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Timber trees: Lesser-known timbers

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(Editors)

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Foreword

Efforts to protect, conserve and sustainably use tropical forests are gaining support worldwide. They include improved management of natural forests, the establishment of timber plantations, the planting of trees in agroforestry systems, and the promotion of the use of non-timber forest products (e.g. rattans, medicines, edible fruits and nuts, essential oils), to serve environmental, socio-economic and commercial interests. Increasing the use of lesser-known timbers is part of this trend. It augments the forests' value and economic importance, which in turn enhances rural development within the region and at the same time encourages the sustainable management of the forest resources.

In a parallel development, new technologies have extended the uses of a large variety of timbers, including lesser-known species, and have opened up new markets. The promotion, planning and scientific monitoring and evaluation of this increased use of lesser-known timbers must, however, be based on up-to-date information. It is in this respect that this Prosea volume on lesser-known timbers is so useful, summarizing as it does the existing information on about 1550 species in 309 genera. It completes the Prosea trilogy on timber trees: the previous volumes, published in 1993 and 1995 respectively, being on major and minor commercial timbers. Like its predecessors, 'Lesser-known timbers' contains detailed information on wood anatomy, on which computer-assisted identification keys could be based in the near future.

This publication is the result of the exemplary collective effort of over a hundred scientists from all over the world, involved in a multitude of forestry-related disciplines, effectively guided by Prosea personnel. The realization of this last volume on timber trees would have been impossible without the financial support of many donor agencies to the Prosea programme in general, and the grants of the International Tropical Timber Organization (ITTO) and the European Union (EU) to this particular project.

It is my hope that the Prosea trilogy on timbers will be extensively used as a reference work by workers in education, research, extension, and industry, and by policy-makers for the benefit of the people of South-East Asia and for the maintenance of the evergreen treasury of South-East Asia and the world.

Soedjarwo
Chairman
'Yayasan Sarana Wanajaya'

In retrospect

The rich and diverse plant resources of South-East Asia provide manifold goods and services vital for our welfare and well-being, particularly to the inhabitants of this dynamic region. Better understanding of such resources is therefore urgently needed to ensure their conservation, management and sustainable utilization. The trilogy on timber trees within the Prosea programme, on 'Major commercial timbers' (1993), 'Minor commercial timbers' (1995) and 'Lesser-known timbers' (1998), has been successfully completed. Together they present an invaluable and unprecedented overview of about 2900 South-East Asian timber species belonging to 420 different genera. The enormous task of bringing together up-to-date information on such a large number of timber-producing species, presented in a comprehensive way in the three volumes, has been achieved thanks to the dedication and meticulous work of an international team of specialists, ably coordinated by the Prosea Foundation. The International Tropical Timber Organization (ITTO) is proud to be associated with this important initiative.

The thrust of ITTO's work and activities is to strike a balance between conservation and utilization of tropical forest resources through their sustainable management. ITTO's successor agreement, the International Tropical Timber Agreement 1994 (ITTA, 1994), which came into force as from 1 January 1997, provides a stronger basis and foundation for international cooperation to achieve the well-known ITTO Year 2000 Objective. To this end a new funding mechanism, The 'Bali Partnership Fund', has been established to provide assistance to ITTO's producer member countries.

From the wealth of information on various timber species, contained in the three books, relevant data may be extracted for purposes of marketing and sustainable management including reforestation. These are issues of crucial importance in view of the depletion of the major commercial timbers, environmental and conservation concerns and the occurrence of large areas of degraded forest lands. For example, a deeper understanding of the ecological requirements of individual species is important for designing silviculturally sound harvesting practices. Equally, data on timber properties will enable their optimum utilization, market promotion and product development, which will enhance the value of forests and thereby go a long way to ensure their protection and sustainable management.

The research and publication of the three volumes on major and minor commercial timbers and lesser-known timbers from the rich tropical forests of South-East Asia, have been made possible through grants from the ITTO, the European Union and the Tropenbos Foundation. The generosity of the Governments of Japan, the Netherlands and Indonesia has enabled ITTO to contribute to this important programme.

I hope the tireless efforts of all those involved in the preparation of these three outstanding volumes with their wealth of information, will contribute to the conservation, management and sustainable development of the forests of South-East Asia.
Finally, I wish the Prosea Foundation every success in undertaking similar endeavours on other groups of the immense and valuable plant resources of the region so that their true potential may be sustainably utilized for the benefit of humankind.

Freezailah bin Che Yeom
Executive Director
International Tropical Timber Organization (ITTO)

1 Introduction

This volume dealing with lesser-known timbers is the third and final part of Handbook Volume 5 'Timber trees'. It highlights 309 genera and about 1550 species. They form a valuable component of the dwindling timber resources of South-East Asia and deserve increased attention.

The general aspects of timber trees have already been dealt with extensively in Volume 5(1) 'Timber trees: Major commercial timbers'. The introduction to that volume includes definitions, role of timber trees, timber trade groups, botany, ecology, wood properties, wood processing, forest management, silviculture, harvesting, agroforestry and urban forestry, forest and timber policy, biodiversity, conservation and breeding, forestry research and prospects. The introductory chapter of Volume 5(2) 'Timber trees: Minor commercial timbers', gives information on recent developments in sustainable forest management and ecolabelling, as well as on general aspects of minor commercial timbers. The introduction to the present volume gives more specific information on lesser-known timbers, including palms.

1.1 Definitions

Two alternative appellations are used for the timbers described in this volume, namely 'lesser-known timbers' and 'lesser-used timbers'. Contrary to the opinion of the 12^{th} Meeting of the International Tropical Timber Council (Johnson, 1992), the term 'lesser-known' is considered more appropriate here because it indicates that the public is unfamiliar with these timbers as well as the need for more research. Moreover, the term 'lesser-used' suggests a lack of market acceptance and utilization, but as can be seen in the entries in this volume many of these timbers are used and occasionally even traded commercially. They nevertheless remain 'lesser-known' to most people.

The definition of 'lesser-known timber species' used here is those timber species which are little known or known only locally and are not marketed or are marketed on a small scale only. These timbers meet one or more of the following criteria:

- Their supply is limited because they have a restricted or sparse occurrence, or have an undesirable form, or are difficult to extract due to e.g. irritant wood or sap properties, or occur on poorly accessible terrain.
- Their existence and their wood properties are largely unknown to timber suppliers and consumers.
- Their wood has undesirable properties; for instance it is too dense, warps severely during seasoning, or has a high silica content.
- Their existence is ignored because better known or more commercial timber species predominate in the forest.

1.2 Choice of genera

The list of genera to be treated in this volume has been compiled by a special task force (see also Volume 5(1) paragraph 1.3), and has been subsequently emended by the editorial team.
The genera incorporated in this volume are those whose wood is reportedly used to some extent, not those genera used only incidentally or with only a very limited application. For a genus to be included, at least one of its species should be used primarily for timber. Species with a different primary use (e.g. edible fruit, firewood, tan bark) are dealt with in other volumes of the Handbook.
Some lesser-known timbers are traded and/or exported commercially as elements of mixed consignments of light, medium or heavy hardwood, and in the case of e.g. 'medang' (comprising the timber of all *Lauraceae*) or 'penarahan' (comprising that of all *Myristicaceae*), the various genera dealt with in this volume constitute only minor proportions of the total amount of timber in such trade groups.
The most important families in number of genera treated in this volume are *Annonaceae* (12), *Euphorbiaceae* (22), *Lauraceae* (10), *Leguminosae* (23), *Meliaceae* (10), *Palmae* (11), *Rubiaceae* (21), *Rutaceae* (10) and *Sapindaceae* (11).

1.3 Coded wood anatomical characters

Proper identification of wood is becoming increasingly important for issues related to sustainable management and eco-labelling, and for the development of end-use classification systems. Both issues contribute to an increased utilization of lesser-known or minor commercial timbers. To aid wood identification, this volume contains a table of generic descriptions of microscopic wood anatomical characters in a coded form. Most of these coded descriptions were prepared during a Prosea Workshop at the Forest Research Institute Malaysia, Kepong, in November 1996, where an international team of wood anatomists studied thousands of samples from the major institutional wood collections of the world. Together with the information from the previous two volumes on major and minor commercial timbers, these coded data form the basis for the development of a computerized identification tool for South-East Asian timbers. Explanatory notes preceding the coded descriptions stress the necessity for a critical appraisal of the potentials and limitations of the data presented.

1.4 Utilization of palm wood

The family of palms comprises about 2500 species, divided into six subfamilies, and is mainly found in the tropics and subtropics. Several species have been domesticated in South-East Asia, such as *Arenga pinnata*, *Borassus flabellifer*, *Cocos nucifera*, *Corypha utan*, *Livistona rotundifolia*, *Metroxylon sagu* and *Oncosperma tigillarium*. Some palms are of major economic importance and are cultivated in small holdings and in plantations, most notably the coconut palm (*Cocos nucifera*) and the introduced African oil palm (*Elaeis guineensis*), both of which are cultivated for their edible oil. At present South-East Asia has more than 7 million ha under coconut and more than 4 million ha under oil palm. Indonesia and the Philippines have the largest areas planted with coconut, Malaysia and Indonesia have the largest area under oil palm.

The stems of nearly all erect palms have been used traditionally to provide timber for tools, fishing and hunting gear, construction material, and even food (e.g. sago from *Metroxylon sagu*). With the advent of palm plantations, the industrial use of palm stems has become of interest. Research on this started in the 1970s when the first coconut plantations were replaced because the yields of these 70-year-old palms were declining. Oil palms have to be replaced after about 30 years. Other reasons for the mass availability of palm stems are the occurrence of diseases ('cadang cadang' and lethal yellowing in the case of coconut), or natural disasters like floods or typhoons. In all cases, it is essential to remove all palm stems to prevent insects like the rhinoceros beetle (*Oryctes rhinoceros*) from breeding in the rotting stems and subsequently attacking young plantations.

Industrially produced palm wood is competitive in areas where other wood is in short supply. In the Philippines coconut timber is sold locally at a lower price than 'white lauan' (*Shorea contorta*) and has gained a significant market share. While denser stems are used for flooring, construction, tool handles and furniture, the lighter material can be used for panelling and packing. Oil palm wood has been tested and found suitable for making particle board, gypsum particle board and medium density fibre (MDF) board. Research in Europe has shown that there is a market for coconut palm wood, especially as the wood originates from plantings and thus would not deplete the tropical forests. Interest in the utilization of palm wood is clearly increasing in South-East Asia, especially in the Philippines and Malaysia. This increasing interest can be inferred from the various recent workshops and seminars dealing with this topic (e.g. de Silva, 1990; Rojo et al., 1988) and the increased output of scientific research (see for example Killmann et al., 1989).

Palm stems differ anatomically and structurally from dicotyledonous wood. Being monocotyledons, palms lack a cambium and thus do not show secondary thickening. Moreover, with the exception of e.g. *Hyphaene* spp., they have no branches. The palm stem is made up of parenchymatic ground tissue in which vascular bundles are scattered. The vascular bundles are smaller in diameter and more densely packed in the periphery of the stem and become larger but fewer towards the centre. They contain xylem and phloem embedded in parenchymatic cells which are surrounded by sclerenchymatic cells with silica bodies (stegmata) on the outside.

The physical and mechanical properties of the palm stem are closely related to its morphology and anatomical structure. Generally speaking, density and related mechanical properties decrease from the periphery towards the centre of the stem and with increasing height. There is no difference in physical and mechanical properties in the radial and tangential directions as the stems have no rays. Furthermore, since cell walls gradually thicken in time, the timber quality of palm stems increases with age. However, in some species (e.g. *Borassus flabellifer* and *Elaeis guineensis*) air-filled spaces (lacunae) develop or increase in between the ground tissue of parenchymatic cells.

Unless grown in plantations the age of palms is difficult to establish and can only be estimated from stem height. When felled as scheduled, coconut palms are usually at least 70 years old, oil palms only 25–30 years. The hapaxanthic

sago palms (*Metroxylon sagu*) can be used after they have flowered, which they do at the age of (8–)15–20 years. Palm stems becoming available through diseases or natural disasters may be of any age.
Sex may also have an impact on stem anatomy and related properties, for instance in *Borassus*. Stems of male palms have a wider high-density peripheral zone and thus yield more timber then female ones.
The moisture content is lowest in the lower outer portion of the stem and highest in the core just below the crown, where it can attain 400%. The high moisture content and low density in the upper portion of the stem also influence the shrinkage and seasoning behaviour. Low strength, high shrinkage values and often severe degrade upon seasoning make the entire upper section as well as the core of the middle section unsuitable for most commercial timber uses.
Dense cell walls, silica content and the alternation of dense and light material result in rapid dulling of tools. Therefore, palm stems can best be worked with tungsten carbide-tipped tools.
In general, palm stems are not resistant to insects or fungi, and when fresh, they are very prone to blue stain due to their high moisture content and their high content of sugars and starch. The stems, however, can be treated with preservatives.

1.5 Research and development

The present debate on the increased use of lesser-known timbers focuses on the effects on the forest ecosystem and the productivity of the forest. It is almost impossible to assess these effects because of a lack of relevant data on lesser-known timbers. In particular, there is a lack of data on the proportion of these lesser-known timbers in various forest types, and on the volume extracted per botanical species and per unit area. Data on natural regeneration and changes in forest composition are virtually non-existent. The increased use of lesser-known timbers may have positive or negative effects for the following, largely unrelated reasons (Rietbergen & Poore, 1995):
- The increased utilization of lesser-known timbers may induce smaller changes in the species composition of the forest because of the tendency to harvest more species, or may lead to greater changes due to heavier logging.
- The effects on financial and economic profitability are unpredictable. Although the utilization of more species increases the economic value per unit area, the cost of extraction may be disproportionally higher.
- As more forest becomes economically profitable, the areas harvested annually may either decrease when log production quotas are enforced, or increase when there are no restrictions.

At least the following issues should be taken into account when increasing the use of lesser-known timbers: sustainable forest management, market acceptance, efficient use, local knowledge, and botanical research.

Sustainable forest management

The objective of sustainable forest management implies extracting a larger array of species. In selective harvesting systems there is a risk of a negative selection pressure on a few timber species. When more species are harvested this risk is reduced and, in addition, silvicultural management becomes more flexible. Minimum diameter limits should be set for all species, depending on aspects such as their ecological niche (small trees only occurring in the undergrowth may for example be harvested when only 20–30 cm in diameter), the width of unusable sapwood, or whether they are needed to provide shade, seed or food for wildlife and/or man (Smith et al., 1994). Some of the lesser-known species, however, may have regeneration requirements which are incompatible with the silvicultural system and need special attention. Proper planning, execution and monitoring of the management are prerequisites to limit the risk of over-exploitation.

Market acceptance

In the last twenty years there has been much debate about promoting lesser-known timbers in the international market. An important conclusion is that lesser-known timbers are often comparable in quality to commercial ones, when properly handled. Furthermore, the consumers appear to be primarily interested in colour and density. This probably explains the emergence of trade in mixed consignments in South-East Asia based on these two characteristics. Finally, an important criterion for end-users' acceptance of a certain timber is the likelihood of sufficient and regular supply. Only if this is guaranteed will the buyer look more closely at the possible end-uses, price and finally physical properties of a timber (Gresham, 1995). As end-uses are not the primary concern of the trader, end-use classification systems have gained little general acceptance.

The drawback of sufficient supply could be overcome by establishing forest plantations and/or by enrichment plantings. This requires silvicultural information on potential species through trials. In this respect the acquisition of seed may be a limiting factor that should be anticipated.

'Sungkai' (*Peronema canescens* Jack) is a good example of a formerly insignificant lesser-known timber that has rapidly become commercial. As it can be raised and planted easily and can grow on poor soils, supplies are rapidly increasing; moreover, its wood is nicely figured and it has good working properties. Other examples of promising lesser-known timbers are 'white magnolia' (*Galbulimima belgraveana*), 'euodia' (*Melicope* spp.), 'memina' (*Pimelodendron* spp.), 'binung' (*Tetrameles nudiflora*) and *Xylia xylocarpa*.

Efficient use

Technology is advancing at a rapid pace, making it possible to utilize an ever-increasing amount of generally lesser-known timber species, including those with smaller diameters. Production methods are becoming more efficient yielding higher conversion rates. The smaller-sized trees are increasingly being used for the production of chips and pulp for wood-based panels such as particle board and fibreboard. The rapid expansion of the market for medium density fibreboard (MDF) and pulp and paper, particularly in Indonesia, Malaysia and Vietnam is most notably in this respect (FAO, 1997). This transformation permits lesser-known timbers to be used more efficiently than when they are used as solid timber.

Local knowledge

It is important to tap local knowledge about lesser-known timbers. It might indicate their prospective commercial value as some may fulfil an essential role in the local need for timber. Surveys of local knowledge therefore seem opportune. The species of interest may grow in natural forest or in village gardens and may be planted or occur as remnants of the forest. Those showing good potential must be investigated further by experimental assessment of their wood properties and growth characteristics.

Botanical research

Botanical collecting and explorations have to be continued in order to establish the correct identity of the species involved and to trace new and valuable timbers. In many South-East Asian countries, however, little emphasis is put on the botanical research so urgently needed for many of the lesser-known timber species.

1.6 Prospects

The vast number of lesser-known timbers presented in this volume are an indication of the ample scope for their increased utilization. Promoting the exploitation of these species without jeopardizing the forest ecosystem remains a challenge to foresters and conservationists and calls for integrated research (Ahluwalia & Karnasudirdja, 1995). Assessing the value of lesser-known timbers needs further attention as well, because some species may have a higher value in the forest (e.g. as fruit trees, medicinal trees, or as an indispensable component of the ecosystem) than when converted into timber.

The demand for timber is still growing in tandem with the increase in world population. World production of roundwood, by far the largest timber class in trade, has risen steadily over the last decade. Annual production from South-East Asian countries rose from 322.5 million m^3 in 1984 to 380 million m^3 in 1994 (FAO, 1996). Some of these countries, e.g. the Philippines and Thailand, have changed from being major exporters to net importers of wood. Reduced availability of timber in many of the major producing countries in the region has also focused attention on harvesting in countries where forest exploitation has, until recently, been comparatively light (e.g. Burma (Myanmar), Cambodia and Papua New Guinea).

Since the 1980s major producing countries in the South-East Asian region have banned or are phasing out the export of unprocessed logs, while encouraging the development of domestic processing into higher value products. The production and trade of processed timber products also continue to increase. Indonesia leads the world in the production of plywood, with 10 million m^3 in 1994 of which 8 million m^3 was exported. Malaysia is the world's leading exporter of tropical sawnwood, with 4.6 million m^3 in 1994 (FAO, 1996). Thanks to these trends there are good prospects for the utilization of many of the lesser-known timbers, especially for the domestic markets.

Finally, sufficient information, good marketing and promotion are essential to obtain general market acceptance of lesser-known timbers. Incentives for increased use of lesser-known timbers such as more favourable tax differentials may be required in producing countries (Rietbergen & Poore, 1995). Consuming countries may facilitate the introduction of new timbers by modifying their current quality control systems. Economic factors and the trends in the prices of well-known timbers such as teak will certainly influence future utilization of the lesser-knowns.

E. Boer, L.T. Hong, W. Killman (paragraph 1.4), S. Prawirohatmodjo & M.S.M. Sosef

2 Alphabetical treatment of genera

Acer L.

Sp. pl. 2: 1054 (1753); Gen. pl., ed. 5: 474 (1754).
ACERACEAE
$x = 13$; *A. laurinum*: $n = 13$

Vernacular names Maple (En, trade name). Indonesia: huru kapas (Sundanese), madang alu (Minangkabau, Sumatra), walik sana, wuru kembang (Javanese). Malaysia: perdu (Sarawak). Philippines: Philippine maple (En), baliag (Mountain Province), laing (Tagalog). Burma (Myanmar): Himalayan maple (En). Thailand: kuam.

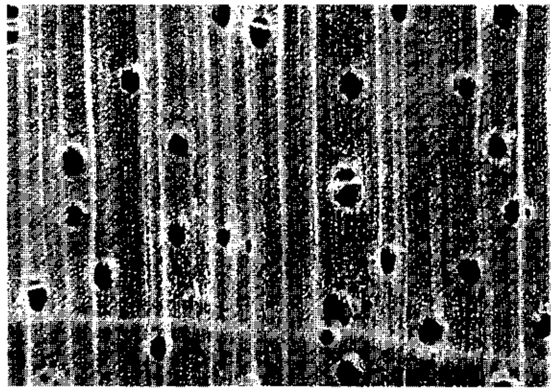
Origin and geographic distribution *Acer* comprises about 200 species occurring mainly in northern hemisphere temperate regions, particularly in North America. The only Malesian species is *A. laurinum* Hassk. (synonyms: *A. caesium* (Reinw. ex Blume) Kosterm., *A. garrettii* Craib, *A. niveum* Blume), which is found in Burma (Myanmar), Thailand, Peninsular Malaysia, Sumatra, Java, Borneo, the Philippines, Sulawesi and the Lesser Sunda Islands (east to Timor).

Uses Utilization of the wood of *A. laurinum* is very limited, due to its scarcity and the absence of heartwood. It has been used for construction, especially in mountainous areas, and is suitable for boxes and crates, and walking sticks. The occasional presence of bird's-eye grain makes it suitable for fine furniture, cabinet work and musical instruments.

Production and international trade Supplies of *A. laurinum* timber are very limited. The wood is used rarely and only on a local scale.

Properties *A. laurinum* yields a lightweight to medium-weight hardwood with a density of 400–720 kg/m^3 at 15% moisture content. Heartwood pale yellow or pale brown with a pink or grey tinge, occasionally almost white, not clearly differentiated from the sapwood; grain straight to slightly interlocked; texture rather fine and even; often with conspicuous figure of coloured bands and flames, occasionally with bird's-eye grain. Growth rings very distinct due to the presence of thicker-walled fibres of a darker colour; vessels small to medium-sized, indistinct to the naked eye, solitary and in radial multiples of 2–3, open; parenchyma apotracheal in marginal or seemingly marginal bands, visible to the naked eye and prominent on longitudinal surfaces; rays visible with a hand lens, narrow and very low with pale deposits giving rise to conspicuous brownish silver grain; ripple marks absent.

The wood is moderately hard and moderately strong. It seasons well, is easy to work and finishes very well. The sapwood is susceptible to blue stain and *Lyctus*. The wood is non-durable when exposed to the weather or in contact with the ground.



Acer laurinum
transverse surface (×20)

See also the table on microscopic wood anatomy.

Botany A deciduous to semi-evergreen, monoecious or dioecious, medium-sized to large tree up to 40(–48) m tall; bole cylindrical, branchless for up to 28 m, up to 110(–150) cm in diameter, with buttresses up to 2 m high; bark surface becoming longitudinally shallowly fissured or scaly with age, red-brown or brown to greyish-brown, middle bark brightly coloured, inner bark fibrous, mottled yellow-brown to red-brown; crown dense. Leaves decussate, simple, entire, whitish or pale blue-grey and with prominent reticulation below, exstipulate. Flowers in a unisexual, axillary, corymbose panicle, small, regular, pale yellowish; sepals and petals 4–5; stamens (4–)6(–8); disk present; ovary superior, 2-locular, woolly, with 2 ovules in each cell, styles 2. Fruit a red or purplish samara which splits into 2(–3), winged, 1-seeded parts. Seedling with either epigeal or hypogeal germination; leaves coarsely, distantly toothed.

Trees have been observed flowering in April to August and are generally leafless when in flower. Pollination is by bees which collect the honey. Ripe fruits are present from July to November, but in Sabah trees are reported to set fruit rarely. The winged fruits are dispersed by wind.

Acer is the only genus of the family *Aceraceae* found in the Malesian area. *A. laurinum* belongs to the monotypic section *Hyptiocarpa* Fang. *A. garrettii* Craib has long been considered to comprise a distinct species but fairly recently it proved to be identical with *A. laurinum*.

Ecology *A. laurinum* occurs scattered in primary, or occasionally secondary, hill or montane forest, at (150–)800–2550 m altitude. It grows in seasonal to non-seasonal climates.

Silviculture *A. laurinum* can be propagated by seed: per kg there are about 4900 dry, winged fruits. It may be planted at 1000–1500 m altitude, but planting on open sites is not recommended. Conversion of the wood should be done rapidly after harvest to avoid serious discolouration from moulds and sap-stain fungi.

Genetic resources and breeding *A. laurinum* is uncommon but fairly widespread and seldom harvested and does not seem to be threatened. There are no records of ex situ conservation.

Prospects As the quality of the wood is not very high, the utilization of *A. laurinum* will probably not increase in the near future. It may prove useful for small objects like household utensils and picture frames. *A. laurinum* has some ornamental value because of its conspicuous glaucous lower leaf surfaces.

Literature 61, 70, 101, 198, 232, 238, 257, 260, 267, 341, 436, 595, 617, 772, 780, 861, 934, 974, 976, 1048, 1125, 1137, 1221.

R.E. Nasution

Acmena DC.

Prodr. 3: 262 (1828).

MYRTACEAE

x = unknown; $2n$ = unknown

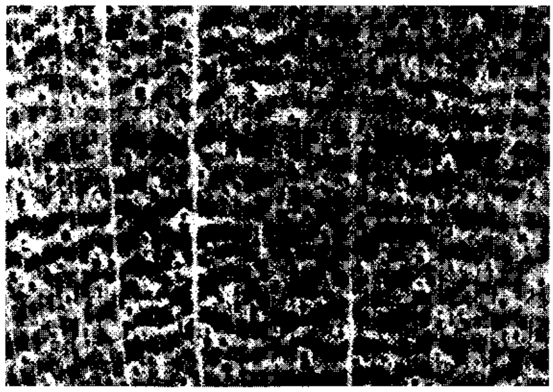
Vernacular names Kelat (trade name, generally used for *Syzygium* species).

Origin and geographic distribution *Acmena* comprises about 15 species which occur from southern Burma (Myanmar), southern China and Thailand, throughout Malesia to the Solomon Islands and Australia. *A. acuminatissima* is the most widespread species.

Uses The wood of *Acmena* is used for construction (ships, bridges and wharfs), building framework, flooring, window-sills and sidings, furniture, joinery, panelling, agricultural and household implements, turnery, plywood and musical instruments.

The bark of *A. acuminatissima* has been used in Indonesia to dye cotton black; its fruits are edible but sour and slightly bitter. *A. hemilampra* is used in Australia as an ornamental.

In Australia several *Acmena* species produce useful structural and joinery timbers traded as 'satin ash' under various descriptive epithets, e.g. blush, cassowary, red eungella, lillipilli, and southern.



Acmena acuminatissima
transverse surface (×18)

Production and international trade On the rare occasions that *Acmena* timber is traded in Malesia it is sold as 'kelat' together with *Syzygium* timber, or as 'mixed medium hardwood'.

Properties *Acmena* yields a medium-weight to heavy hardwood with a density of 720–940 kg/m^3 at 15% moisture content. Heartwood pale brown to dark brown or pink to red-brown, not sharply demarcated from the pale brown or greyish-yellow sapwood; grain straight or interlocked, sometimes slightly wavy; texture fine to medium and even. Growth rings indistinct, boundaries marked by fewer or no vessels; vessels moderately small to medium-sized, solitary and in radial multiples of 2–4, tyloses and white deposits present; parenchyma narrow aliform or confluent to banded, not visible to the naked eye; rays fine, not visible to the naked eye, tending to 2 distinct widths; ripple marks absent.

The wood seasons well but slowly and needs careful seasoning to avoid checking and warping. It is hard, fairly strong and rather difficult to work, but finishes fairly well. The wood is very durable under cover and moderately resistant to decay when exposed to the weather, clear of the ground and well drained with free air circulation; it is not recommended in contact with the ground. The wood is resistant to dry-wood termites, the sapwood is susceptible to *Lyctus*.

See also the table on microscopic wood anatomy.

Botany Shrubs or small to fairly large trees up to 35(–40) m tall; bole up to 150(–200) cm in diameter, often buttressed in older trees, sometimes with stilt roots; bark surface cracking to scaly or flaky, pinkish-brown to reddish-brown, inner bark pinkish-brown. Leaves opposite or subopposite, simple, entire, dotted with oil glands, secondary veins confluent near the leaf margin to form an intramarginal vein; stipules absent. Flowers in a terminal or axillary panicle, bisexual, 4–5-merous; calyx lobes minute or obsolete; petals free, distinct but caducous; stamens numerous; ovary inferior, 2-locular, with 1 long style. Fruit drupaceous, 1-seeded, globose or depressed globose, with subwoody endocarp. Seed lacking a testa, with ruminate cotyledons enclosing an intrusive ramifying mass of tissue. Seedling with hypogeal or semi-hypogeal germination; cotyledons remaining together; first 2–3(–4) pairs of leaves scale-like.

The fruits are eaten by birds, including cassowaries and pigeons which thus disperse the seeds; the thickened endocarp probably prevents digestion of the seed.

Acmena differs from the very large genus *Syzygium* in the globose or subglobose, divaricate anther sacs (more elongate and parallel in *Syzygium*), and particularly in its peculiar seed structure with ruminate cotyledons enclosing a branching mass of tissue which is probably of placental origin. However, one species of *Syzygium* (*S. claviflorum* (Roxb.) A.M. Cowan & J.M. Cowan) shows the same seed structure as *Acmena*. As the anther sacs of this species are similar to those of *Syzygium* it is intermediate between *Acmena* and *Syzygium*. It is sometimes placed in a separate genus *Acmenosperma*.

A. triphlebia has also been treated under *Syzygium* (as *S. triphlebium* Diels) in Prosea Vol. 5(2).

Ecology *Acmena* usually occurs in primary and secondary lowland rain forest. *A. acuminatissima* is occasionally found up to 2600 m altitude in New Guinea, *A. triphlebia* up to 2000 m.

Genetic resources and breeding Although *A. acuminatissima* is widespread and common, several *Acmena* species are known from only a few collections and might be vulnerable. On the other hand, *Acmena* trees are not sought after for their timber or other products.

Prospects Very little is known about the wood and silvicultural aspects of *Acmena* in South-East Asia. More research is desirable, as the timber is considered a useful structural timber in Australia.

Literature 163, 235, 416, 436, 461, 464, 780, 787, 861, 934, 1221.

Selection of species

Acmena acuminatissima (Blume) Merr. & L.M. Perry

Synonyms *Acmena polyantha* (Lauterb. & K. Schumann) Merr. & L.M. Perry, *Eugenia acuminatissima* (Blume) Kurz, *Eugenia saligna* (Miq.) C.B. Rob., *Syzygium cumingianum* (S. Vidal) L.S. Gibbs.

Vernacular names Malaysia: kelat asam (Peninsular). Philippines: binoloan (Samar-Leyte Bisaya). Thailand: daeng kluai (central), wa thung, dok maeo (peninsular).

Distribution From southern Burma (Myanmar), Thailand and southern China, to the entire Malesian region and the Solomon Islands.

Acmena hemilampra (F. v. Mueller ex F.M. Bailey) Merr. & L.M. Perry

Synonyms *Eugenia hemilampra* F. v. Mueller ex F.M. Bailey.

Vernacular names Papua New Guinea: blush satinash (trade name).

Distribution Papua New Guinea (Western District) and eastern Australia.

Acmena triphlebia (Diels) Hartley & Craven

Synonyms *Syzygium triphlebium* Diels.

Distribution New Guinea.

E. Boer (general part),
R.H.M.J. Lemmens (general part, selection of species)

Acrocarpus Wight ex Arn.

Mag. Zool. Bot. 2: 547 (1838).

LEGUMINOSAE

x = unknown; *A. fraxinifolius*: $2n = 24$

Vernacular names Pink cedar, shingle tree (En). Indonesia: delimas (Javanese), madang pariek (Minangkabau, Sumatra). Burma (Myanmar): yetama. Laos: ket 'hoy (Sayaboury), khan khak (Luang Prabang). Thailand: kang khimot, khang chang (northern), sadao chang (eastern).

Origin and geographic distribution *Acrocarpus* is a monotypic genus distributed in eastern India, Burma (Myanmar), Laos, southern China, Thailand, Sumatra and central Java. Its only species is *A. fraxinifolius* Arn., which is planted in many areas within and outside its natural area of distribution (e.g. in India, Africa and Central America).

Uses The wood of *A. fraxinifolius* is suitable for indoor construction, furniture, plywood, packing cases, beehives and fence posts; it is also used as fuelwood and to produce charcoal.

The tree has been recommended for reinforcing river banks and to stabilize terraces, and for use in agroforestry. It is grown for shade in coffee and tea plantations, and is a good source of nectar. The foliage can be used as forage.

Production and international trade *Acrocarpus* timber is probably used on a local scale only.

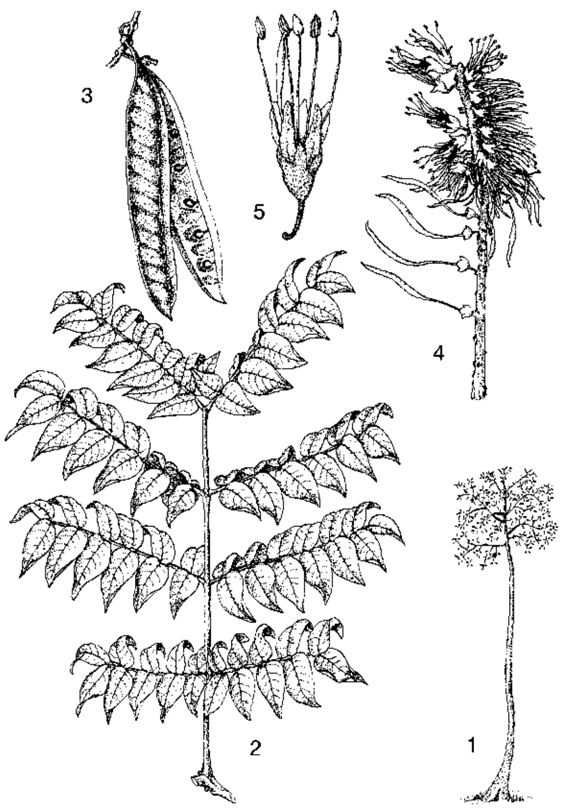
Properties *A. fraxinifolius* yields a medium-weight hardwood with a density of 520–700 kg/m^3 at 12% moisture content. Heartwood pale pinkish, bright red to reddish-brown with darker streaks, sharply differentiated from the pale yellowish sapwood; grain straight to slightly interlocked, sometimes wavy; texture coarse and even; wood lustrous. Growth rings indistinct, delimited by a fine, interrupted line of parenchyma; vessels medium-sized to very large, solitary and in radial multiples of 2–3(–more), occasionally with white deposits; parenchyma paratracheal vasicentric and aliform, visible to the naked eye; rays very fine to moderately fine and moderately broad, forming conspicuous flecks on radial surfaces.

Shrinkage upon seasoning is moderate. The wood seasons well when not too rapidly dried. In India boards 2.5 cm thick took 9 months to air dry. The wood is soft to moderately hard and strong. It is easy to work, saw and peel, especially when green. It finishes fairly well and takes a high polish. The wood is generally rated as non-durable, but Indonesian samples have been rated moderately durable. Graveyard tests in India showed an average service life of 41 months. Impregnation of the sapwood is easy, but that of the heartwood is erratic. The sapwood is highly susceptible to fungal and insect attacks.

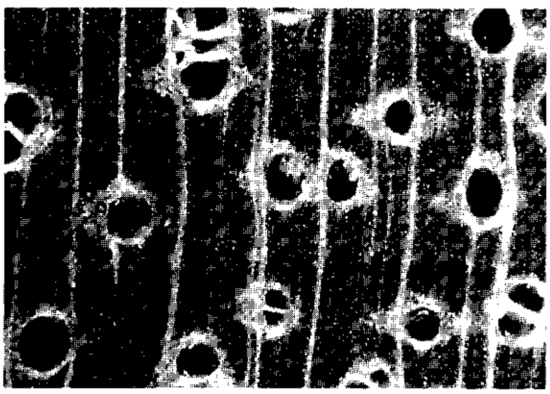
The seed oil was found to contain 84% of lupeol.

See also the tables on microscopic wood anatomy and wood properties.

Botany A deciduous, medium-sized or sometimes large tree up to 30(–50) m tall; bole columnar, branchless for up to 10(–30) m, up to 100 (–400) cm in diameter, often with small buttresses; bark surface smooth or slightly rough, pale grey or pale brown. Twigs often prominently lenticellate. Leaves bipinnate with (2–)3–5 pairs of pinnae and 4–7(–9) pairs of leaflets per pinna, with or without a terminal leaflet; petiole and main rachis up to 80 cm long; stipules small, caducous. Flowers in paniculate inflorescence in the axil of fallen leaves, bisexual, 5-merous; calyx lobes and petals imbricate; petals dark red; stamens exserted; ovary stiped. Fruit an elongated



Acrocarpus fraxinifolius Arn. – 1, tree habit; 2, leaf; 3, dehisced pod; 4, inflorescence; 5, flower.


Acrocarpus fraxinifolius
transverse surface (×20)

and flattened pod, long-stipitate, narrowly winged, (3–)10–18-seeded. Seed slightly lens-shaped, brown. Seedling with epigeal germination; cotyledons free, foliaceous, slightly fleshy; hypocotyl elongated; first leaves paripinnate.
Early growth is very rapid. In India seedlings were 1 m tall after 5.5 months whereas in Malawi a mean annual increment of 2-year-old plants of 2.7–3.3 m in height and 6.1–7.1 cm in diameter was reported. Growth of older trees is still rapid, as observed in India where the mean annual increment of 13-year-old trees was 1.1 m in height and 2.9 cm in diameter and that of 23-year-old trees 0.8 m and 2.2 cm, respectively. Young leaves are characteristically bright red. The trees flower after shedding their leaves. In India flowering and fruiting occur almost every year. Apparently, *A. fraxinifolius* does not have nitrogen-fixing nodules.

Ecology *A. fraxinifolius* grows best in submontane areas in the humid and subhumid tropics with a short dry spell, but is very sensitive to frost. It is rare in Sumatra and Java where it occurs on fertile and constantly wet soils in the forest, sometimes on abandoned agricultural land, at 600–1200 m altitude. In Thailand it occurs in evergreen gallery forest. In India and Burma (Myanmar) it is more frequent and occurs in regions with an annual precipitation of over 2000 mm, growing best in deep, well-drained, clay-loam soils with a pH of 4–7. It regenerates primarily in small, burnt areas, on open patches where fresh soil has been exposed and along newly constructed roads. *A. fraxinifolius* is a light demander and a pioneer, but can tolerate slight shade when young.

Silviculture *A. fraxinifolius* can be propagated by seed; the use of wildlings is reported for India. Patch budding gave 80% success when establishing seed orchards. Collected seed should be left to air dry for about 10 days and can then be stored for many years in airtight containers when kept cool. There are 13 000–47 000 dry seeds/kg. Seed should be pretreated with sulphuric acid for 10 minutes or by hot water and left to imbibe in water for 24 hours before it is sown in the shade. A germination of 80–95% within only 2–7 days is achieved after this pretreatment. Under natural conditions some seeds may germinate within a week, while others may lie dormant for one year before germinating. The seedlings are pricked out into beds or containers and placed in full sunlight. Seedlings are ready for planting when 3 months old and 30–45 cm tall. Seedlings from the nursery beds can be planted bare-rooted or as stumps or striplings. Periodic weeding is required and the first thinning must be performed 3–4 years after planting. As the trees require a large crown for optimal growth, regular thinnings are necessary until the stand is fully developed. On favourable sites a mean annual increment of 10 m^3/ha may be expected. In Malawi 2-year-old trees yielded 33 t/ha of total above-ground biomass. Young trees are susceptible to termite attack, and in India *Atractomorpha crenulata*, a grasshopper, and the caterpillar of *Eurema blanda* defoliated seedlings in nurseries and young plantations. *A. fraxinifolius* is also a host for the wood borer *Xylosandrus compactus*, a small ambrosia beetle. When rainfall is insufficient (less than 1500 mm/year) and a pronounced dry season occurs, the fast early growth may be followed by stagnation and high mortality. The tree coppices vigorously. In India natural regeneration is favoured by clearing the forest floor of weeds and by raking the soil, after which the canopy is gradually removed as young trees become established.

Genetic resources and breeding *A. fraxinifolius* is rare in Malesia where it occurs only very locally. It would be worthwhile establishing germplasm collections from the Malesian populations to obtain planting material adapted to the ecological conditions in this region. This material could be used to establish timber plantations. A germplasm bank of 17 clones and a seed orchard of 16 clones have been established in Arunachal Pradesh in India. India and Kenya are the major seed-exporting countries.

Prospects *A. fraxinifolius* is promising for timber plantations. It is easy to raise in the nursery, its survival after planting is generally very high and it grows fast. No trial plantations have been established in the Malesian area, however.

Literature 70, 104, 130, 152, 163, 276, 343, 364, 370, 405, 436, 465, 658, 735, 861, 919, 920, 924, 928, 1039, 1064, 1104, 1177, 1190.

E. Boer & R.H.M.J. Lemmens

Acronychia J.R. Forster & J.G. Forster

Charact. gen. pl.: 27 (1775).
RUTACEAE
$x = 18$; *A. pedunculata*: $2n = 36$

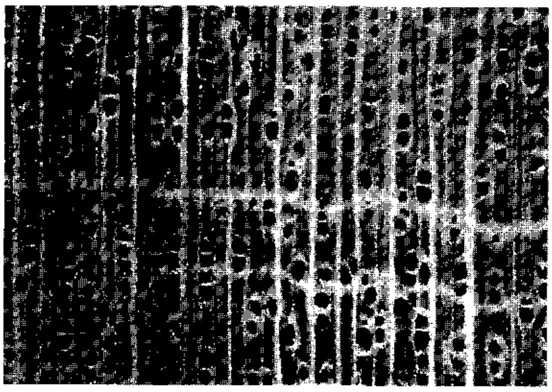
Origin and geographic distribution *Acronychia* comprises 47 species occurring from Sri Lanka and India to Indo-China, south-western China, Taiwan, Thailand, the whole of the Malesian archipelago, east to the Solomon Islands, New Caledonia and Lord Howe Island, and south to eastern and southern Australia. The majority of the species are endemic to New Guinea and Australia.

Uses The wood of *Acronychia* is used for house building, utility furniture, flooring, lining, panelling, mouldings, turnery, carving and tool handles. It also produces a good quality charcoal and has been used as firewood.

In Indo-China an extract from the roots of *A. pedunculata* has been applied to the skin against rheumatism, and an extract from the bark against itch. Roots have also been used as a fish poison; the bark for caulking boats and toughening fishing nets. The leaves contain a volatile, aromatic oil used in stimulating baths. Young leaves are sometimes eaten as a condiment and applied to promote digestion.

Production and international trade As supplies and the size of the timber of *Acronychia* are generally small, utilization is on a local scale only.

Properties *Acronychia* yields a medium-weight hardwood with a density of 490–830 kg/m^3 at 15% moisture content. The following description is based on the Australian species *A. laevis* J.R. Forster & J.G. Forster. Wood whitish, darkening to pale brown or pale yellow on exposure; grain interlocked; texture fine and even. Growth rings indistinct; vessels very small to small, just visible with a hand lens, some solitary but mostly in radial multiples of up to 4, with yellowish deposits; parenchyma paratracheal vasicentric and apotracheal in irregularly spaced bands; rays very fine, only visible with a hand lens; ripple marks absent. Shrinkage of the wood upon air drying is moderate. The wood of South-East Asian species is not very strong and is not durable. The sapwood is susceptible to *Lyctus*.



Acronychia laevis J.R. Forster & J.G. Forster transverse surface (×20)

Leaves contain 0.06% of an aromatic oil. Several species contain alkaloids.

See also the table on microscopic wood anatomy.

Botany Aromatic shrubs or small to medium-sized trees up to 27(–35) m tall, rarely climbers; bole sometimes straight but more often crooked, branchless for up to 23 m, up to 60 cm in diameter, without buttresses; bark surface smooth to finely cracked, greyish, inner bark pale brown to cream-coloured. Leaves opposite, 1-foliolate or 3-foliolate, leaflets entire, with pellucid dots; stipules absent. Inflorescence axillary, paniculate, subcorymbose or reduced to 1 or a few flowers. Flowers bisexual, 4-merous; sepals free or connate at base; petals valvate, deciduous or rarely persistent, white; stamens 8, filaments usually densely ciliate at base; disk intrastaminal; ovary superior, 4(–8)-carpellate, with or without septicidal fissures, with 2 axillary ovules in each cell, style twisted. Fruit a 4(–8)-locular drupe with (1–)2 seeds per cell.

Annual height increment can be 0.5–0.6 m. In Java *A. pedunculata* flowers and fruits throughout the year whereas *A. trifoliolata* has been observed flowering in September to November.

A. trifoliolata is very variable and has been subdivided into 3 varieties. Two of these, var. *ampla* T.G. Hartley and var. *microcarpa* T.G. Hartley, are confined to New Guinea. *A. pedunculata* is also highly variable, especially in the size of the fruit and the pubescence of the disk.

Ecology Within Malesia *Acronychia* species are often found scattered in evergreen, primary or sometimes secondary, upper or lower montane forest. Sometimes they are even present in alpine habitats (e.g. *A. murina* and *A. pullei*), although some are fairly common in lowland forest as well. *A. pedunculata* is found in primary and secondary rain forest and in coastal scrub, up to 2200 m altitude. *A. trifoliolata* is also found in monsoon forest and along the margins of *Casuarina* forest, up to 2400 m altitude.

Silviculture *Acronychia* can be propagated by seed, which germinates easily.

Genetic resources and breeding There are no records of in situ conservation of *Acronychia*. Many narrow-endemic species from New Guinea and Australia may easily become endangered by destruction of their habitat.

Prospects The timber of *Acronychia* appears to be hardly used in South-East Asia. This situation is unlikely to change in the near future.

Literature 70, 163, 221, 413, 436, 464, 497, 568, 595, 672, 861, 883, 974, 1038, 1048, 1170, 1221.

Selection of species

Acronychia carrii T.G. Hartley
Distribution Papua New Guinea.

Acronychia ledermannii Lauterb.
Distribution New Guinea.

Acronychia murina Ridley
Synonyms *Acronychia wichmannii* Lauterb.
Distribution New Guinea.

Acronychia pedunculata (L.) Miq.
Synonyms *Acronychia arborea* Blume, *Acronychia laurifolia* Blume, *Acronychia resinosa* J.R. Forster ex Crevost & Lemarié.
Vernacular names Indonesia: jejerukan (Sundanese), kayu semidra, sarirah (Javanese). Malaysia: ketiak, memali, tengkorak biawak (Peninsular). Philippines: uto (Filipino). Cambodia: kramol, panol. Laos: cavi, mak thao sang. Thailand: ka uam (northern, south-western), kra bueang thuai (central), yaa krong (peninsular). Vietnam: b[is] b[as]i, b[uw][owr]i bung, ch[af]i dai.
Distribution From Sri Lanka and India to Nepal, Burma (Myanmar), Indo-China, southern China, Taiwan and Thailand towards Peninsular Malaysia, Sumatra, Java, Borneo, the Philippines, Sulawesi (Kabaena Island) and Papua New Guinea (Western District).

Acronychia pullei Lauterb.
Distribution New Guinea.

Acronychia rugosa T.G. Hartley
Distribution New Guinea.

Acronychia trifoliolata Zoll. & Moritzi
Synonyms *Acronychia andrewsii* Baker f., *Acronychia halmaheirae* Miq.
Vernacular names Indonesia: cermean (Javanese), cerme-alas (Madura).
Distribution Christmas Island, Java, Sulawesi, the Lesser Sunda Islands, the Moluccas, New Guinea and the Solomon Islands.

Ha Van Tue (general part),
M.S.M. Sosef (selection of species)

Actinodaphne Nees

Wallich, Pl. asiat. rar. 2: 61, 68 (1831).
LAURACEAE
$x = 12$; *A. reticulata* Meissner: $n = 12$

Vernacular names Medang (trade name). Indonesia: huru (Sundanese), wuru (Javanese). Malaysia: medang kuning, medang kunyit (Peninsular). Burma (Myanmar): kyese.

Origin and geographic distribution *Actinodaphne* comprises some 60 or 70 species and is restricted to the Asian tropics and subtropics, from Sri Lanka and India towards Indo-China, China, and Japan to Thailand, the entire Malesian region and east towards the Solomon Islands.

Uses Timber of *Actinodaphne* has been used for light construction, interior finish, furniture, beams and boat building. In general, 'medang' timber is suitable for veneer and plywood production.
Bruised leaves of *A. moluccana* have been applied externally against sores and splinters. Fruits of *A. sesquipedalis* are reported to be poisonous.

Production and international trade The timber of *Actinodaphne* is traded together with that of many other *Lauraceae* genera as 'medang', but probably constitutes only a minor proportion of the total amount traded. In 1984 the total export of medang from Peninsular Malaysia to Singapore was 1500 m^3 with a value of US$ 62 000. In 1992 the export of medang from Sabah amounted to 52 000 m^3 (of which about 10% was sawn timber) with a total value of US$ 4.3 million. In Papua New Guinea the minimum price for medang saw logs was US$ 43/m^3 in 1992. Japan imports medang mainly from Sabah and Sarawak and small amounts only from Papua New Guinea and the Solomon Islands.

Properties *Actinodaphne* yields a medium-weight hardwood with a density of 430–815 kg/m^3 at 15% moisture content. Heartwood pale olive or grey-green to olive-green or brown, sharply differentiated from the paler, up to 5 cm wide sapwood, which occasionally has a yellow tinge; grain straight to moderately interlocked; texture moderately fine and even; wood often with camphor-like smell when freshly cut; planed surface greasy to the touch. Growth rings distinct to occasionally indistinct; vessels moderately small to medium-sized, generally solitary, occasionally in radial multiples of 2–4, visible to the naked eye, tyloses present; parenchyma sparse to moderately abundant, paratracheal vasicentric, in *A. sphaerocarpa* sometimes confluent; rays very fine to moderately

Actinodaphne glomerata
transverse surface (×20)

fine, usually only visible with a hand lens; ripple marks absent.
The wood is of medium strength. The wood of *A. oleifolia* Gamble is siliceous, hence other species may also be siliceous and may present difficulties when sawing. Medang timber is generally easy to slightly difficult to saw, easy to plane. It is durable to slightly durable under cover but non-durable in exposed situations. The sapwood is susceptible to *Lyctus*. The heartwood is resistant to preservative treatment, the sapwood amenable.
Laurotetanine, a poisonous substance, has been traced in *A. procera*.
See also the table on microscopic wood anatomy.

Botany Evergreen, dioecious shrubs or small to medium-sized trees up to 30(–40) m tall; bole straight to moderately straight, fairly cylindrical, usually comparatively short, up to 80 cm in diameter, sometimes fluted at base, sometimes with small steep buttresses up to 1 m high; bark surface smooth to cracking, dark or grey-brown to brown or pinkish-grey, inner bark brown to bright orange-brown. Leaves usually verticillate, occasionally tripliveined, usually aromatic when crushed, exstipulate; bud scales often leafy. Flowers in an axillary, solitary or compound fascicle or umbel, unisexual; tepals 6, with a short tube; fertile stamens usually 9, in 3 whorls, those of the inner whorl with 2 glands each, anthers 4-celled, opening by valves; ovary superior, 1-locular with a single ovule, stigma peltate. Fruit a 1-seeded, black or sometimes red or yellow berry, seated on the persistent enlarged perianth tube. Seedling with hypogeal germination; cotyledons not emergent, peltate; hypocotyl not developed; epicotyl with a few scales, all leaves arranged spirally, eventually verticillate.
Trees of *A. sesquipedalis* are often inhabited by ants. In Java most species flower in the period May–October. The seeds are dispersed by birds.
Like most genera of the *Lauraceae*, *Actinodaphne* is in desperate need of a thorough taxonomic revision. The present state of knowledge results in doubtful identifications and an unstable nomenclature, often rendering the scarce information at the species level unreliable.

Ecology *Actinodaphne* species reaching timber size are generally found in primary, lowland to lower montane rain forest, from sea-level up to 1000(–1400) m altitude. They inhabit a wide variety of habitats including floodplains, peat-swamp forest and kerangas.

Silviculture *Actinodaphne* is propagated by seed.

Genetic resources and breeding As many *Actinodaphne* species have a restricted area of distribution, destruction of their habitat may enhance genetic erosion. Apart from some individual trees in botanic gardens, there are no records of ex situ conservation of *Actinodaphne* species.

Prospects *Actinodaphne* may continue to contribute to the medang timber trade group, but increased use is unlikely.

Literature 41, 70, 162, 163, 209, 218, 267, 304, 402, 436, 464, 543, 595, 605, 614, 829, 861, 1094, 1221, 1242.

Selection of species

Actinodaphne angustifolia (Blume) Nees

Synonyms *Actinodaphne areolata* Blume, *Litsea angustifolia* Blume, *Tetranthera angustifolia* (Blume) Nees.

Vernacular names Indonesia: huru mentek, huru payung (Sundanese).

Distribution West and Central Java.

Actinodaphne glabra Blume

Vernacular names Indonesia: huru payung (Sundanese).

Distribution West Java.

Actinodaphne glomerata (Blume) Nees

Synonyms *Litsea glomerata* (Blume) Blume, *Tetranthera hypoglauca* Miq.

Vernacular names Indonesia: huru dapung, huru meuhmal (Sundanese). Malaysia: medang serai (Peninsular).

Distribution Peninsular Malaysia, Singapore, Sumatra, Borneo and West and Central Java.

Actinodaphne gracilis Miq.

Vernacular names Indonesia: medang junjung, medang pangkat (Indonesian, Sumatra).

Distribution Sumatra.

Actinodaphne latifolia Teschner

Distribution Papua New Guinea.

Actinodaphne macrophylla (Blume) Nees

Synonyms *Actinodaphne maingayi* Hook. f., *Litsea macrophylla* Blume.

Vernacular names Maingay's mountain laurel (En). Indonesia: nyampu payung, wuru kapur, wuru songsong (Javanese). Malaysia: medang tandok (Peninsular).

Distribution Peninsular Malaysia, Singapore and Java.

Actinodaphne malaccensis Hook. f.

Synonyms *Actinodaphne hullettii* Gamble.

Vernacular names Malaysia: medang kechawi (Peninsular).

Distribution Peninsular Malaysia and Singapore.

Actinodaphne moluccana Blume

Vernacular names Indonesia: kayu kalowai (Moluccas).

Distribution The Moluccas.

Actinodaphne obtusa Teschner

Distribution Papua New Guinea.

Actinodaphne procera (Blume) Nees

Synonyms *Litsea procera* Blume.

Vernacular names Indonesia: huru payung (Sundanese), nyampu (Javanese).

Distribution Java.

Actinodaphne pruinosa (Wallich ex Nees) Nees

Synonyms *Laurus pruinosa* Wallich ex Nees.

Distribution Peninsular Malaysia and Singapore.

Actinodaphne rumphii Blume

Distribution The Moluccas.

Actinodaphne sesquipedalis (Wallich ex O. Kuntze) Hook. f. & Thomson ex Meissner

Synonyms *Laurus sesquipedalis* Wallich ex O. Kuntze.

Vernacular names Ant laurel (En). Malaysia: medang payong (Peninsular).

Distribution Southern Burma (Myanmar), Peninsular Malaysia and Borneo.

Actinodaphne sphaerocarpa (Blume) Nees

Synonyms *Litsea sphaerocarpa* Blume.

Vernacular names Indonesia: huru hiris, huru lencir (Sundanese). Malaysia: chempa hutan (Peninsular).

Distribution Peninsular Malaysia and Java.

E.N. Sambas (general part),
M.S.M. Sosef (selection of species)

Adenanthera L.

Sp. pl. 1: 384 (1753); Gen. pl., ed. 5: 181 (1754).

LEGUMINOSAE

$x = 13$; *A. microsperma*: $2n = 24$, *A. pavonina*: $2n = 26, 64$

Vernacular names Coralwood (En, trade name). Coral bean, saga bean (En). Bois de corail (Fr). Indonesia: saga (general). Malaysia: saga (general). Philippines: tanglin (Filipino). Burma (Myanmar): ywe, ywegyi. Thailand: ma klam (general), ma daeng (northern), phai (peninsular). Vietnam: lim v[af]ng, tr[aws] qu[aj]ch.

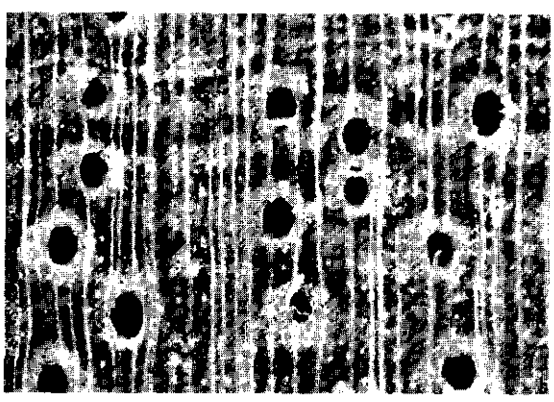
Origin and geographic distribution *Adenanthera* comprises 12 species occurring in Sri Lanka, southern Burma (Myanmar), Indo-China, southern China, Thailand, the entire Malesian region, the Solomon Islands and northern Australia. Within Malesia 9 species are found. Several species, especially *A. pavonina*, are widely cultivated and occasionally naturalized within and outside their natural area of distribution, e.g. in Africa, making it difficult to reconstruct their original distribution.

Uses The wood of *Adenanthera* is used for bridge and house construction (beams, posts, joists, rafters), flooring, paving blocks and vehicle bodies. It may also be suitable for furniture and cabinet work, and turnery, and yields a very good charcoal. In the Philippines it is often used as a substitute for 'ipil' (*Intsia bijuga* (Colebr.) O. Kuntze), and sometimes even sold as such.

Several species are planted as ornamentals, notably *A. pavonina*, because of the glossy red seeds that are used as toys and for necklaces, and in earlier days to weigh gold, silver and diamonds, as the seeds have a narrow range in weight. The seeds can also be eaten when roasted or cooked and contain oil. In Indonesia and Malaysia trees are planted for shade in coffee, clove and rubber plantations. In tropical Africa *A. pavonina* is planted for agroforestry. *A. microsperma* is also mixed in teak (*Tectona grandis* L. f.) plantations. Young leaves of *A. pavonina* are eaten as a vegetable, and in India they have been used in a decoction against rheumatism and gout. The red dye from the wood has been used for dyeing clothes and for the forehead spot of the Brahmins in India. The bark also contains saponin and has been used to wash hair and clothing. The bark and seeds of *A. intermedia* have been used to cure snake bites and in applications for headache and rheumatism. The bark of *A. microsperma* is rich in tannin and has been used to tan leather.

Production and international trade Small amounts of *Adenanthera* timber were exported from India to Europe early in the 20th Century. Nowadays utilization is on a local scale only and supplies are very limited. In Malaysia 'saga' wood also includes that of the genus *Ormosia* (*Leguminosae*).

Properties *Adenanthera* yields a medium-weight to heavy hardwood with a density of 595–1100 kg/m^3 at 15% moisture content. Heartwood bright yellow when fresh, turning to golden-brown or dark brown, rarely coral-red in *A. pavonina*, sharply demarcated from the whitish, yellowish, pinkish or pale brown, up to 5 cm wide sapwood; grain interlocked or wavy; texture moderately fine to slightly coarse and even; wood moderately lustrous. Growth rings indistinct, boundaries tending to distinct, indicated by marginal discontinuous parenchyma; vessels medium-sized to moderately large, solitary and in radial multiples of 2–4, sometimes whitish to yellow deposits or dark-coloured gum-like deposits present; parenchyma moderately abundant to abundant, paratracheal vasicentric, aliform and confluent, the latter two types more towards the end of a growth ring, apotracheal diffuse and in marginal or seemingly marginal bands; rays extremely fine, visible only with a hand lens; ripple marks absent, but observed in *A. forbesii*.



Adenanthera pavonina
transverse surface (×20)

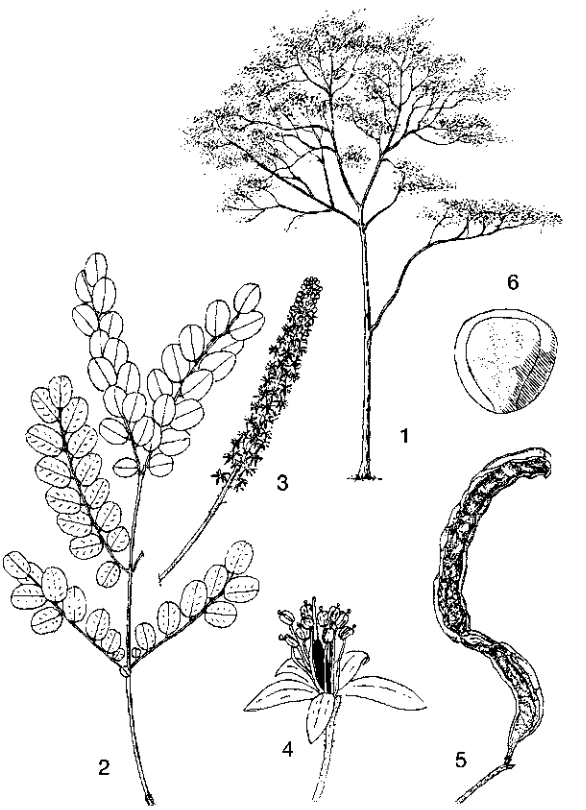
Shrinkage is low to high and the wood seasons very well with only slight warping but it is very susceptible to sap-stain. The wood is very hard and very strong. It is easy to somewhat difficult to work, easy to plane and takes a high finish. The wood is moderately durable to very durable. The heartwood is resistant to dry-wood termites. The sapwood is susceptible to *Lyctus*.

The bark of *A. microsperma* contains 12–26% tannin. Trees should attain at least 25 cm in diameter to have a mean tannin content of 20%.

See also the tables on microscopic wood anatomy and wood properties.

Botany Mostly deciduous, small to medium-sized trees up to 30(–40) m tall, rarely shrubs; bole straight and cylindrical to rather poorly shaped, branchless for up to 16 m, up to 100(–200) cm in diameter, buttresses usually low and small but occasionally up to 4 m high; bark surface smooth to cracked, fissured or flaky, reddish-brown to brown, grey-brown or pale pinkish-grey, inner bark soft, pale brown; crown spreading, diffuse, uneven. Leaves arranged spirally, bipinnate, without glands; leaflets alternate, entire; stipules small, caducous. Inflorescence terminal and axillary, consisting of many-flowered, simple, spike-like racemes, solitary or few together. Flowers 5-merous, small, with jointed pedicels; calyx lobes valvate; petals valvate; stamens 10, free; ovary superior, 1-locular with many ovules, style simple. Fruit a strap-shaped, straight to spirally twisted, many-seeded pod, dehiscent along both sutures. Seed red or red and black, shiny, broadly ellipsoid to broadly obovoid or orbicular. Seedling with epigeal germination; cotyledons emergent, fleshy; hypocotyl elongated; first 2 leaves opposite, subsequent ones arranged spirally, first few leaves pinnate, subsequent ones bipinnate.

Planted *A. microsperma* starts producing seeds at the age of 3 years. On fertile soil its growth is



Adenanthera pavonina L. – 1, tree habit; 2, leaf; 3, inflorescence; 4, flower; 5, pod; 6, seed.

rapid: 20–22 m in height and 20–22 cm in diameter in 12 years. Most species of *Adenanthera* are deciduous but stay leafless for just a few days. They have been observed flowering and fruiting almost throughout the year, though for short intervals. Inflorescences appear at the apex of the young shoots. The flowering-to-fruiting period of *A. malayana* in Peninsular Malaysia is about 15 weeks. Seeds are probably eaten and dispersed by birds.

The seed colour (uniformly red or red with a black dot) is quite constant within a species, despite some contrary reports. *Adenanthera* belongs to the '*Adenanthera* group' within the tribe *Mimoseae* which is characterized by the jointed pedicels with a persistent basal part and alternating leaflets. Its closest relatives are found in Africa.

Ecology *Adenanthera* species are found scattered in primary and secondary, evergreen to dry deciduous rain forest, but also in open savanna-like vegetation, from sea-level up to 900 m altitude. *A. kostermansii* is also found in peat-swamp and freshwater swamp forest. Most species occur on a wide variety of soil types including sand, clay, limestone and other rocks.

Silviculture *Adenanthera* can be propagated by seed. Propagation from large cuttings is also reported to be successful in India, but it proved impossible to propagate *A. microsperma* by stem or root cuttings. Pods of *A. intermedia* (and probably also of other species) should be collected from the trees, as they open before being shed. Available dry seed counts per kg are 6400 for *A. forbesii*, 8000–10 500 for *A. microsperma* and 3750 for *A. pavonina*. Seed needs scarification by filing or scraping the hard seed-coat to overcome seed-coat dormancy, otherwise germination is erratic and may take up to 10 months. Seeds of *A. pavonina* become impermeable with time and after being stored for 8 months they fail to germinate. Their viability, however, is not affected, as after mechanical scarification germination is 100% in 1–4 days. Many seedlings of *A. microsperma* die when grown in full sunlight. Stumps of seedlings of *A. microsperma* with 5–10 cm of stem, 20 cm roots and a diameter of 0.5–2.5 cm have been successfully planted. Direct sowing using 4 seeds/hole has also been successful. *A. microsperma* has been well tested in trials in Java. Fairly dense planting at 2–3 m × 1 m is necessary to prevent trees developing poor stem forms or multiple stems. Using these spacings, canopy closure takes 2–3 years. Early thinning is important, as trees tend to die off when the stand becomes too dense. Timber yield at the age of 12 years is 60–96 m^3/ha. In timber plantations of *A. microsperma* a rotation of 50 years has been recommended.

Genetic resources and breeding *A. pavonina* is widely planted, but there are no known germplasm collections or records of breeding experiments. The other timber-yielding species do not seem to be immediately endangered either.

Prospects Research into plantation establishment and silvicultural management of some promising *Adenanthera* species would be worthwhile, to promote their use.

Literature 12, 57, 130, 151, 162, 163, 198, 209, 218, 260, 261, 267, 304, 308, 341, 343, 348, 360, 366, 405, 408, 435, 436, 464, 487, 488, 633, 722, 780, 800, 829, 831, 841, 861, 889, 924, 934, 1038, 1039, 1045, 1163, 1169, 1198, 1221, 1242.

Selection of species

Adenanthera forbesii Gagnep.
Synonyms *Adenanthera tamarindifolia* auct. non Pierre.
Vernacular names Indonesia: saga (general), raja bunga (Sumatra).
Distribution Sumatra and Borneo.

Adenanthera intermedia Merr.
Vernacular names Philippines: tanglin (Filipino), alalangat (Tagalog), bagiroro (Bikol).
Distribution The Philippines.

Adenanthera kostermansii I.C. Nielsen
Vernacular names Indonesia: saga, tampilih (Kalimantan). Malaysia: rawal (Murut, Sabah), saga paya (Sarawak), timbarayong (Dusun, Sabah).
Distribution Borneo and the southern Philippines.

Adenanthera malayana Kosterm.
Synonyms *Adenanthera bicolor* auct. non Moon.
Vernacular names Wicked heart (En). Indonesia: tanah (Kalimantan). Malaysia: saga daun tajam, saga hitam (Peninsular), saga paya (Sarawak).
Distribution Peninsular Malaysia, Sumatra and Borneo (Kalimantan, Sarawak).

Adenanthera microsperma Teijsm. & Binnend.
Synonyms *Adenanthera pavonina* L. var. *microsperma* (Teijsm. & Binnend.) I.C. Nielsen.
Vernacular names Indonesia: kenderi (general), beuj (Madurese), segawe (Javanese). Cambodia: chreh phnôm, mun trèi, phlëu ni:ëng. Laos: lam[1] ta khouay. Thailand: bon see, phai (peninsular). Vietnam: lim v[as]ng, mang lai, r[af]ng cam th[ar]o.
Distribution Southern Burma (Myanmar), Indo-China, southern China, Thailand, the Andaman Islands, Peninsular Malaysia, Java and the Lesser Sunda Islands (Timor); also cultivated in this region.

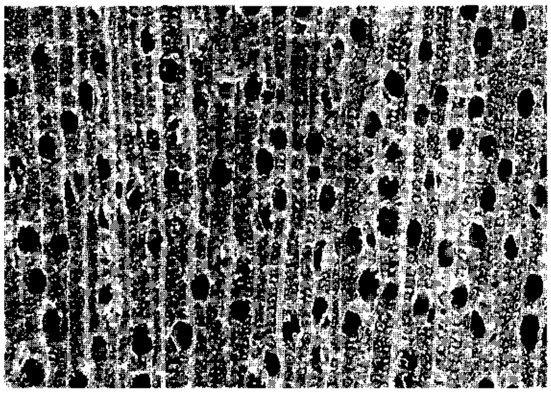
Adenanthera novoguineensis Baker f.
Distribution New Guinea, including New Ireland and New Britain.

Adenanthera pavonina L.
Synonyms *Adenanthera gersenii* Scheffer.
Vernacular names Coralwood (En). Indonesia: kitoke laut (Sundanese), saga telik, segawe sabrang (Javanese). Malaysia: saga tumpul (Peninsular). Philippines: malatanglin (Filipino). Burma (Myanmar): mai-chek. Cambodia: chan' trèi. Laos: lam[2]. Thailand: ma klam ta chang, ma klam ton (general), ma hok daeng (northern).
Distribution Sri Lanka, southern Burma (Myanmar), Indo-China, southern China, Thailand, throughout Malesia (except for the Philippines) and the Solomon Islands; widely cultivated and occasionally naturalized within this region, but also commonly planted in India and Africa.

J.P. Rojo

Adinandra Jack

Mal. Misc. 2: 49 (1822).
THEACEAE
x = unknown; *A. dumosa*: $2n = 20$, *A. griffithii* Dyer: $n = 42$, *A. millettii* (Hook. & Arn.) Benth. & Hook. f. ex Hance: $2n = 84$
Vernacular names Samak (trade name). Oriomo redwood (En). Malaysia: tetiup, tiup-tiup (Peninsular), semapak (Sarawak).
Origin and geographic distribution *Adinandra* comprises about 80 species occurring from Sri Lanka and India to Burma (Myanmar), Indo-China, southern China, Taiwan, Burma (Myanmar), Thailand and throughout the Malesian region (except for the Moluccas). In the latter area the species are distributed as follows: Peninsular Malaysia 10, Sumatra 5, Java 3, Borneo 18, the Philippines 8, Sulawesi 3, the Lesser Sunda Islands 1 and New Guinea 1, which renders the genus a mainly West Malesian one.
Uses The wood of *Adinandra* is used for general construction, flooring, panelling, door and window frames, joinery, furniture, planking and poles for temporary constructions, and yields a good quality plywood. The wood is also suitable as firewood and for the production of charcoal.
A. dumosa may be useful for afforestation or as a cover crop.
Production and international trade 'Samak' is the trade name for timber of the genera *Adinandra*, *Gordonia* and *Schima*. In 1996 Papua New Guinea exported only 61 m^3 of 'Oriomo redwood' logs at an average free-on-board (FOB) price of US$ 104/m^3.
Properties *Adinandra* yields a medium-weight hardwood with a density of 530–860 kg/m^3 at 15%



Adinandra dumosa
transverse surface (×20)

moisture content. Heartwood typically grey-brown with a purple hue, to dark red-brown, not clearly differentiated from the cream to reddish-straw or yellow-pink sapwood; grain straight or interlocked; texture very fine to slightly coarse and even. Growth rings indistinct; vessels moderately small to moderately large, typically angular, mostly solitary, sometimes blocked with gum-like deposits; parenchyma rather sparse, mostly apotracheal diffuse, indistinct even with a hand lens; rays moderately fine, visible with a hand lens; ripple marks absent.

Shrinkage upon seasoning is low to moderate. The wood air dries fairly slowly: boards of *A. dumosa* of 13 mm thick take 3 months to air dry, boards 38 mm thick take 4 months, and boards of *A. villosa* of 25 mm thick take 5 months. There is a moderate risk of cupping and splitting and a high risk of staining during seasoning. The wood is moderately hard to hard and strong. It is fairly easy to easy to work, although planing may be slightly difficult. The pulp yield is low. The wood is durable under cover. The sapwood is probably resistant to *Lyctus*. The heartwood is resistant to preservative treatment.

See also the tables on microscopic wood anatomy and wood properties.

Botany Evergreen shrubs or usually small to medium-sized, or rarely large trees up to 30(–43) m tall; bole straight, sometimes sinuous in small trees, branchless for up to 20(–25) m, up to 80(–100) cm in diameter, without buttresses but sometimes with spurs; bark surface smooth but densely lenticellate, sometimes flaking or peeling off in small irregular scales, dark grey or brown to green-brown, inner bark hard, dull yellow to red-brown, purplish or pink and faintly laminated. Leaves distichous, simple, entire, exstipulate. Flowers axillary, solitary or rarely in pairs or small fascicles, 5-merous; sepals and petals connate at base; sepals unequal; stamens 15–many, in 1–5 bundles and adnate to the base of the corolla; ovary superior, 3–5-locular with many ovules in each cell and often with additional false septae; style 1. Fruit a berry or capsule with few to many, small seeds; calyx persistent. Seedling with epigeal germination; cotyledons emergent, leafy; hypocotyl elongated; first few leaves alternate.

The shoot system is dimorphic with orthotropic leaders with spiral leaves and plagiotropic branches bearing distichous ones. *A. dumosa* develops according to Roux's architectural tree model, characterized by a monopodial, orthotropic trunk with continuous growth, plagiotropic branching and flowering which does not influence the architecture. Both young and old leaves are reddish. Most species seem to flower and fruit throughout the year. *A. dumosa* starts to flower about 2–3 years after planting or when the plants are about 1 m tall. The flowers are self-pollinated. In Peninsular Malaysia and Singapore the seed of *A. dumosa* is dispersed by the fruit bat *Cynopterus brachyotis*.

Adinandra is sometimes placed in the *Ternstroemiaceae*, a family formerly recognized as distinct from *Theaceae* s.s.

Ecology *Adinandra* occurs in primary and secondary lowland to montane rain forest, sometimes in monsoon forest or swamp forest, up to 2000 (–2700) m altitude. *A. dumosa* is a colonizer, rapidly invading degraded land. In Peninsular Malaysia and Singapore it is dominant in the common vegetation type called 'adinandra belukar' being the result of secondary succession after exhaustive agricultural exploitation. Several other species characteristic of kerangas, which is found in similar locations with occasional drought, are present in this formation. *A. dumosa*, however, is best adapted to open conditions, poorly aerated soil and restricted supply of nutrients.

Silviculture *Adinandra* may be raised from seed. In germination trials in Malaysia about 75% of the seed germinated in 21–54 days in the case of *A. acuminata*, versus 11–24 days for *A. dumosa*. *Adinandra* species may spontaneously invade grasslands (e.g. of *Imperata*) where they are remarkably resistant to fire.

Genetic resources and breeding *A. dumosa* is a rain forest pioneer and therefore it is favoured by human activity. It is not known whether other, less widespread *Adinandra* species react in the same way.

Prospects *A. dumosa* is promising for use on plantation scale, although its wood quality is not outstanding and very little is known of its silvicultural aspects.

Literature 70, 92, 151, 163, 198, 209, 267, 378, 387, 402, 423, 436, 438, 444, 464, 543, 578, 678, 701, 829, 831, 832, 861, 1016, 1038, 1039, 1221, 1239, 1242.

Selection of species

Adinandra acuminata Korth.

Vernacular names Malaysia: mungal (Peninsular).

Distribution Peninsular Malaysia, Singapore and Sumatra.

Adinandra caudatifolia Kobuski

Vernacular names Malaysia: bawing (Sabah).

Distribution Borneo (Sabah).

Adinandra clemensiae Kobuski

Distribution Borneo (Sabah).

Adinandra collina Kobuski

Vernacular names Malaysia: bangkao (Dusun).

Distribution Borneo.

Adinandra cordifolia Ridley

Distribution Borneo (Sabah, Sarawak).

Adinandra dumosa Jack

Synonyms *Adinandra cyrtopoda* Miq., *Adinandra jackiana* Korth., *Adinandra trichocoryna* Korth.

Vernacular names Indonesia: pelempang, tiup-tiup (general), ranu (Lampung, Sumatra). Malaysia: tetiup (Peninsular), semapak (Sarawak), bawing (Sabah). Singapore: tiup tiup.

Distribution Peninsular Malaysia, Singapore, Sumatra, Java (probably introduced) and Borneo.

Adinandra forbesii Baker f.

Synonyms *Adinandra brassii* Kobuski.

Vernacular names Papua New Guinea: Oriomo redwood (En).

Distribution New Guinea.

Adinandra integerrima T. Anderson ex Dyer

Synonyms *Adinandra lutescens* Craib, *Adinandra phlebophylla* Hance.

Vernacular names Malaysia: kandis burong, pegula hutan (Peninsular). Thailand: bamram, luk tong (peninsular), phikun pa (north-eastern).

Distribution Cambodia, Thailand and Peninsular Malaysia.

Adinandra maculosa T. Anderson ex Dyer

Distribution Peninsular Malaysia.

Adinandra myrioneura Kobuski

Vernacular names Malaysia: bangkau (Dusun, Sabah).

Distribution Borneo (Sabah).

Adinandra sarosanthera Miq.

Synonyms *Adinandra lamponga* Miq., *Adinandra leiopetala* Miq., *Adinandra macrantha* Teijsm. & Binnend.

Vernacular names Indonesia: kelutum basarang (Lampung, Sumatra), kapa anjing (Palembang, Sumatra), ki sapi (Sundanese). Malaysia: kelat pamah, petuta bukit, pongpong raya (Peninsular).

Distribution Thailand, Peninsular Malaysia, Sumatra, Java and Borneo.

Adinandra villosa Choisy

Synonyms *Adinandra bicuspidata* Kobuski.

Vernacular names Malaysia: jalong.

Distribution Peninsular Burma (Myanmar) and Peninsular Malaysia; possibly also in Thailand.

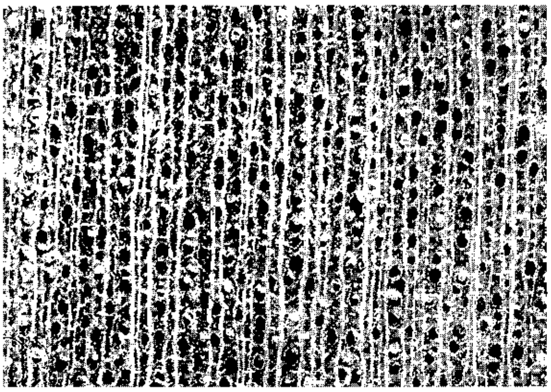
E. Boer (general part),
M.S.M. Sosef (general part, selection of species)

Adinauclea Ridsd.

Blumea 24: 349 (1978).
RUBIACEAE
x = unknown; $2n$ = unknown

Vernacular names Indonesia: kayu lasi (Moluccas), kilali (Buru, Moluccas).

Origin and geographic distribution *Adinauclea* is a monotypic genus confined to Sulawesi and the Moluccas. The only species is *A. fagifolia* (Teijsm. & Binnend. ex Havil.) Ridsd. (synonyms: *Adina fagifolia* (Teijsm. & Binnend. ex Havil.)



Adinauclea fagifolia
transverse surface (×20)

Valeton ex Merr., *Nauclea fagifolia* Teijsm. & Binnend. ex Havil., *Neonauclea fagifolia* (Teijsm. & Binnend. ex Havil.) Merr.).

Uses The wood of *A. fagifolia* has been in demand for the manufacture of furniture and has also been used for building traditional boats.

Production and international trade Small amounts of this timber were traded in the 1920s from northern Sulawesi, but nowadays *A. fagifolia* trees are too scarce to be important.

Properties *A. fagifolia* yields a medium-weight hardwood with a density of 770–880 kg/m^3 at 15% moisture content. Heartwood pale yellow to pink-yellow, with whitish flecks or streaks, turning pale with age, slightly differentiated from the somewhat paler sapwood; grain straight, sometimes slightly interlocked; texture very fine and even; with an aromatic odour when freshly cut. Growth rings not distinct; vessels very small, mostly solitary and few radial multiples; rays very fine; ripple marks absent.

The wood dries slowly and needs care in seasoning to prevent surface checks. It is hard and moderately strong. It works easily, probably easiest when seasoned, and a good polish can be obtained, but it splits easily. The wood is moderately durable and probably resistant to termites and dry rot.

See also the table on microscopic wood anatomy.

Botany A large tree up to 45 m tall; bole branchless for up to 30 m, up to 200(–240) cm in diameter. Terminal vegetative bud flattened. Leaves opposite, simple, entire, with appressed and caducous stipules. Flowers in 1 or 3 heads terminal at branches, 5-merous, interfloral bracteoles present; calyx with a short tube and elliptical-oblong lobes; corolla infundibular, with valvate lobes (but subimbricate at apex); stamens inserted in the upper part of the corolla tube; ovary inferior, 2-locular; style exserted, with globose stigma. Fruit in a head-like infructescence, free, splitting in 4 parts, with persistent central axis. Seed ovoid, bilaterally compressed. Seedling with epigeal germination; cotyledons leafy.

The tree develops according to Troll's architectural tree model, characterized by a sympodial trunk with all axes plagiotropic with continual superposition.

Adinauclea is related to *Adina* and a group of 4 small 'satellite' genera (including *Haldina*, *Metadina* and *Pertusadina*) in the tribe *Naucleeae*. It differs particularly in the strongly flattened terminal vegetative bud and in the mode of dehiscence of the fruit: the calyx remnant detaches with the segments of the fruit wall, whereas in *Adina* and the other related genera the calyx remnant remains attached to the central axis of the fruit.

Ecology *A. fagifolia* occurs in forest from sea-level to mountainous areas, often in stony locations, and both on wet and dry soils.

Silviculture It has been reported from Sulawesi that collecting seed is extremely difficult. In natural forest on the island of Boano (the Moluccas) some 30 trees/ha were found with a timber volume of 40 m^3, whereas in North Sulawesi an estimated average exploitable timber volume of 50 m^3/ha has been reported for a forest type covering about 8000 ha. Hardly any natural regeneration was observed in this latter forest during the inventory. Therefore, exploitation should be followed by artificial regeneration, e.g. enrichment planting. A single log can supply 40–60 m^3 of timber.

Genetic resources and breeding The supply of this timber had already declined considerably in the 1920s because of the great demand. It is not known whether the remaining *A. fagifolia* populations are in danger of extinction, but the species very probably needs protection.

Prospects *A. fagifolia* is a promising timber because of its large size and favourable wood properties for furniture manufacture. Therefore, research on the silvicultural aspects is needed to determine the feasability of sustainably managing the remaining natural stands and of planting new stands.

Literature 402, 436, 861, 943, 1130, 1165.

E. Boer & R.H.M.J. Lemmens

Agrostistachys Dalzell

Hooker's Journ. Bot. Kew Gard. Misc. 2: 41 (1850).

EUPHORBIACEAE

x = unknown; $2n$ = unknown

Vernacular names Malaysia: jejulong, julong-julong (Peninsular), kayu garang (Sabah).

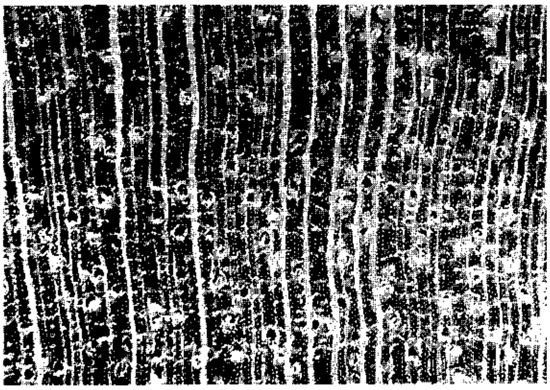
Origin and geographic distribution *Agrostistachys* comprises about 8 species and occurs in Sri Lanka, India, Burma (Myanmar) and Indo-China towards Thailand and the Malesian region. The 4 species found in the latter area are distributed as follows: 3 in Peninsular Malaysia, 1 in Sumatra, 3 in Borneo, 2 in the Philippines, and 1 in Papua New Guinea.

Uses The wood of *Agrostistachys* has been used for walking sticks, fence poles and carrying baskets. It is suitable for the production of pulp and yields a fairly good fuelwood. The logs are also suitable for mushroom cultivation.

The large leaves are used for roofing, thatching and wrapping. The fibrous bark can be used to make rope. The resin on the terminal bud is used to secure knife blades in their handles. The gum of *A. borneensis* used to be used to varnish sheaths and handles of krises.

Production and international trade The wood of *Agrostistachys* is used on a local scale only.

Properties *Agrostistachys* yields a medium-weight to heavy hardwood with a density of 685–940 kg/m^3 at 15% moisture content. Heartwood brown with a rose-pink tinge (*A. borneensis*) or pale yellow (*A. gaudichaudii*), not clearly differentiated from the sapwood; grain straight; texture fine and even. Growth rings mostly indistinct, sometimes delimited by a band of marginal parenchyma; vessels very small, mostly in radial multiples of 2–4, sometimes more; parenchyma sparse, apotracheal occasionally in marginal or seemingly marginal bands, visible to the naked eye, and diffuse, tending to diffuse-in-aggregates, visible only with a hand lens; rays very fine to moderately fine, visible only with a hand lens; ripple marks absent.



Agrostistachys borneensis transverse surface (×20)

There is no information on the durability of this wood, but specimens in the wood collection of the Forest Research Institute Malaysia have not been attacked by fungi or borers.

See also the table on microscopic wood anatomy.

Botany Dioecious, virtually glabrous, small trees up to 15 m tall; bole up to 25 cm in diameter, without buttresses; bark surface smooth; crown narrow and conical to domed and open. Terminal bud with a clear, inflammable, resinous coat. Leaves arranged spirally, in a tight terminal cluster, simple, oblanceolate to cuneate-obovate, up to 60 cm long, entire to dentate, without glands; stipules free, persistent or caducous. Flowers small, on axillary, single or grouped, short to elongate, bracteate spikes. Male flowers in clusters within each bract; calyx splitting into 2–5-segments; petals 5–8; disk composed of 5 glands; stamens (8–)10(–13), anther cells pendulous. Female flowers solitary; sepals 5; petals 5; ovary superior, 3-locular with a single ovule per cell, style entire or bifid. Fruit a crustaceous capsule seated on the blackened disk and the persistent, recurved sepals. Seed smooth.

Agrostistachys develops according to Corner's architectural tree model, characterized by the vegetative growth of a single meristem producing an unbranched axis on which the inflorescences are borne laterally.

Ecology *A. borneensis* occurs locally gregarious in evergreen, lowland and lower montane, sometimes mossy forest, on hillsides and ridge tops, up to 1050 m altitude. It is found in kerangas, dipterocarp-fagaceous forest, low dipterocarp forest and swamp forest. *A. gaudichaudii* is found in lowland, evergreen forest, mainly on alluvial plains, up to 200 m altitude. Soil types include sandstone, yellow sandy clay, clay loam, and rarely white sand and limestone. Both species are understorey trees.

Silviculture *Agrostistachys* can be propagated from seed, which has a high germination percentage. Natural regeneration is generally good.

Genetic resources and breeding As the two timber-yielding species are fairly common and their utilization is very restricted, the risk of genetic erosion is probably small.

Prospects The utilization of *Agrostistachys* timber is unlikely to increase, since the bole is usually small. The wood may gain some importance for the production of pulp and chipboards, and as a fuelwood.

Literature 26, 28, 32, 33, 34, 81, 162, 163, 209, 267, 402, 543, 974, 834, 835, 1195, 1221, 1242.

Selection of species

Agrostistachys borneensis Becc.

Synonyms *Agrostistachys latifolia* (Hook. f.) Pax & K. Hoffm., *Agrostistachys leptostachya* Pax & K. Hoffm., *Agrostistachys longifolia* (Wight) Trimen, non (Müll. Arg.) Kurz.

Vernacular names Bornean jenjulong (En). Malaysia: nulong, nyonyolong (Peninsular). Philippines: haginis-agos (Tagalog).

Distribution Peninsular Malaysia, Singapore, Sumatra and Borneo.

Agrostistachys gaudichaudii Müll. Arg.

Synonyms *Agrostistachys filipendula* Hook. f., *Agrostistachys maingayi* Hook. f.

Vernacular names Malaysia: beko-beko, julong-julong jantan, lidah kerbau (Peninsular). Thailand: chik nam, lao, taachai (peninsular).

Distribution Burma (Myanmar), Peninsular Thailand, Peninsular Malaysia and Singapore.

Nguyen Nghia Thin

Alangium Lamk

Encycl. 1: 174 (1783).

ALANGIACEAE

$x = 11$; *A. chinense*: $n = 33$, $2n = 22$, *A. salvifolium*: $n = 11$

Vernacular names Alangi (En). Indonesia: merlapang. Malaysia: kondolon, satu inchi (Sabah), mentulang (Peninsular). Philippines: malatapai. Burma (Myanmar): tabuya. Thailand: pru. Vietnam: th[oo]i chanh.

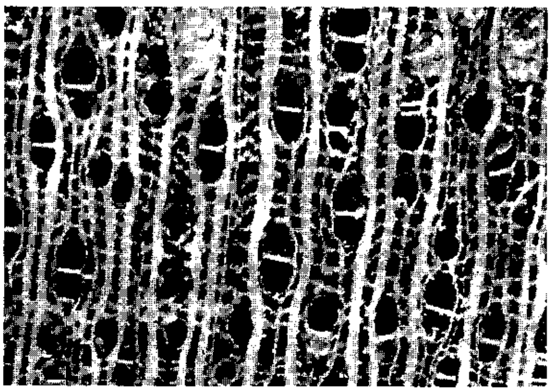
Origin and geographic distribution *Alangium* comprises about 23 species and occurs from tropical Africa and Madagascar to India, Indo-China, China, Japan, Thailand, throughout the Malesian area towards eastern Australia, New Caledonia and Fiji. Within Malesia 15 species occur.

Uses The timber of *Alangium* has been used for house construction (beams, flooring, general framing, indoor panelling), furniture and cabinet work, inlaying, carving, bobbins, spindles, shuttles, rice pestles, tool handles, walking sticks, gunstocks and handicraft articles. The root wood has been used to make tobacco pipes.

The pulp of the fruit is astringent but is eaten in India; the fruit kernel is edible. The root bark of *A. salvifolium* has been used against leprosy and skin diseases. In Indo-China *A. chinense* is also used for firewood.

Production and international trade Since the supply is limited the timber of *Alangium* is not commercially important and probably harvested and traded only locally in mixed consignments of medium hardwood.

Properties *Alangium* yields a medium-weight to heavy hardwood with a density of 440–1100 kg/m^3 at 15% moisture content. Heartwood chocolate to cinnamon-brown, clearly or not clearly demarcated from the wide and buff or yellowish sapwood; grain straight, sometimes interlocked or wavy; texture rather fine and even; in some species the wood tastes slightly bitter. Growth rings not visible, although occasionally marked by narrow dark-coloured marginal parenchyma; vessels moderately small to medium-sized, diffuse porous in section *Conostigma* Bloemb. and sometimes semi-ring porous in section *Marlea* Baillon, mostly in radial multiples of 2–4(–more), occasionally white or yellow deposits present; parenchyma abundant, apotracheal diffuse-in-aggregates, marginally zonate bands in section *Marlea*, distinct with a hand lens; rays moderately fine to medium-sized, visible to the naked eye; ripple marks absent.



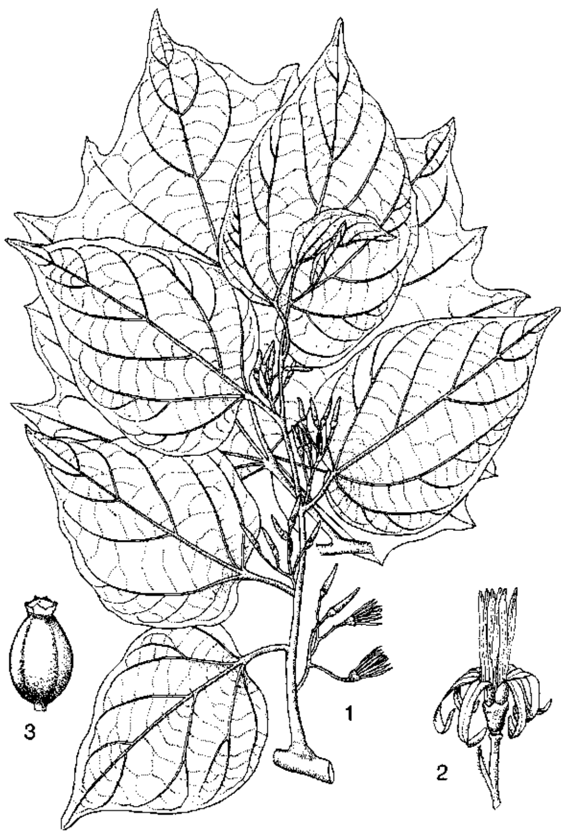
Alangium javanicum
transverse surface (×20)

The wood seasons well and is not subject to checking. It works well, bends easily and takes a high finish. It is strong and moderately hard to hard. The wood is very durable under cover but not in contact with the ground. It is susceptible to ambrosia beetle attack and marine borers. The sapwood of *A. longiflorum* is non-susceptible to *Lyctus*, nor is the heartwood susceptible to dry-wood termites.

The gross energy value of the sapwood of *A. rotundifolium* is about 20 050 kJ/kg, that of heartwood about 20 195 kJ/kg.

See also the tables on microscopic wood anatomy and wood properties.

Botany Shrubs or small to fairly large trees up to 40 m tall (rarely woody climbers); bole up to 90 cm in diameter, sometimes with short thin buttresses or stilt roots; bark surface smooth to cracking or flaking into circular scales, lenticellate or pustular, reddish-brown to dark grey, inner bark usually pale brown to orange-yellow, sometimes purplish-red. Leaves arranged spirally,



Alangium chinense (Lour.) Harms – 1, flowering twig; 2, flower; 3, fruit.

sometimes distichous, simple, entire or occasionally lobed or coarsely dentate, venation varying from palmate to pinnate, exstipulate. Flowers in a sessile or short-stalked, axillary cyme, bisexual; calyx gamosepalous, the rim almost entire or with 4–10 small teeth; petals 4–10, free, valvate, linear; filaments usually hairy inside; intra-staminal disk well developed; ovary inferior, 1–2-locular with 1 pendulous ovule in each cell, style 1. Fruit a drupe, often curved and longitudinally grooved, crowned by a persistent cup-shaped calyx. Seedling with epigeal germination; cotyledons leafy.

Branching is dimorphic, with the leaves arranged spirally on the orthotrophic leader shoot and distichous on the plagiotropic branch shoots. Tree form is according to Massart's architectural model (*A. chinense*), characterized by an orthotropic, monopodial trunk with rhythmic growth consequently producing tiers of plagiotropic branches, or Roux's architectural model (*A. salvifolium*), characterized by a continuously growing monopodial trunk with plagiotropic branches. A single 45-year-old *A. ridleyi* tree in the arboretum of the Forest Research Institute Malaysia, Kepong had attained a diameter of 31 cm, a total height of 22 m and a clear bole of 7 m. Flowering takes place during the dry season, fruiting by the end of the dry season and the beginning of the wet season. Pollination is by insects, mainly small flies. The fruits are eaten by animals like deer and barking deer, and by birds which probably disperse the seeds.

The family *Alangiaceae*, with *Alangium* as the sole genus, has sometimes been included in the *Cornaceae*. The genus is divided into 4 sections which are very distinct, including in their wood structure (see the section on wood anatomy). *A. javanicum* is very polymorphic, with several varieties, although some authors consider it to be a group of closely related species.

Ecology *Alangium* species are found scattered, mainly in primary lowland forest. In Malesia some species ascend up to 1500 m, whereas in the Himalayas *A. chinense* is found up to 3000 m.

Silviculture *Alangium* can be propagated by seed and about 50% of the pyrenes of *A. javanicum* germinated in 4–15 weeks, whereas for *A. ridleyi* about 35% germination has been observed in 4–11 weeks. In Peninsular Malaysia *A. javanicum* is described as a shade-tolerant tree not reaching the canopy top of the forest. Natural regeneration is reported as fairly good.

Genetic resources and breeding There are no records of *Alangium* in seed or germplasm banks. The wide geographical distribution of most species make them less vulnerable to genetic erosion.

Prospects Since the supply of *Alangium* is generally restricted, its importance in international trade is not expected to increase. Due to its good wood characteristics it will probably continue to be used locally for special purposes like toys, handicrafts and indoor panelling.

Literature 107, 117, 162, 163, 235, 267, 340, 343, 402, 436, 438, 464, 584, 780, 823, 829, 831, 832, 861, 934, 947, 974, 1038, 1048, 1169, 1221, 1242.

Selection of species

Alangium chinense (Lour.) Harms

Synonyms *Alangium begoniaefolium* (Roxb.) Baillon, *Alangium cordifolium* Zoll., *Alangium octopetalum* Llanos ex Blanco.

Vernacular names Indonesia: ki careuh, ki caseuli (Sundanese), timangan (Javanese). Philippines: bagaloan (Tagalog). Cambodia: sa^2 nhan. Laos: sa^2 nhan. Thailand: khao yen, matap lawai (northern), phe-suea (eastern). Vietnam: c[aa]y th[oo]i chanh, th[oo]i ba.

Distribution Widely distributed from tropical Africa, India, China, Taiwan, Japan, Indo-China and Thailand towards the Philippines, Java and the Lesser Sunda Islands.

Alangium griffithii (C.B. Clarke) Harms

Synonyms *Alangium densiflorum* (Koord. & Valeton) Wangerin, *Alangium myrianthum* Wangerin, *Alangium uniloculare* King.

Vernacular names Brunei: mayam kampong (Malay). Indonesia: dodaara (Moluccas), manata (Sulawesi). Malaysia: gadong hutan (Sabah), salang rusa, tinjau laut (Peninsular).

Distribution Peninsular Thailand, Peninsular Malaysia, Sumatra, Java, Borneo, Sulawesi and the Moluccas.

Alangium javanicum (Blume) Wangerin

Synonyms *Alangium ebenaceum* (C.B. Clarke) Harms, *Alangium meyeri* Merr., *Alangium tutela* Ridley.

Vernacular names Indonesia: ki parang (Java), samar (Ambon), taramayang (Sumatra). Malaysia: jadam (Sarawak), mempelang (Sabah), mentulang daun bujor (Peninsular). Philippines: putian (general), agakaan (Cagayan), sugkod (Samar).

Distribution Thailand, Peninsular Malaysia, Sumatra, Java, Borneo, the Philippines, Sulawesi, the Moluccas, New Guinea and the Solomon Islands.

Alangium kurzii Craib

Synonyms *Alangium begoniaefolium* (Roxb.) Baillon var. *tomentosum* (Blume) Palm, *Alangium handelii* Schnarf, *Alangium kwangsiense* Melchior.

Vernacular names Indonesia: kalimbangbang, musang (Sumatra), ki careuh (Sundanese). Malaysia: marapangi (Dusun Tambunan, Sabah). Thailand: champa thong, falame (peninsular), saleek dong (northern). Vietnam: co-cha-pa, mon ti[af], tr[ef].

Distribution Burma (Myanmar), Indo-China, China, Thailand, Peninsular Malaysia, Sumatra, Java and Borneo (Sabah).

Alangium longiflorum Merr.

Synonyms *Alangium hirsutum* Bloemb.

Vernacular names Philippines: apitan (Cagayan), lilauen (Ilocos Norte). Thailand: plu (general).

Distribution Borneo and the Philippines.

Alangium nobile (C.B. Clarke) Harms

Vernacular names Indonesia: mara lepang, medang mata udang (Sumatra). Malaysia: kalong, mentulang bulu, poko sutubal (Peninsular).

Distribution Peninsular Malaysia, Singapore, Sumatra and Borneo (Sabah, Sarawak).

Alangium ridleyi King

Synonyms *Alangium costatum* Wangerin.

Vernacular names Indonesia: babi kurus, medang mata udang, taramayang payo (Sumatra). Malaysia: lidah kerbau, lidah kerbau putih, mentulang daun lebar (Peninsular). Vietnam: aloang ca nay sa biet, cay nan.

Distribution Vietnam, Peninsular Malaysia, Singapore, Sumatra and Bangka.

Alangium rotundifolium (Hassk.) Bloemb.

Synonyms *Alangium rotundatum* Ridley ex Burkill & Henderson.

Vernacular names Indonesia: ki careuh (Sundanese), kombang (Bali), musang (Sumatra). Malaysia: marapangi (Dusun Ranau, Sabah).

Distribution Peninsular Malaysia, Sumatra, Borneo (Sabah), Java and Bali.

Alangium salvifolium (L. f.) Wangerin

Synonyms *Alangium hexapetalum* Lamk, *Alangium lamarckii* Thwaites, *Alangium sundanum* Miq.

Vernacular names Indonesia: wait sesatak (Sumatra). Philippines: guntapai (general). Cambodia: ang kol, khou khao. Laos: khou khao, 'phou khao. Thailand: ma ta pu (northern), phlu (central). Vietnam: c[aa]y quang, c[aa]y th[oo]i chanh l[as] x[oo]n.

Distribution The Comoro Islands, India, Sri Lanka, Burma (Myanmar), the Andaman and Nicobar Islands, Indo-China, China, Thailand, Peninsular Malaysia, Singapore, Sumatra, Java, Borneo, the Philippines, Sulawesi, the Lesser Sunda Islands and New Guinea.

C. Phengklai

Albizia Durazz.

Mag. Tosc. 3: 11 (1772).

LEGUMINOSAE

$x = 13$; *A. chinensis, A. lebbeck, A. lebbekoides, A. procera*: $2n = 26$

Vernacular names Albizia (En). Malaysia: batai, batai batu, kungkur (general).

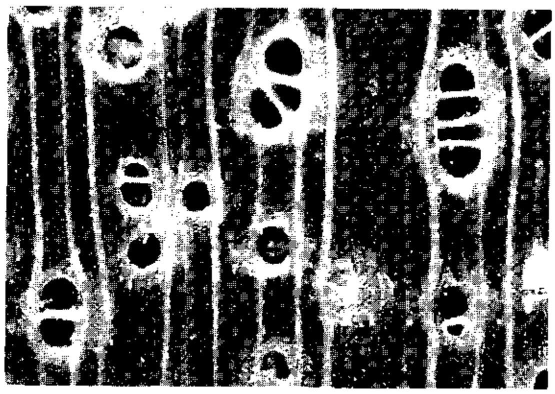
Origin and geographic distribution *Albizia* comprises about 150 species and has a pantropical distribution, with centres of speciation in Africa, Madagascar and tropical America. It occurs throughout the Asian tropics and 20 species are indigenous within the Malesian region. *A. lebbeck* is planted and naturalized throughout the tropics.

Uses In South-East Asia the wood of *Albizia* is quite variable in quality and is used for house construction (posts, beams), bridge construction, mine timber, boat building, dugout canoes, spokes and wheel rims, furniture and cabinet work, framework, mouldings, shuttering, interior finish, parquet and strip flooring, panelling, partitioning, oars, casks, oil presses, agricultural implements, carving, musical instruments, picture frames, turnery, gunstocks, novelties, fancy boxes, matches and matchboxes. The wood is suitable for the production of veneer and plywood, sometimes even for decorative veneers, and produces good firewood and charcoal. In the Philippines *A. acle* is regarded a suitable substitute for black walnut (*Juglans nigra* L.) from the temperate zones.

Albizia is frequently planted as a shade tree for various crops like tea and coffee and to improve the soil fertility, occasionally as an ornamental in parks and along roads. *A. chinensis*, *A. lebbeck* and *A. procera* are also planted to rehabilitate degraded sites and in fire- and wind-breaks. The trunk of *A. lebbeck* and *A. procera* yields a gum which is similar to arabic gum. A red dye and tannin used to be extracted from the bark, especially that of *A. lebbekoides*. The bark of the latter is used in Cambodia as a remedy for colic, and in the Philippines it is put into fermenting sugar cane juice to make an intoxicating liquor. The bark, which contains saponin, has been used as a substitute for soap (especially *A. saponaria*), as a fish poison, and shows insecticidal activity. Leaves of some species are sometimes used as fodder for cattle. The outer bark of *A. splendens* is used for lighting fires in humid conditions.

Production and international trade In Sabah the lightweight wood of *A. chinensis* and *A. pedicellata* is traded as 'batai' together with the wood of *Paraserianthes falcataria* (L.) I.C. Nielsen, the medium-weight timber as 'batai batu'. In 1992 'kungkur' timber (*A. splendens*) was exported from Sabah together with 'petai' (*Parkia* spp.), as a total volume of 2100 m³ of sawn timber and a total value of about US$ 480 000. In 1996 Papua New Guinea exported about 11 810 m³ of 'brown albizia' (*A. procera*) logs at an average free-on-board (FOB) price of US$ 99/m³.

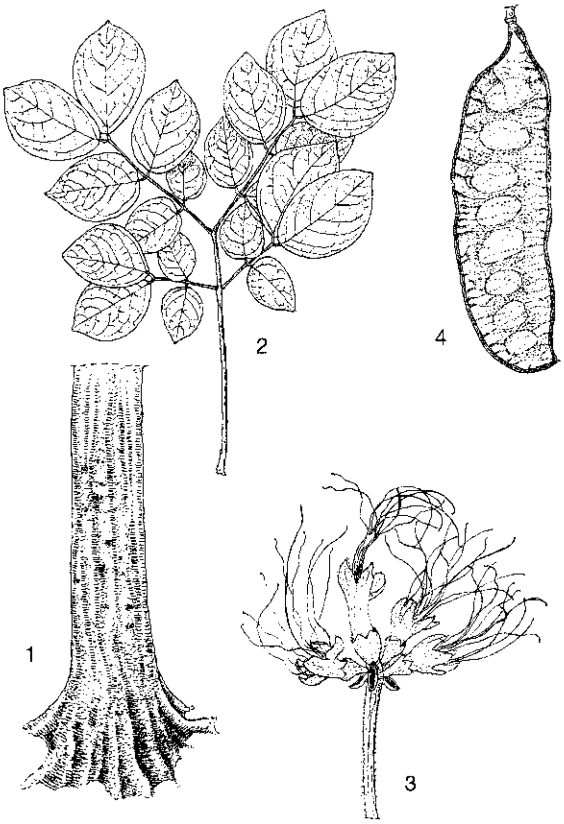
Properties *Albizia* yields a lightweight to medium-weight, occasionally heavy hardwood with a density of 315–950 kg/m³ at 15% moisture content. Important species and their density at 15% moisture content are: *A. pedicellata* 315–450 kg/m³, *A. chinensis* 320–640 kg/m³, *A. splendens* 470–845 kg/m³, *A. lebbekoides* 500–900 kg/m³ and *A. procera* 600–950 kg/m³. Heartwood pale brown to dark reddish-brown or golden-brown with paler



Albizia lebbekoides
transverse surface (×20)

streaks and bands, often similar to *Juglans* spp., sharply demarcated from the white to straw-coloured sometimes very wide sapwood; grain sometimes straight but usually interlocked or wavy; texture moderately fine to moderately coarse and even. Maximum sapwood width of 12–15-year-old trees is 10–12 cm. Growth rings sometimes distinct due to contrast in density of the fibres between earlywood and latewood; vessels medium-sized to very large, solitary and in radial multiples of 2–3(–4) with a tendency to oblique arrangement, vessels with white, yellow or dark gum-like or solid deposits; parenchyma moderately abundant, apotracheal diffuse and paratracheal vasicentric and aliform, sometimes confluent, also apotracheal in marginal bands; rays very fine to moderately fine; ripple marks absent; pith flecks occasionally present.
Shrinkage is low to moderate or high, but the wood seasons well with little or no degrade, although logs of some species are liable to develop heart shakes unless converted green. Boards of *A. splendens* 13 mm and 38 mm thick take respectively 3.5 and 4.5 months to air dry. Kiln drying gives good results. The wood is soft and fairly weak (lightweight species), or moderately hard and strong (medium-weight species); that of *A. procera* is reported hard, strong and tough. The wood is somewhat difficult to work with hand and machine tools and tends to pick up in planing and moulding; the cutting angle should not exceed 20°. The wood of *A. splendens*, however, has good working properties and finishes well, both in the green as well as in the air-dry state. It polishes excellently. The wood is non-durable to durable when in contact with the ground or exposed to the weather. In a graveyard test in the Philippines the average service life was 10 years for *A. acle* and *A. procera*, 3 years for *A. saponaria* and only 16 months for *A. chinensis*. The wood is resistant to dry-wood termites but the sapwood is susceptible to *Lyctus*. The heartwood is extremely resistant to impregnation, the sapwood is permeable. The energy value of the wood is 19 500–21 500 kJ/kg.
Sawdust may cause irritation to mucous membranes. The bark of older trees of *A. lebbekoides* contains 15–20% tannin.
See also the tables on microscopic wood anatomy and wood properties.

Botany Evergreen to briefly deciduous shrubs or small to fairly large trees up to 35(–50) m tall, rarely armed lianas; bole straight or rather crooked, short or branchless for up to 20 m, up to



Albizia saponaria (Lour.) Blume ex Miq. – 1, bole; 2, leaf; 3, inflorescence; 4, pod.

100(–150) cm in diameter, sometimes with small buttresses; bark surface smooth to closely fissured, lenticellate, grey to blackish, inner bark coarsely fibrous, reddish-brown or yellow to cream; crown usually flattened. Leaves arranged spirally, bipinnate, rachis and pinnae with extrafloral nectaries; leaflets many, opposite, entire; stipules caducous. Flowers in pedunculate glomerules or corymbs which are axillary or aggregated into a terminal or axillary panicle, 5-merous, often dimorphic, the marginal flowers in each head bisexual, the central ones male; calyx and corolla connate, valvate; stamens many, united into a tube below, long exserted; ovary superior, 1-locular with many ovules, style filiform. Fruit a straight, flat, dehiscent to indehiscent pod. Seed circular to ellipsoid, more or less flattened, the hard testa with pleurogram. Seedling with epigeal germination; cotyledons emergent, fleshy; hypocotyl elongated; first 2 leaves opposite or subopposite, subsequent ones arranged spirally, initially pinnate or bipinnate from the start.

A. lebbeck develops according to Troll's architectural tree model, characterized by only plagiotropic axes and built by continuous superposition of branches thus forming a sympodial stem. *Albizia* species flower shortly after the appearance of new leaves. In Java *A. lebbekoides* flowers in March–June and fruits in July–November. In Central Java *A. procera* flowers in April–June with the major fruit production in August and September, in East Java these periods are January–October and May–October, respectively. Pollination is generally by bees or butterflies, but bird pollination has also been recorded. In species with indehiscent pods the dispersal unit is the entire pod. The dispersal agent is water, except for *A. pedicellata* for which wind dispersal is reported.
Albizia belongs to the subfamily *Mimosoideae* and the tribe *Ingeae*, together with e.g. the genera *Archidendron* and *Paraserianthes*. The distinction between the various genera is difficult, and has given rise to a complicated nomenclatural history. *Albizia* is often misspelled as *Albizzia*, *A. lebbekoides* often as *A. lebbeckioides*.

Ecology *Albizia* is usually found scattered or in small groups as a pioneer in open, secondary vegetation or primary deciduous or monsoon forest, savanna and scrub vegetation, from sea-level up to 1700 m altitude; *A. chinensis* has been cultivated up to 2400 m. They occur in areas with a seasonal climate, often on sandy soils or otherwise well-drained locations. *A. dolichadena* prefers swamp forest. *A. retusa* is a littoral species. In the Philippines *A. acle* is commonly associated with molave (*Vitex parviflora* A.L. Juss.). In Papua New Guinea *A. procera* is commonly found in fire-induced grasslands in association with *Eucalyptus*. Several species can be planted in rocky and shallow sites with a pronounced dry season of at least 4 months.

Silviculture *Albizia* is easy to propagate from seed. Direct sowing is often applied, as planting out nursery-grown plants disturbs the long taproot which develops rapidly in young seedlings; in the latter case a survival rate of as low as 4% has been recorded. Some 5–10 seeds per planting hole is usually satisfactory for direct sowing. Cuttings can also be used. Seed should be collected from the tree as it is very susceptible to insect attack and rotting. Seed viability is usually high and seed can be stored for up to 5 years without serious decline in viability. Available seed counts per kg are: *A. acle* about 240, *A. chinensis* 49 500–52 000, *A. lebbeck* 7000–10 500, *A. lebbekoides* 49 000–59 000 and *A. procera* 21 000–41 000. Pretreatment of seed with boiling water, concentrated sulphuric acid or by nicking the seed-coat is usually recommended to overcome dormancy, but untreated seed of various species gave 20–80% germination. To assure optimal germination, seeds should be sown in full light. *A. lebbeck* and *A. procera* form nitrogen-fixing nodules in the nursery without any inoculation treatment. When sterilized soil was inoculated with *Rhizobium* obtained from the nodules of a large *A. lebbeck* tree, however, the seedlings from that tree developed optimally. Seedlings are stumped before planting; in *A. lebbeck* the stem is cut back to 5 cm, the roots to 15 cm, whereas in *A. procera* a shoot length of 10–20 cm and a root length of 20–40 cm with a diameter at the collar of 0.5–1.0 cm are recommended. Seedlings up to 1 m tall have been successfully planted as bare-rooted stock. Root cuttings have been successful when taken at least 15 cm long and 1 cm in diameter. In trials in Java the mean annual clear bole volume increment was 7.7–8.5 m^3/ha for 15-year-old trees of *A. chinensis*, 2.8 m^3/ha for 12-year-old *A. lebbekoides* trees and 6.7 m^3/ha for 12-year-old *A. procera* trees. In these trials *A. lebbekoides* developed a poor stem form due to forking and formation of low and heavy branches. In the Philippines *A. chinensis* yielded 10–12 m^3/ha/year on fertile sites. Lopping the branches for fodder and coppicing are very well tolerated. A rotation of 10–15 years is recommended for *A. lebbeck* planted for fuelwood, and of 30 years for timber production. The fungus *Fusarium oxysporum* is a serious disease of several *Albizia* species, causing gummosis of the vessels and eventually leading to death. In the Philippines the following pests have been observed in *A. acle*: *Lophococcus convexus*, a scale insect attacking and killing smaller branches, caterpillars of the faggot worm *Clavia cremeri* feeding on the leaves, and a flat-headed woodborer, *Chrysochroa fulminans*, whose larvae feed on the sapwood, possibly girdling the tree inside and whose adults feed on leaves and green bark.

Genetic resources and breeding In the Philippines *A. acle* is protected and *A. procera* is considered a vanishing timber tree.

Prospects As the timber of several *Albizia* species, especially that of *A. acle* and *A. procera*, is of good quality and growth is moderately fast their potential deserves further exploration.

Literature 12, 47, 101, 130, 162, 193, 198, 209, 218, 234, 238, 259, 260, 261, 267, 300, 304, 308, 333, 341, 343, 344, 348, 387, 402, 405, 406, 432, 436, 464, 488, 526, 536, 632, 633, 677, 678, 696, 697, 736, 740, 741, 780, 804, 816, 829, 831, 839, 857, 861, 865, 899, 910, 933, 934, 955, 970, 974, 1038, 1039, 1086, 1098, 1104, 1163, 1177, 1198, 1199, 1221, 1242.

Selection of species

Albizia acle (Blanco) Merr.

Synonyms *Pithecellobium acle* (Blanco) S. Vidal, *Serialbizzia acle* (Blanco) Kosterm.

Vernacular names Philippines: akle (Filipino).

Distribution The Philippines and South-East Sulawesi.

Albizia carrii Kanis

Distribution Papua New Guinea.

Albizia chinensis (Osbeck) Merr.

Synonyms *Albizia marginata* (Lamk) Merr., *Albizia stipulata* (DC.) Boivin.

Vernacular names Silk tree (En). Indonesia: jeungjing (Sundanese), sengghung (Madura), sengon (Javanese). Philippines: hinagit (Ifugao), kantingen (Iloko), unik (Tagalog). Cambodia: kô:l. Laos: kha:ng (Xieng Khouang), kha:ng hu: (Vieniane), sa² nhan. Thailand: kaang luang, saan kham (northern), khaang hung (north-eastern). Vietnam: cham, s[oos]ng r[aws]n t[af]u (Ha Tuyên), chu m[ef] (Quang Ninh).

Distribution From Sri Lanka and India to Burma (Myanmar), Indo-China, southern China, Thailand, Java and the Lesser Sunda Islands; cultivated in many other tropical countries, within Malesia also in Sumatra, Borneo and the Philippines (Luzon).

Albizia dolichadena (Kosterm.) I.C. Nielsen

Synonyms *Abarema dolichadena* (Kosterm.) Kosterm., *Pithecellobium dolichadenum* Kosterm.

Distribution Borneo (Sabah).

Albizia kostermansii I.C. Nielsen

Distribution Borneo.

Albizia lebbeck (L.) Benth.

Synonyms *Acacia speciosa* (Jacq.) Willd., *Inga leucoxylon* Hassk.

Vernacular names East Indian walnut, lebbek, siris tree (En). Kokko (En, Fr). Indonesia: ki toke, tarisi (Sundanese), tekik (Javanese). Malaysia: oriang (Peninsular). Philippines: langil (Tagalog). Burma (Myanmar): kokko. Cambodia: chres, kokko. Laos: ka 'sê. Thailand: cha kham (northern), phruek, suek (central). Vietnam: h[owj]p hoan, s[os]ng r[aaj]n.

Distribution Probably native to tropical mainland Asia and East Africa, but now cultivated throughout the tropics and throughout Malesia; naturalized in many areas with a seasonal climate.

Albizia lebbekoides (DC.) Benth.

Synonyms *Pithecellobium myriophyllum* Gagnep.

Vernacular names Indonesia: kedinding, tekik (Javanese), tarisi (Sundanese). Philippines: halugamit (Tagalog), lariskis (Iloko). Burma (Myanmar): anya kokko. Cambodia: châmri:ëk (Kampot), kântri'ëk (Kompong Thom). Laos: khan hung, khang hung (Sedone). Thailand: chamaree dong, chamaree pa (central), kang (northern, central). Vietnam: c[aa]m tr[aws]ng (South).

Distribution Indo-China, Thailand, Java, the Philippines, Sulawesi, the Lesser Sunda Islands and Papua New Guinea.

Albizia papuensis Verdc.

Distribution Papua New Guinea.

Albizia pedicellata Baker ex Benth.

Synonyms *Albizia magallanensis* Elmer, *Albizia myriantha* Merr.

Vernacular names Forest albizia (En). Malaysia: batai hutan, petai kerayong, sungga (Peninsular). Philippines: unaki (Bikol).

Distribution Peninsular Malaysia, Sumatra, Borneo and the Philippines.

Albizia procera (Roxb.) Benth.

Synonyms *Acacia procera* (Roxb.) Willd.

Vernacular names Forest siris, white siris (Australian trade name), tall albizia (En). Indonesia: ki hiyang (Sundanese), wangkal, weru (Javanese). Papua New Guinea: brown albizia (En). Philippines: akleng parang (Filipino). Burma (Myanmar): kokko-sit, sit, sitpen. Cambodia: tramkâng', tri:ehs. Laos: 'tho:n. Thailand: suan (northern, north-eastern), thing thon (central). Vietnam: mu[oof]ng xanh.

Distribution From India to Burma (Myanmar), Indo-China, southern China, Taiwan, Thailand, Java, Borneo (rare), the Philippines, Sulawesi, the Lesser Sunda Islands, the Moluccas, New Guinea and northern Australia; probably cultivated in Sumatra.

Albizia retusa Benth.

Synonyms *Albizia littoralis* Teijsm. & Binnend.

Vernacular names Sea albizia (En). Indonesia: ai sielo (Ambon), kelor laut (Moluccas), sutinga (Ternate). Philippines: balunos (Bikol), kasai (Tagalog, Bikol), langil (Tagalog).

Distribution The Ryukyu Islands, peninsular Thailand, throughout Malesia, northern Australia, Vanuatu, Micronesia and the Caroline Islands.

Albizia rosulata (Kosterm.) I.C. Nielsen

Synonyms *Parenterolobium rosulatum* (Kosterm.) Kosterm., *Pithecellobium landakense* Kosterm., *Pithecellobium rosulatum* Kosterm.

Distribution Borneo.

Albizia saponaria (Lour.) Blume ex Miq.

Synonyms *Albizia nediana* Kosterm., *Albizia tomentella* Miq. var. *salajeriana* (Miq.) Koord.

Vernacular names Indonesia: fofau (Halmahera, Ternate), merbuan (Belitung), pateh abal (Ambon). Philippines: salingkugi (Filipino).

Distribution Borneo, the Philippines, Sulawesi and the Moluccas; widely cultivated.

Albizia splendens Miq.

Synonyms *Pithecellobium confertum* Benth., *Pithecellobium splendens* (Miq.) Corner, *Serialbizzia splendens* (Miq.) Kosterm.

Vernacular names Indonesia: benatan (Sumatra). Malaysia: kungkur (general).

Distribution Peninsular Thailand, Peninsular Malaysia, Sumatra and Borneo (Brunei, Kalimantan, Sabah).

J.P. Rojo

Allophylus L.

Sp. pl. 1: 348 (1753); Gen. pl., ed. 5: 164 (1754).

SAPINDACEAE

$x = 14$; *A. cobbe*: $2n = 28$

Vernacular names Tit-berry (En). Brunei: tukil-tukil. Indonesia: cukilan (Javanese), si jangi, sicancang (Minangkabau, Sumatra). Malaysia: chinchang, chunkil (Peninsular), kelampu (Iban, Sarawak). Philippines: barotangol (general), bating-tangkaian, bignai-gubat (Filipino). Burma (Myanmar): zaung-gale. Thailand: chatong, phia fan (northern), tosai (northern, central).

Origin and geographic distribution *Allophylus* comprises a single species: *A. cobbe* (L.) Raeuschel (synonyms: *A. dimorphus* Radlk., *A. fulvinervis* (Blume) Blume, *A. grossedentatus* (Turcz.) Fern.-Vill.). It is pantropical and occurs throughout the Malesian region. In South-East Asia, it slightly penetrates the subtropical regions.

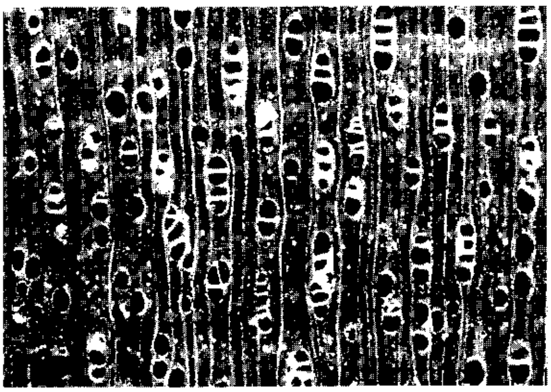
Uses The timber of *A. cobbe* is mainly used for temporary construction and indoor application, e.g. for rafters, walking sticks, handles and other small articles. In the Bismarck Archipelago it is used for floats of outrigger canoes; in the Philippines for beaters for cotton fruits. The wood is also used for fuel.

Trees have occasionally been planted as ornamentals. Extracts or decoctions of the leaves, roots and bark are used medicinally against stomach-ache, bruises and fever. In Mindanao the scraped bark is applied to rigid abdomen and the bark to burns. The slightly sour fruits are eaten. They have been used as a fish poison in New Guinea.

Production and international trade There are no records of commercial trade of *Allophylus* wood and utilization is probably only local.

Properties *A. cobbe* yields a lightweight to medium-weight hardwood. The density of the heartwood of an Indian wood sample was 640 kg/m^3 and that of the sapwood of an Indonesian sample was about 330 kg/m^3 at 15% moisture content. Heartwood buff-coloured or grey; grain straight; texture fine. Growth rings indistinct; vessels moderately small to medium-sized, solitary and in radial multiples of 2–4, open with occasional white deposits; rays very fine, sometimes conspicuous on radial surface.

The wood is moderately soft to moderately hard, but weak and non-durable.



Allophylus cobbe
transverse surface (×20)

See also the table on microscopic wood anatomy.

Botany A monoecious or dioecious, evergreen to partly deciduous, shrub or small to medium-sized tree up to 25 m tall, sometimes a woody climber; bole often crooked, branching low, up to 30 cm in diameter; bark surface smooth. Twigs glabrous to stellate hairy. Leaves arranged spirally, digitate, (1–)3(–5)-foliolate, exstipulate; leaflets usually dentate. Inflorescence axillary, either simple or composed of a few raceme-like thyrses, sometimes paniculate. Flowers unisexual, zygomorphic, 4-merous; sepals persistent; petals with a 2-lobed, usually bearded scale inside; stamens 8, filaments hairy; disk present; ovary superior, deeply 2(–3)-lobed with 1 ovule per cell, style 1. Fruit drupaceous, usually with 1 seed, globular to obovoid, dull orange-red. Seed without an aril. Seedling with epigeal germination; cotyledons emergent, fleshy; first pair of leaves opposite, subopposite or arranged spirally, usually 3-foliolate with serrate or lobed leaflets, subsequent leaves arranged spirally.

Ectotrophic mycorrhizae have been observed in *A. cobbe*. It flowers seasonally, in Java mainly during the west monsoon period. Female flowers appear to be hermaphrodite but show no anther dehiscence. Male flowers open before the female ones. Pollination is by bees. Maturation of the fruits takes 2–3 months. The fruits are mainly eaten by birds which thus disperse the seed.

A. cobbe is extremely variable and used to be divided into many species (some 250!). It is now regarded as a highly variable complex with many local 'races'.

Ecology The extreme morphological variation of *A. cobbe* is also reflected in its ecology. It is found in areas with everwet as well as seasonal climatic conditions, in primary or secondary forest but also in shrub vegetation, on sandy or rocky shores, in mangrove forest and freshwater swamps. The substrate varies from sand to heavy clay or peat and from granitic boulders to limestone outcrops. *A. cobbe* is found up to 1500 (–2000) m altitude.

Silviculture *A. cobbe* may be raised from seed, which has about 30% germination in 30–62 days. It is a pioneer, rapidly colonizing gaps. It is not resistant to fire.

Genetic resources and breeding There are no records of ex situ conservation of *A. cobbe*. Its pantropical occurrence and wide-ranging site requirements mean that it is unlikely to be endangered.

Prospects It is most unlikely that *A. cobbe* will gain importance as a timber, because of its small dimensions.

Literature 70, 161, 163, 209, 341, 364, 396, 436, 465, 595, 683, 829, 831, 861, 934, 1038, 1048, 1102, 1221.

R.R.P. Irwanto

Alloxylon P.H. Weston & Crisp

Telopea 4: 498 (1991).

PROTEACEAE

x = unknown; *A. flammeum* P.H. Weston & Crisp: $2n = 22$

Vernacular names Pink silky oak (En, trade name). Indonesia: kawoli (Je, Merauke, Irian Jaya).

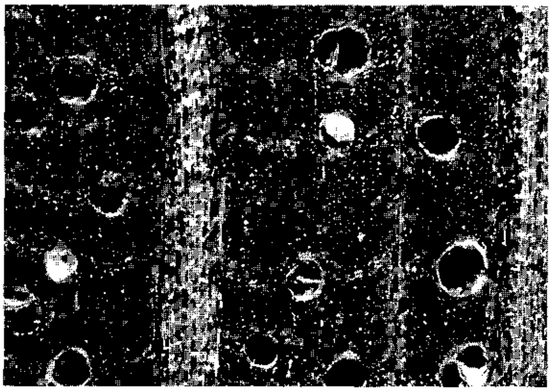
Origin and geographic distribution *Alloxylon* comprises 4 species, 3 of which are endemic to Australia. The only Malesian species is *A. brachycarpum* (Sleumer) P.H. Weston & Crisp (synonyms: *Embothrium brachycarpum* Sleumer, *Oreocallis brachycarpa* (Sleumer) Sleumer) which occurs in the southern Moluccas (Aru Islands) and southern New Guinea.

Uses The nicely figured and attractive wood of *A. brachycarpum* is used for boat-building, interior trim, fine finish, furniture and cabinet work, mouldings, decorative wall panelling, inlaying and marquetry, turning and fancy veneer.

A. brachycarpum is a potential ornamental plant.

Production and international trade In 1996 Papua New Guinea exported only 121 m^3 of 'pink silky oak' logs at an average free-on-board (FOB) price of US\$ 99/m^3. Supplies are very limited.

Properties *A. brachycarpum* yields a medium-weight hardwood with an average density of 540 kg/m^3 at 12% moisture content, but has also been reported to yield a lightweight wood of about 400 kg/m^3. Heartwood pale pinkish-brown to deep pink, sapwood pale pink or pale yellow-brown; grain straight; texture medium to moderately coarse, uneven due to the broad rays; wood nicely figured with conspicuous silver grain and silky lustre on tangential surface. Growth rings indistinct; vessels moderately large, solitary and occasionally in radial multiples of up to 4, in tangential multiples and in clusters tending to tangential arrangement, visible to the naked eye, with pink deposits; parenchyma paratracheal vasicentric, aliform and confluent with narrow bands; rays of two distinct sizes, as wide as or wider than the vessels, conspicuous on radial surface; ripple marks absent.



Alloxylon brachycarpum
transverse surface (×20)

Shrinkage upon seasoning is low and the wood seasons readily with very little degrade. The wood is fairly weak and moderately soft. It works excellently with both hand and machine tools and peels and slices well. It planes to a smooth surface and takes an excellent polish. The wood is moderately durable and extremely resistant to impregnation. The sapwood is susceptible to *Lyctus*.
See also the table on microscopic wood anatomy.

Botany A medium-sized to large tree up to 40 m tall; bole straight, cylindrical, up to 85 cm in diameter, sometimes slightly spurred at base; bark surface shallowly fissured, pustular, peeling off in thick scales, brown to greyish, inner bark wine-red; crown small, open. Leaves arranged spirally, simple, entire, decurrent at base, exstipulate. Inflorescence an axillary raceme, (2–)10–50-flowered, 1-sided. Flowers in pairs, zygomorphic; tepals connate in a long, straight, cylindrical tube which splits into 4 segments, pinkish-red to bright red; stamens sessile, inserted near the apex of the tepals; disk semi-annular; ovary superior, long stipitate, fusiform, 1-locular with many ovules in 2 rows, style long, apically thickened. Fruit an oblong follicle, splitting at one side, with 2 rows of 5–7 seeds. Seed with a large distal wing. Seedling with epigeal germination; cotyledons fleshy; seedling leaves simple, entire.
A. brachycarpum is probably pollinated by birds. Its flowering period is from June to October. Fruits have been observed in July–September and January–February. The winged seeds are dispersed by wind.

Ecology *A. brachycarpum* occurs scattered but is locally common in well-drained, primary, mixed rain forest on hills, ridges and high river banks, up to 800 m altitude. It seems to prefer gallery forest but has also been found in bamboo–eucalypt forest. It is often found growing together with *Acacia*, *Flindersia* and *Grevillea* spp.

Genetic resources and breeding *A. brachycarpum* has a small area of distribution and is probably vulnerable to genetic erosion by habitat destruction.

Prospects The use of *Alloxylon* wood is unlikely to increase, because supplies are very limited. However, this highly decorative wood will remain in demand.

Literature 300, 304, 341, 348, 403, 423, 464, 1024, 1200, 1232.

E. Boer & M.S.M. Sosef

Alphitonia Reissek ex Endl.

Gen. pl.: 1098 (1840).
RHAMNACEAE
x = unknown; $2n$ = unknown

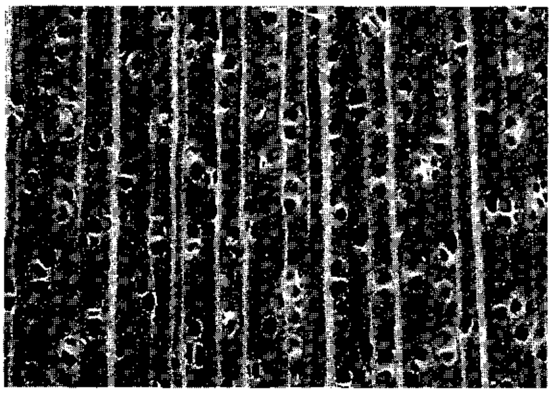
Vernacular names Papua New Guinea: white almond (En).

Origin and geographic distribution *Alphitonia* comprises about 10 species occurring in Borneo, the Philippines, the Lesser Sunda Islands (Timor), the Moluccas, New Guinea, Australia and in the Pacific east to the Marquesas Islands and Hawaii. Only 2 species occur in Malesia.

Uses The wood of *Alphitonia* is used for temporary construction, house building (posts, rafters), interior finish, cabinet making, furniture, mouldings, turnery, veneer, joinery, flooring, vehicle bodies, barrels, fencing and axe handles. It yields a good firewood and is suitable for the production of pulp.
The bark of *A. excelsa* has been used for rope in the Philippines and as soap in the Moluccas. It has also been used in tanning. Its wood has been used to dye cloth red-brown or orange-yellow. In Australia the leaves are used as fodder. In Papua New Guinea *Alphitonia* is regarded as suitable for reforestation purposes.

Production and international trade *Alphitonia* wood is used mainly on a local scale. In 1996 Papua New Guinea exported 515 m^3 of 'white almond' logs at an average free-on-board (FOB) price of US$ 95/m^3.

Properties *A. macrocarpa* yields a lightweight to medium-weight hardwood with a density of 360–650 kg/m^3 at 12% moisture content, *A. excelsa* is a medium-weight to occasionally heavy timber with a density of 685 to over 830 kg/m^3. Heart-



Alphitonia excelsa
transverse surface (×20)

wood pink-brown, sapwood straw-coloured; wood occasionally streaky and always with a smell of 'sarsaparilla' (*Smilax* spp.). Growth rings indistinct; vessels small to medium-sized, solitary and in radial multiples of 2–4 occasionally over 4, with dark gummy and white deposits; parenchyma sparse, paratracheal vasicentric or apotracheal in irregularly spaced bands; rays moderately fine; ripple marks absent.

Shrinkage upon air drying is moderate. The wood of *A. macrocarpa* is weak and non-durable but that of *A. excelsa* is strong and moderately durable. The sapwood is non-susceptible to *Lyctus*.

The bark of *A. excelsa* shows antibacterial activity. The average fibre length of *A. excelsa* wood is 1.04 mm and it is suitable for chemical pulping having a high pulp yield and requiring comparatively few chemicals.

See also the tables on microscopic wood anatomy and wood properties.

Botany Evergreen, small to fairly large trees up to 40 m tall; bole straight, up to 100 cm in diameter, branchless for up to 20 m, without buttresses; bark surface smooth, greyish to whitish or greenish-brown, pustular, inner bark greenish or straw-coloured with spicy odour. Buds and young twigs often densely brownish pubescent. Leaves alternate, simple, entire, whitish or rusty pubescent below; stipules small, caducous. Inflorescence an axillary or rarely terminal, many-flowered cyme. Flowers bisexual, small, whitish to greenish, 5-merous; hypanthium saucer-shaped to hemispherical; sepals keeled within; petals clawed, hooded; disk thick, nectariferous; ovary inferior, 2–3-locular with 1 ovule in each cell, style short, 2–3-lobed. Fruit a globose to broadly ovoid drupe with 2–3 dehiscent stones; mesocarp thick, mealy. Seed almost completely enclosed in a loose, membranous, reddish-brown aril; testa smooth.

A. excelsa develops according to Roux's architectural tree model, characterized by a continuously growing monopodial orthotropic trunk with plagiotropic branches. In the Philippines *A. excelsa* is considered a fast-growing species. Seeds are eaten and dispersed by birds.

Ecology *Alphitonia* is a fairly common element of lowland to montane, disturbed or secondary rain forest, up to 2500 m altitude. In Papua New Guinea *A. excelsa* can be found in the dry savanna belt in the south-east; in Australia it is reported to grow sometimes on very poor sandy soils. *A. macrocarpa* is found in the montane regions of Papua New Guinea, especially in secondary forest and in fallow vegetation.

Silviculture *Alphitonia* is reputed to have pioneer characteristics.

Genetic resources and breeding As harvesting of *Alphitonia* timber is limited, genetic erosion is not a major risk.

Prospects It is unlikely that the use of *Alphitonia* timber, at least in South-East Asia, will increase in the near future, due to its relatively sparse occurrence.

Literature 46, 135, 150, 163, 304, 348, 355, 402, 436, 447, 464, 553, 568, 739, 955, 974, 1048, 1070, 1090, 1222, 1232.

Selection of species

Alphitonia excelsa (Fenzl) Reissek ex Endl.

Synonyms *Alphitonia incana* (Roxb.) Kurz ex Hoogland, *Alphitonia moluccana* Teijsm. & Binnend., *Alphitonia philippinensis* Braid.

Vernacular names Coopers wood, red ash, white ash (En). Indonesia: kayu daun babalik (Ambon), kole (East Kalimantan), laurika (Ternate). Malaysia: balik-angin, pati yata, pokudita (Dusun, Sabah). Philippines: alangsohan (Cebu Bisaya), tangulai, tulo (Tagalog).

Distribution Borneo, the Philippines, Sulawesi, the Lesser Sunda Islands, the Moluccas, New Guinea and Australia.

Alphitonia macrocarpa Mansf.

Distribution New Guinea.

C. Schirarend

Alphonsea Hook. f. & Thomson

Fl. ind. 1: 152 (1855).

ANNONACEAE

$x = 9$; *A. teysmannii* Boerl.: $2n = 18$

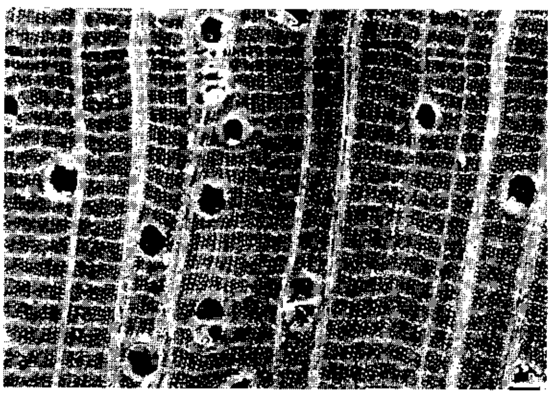
Vernacular names Mempisang (trade name). Brunei: karai. Malaysia: karai (Sabah, Sarawak), pisang-pisang (Peninsular). Vietnam: an phong, th[aa]u l[ix]nh.

Origin and geographic distribution *Alphonsea* comprises about 30 species occurring from Sri Lanka and India to Indo-China, southern China, Thailand, Peninsular Malaysia, Borneo, Java and New Guinea. There are about 13 species within the Malesian region; Peninsular Malaysia is by far the richest area, with about 10 species.

Uses The wood of *Alphonsea* is used for light construction, ship and boat building, light-duty flooring, furniture, household utensils, mine props, agricultural implements, tool handles, spear shafts, wheel spokes, package, matches and matchboxes. It also yields a decorative sliced veneer, and is used as firewood.
The pulp of the fruit of *A. elliptica* and *A. javanica* is sweet and edible.

Production and international trade 'Mempisang' is a general trade name comprising most of the genera of *Annonaceae*, but *Alphonsea* probably comprises only a very minor proportion of the wood traded under this name. In 1992 the export of mempisang from Sabah amounted to 25 000 m^3 of sawn timber and 42 500 m^3 of logs with a total value of about US$ 7.2 million. Small amounts of mempisang originating mainly from Sabah and Sarawak are imported by Japan.

Properties *Alphonsea* yields a medium-weight to heavy hardwood with a density of 610–975 kg/m^3 at 15% moisture content. Heartwood pale yellow-brown with a green tinge, not clearly differentiated from the sapwood; grain straight; texture moderately fine to rather coarse and uneven; wood with silver grain. Growth rings usually indistinct, occasionally indicated by layers with denser fibres; vessels moderately small to medium-sized, mostly solitary, sometimes with radial pairs or small clusters, open; parenchyma abundant, apotracheal in regular, narrow bands (scalariform); rays moderately small to medium-sized; ripple marks absent.
The wood should be treated with anti-stain chemicals immediately after sawing.
See also the table on microscopic wood anatomy.



Alphonsea javanica
transverse surface (×20)

Botany Shrubs or small to medium-sized trees up to 30 m tall; bole up to 65 cm in diameter, sometimes distinctly fluted, without buttresses; bark surface smooth to cracking or slightly fissured, grey-white to grey-green or dark green; inner bark fibrous, pink or pale yellowish; crown conical, dense, branches arising steeply from the trunk. Leaves alternate, simple, entire, often leathery, exstipulate. Flowers in an extra-axillary fascicle, bisexual; sepals 3, valvate, connate, several times smaller than the petals; petals 6, valvate in 2 rows, cream, yellow or green, saccate at base, tips reflexed; stamens many, arranged spirally; carpels 1–11, each with 4–19 ovules in (1–)2 rows, stigma sessile. Fruit apocarpous, often with persistent calyx, each monocarp on a distinct stipe, globose to oblong. Seed with a crustaceous to woody wall. Seedling with epigeal germination.
Seedling growth is reputed to be slow at first, growth being maximal at the age of 10–20 years. *A. elliptica* is evergreen or partly deciduous. In Java *A. javanica* flowers in October.

Ecology *Alphonsea* species occur scattered but may be locally common in lowland or rarely lower montane, primary to highly secondary rain forest, up to 1000 m altitude. They usually occur as understorey trees on hills and ridges, sometimes in monsoon or deciduous forest.

Silviculture *Alphonsea* can be propagated by seed. Natural regeneration is very limited. Fruits and seeds are readily attacked by insects and eaten by animals.

Genetic resources and breeding Most *Alphonsea* species show a narrow area of distribution and are quite rare, hence they seem vulnerable to genetic erosion by destruction of their habitat.

Prospects *Alphonsea* wood is commercially interesting because of its attractive appearance, but its limited availability makes its increased use unlikely.

Literature 40, 70, 162, 163, 209, 267, 554, 672, 673, 707, 740, 837, 861, 863, 883, 1017, 1038, 1126, 1134, 1221.

Selection of species

Alphonsea curtisii King

Distribution Peninsular Malaysia.

Alphonsea elliptica Hook. f. & Thomson

Synonyms *Alphonsea maingayi* Hook. f. & Thomson var. *elliptica* Ridley.

Vernacular names Banana tree (En). Malaysia: terbak (Peninsular). Thailand: pe-sae ga-yu, tamyao (peninsular).

Distribution Peninsular Thailand and Peninsular Malaysia.

Alphonsea javanica R. Scheffer

Synonyms *Alphonsea ceramica* R. Scheffer.

Distribution Central Java.

Alphonsea johorensis J. Sinclair

Distribution Peninsular Malaysia and Borneo.

Alphonsea maingayi Hook. f. & Thomson

Vernacular names Malaysia: mengkudang, pepisang bukit, terbak (Peninsular).

Distribution Peninsular Malaysia.

Nguyen Tien Ban

Alseodaphne Nees

Wallich, Pl. asiat. rar. 2: 61, 71 (1831).

LAURACEAE

$x = 12$; *A. keenanii* Gamble: $n = 12$, *A. petiolaris* (Meissner) Hook. f.: $n = 12$

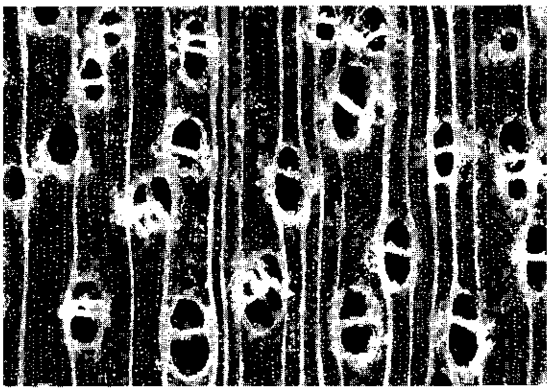
Vernacular names Medang (trade name). Indonesia: huru (Sundanese), malika (Ambon). Burma (Myanmar): kyese-payon.

Origin and geographic distribution *Alseodaphne* comprises about 50 species occurring from Sri Lanka, India and Nepal to Indo-China, southern China, Hainan, Thailand, Peninsular Malaysia, Sumatra, Borneo and the Philippines. The Malesian region harbours about 30 species.

Uses The wood of *Alseodaphne* is used for house building, interior finish, furniture and cabinet making, carving and agricultural implements. Good-quality veneer and plywood can be manufactured from the wood. Some of the heavier species, like *A. bancana* may be used for heavy outdoor construction, ship and boat building and salt-water piling.

Production and international trade The timber of *Alseodaphne* is generally traded together with that of many other *Lauraceae* genera as 'medang'. It constitutes a fair portion of the total amount traded. In 1984 the total export of medang from Peninsular Malaysia to Singapore was 1500 m^3 with a value of US$ 62 000. Japan imports medang mainly from Sabah and Sarawak. In 1992 exports from Sabah amounted to 52 000 m^3 (of which about 10% was sawn timber) with a total value of US$ 4.3 million. The timber is locally in great demand. In South Kalimantan timber of *A. oblanceolata* is available in sufficient and marketable quantities.

Properties *Alseodaphne* yields a medium-weight hardwood with a density of 520–855 kg/m^3 at 15% moisture content. Heartwood pale grey-green to grey-green, moderately sharply differentiated from the pale yellow-green, up to 9 cm wide sapwood, darkening to brown with a green tinge on exposure; grain straight to moderately interlocked; texture moderately fine and even; wood with camphor-like smell when freshly cut; planed surface greasy to the touch. Growth rings indistinct; vessels medium-sized, solitary and in radial groups of 2–4, tyloses often abundant; parenchyma sparse to moderately abundant, paratracheal vasicentric, sometimes confluent in *A. penduliflora*; rays very fine to moderately fine, usually only visible with a hand lens; ripple marks absent.



Alseodaphne insignis
transverse surface (×20)

Shrinkage of the wood upon seasoning is low to high. It seasons easily and without serious defects, although there is a slight risk of splitting and surface checking (observed in *A. nigrescens*) and very slight risk of cupping or bowing. It takes about 3 months and 4.5–5 months, respectively, to air dry boards 13 mm and 38 mm thick. The wood is fairly strong. It is easy to saw and to plane, with only very slight picking up. Sawdust of the wood near the bark contains small hair-like fibres that irritate the skin. The wood is generally fairly durable under cover, but this is variable for the genus. The average service life of *A. insignis* wood in graveyard tests in Peninsular Malaysia is 5.7 years; 5–7 years is reported for the wood of other species. The heartwood is resistant to preservative treatment but sapwood is permeable to such treatment. Using a mixture of 50% creosote and 50% fuel oil in various open-tank methods the absorption is 22–46 kg/m^3 for *A. insignis*, 8–27 kg/m^3 for *A. nigrescens* and over 110 kg/m^3 for sapwood of these species. The wood is slightly susceptible to borer attacks.

A. perakensis leaves contain alkaloids.

See also the tables on microscopic wood anatomy and wood properties.

Botany Evergreen or briefly deciduous, small to medium-sized trees up to 30(–40) m tall; bole usually fairly straight, branchless for up to 21 m, up to 60(–100) cm in diameter, sometimes with small or rarely up to 3 m high buttresses; bark surface smooth to fissured or cracking or even scaly, sometimes dippled, often lenticellate, brown, dark brown or grey to yellowish, inner bark yellow to yellowish-brown or orange-brown to red or pink. Leaves arranged spirally, often crowded at the end of branchlets, simple, entire, exstipulate; terminal bud naked or covered with scales. Flowers in a few-flowered, axillary panicle, bisexual; tepals 6, with a short tube, the outer 3 usually smaller than the inner 3, enlarged in fruit and persistent or caducous; fertile stamens 9, in 3 whorls, those of the inner whorl with 2 glands each, anthers 4-celled, opening by valves; ovary superior, 1-locular with a single ovule, stigma peltate. Fruit a black or grey, 1-seeded, ellipsoid berry on an enlarged, fleshy, usually warty pedicel. Seedling with hypogeal germination; cotyledons not emergent, peltate; hypocotyl not developed; epicotyl with a few scales; all leaves arranged spirally.

Growth is in flushes. Some species show distinct sympodial branching resulting in a pagoda-shaped tree. *A. bancana* is a typical understorey tree in Sepilok, Sabah, with a mean annual diameter increment of less than 0.4 cm. The seeds are dispersed by birds.

Alseodaphne is closely related to the genera *Nothaphoebe* and *Persea*, and the three used to be treated as a single genus. *Nothaphoebe* may be distinguished from *Alseodaphne* by its many-flowered inflorescences and sessile anthers, whereas both *Nothaphoebe* and *Persea* lack the typical enlarged and usually warty fruit stalk. Furthermore, *Alseodaphne* is also very similar to *Dehaasia*, the only differentiating character being the number of anther cells. Identification based solely on fruiting material is therefore very difficult. *Alseodaphne* needs a thorough taxonomic revision, as the status of many species is still doubtful.

Ecology Most *Alseodaphne* species occur as understorey trees of non-seasonal, evergreen, lowland to lower montane rain forest, up to 1600 m altitude. They are found in primary and secondary forest on a wide range of soils and may be locally dominant. Several species inhabit lowland swamp forest. *A. insignis* is found in lowland dipterocarp forest but also in kerangas and peat-swamp forest.

Silviculture *Alseodaphne* is rather sensitive to fire. Mortality of about 50% has been observed in Indonesia.

Genetic resources and breeding It is hard to judge whether genetic erosion by destruction of the habitat seriously threatens *Alseodaphne*, but at least some of the species mentioned below may be vulnerable due to their limited area of distribution.

Prospects In Peninsular Malaysia *Alseodaphne* makes up a small, but notable part of the medang timber trade group, but there is no reason to expect an increase in its utilization.

Literature 70, 162, 163, 218, 267, 387, 556, 603, 605, 608, 614, 626, 677, 678, 755, 829, 861, 908, 933, 955, 974, 1040, 1218, 1221, 1242.

Selection of species

Alseodaphne albifrons Kosterm.

Distribution Peninsular Malaysia and Borneo.

Alseodaphne bancana Miq.

Synonyms *Alseodaphne decipiens* Hook. f.

Vernacular names Indonesia: medang pongot (Sumatra). Malaysia: medang sisek (Sabah).

Distribution Peninsular Malaysia, Singapore, Sumatra, Bangka and Borneo.

Alseodaphne dura Kosterm.
Vernacular names Malaysia: medang hitam (Peninsular).
Distribution Peninsular Malaysia (rare).

Alseodaphne glauciflora Kosterm.
Distribution Sumatra; possibly also in Borneo (Kalimantan).

Alseodaphne insignis Gamble
Vernacular names Indonesia: medang burung. Malaysia: medang payong, medang tanah, medang tandok (Peninsular).
Distribution Peninsular Malaysia, Sumatra and Borneo.

Alseodaphne intermedia Kosterm.
Distribution Peninsular Malaysia, Singapore and Sumatra.

Alseodaphne longipes Quisumbing & Merr.
Vernacular names Philippines: babulo (Tagalog).
Distribution The Philippines.

Alseodaphne macrantha Kosterm.
Distribution Peninsular Malaysia (rare).

Alseodaphne montana Kosterm.
Distribution Borneo (Sabah).

Alseodaphne nigrescens (Gamble) Kosterm.
Synonyms *Dehaasia nigrescens* Gamble.
Vernacular names Malaysia: medang tandok (Peninsular).
Distribution Peninsular Thailand, Peninsular Malaysia, Singapore, Sumatra, Bangka and Belitung; possibly also in Borneo (Sarawak).

Alseodaphne oblanceolata (Merr.) Kosterm.
Synonyms *Beilschmiedia elmeri* Merr., *Beilschmiedia oblanceolata* Merr., *Dehaasia oblanceolata* (Merr.) Kosterm.
Distribution Peninsular Malaysia (rare) and Borneo.

Alseodaphne obovata Kosterm.
Vernacular names Indonesia: lilin-lilin (Kalimantan).
Distribution Peninsular Malaysia and Borneo (Brunei, Sarawak, Kalimantan).

Alseodaphne pendulifolia Gamble
Vernacular names Malaysia: medang payong, medang tembakol (Peninsular).
Distribution Peninsular Malaysia and Borneo (Sabah).

Alseodaphne perakensis (Gamble) Kosterm.
Synonyms *Stemmatodaphne perakensis* Gamble.
Vernacular names Malaysia: medang ketanah, medang kuning, medang tajing (Peninsular).
Distribution Peninsular Malaysia and Singapore.

Alseodaphne ridleyi Gamble
Vernacular names Malaysia: medang sesudu (Peninsular).
Distribution Peninsular Malaysia.

S. Suhandono

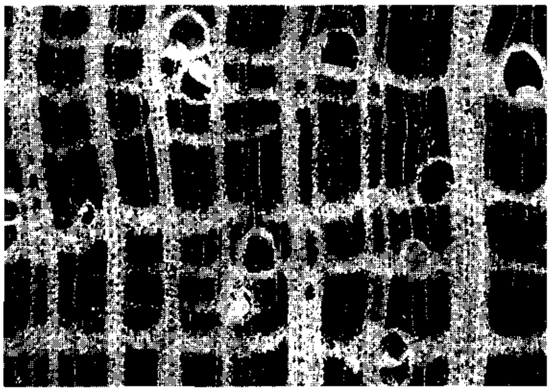
Anisophyllea R. Br. ex Sabine

Trans. Hort. Soc. London 5: 446 (1824).
ANISOPHYLLEACEAE
x = unknown; $2n$ = unknown

Vernacular names Leechwood (En). Indonesia: kayu ribu. Malaysia: dalek (general), mertama, sial menahun (Sarawak).

Origin and geographic distribution *Anisophyllea* comprises about 30 species which are distributed in southern Asia (from Sri Lanka and India to Malesia), tropical Africa and tropical South America (one species only in the latter region). In Malesia 15 species occur: 8 in Peninsular Malaysia, 2 in Sumatra, 2 in Lingga and 9 in Borneo. Many species have a limited distribution. *A. disticha* has the largest area of distribution: throughout western Malesia except Java.

Uses The hard and durable wood of some *Anisophyllea* species is used for beams in house construction, interior finish, furniture, tool handles, fence posts, household implements and sliced veneers. The wood of *A. disticha* is used for making walking sticks and shafts of pikes, spears and lances.
An infusion of the leaves of *A. disticha* is used medicinally against diarrhoea and dysentery. A decoction of the leaves is used for bathing persons suffering from jaundice, whereas the roots and the leaves are an ingredient of medicines used to relieve fatigue.

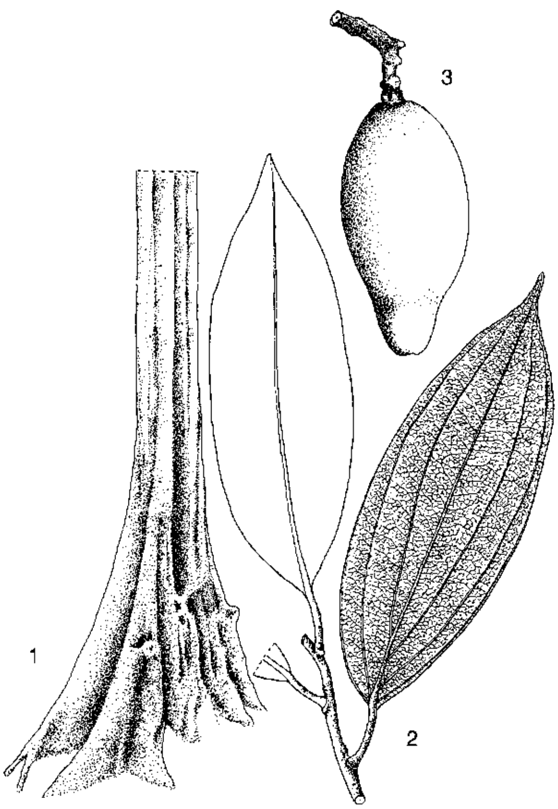


Anisophyllea beccariana
transverse surface (×20)

Production and international trade *Anisophyllea* trees are often too small and too scattered to be important for timber production.

Properties *Anisophyllea* yields a heavy hardwood with a density of 800–980 kg/m^3 at 15% moisture content. Heartwood pink-brown to orange-brown or dark brown, not clearly defined from the sapwood; grain straight; texture medium to coarse and uneven due to the presence of wide rays; wood with conspicuous oak-like silver grain on the radial surface. Growth rings indistinct or absent; vessels medium-sized to large, solitary and in occasional radial pairs, with white chalky deposits; parenchyma abundant, apotracheal diffuse-in-aggregates and in wide bands; rays moderately broad, distinct; ripple marks absent.
The shrinkage of the wood during drying is high. It dries moderately slow to moderately rapid without serious defects except for some slight end checking. The wood is fairly easy to work, moderately durable and difficult to treat with preservatives.
See also the tables on microscopic wood anatomy and wood properties.

Botany Monoecious shrubs or small to occasionally fairly large trees up to 36 m tall; bole up to 80 cm in diameter, often poorly shaped and slightly fluted at base, occasionally with short buttresses; bark surface smooth to slightly cracking or flaky, sometimes finely fissured or dippled or with horizontal rings, greyish-brown to reddish-brown, inner bark granular, yellow or pink to reddish-brown, sapwood often with strong radial rays, yellow to creamy to reddish-brown. Leaves alternate and distichous, simple, often asymmetrical, entire, with 3–5 longitudinal veins, sometimes pinnately veined (*A. griffithii*), in some species with two additional rows of stipule-like leaves; stipules absent. Inflorescence axillary, spike-like to paniculate. Flowers small, unisexual, polygamous or apparently bisexual, usually 4-merous; calyx with triangular lobes; petals entire to deeply divided; stamens twice as many as petals, usually unequal in length; ovary inferior, 3–5-locular with a single ovule in each cell, generally with 4 styles. Fruit a dry and rather hard-shelled drupe (fleshy in *A. disticha*), ellipsoid to pyriform, smooth or ridged, indehiscent, with persistent floral parts, usually 1-seeded. Seedling with hypogeal germination; cotyledons apparently absent, storage function passed on to a specialized hypocotyl. The hypocotyl is contained within the seed-coat and does not appear above the ground. This 'storage hypocotyl' does not grow during germination, does not become erect and is eventually abscised.
The development is according to Massart's architectural tree model, determined by an orthotropic, monopodial trunk with rhythmic growth consequently producing tiers of plagiotropic branches.



Anisophyllea ferruginea Ding Hou – 1, bole; 2, sterile twig; 3, fruit.

In *A. corneri* flowering is aseasonal.

Anisophyllea seems to be most closely related to *Combretocarpus*, which differs in the pinnately veined leaves, the 3-merous flowers and winged fruit. These two genera are often considered to represent a separate tribe (*Anisophylleae*) in the *Rhizophoraceae*, but recent multidisciplinary studies point to the distinction of a separate family (*Anisophylleaceae*).

Ecology *Anisophyllea* species occur scattered, never gregariously, in primary lowland or hill dipterocarp forest, sometimes in old secondary forest. In Sarawak they sometimes occur also in kerangas, up to 1000 m altitude, or very rarely higher. Occasionally, they reach the upper canopy of the forest, but are usually understorey or lower canopy trees.

Silviculture Germination rates of 85–95% in 1–9 months after sowing for stones of *A. grandis* and of 45% in 7 months to 3 years for fruits of *A. griffithii* have been reported.

Genetic resources and breeding Many *Anisophyllea* species are rare and found only in small forest areas, which suggests they may be threatened by destruction of their habitat or excessive harvesting.

Prospects Very little is known on the silviculture and timber utilization of *Anisophyllea*, although the durability and attractive silver grain of the wood may be of future interest. Due to the very limited supply and localized distribution, increased utilization of wood originating from the forest is not foreseen.

Literature 61, 163, 209, 267, 341, 378, 402, 678, 718, 825, 831, 933, 1048, 1221, 1239, 1242.

Selection of species

Anisophyllea apetala Scort. ex King

Vernacular names Malaysia: dalek bukit, dalek limau manis, medang berunit (Peninsular).

Distribution Peninsular Malaysia.

Anisophyllea beccariana Baillon

Vernacular names Malaysia: kerdam, pei (Sarawak).

Distribution Borneo (Sarawak and Brunei); possibly also Sumatra.

Anisophyllea corneri Ding Hou

Vernacular names Malaysia: mertama (Sarawak), nipis kulit, peparah (Peninsular).

Distribution Peninsular Malaysia and Borneo.

Anisophyllea disticha (Jack) Baillon

Vernacular names Indonesia: kayu kancil, kayu ribu (Palembang, Sumatra), keribu (West Kalimantan). Malaysia: kayu ribu-ribu, pokok kancil (Peninsular), ambun ambun, kayu runap (Sarawak).

Distribution Peninsular Malaysia, Sumatra, Lingga, Bangka and Borneo.

Anisophyllea ferruginea Ding Hou

Vernacular names Malaysia: belian landak, kepajang landak, sangkuak (Sarawak).

Distribution Borneo.

Anisophyllea grandis (Benth.) Burkill

Synonyms *Anisophyllea gaudichaudiana* Baillon.

Vernacular names Penang pear (En). Malaysia: dalek limau manis (Peninsular).

Distribution Peninsular Malaysia; possibly also in Borneo (Sarawak).

Anisophyllea griffithii Oliver

Vernacular names Malaysia: dalek tembaga, hampas dadah (Peninsular).

Distribution Peninsular Malaysia and Singapore.

H.C. Ong

Anogeissus (DC.) Guill. & Perr.

Fl. Seneg. tent. 1: 279, t. 65 (1832).

COMBRETACEAE

$x = 12$; *A. latifolia*: $n = 12$

Vernacular names Axlewood (En). Burma (Myanmar): mai-hio, yon. Laos: ben mon. Thailand: takhian-nu. Vietnam: r[aa]m, x[oo]i.

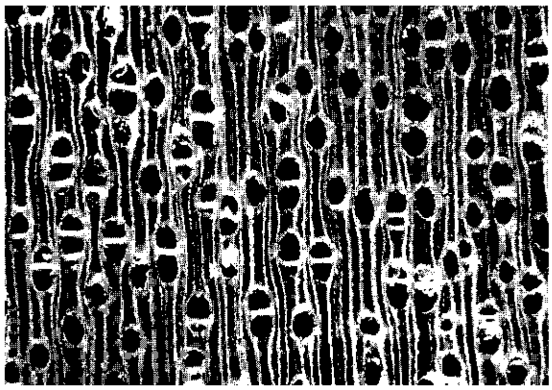
Origin and geographic distribution *Anogeissus* comprises 8 species occurring in tropical Africa (1 species), southern Arabia (2 species), India, Sri Lanka, Nepal, Burma (Myanmar), Indo-China and Thailand.

Uses The wood is mainly used for tool handles and other agricultural implements, and is a well-known substitute for hickory (*Carya* spp.) and ash (*Fraxinus* spp.). It is also used for general heavy construction (poles, rafters), boat building (masts), flooring, cart wheels, spokes and axles, sporting goods (hockey sticks, cricket stumps), sucker rods, pit props, turnery articles, and for furniture. Besides, it yields good charcoal and firewood, and when mixed with other species is suit-

able for the manufacture of writing and packing paper.
In India 'ghatty gum' is tapped from *A. latifolia*. It is a good substitute for gum arabic and used in e.g. calico printing, for sweetmeats, in dye processes, and as a binding agent in pharmaceuticals. The leaves and bark are used for tanning and the leaves yield a black dye that is used commercially in India. Tussar silkworms are fed on its foliage which is also used as fodder for cattle. The medicinal use of *A. latifolia* for curing snake bites and scorpion stings has been reported from India.

Production and international trade Small amounts of *Anogeissus* are exported from India and Burma (Myanmar), mainly to Great Britain. Otherwise trade and utilization is on a local scale only.
Ghatty gum is exported from India on a small scale, a few hundred tons per year.

Properties *Anogeissus* yields a heavy hardwood with a density of 760–940 kg/m^3 for *A. acuminata* and 870–1040 kg/m^3 for *A. latifolia* at 15% moisture content. Heartwood absent or small in diameter even in large trees, purplish-brown or dark brown, often with darker streaks, not clearly differentiated from the wide whitish-grey to greenish-grey or pale yellow to yellowish-grey sapwood; grain straight to shallowly interlocked; texture fine to medium and even. Growth rings usually indistinct, when distinct indicated by layers without vessels; vessels very small to medium-sized, solitary and in radial multiples of 2–4, often arranged in wavy oblique groups, usually open; parenchyma variable in abundance but often sparse, paratracheal vasicentric, aliform or confluent, and occasionally apotracheal in irregularly spaced bands; rays very fine, not visible to the naked eye; ripple marks absent; occasional intercellular canals of traumatic origin in tangential arrangement; pith flecks rare.



Anogeissus acuminata
transverse surface (×20)

Shrinkage upon seasoning is moderate to high, and the wood is difficult to season as it is liable to warping, splitting and surface-checking. Green conversion during or at the end of the rainy season followed by stacking under cover to allow for slow drying is recommended. Kiln drying at low kiln temperatures is possible. The wood is hard, strong and very tough. It is difficult to saw, but with sharp tools it can be turned, machined and finished to a smooth surface. Reports on the durability are contradictory. The sapwood is probably susceptible to *Lyctus*. The heartwood is very resistant to preservative treatment. The energy value of *A. latifolia* is 17 600–20 500 kJ/kg.
Leaves and bark contain about 19% tannin.
See also the tables on microscopic wood anatomy and wood properties.

Botany Deciduous, small to medium-sized trees up to 20(–36) m tall; bole straight and cylindrical or sometimes more poorly shaped, branchless for up to 8(–10) m, up to 80(–100) cm in diameter, occasionally with small buttresses; bark surface smooth or with small scales, pale to dark grey; branches drooping. Leaves opposite or subopposite, variably distichous, simple, entire, exstipulate, with greyish-yellow or whitish hairs below. Flowers sessile, in dense, globose heads on an axillary or terminal peduncle, 5-merous, small; sepals connate in a stalk-like tube, expanded at apex into a 5-lobed cup; petals absent; stamens 10, in 2 rows; disk intrastaminal, lobed; ovary inferior, 1-locular with 2 pendulous ovules, style simple. Fruit a 2-winged pseudo-achene, packed into a dense head, 1-seeded; calyx tube persistent and forming a beak. Seedling with epigeal germination.
Growth rates are fairly high; in natural forest in India the range of mean annual diameter increment of *A. latifolia* is 0.1–0.6 cm, compared with 0.6–1.1 cm for planted 16-years-old trees. *A. acuminata* trees reached a mean height of 12 m and a mean diameter of 7–10 cm 10 years after planting. In India *A. latifolia* is leafless in February–May, flowers in June–September depending on locality, and mature fruits are present in December–March. In Burma (Myanmar) flowering of *A. acuminata* has been observed in February–March, fruiting in April–May. The winged fruits seem adapted to wind dispersal.

Ecology *Anogeissus* species are found in deciduous or semi-evergreen forest, up to 1300 m altitude. They are common elements in teak forest but also occur in the understorey of dipterocarp forest, in mixed deciduous forest, in bamboo forest and even in vegetation under semi-arid conditions like savanna woodland and dry rocky hills. Associated species include Indian walnut (*Albizia lebbeck* (L.) Benth.), Indian rosewood (*Dalbergia* spp.), Indian rose chestnut (*Mesua ferrea* L.) and keruing (*Dipterocarpus* spp.). The average annual rainfall for *A. latifolia* is 225–625 mm, the absolute maximum temperature is 38–45°C and absolute minimum temperature is –1–16°C. It is found on a variety of soil types but prefers deep alluvial soils. It may form pure stands on e.g. sandstone, and does not tolerate waterlogging.

Silviculture Silvicultural information is mainly based on Indian experience. *Anogeissus* can be propagated by seed and tissue culture; the latter technology has been performed on an experimental scale only. Seed viability is extremely low, never more than 3%. It has been suggested that the viability of *A. latifolia* seed increases after a very dry season. In 15 germination tests executed in Burma (Myanmar) seed of *A. acuminata* proved to be completely unviable. There are 105 000–125 000 seeds of *A. latifolia* or 39 000–63 000 dry fruits of *A. acuminata* in 1 kg. Seed should be sown under shade. Germination starts about 20 days after sowing. Seedlings of *A. latifolia* attain 10–20 cm height and develop a taproot of 45 cm in the first growing season. Stumps from 1-year-old seedlings proved to be the best planting stock. Young trees are very intolerant of weed competition. *Anogeissus* trees are light demanding but they can stand slight shade when very young. The trees produce root suckers and coppice and pollard well; they should not be coppiced or pollarded in the rainy season. Planted *A. acuminata* performed best with a mean annual rainfall of 750–1250 mm on deep loamy soils. *A. latifolia* has been tried extensively in India, but generally with disappointing results. Natural regeneration of both *Anogeissus* species, however, is very good. The use of wildlings could prove interesting for artificial regeneration of *Anogeissus*.

Genetic resources and breeding As both *A. acuminata* and *A. latifolia* are widespread and often common, they do not seem to be endangered, except perhaps as a result of excessive collection of gum. There are no records of orchards or germplasm collections of *Anogeissus* species.

Prospects Trials in South-East Asia with *Anogeissus*, in particular *A. acuminata*, are recommended to determine its potential as a fairly fast producer of excellent timber under comparatively dry conditions.

Literature 111, 163, 218, 343, 392, 455, 464, 536, 571, 923, 924, 932, 933, 963, 999, 1038, 1052, 1064, 1098, 1104, 1169, 1177.

Selection of species

Anogeissus acuminata (Roxb. ex DC.) Guill. & Perr.

Synonyms *Anogeissus pierrei* Gagnep., *Anogeissus tonkinensis* Gagnep., *Conocarpus acuminata* Roxb. ex DC.

Vernacular names Burma (Myanmar): hypunsha, yon, yung. Cambodia: choeung chap thom, soy chhmôl, soy nhi. Laos: ang kha nhê, ben mon, en mon. Thailand: heo (northern), takhian-nu (central). Vietnam: hio, ram, sin.

Distribution India, Burma (Myanmar), Indo-China and Thailand.

Anogeissus latifolia (Roxb. ex DC.) Wallich ex Guill. & Perr.

Synonyms *Conocarpus latifolia* Roxb. ex DC.

Vernacular names Axlewood (En).

Distribution India, Sri Lanka and Nepal.

C. Phengklai

Antiaris Lesch. (timber aspects)

Ann. Mus. Natl. Hist. Nat. 16: 478 (1810).

MORACEAE

x = unknown; *A. toxicaria* (several subspecies): $2n = 24, 28$

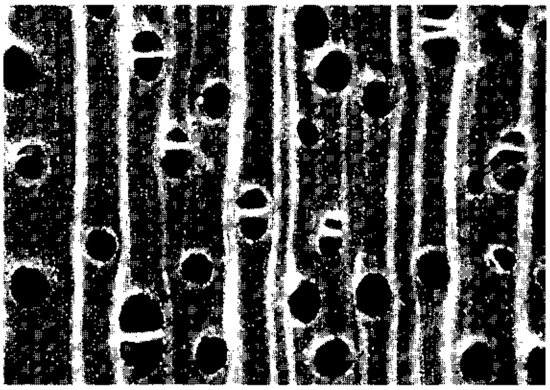
Vernacular names Antiaris (En, trade name), upas tree (En). Indonesia: upas (general), ancar (Javanese), tatai (Sumatra). Malaysia: terap (general), ipoh (Peninsular), tasem (Sarawak). Papua New Guinea: antiaris (En). Philippines: upas (Filipino). Burma (Myanmar): aseik. Laos: 'nong[2]. Thailand: yang nong (central, northern), yuan (peninsular). Vietnam: c[aa]y sui.

Origin and geographic distribution *Antiaris* is a monotypic genus. Its only species, *A. toxicaria* Lesch. (synonyms: *A. africana* Engl., *A. macrophylla* R. Br., *A. welwitschii* Engl.), is found throughout the Old World tropics, from West Africa to Madagascar, Sri Lanka, India, Indo-China, southern China, Thailand, throughout the Malesian region, the Pacific (east to Fiji and Tonga), and northern Australia.

Uses The wood of *A. toxicaria* is used for light construction, interior finish, furniture, moulding, panelling, shuttering, strip flooring, pallets, fruit cases, crates, handles for non-striking tools, plywood, core veneers and when treated also for weatherboards and shingles. It is suitable for the production of blockboard.
The bark yields a latex which is one of the principal components of most dart and arrow poisons in South-East Asia. Seeds, leaves and bark are used as a febrifuge and the seeds also as an antidysenteric. The bark has also been used for dyeing and as a bark cloth to make rough clothing. The fruit is edible.

Production and international trade In general, the wood of *A. toxicaria* is used only locally or traded in mixed consignments of lightweight hardwood. Export from Papua New Guinea, however, is fair. In 1987 2.7% of all timber exported to Japan from Papua New Guinea was *Antiaris*, and in 1992 it ranked in MEP (Minimum Export Price) group 3, yielding a minimum export price for saw logs of US$ 50/m^3. In 1996 Papua New Guinea exported about 6570 m^3 of *Antiaris* logs at an average free-on-board (FOB) price of US$ 118/m^3. In 1992 the export of 'terap' (also including timber of *Parartocarpus* and the lightweight *Artocarpus* species) from Sabah amounted to almost 9000 m^3, mainly as logs, with a total value of US$ 630 000.

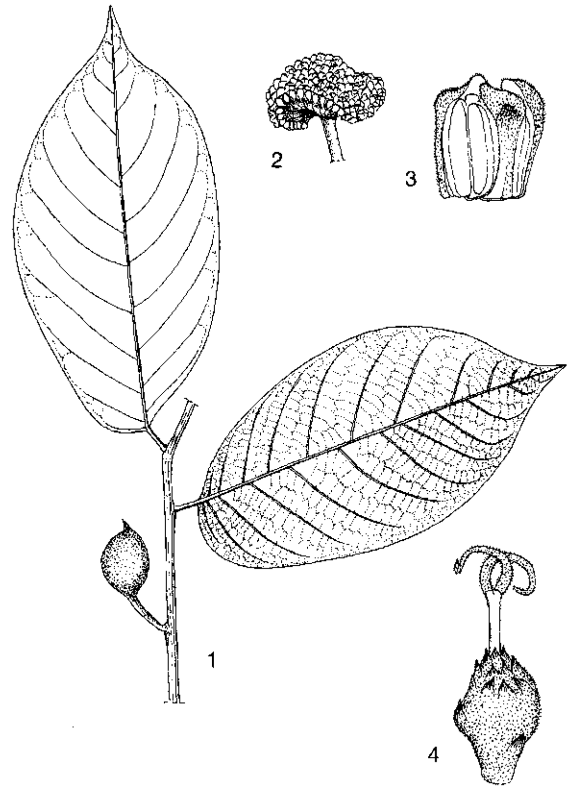
Properties *A. toxicaria* yields a lightweight hardwood with a density of (250–)390–540 kg/m^3 at 15% moisture content. Heartwood almost white, pale yellow or pale yellow-brown, not clearly differentiated from the sapwood which is up to 8 cm wide; grain interlocked; texture moderately coarse to coarse and even; wood lustrous and with ribbon figure on quarter-sawn surface. Growth rings indistinct; vessels moderately large to very large, mostly solitary, some in radial multiples of 2–4(–more), rarely in clusters, often with dark-coloured extraneous deposits, tyloses sparse or absent; parenchyma moderately abundant, paratracheal vasicentric and aliform, occasionally confluent; rays medium-sized, not conspicuous on radial surface; ripple marks absent; wood with laticifers, sometimes appearing as brown dots on tangential faces.



Antiaris toxicaria
transverse surface (×20)

Shrinkage upon seasoning is moderate and the wood dries rapidly with little degrade. The wood is soft and very weak. It is fairly easy to work with hand and machine tools, and is easy to saw, but sharp tools are required to prevent crumbling, particularly along the edges. Some tearing may occur in planing, but it produces a very lustrous surface. It nails, glues and polishes well and is easy to peel. The wood is non-durable, but both heartwood and sapwood are permeable to pressure treatment; a retention of 455 kg/m^3 and 540 kg/m^3 has been determined for heartwood and sapwood, respectively. Rapid conversion and the application of anti-stain chemicals upon felling and immediately after sawing are essential, as the wood is liable to sap-stain. The wood is susceptible to pinhole borers and dry-wood termites. The sapwood is susceptible to *Lyctus*. Sawdust may cause skin irritation and stomach pain.
See also the tables on microscopic wood anatomy and wood properties.

Botany A sometimes deciduous, monoecious, small to large tree up to 45(–60) m tall; bole straight, branchless for up to 23 m, up to 180 cm in diameter, sometimes with steep buttresses up to 3 m high; bark surface smooth becoming slightly fissured, greyish-white, inner bark soft and fibrous, pale yellowish, exuding a creamy copious latex which soon darkens to dirty brown and becomes granular upon exposure; crown conical at first, dome-shaped at maturity. Twigs hairy. Leaves distichous, simple, entire to denticulate, rounded to slightly heart-shaped and slightly unequal at base; stipules free, caducous. Inflorescence on a short shoot, in leaf axils or below the leaves, subtended by involucral bracts, in groups of 2–4, the male ones below the female ones on the same twig. Male inflorescence a short-stalked discoid head with many flowers; each flower with 2–7 tepals and 2–4 stamens. Female inflorescence with 1–2 flowers, sessile or stalked; flower pear-shaped; perianth 4-lobed; ovary adnate to the perianth, 1-locular with a single ovule, styles 2. Fruit forming a drupaceous whole together with



Antiaris toxicaria Lesch. – 1, fruiting twig; 2, male inflorescence; 3, staminate flower; 4, female inflorescence.

the enlarged, fleshy receptacle, ellipsoid to pear-shaped, velvety. Seedling with hypogeal germination; cotyledons not emergent; hypocotyl not elongated; epicotyl with a few scale leaves followed by spirally arranged, conduplicate, dentate leaves.

Trees develop according to Roux's architectural tree model, characterized by a continuously growing monopodial orthotropic trunk and plagiotropic branches. In a 27-year-old trial in Indonesia trees measured on average 17 m in height and 27 cm in diameter. In Java *A. toxicaria* flowers in June on the new shoots.

Formerly, *A. toxicaria* comprised several species, but is now regarded as a single, though variable species. It has been divided into 5 subspecies; subsp. *toxicaria* and subsp. *macrophylla* (R. Br.) C.C. Berg occur within the Malesian region, the first is found from Sri Lanka to Sulawesi, the second from the Philippines to Tonga. The size of the fruit increases from Africa to Polynesia.

Ecology *Antiaris* is found as a rare, scattered tree in primary forest up to 1500 m altitude. It is occasionally found in grassy savanna and on coastal plateaus. In Africa it occurs under semi-arid conditions.

Silviculture *A. toxicaria* can be propagated by seed. About 70–90% of sown stones germinate in 18–89 days. Trees have a good self-pruning ability; they are not resistant to fire. In Ulu Kelantan, Peninsular Malaysia, a density of about 1 tree per 80 ha of natural forest has been observed, but elsewhere in Peninsular Malaysia it is probably even rarer.

Genetic resources and breeding Genetic erosion of *A. toxicaria* is difficult to assess: on the one hand, trees are not widely harvested throughout their natural area of distribution, on the other, they are rare in natural forest in Peninsular Malaysia.

Prospects Its good peeling properties make *Antiaris* acceptable for plywood production, but supply will surely limit an increase in use.

Literature 40, 70, 105, 125, 151, 162, 163, 205, 209, 227, 267, 300, 302, 304, 340, 348, 402, 436, 536, 740, 741, 758, 829, 831, 951, 974, 1038, 1087, 1218, 1221, 1242, 1248.

E. Boer & M.S.M. Sosef

Antidesma L.

Sp. pl. 2: 1027 (1753); Gen. pl., ed. 5: 451 (1754).
EUPHORBIACEAE

$x = 13$; *A. bunius*: $n = 117$; *A. bunius*, *A. ghaesembilla*: $2n = 26$

Vernacular names Indonesia: buni (Indonesian), ki huni (Sundanese), wuni (Javanese). Philippines: bignai (Filipino). Burma (Myanmar): kinbalin. Laos: 'm[ax]o², 's[oox]m². Thailand: mao, mamao, sommao. Vietnam: ch[of]i m[of]i v[of] d[ow].

Origin and geographic distribution *Antidesma* comprises about 200 species distributed in the Old World tropics. Only about 10 occur in tropical Africa and Madagascar, the remainder are found in Asia with a few in tropical Australia and the Pacific.

Uses The wood of *Antidesma* is used for temporary construction, poles, posts, fence posts and small objects like walking-sticks and tool handles. Wood chips, mixed with those of other species, have been used successfully to manufacture hardboard. The hard but small-sized wood is also used for fuel, and *A. ghaesembilla* is well-known in this respect in India.

A. bunius is a comparatively well-known fruit tree, occasionally also applied in reforestation projects. Several other species, e.g. *A. ghaesembilla* and *A. stipulare*, bear edible fruits as well. The young leaves of some species are sour and eaten in salads and used to flavour fish or meat stew, or may serve as a substitute for vinegar. The bark and leaves of some species contain an alkaloid and are applied medicinally, e.g. to relieve fever and against smallpox and body swellings, but are also reported as poisonous.

Production and international trade The use of *Antidesma* wood is limited and on a local scale only because most trees are small.

Properties *Antidesma* yields a medium-weight to heavy hardwood with a density of 580–925 kg/m^3 at 15% moisture content. Heartwood purple-red-brown or grey-brown with a purple-red tinge, not clearly differentiated from the sapwood; grain straight; texture fine and even. Growth rings indistinct; vessels very small to moderately small, usually in radial multiples of 2–4, occasionally with tyloses; parenchyma apotracheal diffuse, difficult to see even with a hand lens; rays extremely fine to medium-sized; ripple marks absent.

A. ghaesembilla is siliceous and may be difficult to work. The wood is moderately hard to hard and strong. It is considered only moderately durable to non-durable; it is resistant to dry-wood termites, but not resistant to fungi. The sapwood is non-susceptible to *Lyctus*.

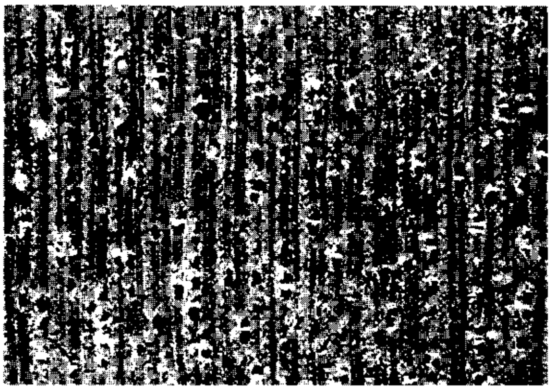
The gross energy value of the wood of *A. ghaesembilla* is 18 615–19 630 kJ/kg.

See also the table on microscopic wood anatomy.

Botany Dioecious shrubs or small to occasionally medium-sized trees up to 20(–28) m tall; bole fairly straight in larger trees, up to 60 cm in diameter, without buttresses. Leaves alternate, simple, entire, mostly short-petioled; stipules caducous or persistent. Flowers in an axillary or terminal or sometimes cauliflorous simple or paniculate spike or raceme, unisexual, small, solitary in the axil of bracts; calyx 3–5-toothed or -lobed with imbricate lobes; petals absent. Male flower with a disk of free or fused glands; stamens 2–5(–10); pistillode small or absent. Female flower with an annular disk; ovary superior, 1(–2)-locular with 2 ovules in each cell, styles 3(–5), terminal or lateral. Fruit drupaceous, with a single 1-seeded carpel, indehiscent, red or black; calyx persistent. Seedling with epigeal germination; cotyledons emergent, leafy; hypocotyl elongated; first few leaves arranged spirally, subsequent ones distichous, conduplicate.

In the Philippines a mean annual diameter increment of 2.0 cm has been recorded for *A. ghaesembilla* for the diameter class 10–20 cm. Vesicular-arbuscular endotrophic mycorrhizae have been observed in *A. ghaesembilla*. In Java most of the timber-yielding species can be found flowering throughout the year. Observations of birds eating the fruit suggest that they disperse the seeds.

Some authors separate *Antidesma* from the *Euphorbiaceae* and place it in a separate family, the *Stilaginaceae*. It is often difficult to identify the individual species of *Antidesma*.



Antidesma moluccanum
transverse surface (×20)

Ecology Timber-yielding *Antidesma* species are often found in the understorey of primary or secondary, lowland to montane rain forest, up to 1800 m altitude. They grow on a wide variety of soils including alluvial flats, clayey soils, peaty soils, volcanic soils, podzols and limestone. Forest types include dry-land forest, swamp forest, beach forest and the inner edge of mangrove forest. *A. ghaesembilla* is locally common and also occurs in more open locations like forest edges and along rivers, often together with *Acacia* spp., on sandy or badly eroded rocky soils, or it appears as one of the first fire-resistant trees in grassland.

Silviculture *Antidesma* can be propagated by seed; the fruit-producing trees are also propagated by stem cuttings, marcotting, budding, and grafting. Depulped and dried fruits of *A. bunius* may be stored for 2–5 years in airtight containers without a serious decrease in seed viability. There are about 28 000 dry seeds/kg for *A. bunius*; these seeds need about 1 month of after-ripening and can then be sown under shade without pretreatment. Fresh seeds, however, need a pretreatment with sulphuric acid for 15 minutes followed by soaking in water for 24 hours. The viability of

Antidesma seeds is very variable, as for example in *A. bunius* (3–70%) and in *A. neurocarpum* (18–84%). Seeds of *A. bunius* germinate in 30–60 days, fruits of *A. cuspidatum* in 12–59 days and seeds of *A. neurocarpum* in 35–96 days. *A. bunius* has been successfully used in teak plantations as a shade-tolerant weed-suppressing species which produces abundant litter. On poor sites, however, its growth is minimal. When planted in 'alang-alang' (*Imperata cylindrica* (L.) Raeuschel) grasslands in the Philippines, *A. ghaesembilla* showed 85% survival after 4 months, but growth was seriously impeded, so it is not recommended for planting in such conditions.

Genetic resources and breeding Except for the cultivated *A. bunius*, there are no records of ex situ conservation of *Antidesma*. The species that have a limited distribution may easily become endangered by destruction of the habitat.

Prospects As trees are small the use of *Antidesma* wood is unlikely to increase, except perhaps if it proves to be suitable for the manufacture of wood-based panels.

Literature 26, 28, 32, 33, 34, 36, 70, 75, 130, 150, 162, 163, 209, 267, 308, 405, 406, 436, 543, 553, 777, 829, 831, 861, 934, 937, 974, 1011, 1038, 1164, 1169, 1195, 1221.

Selection of species

Antidesma bunius (L.) Spreng.

Synonyms *Antidesma crassifolium* (Elmer) Merr., *Antidesma dallachyanum* Baillon, *Antidesma rumphii* Tul.

Vernacular names Bignay, Chinese laurel, salamander tree (En). Antidesme (Fr). Indonesia: buni (general), huni (Sundanese), wuni (Java). Malaysia: buneh, buni (general), berunai (Peninsular). Philippines: bignai (Tagalog), isip (Pampango), paginga (Ibanag). Burma (Myanmar): kywe-pyisin. Laos: kho liên tu. Thailand: ba mao ruese, mamao dong (northern), mao chang (south-eastern). Vietnam: ch[of]i m[of]i.

Distribution From Sri Lanka, southern India and the eastern Himalaya to Burma (Myanmar), Indo-China, southern China, Thailand, and throughout the Malesian region excluding Peninsular Malaysia and most of Borneo (recorded from Banggi Island only) towards Australia (Queensland); possibly not native to the Philippines, also widely cultivated in Indonesia (mainly Java), Peninsular Malaysia, the Philippines and Indo-China.

Antidesma coriaceum Tul.

Synonyms *Antidesma nitens* Pax & K. Hoffm., *Antidesma pachyphyllum* Merr., *Antidesma puncticulatum* Miq.

Vernacular names Malaysia: beras-beras hitam, kayu lundu, kayu mata punai (Peninsular).

Distribution Peninsular Malaysia, Singapore, Sumatra and Bangka.

Antidesma cuspidatum Müll. Arg.

Vernacular names Malaysia: kenidai punai, petaling pagu, sebasah bukit (Peninsular).

Distribution Peninsular Malaysia, Singapore and Borneo (Sarawak).

Antidesma ghaesembilla Gaertn.

Synonyms *Antidesma frutescens* Jack, *Antidesma paniculatum* Blume, *Antidesma pubescens* Roxb.

Vernacular names Black currant tree (En). Indonesia: dempul lelet (Javanese), kutikata gunung (Ambon), onyam (Sundanese). Malaysia: balong ayam, gunchak, kunchor puteh (Peninsular). Philippines: binayuyu (Tagalog). Burma (Myanmar): ntenren. Laos: 'mao^2 noy^2, 'mao^2 muak, 'mao^2 pa siou. Thailand: mangmao, mao khai pla (south-eastern), mamao khao bao (peninsular).

Distribution From Sri Lanka, India and the western Himalayas to Burma (Myanmar), Indo-China, southern China, Thailand, throughout the Malesian region towards the Bismarck Archipelago and northern Australia.

Antidesma leucocladon Hook. f.

Vernacular names Malaysia: gunchiak puteh (Peninsular). Thailand: phak wan lang khao, sommao (peninsular).

Distribution Peninsular Thailand, Peninsular Malaysia and Sumatra.

Antidesma moluccanum Airy Shaw

Distribution The Moluccas, New Guinea and the Solomon Islands.

Antidesma neurocarpum Miq.

Synonyms *Antidesma alatum* Hook. f., *Antidesma inflatum* Merr., *Antidesma rubiginosum* Merr.

Vernacular names Thailand: phlong khao (peninsular).

Distribution Peninsular Thailand, Peninsular Malaysia, Singapore, Sumatra and Borneo.

Antidesma novoguineense Pax & K. Hoffm.

Distribution Papua New Guinea.

Antidesma olivaceum K. Schumann

Distribution New Guinea and the Bismarck Archipelago.

Antidesma sphaerocarpum Müll. Arg.

Synonyms *Antidesma praegrandifolium* S. Moore.

Distribution Papua New Guinea, the Bismarck Archipelago and Samoa.

Antidesma stipulare Blume

Synonyms *Antidesma grandistipulum* Merr., *Antidesma sarawakense* Merr., *Antidesma urophyllum* Pax & K. Hoffm.

Vernacular names Indonesia: buah tahi kambing, katakuti kambing (Ambon), sulaketan (Javanese). Philippines: bignai-pinuso, bignai-tilos (Filipino).

Distribution Peninsular Malaysia, Sumatra, Java, Borneo, the Philippines and the Moluccas (Ambon, Buru).

Antidesma tetradum Blume

Synonyms *Antidesma auritum* Tul., *Antidesma blumei* Tul., *Antidesma salaccense* Zoll. & Moritzi.

Vernacular names Indonesia: ande-andean (Javanese), ki seuheur, wuni peucang (Sundanese).

Distribution Sumatra, Java and Sulawesi; possibly also in Peninsular Malaysia.

Antidesma thwaitesianum Müll. Arg.

Synonyms *Antidesma bunius* (L.) Spreng. var. *thwaitesianum* (Müll. Arg.) Trimen, *Antidesma castroi* Merr. ex Meijer.

Vernacular names Indonesia: maragelang (Kalimantan). Malaysia: beras-beras hitam, kayu mata punai (Peninsular), derupis hutan (Sabah). Thailand: mao luang, mao sian (northern), mat se (peninsular).

Distribution Sri Lanka, Indo-China, Thailand, the Andaman Islands, Peninsular Malaysia, Borneo (Sabah, Kalimantan) and the Philippines (Palawan).

E.N. Sambas (general part),
M.S.M. Sosef (selection of species)

Aphanamixis Blume

Bijdr. fl. Ned. Ind. 4: 165 (1825).

MELIACEAE

x = unknown; *A. polystachya*: $2n$ = 36, 76, c. 150

Vernacular names Indonesia: kayu gula (general), kedoya sapi (Javanese), komalo (Tobaro, Moluccas). Malaysia: chikeh, kulim burong, pasak lingga merak (Peninsular). Philippines: salakin (general), gugoloi (Zambales), kunatan (Tagalog). Laos: kong ta 'sua, ta pou, ta 'sua. Thailand: lao hang, ma hang kan (northern), ta suea (central). Vietnam: g[ooj]i, g[ooj]i g[as]c, g[ooj]i n[uw][ows]c.

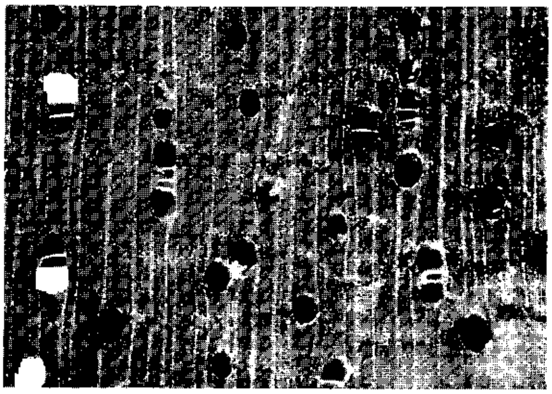
Origin and geographic distribution *Aphanamixis* comprises 3 species occurring from Sri Lanka, India and Bhutan to Burma (Myanmar), Indo-China, southern China, the Andaman Islands, Thailand and throughout the Malesian region towards the Solomon Islands. The only species yielding timber is *A. polystachya* (Wallich) R.N. Parker (synonyms: *Amoora aphanamixis* Schult. & Schult. f., *Aphanamixis cumingiana* (C. DC.) Harms, *Aphanamixis grandifolia* Blume, *Aphanamixis rohituka* (Roxb.) Pierre). It is represented throughout the range of the genus and is occasionally cultivated elsewhere, e.g. in South America and, under glass, in Europe.

Uses The timber of *A. polystachya* is used in house construction and for interior fittings, and is suitable for furniture, boat ribs, canoes, vehicle bodies, turnery and veneer and plywood manufacture.

In India the tree has been planted as an ornamental and occasionally to provide shade. The seeds are bruised and boiled to extract an oil used for making soap, as an illuminant and as medicine. The bark has medicinal properties and is used against rheumatism, cold and pain in the chest. In the Moluccas mashed leaves are used in a solution for disease control in rice and extracts from twigs, bark, fruits and seed have an antifeedant effect on a range of insects. All parts of the fruits are poisonous.

Production and international trade The wood of *A. polystachya* is used on a local scale only. The seed oil is used solely in areas where the tree grows abundantly.

Properties *A. polystachya* yields a medium-weight hardwood with a density of 530–750 kg/m^3 at 15% moisture content. Heartwood pale to dark red, turning dark red-brown upon exposure, sharply demarcated from the pale pink sapwood, up to 6 cm wide; grain usually interlocked; texture moderately fine to coarse, and uneven; tangential



Aphanamixis polystachya
transverse surface (×20)

surface with prominent watered-silk figure, radial surface with palisade markings; wood with faint, cedar-like odour when fresh. Growth rings not distinct, marked by closely spaced marginal parenchyma; vessels small to moderately large, solitary and in radial groups of 2–4, open or filled with dark gum-like or chalky white deposits; parenchyma abundant, visible to the naked eye, apotracheal in mostly narrow to sometimes wider wavy bands; rays very fine to moderately fine, visible with a hand lens; ripple marks absent.

The wood seasons well. It is moderately hard, strong and moderately tough. It is somewhat difficult to saw and plane due to the interlocked grain, but takes a good finish. The wood is very durable for interior work and resistant to fungi; the heartwood is resistant to dry-wood termites and the sapwood is non-susceptible to *Lyctus*.

The seed contains about 43.5% oil.

See also the table on microscopic wood anatomy.

Botany Sometimes dioecious, small to medium-sized trees up to 20(–35) m tall; bole cylindrical, sometimes crooked, branchless for up to 15 m, up to 70 cm in diameter, sometimes with buttresses up to 1(–2) m high; bark surface cracking to flaking, greyish-brown to reddish-brown, inner bark pinkish to red, often exuding white latex. Indumentum of simple, bifid and stellate hairs. Leaves alternate, imparipinnate, exstipulate; leaflets opposite, entire. Flowers bisexual or unisexual (plants then dioecious), in axillary inflorescences; female and bisexual flowers usually in spikes or racemes, male ones in panicles; calyx deeply 5-lobed; petals 3, basally united with the staminal tube which bears 3–8 anthers; disk absent; ovary superior, 3(–4)-locular with (1–)2 ovules in each cell, style stout, with a conical to truncate head. Fruit a 2–3(–4)-valved capsule. Seed arillate. Seedling with cryptocotylar germination; first pair of leaves opposite, simple and toothed, subsequent leaves alternate and imparipinnate.

In Java *A. polystachya* flowers throughout the year. The flowers are insect-pollinated; in Papua New Guinea sweatbees have been observed visiting the flowers. The fruits are dispersed by birds.

Aphanamixis belongs to the tribe *Aglaieae* and is closely related to *Aglaia*. It differs mainly at microscopic level: the wood having banded parenchyma.

Ecology *A. polystachya* occurs in primary and secondary rain forest, up to 1400(–1800) m altitude. It is locally common (especially in New Guinea), is often found along rivers or in floodplains, but has also been reported from seasonally flooded forest, kerangas and forest on limestone.

Silviculture For India it is stated that *A. polystachya* is a shade-tolerant tree and natural regeneration is abundant in shady and moist locations, close to the mother tree.

Genetic resources and breeding For *A. polystachya* chromosome numbers reveal the occurrence of tetraploid and octaploid individuals. Since it is cultivated as well as fairly widespread in the wild, with limited usage, *A. polystachya* does not seem endangered.

Prospects Because of its attractive colour and moderately fine grain the wood of *A. polystachya* is probably suitable for fine furniture and cabinet work. The antifeedant extracts from various parts of the tree need further investigation for possible application in disease and pest control.

Literature 70, 162, 163, 267, 341, 436, 438, 557, 729, 772, 780, 861, 878, 882, 933, 934, 1065, 1104, 1169, 1221, 1232.

T. Uji

Aphananthe Planch.

Ann. Sci. Nat. Bot. ser. 3, 10: 265, 337 (1848).

ULMACEAE

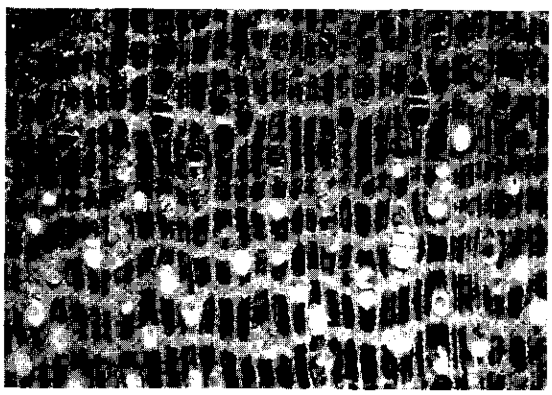
x = unknown; $2n$ = unknown

Origin and geographic distribution *Aphananthe* consists of about 5 species, and occurs in Mexico, Madagascar, Sri Lanka, India, Burma (Myanmar), Indo-China, China, Korea, Japan, Taiwan, the Andaman Islands, Thailand, throughout Malesia (except Peninsular Malaysia and the Moluccas), the Solomon Islands and eastern Australia. Two species occur in Malesia, but exclude each other.

Uses The wood of *Aphananthe* is used locally in house building, especially for planks and light construction. In Australia the wood of *A. philippinensis* is also used for flooring, axe handles, sporting goods, gun stocks and blocks.

Production and international trade Supplies are generally very limited and utilization of the wood of *Aphananthe* is on a local scale only.

Properties *Aphananthe* yields a medium-weight to heavy hardwood with a density of 510–930 kg/m^3 at 15% moisture content. Heartwood creamy white or faint grey with a pale brown tinge, sapwood white; grain of *A. philippinensis* from Philippine stock mainly interlocked, from Australian samples straight; texture fine to medium and even. Growth rings faint; vessels moderately small to medium-sized, in radial multiples of 2–4, indistinct to the naked eye, some tyloses or white deposits; parenchyma predominantly paratracheal vasicentric and aliform to confluent and confluent-banded, apotracheal in mostly regular bands both wider and narrower than the vessels; rays fine, narrower than the vessels, not conspicuous on radial surface; ripple marks absent.
Shrinkage upon air drying is moderate; stock tends to warp and needs careful handling. The wood is moderately hard, of medium strength, tough and resembles hickory (*Carya* spp.). The wood splits cleanly but with difficulty, is hard to turn and difficult to finish to a smooth surface; very sharp tools are required to prevent a woolly surface. The wood is slightly durable to non-durable when exposed to the weather or in contact with the ground, and durable for interior use. The sapwood is susceptible to *Lyctus*.
See also the tables on microscopic wood anatomy and wood properties.



Aphananthe philippinensis
transverse surface (×20)

Botany Deciduous or semi-deciduous, monoecious shrubs or small to medium-sized trees up to 30 m tall; bole up to 60 cm in diameter, often with buttresses up to 1 m high and spreading up to 2 m, or bole fluted at base; bark surface smooth or rough to finely fissured, peeling off in rectangular flakes, lenticellate, grey-brown. Leaves alternate, simple, entire, serrate or dentate, pinnately veined or 3-veined at base, petiolate; stipules subulate, caducous. Flowers unisexual, 4–5-merous, with imbricate perianth lobes. Male flowers in an axillary condensed raceme in lower part of new shoots; stamens glabrous; pistil reduced to a cluster of hairs. Female flowers usually solitary near top of new shoots, lacking stamens or staminodes; ovary sessile, superior, 1-locular with a single ovule, with 2 tubular stigmatic arms. Fruit a fleshy, ovoid-globose drupe, red when mature, 1-seeded. Seed with membranous seed-coat, without endosperm.
The trees grow in flushes. They often flower twice a year, in Malesia usually in March–April and September–October. Pollination of the flowers is probably by wind. Fruits ripen in approximately 2–3 months. They are probably eaten by birds which may disperse the seeds.
Aphananthe is usually included in the tribe *Celtideae* (or subfamily *Celtidoideae*) and is related among others to *Celtis*, which differs particularly in its several-flowered female inflorescences having female flowers with staminodes, and in its broader cotyledons. It is also related to *Gironniera*, which differs in its overlapping stipules leaving circular scars after falling. Wood anatomy supports the traditional placement of *A. cuspidata* in *Gironniera*, and not in *Aphananthe*.

Ecology In Malesia *Aphananthe* is mainly found in areas subject to a rather strong seasonal climate, in lowland and hill forest up to 750 (–1300) m altitude. It is found on a range of soils, is locally abundant and occasionally forms dense thickets. In Thailand *A. cuspidata* occurs in evergreen or semi-deciduous forest along streams. *A. philippinensis* is often found in semi-deciduous gallery forest and mixed *Eucalyptus* forest. In the Philippines it grows in thickets and secondary growth.

Silviculture *Aphananthe* shows pioneer characteristics and is reportedly fast-growing.

Genetic resources and breeding The Malesian *Aphananthe* species do not seem to be endangered because they are widespread and locally common. Moreover, they are usually found in forest types which are not very vulnerable. In several regions, however, *Aphananthe* is rare and may easily be liable to genetic erosion, e.g. *A. cuspidata* in Borneo, the Philippines and Sulawesi.

Prospects The present utilization of *Aphananthe* is very limited. It is unlikely that there will be a change in the near future.

Literature 70, 163, 261, 304, 341, 383, 436, 464, 536, 568, 861, 934, 1037, 1271.

Selection of species

Aphananthe cuspidata (Blume) Planch.

Synonyms *Gironniera curranii* Merr., *Gironniera cuspidata* (Blume) Kurz, *Gironniera reticulata* Thwaites.

Vernacular names Indonesia: kayu belikat (Sumbawa), kayu loko (Flores), sulu (Java, Bali). Philippines: dulcis (Bagobo). Thailand: chai haeng, e nieo, kruai laem (northern).

Distribution Sri Lanka, India, Burma (Myanmar), Indo-China, China, the Andaman Islands, Thailand, north-eastern Sumatra, Java, the Lesser Sunda Islands, Borneo (Sabah), Sulawesi (rare) and the Philippines (Mindanao, rare).

Aphananthe philippinensis Planch.

Vernacular names Philippines: alaisiis (Tagalog).

Distribution The Philippines (Luzon), eastern New Guinea, the Solomon Islands and eastern Australia.

N.O. Aguilar (general part),
E. Boer (general part),
R.H.M.J. Lemmens (general part, selection of species)

Aporosa Blume

Bijdr. fl. Ned. Ind. 10: 514 (1825).
EUPHORBIACEAE
x = unknown; *A. dioica*: $n = 26$

Vernacular names Indonesia: sasah (Sundanese). Malaysia: sebasah (Peninsular). Philippines: malabignai. Thailand: mueat. Vietnam: ng[ax]m, th[aaf]u t[as]u.

Origin and geographic distribution *Aporosa* comprises about 80 species occurring in Sri Lanka and India to Indo-China, southern China, Thailand, throughout the Malesian region (except for the Lesser Sunda Islands) towards the Solomon Islands. Within Malesia some 60 species are present which are distributed as follows: 27 in Peninsular Malaysia, 17 in Sumatra, 6 in Java, 32 in Borneo, 3 in Sulawesi, 5 in the Moluccas, 9 in the Philippines, 22 in New Guinea.

Uses The wood of *Aporosa* has been used for local house construction (rafters, flooring etc.), furniture, and small household implements like tool handles and rice pounders. It is suitable for firewood.

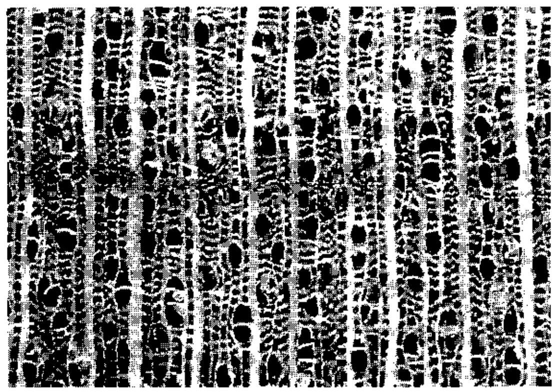
The bark and sometimes also the leaves of *A. frutescens* used to be used in the batik industry as a mordant to fix the red dye from *Morinda citrifolia* L. The fruit of *A. prainiana* is reported to be edible.

Production and international trade As the supply is generally small, the wood of *Aporosa* is utilized on a local scale only.

Properties *Aporosa* yields a medium-weight hardwood with a density of 570–890 kg/m^3 at 15% moisture content. Heartwood pale yellow-brown to brown with orange or purple-red tinges, not sharply differentiated from the sapwood; grain straight; texture moderately fine and uneven; wood with appreciable silver grain on quarter-sawn surfaces. Growth rings absent; vessels moderately small to medium-sized, often distinctly angular, solitary in some species but mostly in radial multiples of 2–4, tyloses sparse; parenchyma abundant, apotracheal diffuse-in-aggregates, visible only with a hand lens; rays of 2 sizes, very fine and medium-sized to moderately broad; ripple marks absent.

The wood is moderately hard and strong and is probably easy to work, as it is non-siliceous. It is moderately durable when exposed to the weather or in contact with the ground.

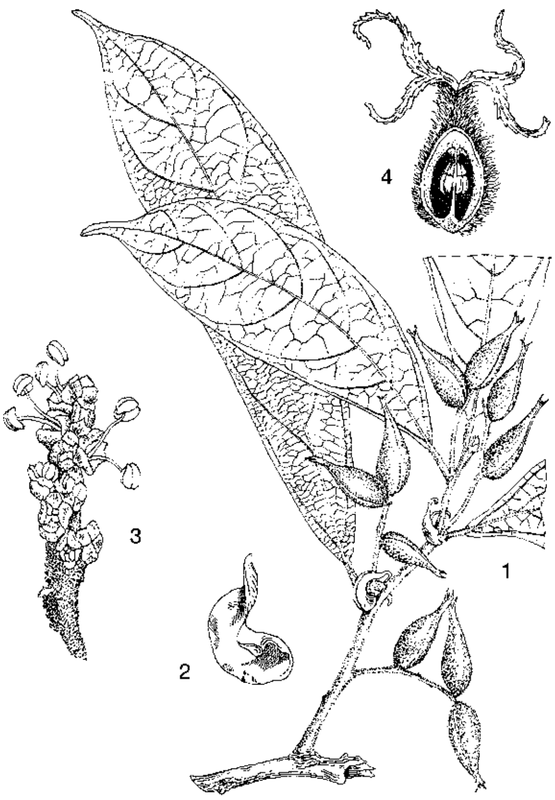
The average fibre length of *A. dioica* is 1.630 mm.



Aporosa papuana
transverse surface (×20)

Leaves accumulate aluminium, rendering them pale when dried.
See also the table on microscopic wood anatomy.

Botany Evergreen, dioecious, small to medium-sized trees up to 30(–50) m tall; bole usually straight, up to 60 cm in diameter, without buttresses; bark surface smooth to finely scaly or finely fissured, often powdery, inner bark firmly fibrous and dark red-brown or granular and orange-brown. Leaves arranged spirally, simple, entire to toothed, often finely dotted below; petiole usually kneed; stipules caducous or persistent. Flowers small, apetalous; disk absent. Male flowers in solitary or clustered, axillary catkins; sepals 3–4; stamens 2(–5); pistillode minute. Female flowers in a shorter and fewer-flowered spike or cluster, rarely in a more extended raceme; sepals 3–6; ovary superior, 2(–4)-locular with 2 ovules in each cell, styles bifid, persistent. Fruit a few-seeded capsule, splitting regularly or irregularly or not dehiscent, ovoid to globose, with a leathery-fleshy wall. Seed with a dry or fleshy seed-coat. Seedling



Aporosa lagenocarpa Airy Shaw – 1, fruiting twig; 2, stipule; 3, male inflorescence; 4, sectioned ovary and styles.

with epigeal germination; cotyledons emergent, leafy, bilobed; hypocotyl elongated; all leaves arranged spirally.
The flowering-to-fruiting period of *A. nigricans* in Pennsular Malaysia is about 12 weeks.
Although *Aporosa* may be quite abundant in some forests, the trees are often overlooked as they show no striking features. *Aporosa* belongs to the subfamily *Phyllanthoideae* and the tribe *Antidesmeae*. The generic name is often spelled as *Aporusa*; the present spelling, *Aporosa*, is clearly correct, according to the International Code of Botanical Nomenclature.

Ecology *Aporosa* is locally common and is usually found in the understorey of primary and secondary lowland rain forest, both in well-drained locations and in seasonal or permanent swamp forest. Individual species can be encountered in more disturbed or more open sites, e.g. in mixed bamboo forest and in montane localities, in New Guinea often in fagaceous forest, up to 2000 m altitude.

Silviculture *Aporosa* can be propagated by seed. Seeds sown with adhering pulp generally germinate well (80–98%). Germination was very poor, however, for *A. microstachya* (6%), *A. prainiana* (14–25%) and *A. stellifera* (12%). Germination usually starts 2–3 weeks after sowing and is completed within 2 months. Most species are reported to be fire-resistant.

Genetic resources and breeding There is little risk of genetic erosion in *Aporosa*, since at present it is rarely felled for timber.

Prospects As *Aporosa* is a fairly common forest component in South-East Asia, its wood might become increasingly important.

Literature 22, 26, 28, 32, 33, 34, 36, 70, 162, 163, 174, 189, 209, 267, 436, 543, 553, 696, 800, 829, 831, 834, 835, 861, 883, 908, 974, 996, 1038, 1195, 1221.

Selection of species

Aporosa arborea (Blume) Müll. Arg.

Synonyms *Aporosa arborescens* (Hassk.) Müll. Arg., *Baccaurea forbesii* Pax & K. Hoffm.

Vernacular names Indonesia: caratan, ki kuya (Sundanese), wuru dedek (Javanese). Thailand: plueak khao (peninsular).

Distribution Peninsular Thailand, Peninsular Malaysia, Sumatra, Java and Borneo (Sabah).

Aporosa aurea Hook. f.
Vernacular names Malaysia: rambai chuchut, sebasah hitam, sebasah minyak (Peninsular). Thailand: kraduk khang.
Distribution Peninsular Thailand, Peninsular Malaysia, Sumatra and Borneo (Sarawak, Sabah).

Aporosa benthamiana Hook. f.
Synonyms *Aporosa euphlebia* Merr., *Aporosa grandifolia* Merr., *Aporosa stipulosa* Merr.
Vernacular names Crescent tree (En). Malaysia: kelempeti (Peninsular). Philippines: manlobadon (Manobo).
Distribution Peninsular Malaysia, Singapore, Borneo and the Philippines.

Aporosa bracteosa Pax & K. Hoffm.
Vernacular names Malaysia: sebasah jantan (Peninsular).
Distribution Peninsular Malaysia, Singapore, Sumatra and Borneo (Sarawak).

Aporosa bullatissima Airy Shaw
Vernacular names Brunei: senumpol bulu (Iban).
Distribution Borneo.

Aporosa caloneura Airy Shaw
Distribution Borneo (Sabah, Sarawak).

Aporosa decipiens Pax & K. Hoffm.
Distribution Papua New Guinea.

Aporosa dioica (Roxb.) Müll. Arg.
Synonyms *Aporosa aurita* (Tul.) Miq., *Aporosa microcalyx* (Hassk.) Hassk., *Aporosa roxburghii* Baillon.
Vernacular names Bastard oak (En). Indonesia: peuris, renyung (Sundanese). Malaysia: pelangah, pelangas, pelangi (Peninsular). Thailand: khonta chang, khrop bai yai, nuan sian (peninsular). Vietnam: ng[ax]m, th[aaf]u t[as]u.
Distribution From the eastern Himalayas and India (Assam) to Indo-China, southern China, Thailand, Peninsular Malaysia, Sumatra, Java and Borneo.

Aporosa falcifera Hook. f.
Distribution Peninsular Thailand, Peninsular Malaysia, Singapore, Sumatra and Borneo.

Aporosa frutescens Blume
Synonyms *Aporosa banahaensis* (Elmer) Merr., *Aporosa fruticosa* (Blume) Müll. Arg., *Aporosa similis* Merr.
Vernacular names Bastard rukam (En). Indonesia: berih (Javanese), kayu malam (Bangka), sasah (Sundanese). Malaysia: mesekam, rukam utan (Peninsular). Philippines: hauai (Manobo). Burma (Myanmar): liyo. Thailand: khruen (Trat).
Distribution Lower Burma (Myanmar), Thailand, Peninsular Malaysia, Singapore, Sumatra, Java, Borneo, the Philippines, Sulawesi and the Moluccas.

Aporosa hermaphrodita Airy Shaw
Distribution Papua New Guinea.

Aporosa lagenocarpa Airy Shaw
Distribution Borneo.

Aporosa laxiflora Pax & K. Hoffm.
Distribution New Guinea and the Bismarck Archipelago.

Aporosa lunata (Miq.) Kurz
Synonyms *Antidesma lunatum* Miq.
Distribution Peninsular Thailand, Peninsular Malaysia, Singapore, Sumatra and Borneo.

Aporosa microstachya (Tul.) Müll. Arg.
Synonyms *Aporosa maingayi* Hook. f.
Vernacular names Maingay's tree (En). Malaysia: beras-beras, kangkong udang, nipis kulit betina (Peninsular). Thailand: krim khao (peninsular).
Distribution Burma (Myanmar), Thailand, Peninsular Malaysia and Singapore.

Aporosa nervosa Hook. f.
Vernacular names Malaysia: pelangeh, sekam merah (Peninsular).
Distribution Peninsular Malaysia, Singapore, Sumatra, Borneo and the Philippines.

Aporosa nigricans Hook. f.
Vernacular names Malaysia: bantuman (Peninsular).
Distribution Peninsular Malaysia, Singapore, Sumatra and Borneo (Brunei, Sabah, Sarawak).

Aporosa papuana Pax & K. Hoffm.
Distribution New Guinea and the Solomon Islands.

Aporosa prainiana King ex Gage
Vernacular names Malaysia: beras-beras hutan, kuku balam, petaling tandok (Peninsular).

Distribution Peninsular Malaysia, Singapore, Sumatra and Borneo.

Aporosa sphaeridophora Merr.

Synonyms *Aporosa acuminatissima* Merr. (1920, not 1929), *Aporosa campanulata* J.J. Smith.

Vernacular names Indonesia: ki endog, koneng sari (Sundanese). Philippines: bignai-lalaki (Filipino), bigloi-tilos (Tagalog).

Distribution Java, the Philippines and the Moluccas (Ambon); possibly also in Sumatra.

Aporosa stellifera Hook. f.

Vernacular names Malaysia: damak-damak paya, rambai kera (Peninsular).

Distribution Peninsular Malaysia.

Aporosa symplocoides (Hook. f.) Gage

Synonyms *Baccaurea symplocoides* Hook. f.

Vernacular names Malaysia: kumpa menang, peperai pelandok, sebasah (Peninsular).

Distribution Peninsular Thailand, Peninsular Malaysia, Singapore, Sumatra and Borneo (Sabah, Sarawak).

Aporosa vagans Schot

Distribution New Guinea.

Nguyen Nghia Thin & Tran Van On

Archidendron F. v. Mueller

Fragm. 5: 59 (1865).

LEGUMINOSAE

$x = 13$; *A. clypearia*: $n = 13$

Vernacular names Indonesia: jengkol (general). Malaysia: keredas (Peninsular).

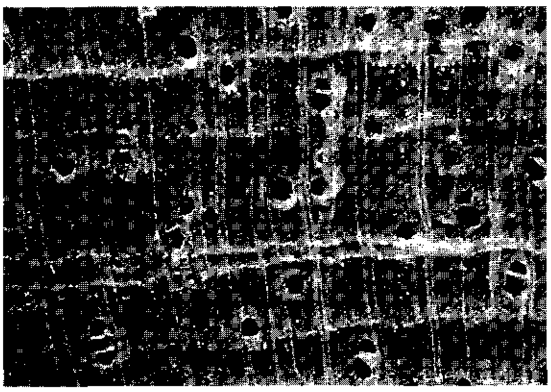
Origin and geographic distribution *Archidendron* comprises 94 species and occurs from Sri Lanka and India to Indo-China, southern China, Taiwan, Burma (Myanmar), Thailand, throughout the Malesian region, Micronesia, the Solomon Islands and north-eastern and eastern Australia. There are 2 centres of speciation, one in Indo-China, extending to western Malesia, the other in New Guinea. Within Malesia 62 species are found.

Uses The wood of *Archidendron* is used for light construction, interior joinery, furniture and cabinet work, canoes, paddles, fencing, household utensils, knife handles, weapon sheaths, boxes and coffins. It is also used as fuel.

A. ellipticum has been used as cover crop in forest plantations in Indonesia. The seeds of *A. jiringa* and, occasionally, also those of *A. bubalinum* and *A. microcarpum* are used to flavour food. They are also applied traditionally as a diuretic, but are poisonous when eaten in large amounts. Young seeds are often eaten raw. The pods of *A. jiringa* have been used to obtain a purple dye for silk; they are still a source of shampoo. In Borneo a black dye is produced from the bark and leaves; the bark is also used with mud for matting. The ash of old leaves is a remedy against pain in the chest and for itch, that of young leaves is applied to wounds. A poultice of leaves of *A. clypearia* and *A. microcarpum* is a traditional medicine to treat chickenpox, smallpox, sore legs, swellings and coughs. The bark of *A. clypearia* yields tannin for nets and to treat scabies, that of *A. bubalinum* is used as a febrifuge. The bark of *A. ellipticum* and *A. jiringa* is also applied as fish poison.

Production and international trade The wood of *Archidendron* is used on a local scale only. Seeds of *A. jiringa* are found regularly in local markets in Malaysia and Indonesia.

Properties *Archidendron* yields a lightweight to medium-weight hardwood with a density of 350–860 kg/m^3 at 15% moisture content. Heartwood whitish with a pink tinge, yellowish or pale red-brown, darkening to deep brown with age, clearly demarcated from the up to 3 cm wide white, greyish-white, pale yellow or pale brown sapwood; grain straight, slightly interlocked or wavy; texture moderately coarse but even; wood lustrous. Growth rings usually indistinct, but distinct in *A. jiringa*, boundary indicated by marginal parenchyma, occasionally by darker-coloured latewood; vessels medium-sized to moderately large, mostly solitary but also in radial multiples



Archidendron glabrum (K. Schumann) K. Schumann & Lauterb.
transverse surface (×20)

of 2–3, vessels with white, yellow or white deposits conspicuous on longitudinal surfaces; parenchyma moderately abundant, paratracheal vasicentric, aliform, occasionally confluent forming broad bands, and apotracheal in marginal or seemingly marginal bands, diffuse very sparsely present; rays moderately fine; ripple marks absent.
The wood is moderately hard. It is easy to saw and work to a smooth finish, but requires considerable filling if it is to be polished. The wood is only moderately durable when exposed to the weather or in contact with the ground. The sapwood is susceptible to *Lyctus* and to stain.
See also the table on microscopic wood anatomy.

Botany Usually evergreen, unarmed shrubs or small to medium-sized or rarely fairly large trees up to 30(–42) m tall; bole straight to rather crooked, short to branchless for up to 20 m, up to 90(–150) cm in diameter, occasionally with short buttresses; bark surface smooth to closely fissured, lenticellate, brown to pale grey, inner bark greenish-yellow to purplish-red. Leaves arranged spirally, bipinnate; rachis and pinnae with extrafloral nectaries; leaflets opposite, rarely alternate or 1-foliolate; stipules sometimes present. Inflorescence composed of a pedunculate glomerule, umbel, corymb, or raceme which is simple or compound in an axillary, terminal or cauliflorous panicle. Flowers bisexual or sometimes unisexual, 5-merous, sometimes 3-merous; both calyx and corolla connate, valvate; stamens many, staminal tube united with corolla tube at base, long exserted; ovaries 1–15 per flower, superior, sessile or stalked, 1-locular with many ovules. Fruit a coriaceous to woody, straight to spirally twisted, flat or terete, sometimes segmented pod, dehiscing along 1 or both sutures, often reddish or purple. Seed ellipsoid, flattened, without pleurogram. Seedling with hypogeal or semihypogeal germination; cotyledons not emergent, fleshy; hypocotyl sometimes slightly elongated; first leaf or first few leaves scale-like, subsequent ones bipinnate.
All three Philippine timber-yielding species have root nodules. Many species have been observed flowering and fruiting almost throughout the year. Flowers of *A. jiringa* open in the evening and are pollinated by moths and other insects. Seeds are eaten by squirrels, monkeys, and probably birds which disperse them.
Archidendron belongs to the subfamily *Mimosoideae* and the tribe *Ingeae*. Within the tribe generic limits are uncertain and have been disputed. Species formerly included in e.g. *Pithecellobium* sect. *Clypearia* Benth., and the genera *Abarema* sensu Kosterm., *Cylindrokelupha* Kosterm., *Paraalbizzia* Kosterm. and *Zygia* sensu Kosterm. have been transferred to *Archidendron*. Some species of *Archidendron* and *Pithecellobium* have been transferred to the small genus *Archidendropsis*; *Archidendropsis spicata* (Verdc.) I.C. Nielsen from New Guinea, locally known as 'koboar', is used to build canoes and is of particular interest as a lesser-known timber. *Archidendron* is the only genus within the family with more than one ovary per flower.

Ecology Timber-yielding *Archidendron* species occur in primary and secondary, lowland to lower montane, evergreen rain forest, up to 1650 m altitude. They occur in swamps and riverine forest, but also on well-drained locations, and on a wide variety of soils including clay, laterite, sand and limestone soils.

Silviculture *Archidendron* can easily be propagated by seed. When stored in airtight containers at ambient temperature, seeds of *A. globosum* remain 100% viable for 4 months; viability rapidly decreases to about 60% and 25% for seeds stored for 5 and 6 months, respectively, whereas seeds stored for 7 months or more is no longer viable. Seeds of *A. clypearia*, *A. ellipticum* and *A. microcarpum* have 85–100% germination in 6–40 days, germination of *A. bubalinum* seeds starts later and is almost complete in 35–50 days.

Genetic resources and breeding Logging of *Archidendron* is virtually non-existent and is not likely to cause genetic erosion.

Prospects Some *Archidendron* species may have some potential for the manufacture of small household items, but more research needs to be done first on their physical and chemical wood properties.

Literature 12, 75, 151, 163, 198, 238, 253, 260, 267, 304, 341, 343, 366, 436, 829, 831, 840, 861, 974, 1015, 1038, 1039, 1163, 1169, 1221.

Selection of species

Archidendron arborescens (Kosterm.) I.C. Nielsen

Synonyms *Abarema arborescens* (Kosterm.) Kosterm., *Pithecellobium arborescens* Kosterm.

Distribution Papua New Guinea.

Archidendron bubalinum (Jack) I.C. Nielsen

Synonyms *Cylindrokelupha bubalina* (Jack) Kosterm., *Ortholobium bubalinum* (Jack) Kosterm., *Pithecellobium bubalinum* (Jack) Benth.

Vernacular names Indonesia: jering antan, kabau (Sumatra). Malaysia: buah pelong, keredas antan, keredas padi (Peninsular). Thailand: kanua, kue-da, yi-ring buu-kong (peninsular).

Distribution Peninsular Thailand, Peninsular Malaysia and Sumatra.

Archidendron clypearia (Jack) I.C. Nielsen

Synonyms *Abarema clypearia* (Jack) Kosterm., *Pithecellobium angulatum* Benth., *Pithecellobium clypearia* (Jack) Benth.

Vernacular names Greater grasshopper tree (En). Indonesia: jeungjing, ki angir (Sundanese), sengon wewe (Javanese). Malaysia: chahar, jering monyet, petai belalang (Peninsular). Philippines: potkipot (Panay Bisaya). Burma (Myanmar): tawmezali. Cambodia: trânôm kaphé:m. Laos: ben bay[2] ben 'fay[2], sa thon. Thailand: ka sathon, lep muen (northern), lak khoei lak kluea (peninsular). Vietnam: gi[as]c, kh[es]t, lim s[ee]t.

Distribution From Sri Lanka, India and Burma (Myanmar) to Indo-China, southern China, Thailand and throughout the Malesian region except for the Lesser Sunda Islands.

Archidendron cockburnii I.C. Nielsen

Distribution Borneo.

Archidendron ellipticum (Blume) I.C. Nielsen

Synonyms *Abarema elliptica* (Blume) Kosterm., *Pithecellobium ellipticum* (Blume) Hassk., *Pithecellobium waitzii* Kosterm.

Vernacular names Indonesia: bangkong (Javanese), jengkol utan (Sumatra), ki caang (Sundanese). Malaysia: jiring tupai, kabau, saga gajah (Peninsular). Philippines: bugas (Igorot, Panay Bisaya), salang-cogi (Negros).

Distribution The Nicobar Islands, peninsular Thailand, Peninsular Malaysia, Sumatra, Java, Borneo and the Philippines.

Archidendron globosum (Blume) I.C. Nielsen

Synonyms *Abarema globosa* (Blume) Kosterm., *Pithecellobium affine* Baker ex Benth., *Pithecellobium globosum* (Blume) Kosterm.

Vernacular names Malaysia: lulai bunga, lulai merah (Peninsular).

Distribution India (Assam), Burma (Myanmar, Mergui Island), Peninsular Malaysia, Sumatra, Java and Borneo.

Archidendron havilandii (Ridley) I.C. Nielsen

Synonyms *Cylindrokelupha havilandii* (Ridley) Kosterm., *Ortholobium havilandii* (Ridley) Kosterm., *Pithecellobium havilandii* Ridley.

Distribution Borneo.

Archidendron jiringa (Jack) I.C. Nielsen

Synonyms *Pithecellobium jiringa* (Jack) Prain, *Pithecellobium lobatum* Benth., *Zygia jiringa* (Jack) Kosterm.

Vernacular names Indonesia: jengkol, jering, jingkol (Java). Malaysia: jering, jiring (general). Burma (Myanmar): tangyin, tanyeng-pen. Thailand: chaniang (eastern), niang, niang-nok (peninsular).

Distribution Bangladesh, Burma (Myanmar), Thailand, Peninsular Malaysia, Sumatra, Java and Borneo; also cultivated locally.

Archidendron kunstleri (Prain) I.C. Nielsen

Synonyms *Abarema kunstleri* (Prain) Kosterm., *Pithecellobium elmeri* Ridley, *Pithecellobium kunstleri* Prain.

Vernacular names Indonesia: siagar (Sumatra).

Distribution Peninsular Malaysia, Sumatra and Borneo.

Archidendron lucyi F. v. Mueller

Synonyms *Archidendron chrysocarpum* K. Schumann & Lauterb., *Archidendron solomonense* Hemsley, *Pithecellobium lucyi* (F. v. Mueller) F. v. Mueller.

Distribution The Moluccas, New Guinea, the Solomon Islands and Australia (Queensland).

Archidendron microcarpum (Benth.) I.C. Nielsen

Synonyms *Abarema microcarpa* (Benth.) Kosterm., *Pithecellobium microcarpum* Benth.

Vernacular names Red pepper tree (En).

Distribution Peninsular Malaysia, Sumatra and Borneo.

Archidendron molle (K. Schumann) de Wit

Synonyms *Albizia mollis* (K. Schumann) F. v. Mueller, *Hansemannia mollis* K. Schumann, *Pithecellobium molle* (K. Schumann) Mohlenbr.

Distribution New Guinea.

Archidendron parviflorum Pulle

Synonyms *Archidendron gawadense* (Baker f.) de Wit, *Archidendron warenense* Kaneh. & Hatus.

Distribution New Guinea.

Archidendron scutiferum (Blanco) I.C. Nielsen

Synonyms *Abarema scutifera* (Blanco) Kosterm., *Pithecellobium scutiferum* (Blanco) Benth.

Vernacular names Philippines: anagap (Filipino).

Distribution The Philippines.

I. Faridah Hanum

Ardisia Sw.

Prodr.: 3, 48 (1788).

MYRSINACEAE

$x = 23$; *A. crenata* (Sims) Little, *A. solanacea* Roxb.: $2n = 46$

Vernacular names Indonesia: lampeni (Sundanese), lempeni (Javanese). Malaysia: mata ayam, mata itek, mata pelandok (Peninsular). Philippines: tagpo, tagpong (Filipino).

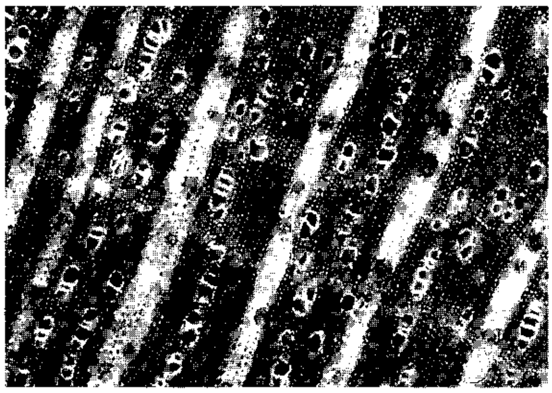
Origin and geographic distribution *Ardisia* comprises almost 400 species and shows a pantropical distribution. It occurs throughout South-East Asia with western Malesia as the main centre of diversity. Peninsular Malaysia has some 75 species, Borneo 92, New Guinea 31.

Uses The wood of *Ardisia* is occasionally used for posts in local house building.

Production and international trade *Ardisia* wood is used rarely and on a local scale only.

Properties *Ardisia* yields a medium-weight hardwood with a density of about 510 kg/m^3 at 15% moisture content. Heartwood yellow-brown, brown or grey-purple-brown, not clearly differentiated from the sapwood; grain straight; texture moderately fine and uneven; wood with silver grain on radial surface and darker-coloured striations on tangential surface due to the broad and high rays. Growth rings indistinct; vessels moderately small to medium-sized, solitary, in radial multiples of 2–4 or in small clusters, sometimes arranged obliquely, angular in outline, open or with white or yellow deposits; parenchyma sparse, paratracheal vasicentric, rarely visible with a hand lens; rays moderately broad to very broad, widely spaced, conspicuous on all surfaces; ripple marks absent.

See also the table on microscopic wood anatomy.



Ardisia macrophylla Reinw. ex Blume transverse surface (×20)

Botany Shrubs or small, rarely medium-sized trees up to 12(–35) m tall; bole up to 30(–50) cm in diameter, rarely with buttresses up to 3 m high (*A. copelandii*); bark surface smooth, grey to brown. Branches often flattened-triangular at base. Leaves alternate or sometimes pseudo-whorled, simple, entire to toothed, dotted with glands, sometimes scaly, exstipulate. Flowers in an axillary or terminal raceme, cyme, corymb or umbel, (4–)5-merous; sepals free or basally connate, often dotted with glands; petals free or adherent at base, overlapping to the right; stamens inserted on the petals by very short filaments; ovary superior, 1-locular with few to many ovules in more than 1 row, style single, stigma minute. Fruit a globose, 1-seeded drupe. Seed globose, with hard endosperm. Seedling with epigeal germination; cotyledons emergent, rudimentary or leafy; hypocotyl elongated; leaves arranged spirally, involute.

In Java *A. lanceolata* has been observed flowering throughout the year.

In recent years many new species have been described in *Ardisia*. It is subdivided into 17 subgenera. The genera *Tetrardisia* and *Afrardisia* from Africa were recently included in *Ardisia*.

Ecology *A. lanceolata* is found in primary and secondary lowland and hill forest, up to 1200 m altitude.

Silviculture *Ardisia* can be propagated by seed. A germination test with various non-timber species gave 80–100% germination in 0.5–6 months after sowing.

Genetic resources and breeding As the use of *Ardisia* timber is very limited, genetic erosion due to harvesting seems unlikely.

Prospects It is unlikely that *Ardisia* will be increasingly used for timber. *A. lanceolata* has potential as an ornamental because of its attractive flowers.

Literature 70, 163, 267, 464, 543, 661, 791, 829, 831, 974, 1061, 1063, 1221.

Selection of species

Ardisia copelandii Mez

Vernacular names Indonesia: banglai, merbumbun (Kalimantan). Malaysia: merjimah, pogong buang (Iban, Sabah), mertapis (Sarawak). Philippines: Copeland tagpo (Filipino).

Distribution Borneo and the Philippines.

Ardisia lanceolata Roxb.

Synonyms *Ardisia plagioneura* (O. Kuntze) R. Scheffer, *Ardisia purpurea* Reinw.

Vernacular names Indonesia: ki lampeni, lampeni utan (Sundanese). Malaysia: lutut ayam, mentua pelandok, salan bukit (Peninsular).

Distribution Peninsular Malaysia, Singapore, Sumatra, Java, Borneo and Sulawesi.

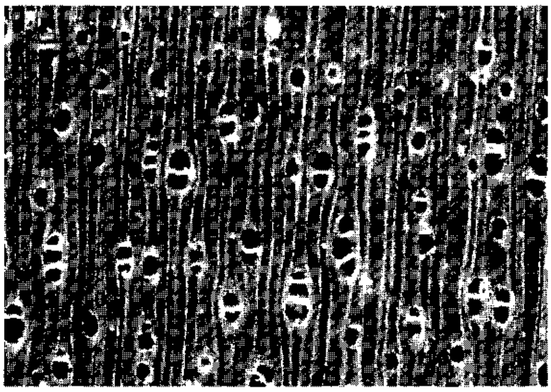
E. Boer (general part),
M.S.M. Sosef (general part, selection of species)

Arytera Blume

Rumphia 3: 169 (1847).
SAPINDACEAE
x = unknown; $2n$ = unknown

Vernacular names Indonesia: kayu sampi (Bali), ki lalayu (Sundanese), penjalinan (Javanese). Malaysia: bedara emping, kelayu hitam, tampong kechil (Peninsular). Philippines: alasan (Filipino). Thailand: seefan, taet ling (peninsular).

Origin and geographic distribution *Arytera* comprises about 28 species and is distributed from north-eastern India and Burma (Myanmar) to southern China, Indo-China, Thailand, the entire Malesian region, the Solomon Islands towards northern and eastern Australia and the Pacific east to Tonga and Samoa. Centres of diversity are located in New Guinea and New Caledonia. Only one of the 12 species found within Malesia yields timber: *A. litoralis* Blume (synonyms: *A. geminata* Lauterb. & K. Schumann, *A. gigantosperma* Radlk., *A. xerocarpa* (Blume) Adelb.). This species is widespread and occurs from north-eastern India to Indo-China, southern China, Thailand, across Malesia east to the Solomon Islands.



Arytera litoralis
transverse surface (×20)

Uses The wood of *A. litoralis* is used for rafters in local house construction and for fencing. In India it is also used for agricultural implements and tool handles.
The fruits are rather sour but edible. The conical crown and abundant colourful fruits make *A. litoralis* a potential ornamental tree.

Production and international trade There are no records of commercial trade of *Arytera* timber. It is probably only used on a local scale.

Properties *Arytera* yields a medium-weight to heavy hardwood with a density of 700–1120 kg/m^3 at 15% moisture content. Heartwood pinkish or pale red, not clearly differentiated from the sapwood; grain usually straight; texture very fine to fine and even. Growth rings distinct to indistinct, boundaries marked by narrow, marginal parenchyma; vessels moderately small, solitary and in radial multiples of 2–3(–more), open or blocked by white chalky deposits; parenchyma sparse, paratracheal vasicentric, and apotracheal in marginal or seemingly marginal bands; rays extremely fine; ripple marks absent.
The wood is hard, strong and tough. It is non-durable when exposed or in contact with the ground. The sapwood is susceptible to *Lyctus*.
See also the table on microscopic wood anatomy.

Botany A monoecious, small to medium-sized tree up to 40 m tall, rarely a shrub; bole often twisted, usually branching rather low, up to 90 cm in diameter, with plank-like buttresses up to 1.6 m high; bark surface smooth or scaly, greyish-green to dark reddish or almost black. Leaves arranged spirally, paripinnate, 1–6-jugate, exstipulate; leaflets opposite or subopposite, petioluled, entire, usually with domatia in the axils of main veins. Flowers in an axillary to pseudoterminal or rarely ramiflorous panicle, functionally unisexual, usually 5-merous; calyx dentate; petals about as long as the calyx, with 2 scales at base inside; disk entire; stamens (6–)8(–10); ovary superior, 2–3-locular with 1 ovule in each cell, puberulous, style 1. Fruit a coriaceous capsule, with 1–2(–3) well-developed lobes. Seed dull brown to blackish, with an apically open yellowish arillode. Seedling with hypogeal germination; cotyledons not emergent; hypocotyl not elongated; epicotyl with a few small scales; all leaves arranged spirally, first pair of leaves with 2 leaflets, leaflets conduplicate.

A. litoralis flowers and fruits throughout the year and is probably duo-dichogamous, which means that an initial male phase is followed by a female phase which is then followed by a male phase again. The flowers are pollinated by insects, probably bees. The seeds are eaten and dispersed by birds which are attracted by the striking contrast between seed-coat and arillode.

Ecology *A. litoralis* is scattered but may be locally common in brackish habitats. It is found in primary and secondary forest on a wide variety of soil types, up to 1500 m altitude.

Silviculture *A. litoralis* may be propagated from seed. Seeds sown with adhering aril have 90–95% germination in 18–58(–101) days.

Genetic resources and breeding There are no records of ex situ conservation of *A. litoralis*. Due to its wide area of distribution it does not seem to be threatened.

Prospects Because of its poor shape it is unlikely that *A. litoralis* will gain importance as a timber. It may prove a useful ornamental tree.

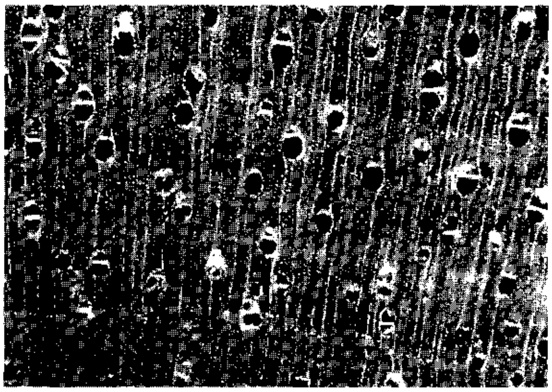
Literature 70, 163, 340, 341, 371, 436, 595, 825, 829, 831, 934, 1038, 1048, 1108, 1221.

J.L.C.H. van Valkenburg

Astronia Blume

Bijdr. fl. Ned. Ind. 17: 1080 (1816).
MELASTOMATACEAE
x = unknown; $2n$ = unknown

Origin and geographic distribution *Astronia* comprises about 60 species occurring in India, Burma (Myanmar), Indo-China, Taiwan, Thailand, and throughout the Malesian region towards the Pacific, east to Tahiti. About 20 species are found within the Malesian region: 2 in Peninsular Malaysia, 1 in Sumatra, 2 in Java, 2 in Borneo, 4 in Sulawesi, 4 in the Moluccas and 8 in New Guinea. 33 Species have been described from the Philippines, but the actual number is probably much lower.



Astronia hollrungii
transverse surface (×20)

Uses The wood of *Astronia* is used for poles and planks in local house building and for tool handles. Occasionally, it is used for general construction purposes in the highlands of Papua New Guinea.

The leaves and bark of *A. papetaria* have been applied in sauces as 'obat papeda' to add a sour flavour.

Production and international trade Utilization of the wood of *Astronia* is very limited and on a local scale only.

Properties *Astronia* yields a medium-weight hardwood with a density of 490–700 kg/m^3 at 15% moisture content. Wood pale brown. Growth rings indistinct; vessels moderately small to medium-sized, solitary and in radial multiples of 2–3; parenchyma paratracheal scanty and apotracheal diffuse; rays very fine; ripple marks absent.

The wood is non-durable and of moderate strength.

See also the table on microscopic wood anatomy.

Botany Shrubs or small to medium-sized trees up to 20(–30) m tall; bole up to 80 cm in diameter, without buttresses, but often spurred; bark surface smooth to finely cracked or flaky and papery, peeling in long strips, greenish-brown to dark brown, inner bark straw to cream. Branches compressed to quadrangular, covered with reddish-brown scales but becoming glabrous. Leaves opposite or ternate, simple, entire, 3- or 5-veined from the base or slightly above the base, exstipulate, with small brown scales on lower surface. Flowers in a terminal or rarely axillary thyrse, sometimes

unisexual by abortion, 5-merous; calyx cup-shaped, yellow-green, undulate to dentate, densely lepidote; petals free, white or purple; stamens 10, equal, anthers opening by slits, axe-shaped; ovary inferior and united with the calyx tube, 2–5-locular with many ovules in each cell, style short. Fruit a leathery, pale brown, subglobose, irregularly dehiscing, many-seeded capsule. Seed linear or oblanceolate.
In Java *A. spectabilis* flowers and fruits throughout the year.
Astronia belongs to the tribe *Astronieae* and is very similar to *Astronidium* with which it may eventually have to be united.

Ecology *Astronia* species usually occur in primary lowland and lower montane forest, up to 1500 m altitude, sometimes in secondary forest or forest edges. *A. spectabilis* occurs in montane forest at 1300–2500 m altitude. *A. atroviridis* is found in mid-montane to upper montane forest up to 2800 m altitude.

Genetic resources and breeding Species with a narrow geographical distribution (e.g. *A. papetaria*) are vulnerable to genetic erosion.

Prospects The importance of *Astronia* wood is extremely limited, partly because the wood properties have been little studied. This is unlikely to change in the near future, especially as the trees are small.

Literature 70, 79, 163, 300, 436, 497, 750, 785, 861, 1151, 1221, 1232.

Selection of species

Astronia atroviridis Mansf.
Distribution Papua New Guinea.

Astronia hollrungii Cogn.
Distribution Papua New Guinea.

Astronia macrophylla Blume
Vernacular names Indonesia: kayu lapan (Sumatra), ki harendong (Sundanese).

Distribution Peninsular Malaysia (rare), Sumatra, Java, Borneo, Sulawesi, the Talaud Islands and the Moluccas.

Astronia papetaria Blume
Vernacular names Indonesia: apayer, obat papeda (Moluccas).

Distribution The Moluccas (Ambon, Ternate).

Astronia spectabilis Blume
Synonyms *Astronia intermedia* Blume.

Vernacular names Indonesia: ampet, gembirung (Javanese), ki calungcung (Sundanese).

Distribution Java, Sulawesi and the Lesser Sunda Islands.

N.O. Aguilar (general part),
E. Boer (general part),
M.S.M. Sosef (general part, selection of species)

Atuna Raf.

Sylva tellur.: 153 (1838).
CHRYSOBALANACEAE
x = unknown; $2n$ = unknown

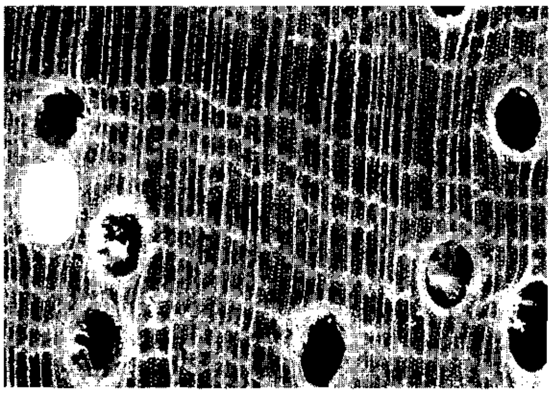
Vernacular names Merbatu (trade name).

Origin and geographic distribution *Atuna* comprises 8 species which occur in southern India, Thailand and throughout the Malesian region (except for the Lesser Sunda Islands) towards Fiji and Samoa. In Malesia 5 species occur. The genus is very rare in Java and Sulawesi.

Uses The wood of *Atuna* is used for house building (beams and rafters), posts and poles (temporary), and especially for salt-water piling and other marine constructions. It is also suitable for parquet flooring and railway sleepers. It provides good fuelwood and good-quality charcoal.
In Ambon a dish called 'koku koku' is prepared from the mashed seeds of *A. racemosa* subsp. *excelsa* mixed with fish, ginger, onions, chillies and lime juice. In the Solomon Islands pounded seeds of the same species are used to caulk boats and to waterproof bottles made from gourds; the uses of the oil extracted from the seeds include to scent coconut oil and for hairdressing. The bark and pounded seeds are used medicinally against diarrhoea. In Fiji the leaves are used to thatch the outside walls of houses.

Production and international trade *Atuna* wood is most likely traded in mixed consignments of medium-weight hardwood or together with that of the genera *Maranthes* and *Parinari* as 'merbatu'. Supplies are, however, limited.

Properties *Atuna* yields a medium-weight to heavy hardwood with a density of 685–1000 kg/m^3 at 15% moisture content. Heartwood pale brown to red-brown, not clearly demarcated from the paler to white sapwood; grain straight, occasionally interlocked; texture rather fine; wood sometimes fairly indistinctly streaked. Growth rings indistinct, occasionally locally marked by darker



Atuna racemosa subsp. *racemosa*
transverse surface (×20)

zones containing reduced amounts of vessels and parenchyma; vessels medium-sized to very large, almost exclusively solitary; parenchyma abundant, banded in narrow bands; rays fine, visible with a hand lens; ripple marks absent.
The wood seasons with little degrade. It is hard and fairly strong and is very difficult to cut and saw due to its high silica content, but can easily be split for firewood. It is non-durable in contact with the ground or when exposed to the weather, is not resistant to termites, but is fairly resistant to marine borer attack in salt-water. The sapwood is non-susceptible to *Lyctus*.
See also the table on microscopic wood anatomy.

Botany Small to large trees up to 45 m tall; bole up to 100 cm in diameter, fluted at base or with short buttresses; bark surface smooth, often lenticellate, becoming cracked or patchy, with adherent scales, grey, grey-green or black, often with white mottles, inner bark fibrous, hard and gritty, orange-brown or red-brown to purplish, without exudate. Leaves alternate, simple, entire, almost glabrous, the veins usually papillose below; stipules keeled, caducous. Inflorescence an axillary raceme or contracted panicle. Flowers bisexual, zygomorphic, with an obconical to cylindrical receptacle and 5 unequal sepals; petals 5, white; stamens 10–20, filaments free and inserted unilaterally on the margin of the disk; ovary inserted at or near the top of the receptacle, 2-locular with a single ovule in each cell, style 1, emerging from the base of the ovary. Fruit a fairly large, hard drupe, crustaceously warty, splitting irregularly to reveal the fibrous interior; cotyledons strongly ruminate. Seedling with hypogeal germination; cotyledons not emergent; hypocotyl not developed; all leaves alternate.
The ultimate shoots show a complicated system of divaricate branching. The fruits are dispersed by ocean currents, by a scatter-hoarding squirrel and possibly by wild pigs. *A. racemosa* subsp. *racemosa* has been observed to flower in January in Java and to fruit in February in Sumatra.
The family *Chrysobalanaceae* has sometimes been treated as a subfamily of the *Rosaceae*. *Atuna* is closely related to the pantropical genus *Parinari*. *A. racemosa* has been divided into 2 subspecies: subsp. *racemosa* is found throughout the range of the species except for Java, whereas subsp. *excelsa* (Jack) Prance occurs in Peninsular Malaysia, Sumatra, Java, Borneo, and North Sulawesi.

Ecology *Atuna* is found as an understorey or canopy tree in well-drained evergreen lowland and hill forest, often in mixed dipterocarp forest, up to 800 m altitude. *A. racemosa* subsp. *racemosa* is also found along rivers, in freshwater or brackish swamps and even in mangrove forest. *A. cordata* is locally common in hill forest on ultrabasic rock up to 1200 m altitude.

Silviculture *Atuna* can be propagated by seed. About 280 dry fruits/kg have been counted for *A. racemosa* subsp. *racemosa*.

Genetic resources and breeding There are no records of conservation of *Atuna* species, except for a few specimens in botanical gardens. Deforestation may easily endanger those species with a narrow geographical distribution.

Prospects As *Atuna* timber is resistant to marine borers, especially when pressure-treated with appropriate preservatives, it will probably continue to be used for marine constructions.

Literature 162, 163, 198, 261, 267, 341, 405, 431, 436, 615, 621, 632, 829, 861, 903, 904, 934, 974, 1048, 1221.

Selection of species

Atuna cordata Cockburn ex Prance

Distribution Borneo (Sabah).

Atuna racemosa Raf.

Synonyms *Atuna elata* (King) Kosterm., *Atuna excelsa* (Jack) Kosterm., *Cyclandrophora excelsa* (Jack) Kosterm., *Parinari glaberrimum* (Hassk.) Hassk.

Vernacular names Indonesia: atung (Moluccas), lomo (Sulawesi), pele kambing (Sumatra). Malaysia: kukut (Sarawak), membatu (Sabah). Philippines: tabon-tabon (general), botga (Bikol), getabon (Tagbanua).

Distribution Thailand, throughout the Malesian region (except for the Lesser Sunda Islands), the Solomon Islands and the Pacific towards Fiji, Tonga and Samoa.

G.T. Prance

Avicennia L.

Sp. pl. 1: 110 (1753); Gen. pl., ed. 5: 119 (1754).
AVICENNIACEAE
x = unknown; *A. alba*: $2n$ = c. 66

Vernacular names Api-api (trade name). Papua New Guinea: white mangrove (En). Thailand: samae. Vietnam: m[aws]m.

Origin and geographic distribution *Avicennia* comprises 8 species and occurs throughout the tropics and Australia, in Asia north to Taiwan. Of these, 4 occur throughout Malesia.

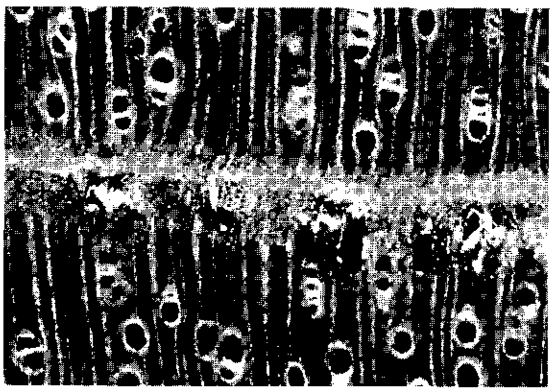
Uses The wood of *Avicennia* is used for house building (posts, columns, beams, roofing), mine props, inlaying and other decorative purposes, furniture, boat building (knees, crooks), panelling, rice mortars and mallets. It is thought to be suitable for paving blocks and for the naves and hubs of wheels of light vehicles. Wood chips are used to produce pulp for the manufacture of rayon. It is a poor firewood, burning by smouldering, but for this reason has been used for curing fish and smoking rubber. It is occasionally used to produce charcoal.

The wood ash has been used as soap in India. In the Philippines the wood has been used to obtain salt, in a process in which small amounts of saltwater are poured over the burning wood until all the wood is reduced to ashes. The ashes are then placed in a large funnel and seawater is filtered through. The filtrate is evaporated and yields the salt. The bark is traditionally used for tanning leather but contains only little tannin; it is sometimes used to treat skin parasites and gangrenous wounds. The seeds are edible but only after roasting or boiling to reduce the bitter taste. The resin from the seed is used medicinally as an ointment for ulcers, tumours, and has been applied as a contraceptive. The heartwood of *A. alba* is used to treat thrush in children, whereas the bark and roots of *A. officinalis* (or the resin they exude) are believed to be aphrodisiac. Seedlings and young leaves of *A. officinalis* are edible, and leaves of *A. marina* are used as green manure and fodder in the Middle East. In the Philippines branches of *A. marina* are used to make artificial Christmas trees; they are nailed around a post and painted. The same species is thought suitable for small-scale agroforestry in coastal villages, yielding luxury lumber and construction material.

Production and international trade The wood of *Avicennia* is probably used fairly often, but mainly on a local scale. In 1996 Papua New Guinea exported only 10 m^3 of 'white mangrove' logs at an average free-on-board (FOB) price of US$ 100/m^3.

Properties *Avicennia* yields a medium-weight hardwood with a density of 560–800 kg/m^3 at 15% moisture content. Heartwood greyish with a purplish cast, not differentiated from the white to grey-white sapwood; grain sometimes straight, but usually interlocked or irregularly wavy; texture of secondary xylem moderately fine and uneven from included phloem; wood with pronounced watered-silk figure on tangential face; taste slightly salty. Growth rings indistinct, but growth-ring-like bands indicated by anastomosing bands of included phloem; vessels very small to moderately large, mostly in radial multiples of 2–4, sometimes over 4, open; parenchyma moderately abundant, paratracheal vasicentric, occasionally aliform and confluent, distinct; rays moderately fine to medium-sized; ripple marks absent; included phloem in regular bands, alternating with appreciably wider secondary xylem bands.

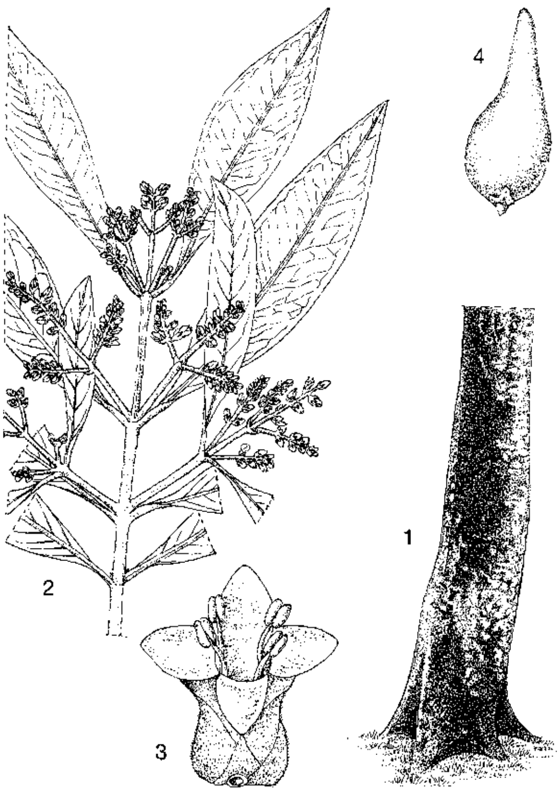
Shrinkage may be high to very high but, with care, the wood seasons well. The wood is moderately hard to hard, moderately strong and tough to very tough; the heartwood, however, is reported to be brittle. It is rather difficult to work due to the interlocked grain and the presence of stone cells and it splits radially with difficulty. The wood is non-durable, but the rare heartwood is re-



Avicennia alba
transverse surface (×20)

ported to be moderately durable. In a graveyard test in the Philippines the average service life of *A. officinalis* stakes was about 7 months. Apparently, the wood of *A. marina* is very durable in water. The sapwood is generally considered to be non-susceptible to *Lyctus*; the wood of *A. marina* is considered resistant to termites. The heartwood is extremely resistant to pressure treatment.
The gross energy value of *A. officinalis* is 18 075–18 755 kJ/kg.
See also the table on microscopic wood anatomy.

Botany Shrubs or small to medium-sized trees up to 30 m tall; bole often crooked, branchless for up to 5(–10) m, up to 60(–160) cm in diameter, without buttresses but often with small aerial roots and with numerous thin pneumatophores; bark surface smooth to shallowly fissured, lenticellate, occasionally flaky, grey or reddish-brown, inner bark whitish, producing a little resin. Twigs usually swollen towards the nodes. Leaves decussate, simple, entire, slightly fleshy, usually greyish below, exstipulate. Inflorescence terminal or axillary, spicate or capitate. Flowers sessile, bisexual; calyx enclosed by a bract and 2 bracteoles, 5-lobed; corolla actinomorphic or slightly zygomorphic, campanulate, 4(–6)-lobed, yellow or orange-yellow; stamens 4(–6), alternating with the corolla lobes, inserted basally or at the corolla throat; ovary superior, 1-locular with 4 ovules in 4 imperfect chambers, stigma 2-lobed. Fruit a 2-valved nut, leathery, often beaked, viviparous, splitting upon growth of the cotyledons. Seed 1, lacking a seed-coat. Seedling with epigeal germination; cotyledons emergent, the outer 2-lobed to emarginate, the inner rounded; radicle with hairs developing into secondary roots; hypocotyl elongated; all leaves opposite.



Avicennia alba Blume – 1, bole; 2, flowering twig; 3, flower; 4, fruit.

A. marina has a characteristic rooting system with long spreading, unbranched horizontal roots along which short pneumatophores are positioned. Tree shape confirms to Attims' architectural tree model, characterized by a monopodial trunk with equivalent branches showing continuous growth, and the inflorescences not influencing shoot construction. *A. marina* appears to have a very high minimum temperature requirement for shoot growth: 21°C. In Bangladesh *A. officinalis* showed a mean annual diameter increment of 0.2 cm. Flowers are protandrous and are produced throughout the year but usually with some peaks; near the equator *A. marina* flowers chiefly in November and December, in New Guinea *A. alba* flowers chiefly in December and January whereas *A. officinalis* flowers chiefly from August to November, and *A. rumphiana* in October and November. *A. officinalis* has been observed to be pollinated by flies, *A. marina* by bees; flowers produce nectar. In *A. marina* the fruit takes 2–3 months to mature in regions around the equator but up to 10 months in southernmost sites.
Avicennia is sometimes treated as a member of the family *Verbenaceae*, but most taxonomists agree on its distinctness based on its free central placentation, pendant orthotropous ovules and wood anatomy. *A. marina* is highly polymorphic and divided into 3 subspecies: subsp. *marina* in the western part of its area of distribution, subsp. *eucalyptifolia* (Zipp. ex Moldenke) Everett (synonym: *A. eucalyptifolia* Zipp. ex Moldenke) in the centre, and subsp. *australasica* (Walp.) Everett further east.

Ecology *Avicennia* is a characteristic element of the outer mangrove fringe along the shore or tidal rivers. They are pioneers capable of rapidly colonizing new mud flats or sand banks in the tidal zone. *Avicennia* often occurs gregariously or in pure stands and is very tolerant of hypersaline conditions. *A. marina* exhibits an exceptionally wide ecological tolerance of salinity, temperature, intertidal position, and substrate (mud to rocky sites).

Silviculture *Avicennia* can be propagated generatively. There are about 175 propagules/kg; a propagule being the viviparous fruit. The fruit can be stored and transported in saline water, but it is regarded as recalcitrant because it does not tolerate prolonged storage. In a germination experiment in Peninsular Malaysia it was found that fresh fruits of *A. alba* had a germination rate of about 85% in 7–26 days and those of *A. officinalis* had about 60% in 7–26 days. In the Philippines germination of *Avicennia* attained 85–100%. In the wild, seed germinates promptly and wildlings may also be collected to serve as planting stock. Crabs consume the propagules and may be the main reason for the absence of *A. marina* in certain areas. When other mangrove species have been cut for charcoal production, *Avicennia* often becomes dominant. As it is light-demanding it soon disappears again as succession continues. A dense stand is essential to obtain a straight bole, a spacing of 4 m × 4 m is applied in the Philippines when planting *A. officinalis* for firewood. The coppicing ability is good and trees are difficult to kill by girdling as new aerial roots soon develop just above the point where the trees have been girdled.

Genetic resources and breeding Although mangroves are generally heavily exploited for charcoal, *Avicennia* species are often left, as their wood is regarded inferior for this purpose.

Prospects The potential of *Avicennia* is limited, as many mangrove species (e.g. *Rhizophora*) are much more suitable for reforestation and firewood production.

Literature 38, 52, 60, 76, 151, 162, 163, 178, 209, 267, 292, 300, 304, 348, 402, 406, 436, 438, 464, 536, 632, 647, 718, 773, 780, 829, 831, 861, 880, 917, 934, 1038, 1044, 1079, 1111, 1113, 1189, 1221, 1242, 1252.

Selection of species

Avicennia alba Blume

Synonyms *Avicennia marina* (Forsk.) Vierh. var. *alba* (Blume) Bakh., *Avicennia officinalis* L. var. *alba* (Blume) Hook. ex Jafri, *Avicennia spicata* Kunth.

Vernacular names Indonesia: ros-rosan (Javanese). Malaysia: api-api hitam (Sarawak), api-api puteh (Peninsular). Philippines: api-api puti (general). Burma (Myanmar): lame. Thailand: samae khao (central), mae le, phephe le (peninsular). Vietnam: m[aws]m tr[aws]ng.

Distribution Along the coasts from western India and Sri Lanka to Burma (Myanmar), Indo-China, Thailand, throughout the Malesian region (except for the northern Philippines), the Palau and Yap Islands and the Solomon Islands.

Avicennia marina (Forsk.) Vierh.

Synonyms *Avicennia intermedia* Griffith, *Avicennia mindanaense* Elmer, *Avicennia sphaerocarpa* Stapf ex Ridley.

Vernacular names Grey mangrove, olive mangrove (En). Malaysia: api-api jambu (Peninsular), api-api merah (Sarawak). Philippines: bungalon (Filipino). Thailand: pepe dam (peninsular), samae thale (central). Vietnam: m[aws]m [owf]i.

Distribution Along the coasts of eastern Africa and Madagascar towards India, Indo-China, southern China, Taiwan, Thailand, throughout the Malesian region, the Solomon Islands, New Caledonia, Australia and northern New Zealand.

Avicennia officinalis L.

Synonyms *Avicennia obovata* Griffith, *Avicennia oepata* Hamilton.

Vernacular names White mangrove (En). Indonesia: ki balanak (Sundanese). Malaysia: api-api ludat (Peninsular), api-api sudu (Sarawak). Philippines: api-api (general). Burma (Myanmar): thame, theme-net. Thailand: ape ape (peninsular), samae dam (central). Vietnam: m[aws]m-lu[os]i-d[of]ng.

Distribution Along the coasts from western India to Indo-China, Thailand and throughout the Malesian region.

Avicennia rumphiana Hallier f.

Synonyms *Avicennia lanata* Ridley, *Avicennia marina* (Forsk.) Vierh. var. *rumphiana* (Hallier f.) Bakh.

Vernacular names Malaysia: api-api bulu (Peninsular).

Distribution Peninsular Malaysia, the Philippines, the Moluccas and New Guinea.

L.S.L. Chua

Baccaurea Lour.

Fl. cochinch.: 641, 661 (1790).
EUPHORBIACEAE
$x = 13$; *B. ramiflora*: $n = 13$, $13 + 1B$

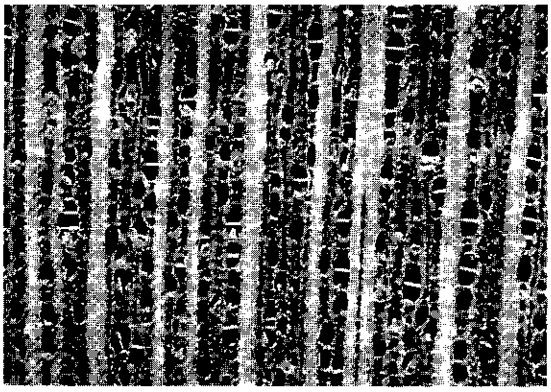
Vernacular names Tampoi (trade name). Indonesia: kepundung, menteng, tampui (general). Malaysia: tampoi (general), kunau kunau (Sabah), rambai hutan (Peninsular, Sabah). Philippines: dilak. Burma (Myanmar): kanaso, maimak-hpa. Laos: fai. Thailand: mafai, rambai, somfai. Vietnam: d[aa]u da.

Origin and geographic distribution *Baccaurea* comprises about 55 species occurring from India to Indo-China, southern China, the Andaman Islands, Thailand, throughout the Malesian region (except for the Lesser Sunda Islands) towards the Pacific Islands (east to Fiji, Tahiti and Samoa). Some 40 species are found within Malesia and are distributed as follows: Peninsular Malaysia 20 species, Sumatra 22, Java 5, Borneo 2, the Philippines c. 3, Sulawesi c. 5, the Moluccas c. 4 and New Guinea c. 4.

Uses The wood of *Baccaurea* is used mainly for poles in native house construction, boat building, wharf piling, furniture (general-utility purposes) and boxes. Additionally, it is suitable for general light construction under cover such as posts, beams, joists and rafters, carving, and for general-utility plywood.
Four *Baccaurea* species are frequently cultivated for their generally sour-tasting fruits: *B. dulcis*, *B. motleyana*, *B. racemosa* and *B. ramiflora*. Most other species have edible, but less tasty fruits. *Baccaurea* species are also considered good support trees for rattan cultivation. The cultivated species are used as shade and avenue trees. The bark of a few species is used, along with other ingredients, to colour silk yellow, red or mauve. The bark is also applied medicinally to treat skin diseases and inflammation of the eyes.

Production and international trade As the supply of *Baccaurea* timber is very limited, the wood is utilized on a local scale only.

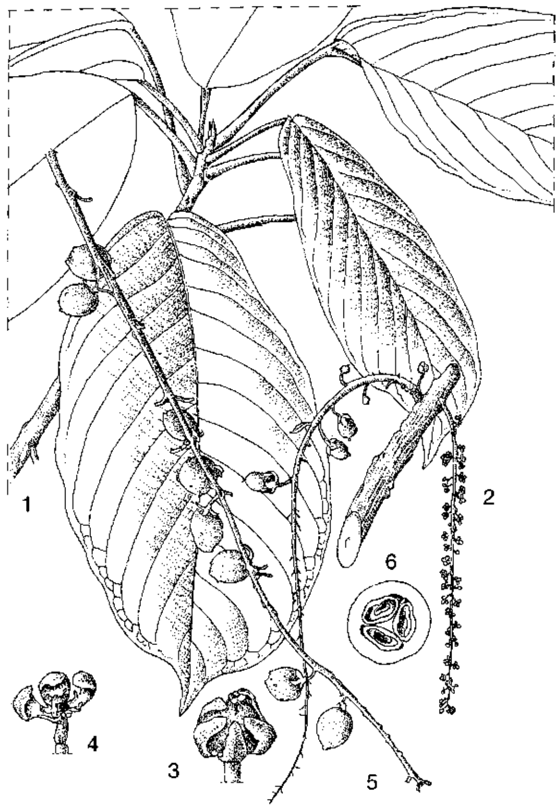
Properties *Baccaurea* yields a medium-weight to heavy hardwood with a density of 630–950 kg/m^3 at 15% moisture content. Heartwood yellowish-brown, darkening to brown with an orange-yellow or purple-red tinge, not clearly differentiated from the sapwood; grain straight or interlocked; texture moderately fine and uneven due to wide rays; wood with slight silver grain on quarter-sawn surface. Growth rings indistinct, sometimes suggested by darker coloured tissue; vessels moderately small to medium-sized, angular, solitary and in radial multiples of 2–4(–more), tyloses sparse; parenchyma abundant, apotracheal diffuse-in-aggregates; rays of 2 kinds, very fine or medium-sized to moderately broad; ripple marks absent.



Baccaurea papuana
transverse surface (×20)

Shrinkage is moderate and the wood seasons moderately slowly without serious degrade. The wood is moderately hard and moderately strong. It is reputed to be durable and can be treated with preservatives.
The leaves of *B. angulata* Merr. and possibly other species accumulate aluminium, rendering them pale when dried.
See also the tables on microscopic wood anatomy and wood properties.

Botany Evergreen, dioecious, small to medium-sized trees up to 30(–40) m tall; bole straight to rather poorly shaped and/or forked, branchless for up to 20 m, up to 70 cm in diameter, often with small buttresses or prominently fluted; bark very thin, surface shallowly finely dippled or with minute papery scales, red to orange-brown, inner bark softly fibrous, often deep red-brown; crown rather dense. Indumentum of simple to stellate hairs. Leaves arranged spirally, often crowded towards the end of twigs, simple, entire; petiole often long and kneed at the top; stipules early caducous. Inflorescence axillary to cauliflorous; male inflorescence narrowly thyrsoid; female inflorescence narrowly racemose. Flowers unisexual, small; sepals 4–5; petals absent. Male flowers with 4–8 stamens; disk-glands absent or free or connate; pistillode evident. Female flowers somewhat larger; disk absent; ovary superior, 2–5-locular with 2 ovules in each cell, styles bifid. Fruit variably fleshy and indehiscent or sometimes dry



Baccaurea motleyana (Müll. Arg.) Müll. Arg. - 1, sterile twig; 2, female inflorescence; 3, female flower; 4, male flower with 2 sepals removed; 5, infructescence; 6, fruit in cross section.

and dehiscent, (2–)3(–5)-locular capsule, 1–6-seeded. Seed often enclosed in a juicy, brightly coloured outer layer. Seedling with epigeal germination; cotyledons emergent, leafy, often bilobed; hypocotyl elongated; first pair of leaves opposite or alternate, subsequent ones arranged spirally.

Some species show rhythmic growth, with the branches produced in pseudo-whorls as in *Terminalia*. Flowering is synchronized, particularly in male trees and takes 2–3 weeks. In Malaysia flowering occurs in January–March and in Papua New Guinea *B. papuana* flowers in July–August. Flowering and fruiting is annually or biannually. The flowers are pollinated by bees and flies; those of some species are reported as fragrant or with a musky odour. Birds, deer, monkeys and rats eat and disperse the fruits.

The actual morphological origin of the outer seed layer, sometimes erroneously called an aril, is still unknown.

Ecology *Baccaurea* species are generally uncommon, but may locally occur as an important element of the lower storey of primary lowland rain forest. They are found in well-drained as well as swampy locations, up to 1000(–1800) m altitude, on a wide range of soils in primary and secondary evergreen rain forest, kerangas and peat-swamp forest.

Silviculture *Baccaurea* can be propagated by seed, but some fruit-producing species are also vegetatively propagated by air layering of female trees. Seeds of several species usually germinate in 2–6 weeks after sowing, with a germination rate of over 65%. The germination rate of fruits or seed sown with adhering pulp is less predictable: 3–100% germination in approximately the same time.

Genetic resources and breeding There are no records of *Baccaurea* in seed and germplasm banks. In several fruit-producing species there appears to be serious genetic erosion. Harvesting for timber, however, is unlikely to have a great impact on the genetic resource base.

Prospects Since *Baccaurea* species are fairly widespread and locally common as lower storey trees in primary forest, there is some scope for increased utilization of the wood for timber and wood-based panels.

Literature 26, 28, 32, 33, 34, 36, 70, 82, 151, 162, 163, 189, 209, 267, 436, 464, 543, 553, 644, 740, 741, 825, 829, 831, 861, 974, 977, 1038, 1043, 1164, 1169, 1195, 1221, 1242, 1259.

Selection of species

Baccaurea bracteata Müll. Arg.

Synonyms *Baccaurea crassifolia* J.J. Smith.

Vernacular names Monkey's tampoi (En). Indonesia: pangal (Kalimantan). Malaysia: tampoi bunga (Peninsular), tampoi paya (Sabah).

Distribution Peninsular Thailand, Peninsular Malaysia, Singapore, Sumatra and Borneo.

Baccaurea brevipes Hook. f.

Vernacular names Blue rambai (En). Malaysia: rambai ayam, rambai tikus (Peninsular).

Distribution Peninsular Malaysia, Sumatra and Borneo.

Baccaurea dasystachya (Miq.) Müll. Arg.

Vernacular names Indonesia: rukis (Sumatra), rupis (Belitung).

Distribution Sumatra.

Baccaurea dulcis (Jack) Müll. Arg.
Vernacular names Ketupa (En). Indonesia: cupa, tupa (general), kapundung (Sundanese).
Distribution Southern Sumatra; cultivated locally in Sumatra and western Java.

Baccaurea edulis Merr.
Distribution Borneo.

Baccaurea javanica (Blume) Müll. Arg.
Synonyms *Baccaurea acuminata* (Miq.) Müll. Arg., *Baccaurea leucodermis* Hook. f. ex Ridley, *Baccaurea minahassae* Koord.
Vernacular names Indonesia: heucip (Sundanese), jirek emprit, kapundung lanang (Javanese). Malaysia: setambun (Peninsular).
Distribution Peninsular Malaysia, Sumatra, Java, Borneo, Sulawesi and the Sangihe and Talaud Islands.

Baccaurea kunstleri King ex Gage
Synonyms *Baccaurea cordata* Merr.
Vernacular names Thailand: chamrai, kacham puuling, mafai ling (peninsular).
Distribution Peninsular Thailand, Peninsular Malaysia, Singapore, Sumatra and Borneo.

Baccaurea lanceolata (Miq.) Müll. Arg.
Synonyms *Adenocrepis lanceolatus* (Miq.) Miq., *Baccaurea glabriflora* Pax & K. Hoffm.
Vernacular names Green rambai (En). Indonesia: lengsu (Sundanese), lompayang (Kalimantan). Malaysia: asam pahong, medang kelawar, mempaung (Peninsular). Thailand: som huuk, som lok (peninsular).
Distribution Peninsular Thailand, Peninsular Malaysia, Singapore, Sumatra, Java, Borneo and the Philippines (Palawan).

Baccaurea macrocarpa (Miq.) Müll. Arg.
Synonyms *Baccaurea borneensis* Müll. Arg., *Baccaurea griffithii* Hook. f.
Vernacular names Greater tampoi (En). Indonesia: kapul (Indonesian, Kalimantan), tampoi bulan (Indonesian, Bangka), tuak tampoi (Kalimantan). Malaysia: tampoi merah (Sabah).
Distribution Peninsular Malaysia, Singapore, Sumatra and Borneo.

Baccaurea minor Hook. f.
Synonyms *Aporosa billitonensis* Pax & K. Hoffm., *Baccaurea pendula* Merr.
Distribution Peninsular Malaysia, Singapore, Sumatra and Borneo.

Baccaurea motleyana (Müll. Arg.) Müll. Arg.
Synonyms *Baccaurea pubescens* Pax & K. Hoffm.
Vernacular names Rambai (En). Indonesia: rambai (general). Malaysia: rambai (general). Philippines: rambi (Filipino). Thailand: lam khae, rambai (peninsular), mafai farang (central).
Distribution Native in Peninsular Malaysia, Singapore, Sumatra, Java and Borneo; also cultivated in this region and in Peninsular Thailand, the Philippines and Bali.

Baccaurea nanihua Merr.
Vernacular names Indonesia: haharu, makar lasi, nani hua (Ambon).
Distribution Kalimantan and the Moluccas (Ambon).

Baccaurea papuana F.M. Bailey
Synonyms *Baccaurea pluriloculariS* J.J. Smith.
Distribution New Guinea.

Baccaurea parviflora (Müll. Arg.) Müll. Arg.
Synonyms *Baccaurea rostrata* Merr., *Baccaurea scortechinii* Hook. f., *Baccaurea singaporica* Pax & K. Hoffm.
Vernacular names Indonesia: setambun (general). Malaysia: asam tambun, setambun (Peninsular). Thailand: mafai-ka, mafai-tao, somfai-pa (peninsular).
Distribution Peninsular Burma (Myanmar), Peninsular Thailand, Peninsular Malaysia, Singapore, Sumatra and Borneo.

Baccaurea polyneura Hook. f.
Synonyms *Baccaurea dolichobotris* Merr., *Baccaurea hookeri* Gage.
Vernacular names Malaysia: jentik merah, jentik-jentik (Peninsular).
Distribution Peninsular Malaysia, Singapore and Sumatra.

Baccaurea pubera (Miq.) Müll. Arg.
Synonyms *Baccaurea elmeri* Merr., *Baccaurea latifolia* King ex Hook. f., *Baccaurea puberula* Merr.
Vernacular names Malaysia: tampoi kuning (Sabah).
Distribution Peninsular Malaysia, Sumatra and Borneo (Sabah, Sarawak).

Baccaurea racemosa (Reinw. ex Blume) Müll. Arg.

Synonyms *Baccaurea wallichii* Hook. f.

Vernacular names Kapundung (En). Indonesia: bencoy. Malaysia: jinteh merah, kapundung, menteng.

Distribution Peninsular Malaysia, Singapore, Sumatra, Java and Borneo.

Baccaurea ramiflora Lour.

Synonyms *Baccaurea cauliflora* Lour., *Baccaurea sapida* (Roxb.) Müll. Arg., *Baccaurea wrayi* King ex Hook. f.

Vernacular names Burmese grape (En). Indonesia: mafai setambun, tajam molek. Malaysia: pupor, setambun, tajam molek (Peninsular). Thailand: hamkang (north-eastern). Vietnam: dz[aa]u mi[ee]n dz[uw][ows]i, gi[aa]u gia d[aa]t, gi[aa]u ti[ee]n.

Distribution From the eastern Himalayas to Indo-China, southern China, Thailand and Peninsular Malaysia.

Baccaurea reticulata Hook. f.

Vernacular names Lesser tampoi (En). Malaysia: taban merkeh, tampoi bunga (Peninsular).

Distribution Peninsular Malaysia, Singapore, Sumatra and Borneo (Brunei, Sarawak).

Baccaurea sumatrana (Miq.) Müll. Arg.

Synonyms *Baccaurea bivalvis* Merr., *Baccaurea kingii* Gage.

Vernacular names Malaysia: jentik-jentik, mesekam, tampoi kera (Peninsular).

Distribution Peninsular Malaysia, Singapore, Sumatra and Borneo.

Salma Idris

Barringtonia J.R. Forster & J.G. Forster

Charact. gen. pl.: 38 (1775).

LECYTHIDACEAE

x = unknown; *B. acutangula*: $n = 13$, $2n = 26$, *B. racemosa*: $2n = 52$

Vernacular names Putat (trade name), vutu (Pacific, trade name). Barringtonia (En). Brunei: angas gimpalang, angas gimplang. Indonesia: butun (general), keben (Javanese), songgom (Sundanese). Malaysia: tampalang (Sabah). Philippines: botong, ulam (Tagalog). Burma (Myanmar): kyi-bin, kyi-gyi. Thailand: chik.

Origin and geographic distribution *Barringtonia* comprises about 40 species which occur from tropical and subtropical regions of East Africa (1 species), Madagascar (2 species) to Afghanistan, Pakistan, India, Sri Lanka, Indo-China, southern China, Taiwan, the Ryukyu Islands, Thailand and the whole of the Malesian region towards northern Australia and the Pacific, east to Samoa and the Society Islands (Tahiti). Malesia represents the centre of diversity of *Barringtonia* with 32 species occurring there. One species (*B. asiatica*) has been introduced into East Africa, Hawaii, the West Indies and St. Helena.

Uses The wood of *Barringtonia* is used for temporary construction, local house building (posts, beams), general planking, flooring, boat building, mouldings, interior finish, handles of non-striking tools, household utensils, agricultural implements, boxes and crates and wooden pallets. The wood is suitable for veneer and plywood manufacturing. It has been applied in various kinds of wood-based panels like hardboard, particle board and blockboard, and has been used for the production of pulp. In India the wood is used additionally for carts, rice pounders and cabinet work. In the Philippines it has been reported that when treated with preservatives the timber can be used to make good ties and paving blocks, and that it might serve as an attractive cabinet wood. In the Nicobar Islands, Papua New Guinea and Pacific islands, the bole is used to make canoes. In the Pacific region the wood has additionally been used for carving and turnery. The wood is sometimes used for fuel.

Several species are planted as ornamentals. *B. asiatica* has also been planted as wind-break and for shade. Seed of most of the species contains saponins which are used as fish poison; the whole fruit, bark, wood or root is sometimes employed for the same purpose. In the Philippines the fruits are used to poison wild pigs and also for fish-net floats. Young leaves and shoots of some species are eaten as a salad. In Peninsular Malaysia the leaves of *B. racemosa* are used as a traditional vegetable with medicinal properties (against high blood pressure and as a depurative). Pounded leaves are said to cure chicken pox. In India *B. acutangula* is used for the production of honey. Bark, leaves and fruits of *B. asiatica* have been used medicinally for treating sores. In the Philippines its leaves have been topically applied against rheumatism and the seed as a vermifuge. A decoction of the leaves of *B. macrostachya* is said to cure stomach-ache. An infusion of the leaves and bark of *B. calyptrata* has been used to treat chest pains and fever.

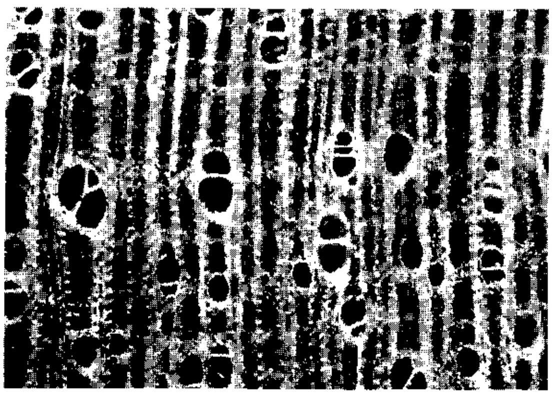
Production and international trade As the trees are often not large enough to be converted in saw-mills and supplies are small, utilization of the timber of *Barringtonia* is limited and it is not sold on the international market. In local trade, however, it is sold in mixed consignments of light or medium hardwood. 'Putat' is the South-East Asian standard trade name for timber of *Barringtonia* spp. and *Planchonia* spp. (*Lecythidaceae*).

Properties *Barringtonia* yields a medium-weight hardwood with a density of 480–815 kg/m^3 at 15% moisture content. Heartwood cream-white, pale yellow-brown, sometimes with reddish tinge, not differentiated from the sapwood; grain straight to interlocked; texture moderately fine and even. Growth rings indistinct, boundaries sometimes indicated by darker zones or by narrow, discontinuous layers of parenchyma; vessels medium-sized to moderately large, solitary and in radial multiples of 2–4, rarely in clusters (*B. calyptrata*), open; parenchyma moderately abundant, paratracheal scanty, vasicentric, aliform or occasionally confluent, and apotracheal diffuse-in-aggregates, visible with a hand lens, in *B. asiatica* also in regular bands both wider and narrower than the vessels; rays moderately broad or broad, visible to the naked eye; ripple marks absent.

Shrinkage upon air drying is moderate to high and it takes about 2 months and about 5 months, respectively, to air dry 13 mm and 38 mm thick boards of *B. pendula*, which is fairly slow. There is only a slight risk of insect attack and stain during air drying; severe cupping was observed in samples from Sabah. The wood kiln dries well from the green state, but some surface checking and slight warping occurs in back-sawn material. Boards of 25 mm and 50 mm thick of *B. samoensis* take 4–5 days and 8–9 days, respectively, to kiln dry. The wood is soft to moderately hard and fairly weak. It is easy to work and plane with hand and machine tools, although sawing has been reported to be difficult for *B. asiatica*; the finish may be slightly fibrous, and hence very sharp tools are required. Peeling of *B. pendula* did not present problems; the veneers dried easily but were liable to develop end splits and waviness. The wood is non-durable; the sapwood is permeable, the heartwood moderately resistant to pressure impregnation. The wood is liable to sap-stain, termite, and marine borer attack. The sapwood is susceptible to *Lyctus*.

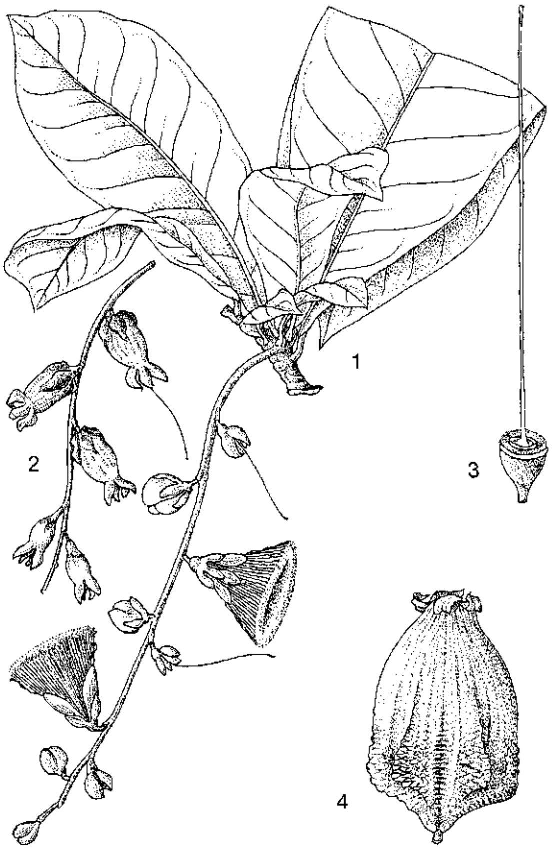
The gross energy value of the wood of *B. acutangula* is about 20 650 kJ/kg. The seed is especially rich in saponins.

See also the tables on microscopic wood anatomy and wood properties.



Barringtonia calyptrata
transverse surface (×20)

Botany Evergreen shrubs or small to medium-sized or occasionaly large trees up to 30(–47) m tall; bole branchless for up to 18 m, up to 60(–100) cm in diameter, rarely with thick buttresses spreading to 1.2 m, sometimes with steep, thick buttresses or a fluted base (*B. pendula*); bark surface slightly grooved and longitudinally fissured, cracked or scaly, sometimes smooth or dippled with roundish scales (*B. scortechinii*), thick, lenticels often distinctly diamond-shaped, brown, red-brown or grey, sometimes tinged with pink; inner bark finely, firmly fibrous, yellow-brown to pink or white with yellowish streaks (*B. asiatica*), without exudate. Leaves arranged spirally, crowded towards the ends of twigs, simple, obovate or obovate-oblong, dentate (except in *B. asiatica*), glabrous, with numerous lateral veins; stipules small, triangular, caducous. Flowers in a many-flowered, terminal or axillary, or sometimes cauliflorous, erect or pendulous raceme or spike, white, pink or red, often very large, very fragrant, fluffy from the numerous stamens; calyx rupturing circumscissile or into 2–4(–5) segments or with 4(–5) free lobes, the tube angular or winged; petals (3–)4(–5), free but connate to the filament tube; disk circular; ovary inferior, 2–4-locular with 2–6 ovules in each cell, with a single style. Fruit a medium to large, 1-seeded berry, ovoid to fusiform, smooth, grooved or angled, crowned by the persistent calyx. Seedling with hypogeal germination; cotyledons absent (seed containing a swollen hypocotyl); shoot with scales at the first few nodes.



Barringtonia racemosa (L.) Spreng. – 1, flowering twig; 2, young infructescence; 3, gynoecium; 4, mature fruit.

Branching is predominantly sympodial. Flowering takes place during the night with the corolla opening early in the evening and falling the next morning. In *B. asiatica* only 1 flower per inflorescence opens every night whereas in *B. racemosa* about half of the flowers in a single inflorescence bloom simultaneously. Most species flower throughout the year but full bloom is generally reached in May and August to September. Pollination of the fragrant flowers is generally by bats or insects (mainly moths) which are also attracted by the copious nectar. After shedding of the flowers, the inflorescences are often crowded with ants attracted by the nectar. A comparatively high percentage of the fruits is seedless. In lowland dipterocarp forest in Peninsular Malaysia the flowering-to-fruiting period of *B. pendula* is 8–18 weeks. Seed dispersal is usually by squirrels and other animals that feed on the fruits. Fruits of *B. asiatica* and several other species are buoyant thanks to the thick layer of spongy, fibrous pericarp, and are dispersed by sea currents.

The family *Lecythidaceae* is sometimes split into three separate families, with *Barringtonia* being a member of the *Barringtoniaceae*. Species of *Barringtonia* are extremely variable in e.g. leaf shape, size and margin, position and shape of spikes, and fruit shape and size. Despite this polymorphism the species are generally easy to recognize.

Ecology Most *Barringtonia* species are quite common elements of the canopy layer in evergreen, primary or sometimes secondary, lowland rain forest. They often occur on river banks or in estuaries, or in permanently or seasonally swampy locations but some species prefer well-drained habitats. Most species are found below 600 m but a few grow in montane forest up to 1500(–2000) m altitude. *Barringtonia* species are present in areas subject to perhumid or seasonal conditions. *B. asiatica* is a very characteristic element of the coastal fringe forest (*Barringtonia* formation) and is associated with other trees like *Calophyllum inophyllum* L., *Casuarina equisetifolia* L., *Hibiscus tiliaceus* L. and pandans (*Pandanus* spp.). *B. racemosa* may form almost pure stands along tidal rivers or in upper mangrove swamps.

Silviculture *Barringtonia* can be propagated by seed or by cuttings. Seeds of *B. asiatica* have about 70% germination in 36–63 days, compared with about 75% for *B. scortechinii* in 5–15 months. Sown fruits of *B. macrostachya* have about 40% germination in 9–22 months. Seeds of *B. acutangula* should be sown in full light, giving a germination of about 90%. *B. asiatica* can also be propagated by cuttings. *B. asiatica* is not resistant to fire.

Genetic resources and breeding As trees are not often harvested for timber, there is no threat to the genetic diversity of *Barringtonia*. There are no records of *Barringtonia* in seed or germplasm banks.

Prospects In view of the poor wood quality it is unlikely that the importance of *Barringtonia* for timber, either by exploiting natural forest or by establishing plantations will increase.

Literature 130, 151, 162, 163, 198, 209, 267, 302, 304, 340, 348, 387, 406, 436, 438, 450, 464, 536, 543, 678, 679, 751, 752, 800, 828, 829, 831, 861, 872, 889, 934, 940, 1038, 1053, 1169, 1192, 1221, 1232, 1236, 1239, 1242.

Selection of species

Barringtonia acutangula (L.) Gaertn.

Synonyms *Barringtonia edaphocarpa* Gagnep., *Barringtonia pedicellata* Ridley, *Barringtonia spicata* Blume.

Vernacular names Indian putat (En). Indonesia: alakang (South Sulawesi), kacuk (Je dialect, Merauke). Malaysia: jurai-jurai, pokok gajah beranak, putat nasi (Peninsular). Philippines: kalambuaia (Iloko). Burma (Myanmar): kyeni, kyi. Laos: ka dôn nam², ka dôn noy². Thailand: chik na (peninsular), kradon thung (north-eastern), tong (northern). Vietnam: c[aa]y m[uu]n, c[aa]y vung, ran bung.

Distribution From Afghanistan, Pakistan, India and Sri Lanka to Indo-China, southern China, Burma (Myanmar), Thailand, and throughout the Malesian area towards northern Australia.

Barringtonia apiculata Lauterb.

Synonyms *Barringtonia forbesii* Baker, *Barringtonia sepikensis* Lauterb.

Distribution South-eastern Sulawesi, Misool and Waigeo Island, New Guinea and the Louisiade Archipelago (Rossel Island).

Barringtonia asiatica (L.) Kurz

Synonyms *Barringtonia speciosa* J.R. Forster & J.G. Forster.

Vernacular names Sea putat (En). Indonesia: bitung (Sangir Island), keben-keben (Bali). Malaysia: putat laut (general), butong, putat ayer (Peninsular). Philippines: boton, botong (Filipino). Burma (Myanmar): kyi-git. Thailand: chik le, don le (peninsular).

Distribution From Madagascar to Sri Lanka, India, Burma (Myanmar), Indo-China, the Andaman Islands, Thailand, throughout the Malesian region towards northern Australia and into the Pacific, east to Samoa and the Society Islands (Tahiti); also planted within this region and introduced into continental East Africa, Hawaii, the West Indies and St. Helena.

Barringtonia calyptrata (Miers) R. Br. ex F.M. Bailey

Synonyms *Barringtonia flava* Lauterb.

Vernacular names Indonesia: tufan (Aru Islands).

Distribution The Aru Islands, New Guinea and northern Australia (Queensland).

Barringtonia lanceolata (Ridley) Payens

Synonyms *Careya lanceolata* Ridley, *Planchonia lanceolata* (Ridley) Knuth.

Vernacular names Malaysia: bubunak (Murut, Sarawak), tampalang (Sabah), tatisai, telisai sugud (Dusun, Sabah).

Distribution Borneo.

Barringtonia lauterbachii Knuth

Vernacular names Indonesia: bottegaib (Manokwari, Irian Jaya), temakkofus (Tehid, Irian Jaya), usin (Biak, Irian Jaya).

Distribution New Guinea and the Louisiade Archipelago (Rossel Island).

Barringtonia macrostachya (Jack) Kurz

Synonyms *Barringtonia acuminata* Korth., *Barringtonia balabacensis* Merr., *Barringtonia cochinchinensis* (Blume) Merr. ex Gangep.

Vernacular names Red putat (En). Indonesia: kayu putat, tuwah dotan (Sumatra), panga ha (Morotai). Malaysia: putat bukit putih, putat gajah (Peninsular), semuting (Dayak, Sarawak). Philippines: apalang (Tagalog), karakauat (Negrito), ulam (Tagbanua). Burma (Myanmar): cây tam lang, thay nya oo. Thailand: chik nom (peninsular). Vietnam: c[aa]y mung san.

Distribution From southern China, Burma (Myanmar) and Indo-China to Thailand, Peninsular Malaysia, Singapore, Sumatra, Borneo, the Philippines, northern Sulawesi and the Moluccas.

Barringtonia pendula (Griffith) Kurz

Synonyms *Barringtonia musiformis* King, *Barringtonia yunnanensis* Hu.

Vernacular names Banana putat (En). Malaysia: putat bukit, putat gajah (Peninsular), langkong (Iban, Sarawak).

Distribution Southern China, southern Burma (Myanmar), the Nicobar Islands, peninsular Thailand, Peninsular Malaysia, Sumatra and Borneo (Sabah, Sarawak).

Barringtonia racemosa (L.) Spreng.

Synonyms *Barringtonia insignis* Miq., *Barringtonia pallida* (Miers) Koord. & Valeton, *Barringtonia salomonensis* Rech.

Vernacular names Common putat (En). Brunei: putat aying. Indonesia: butun darat (Indonesian, Moluccas), penggung (Java), putat sungai (Bangka). Malaysia: putat ayam, putat kampong (Peninsular), putat ayer (Sabah). Philippines:

apalang (Filipino). Burma (Myanmar): kye-bin, kyi. Laos: som pawng. Thailand: chik ban, chik suan (central).

Distribution From eastern Africa and Madagascar to Sri Lanka, India, Burma (Myanmar), Indo-China, southern China, Taiwan, the Ryukyu Islands, Thailand, the Andaman and Nicobar Islands, throughout the Malesian region towards Micronesia, Polynesia (east to Fiji and Samoa) and northern Australia.

Barringtonia revoluta Merr.

Synonyms *Barringtonia flagellata* Lütjeharms & v. Ooststroom.

Vernacular names Brunei: putat samba. Indonesia: peranap (Sumatra). Malaysia: buah carrot (Dusun, Sarawak), karut, rengas (Iban, Sabah). Philippines: pusak (Tagbanua, Palawan), ulam-pampang (Tagalog).

Distribution Peninsular Malaysia, Sumatra, Borneo (Brunei, Sabah, Sarawak) and the Philippines (Palawan).

Barringtonia samoensis A. Gray

Synonyms *Barringtonia confusa* Lütjeharms & v. Ooststroom, *Barringtonia longipedicellata* Kaneh. & Hatus., *Barringtonia semisuta* (Miers) Knuth.

Distribution South-East Sulawesi, the Moluccas, New Guinea, Micronesia and Polynesia (Samoa).

Barringtonia sarcostachys (Blume) Miq.

Synonyms *Barringtonia anacardiifolia* Ridley, *Barringtonia dolichobotrys* Merr., *Barringtonia dolichophylla* Merr.

Vernacular names Brunei: tubai langkong (Iban). Indonesia: putat-talang (Sumatra). Malaysia: keroot (Iban, Sarawak), langkong (Sabah, Sarawak), tampalang (Dusun, Sabah).

Distribution Sumatra and Borneo.

Barringtonia scortechinii King

Vernacular names Scortechini's putat (En). Malaysia: putat gajah, putat hutan, putat tuba (Peninsular).

Distribution Peninsular Thailand, Peninsular Malaysia, eastern Sumatra and Borneo.

S.C. Lim

Bauhinia L.

Sp. pl. 1: 374 (1753); Gen. pl., ed. 5: 177 (1754).
LEGUMINOSAE
$x = 13, 14$; *B. malabarica*: $2n = 28$

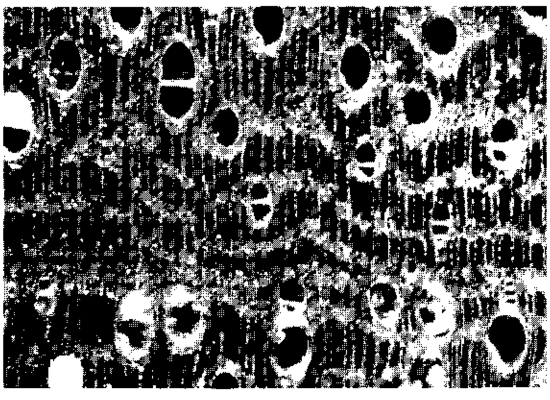
Vernacular names Malabar bauhinia (En), mountain ebony (En, India). Indonesia: benculuk, kendayakan (Java), kripi (Sumba). Philippines: alibangbang (Bisaya, Pampangan, Tagalog). Burma (Myanmar): bwaygyin, bwechin, bwegyin. Cambodia: choeung kôô. Laos: 'sô'm² 'sièo². Thailand: chongkho, salaeng phan, sieo som. Vietnam: m[os]ng b[of], tai t[uw][owj]ng, tai voi.

Origin and geographic distribution *Bauhinia* is a pantropical genus of approximately 300 species. Few species occur naturally in Malesia, but several are commonly planted as an ornamental. Most species are climbers or shrubs, but some reach the size of a small tree. The only timber-yielding species in Malesia is *B. malabarica* Roxb. (synonyms: *Piliostigma acidum* (Reinw. ex Korth.) Benth., *Piliostigma malabaricum* (Roxb.) Benth.), which is distributed in India, Burma (Myanmar), Indo-China, Thailand, the Philippines, Central and East Java, the Lesser Sunda Islands and northern Australia.

Uses Particularly in the Philippines, the wood of *B. malabarica* is used locally for temporary and interior construction and for the heels of slippers, and as firewood and for charcoal production.
The bright flowers of *B. malabarica* make it an attractive ornamental and roadside tree. The young leaves are eaten as a side-dish together with rice in Java, and are used to flavour meat and fish in the Philippines; they taste sour and are also eaten as relish. The bark is used to make ropes. Pounded bark is used in Timor for poulticing wounds. An infusion of fresh flowers is reported as anti-dysenteric. In the Philippines leaves are used as a febrifuge.

Production and international trade The wood of *B. malabarica* is utilized at a local scale only.

Properties *B. malabarica* yields a medium-weight hardwood with a density of 665–820 kg/m³ at 15% moisture content. Heartwood pale red, not clearly differentiated from the sapwood; grain straight or slightly interlocked; texture moderately fine. Growth rings indistinct to distinct, when distinct banded parenchyma and vessels unevenly distributed; vessels medium-sized to moderately large, mostly in radial pairs, sometimes in radial multiples of over 4; parenchyma apotracheal in wide or occasionally narrow bands, conspicuous,



Bauhinia malabarica
transverse surface (×20)

and paratracheal vasicentric, but hardly visible; rays extremely fine, not visible to the naked eye; ripple marks present, but not distinct.
The wood seasons well; shrinkage is low. It is moderately hard and comparatively strong. It works moderately easy and is durable only for interior work. The sapwood is susceptible to *Lyctus* and the heartwood is susceptible to dry-wood termites. The energy value of the wood is about 18 100 kJ/kg.
See also the tables on microscopic wood anatomy and wood properties.

Botany An evergreen or nearly evergreen, dioecious, small tree up to 17 m tall; bole short and often gnarled, up to 50 cm in diameter; bark surface rather fissured and peeling off in long strips, yellowish-brown and chequered. Leaves alternate, simple, ovate to rotund, bifid up to one fourth of their length with a broad sinus and broadly rounded lobes; stipules linear, caducous. Flowers in a compound, densely-flowered, racemose inflorescence, clavate in bud, long-pedicelled, unisexual; calyx tubular and splitting into 3–5 segments above; petals 5, white. Male flowers with 10 stamens; ovary rudimentary. Female flowers with 10 minute staminodes; ovary superior, stiped, stigma peltate. Fruit an indehiscent, strap-shaped and striate pod with a long beak, 10–30-seeded. Seed oblong, dark brown. Seedling with epigeal germination; cotyledons emergent; hypocotyl elongated; all leaves alternate.
In secondary forest in the Philippines a mean annual diameter increment of 2.3–2.8 cm has been recorded for *B. malabarica*, but a value as low as 0.1 cm is reported from India. In Java it flowers in March–April and fruits in July–October. Ectomycorrhizae are known to be present.
B. malabarica differs from other South-East Asian *Bauhinia* species particularly in being dioecious.

Ecology *B. malabarica* often occurs in areas with a distinct dry season. In Java and Thailand it is common in teak forest and open deciduous forest, and sometimes also in savanna, usually up to 400 m altitude; in Timor it occurs up to 600 m, often on limestone. In the Philippines it is locally common on drier, hilly sites. Although it is locally frequent, it is never dominant. The annual rainfall in its natural habitat in India varies between 1000 and 3000 mm.

Silviculture *B. malabarica* can be raised from seed. There are about 15 500 dry seeds/kg. The germination percentage of seeds stored for 2 weeks is about 45%, but this drops to about 25% after 3 months of storage. Germination takes 55–123 days. Seeds should be sown no deeper than 1 cm and in full sunlight to allow optimal germination. In the nursery seeds are pretreated with hot water for 2–3 minutes and soaked in cold water for 24 hours before sowing. Average height and diameter are 33 cm and 0.5 cm after 1 month and 76 cm and 1.1 cm, after 4 months. *B. malabarica* can be planted in lowland areas with a dry season of 4–6 months, but when planted on poor soils growth stagnates after a few years. The survival of seedlings planted in *Imperata cylindrica* (L.) Raeuschel vegetation was only about 43%. *B. malabarica* is fire-resistant and occurs naturally scattered in grasslands subject to fire in the Philippines.

Genetic resources and breeding *B. malabarica* is widespread and locally common in vegetation types which are usually not subject to heavy logging. The risk of genetic erosion is therefore small.

Prospects The value of *B. malabarica* as a timber tree seems to be negligible because of the small size and often poor form of the bole. In the Philippines managing fire-prone areas with the aim of producing pulp from *B. malabarica* may have potential. Besides that, it is an attractive ornamental.

Literature 70, 130, 163, 199, 209, 254, 308, 343, 405, 436, 662, 664, 776, 777, 861, 916, 934, 1039, 1104, 1107, 1198.

I. Samsoedin

Berrya Roxb.

Pl. Coromandel 3: 60, t. 264 (1820).
TILIACEAE
x = unknown; *B. cordifolia*: $2n = 40$

Vernacular names Halmalille wood, trincomali wood (En). Philippines: malibayo. Burma (Myanmar): mai-long. Thailand: liang (general).

Origin and geographic distribution *Berrya* comprises 4 species occurring from Sri Lanka and India to the Andaman and Nicobar Islands, Burma (Myanmar), Indo-China, Thailand, Peninsular Malaysia, Java, Christmas Island, Borneo, the Philippines and Sulawesi. *B. cordifolia* has been planted in Peninsular Malaysia and Indonesia, and has also been introduced to tropical West Africa, India, Hawaii and Fiji.

Uses The heavy wood of *Berrya* is used for high-grade construction, heavy-duty flooring, ship and boat building, vehicle bodies, furniture, sporting goods, agricultural implements, boxes and crates, railway sleepers, piling, carving, turnery, draining boards and bentwood sticks. It is especially suitable for purposes where strength and elasticity are required.

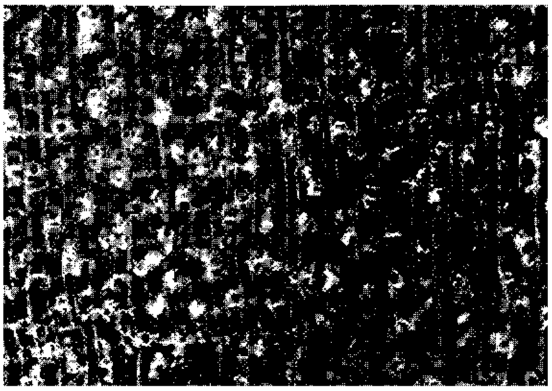
In West Africa *B. cordifolia* has been planted in wind-breaks and shelter belts. An ethanol extract of this species proved highly toxic to the European corn borer (*Ostrinia nubilalis*).

Production and international trade In the Malesian region *Berrya* wood is used on a local scale only. In India and Burma (Myanmar), however, the wood (mainly that of *B. cordifolia*) is valued and commercially traded. In the 1970s annual exports from Burma (Myanmar) amounted to about 500 t, approximately 600 m^3.

Properties *Berrya* yields a heavy or sometimes medium-weight hardwood with a density of 690–935(–1080) kg/m^3 at 15% moisture content. Heartwood dark red to brown, often with darker streaks, distinct from the whitish to pale brown sapwood; grain straight or shallowly interlocked; texture fine to medium; wood greasy to the touch, with pungent odour when freshly sawn. Growth rings may be distinct; vessels very small to medium-sized, almost all in radial multiples of 2–4, multiples of over 4 common, tyloses abundant; parenchyma paratracheal confluent and apotracheal in narrow bands, the latter not visible to the naked eye; rays very fine, not visible to the naked eye; ripple marks distinct.

Stock seasons slowly and is not subject to serious splitting, but may develop some surface checks; stacks must be weighted down. The wood is hard, strong, and tough and elastic. It is difficult to saw, but works remarkably well with all other tools, takes a good finish and a high polish, has good wearing and weathering properties, and is rather difficult to glue. The wood is very durable. The heartwood is extremely resistant to impregnation, but does not need any treatment for practical purposes. Under cover the heartwood is resistant to dry-wood termites, but the sapwood is susceptible to *Lyctus*.

See also the tables on microscopic wood anatomy and wood properties.



Berrya cordifolia
transverse surface (×18)

Botany Deciduous, small to medium-sized trees up to 30(–40) m tall; bole frequently crooked in Malesia but apparently better shaped in India and Indo-China, branchless for up to 15 m, up to 80 cm in diameter, fluted at base or with low buttresses; bark surface vaguely fissured, becoming irregularly flaky, pale brown, inner bark white to pale brown. Indumentum of stellate hairs. Leaves arranged spirally, simple, frequently with a dentate margin, palmately (3–)5–7-veined, with tufts of hairs in primary vein-axils below; stipules small and caducous. Flowers in an axillary or terminal panicle; sepals fused but irregularly splitting or 3–5-lobed; petals (3–)5(–6), pink or white; stamens many, in 5 lax bundles, connate at base, anthers dorsifixed; ovary superior, 2–5-locular with 2–6 ovules per cell; style 1. Fruit a globose capsule, each valve with 2 longitudinal wings. Seed hairy or enclosed in papery exotesta. Seedling with epigeal germination; cotyledons emergent, leafy; hypocotyl elongated; seedling leaves toothed.

Seedling growth of *B. cordifolia* is comparatively slow. In Java *B. javanica* flowers from April to June and in September, whereas *B. cordifolia* does so in February to June. In northern Australia

B. javanica flowers from April to May and fruits have been collected from April to November. *B. cordifolia* is fairly fast-growing with an average annual diameter increment of 1 cm for at least the first 30 years.

Ecology *Berrya* is usually found scattered in deciduous primary forest, sometimes in secondary forest or in brushwoods and thickets, up to 1000 m altitude. It seems to prefer dry slopes, and has been found on a variety of soils, including limestone soils. However, at least *B. cordifolia* does not grow well on clayey soils; it tolerates poor drainage, but is not resistant to drought. In Burma (Myanmar) *B. cordifolia* is found in association with teak (*Tectona grandis* L. f.), *Terminalia tomentosa* (Roxb.) Wight & Arn., *Dalbergia cultrata* Graham ex Benth. and *Homalium tomentosum* (Vent.) Benth. It requires partial shade especially in the seedling stage; solitary trees in full sun grow poorly.

Silviculture *Berrya* can be propagated by seed. Seedweight of *B. cordifolia* is about 52 000 seeds/kg; about 30% of the seed germinates in 14–33 days, but a germination percentage of 20% has also been reported. In India and Sri Lanka seedlings 8–10 months old are used as bare-rooted planting stock. Stumps prepared from 1.5–2-year-old stock having a diameter of 2 cm can also be used; the shoot is trimmed to 3–4 cm and the roots to 20 cm. Planting of stumps resulted in 70–75% survival. *B. cordifolia* coppices well and produces root suckers. In the Philippines it is attacked by seedling blight (*Pellicularia rolfsii*).

Genetic resources and breeding Thanks to the wide geographic distribution of the timber-yielding species there is little risk of genetic erosion of *Berrya* species.

Prospects The fast growth of *B. cordifolia* and its high-quality timber make it worthwhile to start silvicultural research in the Malesian region.

Literature 61, 70, 163, 164, 192, 306, 357, 400, 436, 438, 464, 536, 751, 829, 887, 934, 974, 1039, 1104, 1169, 1221.

Selection of species

Berrya cordifolia Roxb.

Synonyms *Berrya ammonilla* Roxb.

Vernacular names Indonesia: kalong (Javanese), ketapang baluh (Kangean, Madura), sepat (general). Malaysia: inchong perlis (Peninsular). Philippines: malibayo, pakpak-balang (Tagalog), anobrang (Iloco). Burma (Myanmar): mai-long, petwun. Thailand: liang man (northern).

Distribution Sri Lanka, India, Burma (Myanmar), the Andaman and Nicobar Islands, Indo-China, Thailand, Peninsular Malaysia, Java, Christmas Island, Borneo, the Philippines and Sulawesi.

Berrya javanica (Turcz.) Burrett

Synonyms *Berrya quinquelocularis* Teijsm. & Binnend. ex Koord. & Valeton.

Distribution Java and northern Australia.

Berrya mollis Wallich ex Kurz

Synonyms *Berrya ammonilla* Roxb. var. *mollis* (Wallich ex Kurz) Mast.

Vernacular names Laos: liěng, liěng 'khai. Thailand: liang (general), po liang (northern), thum thuai (central).

Distribution India, Burma (Myanmar), Indo-China and Thailand.

E. Boer (general part),
M.S.M. Sosef (general part, selection of species)

Bhesa Buch.-Ham. ex Arn.

Edinburgh New Philos. Journ. 16: 315 (1834).

CELASTRACEAE

x = unknown; $2n$ = unknown

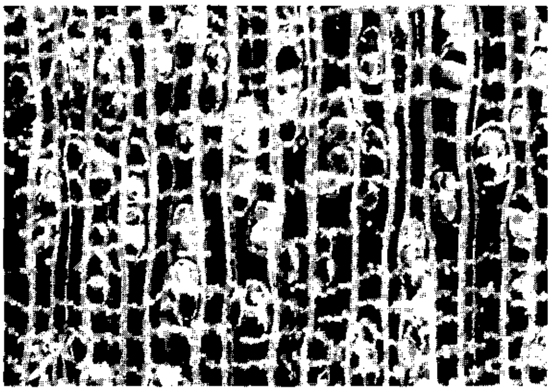
Vernacular names Brunei: serunai. Malaysia: biku-biku (general), benak (Peninsular), mata ulat (Sabah).

Origin and geographic distribution *Bhesa* comprises 5 species and occurs from Sri Lanka and India to Burma (Myanmar), Indo-China, Thailand, Peninsular Malaysia, Sumatra, Borneo, the Philippines and New Guinea. Four species are found in Malesia.

Uses The wood of *Bhesa* is used for general construction under cover (e.g. beams, posts), and possibly for cabinet work and panelling where a decorative wood is required.
Its fruits are sour but edible.

Production and international trade In Sabah the timbers of *Bhesa* and *Kokoona* are grouped together and sold as 'mata ulat'. Trade is on a local scale only, however.

Properties *Bhesa* yields a medium-weight hardwood with a density of 725–835 kg//m^3 at 15% moisture content. Heartwood straw-coloured, or yellowish-brown to brown with a purple-red tinge, usually not clearly but occasionally sharply differ-



Bhesa archboldiana
transverse surface (×20)

entiated from the wide sapwood; grain interlocked; texture fine to moderately fine and uneven; wood with zig-zag figure on tangential surface due to bands of parenchyma. Growth rings indistinct; vessels moderately small to medium-sized, angular, solitary and in radial multiples of 2–4(–6) or clusters, open; parenchyma abundant, apotracheal diffuse-in-aggregates to narrow bands, conspicuous to the naked eye; rays medium-sized, visible to the naked eye; ripple marks absent.
See also the table on microscopic wood anatomy.

Botany Evergreen, medium-sized to fairly large trees up to 40 m tall; bole up to 90 cm in diameter, with small buttresses and often fluted at base; bark surface smooth to slightly fissured or scaly, grey-brown to dark brown, inner bark mottled orange and cream; crown spreading, dark green. Leaves arranged spirally, simple, entire, tertiary venation scalariform; petiole swollen at apex; stipules lanceolate, caducous. Inflorescence axillary, solitary or paired, paniculate or racemose; pedicels jointed. Flowers bisexual, (4–)5-merous, whitish to greenish, fragrant; calyx deeply lobed; petals contorted; disk entire or lobed; stamens inserted on or just below the disk; ovary superior, 2-locular with 2 ovules in each cell, often hairy at apex, styles 2. Fruit an entire or 2-lobed capsule, dehiscing lengthwise into 2 valves or on 1 side only. Seed partly or completely covered by the bright orange-red or pink aril. Seedling with epigeal germination; cotyledons emergent, fleshy (*B. robusta*) or leafy (*B. paniculata*); hypocotyl elongated; all leaves arranged spirally (*B. paniculata*) or the first 2 opposite (*B. robusta*).
Growth of *B. paniculata* is reported to be slow. After a dry spell flowers develop in the axils of scale leaves; the resting bud resumes growth and forms new leaves when the fruits are ripe. Pollination is probably by insects. In Peninsular Malaysia flowering and fruiting have been observed for seven consecutive years and *B. paniculata* flowered throughout the year, but it produced a full crop of fruits only once during the period of observation. *B. robusta* flowered and fruited 10 times in 7 years, which is exceptional in tropical trees; its fruits ripened in about three months. The seeds are eaten by the giant squirrel, but birds attracted by the brightly coloured arils also disperse the seeds.

Ecology *Bhesa* is found scattered in primary lowland to montane rain forest, up to 1500(–2150) m altitude. It occurs in both dry land forest, e.g. mixed dipterocarp forest and kerangas, and in peat-swamp or freshwater swamp forest, under perhumid to seasonal conditions. *B. indica* grows in dense forest at 800–2150 m altitude.

Silviculture *Bhesa* can be propagated by seed. In germination trials the germination rate of cleaned seeds of *B. paniculata* was 35–45% in 14–34(–64) days and about 25% in 23–74 days for seeds sown with the aril attached. Seeds of *B. robusta* have about 45% germination in 13–39 days. In a 50 hectare plot in lowland forest in Peninsular Malaysia 173 individuals of at least 1 cm in diameter of *B. paniculata* were counted and only 23 of these exceeded 10 cm diameter, i.e. about 0.5 stems/ha.

Genetic resources and breeding As *Bhesa* is not an important commercial timber, trees are seldom logged from concession areas. As they in addition occur in a wide variety of habitats, they do not seem endangered.

Prospects No change is expected in the current uses of *Bhesa*. *B. paniculata* can be considered for planting as an ornamental tree because of the deep green foliage and clusters of pink fruits.

Literature 61, 151, 162, 198, 209, 267, 273, 341, 436, 770, 829, 831, 861, 974, 1038, 1048, 1221, 1232, 1242.

Selection of species

Bhesa archboldiana (Merr. & L.M. Perry) Ding Hou

Synonyms *Kurrimia archboldiana* Merr. & L.M. Perry.

Distribution New Guinea, the Louisiade Archipelago and the d'Entrecasteaux Islands.

Bhesa indica (Bedd.) Ding Hou

Synonyms *Kurrimia bipartita* M.A. Lawson, *Kurrimia indica* (Bedd.) Gamble.

Vernacular names Malaysia: buah chendara, hashim, malayray (Peninsular). Thailand: huyan (peninsular).

Distribution Southern India, Burma (Myanmar), southern Thailand and Peninsular Malaysia.

Bhesa paniculata Arn.

Synonyms *Kurrimia luzonica* S. Vidal, *Kurrimia minor* Ridley, *Kurrimia paniculata* Wallich ex Arn.

Vernacular names Malayan spindle tree (En). Brunei: serunai. Indonesia: merlantaan rawang (Sumatra), pimpuh (Palembang, Sumatra), rawang (Batak, Sumatra). Malaysia: biku-biku (Peninsular, Sabah), serunai (Sarawak), simum (Iban, Sarawak). Philippines: kuela (Panay Bisaya). Thailand: tum phra, yang kriang (peninsular).

Distribution Southern India, peninsular Thailand, Peninsular Malaysia, Sumatra, Borneo and the Philippines.

Bhesa robusta (Roxb.) Ding Hou

Synonyms *Kurrimia maingayi* M.A. Lawson, *Kurrimia pulcherrima* Wallich ex M.A. Lawson, *Kurrimia robusta* Kurz.

Vernacular names Red-flowered Malayan spindle tree (En). Indonesia: balam buju (Palembang, Sumatra), bengkinang (Sumatra), janting (Belitung). Malaysia: biku-biku, medang gidap, medang tijoh (Peninsular). Burma (Myanmar): tagu-bok. Thailand: krabok khai (eastern), kradong daeng, lamok (south-eastern).

Distribution North-eastern India, Bangladesh, Burma (Myanmar), the Andaman Islands, Indo-China, Thailand, Peninsular Malaysia, Sumatra and Borneo.

K.M. Kochummen

Blumeodendron (Müll. Arg.) Kurz

Journ. As. Soc. Beng. 42: 245 (1873).
EUPHORBIACEAE
x = unknown; $2n$ = unknown

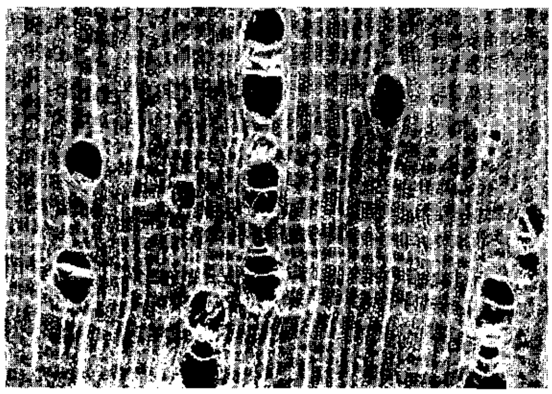
Vernacular names Tengkurung (trade name). Malaysia: gaham badak (Peninsular, Sabah), medang lempong (Peninsular), merbulan (Peninsular, Sarawak). Philippines: lindog (Tagalog).

Origin and geographic distribution *Blumeodendron* comprises 6 species and occurs in the Andaman Islands, southern Burma (Myanmar), peninsular Thailand, throughout the Malesian region (except for the Lesser Sunda Islands and Sulawesi) towards the Bismarck Archipelago.

Uses The wood of *Blumeodendron* is used for internal construction and shuttering and, when treated, also for fencing and light constructional work. The logs are generally too small for rotary peeling. The wood of *B. subrotundifolium* yields a good quality charcoal.
The aril of the seed is edible.

Production and international trade Because the logs are generally small, *Blumeodendron* wood is used on a local scale only.

Properties *Blumeodendron* yields a medium-weight or occasionally heavy hardwood with a density of (430–)510–895 kg/m^3 at 15% moisture content. Heartwood pale yellow-brown or straw-brown with a slight pink tinge, not clearly differentiated from the sapwood; grain usually straight, sometimes slightly interlocked; texture moderately coarse and even; occasionally with small corewood with black streaks or grey-black with orange streaks. Growth rings generally indistinct, boundaries sometimes visible due to colour differences; vessels medium-sized to moderately large, solitary and in radial multiples of 2–4, tyloses present but not abundant; parenchyma moderately abundant, apotracheal in narrow bands, just visible to the naked eye; rays very fine to moderately fine; ripple marks absent.
Shrinkage upon seasoning is moderate to high. The wood is subject to degrade with moderately severe end-checking, slight cupping, bowing and splitting. During drying it is highly susceptible to sap-stain and insect attack. Air drying of 13 mm



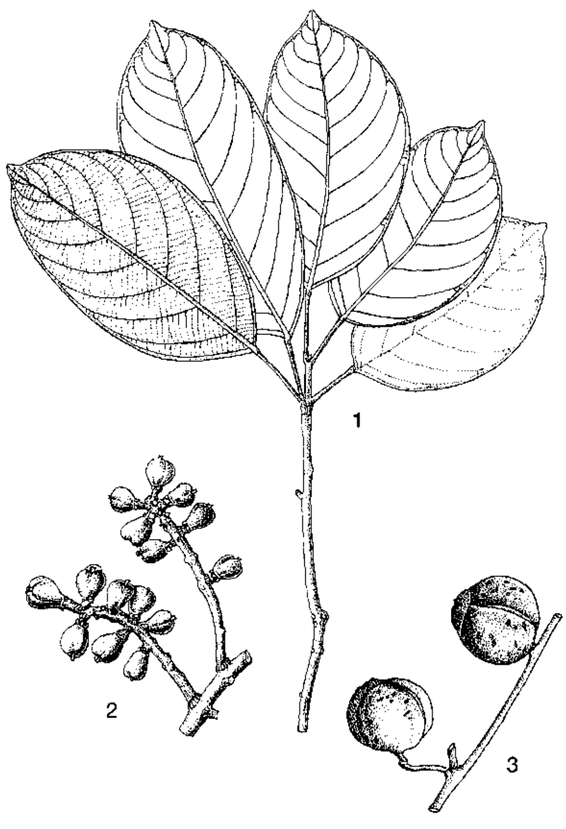
Blumeodendron tokbrai
transverse surface (×20)

and 38 mm thick boards of *B. tokbrai* takes 3–4 months and 4–5 months respectively. In Malaysia kiln schedule K is recommended. The wood is moderately hard to hard and moderately strong. It is easy to work, plane and bore, with some picking up in planing. Cutting edges blunt moderately rapidly. The wood is non-durable, with an average service life of 1.5 years in a graveyard test in Malaysia. It is easy to treat with preservatives, having an absorption of 80 kg/m^3 of a 50% creosote and 50% diesel oil mixture when not heated and 240 kg/m^3 when heated. The wood is susceptible to termite attack. The sapwood is susceptible to *Lyctus*.

The mean fibre length of *B. tokbrai* from Indonesia is 1.456 mm.

See also the tables on microscopic wood anatomy and wood properties.

Botany Dioecious, small to medium-sized or rarely large trees up to 35(–50) m tall; bole usually straight, up to 120 cm but generally 40–50 cm in diameter, sometimes fluted or with small buttresses, occasionally stilt-rooted (*B. tokbrai* in peat-swamp forest); bark surface smooth to finely rugose or scaly, grey-white to ochre-fawn or warm orange-brown, inner bark granular to laminate, brown, yellow-brown or pinkish; crown dense. Leaves alternate to subopposite or falsely whorled, simple, entire; petiole long, prominently kneed at both ends; stipules obsolete. Male flowers in an axillary, condensed cyme or false raceme; calyx valvate, 3–4-partite; petals absent; stamens 14–40, with numerous small glands at their bases; pistillode absent. Female flowers in an axillary, short raceme; sepals 3–5; petals absent; disk annular; ovary superior, 2–3-locular with a single ovule in each cell, styles 2, connate at base. Fruit a large, woody, 1–2-seeded capsule on a thickened pedicel. Seedling with epigeal germination; cotyledons not emergent; hypocotyl elongated; first pair of leaves exstipulate, opposite, subsequent ones alternate or arranged spirally.



Blumeodendron tokbrai (Blume) J.J. Smith – 1, sterile twig; 2, young fruits; 3, fruits.

In Java *B. tokbrai* has been observed flowering from April to November, *B. kurzii* almost throughout the year. In Peninsular Malaysia *Blumeodendron* has been reported flowering and fruiting in mast years.

B. subrotundifolium closely resembles *B. kurzii* and the two may prove to be conspecific.

Ecology *Blumeodendron* species are canopy or subcanopy trees and may be fairly common in primary or sometimes secondary forest, generally at low altitudes, but ascending up to 2700 m altitude. They are found on flat land, on hills and slopes and also in swamp forest. Soil types vary between sandstone, sandy loams, loam and even clayey soils. *B. tokbrai* is occasionally found in mangrove forest. *B. calophyllum* is locally common in primary kerangas forest on yellow sandy clay soil.

Silviculture *Blumeodendron* can be propagated by seed. About 40% of the seeds of *B. calophyllum* germinate in 58–139 days.

Genetic resources and breeding As most *Blumeodendron* species are widespread, they do not seem in immediate danger of genetic erosion or extinction.

Prospects Because of the generally good quality of the wood of *Blumeodendron*, its use may increase when similar timbers become more scarce. However, its average small size limits its applicability.

Literature 21, 26, 28, 32, 33, 34, 36, 70, 162, 163, 267, 387, 436, 543, 676, 677, 740, 741, 745, 829, 831, 861, 974, 1195, 1221, 1242.

Selection of species

Blumeodendron calophyllum Airy Shaw

Vernacular names Malaysia: damar katop (Peninsular).

Distribution Peninsular Malaysia and Borneo (Brunei, Sarawak).

Blumeodendron kurzii (Hook. f.) J.J. Smith

Synonyms *Blumeodendron cuneatum* S. Moore, *Blumeodendron sumatranum* S. Moore.

Vernacular names Indonesia: tokbrai (Sundanese). Malaysia: medang lempong (Peninsular). Thailand: yaka (peninsular).

Distribution Burma (Myanmar), the Andaman Islands, peninsular Thailand, Peninsular Malaysia, Sumatra, Java, Borneo and New Guinea; possibly also in the Philippines.

Blumeodendron subrotundifolium (Elmer) Merr.

Synonyms *Blumeodendron subcaudatum* Merr.

Vernacular names Philippines: lindog (Panay Bisaya), lindog-bilog (Tagalog).

Distribution Peninsular Malaysia, Borneo and the Philippines.

Blumeodendron tokbrai (Blume) J.J. Smith

Synonyms *Blumeodendron borneense* Pax & K. Hoffm., *Blumeodendron elateriospermum* J.J. Smith, *Blumeodendron vernicosum* (Hook. f.) Gage.

Vernacular names Indonesia: keterung (Riau Archipelago, Kalimantan), ki kukuran, tokbrai (Sundanese). Malaysia: gaham badak (Peninsular).

Distribution Peninsular Malaysia, Singapore, Sumatra, Java, Borneo, the Philippines, the Sangihe and Talaud Islands, the Moluccas, New Guinea and the Bismarck Archipelago.

E.N. Sambas (general part),
M.S.M. Sosef (selection of species)

Bombax L.

Sp. pl. 1: 511 (1753); Gen. pl., ed. 5: 227 (1754).
BOMBACACEAE
x = unknown; *B. ceiba*: $2n = 72$

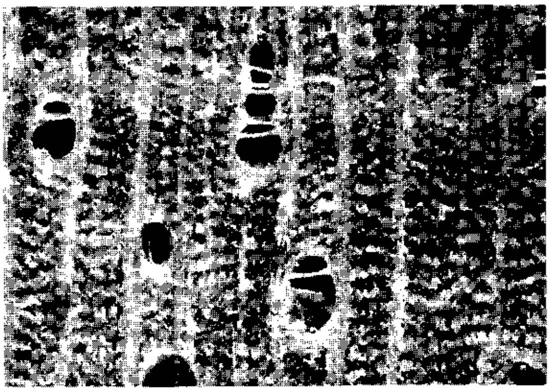
Vernacular names Kekabu (trade name). Cottonwood (En). Indonesia: randu alas. Malaysia: kekabu hutan (Peninsular), kapok, tambaluang (Sabah). Papua New Guinea: bombax, kapok. Philippines: malabulak. Burma (Myanmar): didu, letpan, thinbaw. Thailand: ngiu. Vietnam: g[aj]o d[or], g[aj]o hoa trang, p'lang.

Origin and geographic distribution *Bombax* comprises 8 species occurring in the Old World tropics from tropical Africa to Indo-China, throughout the Malesian area towards northern Australia. Three species are native to Malesia.

Uses In the Malesian region *Bombax* is used as a low grade utility timber only. It has been applied for packing cases, matchboxes, matches, core veneer, temporary construction, musical instruments, mouldings, household appliances, buoys, novelties and, when treated, for low grade furniture and interior partitioning. Locally it is used for making canoes. In Papua New Guinea large logs of *B. ceiba* were formerly peeled for plywood and veneer production. In India, where *B. ceiba* is much more common, it is the major indigenous source of wood for the production of matches.
The kapok from the fruits of *B. ceiba* can be used for stuffing pillows etc., and the tree is sometimes planted as an ornamental for its bright red flowers; in Vietnam it is also planted around temples. In Java *Bombax* is grown in cemeteries and the trees are considered sacred. The gum from the bark and roots has been used as a medicine against diarrhoea, dysentery and fever. Fibres from the bark of *B. ceiba* are used for making paper pulp, oil from the seed is used in food and for soap making and the flowers are eaten after boiling. Leaves and twigs may be used as a forage for cattle.

Production and international trade Within the Malesian region supplies are generally very limited and trade is only local. In Peninsular Malaysia *Bombax* is often traded as 'durian' wood in small proportions in mixed consignments mainly comprising wood of *Durio* spp. In 1996 Papua New Guinea exported about 1050 m^3 of *Bombax* logs at an average free-on-board (FOB) price of US$ 97/m^3.

Properties *Bombax* yields a lightweight hardwood with a density of 120–545 kg/m^3 at 15% moisture content. Heartwood straw-coloured, sharply differentiated (*B. valetonii*) or not (*B. ceiba*) from the white sapwood; grain straight or slightly interlocked; texture moderately coarse and even. Growth rings indistinct; vessels medium-sized to large, solitary and in radial multiples of 2–4, rarely in clusters; parenchyma abundant, apotracheal diffuse to diffuse-in-aggregates, visi-



Bombax ceiba
transverse surface (×20)

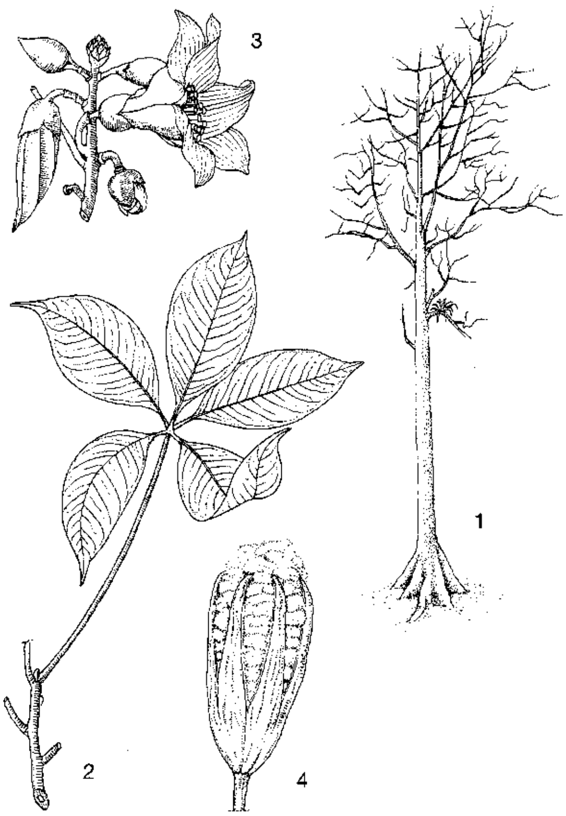
ble with a lens; rays medium-sized, conspicuous on radial surface, and fine, hardly visible even with a lens; ripple marks present, but not always distinct due to vertical fusion of rays.

Shrinkage is low to moderate and the wood seasons fairly rapidly with negligible degrade except for fungal and insect attacks. Board 13 mm and 38 mm thick boards take respectively 2.5 months and 3.5 months to air dry. The wood is soft and weak. It is easy to work in green as well as in seasoned condition. The wood is non-durable, with an average service life of 0.9 years in a graveyard test in Peninsular Malaysia. It is extremely easy to treat with preservatives: an average absorption of 592 kg/m^3 of creosote by the open-tank method is reported, whereas an average absorption of 415 kg/m^3 is obtained by the hot and cold tank process using 50% creosote and 50% diesel oil. The sapwood is susceptible to *Lyctus* and blue stain. The large difference in wood properties between wood samples of *B. ceiba* originating from India and those from the South-East Asian region, which is often mentioned in literature, is only slightly reflected by data on mechanical properties, the wood from India being only slightly stronger.

See also the tables on microscopic wood anatomy and wood properties.

Botany Deciduous, small to large trees up to 35(–45) m tall; bole straight, branchless for up to 20(–25) m, up to 150(–400) cm in diameter, with large buttresses, up to 6 m high, often fluted, bole or sometimes only the branches armed with sharp woody knobs or spines, often in rows; bark surface shallowly fissured, whitish to pale brownish-grey, inner bark soft and fibrous, red to orange or pink or straw, with slight cream and reddish flames; crown flat. Leaves arranged spirally, palmately compound; leaflets 5–9, entire; stipules caducous. Flowers solitary or in fascicles, large; epicalyx lacking; calyx cup-shaped with 2–4 lobes; petals 5, hairy; stamens numerous, the filaments joined into a short tube and forming 5 bundles, anthers 1-celled; ovary superior, 5-locular with many ovules in each cell, style club-shaped. Fruit a large woody capsule splitting into 5 parts, the inner walls covered with cottony down. Seed embedded in dense woolly hairs. Seedling with epigeal germination; cotyledons heart-shaped; hypocotyl elongated; first leaves alternate and with 3 leaflets up to about the 4th node, then the number of leaflets increases.

Growth is according to Aubréville's architectural tree model, characterized by a monopodial trunk with rhythmic growth, branches with rhythmic growth but modular, each branch plagiotropic by apposition. In a trial in Java growth was very slow and *B. ceiba* attained a height of 1–4.5 m 5.5 years after planting. For India very fast growth is reported; a mean annual diameter increment of 2.5 cm is



Bombax valetonii Hochr. – 1, tree habit. Bombax ceiba L. – 2, leaf; 3, inflorescence; 4, fruit.

not at all exceptional. In Peninsular Malaysia under natural forest conditions mean annual diameter increment of *B. valetonii* as a dominant or co-dominant tree is 1.2–1.6 cm. Flowers appear when the leaves have fallen. New growth commences after the fruits have matured. In Peninsular Malaysia flowering is from November–February, in Java from April–November and in Papua New Guinea from June–September. Nectar is collected from the flowers by bees, butterflies, birds and bats. Grafted plants start producing viable seed after three years. Seed is dispersed by wind.
The family *Bombacaceae* is sometimes incorporated in the *Malvaceae*.

Ecology *Bombax* can be found in primary and secondary forest, often near rivers, up to 750 m altitude (within Malesia). *B. ceiba* is often found at forest edges or disturbed forest and can be locally dominant.

Silviculture *Bombax* can be propagated by seed, including direct sowing, and by vegetative means through cuttings and grafting. For *B. ceiba* there are about 28 000 seeds/kg. To obtain seeds the fruits are dried in the sun and when they open the seeds are removed. Seed can be stored in closed receptacles for 1–2 years. About 90% of *B. ceiba* seeds germinate in 6–18 days. Seedlings can be planted out as bare-rooted stock, as container stock or as stumps. Container stock is not successful in India due to slow development after planting, but 82% survival has also been reported. For stumps, the fleshy taproot should be 50–60 cm long, and the diameter at the collar should be 1–2.5 cm. Direct sowing in lines 45–60 cm apart after the harvest of a field crop showed very good results in India. Cuttings were not effective; high mortality occurred after planting out in the field. For *B. ceiba* as an ornamental tree, however, propagation by cuttings under mist is very successful and 100% rooting is obtained even without the application of growth hormones. Patch budding is used to establish seed orchards of *B. ceiba* in India; about 80% of the grafted plants survive, provided they are not transplanted. Weeding and thinning is necessary for up to three years. *B. ceiba* in India is characterized as a strong light-demander with abundant natural regeneration on open sites and easy natural pruning under forest conditions. It coppices well but only for the first few years. *Bombax* at first shows pioneer characteristics, but later develops those of a mature phase emergent. *Fomes lignosus*, a fungal wound parasite causing wood decay, and *Dysdercus cingulatus* (red cotton bug) nymphs and adults which feed on the sap of tender parts, have been observed on *B. ceiba*.

Genetic resources and breeding A germplasm bank has been established in Arunachal Pradesh (India) where 22 clones of *B. ceiba* are available, and 15 clones are present at the Forest Research Institute at Dehra Dun. Seed orchards have been established at 6 locations in the states of Arunchal Pradesh and Uttar Pradesh. *B. ceiba* shows both self- and cross-pollination, but the rate of outcrossing is unknown.

Prospects Judging by the experiences gained in India with *B. ceiba* prospects are promising. The large differences in growth rate reported for *B. ceiba* in South-East Asia and India, however, need reconfirmation; research is needed to determine whether these differences can be attributed to genetic variation.

Literature 70, 104, 131, 152, 161, 162, 163, 174, 209, 260, 267, 300, 302, 312, 348, 387, 402, 403, 436, 438, 526, 571, 595, 632, 633, 672, 678, 697, 829, 831, 861, 883, 889, 933, 934, 953, 974, 1038, 1104, 1169, 1177, 1221, 1239, 1242, 1265.

Selection of species

Bombax ceiba L.

Synonyms *Bombax malabaricum* DC., *Gossampinus malabarica* (DC.) Merr., *Salmalia malabarica* (DC.) Schott & Endl.

Vernacular names Cottonwood, Indian bombax, silk cotton tree (En). Fromager (Fr). Indonesia: kapuk hutan (Indonesian), kapok kalingi (Timor), randu agung (Javanese). Malaysia: kapok, tambaluang (Sabah). Papua New Guinea: bombax, kapok. Philippines: malabulak (general), babui-gubat (Mindoro), taglinan (Tagalog). Burma (Myanmar): letpan. Laos: ngiou^2 ban^2. Thailand: ngui, ngui ban (general). Vietnam: g[aj]o d[or], m[oo]c ni[ee]n.

Distribution From Pakistan and India towards Burma (Myanmar), Indo-China, China, Taiwan, Thailand, Java, Borneo (Sabah), the Philippines, Sulawesi, the Lesser Sunda Islands, the Moluccas, New Guinea and northern Australia.

Bombax valetonii Hochr.

Synonyms *Bombax larutensis* Ridley, *Gossampinus valetonii* (Hochr.) Bakh., *Salmalia valetonii* (Hochr.) Corner.

Vernacular names Indonesia: dangdeur leuweung, kabu-kabu (Sundanese), randu alas (Javanese). Malaysia: kekabu hutan (Peninsular).

Thailand: krai (northern), ngui pa (south-western), nun pa (central).

Distribution Thailand, Peninsular Malaysia, Sumatra and Java.

Nguyen Ba & Nguyen Nghia Thin

Borneodendron Airy Shaw

Kew Bull. 16: 359 (1963).

EUPHORBIACEAE

x = unknown; $2n$ = unknown

Vernacular names Malaysia: aara aara (Sabah), bangkau bangkau (Bajau, Sabah).

Origin and geographic distribution *Borneodendron* is a monotypic genus found in Borneo (Sabah). The only species is *B. aenigmaticum* Airy Shaw.

Uses The wood of *B. aenigmaticum* is used for local house construction and possibly for boat building. Because of its beautiful warm-brown colour, the wood may be suitable for attractive furniture and turnery articles.

Production and international trade Utilization and supplies are very limited because *B. aenigmaticum* is only found on ultrabasic soils and often in protected forest areas.

Properties *B. aenigmaticum* yields a medium-weight hardwood with a density of 795–885 kg/m³ at 15% moisture content. Heartwood dark red-brown, sharply demarcated from the up to 8 cm wide yellow-brown sapwood; grain straight to shallowly interlocked; texture fine and even; planed surfaces slightly lustrous. Growth rings suggested by darker bands of tissue; vessels medium-sized, solitary and in radial multiples of 2–3, tyloses abundant; parenchyma abundant, apotracheal in narrow bands, distinct to the naked eye; rays fine, distinct to the naked eye on transverse surface; ripple marks absent; radial canals present, distinct with a hand lens.

Borneodendron aenigmaticum
transverse surface (×20)

Seasoning causes very little degrade. The wood is moderately hard. It can be planed to a very smooth surface, with but little picking up on radial faces. The wood is reputedly durable. Impregnation may be very difficult due to the abundance of tyloses. It is probably resistant to insect attack. Large trees are often hollow.

See also the table on microscopic wood anatomy.

Botany A monoecious, large tree up to 50 m tall; bole up to 75 cm in diameter, occasionally with small buttresses up to 70 cm high; bark surface scaly, fissured, grey-brown, inner bark striate or mottled, pink-red; exudate watery and sticky at first, drying red. Indumentum on innovations of stellate scales. Leaves in whorls of 3, simple, entire, petiolate, obovate; stipules caducous. Male flowers in a terminal, subcapitate, nodding, catkin composed of 2–4, 3-flowered whorls; bracts large; sepals and petals absent; stamens 25–30, filaments connate into a column, anthers dorsally and apically pilose; disk absent. Female flower solitary, axillary, on a flattened, rigid pedicel; sepals 3, caducous; petals absent; ovary superior, 2-locular with 1 ovule per cell, stigmas bifid. Fruit a 2-locular, black, flattened capsule.

The tree has been found fruiting from January to September.

Ecology *B. aenigmaticum* is locally abundant and may even form pure stands over limited areas on ultrabasic soils in primary forest and forest dominated by *Gymnostoma sumatranum* (Jungh. ex de Vriese) L.A.S. Johnson under xerophytic conditions, up to 1400 m altitude. It may also grow on other soils.

Genetic resources and breeding *B. aenigmaticum* is a comparatively rare and endemic tree of ultrabasic soils. However, its occurrence in protected forest areas gives it some protection.

Prospects Given its local occurrence, mainly in protected forest areas, no increase of the utilization of *Borneodendron* timber is to be expected. If ultrabasic soil is a prerequisite for this species, only small-scale silviculture may be expected at the most.

Literature 20, 23, 24, 28, 162, 1195.

P.C. van Welzen

Boouea Meisn.

Pl. vasc. gen.: tab. diagn. 75, comm. 55 (1837).
ANACARDIACEAE
x = unknown; $2n$ = unknown

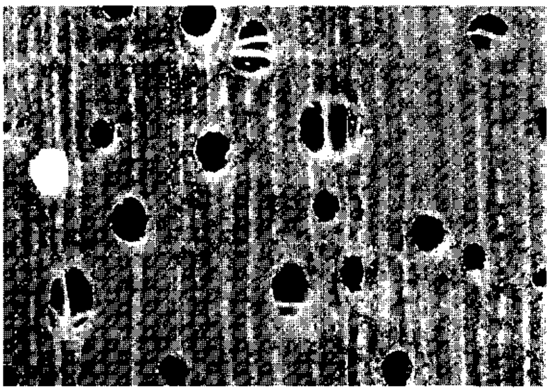
Vernacular names Plum mango (En). Malaysia: kundang (general), merapoh (Peninsular).

Origin and geographic distribution *Bouea* comprises 3 species and is found in Burma (Myanmar), the Andaman Islands, Indo-China, southern China, Thailand, Peninsular Malaysia, Sumatra, Java and Borneo. One species is a rare endemic of Vietnam, the other two are more widespread and cultivated within their natural area of distribution, *B. macrophylla* also in Ambon.

Uses The dark brown centre of the heartwood of *Bouea* is sought after in Peninsular Malaysia for cabinet work and tobacco pipes. The wood has also been used in house building (e.g. joists, rafters), for scabbards, tool handles and rice pounders. In Indo-China the frequently occurring burrs on the bole are used for joinery.
The dense crowns render *Bouea* an attractive ornamental shade tree. Fruits are eaten raw, steamed or made into an excellent compote and young fruits are sometimes pickled or made into preserve. The young leaves of *B. macrophylla* can be eaten raw, e.g. with rice.

Production and international trade Utilization of the wood of *Bouea* is very limited and on a local scale only.

Properties *Bouea* yields a medium-weight hardwood with a density of 675–895 kg/m^3 at 15% moisture content, but a density of 910–1130 kg/m^3 was recorded for two specimens of *B. oppositifolia* from Indonesia, which implies that it is a heavy hardwood. Heartwood pale brown with a pinkish tinge, reportedly with a core of dark brown wood with black streaks in *B. macrophylla*, sapwood pale brown with a red tinge, grey-brown or yellowish-brown usually not clearly differentiated from heartwood; it has been stated that the sapwood is up to 7 cm wide; grain straight or interlocked; texture rather coarse but even; wood with attractive zig-zag figure due to darker parenchyma. Growth rings occasionally distinct macroscopically due to wider spacing of banded parenchyma; vessels medium-sized to moderately large, mainly solitary but also in radial multiples of 2–3, tyloses rare; parenchyma moderately abundant, paratracheal vasicentric to occasionally aliform and apotracheal in wide regularly to irregularly spaced bands, the apotracheal parenchyma visible to the naked eye; rays very fine to moderately fine, visible with a hand lens; ripple marks absent.
Wood samples generally season well without defects. The wood is hard and strong. The heartwood is reputed to be durable, but the sapwood is susceptible to *Lyctus*.
See also the table on microscopic wood anatomy.



Bouea macrophylla
transverse surface (×20)

Botany Medium-sized to fairly large trees up to 36 m tall; bole up to 80 cm in diameter, not buttressed; bark surface smooth to cracked or finely fissured, dark grey to reddish-brown or pale greyish-brown, inner bark finely fibrous, red or reddish-brown, with gummy exudate; crown very dense. Young twigs often 4-angular; buds pointed and prominent. Leaves decussate, simple, entire, with a resinous smell when crushed. Flowers male or bisexual, small, in an axillary or rarely terminal panicle, 3–5-merous, whitish or pale yellow to yellowish-green; calyx lobed; petals keeled; disk present; ovary superior, 1-locular with 1 ovule, style short, stigma round and flat, sometimes 2–3-grooved. Fruit a drupe. Seed with testa adherent to the endocarp. Seedling with semi-hypogeal germination; cotyledons not or only slightly emergent, fleshy; hypocotyl not elongated; leaves conduplicate.
Growth of *B. oppositifolia* in Burma (Myanmar) is slow. *B. macrophylla* is evergreen, *B. oppositifolia* is deciduous. The inflorescences appear together with the new leaves. In Indonesia *B. macrophylla* flowers from June–November and fruits from March–June. The fruits of *B. macrophylla* are dispersed by bats.
Bouea is the only genus within the family *Anacardiaceae* having decussate leaves. It may be mistaken for genera of other families like *Garcinia*, *Syzygium*, *Olea* or *Memecylon*, but can be distin-

guished by the resinous smell of the broken twigs or crushed leaves and the pointed buds.

Ecology *B. macrophylla* occurs naturally in evergreen lowland rain forest up to 300 m altitude; when cultivated it is found up to about 850 m. It thrives on light, fertile soils. *B. oppositifolia* is found in evergreen to deciduous lowland rain forest including sandy coastal forest and peat-swamp forest, up to 700 m altitude.

Silviculture *Bouea* can be grown from seed, but *B. macrophylla* is also propagated by marcotting or grafting. Seeds rapidly lose their viability and should be sown immediately after collecting. Fruits germinate more slowly and more erratically than stones, which always show 100% germination. Stones of *B. macrophylla* took 11–22 days to germinate and *B. oppositifolia* stones took 19–33(–57) days. *B. macrophylla* needs shade for several months after planting.

Genetic resources and breeding *B. macrophylla* includes several fruit varieties that differ in sweetness. A germplasm collection of *B. oppositifolia* is maintained in Thailand.

Prospects The use of *Bouea* may increase because it may serve as a multipurpose tree providing timber, fruit and shade.

Literature 162, 163, 209, 267, 341, 343, 371, 436, 825, 829, 831, 861, 1038, 1048, 1123, 1164, 1221, 1242.

Selection of species

Bouea macrophylla Griffith

Synonyms *Bouea gandaria* Blume.

Vernacular names Gandaria, plum mango (En). Indonesia: gandaria (general), pao gandari (Madura). Malaysia: kundang (general), kundang daun besar, setar (Peninsular). Thailand: ma prang, som prang (peninsular).

Distribution Peninsular Malaysia, Sumatra and West Java; cultivated in Thailand, Sumatra, West and Central Java, Borneo and Ambon.

Bouea oppositifolia (Roxb.) Meisn.

Synonyms *Bouea burmanica* Griffith, *Bouea microphylla* Griffith, *Matania laotica* Gagnep.

Vernacular names Burmese plum, marian plum (En). Indonesia: raman burung (Sumatra), raman uris (Bangka), ramania pipit (Kalimantan). Malaysia: kundang daun kechil, merapoh, rumenia (Peninsular). Burma (Myanmar): baran, barine, mayan. Cambodia: mao pran. Laos: ('mak) 'phang, ('mak) 'phou. Thailand: ma prang wan (general), ma phang (northern), ma yong (central). Vietnam: s[ow]n cha, s[ow]n tra, x[uw]ng ca.

Distribution The Andaman Islands, Burma (Myanmar), Indo-China, southern China, Thailand, Peninsular Malaysia, Sumatra and Borneo.

D. Sulistiarini

Brachychiton Schott & Endl.

Melet. Bot.: 34 (1832).

STERCULIACEAE

$x = 20$; for all 16 Australian species examined: $2n = 40$

Vernacular names Brachychiton, flame tree (En).

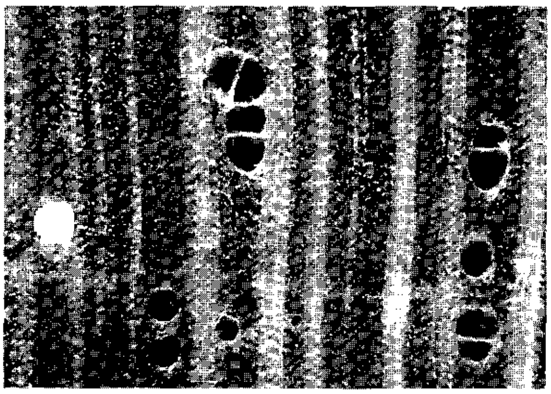
Origin and geographic distribution *Brachychiton* comprises about 30 species and is essentially Australian, but 2 species occur in Papua New Guinea, one of which is endemic. Many species have very restricted areas of distribution.

Uses In Australia the wood of several *Brachychiton* species (e.g. *B. acerifolius* (Cunn. ex G. Don) MacArthur and *B. discolor* F. v. Mueller) is applied where a very light wood is advantageous, e.g. for boxes, sporting goods, blockboard, matches, toys and novelties. It is also used for the production of wood-wool board.

In Australia some species are much valued as fodder plants, particularly *B. populneus* (Schott & Endl.) R. Br. and *B. rupestris* (Mitchell ex Lindley) K. Schumann. These and other species are also planted as ornamental and shade trees.

Production and international trade There are no records of trade of *Brachychiton* from the Malesian area; in Australia it is sold sporadically, and has been used by the plywood industry for core stock.

Properties *Brachychiton* yields a lightweight hardwood with a density of 275–400 kg/m^3 at 15% moisture content. Heartwood and sapwood white to cream; grain of the Australian *B. discolor* fairly straight, its texture coarse and its wood lustrous with mottled appearance. Growth rings indistinct; vessels medium-sized to large, solitary and in radial multiples of 2–4, tyloses sparse but often with gum-like deposits; parenchyma abundant, apotracheal diffuse to diffuse-in-aggregates, paratracheal vasicentric to sometimes aliform, or in wide irregularly spaced apotracheal bands; rays medium-sized to broad, conspicuous on radial surface; faint ripple marks due to storied parenchyma and vessels, visible with a hand lens.



Brachychiton acerifolius
transverse surface (×20)

The wood of the Australian *B. acerifolius* and *B. discolor* needs slow and careful seasoning and preliminary drying in the log before sawing. The wood is weak and very soft, and is easy to work with all tools, but cannot be planed to a smooth surface. The wood is non-durable. The sapwood is susceptible to *Lyctus*. The sapwood is permeable, the heartwood is moderately resistant to impregnation. The wood is highly susceptible to blue stain and sap-stain.
See also the tables on microscopic wood anatomy and wood properties.

Botany Deciduous, monoecious shrubs or small to medium-sized trees up to 35 m tall; bole cylindrical, sometimes slightly swollen towards the base, branchless for up to 15 m, up to 75 cm in diameter; bark surface finely fissured, grey or brown. Leaves alternate, simple, shallowly 3(–5)-lobed, hairy below, petiolate; stipules caducous. Flowers in an axillary or cauliflorous, paniculate inflorescence, unisexual, pinkish-red to brownish-red; perianth campanulate, 5-lobed; androgynophore present. Male flower with 15–30 stamens and rudimentary ovaries. Female flower with 5 free superior ovaries with many ovules, 5 styles and stigmas and up to 30 staminodes. Fruiting head consisting of up to 5 woody follicles dehiscing along the inner suture, with brown stellate hairs outside, many-seeded. Seed loosely enclosed by a hirsute exotesta, initially covered with a yellow or orange pulpy layer, endosperm abundant, cotyledons flat and thin. Seedling with the cotyledons emergent or not.
Leaves of young trees have more lobes and are more deeply lobed than those on mature trees described above. Trees are deciduous during the dry season. In Papua New Guinea *B. carruthersii* is deciduous from June to October, flowers from January to May and fruits ripen in 3–4 months; *B. velutinosus* flowers from May to September.
Brachychiton has previously been included in *Sterculia*. The characteristics of the fruit, seedcoat and embryo, however, strongly support the retention of *Brachychiton* as a separate genus. Ripe fruits of *Brachychiton* are brown to black, whereas those of *Sterculia* are pink, scarlet or vermillion. *Brachychiton* seeds abscise before the fruit dehisces and, unlike *Sterculia*, do not remain attached to the pericarp by their funicle.

Ecology In Papua New Guinea *Brachychiton* is mainly found in coastal lowland and on river flats, but also occurs on slopes and ridge crests up to 500 m altitude. The soils range from fine sands to friable clays. It is often found in thickets and semi-deciduous, liana-rich forest together with *Adenanthera*, *Alstonia*, *Bombax*, *Buchanania*, *Cleistanthus*, *Clerodendrum*, *Diospyros*, *Erythrina*, *Ficus*, *Gardenia*, *Garuga*, *Gyrocarpus*, *Harpullia* or *Pandanus* species.

Genetic resources and breeding Both *B. carruthersii* and *B. velutinosus* have restricted areas of distribution and seem to be at risk of genetic erosion.

Prospects The lightweight *Brachychiton* wood has potential for special applications, but limited supplies restrict its use.

Literature 125, 128, 173, 214, 304, 348, 393, 536, 1037, 1185, 1186, 1187.

Selection of species

Brachychiton carruthersii F. v. Mueller

Distribution Papua New Guinea.

Brachychiton velutinosus Kosterm.

Distribution Papua New Guinea (Central District) and northern Australia (Cape York Peninsula).

W.G. Keating (general part),
R.H.M.J. Lemmens (general part, selection of species),
J. Ilic (wood anatomy)

Brackenridgea A. Gray

Char. new gen. pl.: 5 (1853).
OCHNACEAE
x = unknown; $2n$ = unknown

Vernacular names Brown ochna (En, trade name).

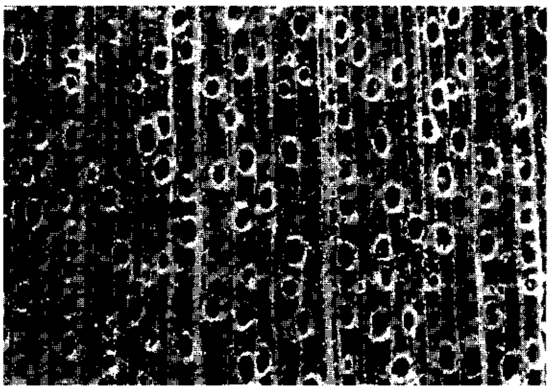
Origin and geographic distribution *Brackenridgea* comprises about 8 species occurring in tropical East Africa and Madagascar, and in the Andaman Islands, Thailand, Peninsular Malaysia, Sumatra, Borneo, the Philippines, Sulawesi, New Guinea, Australia (Queensland) and Fiji. Within the Malesian region 4 species are present.

Uses The wood of *Brackenridgea* is used for rafters in house building.
The leaves of *B. hookeri* used to be chewed as a masticatory in Peninsular Malaysia.

Production and international trade The wood of *Brackenridgea* is used rarely and on a local scale only.

Properties *Brackenridgea* yields a medium-weight hardwood with a density of 710–790 kg/m³ at 15% moisture content. Heartwood red-brown, sapwood white to pale yellow; texture fine. Growth rings indistinct; vessels small to medium-sized, exclusively solitary; parenchyma not abundant, apotracheal diffuse, and scanty paratracheal to unilaterally paratracheal sometimes appearing aliform; rays fine to moderately fine; ripple marks absent.
The wood is fairly strong and hard, moderately durable under cover and resistant to insect attack. The sapwood is considered to be non-susceptible to *Lyctus*.
See also the table on microscopic wood anatomy.

Botany Small to medium-sized trees up to 35 m tall; bole straight, cylindrical, up to 60(–120) cm in diameter, sometimes slightly fluted or with small buttresses; bark surface smooth to slightly fissured and scaly, brown to reddish-brown or greyish-brown, inner bark pinkish-brown or reddish-brown. Leaves alternate, simple, entire or finely toothed, lateral veins strongly curved to the apex and often some of the lower ones parallel to the margin; stipules divided into several pointed lobes, caducous. Inflorescence thyrsoid, composed of simple or compound condensed cymes. Flowers regular; sepals 5, enlarged, fleshy and red in fruit; petals 5–10, white or yellow; stamens 10–many, in 1–several whorls; gynophore hemispherical; carpels 5–10, each with a single ovule, free but sharing a common style. Fruiting head with 1–2(–5) drupelets, greenish or reddish, becoming almost black when ripe.
Branches are spreading and monopodial. Flowering and vegetative growth tend to occur alternately. Seed dispersal is mainly by birds attracted by the black fruits contrasting with the red calyx and gynophore. The fruits also float due to 2 air-filled spaces between the inner and outer fruit wall.
Brackenridgea has been divided into 2 sections: in sect. *Brackenridgea* all flowers in a cyme open simultaneously, the white corolla is 5-merous, stamens 10 and carpels 5; in sect. *Notochnella* (v. Tiegh.) Kanis the flowers in a cyme open successively, the corolla is yellow and irregular, stamens many, in more than 1 whorl and carpels 5–10. Within *B. palustris* 3 subspecies are recognized: subsp. *foxworthyi* (Elmer) Kanis confined to Palawan, subsp. *kjellbergii* Kanis to Sulawesi, and subsp. *palustris* occuring in Peninsular Malaysia, Sumatra and Borneo.



Brackenridgea forbesii
transverse surface (×20)

Ecology *Brackenridgea* is found scattered in evergreen, primary lowland and hill forest, up to 750(–1000) m altitude. It is confined to the perhumid regions. Vegetation types include kerangas and peat-swamp forest. It occurs on a wide range of usually rather poor soils, from clay to sand or peat. *B. forbesii* has been reported from ultrabasic soils.

Genetic resources and breeding As *Brackenridgea* is not commercially exploited there is no risk of genetic erosion.

Prospects It is unlikely that the use of *Brackenridgea* for timber will increase in the near future.

Literature 163, 198, 304, 341, 403, 436, 523, 861, 1038, 1039, 1048, 1221.

Selection of species

Brackenridgea forbesii v. Tiegh.

Vernacular names Indonesia: jobias (Je, Irian Jaya), obaising (Mooi, Irian Jaya), serukdeho (Manikiong, Irian Jaya).

Distribution New Guinea.

Brackenridgea hookeri (Planch.) A. Gray

Synonyms *Brackenridgea denticulata* Furtado, *Brackenridgea perakensis* v. Tiegh., *Ouratea hookeri* (Planch.) Burkill.

Vernacular names Malaysia: bunga kelat merah, pendorah (Peninsular), empodat (Sarawak). Thailand: nuan yung (peninsular).

Distribution The Andaman Islands, southern Thailand, Peninsular Malaysia and Borneo.

Brackenridgea palustris Bartelli

Synonyms *Brackenridgea foxworthyi* (Elmer) Furtado, *Brackenridgea serrulata* Bartelli, *Gomphia corymbosa* (King) Ridley.

Vernacular names Indonesia: mayang-mayang, rampat dahan (Sumatra), mensulung kayu (Bangka). Malaysia: lidah mura, pendorah (Peninsular), ubah midin (Sarawak). Thailand: daeng lueat nok (peninsular).

Distribution Peninsular Thailand, Peninsular Malaysia, Sumatra, Borneo, the Philippines (Palawan) and Sulawesi.

K.M. Kochummen (general part, selection of species),
J. Ilic (wood anatomy)

Bridelia Willd.

Sp. pl. 4(2): 978 (1806).
EUPHORBIACEAE
$x = 13$; *B. retusa*, *B. stipularis* (L.) Blume: $n = 13$

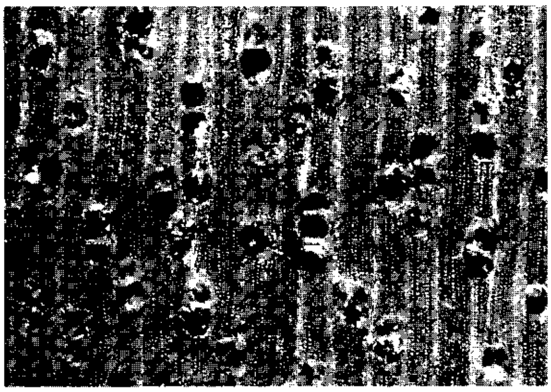
Vernacular names Indonesia: kanderi (general), kandri (Javanese), kanyere (Sundanese). Malaysia: kenidai, kernam (Peninsular), kerdam (Sarawak). Papua New Guinea: scrub ironbark (En).

Origin and geographic distribution *Bridelia* comprises about 50 species and is distributed in the Old World tropics. Most species occur in Asia, from Sri Lanka, India and the Himalayas to Burma (Myanmar), Indo-China, southern China, the Ryukyu Islands, Taiwan, Thailand, and throughout the Malesian region towards the Solomon Islands, Vanuatu and northern Australia.

Uses The wood of *Bridelia* is used for temporary construction, agricultural implements, interior trim, light framing, joinery, drawer slides and sides, carts, carving, tool handles and other applications requiring toughness and flexibility. Material for tool handles must be properly selected. The attractively mottled silver grain makes the wood suitable for decorative purposes.
A decoction of the leaves or bark of several species, mainly that of *B. tomentosa*, is applied medicinally against itch, colic, stomach-ache, fever and dysentery. The leaves are attributed to have purgative, laxative and anti-bacterial properties. The fruits of most species can be eaten raw. Those of *B. insulana* are applied to colour palm wine red.

Production and international trade Supplies are generally extremely small; this, plus the usual small size of the trees, means that the wood of *Bridelia* is utilized mainly on a local scale. In 1996 Papua New Guinea exported only 92 m^3 of 'scrub ironbark' logs at an average free-on-board (FOB) price of US\$ 101/m^3.

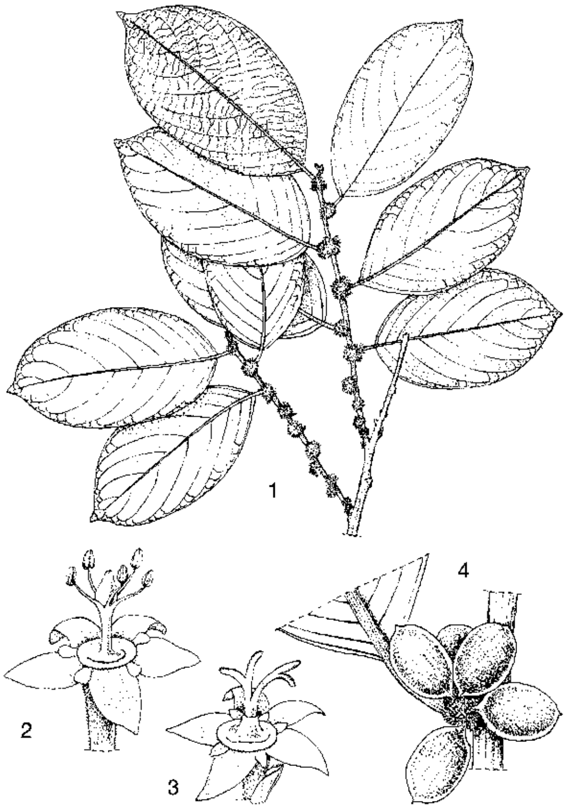
Properties *Bridelia* yields a medium-weight hardwood with a density of 450–880 kg/m^3 at 15% moisture content; *B. glauca* and *B. insulana* are comparatively light and have a density of 450–610 kg/m^3 and 530–630 kg/m^3, respectively. Heartwood pink with straw-coloured streaks or olive-grey-brown, distinct only in the green condition from the 3 cm wide, yellow-brown or straw sapwood; grain interlocked and sometimes wavy; texture moderately fine and even; attractive mottled silver grain present on radial surface of *B. retusa* wood; wood very greasy. Growth rings indistinct; vessels moderately small, mostly in radial multi-



Bridelia macrocarpa
transverse surface (×20)

ples of 2–several, tyloses present; parenchyma paratracheal vasicentric, usually not visible; rays moderately fine, visible to the naked eye on the transverse surface; ripple marks absent.
Shrinkage upon seasoning is moderate; *B. tomentosa* is reported to warp badly during drying but *B. retusa* can be seasoned without serious degrade. The wood is hard, not very strong and fairly tough. It is easy to work with hand and machine tools, but is somewhat fibrous; *B. tomentosa* wood is reported to be extremely difficult to handsaw when green. The durability varies from moderately durable to non-durable under exposed conditions. However, house posts made of *B. macrocarpa* wood reputedly lasted for 10 years, which classifies it as durable. Wood samples are susceptible to attack by ambrosia beetles. The sapwood is susceptible to *Lyctus*.
The mean fibre lenght of *B. tomentosa* is 1.160 mm.
See also the tables on microscopic wood anatomy and wood properties.

Botany Usually monoecious shrubs, climbers or small to medium-sized trees up to 20(–30) m tall; bole straight to fairly irregular, branchless for up to 12(–17) m, up to 50(–85) cm in diameter, occasionally with small buttresses up to 1.8 m high; bark surface smooth to prominently longitudinally fissured, flaking in scales or long strips, dark brown to grey-brown, inner bark fibrous, pink. Leaves alternate, distichous, simple, with the lateral veins close, straight and parallel, short-stalked, margin entire to slightly crenate; stipules caducous. Flowers crowded in a small glomerule that is solitary or grouped in a spike and axillary, unisexual, very small, 5-merous; sepals valvate; petals smaller than the sepals. Male flowers with annular or interrupted disk; filaments connate into a column; pistillode present. Female flowers with annular or cupular disk; ovary superior, 2(–3)-locular with 2 ovules in each cell, styles 2, free or variably united, bifid, stigmas terete to flat. Fruit a small, 1–2(–3)-locular drupe with a persistent calyx and 1 seed per locule. Seed with smooth testa. Seedling with epigeal germination; cotyledons emergent, bilobed; hypocotyl elongated; first pair of leaves opposite, subsequent ones arranged spirally, soon distichous.
The larger figures above related to the tree size and bole all refer to *B. macrocarpa*. In a nursery in India *B. retusa* seedlings had attained a height of only 8–15 cm after one year and 15–50 cm after two years. In natural forest a mean annual diameter increment of 0.1–0.4 cm has been recorded; a value of 0.5–1.0 cm is known from wood samples. There is some discussion about the correct spelling of the name *Bridelia*. According to nomenclatural rules it should be '*Briedelia*' but at the time of writing a proposal to conserve the first spelling has been submitted. *Bridelia* is one of the 2 genera of the tribe *Bridelieae* (together with *Cleistanthus*) within the subfamily *Phyllanthoideae*.



Bridelia pustulata Hook. f. – 1, flowering twig; 2, male flower; 3, female flower; 4, fruits.

Ecology *Bridelia* is fairly common in secondary, evergreen to semi-deciduous forest, forest margins or scrub vegetation and is found less often in primary forest. It is often associated with streams or rivers and is found in well-drained habitats as well as in peat-swamp forest and occasionally along the edge of mangrove vegetation, from sea-level up to 1800 m altitude. Soil types vary from sandy alluvium to clay soils or black rocky soils. *B. tomentosa* also occurs in open savanna.

Silviculture *Bridelia* can be propagated by seed. For *B. retusa* 16 000–17 500 pyrenes/kg have been counted. The germination rate of *B. insulana* is 90–95% in 9–30 days for seeds and 55% in 15–36 days for fruits. *B. retusa* tolerates moderate shade and regenerates from coppicing and by root suckers.

Genetic resources and breeding As *Bridelia* is fairly common, especially in secondary vegetation, there seems to be little risk of genetic erosion.

Prospects Increased utilization is unlikely, but *Bridelia* wood will probably keep its value for applications where toughness is demanded.

Literature 25, 26, 28, 32, 33, 34, 36, 70, 125, 151, 162, 163, 209, 238, 267, 291, 300, 301, 348, 436, 543, 545, 671, 696, 829, 831, 861, 874, 974, 1038, 1104, 1169, 1195, 1221, 1232, 1242, 1268.

Selection of species

Bridelia glauca Blume

Synonyms *Bridelia nooteboomii* Chakrab., *Bridelia platyphylla* Merr., *Bridelia pubescens* Kurz.

Vernacular names Indonesia: gandri kebo (Javanese), kanyere badak, ki howe (Sundanese). Philippines: balitahan (Cebu Bisaya), balitahan-tilos (Tagalog). Thailand: see-thoh-phaa-nee, si-waa la-thee (northern).

Distribution From India to Burma (Myanmar), Indo-China, Taiwan, Thailand, the whole of the Malesian region (except for the Lesser Sunda Islands) and in the Bismarck Archipelago.

Bridelia insulana Hance

Synonyms *Bridelia minutiflora* Hook. f., *Bridelia penangiana* Hook. f., *Bridelia subnuda* K. Schumann & Lauterb.

Vernacular names Indonesia: kanderi besar (general), kandri kebo (Javanese), ki pahang gunung (Sundanese). Philippines: subiang (Filipino).

Distribution Southern Burma (Myanmar), Indo-China, Thailand, throughout the Malesian region towards the Solomon Islands and northern Australia.

Bridelia macrocarpa Airy Shaw

Synonyms *Bridelia beguinii* Airy Shaw.

Distribution The Moluccas (Halmahera) and New Guinea.

Bridelia pustulata Hook. f.

Vernacular names Malaysia: bebungkal, kenidai gajah, kenidai hutan (Peninsular).

Distribution Peninsular Malaysia, Singapore, Sumatra, Borneo and the Philippines.

Bridelia retusa (L.) A. Juss.

Synonyms *Bridelia cambodiana* Gagnep., *Bridelia pierrei* Gagnep., *Bridelia spinosa* (Roxb.) Willd.

Vernacular names Burma (Myanmar): seikchi. Thailand: rang thon (eastern), teng nam (south-western).

Distribution From Sri Lanka and India to Burma (Myanmar), Indo-China, southern China, Thailand and northern Sumatra; possibly also in Peninsular Malaysia.

Bridelia tomentosa Blume

Synonyms *Bridelia glabrifolia* Merr., *Bridelia lancifolia* Roxb., *Bridelia monoica* Merr.

Vernacular names Indonesia: gandri (Javanese). Malaysia: kenidai jantan, kerenan (Peninsular). Philippines: agai (Tagalog), usli (Tagbanua). Thailand: khon non (peninsular), sa lao (eastern).

Distribution From northern India to Nepal, Burma (Myanmar), Indo-China, southern China, Taiwan, Thailand, throughout the Malesian region towards northern Australia.

H.C. Ong

Broussonetia L'Hér. ex Vent.

Tabl. règn. vég. 3: 547 (1799).

MORACEAE

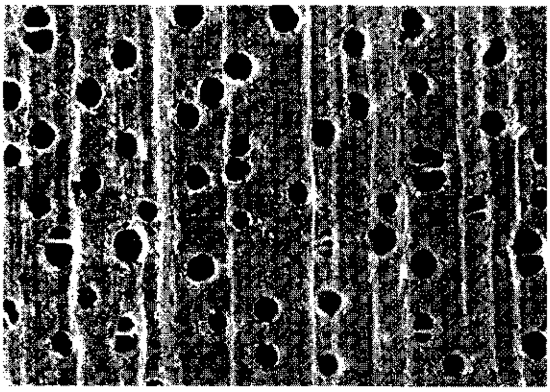
$x = 13$; *B. papyrifera* (L.) L'Hér. ex Vent.: $2n = 26$, *B. kazinoki* Siebold: $2n = 26, 39$

Vernacular names Indonesia: bohulilambaji, ragantulu (Sulawesi). Philippines: himbabao, malambingan (Filipino), babayan (Tagalog).

Origin and geographic distribution *Broussonetia* comprises about 7 species occurring from India and Sri Lanka to Indo-China, China, Japan, Taiwan, Thailand, and throughout the Malesian region. Only 1 species yields timber: *B. luzonica* (Blanco) Bureau (synonyms: *Allaeanthus luzonicus* (Blanco) Fern.-Vill., *A. glaber* Warb.) which occurs in the Philippines and Sulawesi and has been introduced into Polynesia.

Uses The wood of *Broussonetia* is used for panelling, furniture and cabinet work, gunstocks, musical instruments, butchers' blocks, and especially for boat planking.

Trees have been planted in southern Luzon to shade 'abaca' (*Musa textilis* Nee). Young leaves and flowers can be eaten as a vegetable. The fibrous bark yields inferior rope.



Broussonetia luzonica
transverse surface (×18)

Production and international trade The wood of *Broussonetia* is used on a local scale only.

Properties *B. luzonica* yields a medium-weight hardwood with a density of 495–630 kg/m^3 at 15% moisture content. Heartwood variably coloured with grey, red and fawn shades on radial surface, not sharply demarcated from the pale sapwood; grain interlocked; texture moderately fine; wood lustrous and with distinct ribbon figure on radial surface. Growth rings indistinct; vessels medium-sized, some moderately large, mostly solitary, occasionally in radial multiples of 2(–4), tyloses present but not abundant; parenchyma paratracheal and clearly vasicentric to slightly aliform and in wide irregularly spaced apotracheal bands; rays medium-sized, visible to the naked eye; ripple marks absent.
The wood seasons well. It is moderately soft, but fairly strong and easy to work. The wood is not resistant to fungal attacks, the heartwood is resistant to dry-wood termites. The sapwood is susceptible to *Lyctus*.
See also the table on microscopic wood anatomy.

Botany A deciduous, dioecious, small to medium-sized tree up to 25 m tall; bole up to 60 cm in diameter; bark surface slightly fissured, pale grey, inner bark fibrous. Leaves distichous, simple, entire, tomentose below; stipules membranous, long pointed. Inflorescence axillary. Male flowers in a dense raceme or spike, sessile; interfloral bracts stalked; perianth 4-lobed, white villous; stamens 4; pistillode minute. Female flowers in a globose head; perianth utricular, with 4 small lobes or teeth; ovary superior, sessile, 1-locular with a single ovule, style 1, filiform. Fruit a globose syncarp with numerous seeds, endocarp crustaceous to woody. Seedling with epigeal germination; cotyledons emergent; hypocotyl elongated.
Seedling growth is very rapid. In the Philippines seedlings 30 cm tall showed average diameter and height increments of 4.3 cm and 4.9 m, respectively, in 14 months. Maximum diameter and height increments in the same experiment were 6 cm and 7.3 m, respectively.
B. papyrifera, the 'paper mulberry', is a well-known source of pulp in South-East Asia.

Ecology *B. luzonica* occurs in secondary forest, forest edges and thickets, up to 1000 m altitude. It prefers well-drained and sometimes rocky locations.

Silviculture In the Philippines the survival rate of planted *B. luzonica* was about 85%. *B. papyrifera* was planted in a trial in Indonesia, but it developed a crooked habit. The latter easily produces root suckers and coppices profusely and for this reason has become a pest in some areas in India.

Genetic resources and breeding In the Philippines *B. luzonica* has been depleted due to destruction of its habitat.

Prospects Because of the very limited supply and its depletion, the use of the wood of *B. luzonica* is likely to decrease.

Literature 150, 205, 235, 238, 427, 780, 861, 934, 1254.

E. Boer & M.S.M. Sosef

Brownlowia Roxb.

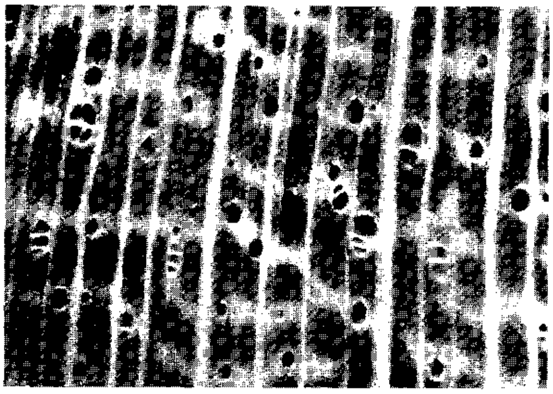
Pl. Coromandel 3: 61 (1820).
TILIACEAE
x = unknown; $2n$ = unknown

Origin and geographic distribution *Brownlowia* comprises about 28 species occurring from India and Bangladesh to Burma (Myanmar), Indo-China, Thailand and the Malesian region except for Java and the Lesser Sunda Islands, east to the Solomon Islands and south to northern Australia. Borneo is regarded as the centre of diversity with 19 species.

Uses In Papua New Guinea the wood of *Brownlowia* is used for pallets and is considered suitable for mouldings and interior finish.

Production and international trade The wood of *Brownlowia* is used on a local scale only.

Properties *Brownlowia* yields a lightweight to medium-weight hardwood with a density of 465–640 kg/m^3 at 15% moisture content. Heartwood red-brown to brown, sapwood yellow-brown to pale yellow. Growth rings distinct; vessels moder-



Brownlowia argentata
transverse surface (×20)

ately small, solitary and in radial multiples of 2–4; parenchyma apotracheal diffuse and diffuse-in-aggregates, paratracheal vasicentric, narrow; rays fine to moderately fine; ripple marks present.

Air drying of the wood of *B. stipulata* Kosterm. is fairly slow and it takes 3 months for 13 mm thick boards and 5 months for 38 mm thick boards to air dry from green to 20% moisture content. The wood is only moderately strong and non-durable. It is probably susceptible to *Lyctus*.

See also the table on microscopic wood anatomy.

Botany Evergreen shrubs or small to medium-sized trees up to 30 m (outside Malesia up to 40 m) tall; bole often crooked, sometimes branchless for up to 13 m, up to 50 cm (outside Malesia up to 150 cm) in diameter, usually with small concave buttresses; bark surface smooth becoming papery flaked, hoop-marked, pale ochrous to grey-brown, inner bark dark reddish-brown. Indumentum of stellate hairs and/or scales. Leaves arranged spirally, simple, sometimes peltate, entire, usually broadly ovate, palmately or pinnately veined, often fimbriate scaly below, stipulate; petiole thickened at both ends. Flowers in a terminal panicle; calyx bell-shaped with 5 teeth; petals 5; stamens many, free or connate at base, often in 5 bundles, staminodes 5; ovary with 5 loosely connected, ribbed carpels each with 2 ovules, style long, simple. Fruit with 1–5, free, 1-seeded, woody carpels splitting open along a groove or ridge at the back. Seed without endosperm. Seedling with epigeal germination; cotyledons emergent, leafy; hypocotyl elongated; seedling leaves toothed, all alternate-spiral.

In Thailand *B. peltata* flowers and fruits from February to August. The fruits float in water and are thus dispersed.

In India and Indo-China *B. elata* Roxb. and *B. tabularis* Pierre represent large trees whose wood is reported to be very durable and to be used for luxury furniture.

It may well be that *B. helferiana* Pierre is conspecific with *B. peltata*, which would extend the range of the latter to Burma (Myanmar), peninsular Thailand and Peninsular Malaysia.

Ecology *Brownlowia* species are locally frequent in primary evergreen forest, up to 600 m altitude. They prefer swamps or damp or periodically inundated locations, sometimes on hills or along rivers, in mixed dipterocarp forest, usually on clayey soils, but *B. peltata* prefers well-drained soils. *B. argentata* constitutes a common element of the vegetation along tidal rivers towards the inner mangroves, especially on sandy soils.

Silviculture *Brownlowia* may be raised from seed. About 40% of the sown fruits of *B. helferiana* germinated in 4–31 days.

Genetic resources and breeding There are no records of in situ or ex situ conservation. The indiscriminate clearing of mangrove forest for economic activities may significantly endanger *Brownlowia* species like *B. argentata*. Its comparatively wide distribution and efficient seed dispersal, however, diminish the risk of genetic erosion.

Prospects As information on *Brownlowia* timber is scanty, economic interest is still extremely low and this is not expected to change in the near future.

Literature 61, 163, 209, 348, 400, 464, 609, 612, 829, 831, 887, 974, 1039, 1221.

Selection of species

Brownlowia arachnoidea Kosterm.

Distribution Borneo (Kalimantan, Sabah).

Brownlowia argentata Kurz

Synonyms *Brownlowia lepidota* Warb., *Brownlowia riedelii* Hemsl.

Vernacular names Brunei: itek-itekan. Indonesia: kiei (Jense, Irian Jaya), lukin (Seram), pribo (Inanwattan, Irian Jaya). Malaysia: dungun, durian laut (Peninsular), dungun ayer (Malay, Sarawak). Philippines: maragomon-puti (Tagalog).

Distribution Peninsular Malaysia, Borneo, the Philippines, the Moluccas, New Guinea and the Solomon Islands.

Brownlowia ferruginea Kosterm.

Distribution Borneo (Kalimantan).

Brownlowia peltata Benth.

Synonyms *Brownlowia elmeri* Merr.

Vernacular names Brunei: bangkinit. Malaysia: bangkirai (Kedayan, Sarawak), peringgan (Dusun, Sarawak). Thailand: prong (peninsular).

Distribution Borneo.

Isa Ipor (general part, selection of species),
J. Ilic (wood anatomy)

Bruguiera Lamk

Tabl. Encycl. Meth., Bot.: t. 397 (1793).

RHIZOPHORACEAE

$x = 18$; *B. gymnorhiza*: $2n = 36$ (+ 1B)

Vernacular names Bakau (trade name). Black mangrove (En). Indonesia: tanjang (Java). Malaysia: berus, lenggadai, tumu (Peninsular). Papua New Guinea: black mangrove (En), mangro (pidgin). Philippines: pototan (general), bakauan (Tagalog). Burma (Myanmar): byu. Cambodia: prasak. Thailand: prasak. Vietnam: v[ej]t.

Bakau is the standard Malaysian name for the timber of the *Rhizophoraceae* genera *Bruguiera*, *Ceriops* and *Rhizophora*, whereas in Indonesia it applies only to *Bruguiera* and *Rhizophora*.

Origin and geographic distribution *Bruguiera* consists of 6 species and is distributed from tropical East Africa and Madagascar, through South and South-East Asia to north-eastern Australia, Micronesia and Polynesia. *B. gymnorhiza* has the broadest range of distribution, covering the entire area of the genus, but all species are comparatively widespread. The South and South-East Asian region probably represents the centre of origin.

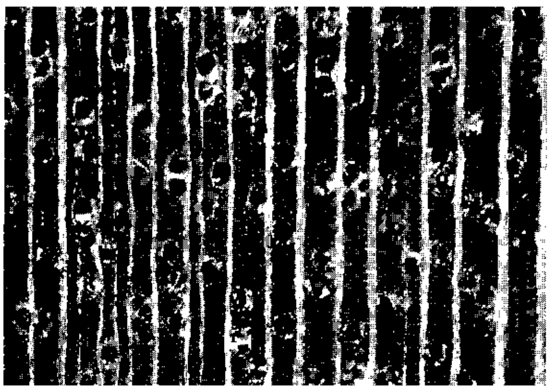
Uses The wood of *Bruguiera* is used for construction (columns, beams and rafters), piles, telegraph poles, pit props, railway sleepers, fish stakes, tool handles, scaffolding, occasionally for furniture, cabinet work and parquet flooring, but the use for firewood and charcoal is generally more important. Moreover, it is suitable for the production of pulp by the sulphate process and the trees are increasingly felled for this purpose, especially in Borneo.

The germinating seeds and sometimes the leaves are boiled and eaten as a vegetable or preserved. A condiment and an adhesive can be obtained from the bark. The bark of *B. gymnorhiza* is extensively used for tanning leather and fishing nets. The fruit may be applied as an astringent in betel quid or may be chewed as a substitute for betel nut (*Areca catechu* L.). The medicinal use of the fruit includes its application in the treatment of shingles and eye diseases. The bark is used as an astringent medicine against diarrhoea and sometimes malaria. The roots and leaves are used to cure burns.

Production and international trade Although *Bruguiera* wood is usually lighter in weight and in colour than *Rhizophora* wood, it is generally traded together. The production of tannin from *B. gymnorhiza* is important, and at present Borneo accounts for an important portion of world supplies. In Malaysia the production of firewood and charcoal are more important.

Properties *Bruguiera* yields a medium-weight to heavy hardwood with a density of 630–1010 kg/m^3 at 15% moisture content. The heartwood is pale pinkish-brown to red-brown or dark brown (grey in *B. parviflora*), not clearly demarcated, but sometimes distinct from the pale brown sapwood; grain usually interlocked or sometimes straight; texture fine and even; wood with conspicuous silver grain. Growth rings absent, occasionally visible due to zones of fewer vessels; vessels small to very small and indistinct to the naked eye, mostly in radial multiples of 2–3, occasional tyloses present; parenchyma scanty paratracheal, indistinct even with a lens; rays generally visible except in *B. parviflora*; ripple marks absent.

Logs shrink and check excessively during seasoning. The wood is strong to very strong and hard to very hard. The wood works and finishes well. It is non-durable to moderately durable when exposed to the weather or in contact with the ground. Poles of *B. gymnorhiza*, however, may have a service life of 10 years. *B. parviflora* is susceptible to attack by dry-wood termites, the sapwood is gen-



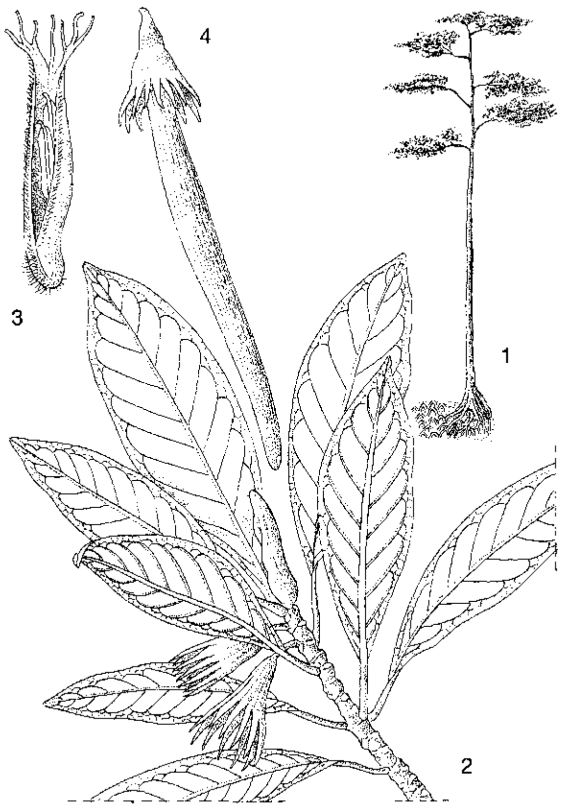
Bruguiera gymnorhiza
transverse surface (×20)

erally regarded as non-susceptible to *Lyctus*. The wood is easy to treat with preservatives: *B. gymnorhiza* wood absorbs 200 kg/m^3.

The energy value of the wood of is 18 950–20 200 kJ/kg. The tannin content of the bark (based on dry weight) is 6–26% for *B. cylindrica*, 21–36% for *B. gymnorhiza*, 9–17% for *B. parviflora* and 27–32% for *B. sexangula*.

See also the tables on microscopic wood anatomy and wood properties.

Botany Small to fairly large trees up to 40 m tall, bole up to 70(–90) cm in diameter, buttresses present, with kneed pneumatophores, sometimes with stilt roots; bark surface fissured to smooth, distinctly or obscurely lenticellate, greyish to blackish or brown, inner bark usually pinkish, often fibrous. Leaves decussate, simple, leathery, entire, usually pointed at apex, black dotted below, petiolate; stipules present. Flowers either solitary and large, or in up to 6-flowered cymes and small, bisexual, 8–16-merous; calyx lobed; petals 2-lobed, with appendages; stamens twice as many as the petals, enclosed in pairs by the pouched petals; ovary inferior, 2–4-locular with 2 ovules in each cell, style obscurely (2–)3(–4)-lobed. Fruit a berry, included in and adnate to the calyx tube, with persistent calyx lobes, 1(–2)-seeded, viviparous. Seedling with cotyledons united at base; hypocotyl cigar-shaped, terete or obscurely ribbed, blunt, falling with the fruit.



Bruguiera gymnorhiza (L.) Savigny – 1, tree habit; 2, flowering twig; 3, petal with enclosed stamen-pair; 4, fruit and hypocotyl.

Bruguiera trees grow slowly. In Sarawak *B. cylindrica* takes 60 years to attain a diameter of 18.5 cm, whereas *B. parviflora* and *B. gymnorhiza* take 40 years to attain 16 cm in diameter. Growth decreases with decreasing salinity as in the process of sedimentation in mangrove forest. Tree form is according to Aubréville's architectural model, characterized by a monopodial trunk having rhythmic growth and plagiotropic branches (e.g. *B. gymnorhiza*), or according to Attims's model, with a monopodial trunk having more continuous growth and orthotropic branches (e.g. *B. parviflora*). Large-flowered species with pendent flowers are visited by birds such as honey eaters or by insects; small-flowered species with erect flowers are often visited by butterflies. The pouched petals 'explode' when triggered, scattering pollen on the visitor. In Indonesia trees bear fruit in July–December. In north-eastern Papua New Guinea they flower in July–August. The fruits are dispersed by water.

Bruguiera is related to the other 'mangrove genera' *Ceriops*, *Kandelia* and *Rhizophora*. It can be distinguished particularly by its more numerous calyx lobes, its hypocotyl falling with the fruit, and the explosive mechanism of pollen release.

Ecology *Bruguiera* is a characteristic element of the middle and inner mangrove community, extending into the transitional landward communities, and often ascending tidal parts of rivers. Its salinity tolerance is 1–3%. Annual rainfall should be over 1000 mm. *B. gymnorhiza* trees are often the largest and oldest ones of the mangrove, and their presence marks the final stage of the succession of mangrove towards swamp or dry-land rain forest. Some species, e.g. *B. cylindrica* and *B. parviflora*, behave like pioneers and may form pure stands. *B. cylindrica* is characteristic of stiff clay soils with negligible aeration but does not tolerate prolonged immersion of its pneumatophores.

Silviculture In the Philippines seeds of *B. cylindrica* germinate completely in 2–18 days after sowing, compared with 2–5 days for *B. gymnorhiza* and 5–10 days for *B. sexangula*. In Indonesia seedlings of *B. gymnorhiza* are collected from the trees or from the ground and can be planted out at 3 m × 1 m after a period of 3–4 months in the nursery. Nurseries outside the mangrove forest should be made by planting fruits in polythene bags filled with brackish clay continuously soaked with seawater or a solution of approximately 30 g NaCl/l of water. Plants develop best where the tidal range is only about 0.35 m and the salinity is 1–2.5%. The seedlings can remain alive in the water for 5–6 months. Little is still known about the silvicultural management of mangrove forests, although some experimental work has been done on natural and artificial regeneration. *B. gymnorhiza* inhibits natural regeneration under its canopy. In Thailand the mortality during the first year of *B. gymnorhiza* planted at 1 m × 1 m was 80% in mangrove forest and 9% on cleared areas. In general, clear felling with natural regeneration can be carried out in strips perpendicular to the coast, leaving several mother trees. *B. cylindrica* is a prolific seed bearer and a healthy forest normally develops even after clear felling. The young and pure stands thus formed may be extremely dense and may contain 55 000–70 000 poles per ha. Due to its extremely slow growth the rotation should be longer than 20 years, even when harvested for charcoal and chipwood. *B. cylindrica* does not reach exploitable size until about 40 years old. For *B. gymnorhiza* a cutting cycle of 10–20 years is suggested, and a rotation of 30 years is applied in mangrove forests in Thailand. *Bruguiera* does not coppice. In mangrove forest in Peninsular Malaysia the fern *Acrostichum* became a weed and had to be controlled after the forest had been logged. In West Kalimantan the total standing volume of *B. gymnorhiza* trees over 10 cm diameter is estimated at 17.8 m^3/ha, accounting for over 20% of the total standing volume of this tree class.

Genetic resources and breeding Most *Bruguiera* species occur commonly or even gregariously in the mangroves of South-East Asia. However, they are still locally threatened in areas where mangrove vegetation is indiscriminately cleared.

Prospects Since *B. cylindrica* is one of the few economic species growing in brackish, anaerobic soil conditions and having a very long harvesting cycle, it needs special attention in mangrove management programmes. Cutting *Bruguiera* to extract tannin and produce charcoal leads to a gradual transformation into a *Rhizophora*-dominated vegetation. This process is hastened by the introduction of *Rhizophora* seedlings. The slow growth of *Bruguiera* makes it more suitable for planting for charcoal or chipwood than for sawn timber.

Literature 37, 61, 151, 186, 260, 267, 300, 304, 333, 341, 343, 348, 402, 439, 696, 708, 773, 829, 845, 934, 1038, 1048, 1101, 1221, 1242.

Selection of species

Bruguiera cylindrica (L.) Blume

Synonyms *Bruguiera caryophylloides* (Burm. f.) Blume.

Vernacular names Indonesia: lindur (Madura), tanjang sukun (Java). Malaysia: bakau belukap (Peninsular), berus ngayong (Sarawak). Philippines: pototan-lalaki (Tagalog). Burma (Myanmar): byu, saung. Thailand: rui, thua daeng (south-eastern), thua khao (peninsular). Vietnam: v[ej]t tr[uj], v[ej]t khang.

Distribution From India and Sri Lanka, throughout South-East Asia, to northern Australia.

Bruguiera exaristata Ding Hou

Distribution Timor, southern New Guinea and northern Australia.

Bruguiera gymnorhiza (L.) Savigny

Synonyms *Bruguiera conjugata* Merr.

Vernacular names Black mangrove, Burma mangrove (En). Indonesia: putut (Sumatra), tanjang (Java). Malaysia: bakau besar, tumu merah (Peninsular), berus kurong (Sarawak), putut (Sabah). Papua New Guinea: black mangrove (En), mangoro (Pidgin). Philippines: busaing (general). Singapore: tumu merah. Burma (Myanmar): byu-u-talon. Cambodia: kong kang, prâsâk' nhii, prâsâk' tôôch. Thailand: kong-kang hua sum, prasak (central). Vietnam: v[ej]t d[uf].

Distribution From tropical East Africa and Madagascar, through South and South-East Asia, to north-eastern Australia, Micronesia and Polynesia.

Bruguiera hainesii C.G. Rogers

Vernacular names Malaysia: berus mata buaya (Peninsular). Burma (Myanmar): saung-po.

Distribution Southern Burma (Myanmar), Thailand, Peninsular Malaysia and New Guinea.

Bruguiera parviflora (Roxb.) Wight & Arn. ex Griffith

Vernacular names Malaysia: berus lenggadai (Sarawak), langarai (Sabah), lenggadai (Peninsular). Papua New Guinea: black mangrove (En). Philippines: langarai (general). Burma (Myanmar): byu-kyettet. Thailand: lang-kra-dai, rang ka thae, thua dam (peninsular). Vietnam: v[ej]t t[as]ch.

Distribution Indo-China, Thailand, throughout Malesia to Melanesia and Australia.

Bruguiera sexangula (Lour.) Poiret

Synonyms *Bruguiera eriopetala* Wight & Arn. ex Arn.

Vernacular names Indonesia: bakau tampusing (Kalimantan), busing, mata buaya (Sumatra). Malaysia: berus putut (Sarawak), mata buaya (Sabah), tumu putih (Peninsular). Philippines: pototan (general), busain, tagasa (Tagalog). Burma (Myanmar): saung. Thailand: khlak, phangka hua sum (peninsular), prasak daeng (south-eastern). Vietnam: v[ej]t den.

Distribution From India and Sri Lanka throughout South-East Asia to New Guinea and New Britain; introduced and naturalized in Hawaii.

Saberi Othman

Buchanania Spreng.

Journ. Bot. (Schrader) 2: 234 (1801).

ANACARDIACEAE

x = unknown; $2n$ = unknown

Vernacular names Buchanania, pink satinwood (En). Brunei: kalan tundang, salingkawang, tengawan. Indonesia: pauhan. Malaysia: kepala tundang (Sabah), otak udang (Peninsular, Sarawak). Papua New Guinea: pink satinwood. Philippines: balinghasai (Filipino).

Origin and geographic distribution *Buchanania* comprises about 25 species occurring from India to Indo-China, southern China, Taiwan, Thailand, the whole of the Malesian region, Australia and the Pacific, east to Samoa. There are 8 species in Malesia.

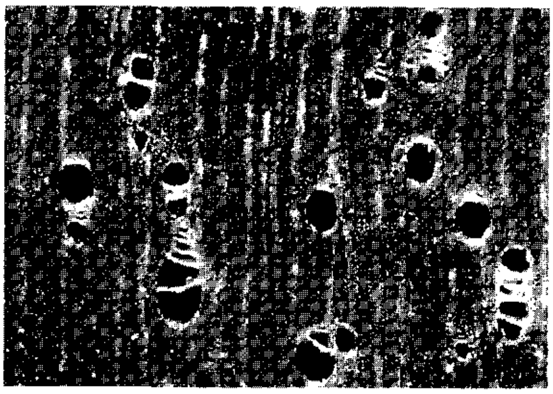
Uses *Buchanania* is used for light construction, canoes, furniture, drawers, mouldings, light framing, interior finish, household implements, cigar boxes, turnery articles, veneer and blockboard, and also for pulp and as firewood.

The fruits of some species are edible. Tannin is extracted from the bark of *B. arborescens* and used for toughening fishing nets. In Peninsular Malaysia the pounded leaves are used as a poultice to treat headache. In Australia *B. arborescens* is recommended as a shade tree for dry, sunny sites and poor soils.

Production and international trade Small amounts of *Buchanania* wood are imported by Japan, mainly from Papua New Guinea. In 1996 Papua New Guinea exported a fair amount of about 59 150 m^3 of 'pink satinwood' logs at an average free-on-board (FOB) price of US$ 115/m^3. In the Philippines pink satinwood probably reaches the market in mixed consignments of lightweight hardwood.

Properties *Buchanania* yields a lightweight to medium-weight hardwood with a density of (280–)370–640 kg/m^3 at 15% moisture content. Heartwood pale grey to pinkish-brown, not clearly differentiated from the pale pink, up to 7 cm wide sapwood; grain straight or shallowly interlocked; texture fine to moderately fine and even; wood slightly lustrous. Growth rings mostly indistinct, rarely distinct due to differences in colour; vessels moderately small to medium-sized, solitary and in radial multiples of 2–3(–4), few in clusters, tyloses few, mostly absent, sometimes with white deposits; parenchyma sparse, paratracheal vasicentric to weakly aliform, visible only with a hand lens; rays extremely fine to moderately fine; ripple marks absent; radial canals sometimes evident.

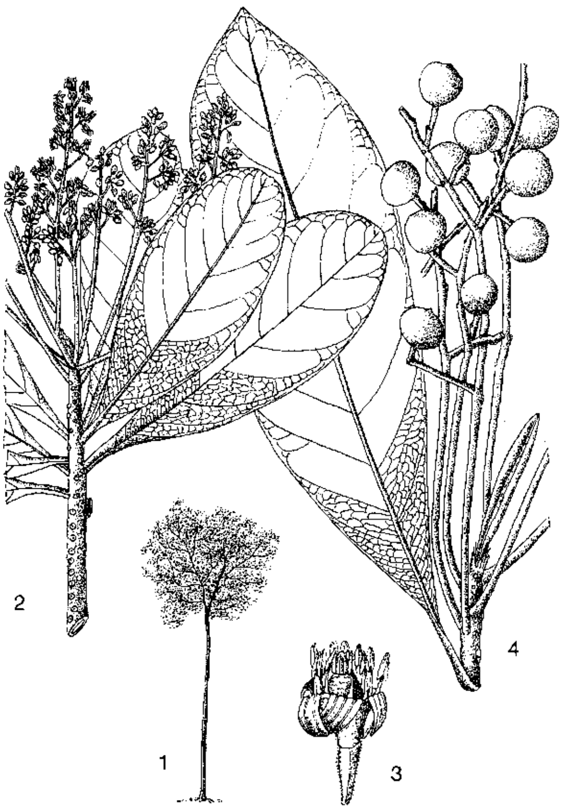
Shrinkage of the wood is moderate to high, but it seasons well and kiln drying of 25 mm thick boards from green to 12% moisture content takes around 3 days. Boards containing tension wood may distort badly. The wood is moderately soft and fairly weak. It is easy to work with all hand and machine tools and generally can be planed to a good finish. Sawdust may cause dermatitis. The wood is non-durable when exposed to the weather



Buchanania arborescens transverse surface (×20)

or in contact with the ground. In a graveyard test in the Philippines the wood of *B. arborescens* lasted for only 7 months. The heartwood is susceptible to dry-wood termites and marine borers. The sapwood is very susceptible to *Lyctus*. The absorption of preservatives in the heartwood under pressure is variable, the sapwood is permeable.
See also the tables on microscopic wood anatomy and wood properties.

Botany Evergreen, small to fairly large, rarely large trees up to 35(–42) m tall; bole cylindrical, straight, branchless for up to 20 m, up to 100 cm in diameter, sometimes with small buttresses up to 1(–4) m high; bark surface smooth or pockmarked, pale whitish to grey-brown or reddish-brown, inner bark fibrous, reddish-brown or pink, exuding a clear, colourless or pink or greyish gum; crown compact. Leaves arranged spirally, simple, entire, sessile or petiolate, exstipulate. Flowers in an axillary panicle, small, (4–)5(–6)-merous, whitish; calyx lobed, persistent or caducous; stamens twice the number of petals, anthers usually sagittate; disk shallowly cup-shaped, margin dentate; ovary superior, carpels 4–6, connate at the very base only, each with 1 ovule, usually only 1 carpel fertile, style short, stigma oblique, truncate. Fruit a 1-celled drupe with woody or bony stone. Seed with testa free from the endocarp. Seedling with epigeal germination; cotyledons emergent, fleshy; hypocotyl elongated; leaves conduplicate, first pair opposite, subsequent ones arranged spirally.



Buchanania arborescens (Blume) Blume – 1, tree habit; 2, flowering twig; 3, flower; 4, fruiting twig.

Flowering is regular, once a year. In Java *B. arborescens* has been observed with flowers in January–August and with fruits in April–November. In Australia the same species flowers in August and September; in Peninsular Malaysia the main flowering period is from April to June.
For a long time the epithet of *B. sessifolia* was misspelled as 'sessilifolia'.

Ecology *Buchanania* species are found scattered or sometimes gregarious in primary and secondary, lowland rain forest up to 600(–1000) m altitude. In Papua New Guinea they can also be found in lower montane forest up to 1500 m altitude. *B. arborescens* is a fairly common lower-storey tree of sandy and rocky coasts, kerangas and river banks, but is also found in peat-swamp forest and on limestone hills. *B. sessifolia* is generally found in well-drained sites but occasionally also in wet locations including freshwater swamps.

Silviculture *Buchanania* can be propagated by seed. About 8100 dry fruits/kg have been counted for *B. arborescens*. Only about 5% of the seeds of *B. arborescens* germinate in 38–61 days, compared with about 40% in 14–49 days for *B. sessifolia*. In Java wildlings of *B. arborescens* have been underplanted in teak plantations to control weed development. *Buchanania* is not resistant to fire.

Genetic resources and breeding There are no records of *Buchanania* in seed or germplasm banks. It is occasionally found in botanical gardens.

Prospects The availability of *Buchanania* timber and its supply to the market are limited, except in Papua New Guinea. It is unlikely that this situation will change in the near future.

Literature 40, 125, 151, 161, 162, 163, 209, 238, 259, 260, 267, 300, 340, 341, 343, 346, 348, 360, 405, 464, 487, 513, 632, 714, 780, 829, 831, 861, 934, 1038, 1048, 1221, 1232, 1242.

Selection of species

Buchanania amboinensis Miq.

Synonyms *Buchanania aruensis* Ridley, *Buchanania heterophylla* K. Schumann.

Vernacular names Indonesia: hutong utan (Ambon), litoco (Morotai).

Distribution The Moluccas and New Guinea.

Buchanania arborescens (Blume) Blume

Synonyms *Buchanania florida* Schauer, *Buchanania lucida* Blume, *Buchanania platyphylla* Merr.

Vernacular names Sparrow's mango (En). Brunei: kepala tundang, rengas ayam. Indonesia: popohan (general), getasan (Javanese), rawa-rawa pipit (Kalimantan). Malaysia: otak udang tumpul (Peninsular), rengas laut (Sarawak), beluno-beluno (Sabah). Philippines: balinghasai (general). Thailand: chaa muang (northern), luaet khwai, mamuang khee kratai (peninsular). Vietnam: c[aa]y m[uw]ng ri.

Distribution From India and the Andaman Islands to Burma (Myanmar), Indo-China, southern China, Taiwan, Thailand, throughout the Malesian region towards the Solomon Islands and northern Australia.

Buchanania insignis Blume

Synonyms *Buchanania acuminatissima* Merr.

Vernacular names Indonesia: binjai (Martapura, Kalimantan), terantang (Kutai, Kalimantan). Philippines: balihud, maguliok (Tagalog).

Distribution Borneo (Brunei, Kalimantan, Sabah) and the Philippines.

Buchanania macrocarpa Lauterb.

Synonyms *Buchanania mollis* Lauterb., *Buchanania montana* Lauterb.

Vernacular names Indonesia: bengen (Manokwari, Irian Jaya), klobum (Mooi, Irian Jaya), inaandoi (Biak, Irian Jaya).

Distribution The Moluccas (Seram), New Guinea and the Solomon Islands.

Buchanania microphylla Engl.

Vernacular names Philippines: palinlin (Tagalog).

Distribution China (Hainan) and the Philippines.

Buchanania nitida Engl.

Synonyms *Buchanania sorsogonensis* Elmer, *Campnosperma philippense* Merr.

Vernacular names Philippines: balitantan (Tagalog), lubilubi (Panay Bisaya), managas (Manobo).

Distribution The Philippines and the Moluccas.

Buchanania sessifolia Blume

Synonyms *Buchanania acuminata* Turcz., *Buchanania oxyphylla* Miq.

Vernacular names Brunei: terenting tchit (Iban). Indonesia: jinga (Balikpapan, Kalimantan), pauh pipit, terentang ayam (Palembang, Sumatra). Malaysia: kepala tundang tungkai pendek (Sabah), otak udang tajam, rengas ayam (Peninsular).

Distribution Laos, peninsular Thailand, Peninsular Malaysia, Sumatra and Borneo.

Buchanania splendens Miq.

Synonyms *Buchanania fragrans* Ridley.

Vernacular names Indonesia: awa bonan-bonan, bonan-bonan payo, tutun bonan (Sumatra).

Distribution The Andaman and Nicobar Islands, Sumatra and Borneo.

D. Sulistiarini

Callerya Endl.

Gen. pl., Suppl. 3: 104 (1843).

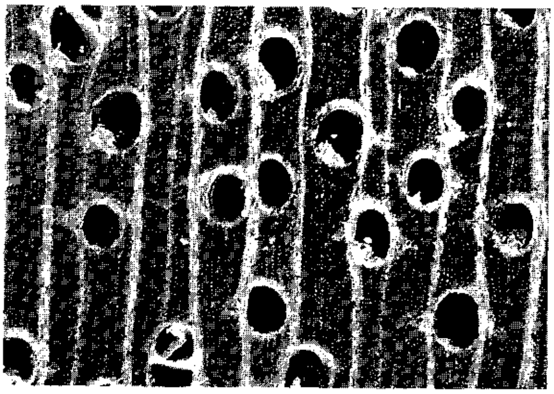
LEGUMINOSAE

$x = 8$; *C. cinerea* (Benth.) Schot: $n = 8$, *C. dasyphylla* (Miq.) Schot: $2n = 16$, *C. reticulata* (Benth.) Schot: $2n = 32$

Origin and geographic distribution *Callerya* comprises 19 species which occur from the Himalayas to China, Taiwan, Indo-China, Thailand, Peninsular Malaysia, Sumatra, West Java, Borneo, the Philippines, Papua New Guinea and Australia (Queensland, New South Wales); 9 species are present within Malesia.

Uses The wood of *Callerya* is used for medium-heavy construction (beams, rafters) and because of its fine colour also for decorative furniture, parquet flooring, partitioning, interior finish, turnery and fancy boxes. It is rarely used for fuel.

C. atropurpurea has attractive pink to deep purple flowers and is planted as an ornamental and shade tree along roadsides. Its leaves are eaten as a vegetable. The seeds have been applied in traditional medicine in Sumatra against swellings, and can be used to stupefy fish. The



Callerya atropurpurea
transverse surface (×20)

seeds of *C. vasta* yield an edible oil.

Production and international trade Wood of *C. atropurpurea* has formerly been exported from Burma (Myanmar). At present it is used on a local scale only.

Properties *Callerya* yields a medium-weight hardwood with a density of 600–815 kg/m^3 at 15% moisture content. Heartwood pale orange-brown with paler streaks when fresh, not clearly differentiated from the sapwood, but wood rapidly infected by sap-stain causing a dirty grey-brown to almost black colour; grain interlocked; texture rather coarse and uneven; zig-zag marking on tangential surfaces due to wood parenchyma. Growth rings sometimes visible, boundary indicated by a more or less continuous band of parenchyma; vessels moderately large, solitary and in radial multiples of 2–4, open; parenchyma abundant, paratracheal aliform and confluent, and sometimes appearing in marginal bands due to anastomosing confluent parenchyma, conspicuous to the naked eye on all surfaces; rays very fine to moderately fine; ripple marks fine, usually present but difficult to see.

Shrinkage upon seasoning is low and in Malaysia kiln schedule G is recommended. The wood is moderately hard to hard, fairly strong and reported to be slightly difficult to work. It is non-durable and susceptible to sap-stain. The sapwood is susceptible to *Lyctus*. Both heartwood and sapwood are easily treated with preservatives.

Mature leaves of *C. atropurpurea* contain 12% protein.

See also the table on microscopic wood anatomy.

Botany Evergreen, usually lianas or scandent shrubs, occasionally trees up to 35 m tall; bole straight to poorly shaped, branchless for up to 13 m, up to 60 cm in diameter, with steep buttresses up to 3 m high; bark surface smooth to fissured or flaking, brown to pale greyish or yellowish-brown, inner bark laminated or mottled, fawn, ochre spotted, exuding a sticky, red resin; crown dense, broad. Leaves arranged spirally, imparipinnate; leaflets opposite, entire; stipules narrow, caducous, stipellae narrow, caducous or persistent. Flowers papilionaceous, in axillary or terminal racemes often forming leafy panicles, with linear to ovate bracts and bracteoles; calyx variably oblique, the long lower tooth enclosing the corolla in bud; stamens 10, diadelphous, 9 united in a sheath, 1 free; disk usually distinct; ovary superior, 1-locular with 2–14 ovules. Fruit a woody, tardily dehiscing pod with 1–5 seeds. Seed lens-shaped, orbicular to ellipsoid. Seedling with hypogeal or semi-hypogeal germination; cotyledons not emergent, fleshy; hypocotyl not elongated; all leaves arranged spirally, first few ones scale-like, subsequent ones imparipinnate.

Trees flower after a period of dry weather. *C. atropurpurea* has been observed flowering in February–August and fruiting in May–October, but does not flower and bear fruit annually. *C. vasta* flowers from May–November and fruits from August–February. Flowers of *C. atropurpurea* are pollinated by carpenter bees of the genus *Xylocopa*.

Callerya belongs to the tribe *Millettieae*, the generic limits of which are currently being revised. To date, *Callerya* comprises species formerly accommodated in *Adinobotrys*, *Millettia*, *Padbruggea* and *Whitfordiodendron*.

Ecology *C. atropurpurea* is found in primary or secondary, evergreen forest, up to 1200 m altitude. It prefers well-drained locations and occurs on clay or limestone. *C. vasta* is found in swampy sites, on periodically inundated alluvial soils, and on dry slopes, on brown-yellow sandy clay, up to 250 m altitude.

Silviculture *Callerya* can be propagated by seed. About 85% of *C. atropurpurea* seeds germinate in 2–11 months.

Genetic resources and breeding *C. atropurpurea* and *C. vasta* are fairly common and do not seem to be threatened.

Prospects It is unlikely that the non-durable *Callerya* timber will gain importance in the near future.

Literature 56, 163, 209, 218, 238, 267, 368, 436, 553, 740, 741, 770, 829, 831, 861, 884, 995, 1038, 1184, 1221.

Selection of species

Callerya atropurpurea (Wallich) Schot

Synonyms *Adinobotrys atropurpurea* (Wallich) Dunn, *Millettia atropurpurea* (Wallich) Benth., *Whitfordiodendron pubescens* (Craib) Burkill.

Vernacular names Indonesia: kayu ujau, meribugnan (Sumatra). Malaysia: jenerik, tulang daing (Peninsular). Burma (Myanmar): kwe tanyin. Thailand: kasae, yee-ni-keh (peninsular).

Distribution Burma (Myanmar), Indo-China, Thailand, Peninsular Malaysia, Sumatra and East Kalimantan; also planted in Singapore and Java (Bogor).

Callerya vasta (Kosterm.) Schot

Synonyms *Millettia vasta* Kosterm.

Vernacular names Brunei: talapak. Malaysia: kedang belum (Iban, Sabah).

Distribution Borneo.

I. Faridah Hanum

Callicarpa L.

Sp. pl. 1: 111 (1753); Gen. pl., ed. 5: 50 (1754).

VERBENACEAE

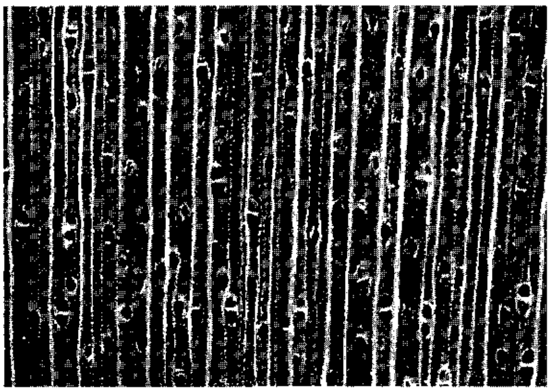
$x = 8$ or 9; *C. japonica* Thunb.: $2n = 32, 36$, *C. longifolia* Lamk: $n = 18$, *C. macrophylla* Vahl: $2n = 34$

Vernacular names Beauty berry, French mulberry, Malayan lilac (En). Callicarpa (Fr). Brunei: tampang besi. Indonesia: katumpang (Sundanese), meniran (Javanese), setampo (Sumatra). Malaysia: tampang besi (Peninsular). Thailand: hu khwai (northern). Vietnam: b[oj]t [ees]ch, tr[uws]ng [oos]c.

Origin and geographic distribution *Callicarpa* comprises about 150 species occurring in North and Central America, the West Indies and in tropical Asia from India and Sri Lanka to Indo-China, China, Japan, Taiwan, Thailand, throughout the Malesian region, northern Australia and Polynesia. The highest species diversity and the postulated origin of the genus is located in eastern Malesia.

Uses The wood of *Callicarpa* is used for house building, light construction, and for fiddles. It is also applied for fuel. In India the wood of *C. tomentosa* (L.) Murr. is made into charcoal.

Twigs of *C. arborea* are used in the Philippines to stupefy fish and as prawn bait; its bark is used as a substitute for betel nut (*Areca catechu* L.). Many



Callicarpa arborea
transverse surface (×20)

non-timber-yielding species of *Callicarpa* have medicinal applications, especially for poulticing.

Production and international trade *Callicarpa* wood is used rarely, and only locally.

Properties *Callicarpa* yields a lightweight to medium-weight hardwood with a density of 455–510 kg/m^3 at 15% moisture content, Indian samples are slightly heavier. Heartwood pale yellow-brown turning pale greyish-brown upon exposure, not clearly differentiated from the occasionally slightly paler sapwood; grain straight or interlocked; texture moderately fine and even; wood rather lustrous. Growth rings indistinct sometimes distinct in Indian material; vessels medium-sized, solitary and in radial multiples of 2–3, open; parenchyma sparse, paratracheal occasionally vasicentric; rays very fine to medium-sized, the latter visible to the naked eye; ripple marks absent.

The wood is reported to season poorly. It is moderately soft to moderately hard, moderately strong and is easy to saw and work, but does not finish smoothly. The wood is non-durable.

C. maingayi contains maingayic acid.

See also the table on microscopic wood anatomy.

Botany Evergreen shrubs or small trees up to 18 m tall; bole up to 60 cm in diameter, without buttresses; bark surface smooth, becoming scaly, grey, inner bark brownish, without exudate. Leaves decussate, but often with 1 or 2 alternate ones between the pairs, simple, margin entire to toothed, lower surface white to brownish-grey woolly or scurfy; stipules absent. Inflorescence axillary or rarely terminal, cymose. Flowers bisexual, small, crowded, subsessile, actinomorphic, 4–5-merous; calyx campanulate or rarely tubular, minutely toothed or sometimes entire; corolla with

a short tube, pink, lilac or violet; stamens inserted on the corolla tube, exserted; ovary superior, 2–5-locular with 2 ovules in each cell, style elongate, stigma obscurely lobed. Fruit a small, globose, white, purple or black drupe with a persistent calyx. Seed with scanty or no endosperm. Seedling with epigeal germination; cotyledons emergent; hypocotyl elongated.
Mean annual diameter increment as measured in Indian wood samples of *C. arborea* is about 1 cm. In Peninsular Malaysia flowering is throughout the year, but in the Philippines *C. arborea* flowers in June and July. Pollination is by wind or insects; in Peninsular Malaysia *C. maingayi* is pollinated by carpenter bees (*Xylocopa*). Seed dispersal is probably by birds and small animals that eat the ripe fruits.
The Malesian *Callicarpa* species are poorly known botanically and in need of a thorough taxonomic revision.

Ecology *Callicarpa* occurs scattered in lowland rain forest, up to 1000(–1400) m altitude. Several species are also found in secondary forest or as understorey trees. *C. arborea* is reported as a pioneer species.

Silviculture Most *Callicarpa* species can be grown from cuttings.

Genetic resources and breeding As *Callicarpa* is botanically poorly known it is difficult at present to assess the conservation of its genetic resources. There are no records of ex situ conservation.

Prospects It is very unlikely that the wood of *Callicarpa* will gain importance in the near future.

Literature 46, 56, 163, 209, 235, 267, 364, 436, 464, 648, 653, 812, 861, 874, 1038, 1221.

Selection of species

Callicarpa arborea Roxb.

Synonyms *Callicarpa magna* Schauer, *Callicarpa tomentosa* auct. non (L.) Murr.

Vernacular names Great woolly Malayan lilac (En). Indonesia: sitapueng (Minangkabau, Sumatra), tepong-tepong (Palembang, Sumatra), tinjau (Lampung, Sumatra). Malaysia: ambong-ambong bukit, kata kerau, tamah kerbau (Peninsular). Philippines: atimla (Filipino). Burma (Myanmar): duang-satpa. Thailand: hu khwai khao, katok chang (peninsular), pha khao (northern). Vietnam: tu h[us].

Distribution From India to Burma (Myanmar), Indo-China, Thailand, Peninsular Malaysia, Sumatra, Java, the Philippines, Sulawesi and New Guinea.

Callicarpa maingayi King & Gamble

Vernacular names Malaysia: balek angin laut, mendapor, tutok puteh (Peninsular). Thailand: hu khwai khao, plao khon, toh (peninsular).

Distribution Thailand and Peninsular Malaysia.

Rusea Go

Camptostemon Mast.

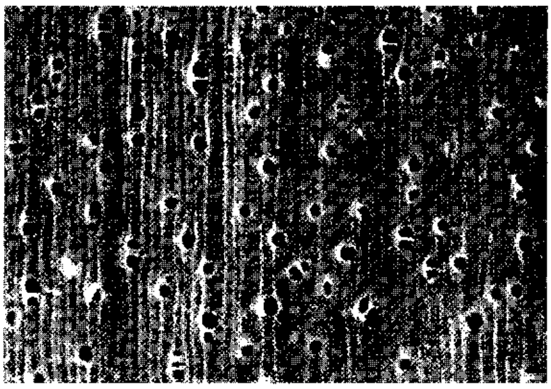
Hooker's Icon. Pl. 12: 18, t. 1119 (1872).
BOMBACACEAE
x = unknown; $2n$ = unknown

Origin and geographic distribution *Camptostemon* comprises 2 species and occurs in Borneo, the Philippines, Sulawesi, the Aru Islands, New Guinea and northern Australia.

Uses The wood of *Camptostemon* is used for mouldings, interior finish, household utensils, carving and inlaying. In the Philippines it is very often applied as a substitute for 'lanete' (*Wrightia* spp.). It is suitable for the manufacture of pulp and paper.

Production and international trade Utilization of *Camptostemon* wood is only local and supplies are scarce.

Properties *Camptostemon* yields a medium-weight hardwood with a density of 470–635 kg/m^3 at 15% moisture content. Heartwood white, pale buff to pinkish-buff, sometimes with pink circular bands, not distinct from the sapwood. The follow-



Camptostemon philippinense
transverse surface (×18)

ing properties are based on material of *C. philippinense* only. Grain straight or slightly wavy; texture fine. Growth rings mostly indistinct; vessels very small to moderately small, solitary and in radial multiples of 2–3, without contents; parenchyma paratracheal vasicentric and apotracheal diffuse to diffuse-in-aggregates, conspicuous; rays very fine, distinct; ripple marks distinct.
The wood seasons well with negligible checking and warping. It is fairly strong and moderately soft, and is easy to work. The wood is non-durable. The heartwood is resistant to dry-wood termites and the sapwood is non-susceptible to *Lyctus*. Sulphate pulp with a good strength can be produced from *C. schultzii*.
See also the table on microscopic wood anatomy.

Botany Evergreen shrubs or small to medium-sized trees up to 33 m tall; bole up to 60 cm in diameter, sometimes fluted at base, with thick, knobbly pneumatophores with circular lenticels; bark surface fissured and lenticellate, yellowish-white, brown or grey-brown, inner bark pink to pale straw-coloured. Lower leaf surface, petiole and inflorescence covered with small scales. Leaves arranged spirally, clustered at the end of twigs, simple, entire, below with greyish scales and ferrugineous ones on the midrib. Flowers small, in axillary, subumbellate cymules on short peduncles; epicalyx present; calyx 3-lobed; petals 5, white; stamens united in a column; ovary superior, 2-locular with 1 ovule in each cell; style columnar, divided in 2 short lobes. Fruit a capsule, dehiscing with 2 valves. Seed covered by a dense, cotton-like substance.
Trees show no seasonality of flowering and fruiting, despite the sometimes strongly seasonal climate.
Very little is known botanically about *Camptostemon*, especially about *C. philippinense*.

Ecology *Camptostemon* grows in mangrove swamps and occurs in areas with perhumid to subhumid climates. *C. schultzii* occurs on dark muddy soils with good drainage. It favours areas with brackish water, periodically inundated by spring tides. It may occur scattered, locally common or even in pure stands, and is often associated with *Bruguiera* and *Rhizophora* species.

Genetic resources and breeding The disappearance of mangrove forest in Indonesia and the Philippines may threaten *Camptostemon*, in particular *C. philippinense*.

Prospects As supplies are dwindling the utilization of the wood will remain local and will most probably diminish.

Literature 77, 78, 348, 403, 458, 464, 785, 861, 880, 934.

Selection of species

Camptostemon philippinense (S. Vidal) Becc.

Synonyms *Cumingia philippinensis* S. Vidal.

Vernacular names Philippines: gapas-gapas (general), bungalon, libatong-puti (Tagalog).

Distribution Borneo, the Philippines and Sulawesi.

Camptostemon schultzii Mast.

Synonyms *Camptostemon aruense* Becc.

Distribution The Aru Islands, New Guinea and northern Australia.

E. Boer (general part),
M.S.M. Sosef (general part, selection of species)

Canthium Lamk

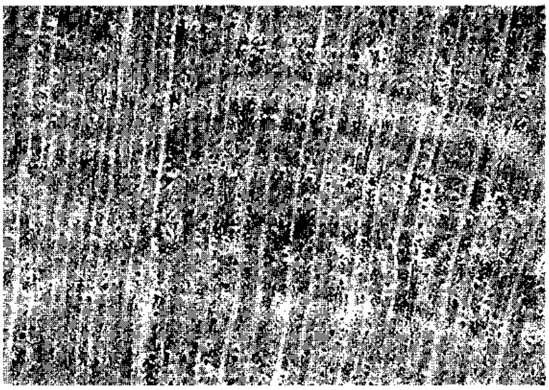
Encycl. Meth., Bot. 1: 602 (1785).
RUBIACEAE
x = unknown; $2n$ = 44 for several African and Indian species

Origin and geographic distribution *Canthium* in the broad sense is a large genus of over 200 species which occurs in the African and Asian tropics. In Asia *Canthium* sensu stricto is restricted to India, Sri Lanka, Burma (Myanmar), Indo-China, southern China, Thailand and western Malesia (east to the Philippines, Borneo and Java). Several dozen species are found in Malesia, but most of these are shrubs, small trees or climbers and only a few reach timber size.

Uses The wood of *Canthium* is used locally in house and boat building, and for flooring and implements.

Production and international trade Utilization of the wood is only local and very limited because the trees are usually small and scattered.

Properties Most of the following information refers to species identified as belonging to *Psydrax* from Malaysia and the Philippines, but which most probably applies to species of *Canthium*. Usually they yield a medium-weight hardwood. Indonesian samples of *Canthium* species are medium-weight to heavy hardwoods with a density of 560–1060 kg/m^3 at 15% moisture content. Heartwood pink when fresh, turning pale brown



Canthium attenuatum R. Br. ex Benth. transverse surface (×20)

or orange-brown with age, not distinct from the paler sapwood; grain straight; texture very fine and even. Growth rings indistinct or sometimes visible to the naked eye, marked by vessel-free zones; vessels very small to medium-sized, almost exclusively solitary but with occasional radial pairs, open; parenchyma moderately abundant, indistinct with a hand lens, apotracheal diffuse or diffuse-in-aggregates, or scanty paratracheal; rays extremely fine and moderately fine; ripple marks absent.

The wood is very hard and that of the Indonesian *Canthium* species is strong and moderately durable.

See also the table on microscopic wood anatomy.

Botany Spiny or unarmed climbers or shrubs to small or medium-sized trees up to 25 m tall; bole usually straight; bark surface smooth to irregularly fissured or cracking, sometimes lenticellate, greyish-brown, inner bark brown. Leaves opposite, simple, entire, short-stalked; stipules triangular. Flowers axillary, solitary or in a stalked cyme-like or umbel-like inflorescence, 4–5(–6)-merous; calyx with triangular lobes; corolla with a short tube and valvate lobes; stamens inserted in the throat of the corolla tube; ovary inferior; style with globose to cylindrical stigma. Fruit berry-like, ovoid, obovoid to globose, often strongly bilobed and slightly laterally compressed. Seed plano-convex. Seedling with epigeal germination; cotyledons leafy, green.

In Java *C. glabrum* flowers almost throughout the year. The trees usually have a straight trunk with evenly spaced pairs of horizontal main branches.

Canthium belongs to the tribe *Vanguerieae* which is renowned for its very closely related genera with poorly defined limits. Many genera have been split off from *Canthium* in the broad sense, such as the South-East Asian genera *Meyna*, *Perakanthus* and *Psydrax* (the latter is also present in Africa, the Pacific and Australia). *Psydrax* has several species which grow to timber size. Many *Psydrax* specimens belonging to species collected in Malesia have been named *Canthium didymum* Gaertn. or *Canthium diococcum* (Gaertn.) Merr. However, the true *Psydrax diococca* Gaertn. (synonym: *Canthium didymum*) occurs only in Sri Lanka and southern India. Research is needed to decide whether some of the species treated here under *Canthium*, i.e. *C. lucidulum* and *C. sumatranum*, belong to *Canthium* sensu stricto or to one of the related genera.

Ecology *Canthium* trees occur scattered, mainly in lowland or sometimes in lower montane forest up to 1000 m altitude.

Silviculture *Canthium* may be raised from seed. For *C. glabrum* there are 4950–5600 dry seeds/kg. Only about 25% of the fruits of *C. glabrum* sown germinate in 43–123 days.

Prospects Knowledge of *Canthium* and related genera is scarce. A taxonomic revision of the genera and species for South-East Asia, therefore, is required to interpret the literature and to serve as a basis for further research. On the other hand, most species are economically of no interest since they seldom reach merchantable size.

Literature 70, 144, 145, 163, 209, 267, 405, 436, 543, 716, 829, 831, 861, 934, 1221.

Selection of species

Canthium confertum Korth.

Synonyms *Plectronia conferta* (Korth.) Valeton.

Vernacular names Malaysia: kemuning jantan hutan, mata keli jantan, chareh (Peninsular).

Distribution Peninsular Malaysia, Singapore and Borneo; possibly also in Sumatra and the Philippines.

Canthium glabrum Blume

Synonyms *Plectronia glabra* (Blume) Benth. & Hook. f. ex Kurz.

Vernacular names Indonesia: balung (Javanese), ki caruluk, ki kopi (Sundanese). Malaysia: mengkoi, salang rusa, sebusok betina (Peninsular). Thailand: hu suea (northern), khang ten, khao kwang (peninsular).

Distribution Burma (Myanmar), Indo-China, Thailand, Peninsular Malaysia, Singapore and Java.

Canthium lucidulum Miq.

Synonyms *Plectronia lucidula* (Miq.) Valeton.
Vernacular names Indonesia: kayu litah, kepinis, temeras rawang (Palembang, Sumatra).
Distribution Sumatra.

Canthium sumatranum Miq.

Synonyms *Plectronia sumatrana* (Miq.) Valeton.
Vernacular names Indonesia: tinjau (Kubu, Sumatra).
Distribution Sumatra.

E. Boer (general part),
R.H.M.J. Lemmens (general part, selection of species)

Cantleya Ridley

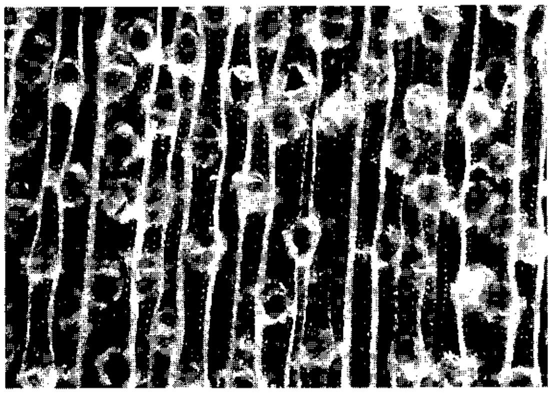
Fl. Mal. Pen. 1: 436 (1922).
ICACINACEAE
x = unknown; $2n$ = unknown

Vernacular names Dedaru (trade name). Brunei: cendana, samala, seranai. Indonesia: bedaru (general), garu buaya (Sumatra), mendaru (Bangka). Malaysia: bedaru (Sarawak), daru-daru (Peninsular), dedadu (Sabah).

Origin and geographic distribution *Cantleya* is a monotypic genus. The only species, *C. corniculata* (Becc.) Howard (synonyms: *C. johorica* Ridley, *Stemonurus corniculatus* (Becc.) Ridley, *Urandra corniculata* (Becc.) Foxw.), is found in Peninsular Malaysia (Johore), the Riau and Lingga Archipelago, Bangka, Sumatra and Borneo.

Uses The heavy and hard wood of *Cantleya* is used for medium to heavy construction, bridge building, ship building, laboratory benches, heavy duty flooring, piling, flag poles, pepper support poles, vehicle bodies, bedding wood, tool handles, canes and fancy turnings. In Borneo it has been regarded as the second most valuable wood for house building. The reputed usefulness for heavy-duty furniture is doubtful. The fragrant wood may be used as a substitute for sandalwood (*Santalum album* L.).
The fruits are edible, but said to be of rather poor quality.

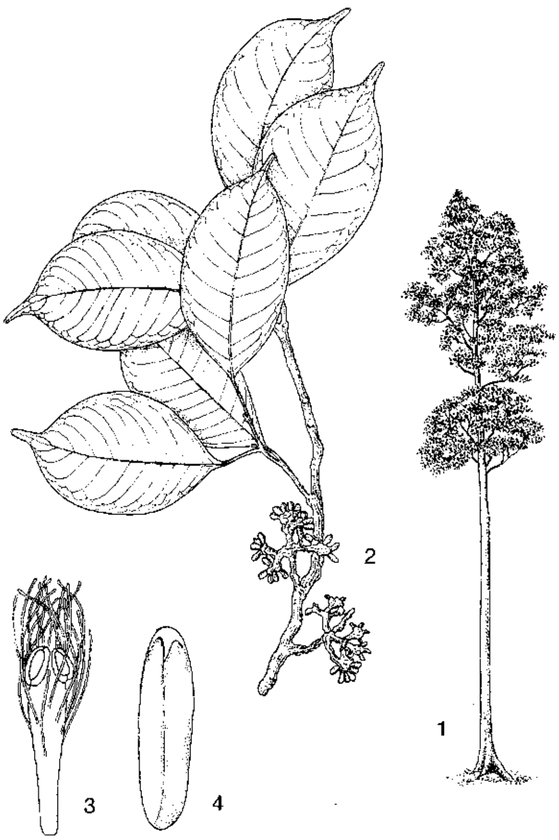
Production and international trade At the beginning of the 20th Century, 'dedaru' was reported to have been found in the Singapore market, supplies coming from Sumatra and Borneo. It is still exported from the latter areas but it is also used locally. As supplies are very limited, dedaru seldom comes on the market, and when it does it is generally sold in mixed consignments. Some of it may be marketed as 'balau' (heavy *Shorea* spp.). The fragrant wood is reputed to have been exported to China.



Cantleya corniculata
transverse surface (×20)

Properties *C. corniculata* yields a heavy hardwood with a density of 840–1360 kg/m^3 at 15% moisture content. Heartwood yellow-brown, sharply demarcated from the pale yellow-brown, 5 cm wide sapwood; grain interlocked; texture rather fine and even; wood with conspicuous ribbon figure on radial surface; freshly cut material with a fragrant odour. Growth rings absent; vessels medium-sized, mostly solitary with few radial or oblique pairs, open or containing tyloses; parenchyma moderately abundant, just visible to the naked eye, paratracheal vasicentric and slightly aliform; rays moderately fine to medium-sized, visible to the naked eye; ripple marks absent.
Shrinkage upon drying is low. The wood seasons well with a slight risk of surface checking; warping and splitting has been reported, but is probably not a problem. Boards of 13 mm and 38 mm thick take 2.5 and 6 months, respectively, to air dry. The wood is very hard and very strong. It is moderately difficult to saw, but fairly easy to turn and easy to plane. The wood is very durable, even in contact with the ground; the sapwood is susceptible to blue stain.
See also the tables on microscopic wood anatomy and wood properties.

Botany An evergreen, medium-sized to fairly large tree up to 40 m tall; bole slender, cylindrical,



Cantleya corniculata (Becc.) Howard – 1, tree habit; 2, flowering twig; 3, stamen; 4, petal.

branchless for up to 20 m, up to 60(–150) cm in diameter, usually expanded at base or rarely with buttresses up to 1.5 m high; bark surface finely, shallowly and rather irregularly, longitudinally fissured, grey or grey-green to brownish, inner bark fibrous, very thin, white; crown dense with small branches; twigs zig-zag. Leaves arranged spirally, simple, entire, abruptly bluntly acuminate, margin slightly curved inward, exstipulate. Flowers bisexual, in an axillary cyme, peduncle covered with small bracts and giving rise to dichotomously branched smaller branches bearing small clusters of sessile flowers; calyx 5-lobed; petals (4–)5, valvate, with inflexed apex; stamens (4–)5, broadening upwards and club-shaped, pubescent distally, anther cells almost horseshoe-shaped; ovary superior, 1-locular with 2 apical ovules, stigma sessile. Fruit a 1-seeded, fusiform drupe with thin, pulpy exocarp and fibrous-corky endocarp, brown to blackish when mature, splitting on one side from below up to the middle.

Trees flower and bear fruit throughout the year. The fruits are eaten by animals.

Ecology *C. corniculata* is comparatively rare and scattered, and occurs as a canopy tree in primary forest, from sea-level up to about 300 m altitude. It is found in the drier parts of freshwater and peat-swamp forest, in kerangas as well as in drier hill forest, on marshy or sandy soils. It has been found together with 'meranti bakau' (*Shorea uliginosa* Foxw.), 'punah' (*Tetramerista glabra* Miq.) and 'kempas' (*Koompassia malaccensis* Maingay ex Benth.).

Silviculture In natural forest, natural regeneration of *C. corniculata* is generally sparse, although seed production is prolific. In a single germination trial, all seeds failed to germinate. In Bangka *C. corniculata* made up 3.5% of the total timber volume of trees over 10 cm in diameter.

Genetic resources and breeding *C. corniculata* may easily become endangered because of destruction of its habitat or overcutting, as it is scattered and the timber is much in demand. There are no records of *Cantleya* in seed or germplasm banks.

Prospects As supplies are dwindling, utilization of *Cantley* wood is expected to decrease. As the timber is held in esteem, the time is ripe for plantation establishment, necessitating research on its silvicultural characteristics.

Literature 151, 162, 163, 198, 218, 259, 267, 341, 354, 387, 436, 453, 526, 537, 678, 743, 861, 933, 1026, 1040, 1075, 1091, 1099, 1221, 1222, 1242.

S.P. Teo

Carallia Roxb.

Pl. Coromandel 3: 8, t. 211 (1811).

RHIZOPHORACEAE

x = unknown; $2n$ = unknown

Vernacular names Indonesia: ringgit dareh (general). Malaysia: meransi (general), kerakas payau (Sarawak), perepat hutan (Sabah). Philippines: bakauan-gubat (general). Thailand: chiang phra. Vietnam: s[aw]ng m[ar]. Burma (Myanmar): maniawga.

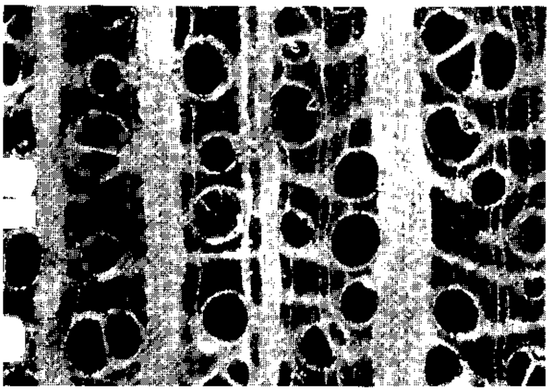
Origin and geographic distribution *Carallia* comprises about 15 species occurring in Madagascar and from Sri Lanka and India to Indo-China, throughout the Malesian region towards the Solomon Islands and northern Australia. Most species have limited areas of distribution, but *C.*

brachiata occurs throughout the area of distribution of the genus.

Uses The wood of *Carallia* is used for general construction, house building, posts, cabinet work, furniture, parquet flooring, musical instruments, handles of spears and choppers, picture frames, ornamental veneers, decorative interior finish and panelling, pallets and packing material. It is suitable for railway sleepers, transmission posts and all kinds of novelty items. Due to its high energy value the wood yields good-quality fuelwood and charcoal and was once rated as the best fuel for steamers.
The leaves and bark are used in local medicine to treat sapraemia and itch. *C. brachiata* cv. Honiara is a fastigiate cultivar with great potential as an ornamental.

Production and international trade The trees usually are too scattered to be of great commercial importance. A small amount of *Carallia* timber is imported into Japan from Sabah and Sarawak. In 1996 Papua New Guinea exported about 1000 m^3 of *Carallia* logs at an average free-on-board (FOB) price of US\$ 98/m^3.

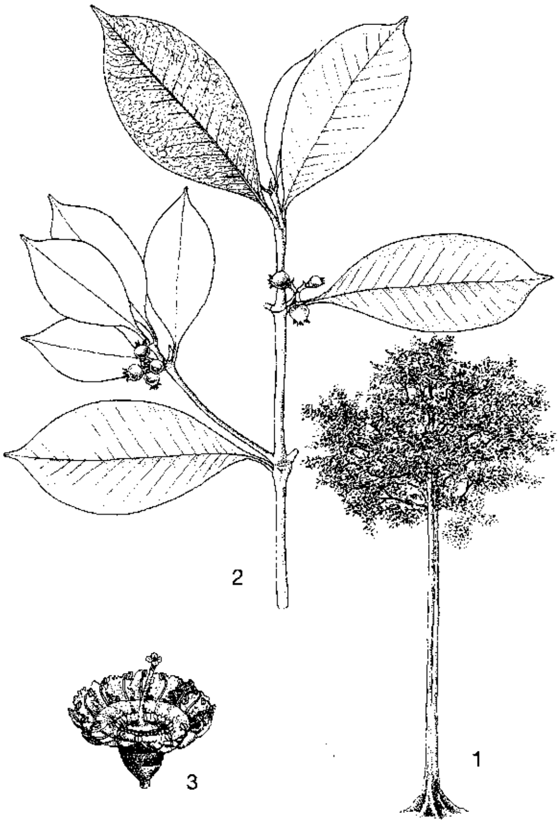
Properties *Carallia* yields a medium-weight to heavy hardwood with a density of 640–1050 kg/m^3 at 15% moisture content. Heartwood buff or reddish-yellow, indistinctly to moderately distinctly demarcated from the paler, sometimes yellowish-white sapwood; grain straight, interlocked or slightly wavy; texture coarse and uneven due to the presence of large rays; wood with conspicuous silver grain on radial surfaces. Growth rings indistinct or absent; vessels medium-sized to moderately large, mostly solitary but also in radial or tangential multiples of 2–3, usually blocked by tyloses, white deposits common; parenchyma moderately abundant to abundant, paratracheal aliform to confluent, and apotracheal in broad wavy bands which often branch and diffuse but not conspicuous; rays of 2 distinct sizes, medium-sized to very broad, the broad ones conspicuous; ripple marks absent.



Carallia brachiata
transverse surface (×20)

Shrinkage upon air drying is low and the wood seasons well, but end splitting and surface checking should be prevented by protecting the ends from rapid drying out; it takes respectively 2 and 5 months to air dry boards 13 mm and 38 mm thick. The wood is strong. It is easy to saw and plane and takes a good finish. Immediately after sawing the timber should be treated with anti-stain chemicals. To obtain the attractive silver grain, boards should be quarter-sawn, which limits their width to about 20 cm. The wood is durable under cover, but durability in contact with the ground or when exposed to the weather is not well established and it is reported as being moderately durable to non-durable. It is prone to termite and marine borer attack, whereas the absorption of preservatives is moderate (95–130 kg/m^3). The sapwood is susceptible to *Lyctus*.
See also the tables on microscopic wood anatomy and wood properties.

Botany Shrubs or small to fairly large trees up to 36(–50) m tall; bole up to 70 cm in diameter, occasionally with small buttresses (up to 1 m high), sometimes with small stilt roots or aerial roots at base; bark surface smooth to finely cracking or shallowly to deeply fissured, lenticellate, often hoop-marked, grey to reddish-brown or dark brown, inner bark striate, yellowish-brown to pinkish-brown, sapwood creamy to yellow-brown, with prominent rays; twigs solid. Leaves decussate, simple, elliptical to obovate or narrowly obovate, margin entire to dentate or serrate, often with black dots beneath; stipules interpetiolar, lanceolate. Flowers in a sessile or peduncled cyme or solitary, bisexual, sessile or stalked, with 2 bracteoles; calyx (4–)5–8-lobed; petals 5–8, free, clawed; stamens twice the number of petals, generally free, unequal in length; disk annular; ovary inferior or semi-inferior, 5–8-locular with 2 ovules in each cell (rarely 1-locular with 10–12 ovules), stigma discoid or capitate. Fruit a 1-celled berry, small, pulpy, crowned by floral remains, 1(–5)-seeded, pink to red when ripe. Seed ellipsoid or reniform. Seedling with epigeal germination; cotyledons leafy, green; hypocotyl elongated; all leaves opposite, those of some species densely and sharply dentate.
Initial growth is slow and seedlings attain only



Carallia brachiata (Lour.) Merr. - 1, tree habit; 2, fruiting twig; 3, flower.

15–35 cm in height after 2 years; after 5 years the mean height is 2.3 m and the diameter at the base is 9 cm. A single *C. brachiata* tree of 35 years old was 16 m tall with a clear bole of 2.4 m and a diameter of 29 cm. Seedlings of *C. brachiata* cv. Honiara attained 60 cm in height in 10 months. Growth is monopodial and trees flower and fruit abundantly in mast fruiting years, but individuals may flower less profuse in other years as well. Trees of *C. brachiata* occasionally develop adventitious roots in swampy or wet conditions and sometimes flower in the juvenile state.
Carallia species may resemble *Syzygium*, but the trees are monopodial.

Ecology *Carallia* species occur scattered in lowland to montane forest up to 1800 m altitude. They are found in primary or less often secondary forest, in mixed dipterocarp forest, freshwater swamp forest, kerangas and on hills and ridges, mostly on peat soils or podzolic soils; rarely in savannas.

Silviculture *Carallia* may be propagated by seed or by cuttings. It seems that seed soon loses its viability. Seed of *C. brachiata* had 45% to almost 100% germination in 1–3.5 months including one seed lot which did not start to germinate until after 52 days. Fresh seed of *C. brachiata* cv. Honiara germinated almost completely in 24–45 days. Seedlings may be kept in the nursery for 2 years before being planted out in the field. Direct sowing was not successful as the young plants proved to be sensitive to drought. *Carallia* tolerates shade; planting in open sites will be difficult. It coppices well and reproduces freely from root suckers.

Genetic resources and breeding *C. brachiata* is widely distributed but nowhere common. In some regions it is rather rare, e.g. in the Philippines. Other less widespread species also occur scattered in the forest. *C. brachiata* cv. Honiara is a cultivar with a narrow columnar habit and pendulous branches, recently planted along roads in Singapore.

Prospects The supply of *Carallia* wood is small due to the scattered occurrence of the trees and their often small size. However, more research on the silvicultural aspects seems worthwhile as the wood is of good quality and utilitarian value.

Literature 40, 61, 124, 151, 163, 209, 235, 260, 267, 304, 341, 343, 387, 536, 543, 678, 740, 741, 780, 785, 829, 831, 832, 861, 924, 933, 934, 1039, 1048, 1052, 1104, 1177, 1221, 1239, 1242, 1246.

Selection of species

Carallia borneensis Oliver

Synonyms *Carallia mindanaensis* (Merr.) Merr., *Sagittipetalum mindanaense* Merr., *Sagittipetalum palawanense* Elmer.

Vernacular names Indonesia: karibas (Kalimantan). Malaysia: kemuning hutan (Sabah). Philippines: magtungod (Samar-Leyte Bisaya).

Distribution Borneo, the southern Philippines and New Guinea (Irian Jaya).

Carallia brachiata (Lour.) Merr.

Synonyms *Carallia integerrima* DC., *Carallia lucida* Roxb., *Carallia scortechinii* King.

Vernacular names Brunei: meransi, sabar buku. Indonesia: kitamiyang (Sundanese), ringgit dareh (Kubu, Sumatra), sepat (Javanese). Malaysia: mesinga (Peninsular), rabong, radipah (Sarawak). Philippines: bakawan-gubat (general), anosep (Tagalog), katolit (Iloko). Burma (Myanmar): maniawga-yat. Cambodia: tra meng. Laos:

bong nang, halay, koueum. Thailand: chiang phra nang ae (general). Vietnam: ma m[ax], s[aw]ng m[ar], sen d[ow].

Distribution Madagascar, India, Sri Lanka, Burma (Myanmar), Indo-China, southern China, Thailand, throughout the Malesian region, the Solomon Islands and northern Australia.

Carallia eugenioidea King

Synonyms *Carallia montana* Ridley.

Distribution Vietnam, Peninsular Malaysia and central Sumatra.

Carallia euryoides Ridley

Distribution Peninsular Malaysia.

Carallia lanceaefolia Roxb.

Vernacular names Vietnam: s[aw]ng m[ar].

Distribution Burma (Myanmar), Laos, Vietnam, southern China and Peninsular Malaysia.

Ding Hou

Carapa Aubl.

Hist. pl. Guiane 2, Suppl.: 32, t. 387 (1775).

MELIACEAE

x = unknown; *C. guianensis*: $2n = 58$, *C. procera*: $2n = 58$

Vernacular names Andiroba (Fr, Sp, trade name). Crabwood (En, trade name). Bastard mahogany, carapa (En).

Origin and geographic distribution *Carapa* comprises 3–4 species occurring in the Neotropics and tropical Africa. Two of them have been introduced into the Malesian region (Java, Peninsular Malaysia and Singapore) and are potential plantation species.

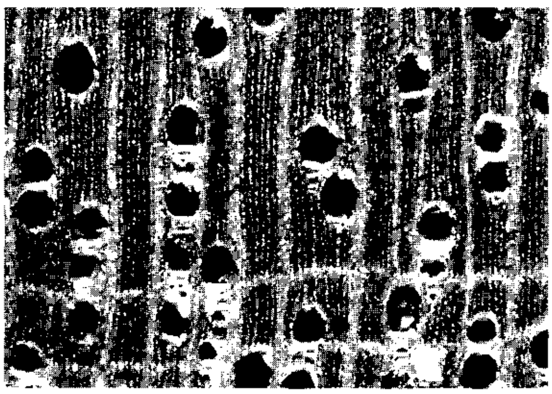
Uses The wood of *Carapa* resembles mahogany (*Swietenia* spp.) but is less attractive in appearance. Main applications are for high quality furniture, stairs and flooring, and as veneer for furniture, interior work and plywood. Furthermore, it is used for cabinet work, masts, fire-resistant building material and as a substitute for okoumé (*Aucoumea klaineana* Pierre) and walnut (*Juglans regia* L.). The wood is suitable for the production of pulp and paper.

The bark is used for tanning and medicinally as a febrifuge. The oil obtained from the seeds and called 'crab oil' or 'andiroba' is well-known and used as lamp oil and for making soap and candles. It is also applied as an external medicine against skin complaints and has insecticidal properties. *Carapa guianensis* is planted as an ornamental in the Caribbean, where it is locally naturalized, and is suitable for enrichment planting.

Production and international trade *Carapa* is of considerable importance in tropical America where it is locally heavily exploited. It is exported mainly from Brazil and the Guianas, but it is hardly known in South-East Asia. The oil obtained from the seeds is of importance for local industries in Brazil and may be exploited commercially in Africa.

Properties The following macroscopic description and wood properties are entirely based on material from Central and South America. *Carapa* yields a medium-weight hardwood with a density of 580–750 kg/m^3 at 12% moisture content. Heartwood pale pink to red-brown when fresh, darkening to a fairly uniform reddish-brown, not clearly demarcated from the 2.5–5 cm wide pale brown to greyish sapwood; grain generally straight, sometimes interlocked; texture fine to coarse. Growth rings occasionally indicated by marginal parenchyma; vessels medium-sized, mostly solitary, also in radial multiples of 2–3, open; parenchyma paratracheal, and apotracheal in marginal bands; rays moderately fine to broad, conspicuously dark on radial split surface; irregularly storied; rarely with tangential lines of traumatic ducts.

Shrinkage upon seasoning is moderate to high; the wood is moderately difficult to air dry, requiring slow drying under cover, kiln schedule C is recommended. The timber is moderately soft to moderately hard, strong and moderately tough. It has good working properties with a moderate dulling effect on tools and a slight tendency to



Carapa guianensis
transverse surface (×20)

split on nailing. It glues well and polishes satisfactorily. The heartwood is moderately durable, fairly resistant to termites, but sapwood is susceptible to *Lyctus* and pinhole borer attack. Logs are liable to severe ambrosia beetle attack. The heartwood is resistant and sapwood amenable to preservative treatment.

The energy value of the wood is about 20 000 kJ/kg. In South America foresters recognize two types of wood: 'red' or 'hill crabwood' and 'white crabwood'. The first is said to be superior and is obtained from trees growing on higher land, whereas white crabwood is derived from trees in swampy locations.

See also the tables on microscopic wood anatomy and wood properties.

Botany Deciduous or semi-evergreen, monoecious, medium-sized to large trees up to 35(–55) m tall; bole straight and cylindrical, branchless for up to 20(–30) m, up to 100(–200) cm in diameter, sometimes fluted, with short buttresses up to 2 m high; bark surface flaking into squarish scales or in horizontal strips, light grey to greyish-brown or dark brown, sometimes reddish, inner bark fibrous, red or pinkish-brown. Leaves alternate, paripinnate with a dormant glandular leaflet at the apex, exstipulate; leaflets opposite, entire. Flowers borne in a large, axillary or subterminal thyrse, unisexual but with well developed vestiges of the opposite sex, 4–5(–6)-merous; calyx lobed almost to the base; petals slightly contorted; stamens united in a tube which bears 8–10 anthers; disk bowl-shaped; ovary superior, 4–5(–6)-locular with (2–)3–8 ovules in each cell, style short with a discoid stigma. Fruit a pendulous, subglobose, woody capsule. Seed with woody sarcotesta. Seedling with the cotyledons not emergent; cataphylls arranged spirally; first pair of leaves simple, subsequent ones trifoliolate, bright red.

C. guianensis shows gigantic leaves in the monocaulous juvenile stage, decreasing in size when branching is initiated. *C. procera* retains a branch-like feature in the failure of the leaves to develop a basal abscission zone. The rachis becomes embedded in the trunk after the leaflets have fallen. *C. guianensis* develops according to the architectural model of Scarrone, characterized by an indeterminate trunk bearing tiers of orthotropic branches which branch sympodially as a result of terminal flowering. The life span of *C. guianensis* in Costa Rica is estimated at about 440 years. In trials in West Java the mean annual increment of 8.5–11-year-old *C. guianensis* in a perhumid climate with an annual rainfall of 3500–4000 mm was 0.6–1.5 cm in diameter and 0.8–1.6 m in height, and in a seasonal climate with an annual rainfall of 1900 mm 0.9–1.0 cm in height and 0.8 m in diameter. These values had decreased to 0.8 cm and 0.6 m, respectively when the trial with 4000 mm of rain annually was 27 years old. In South America *C. guianensis* showed a mean annual diameter increment of 1.6–2.0 cm in 25-year-old plantations. The flowering period depends heavily on the climate, but is usually concentrated in one short period per year. Pollination is probably by insects. Usually only one or two fruits in an inflorescence mature in about 8 months to a year. The seeds float and are thus dispersed by water but are also, at least in Costa Rica, scatter-hoarded by agoutis and occasionally by pigs. Trees are often found swarming with ants which visit the extrafloral nectaries at the shoot apices and tips of leaflets.

Ecology *C. guianensis* and *C. procera* are locally common elements of the canopy or sub-canopy layer of the South-American evergreen to semi-evergreen rain forest. They sometimes occur as dominant trees or even in almost pure stands and are found predominantly along rivers and on periodically flooded or swampy locations, but also on higher ground and low hills.

Silviculture *C. guianensis* can be propagated by seed, which can be stored for only two months. Large cuttings can be used when planted in swampy soil, but this technique is not used on a large scale. A mature tree may produce 750–4000 seeds a year, but seed production may be almost zero in unfavourable years. There are about 62 dry seeds/kg. When sown on the surface or shallowly in moist soil, all fresh seeds will germinate. A lower germination rate may be due to seeds drying out, excessive watering or insect damage. Unscarified seeds complete germination in 19–21 days, while scarified seeds take only 6–7 days. Early growth in the nursery is moderately fast and seedlings may attain 0.5 m in the first year. The roots of 1-year-old seedlings are pruned at about 15 cm while still in the nursery bed and when new rootlets begin to develop the plants can be uprooted and planted out. In a trial in West Java with a seasonal climate *C. guianensis* suffered from shoot borer (*Hypsipyla*) attack. In plantations in its natural habitat it is also susceptible to various *Hypsipyla* species, which tunnel into the leading shoots and causing malformations of the stem. *C. guianensis* may be considered for cultivation on swampy soils, since in a trial in Indonesia it proved very resistant to oxygen deficiency and mortality was not observed until 90 days. *Carapa* is moderately tolerant of shade, but full overhead light is required for fast growth. It coppices freely and is resistant to fire. In swamp forest trees reach the felling size in 20–25 years, at higher elevations probably at 40–60 years.

Genetic resources and breeding Because of its importance for local oil-processing industries, *C. guianensis* is protected in Pará State (Brazil).

Prospects *Carapa* seems a promising plantation tree for South-East Asia. More information on growth performance in South-East Asia and genetic variability is required for successful cultivation.

Literature 163, 175, 177, 209, 210, 283, 334, 341, 366, 369, 402, 405, 427, 758, 769, 878, 879, 949, 1065, 1166, 1227.

Selection of species

Carapa guianensis Aubl.

Synonyms *Carapa nicaraguensis* C. DC., *Carapa slateri* Standley, *Granatum guianense* (Aubl.) O. Kuntze.

Distribution From Central America (Belize) and the Caribbean south to Amazonian Brazil; introduced into Peninsular Malaysia, Singapore and Java.

Carapa procera DC.

Synonyms *Carapa guineensis* Sweet ex A. Juss., *Carapa surinamensis* Miq., *Carapa touloucouna* Guill. & Perr.

Distribution Surinam, French Guiana, Brazil (Amazonas) and west and central Africa; introduced into Java.

S.I. Wiselius

Careya Roxb.

Pl. Coromandel 3: 13, t. 218 (1811).

LECYTHIDACEAE

$x = 13$; *C. arborea*: $2n = 26$

Vernacular names Tummy wood (En). Malaysia: putat kedang (Peninsular). Burma (Myanmar): sangawn-gmawt. Laos: ka dôn. Thailand: hu kwang (south-eastern), kra don (general), pha hat (northern).

Origin and geographic distribution *Careya* comprises 4 species occurring from Afghanistan, India, Sri Lanka and Nepal to Burma (Myanmar), Indo-China, the Andaman Islands, Thailand and Peninsular Malaysia. The only Malesian species is *C. arborea* Roxb. which is found almost throughout the range of the genus, but in Peninsular Malaysia it is rare and only occurs in the north-west.

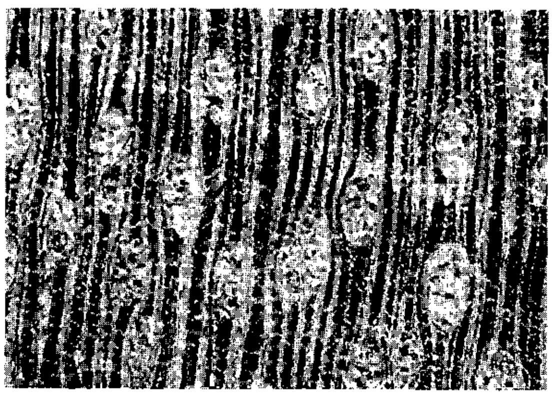
Uses The wood of *C. arborea* is used, mainly in India and Burma (Myanmar), for general construction (house posts, planking), furniture and cabinet work, carts, mouldings, turnery, piling and agricultural implements.

C. arborea makes a good shade tree. The fibrous bark contains a brown dye, has been applied medicinally for body swellings and is used locally for cordage. The fruit is edible but the seeds are reported as slightly poisonous. In India the tussar silkworm is fed on the leaves.

Production and international trade Utilization of the wood of *C. arborea* is very limited and probably at a local scale only.

Properties The following description is based on samples from Burma (Myanmar) and India. *C. arborea* yields a medium-weight to heavy hardwood with a density of 770 kg/m³ to over 1000 kg/m³ at 15% moisture content. Heartwood pale red to dark red-brown in older trees, sapwood wide, pale reddish-white; grain straight; texture medium and even. Growth rings distinct; vessels medium-sized to moderately large, the majority solitary but also in radial multiples of 2–4, occluded with pale brown tyloses and with white deposits; parenchyma apotracheal in fine and mostly regular bands, diffuse and diffuse-in-aggregates, and paratracheal scanty; rays moderately fine, not visible to the naked eye.

Shrinkage of the wood is very high, so it should be seasoned slowly as it easily develops surface



Careya arborea
transverse surface (×20)

checks, end splits, and is very liable to warp and twist. It is moderately hard and somewhat difficult to saw, but presents no difficulties when worked with hand and machine tools. It yields a smooth finish and a good polish. The wood is durable, especially under water.
See also the table on microscopic wood anatomy.

Botany A deciduous, small to medium-sized tree up to 20 m tall; bark surface flaking in thin strips, fissured, dark grey; crown spreading. Leaves arranged spirally, often clustered at the apices of twigs, simple, broadly obovate, tapering at base, margin crenate-denticulate; stipules small, caducous. Flowers in a terminal, erect raceme, bisexual, large, white; calyx 4-lobed, coriaceous; petals 4, free; stamens many, connate at base; disk annular; ovary inferior, 4–5-locular with many ovules in 2 rows per cell, style 1. Fruit a large, many-seeded drupe, globose to depressed globose, crowned by the persistent sepals. Seedling with hypogeal germination; cotyledons absent (seed containing a swollen hypocotyl); shoot with scales at the first few nodes.
In India the annual diameter increment can be up to 0.5 cm, but growth of coppice is faster, 0.6–0.9 cm in diameter for 8-year-old coppice shoots. In eastern India new shoots develop in March–April and the trees flower during this period. Mature fruits can be observed in May.
The family *Lecythidaceae* is sometimes divided into three separate families with *Careya* belonging to the *Barringtoniaceae*. *Careya* is closely related to *Planchonia* and both are placed in the subfamily *Planchonioideae* in which the genus *Barringtonia* is also included.

Ecology *C. arborea* is light-demanding. It is found scattered but is locally common in primary or secondary, evergreen or deciduous, slightly seasonal forest, sometimes in more open country and along forest edges, and is absent from perhumid rain forest. It occurs on well-drained, sandy or even rocky soils.

Silviculture *C. arborea* can be propagated by seed. Seeds germinate for over 90% in 11–46 days. Growth is poor in perhumid regions, where leaf-change and flowering become unsynchronized between different branches. The tree is highly fire-resistant and coppices well.

Genetic resources and breeding Having a very wide distribution and being seldom harvested for timber, *C. arborea* does not seem to be threatened.

Prospects Very little is known botanically about *C. arborea*. Because of the bad seasoning characteristics, increased utilization is very unlikely.

Literature 163, 364, 464, 575, 764, 828, 829, 831, 874, 904, 940, 1038, 1104, 1105, 1169, 1221.

G.T. Prance

Caryota L.

Sp. pl. 2: 1189 (1753); Gen. pl., ed. 5: 497 (1754).
PALMAE
$x = 14, 16, 17$; *C. cumingii*: $2n = 17$, *C. mitis*: $2n = 28, 32, 34$, *C. urens* L.: $2n = 32$

Vernacular names Fishtail palm (En). Indonesia: nibung, sarai. Malaysia: rabok, tukas. Philippines: pugahan (Filipino), anibong (Tagalog). Burma (Myanmar): minbaw. Thailand: tao rang. Vietnam: d[uf]ng d[if]nh, m[os]c.

Origin and geographic distribution *Caryota* comprises about 12 species occurring from Sri Lanka and India to Indo-China, southern China, Burma (Myanmar), Thailand, throughout the Malesian region towards the Solomon Islands and northern Australia.

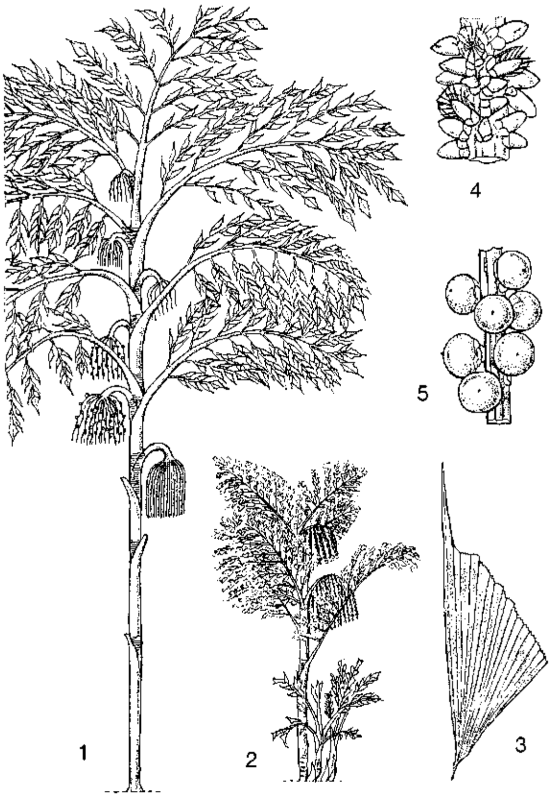
Uses *Caryota* stems yield an inferior timber sometimes used for construction purposes such as planking, rafters, roofing, partitioning and fencing. In Papua New Guinea it is commonly used for flooring and for making spears.
Most species are multipurpose palms. Several are commonly planted for ornamental purposes. The trunk yields starch (sago). In Sarawak the sago of *C. no* is favoured by the native Punan for its high yield and sweet flavour. The inflorescences, especially those of *C. rumphiana*, are tapped to produce sugar or palm wine. The palm cabbage (apical meristem) and palm heart are edible when cooked. The fruits and seeds are edible but the mesocarp contains needle-like crystals that cause irritation. The seeds may be chewed as a substitute for betel nut (*Areca catechu* L.). The leaf sheath fibre ('kittul') of the larger species are used to caulk boats, make rope, brushes and brooms, and the finer fibres for tinder and to make fishing lines or sewing thread. In the Philippines the leaf sheath is sometimes split to weave baskets.

Production and international trade The use of *Caryota* wood and of the other products is fair, but on a local scale only.

Properties Cortex black with white streaks and narrow; central cylinder delimited by a wide peripheral zone of congested vascular bundles; central vascular bundles diffuse, each with a fi-

brous phloem sheath, xylem sheathed by parenchyma, metaxylem with 2 wide vessels, phloem undivided; ground parenchyma cells secondarily expanded in old stems, becoming somewhat lobed and enclosing wide air spaces.
The wood of *C. rumphiana* is the most durable palmwood in the Moluccas. The best quality wood is obtained when harvested just before flowering. This may be partly because less starch is stored at this time in the stem.
The average fibre length of *C. cumingii* is 1.5–2.2 mm.

Botany Unarmed, monoecious, hapaxanthic, solitary or clustered, small to large palms up to 40 m tall; pole straight, unbranched, up to 70 cm in diameter, obscured at first by persistent fibrous leaf bases and sheaths, conspicuously ringed with narrow leaf scars, internodes elongated. Leaves bipinnate (pinnate in juveniles), induplicate with a terminal leaflet; sheath triangular, disintegrating into strong black fibres, densely hairy; petiole channelled above; leaflets numerous, obliquely



Caryota mitis Lour. – 1, habit; 2, habit with tillers; 3, leaflet; 4, part of inflorescence; 5, part of infructescence.

wedge-shaped, upper margin irregularly toothed. Inflorescence axillary, solitary, pendulous, branched to 1 order or rarely unbranched, bisexual; prophyll tubular; peduncular bracts up to 8, large; distal portion of rachis bearing spirally arranged, protandrous triads of 2 male flowers and 1 female flower. Flowers with 3 sepals and 3 petals. Male flower with free petals; stamens 6–many, filaments short, sometimes connate at base. Female flower globose; petals connate up to halfway; ovary superior, 3-locular with a single ovule per cell, stigma 3-lobed. Fruit a globose, smooth drupe, 1–2-seeded, orange or red to dark red or purple; mesocarp fleshy, with irritant, needle-like crystals. Seed with ruminate endosperm. Seedling with epigeal, remote-tubular germination; eophyll bifid with rhombic, divergent, praemorse segments.
Vesicular-arbuscular mycorrhizae have been found in *C. urens*. When mature, the tree produces an inflorescence from the uppermost leaf axil and in a period of several years it flowers from subsequent downward axils. It dies after the last inflorescence has fruited. *C. urens* develops according to Holttum's architectural tree model, characterized by a single apical meristem which differentiates completely into an inflorescence after initial vegetative development. In Java *C. no* was observed to start flowering after 16 years, suggesting a life cycle of about 20 years. The fruits are eaten by monkeys and other mammals, e.g. civet cats and bats, as well as by large birds such as hornbills and cassowaries thus dispersing the seeds.
Caryota is in need of a taxonomic revision, as the identity of many species and forms is unclear. It is closely related to *Arenga* and *Wallichia* with which it forms the tribe *Caryoteae* of the subfamily *Arecoideae*. *Caryota* is easily recognized by its double pinnate leaves, bisexual inflorescence and seeds with ruminate endosperm. *C. urens* is a tall palm from Sri Lanka, India and Burma (Myanmar) that was probably introduced to Vietnam and Thailand, and which has been used for construction and for tapping sugar and palm wine.

Ecology *Caryota* is found in primary and secondary, lowland to montane forest, up to 2000 m altitude. It occurs in monsoon and perhumid climates. In Peninsular Malaysia *C. mitis* is characteristic of secondary forest and of forest on limestone.

Silviculture *Caryota* can be propagated by seed, which remains viable for 4–6 weeks. Seeds of *C. urens* germinate in 18–30 days but those of *C.*

cumingii do not start germinating until 10 months after soaking in water for several days. The daily yield per tree of sap for wine and sugar from *C. urens* is 20–27 l; its trunk yields 100–150 kg of starch. The harvest of *Caryota* for sago and other purposes is mainly from wild and semi-wild populations.

Genetic resources and breeding *C. no* has been identified as a vulnerable species by the International Union for the Conservation of Nature (IUCN).

Prospects It is unlikely that the use of *Caryota* wood will increase in the near future, but it has potential as an ornamental. Furthermore, its products for human consumption (sap, starch, palm cabbage, palm heart) make it an interesting multipurpose agroforestry species, in particular *C. mitis*.

Literature 70, 86, 150, 163, 236, 278, 285, 323, 324, 338, 402, 436, 499, 500, 563, 720, 733, 873, 978, 1051, 1059, 1100, 1110, 1176, 1210.

Selection of species

Caryota cumingii Lodd. ex Mart.

Synonyms *Caryota merrillii* Becc.

Vernacular names Philippines: pugahan (Filipino), anibong (Tagalog), anivung (Ibanag).

Distribution The Philippines.

Caryota maxima Blume ex Mart.

Synonyms *Caryota aequatorialis* (Becc.) Ridley, *Caryota macrantha* Burret, *Caryota rumphiana* Mart. var. *javanica* Becc.

Vernacular names Giant fishtail palm (En). Indonesia: andudu (Balinese), nibung besar (Indonesian, Moluccas), suwangkung (Sundanese). Malaysia: baroh, dudok, rabok gunung (Peninsular).

Distribution Peninsular Malaysia, Sumatra and Java; probably also in peninsular Thailand.

Caryota mitis Lour.

Synonyms *Caryota griffithii* Becc.

Vernacular names Common fishtail palm (En). Indonesia: genduru (Javanese), risi (Palembang), sarai (Sundanese). Malaysia: dudok, merdin, rabuk (Peninsular). Philippines: pugahang-suui (Filipino), barukan, bato (Tagbanua). Burma (Myanmar): minbaw. Cambodia: 'ânnsaè tô:ch. Laos: ta:w h'a:ngz. Thailand: khuangmu (northern), taorang-daeng (southern). Vietnam: d[uf]ng d[if]nh.

Distribution Burma (Myanmar), Thailand, Indo-China, Peninsular Malaysia, Sumatra, Java, the Philippines and northern Sulawesi; probably also in southern Borneo.

Caryota no Becc.

Synonyms *Caryota rumphiana* Mart. var. *borneensis* Becc.

Vernacular names Indonesia: sarai raja (general), unus (Dayak, Kalimantan). Malaysia: entibap, mudol (Sarawak), kayu no (Malay, Sarawak).

Distribution Borneo.

Caryota rumphiana Mart.

Vernacular names Indonesia: nibung besar (Indonesian, Moluccas), palun (Ambon), walat (Buru). Philippines: takipan-tilos (Filipino).

Distribution The Philippines, northern Sulawesi, the Moluccas and New Guinea.

L.G. Saw

Casearia Jacq.

Enum. syst. pl.: 4 (1760).

FLACOURTIACEAE

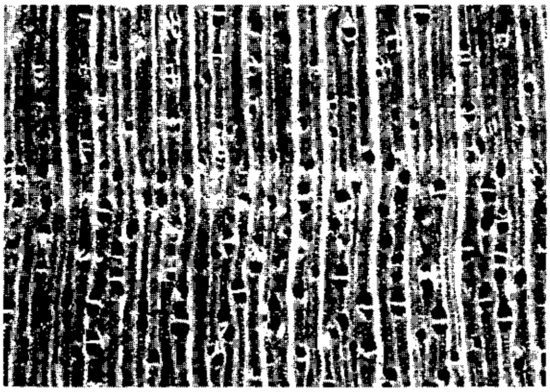
x = probably 11; *C. graveolens* Dalzell: $2n = 42$

Origin and geographic distribution *Casearia* comprises about 180 species and is distributed in all tropical and subtropical regions of the world. Within the Malesian area 60 species occur. The genus is morphologically most diverse in South America.

Uses The wood of *Casearia* is used under cover for house building, light construction, doors, interior finish, mouldings and combs; it has been reported as suitable for bobbins and for the manufacture of a good-quality general-purpose plywood. In Timor the leaves are fed to livestock. In Cambodia the roots of *C. grewiaefolia* have been used medicinally against diarrhoea and the bark as a tonic.

Production and international trade *Casearia* wood is used locally but only on a very small scale.

Properties *Casearia* yields a medium-weight hardwood with a density of 540–800 kg/m^3 at 15% moisture content. Heartwood white to pale yellow or pale brown, not demarcated from the cream-coloured sapwood; grain generally straight, occasionally slightly interlocked; texture fine and even. Macroscopic features of wood of *Flacour-*



Casearia grewiaefolia
transverse surface (×20)

tiaceae are remarkably similar: growth rings indistinct; vessels small, solitary and in radial multiples of 2–4(–7); parenchyma absent or sparse, paratracheal; rays fine, usually not visible to the naked eye; ripple marks absent.
Shrinkage of the wood upon seasoning is low, but precautions are needed to prevent end splitting of logs. The wood is hard, but can be peeled without difficulty. It is non-durable when exposed to the weather or in contact with the ground, but durable under cover. The sapwood is susceptible to *Lyctus*.
See also the tables on microscopic wood anatomy and wood properties.

Botany Small to medium-sized trees up to 20(–35) m tall; bole up to 60 cm in diameter, sometimes with small buttresses; bark surface smooth, becoming scaly, sometimes pustulate, grey or pale greyish-brown to whitish, inner bark pale brown to yellow-brown. Twigs often slightly zigzag. Leaves alternate, distichous, simple, often with translucent dots or lines, margin entire or wavy to toothed; stipules small and early caducous. Flowers bisexual, axillary, in clusters or rarely solitary, small; calyx 5-lobed; petals absent; stamens (5–)8–10(–12), alternating with mostly hairy staminodes; ovary superior, 1-locular; style absent or very short. Fruit a fleshy to hard capsule, splitting into (2–)3 valves. Seed arillate. Seedling with epigeal germination; cotyledons emergent, leafy; hypocotyl elongated; all leaves arranged spirally.
The tree form is according to Roux's architectural tree model, characterized by a continuously growing monopodial orthotropic trunk with plagiotropic branches bearing mostly distichous leaves. Flowers and fruits have been observed in all seasons. Fruits are probably dispersed by animals which are attracted by the coloured aril.
All Malesian species of *Casearia* belong to the section *Casearia* which also comprises all African, Australian and Pacific species and the majority of the American ones. *C. grewiaefolia* is polymorphic and several varieties have been distinguished.

Ecology The timber-producing species of *Casearia* occur in primary or sometimes secondary, evergreen or semi-evergreen rain forest, usually in the lowlands but sometimes also up to 1900 m altitude. They may be encountered as important elements of the understorey and have been reported from e.g. forest on clayey soils, well-drained alluvium, river banks, kerangas and peat-swamps. *C. grewiaefolia* is found in an especially wide range of habitats, including thickets and coastal forests, often on calcareous soils.

Silviculture Germination tests have been carried out on two Malaysian *Casearia* shrub species: after removal of the aril seeds of *C. capitellata* Blume showed 20% germination in 22–53 days and all seeds of *C. velutinosa* Ridley germinated in 45–67 days. *Casearia* is not resistant to fire.

Genetic resources and breeding No records are available of ex situ conservation of *Casearia* species. *C. gigantifolia*, a narrow endemic species, may easily become endangered through destruction of its habitat.

Prospects The very limited importance of *Casearia* spp. as timber is reflected in the absence of silvicultural information and of a quality assessment of the wood. It is not expected that this will change in the near future.

Literature 61, 163, 180, 198, 267, 320, 340, 341, 343, 348, 436, 464, 543, 595, 772, 809, 829, 831, 861, 974, 1028, 1030, 1038, 1169, 1221, 1232.

Selection of species

Casearia flavovirens Blume

Synonyms *Casearia odorata* Teijsm. & Binnend.

Vernacular names Indonesia: penjaliran tenjang (Javanese), putih meyong (Bali), rasakadu (Sundanese).

Distribution Java and the Lesser Sunda Islands (Bali).

Casearia gigantifolia v. Slooten

Vernacular names Indonesia: kadundun dotan, kadundun payo, kadundun silai (Simeuluë, Sumatra).

Distribution North Sumatra (Simeuluë Island).

Casearia grewiaefolia Vent.

Synonyms *Casearia hexagona* Decne, *Casearia laurina* Blume, *Casearia leucolepis* Turcz.

Vernacular names Indonesia: durenan glam (Javanese), madang klapah (Sumatra), surian (Kalimantan). Malaysia: tapion kirabas (Sabah). Philippines: boyboyok (Iloko), butong-manok (Bikol), kaluag (Tagalog). Cambodia: chrouôy (Cambodge), chrouy (Kompong Chnang). Laos: kho lên, kho lên phou. Thailand: kolaen (eastern), kruai pa (central), kuai (northern). Vietnam: c[aa]y van n[us]i (Quang Nam), c[aa]y k[ee]n (Khanh Hoa).

Distribution Indo-China, Thailand, throughout the Malesian area towards the Solomon Islands and Queensland (Australia).

Casearia tuberculata Blume

Synonyms *Casearia coriacea* auct. non Vent., *Casearia hydnocarpoides* Quisumb.

Vernacular names Indonesia: cangcanatan, ki bonteng (Javanese), kayu banitan batu (Sumatra).

Distribution Sumatra, Java and the Philippines (Palawan); formerly also in Singapore.

Casearia velutina Blume

Synonyms *Casearia elliptica* auct. non Willd., *Casearia propinqua* Blume, *Casearia tomentosa* auct. non Roxb.

Vernacular names Indonesia: cikalbalung, kabanbara (Javanese).

Distribution Sumatra and Java.

E. Boer (general part),
M.S.M. Sosef (general part, selection of species)

Cassia L.

Sp. pl. 1: 376 (1753); Gen. pl., ed. 5: 178 (1754).
LEGUMINOSAE
$x = 12, 14$; *C. javanica*: $n = 12, 2n = 28$

Vernacular names Johar (trade name). Indonesia: bobondelan (Sundanese), boking-boking (Sumatra), trengguli (Javanese). Malaysia: bebusok, busok-busok (Peninsular). Philippines: pink shower (En), antsoan (Bikol). Cambodia: bô prùk'. Laos: khoun loy². Thailand: chaiyaphruk, kalapaphruk (central), kalaphruk (northern). Vietnam: b[uf] c[aj]p.

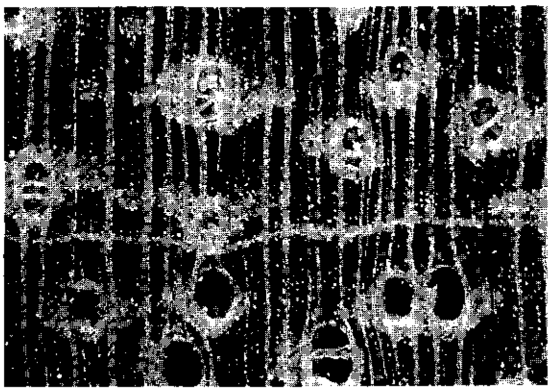
Origin and geographic distribution *Cassia* in the narrow sense comprises about 30 species with a pantropical distribution. Only a few species occur naturally in tropical Asia, and only 3 in Malesia. *Cassia javanica* L. is the only species with some importance as a timber tree. It occurs in India, Burma (Myanmar), Indo-China, southern China, Thailand and throughout Malesia. It has been planted for so long that the natural area of distribution is difficult to reconstruct. It is also planted as an ornamental in Central and South America. *C. grandis* L. f. and *C. fistula* L. have been introduced into the Malesian area for ornamental purposes.

Uses The wood of a few *Cassia* species, particularly *C. javanica*, is used for general construction, furniture and cabinet making.

Cassia is a well-known ornamental or roadside tree; several species are planted for this purpose. Some of the introduced ornamental species grow to medium-sized trees and may provide larger sizes of timber when cut. Some species are valued medicinal plants (e.g. *C. fistula*). *C. javanica* is also extensively used as an ornamental and roadside tree, particularly forms of subsp. *agnes* (de Wit) K. Larsen with larger flowers. The bark has been used for tanning leather, but the amount of tannin is comparatively low. The pods and seeds are used in local medicine; they are purgative.

Production and international trade *Cassia* timber is not traded in large amounts on the international market, but the heartwood in particular is exported in small volumes and is locally in demand as it is decorative and durable.

Properties *C. javanica* yields a lightweight to heavy hardwood with a density of 400–875 kg/m³ at 15% moisture content. Heartwood pale yellow



Cassia fistula
transverse surface (×20)

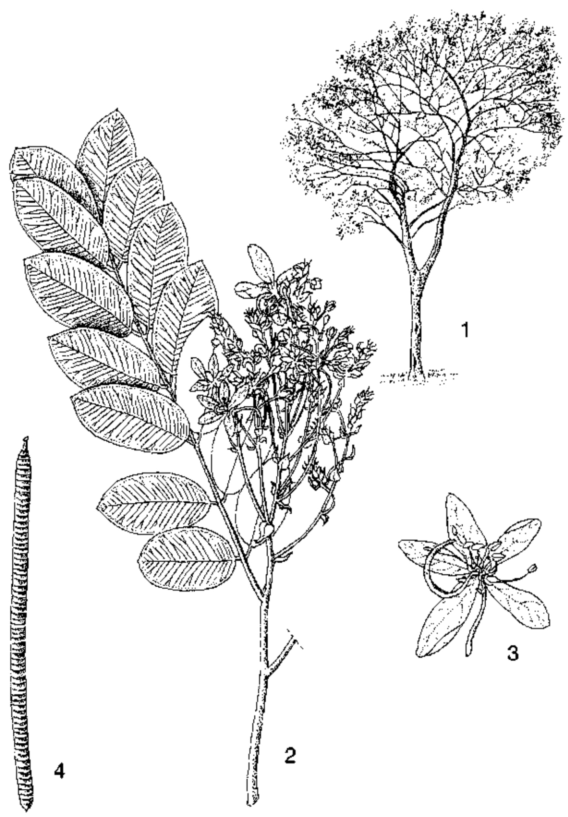
when fresh, turning red or pale orange-brown with age, demarcated sharply or not sharply from the 2–5 cm wide white sapwood; grain interlocked; texture moderately fine; taste bitter. Growth rings not always distinct, the boundaries indicated by a fine line of parenchyma forming a more or less distinct, but interrupted ring; vessels medium-sized to moderately large, solitary and in radial pairs, reddish gummy deposits in many vessels; parenchyma abundant, apotracheal diffuse, and paratracheal vasicentric, aliform to confluent, the latter connecting 2–4 vessels; rays very fine, not visible to the naked eye; ripple marks occasionally locally just discernable.

Shrinkage of the wood is low; it seasons well with little or no degrade. The wood is hard and strong. It works well and finishes well. The sapwood is very perishable, the heartwood moderately durable when exposed to the weather or in contact with the ground, and very durable for interior work. The sapwood is susceptible to *Lyctus*.

See also the tables on microscopic wood anatomy and wood properties.

Botany A semi-deciduous, small to medium-sized, sometimes fairly large tree up to 25(–40) m tall; bole often curved, up to 60 cm in diameter, small buttresses sometimes present, trunk of young trees and branches either smooth or spiny; bark surface smooth, sometimes shallowly longitudinally fissured, greyish to pale brown or red-brown, sometimes blackish mottled, inner bark yellow to orange. Leaves alternate, distichous, paripinnate with up to 17(–20) pairs of leaflets; stipules 2-lobed, caducous. Flowers in an axillary or terminal, many-flowered, subsessile, distinctly bracteate raceme, 5-merous; calyx deeply divided, lobes firm, imbricate, reflexed; petals widely spreading, whitish to reddish or buff; stamens 10, irregularly accrescent toward the abaxial side of the flower, longest ones S-shaped; ovary superior, linear and curved, stigma terminal or subterminal. Fruit a woody, pendulous, short stiped, linear pod with septa between the numerous seeds, indehiscent, dark brown to black. Seed brown, smooth and glossy, lying transverse in the pod. Seedling with epigeal germination; cotyledons emergent, semi-fleshy; first few leaves arranged spirally.

C. javanica trees show Troll's architectural model, with sympodial growth and all axes plagiotropic, the architecture being built by their continual superposition. In East Java *C. javanica* flowers in October–December and fruits in the dry season. It has been observed flowering and fruiting in a mast fruiting year in Peninsular Malaysia.



Cassia javanica L. – *1, tree habit; 2, flowering twig; 3, flower; 4, pod.*

Until the beginning of the 1980s, *Cassia* was considered to be a very large genus of over 500 species, but then the genus was split into 3 genera: *Cassia* sensu stricto, *Senna* and *Chamaecrista*. *Cassia* s.s. includes far fewer species than the latter two genera that have approximately 270 and 250 species, respectively. *C. javanica* is very polymorphic and several subspecies are distinguished. *C. agnes* (de Wit) Brenan, *C. bartonii* F.M. Bailey, *C. nodosa* Buch.-Ham. ex Roxb. and *C. renigera* Wallich ex Benth. are all reduced to one of these subspecies.

Ecology *C. javanica* is usually found in more open sites in the forest, up to 400 m altitude, but can also occur in closed evergreen primary forest. It is often naturalized in secondary forest close to locations where it has been planted. In Java it has been reported from fertile volcanic loams, and from marshy, sandy and limestone soils.

Silviculture *C. javanica* can be propagated by seed or by vegetative means. There are 5700–8400 dry seeds/kg. Pods can easily be collected from the ground and have to be opened with a chopping knife. Seed storage is variable: fresh seed can be stored for only 3 weeks in airtight containers, but storing dry seeds for over one year is also reported. Seeds start to germinate after 7 days and 80% of the seedlings appear within in 14–30 days. The germination rate is about 70%; 50% of the seed sown yields good plants. Other records, however, show a germination rate of 20–65% in 5 days to well over one year. For India, where late and prolonged germination is a problem, it is reported that mechanical scarification may be used to overcome seed dormancy. The planting of large cuttings of *C. javanica* in the Philippines was unsuccessful as only 10% of the cuttings survived. Air layering failed altogether. *C. javanica* is not resistant to fire.

Genetic resources and breeding *C. javanica* is rather common in several areas and, moreover, is extensively planted. It is not endangered or liable to genetic erosion.

Prospects *C. javanica* seems worth trying as a timber plantation tree. It is considered to grow comparatively fast and may provide timber of fair quality. In addition it is an attractive tree, offering the potential of combining its uses as an ornamental and timber tree.

Literature 70, 161, 163, 183, 198, 209, 235, 255, 261, 267, 343, 402, 405, 436, 471, 473, 780, 829, 831, 861, 934, 955, 1023, 1163, 1198, 1221, 1226, 1242.

B. Ibnu Utomo W.

Casuarina L.

Amoen. acad. 4: 143 (1759).

CASUARINACEAE

$x = 9$; *C. cunninghamiana* Miq., *C. glauca* Sieber ex Sprengel, *C. junghuhniana*: $2n = 18$, *C. equisetifolia*: $2n = 18$, (20)

Vernacular names Agoho (trade name). Casuarina (En). Indonesia: cemara (general). Malaysia: aru, ru (general). Papua New Guinea: sheoak (En), yar (Pidgin). Philippines: agoho. Thailand: son. Vietnam: duong-lieu, phi lao.

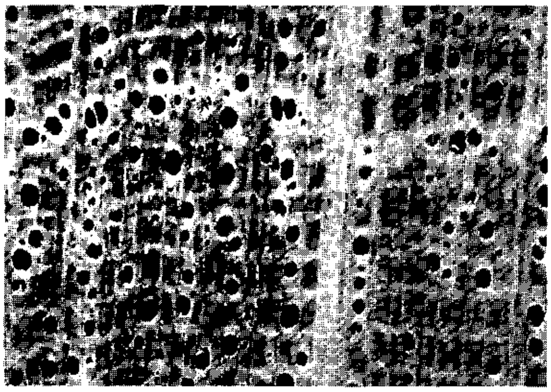
Origin and geographic distribution *Casuarina* comprises 17 species occurring from India to Indo-China, Thailand and throughout the Malesian region towards Melanesia, Polynesia and Australia. Only a few species are native to Malesia, several others have been introduced. Some species have been introduced throughout the tropics, notably Africa and the West Indies, mainly as ornamentals and for the production of firewood.

Uses *Casuarina* wood is used for house building under cover (beams, joists, rafters), fence posts, masts, tools handles, shuttles, oars, cartwheels and, when treated, also for shingles, power line transmission poles, mine props and for salt-water and freshwater piling including fish traps (but only when permanently submerged). It yields a very good firewood and produces a high quality charcoal. It is also suitable for the production of chemical and semi-chemical pulps and as raw material for rayon fibres. In Egypt the wood of *C. equisetifolia* is used extensively to produce chipboard.

Several species are commonly planted as ornamentals. They are also planted for soil improvement and to provide mulch and are suitable as a drought fodder. *C. equisetifolia* is a popular agroforestry tree in coastal and saline areas where it may also serve as a shelter-belt. It is often used in erosion control, especially to stabilize coastal sands. Its bark contains tannin and is still used locally to tan fishing nets and to dye fabrics a dull pale red. The bark is also applied medicinally to treat diarrhoea, dysentery and stomach-ache, and in Peninsular Malaysia a decoction of the twigs is used as a lotion to treat swellings. In Papua New Guinea *C. oligodon* is planted in the highlands for soil improvement, fuelwood and as a shade tree in coffee plantations; its needle-like leaves are used to retain heat when stones are used to prepare food in underground ovens.

Production and international trade The wood of *Casuarina* occasionally reaches the market, but is mainly traded locally. In 1996 Papua New Guinea exported about 530 m^3 of *Casuarina* logs at an average free-on-board (FOB) price of US$ 100/m^3.

Properties *Casuarina* yields a medium-weight but usually heavy hardwood with a density of 790–1300 kg/m^3. Heartwood pale red or pale brown to dark red-brown, moderately sharply to sharply differentiated from the sapwood which is 5–10 cm wide and yellowish or pale yellow-brown with a pink tinge; grain straight, slightly interlocked or wavy; texture fine to moderately fine and even in *C. equisetifolia*, uneven in species with wide rays; heartwood with occasional black streaks. Growth rings indistinct except for some marginal parenchyma bands; vessels medium-sized to moderately large, mostly solitary, but with a tendency to radial or oblique arrangement, often containing brown to red-brown gum-like substances, occasionally with chalky white de-



Casuarina cunninghamiana
transverse surface (×20)

posits; parenchyma abundant, paratracheal vasicentric and apotracheal in regular, wavy, narrow bands, rarely diffuse; rays extremely fine or very fine in *C. equisetifolia*, but usually also with broad rays and of 2 distinct widths in most other species, sometimes exceptionally broad compound rays appear to split to very fine rays; ripple marks absent.

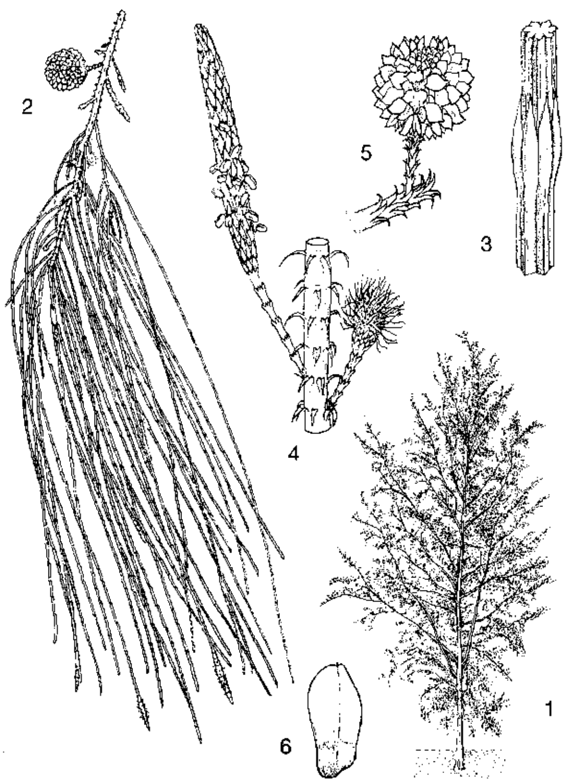
Shrinkage is moderate to very high and in the latter case the wood is difficult to season due to severe warping and checking. Stain may be moderate during drying; boards 13 mm and 38 mm thick take respectively about 2.5 and 4 months to air dry from the green condition. The wood is hard to very hard and strong. When dry it is difficult to work with hand and machine tools because of its high density and hardness, but it finishes smoothly. The wood is moderately durable when exposed to the weather or in contact with the ground; the average service life of test stakes of *C. equisetifolia* in a graveyard test in the Philippines was about 3.5 years whereas test stakes of *C. junghuhniana* lasted on average 4.5 years. The heartwood is highly resistant to pressure treatment, but sapwood is amenable to such treatment. The heartwood is resistant to dry-wood termites. The sapwood is non-susceptible to *Lyctus*.

The mean fibre length of *C. equisetifolia* from Indonesia is 1.414 mm. The gross energy value of the wood of *C. equisetifolia* is 20 000–24000 kJ/kg.

See also the tables on microscopic wood anatomy and wood properties.

Botany Evergreen, dioecious or monoecious trees up to 35(–60) m tall; bole straight, cylindrical, usually branchless for up to 10 m, up to 100(–150) cm in diameter, occasionally with buttresses; bark surface ridged or fissured and flaking into oblong pieces, brown, inner bark deep dirty brown. Branchlets slender and wiry, articulated, dimorphic, either deciduous or persistent. Leaves reduced to scales, in whorls of 5–20 that define the articulations. Flowers unisexual; perianth absent, replaced by 2 bracteoles. Male flowers in a terminal, bracteate spike, with a single stamen. Female flowers in a condensed spike on a short lateral branchlet, with thin cone bracts; ovary composed of 2 fused carpels, with 2 ovules and a 2-branched style. Infructescence a woody cone-like structure. Fruit a grey or yellow-brown winged nut (samara). Seed solitary. Seedling with epigeal germination; cotyledons emergent, fleshy; hypocotyl elongated; first whorl with 2 opposite scale leaves, subsequent whorls with increasing numbers of scales.

Early growth can be very rapid, occasionally exceeding 3 m/year. In 11–13.5-year-old trials with *C. equisetifolia* in Indonesia the mean annual increment was 1.8–2.1 m in height and 1.6–2.0 cm in



Casuarina equisetifolia L. – 1, habit of young tree; 2, flowering twig; 3, branchlet; 4, male and female inflorescence; 5, infructescence; 6, fruit.

diameter. Most species fix atmospheric nitrogen by forming root nodules with the symbiont *Frankia*. Moreover, *C. equisetifolia* possesses proteoid roots and forms associations with vesicular-arbuscular mycorrhizae. *Casuarina* is known to be highly variable in tree shape. *C. equisetifolia* develops according to Attims' architectural tree model, characterized by axes with continuous growth, differentiated into a monopodial trunk and equivalent branches. The crown shape is initially conical and tends to flatten with age. Twigs are either entirely green and deciduous or green only at their tips, becoming woody. Trees of individual species may be entirely unisexual or bisexual. Pollination is by wind. Cones of *C. equisetifolia* mature in about 18–20 weeks. The fruits are wind-dispersed.
Recently, three genera were split off from *Casuarina*: *Allocasuarina* with about 40 species, *Gymnostoma* with about 20 species and *Ceuthostoma* with 2 species.

Ecology *Casuarina* is often found growing gregariously or even in pure stands, commonly along rivers or on rocky locations. *C. equisetifolia* is a typical pioneer of sandy coasts, but has been reported at up to 800 m altitude in the Philippines. *C. grandis* is not recorded from above 600 m altitude. *C. oligodon* chiefly occurs between 1500 and 2500 m altitude, but has been recorded from as low as 250 m. In Java *C. junghuhniana* grows naturally at 1200–3100 m altitude mainly in montane fire-climax forest, but in the Lesser Sunda Islands it comes down to sea-level. All species prefer a seasonal climate, and *C. equisetifolia* even tolerates arid conditions with an annual rainfall of 200–300 mm.

Silviculture *Casuarina* is usually propagated by seed, the samaras being the unit of sowing, although cuttings are increasingly used; air layering is sometimes practised but is too costly for large-scale operations. There are 300000–770000 dry seeds of *C. equisetifolia* and 1.0–1.8 million of *C. junghuhniana* per kg. Seeds remain viable for 6 months to 2 years when stored cool and dry. They can be sown without pretreatment but after sowing they should be protected from ants. The germination rate is 30–80% for *C. equisetifolia* and 20–60% for *C. junghuhniana*; germination starts after 4–10 days. Appropriate watering and avoiding too dense sowings and too much shade should check damping-off in the nursery. Seedlings can be pricked out when 3–10 cm tall and transferred to beds or containers. They are ready for planting out in the field when about 30–50 cm tall. Shoot cuttings can be prepared from shoots 1–2 mm thick and 10–15 cm long, and several rooting hormones can be used to enhance rooting. It is recommended to inoculate seedlings or rooted cuttings with effective *Frankia* strains when introducing *Casuarina* to a new area. To do so it is usually sufficient to mix soil collected in established plantations with soil in the nursery. *Casuarina* should be planted on well-drained light soils, as planting on clayey soils will result in poor growth and increased susceptibility to diseases and pests. Although often planted at 4 m × 4 m, the recommended spacing for Malaysia and Indonesia is closer, being 2–3 m × 1–2 m to allow for earlier returns from thinnings. Young trees are susceptible to competition from weeds, especially grasses, and to fire. Only *C. oligodon* in the highlands of Papua New Guinea does not suffer from competition from grasses and is commonly planted to reforest old vegetable gardens as part of an agricultural cycle. *Casuarina* trees are susceptible to drought until their roots reach the groundwater table, which may take up to 2–3 years after planting. *C. equisetifolia* is not resistant to fire whereas *C. junghuhniana* sprouts readily even after a severe fire. Timely thinning is essential, as *Casuarina* trees are light-demanding. *Casuarina* does not self-prune readily and may have to be pruned to keep plantations accessible. The most serious disease of *C. equisetifolia* is the fungus *Trichosporum vesiculorum* ('black blister disease'). The symptoms of infection are stem wilt, foliar wilt, cracking of the bark and the formation of blisters enclosing a black powdery mass of spores, the black-brown colour of the wood and an alcoholic odour. The wood borers *Zeuzera* spp. and *Hypsipyla robusta* are known to cause severe damage to the wood. The rotation for *C. equisetifolia* for firewood is 6–15 years, that for *C. junghuhniana* for the production of poles and firewood is as short as 5 years. For *C. equisetifolia* a mean annual increment of 6–18 m^3/ha has been observed on fertile soils in Malaysia and 7–13 m^3/ha in trials in Java. For *C. junghuhniana* 10–15 m^3/ha per year is obtainable.

Genetic resources and breeding The Australian Tree Seed Centre of the Division of Forestry of the Commonwealth Scientific and Industrial Research Organisation (CSIRO) has seed collections of both *C. equisetifolia* and *C. junghuhniana*. In cultivation *C. equisetifolia* hybridizes readily with *C. glauca* and *C. junghuhniana*. A male hybrid of *C. equisetifolia* and *C. junghuhniana* was introduced into Thailand around 1900 and from there to India. It has a good stem form and a symmetrical conical crown.

Prospects Apart from the well-known *C. equisetifolia* and *C. junghuhniana*, *C. grandis* seems to have economic potential as a fast-growing timber, and hybrids with other *Casuarina* species may be of particular interest.

Literature 57, 130, 132, 151, 162, 163, 193, 198, 259, 260, 261, 267, 281, 300, 304, 311, 333, 340, 348, 354, 359, 387, 402, 405, 406, 436, 464, 488, 501, 526, 536, 633, 678, 696, 697, 745, 780, 792, 817, 819, 829, 831, 861, 897, 898, 933, 934, 955, 1038, 1040, 1048, 1068, 1106, 1177, 1198, 1199, 1221, 1242.

Selection of species

Casuarina equisetifolia L.

Synonyms *Casuarina litorea* L., *Casuarina muricata* Roxb.

Vernacular names Coast she-oak, common ru, whistling pine (En). Filao (Fr). Indonesia: cemara laut (general), ai samara (Ambon), aru (Batak, Sumatra). Malaysia: aru, ru (Peninsular), ru laut (Sarawak). Philippines: agoho (Filipino), agoso (general), aro (Iloko). Burma (Myanmar): pink-tin-yu. Laos: pêk nam^2, 'sôn tha lé. Thailand: son thale (general), ku (peninsular). Vietnam: c[aa]y phi lao.

Distribution From peninsular Thailand and throughout the Malesian region towards northern and eastern Australia, Melanesia and Polynesia; introduced into many other tropical regions.

Casuarina grandis L.A.S. Johnson

Distribution Papua New Guinea.

Casuarina junghuhniana Miq.

Synonyms *Casuarina montana* Jungh. ex Miq.

Vernacular names Mountain ru, red-tipped ru (En). Indonesia: cemara gunung (general), ajaob, kasuari (Timor). Thailand: son pratiphat (general).

Distribution Indigenous to East Java and the Lesser Sunda Islands; introduced into Kenya and Tanzania and the male hybrid also into Thailand and India.

Casuarina oligodon L.A.S. Johnson

Vernacular names Papua New Guinea: soft yar, yar (En).

Distribution New Guinea; also cultivated.

Suhardi

Cathormion Hassk.

Retzia 1: 231 (1855).

LEGUMINOSAE

x = unknown; $2n$ = 26 reported for an African species

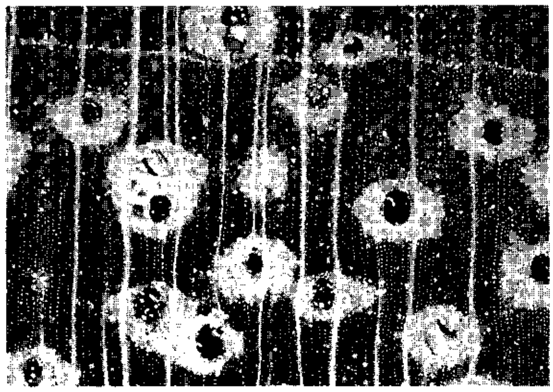
Vernacular names Indonesia: lambaran (Sundanese), lom (Javanese), kiutasi (Timor). Cambodia: sâmbu:ë sâ:r. Thailand: ma kham khaek (general), rakam pa (northern). Vietnam: me d[aas]t, ti[ee]m.

Origin and geographic distribution *Cathormion* is a pantropical genus comprising about 12 species. The only species occurring in South-East Asia is *Cathormion umbellatum* (Vahl) Kosterm. (synonyms: *Pithecellobium malayanum* Pierre, *Pithecellobium moniliferum* (DC.) Benth., *Pithecellobium umbellatum* (Vahl) Benth.), which is distributed from Sri Lanka and southern India to Indo-China (Cambodia, Laos and southern Vietnam), Thailand, Sumatra, Java, the Lesser Sunda Islands, Sulawesi, the Moluccas, New Guinea and northern Australia.

Uses The wood of *C. umbellatum* is used in house building.

Production and international trade The wood of *C. umbellatum* is used rarely and on a local scale only.

Properties *C. umbellatum* yields a medium-weight hardwood with a density of 720–840 kg/m^3 at 15% moisture content. Wood similar in appearance to *Samanea saman* (Jacq.) Merr. Heartwood pale to dark brown with dark streaks and pale brown ribbon figure, sharply demarcated from the white to yellowish-white sapwood; grain straight to wavy; texture moderately coarse to coarse and even. Growth rings indistinct to barely visible due



Cathormion umbellatum
transverse surface (×20)

to zonate bands of parenchyma; vessels medium-sized to large, solitary and in radial multiples of 2–3, mostly open, sometimes with pale brown or reddish gummy deposits and occasional creamy to yellowish chalky deposits; parenchyma moderately abundant, paratracheal vasicentric, aliform to sometimes confluent, and apotracheal diffuse sometimes present, difficult to see, and in narrow irregularly spaced bands; rays fine, not visible to the naked eye; ripple marks absent.
The wood is fairly strong and hard. It is considered slightly durable in contact with the ground or exposed to the weather, but durable when used under cover.
See also the tables on microscopic wood anatomy and wood properties.

Botany Shrubs or small, sometimes medium-sized trees up to 15(–22) m tall; bole often short, crooked, up to 60(–70) cm in diameter; bark surface rough, deeply fissured and peeling in irregular flakes, dark greyish-brown to dark brown, inner bark orange-brown to reddish; crown irregular and dense, often flat-topped, with numerous spiny branches. Leaves arranged spirally, bipinnate, rachis and pinnae glandular, pinnae 1–2(–4) pairs, leaflets (3–)5–8(–13) pairs, asymmetrical; stipules spinescent. Flowers in stalked corymbs in leaf axils or on short lateral branches, 5-merous, central flower larger than marginal ones; calyx subtubular; corolla funnel-shaped with valvate lobes; stamens numerous, united into a tube at base; ovary superior, sessile. Fruit a woody, indehiscent pod, breaking up into 1-seeded segments. Seed broadly ellipsoid, flat, brown to black, endosperm absent, cotyledons large.
Flowering occurs when the leaves are unfolding. The 1-seeded pod segments are dispersed by water.
Cathormion is closely related to (and possibly congeneric with) *Albizia*, but differs in its segmented pod (rare in *Albizia*). It has been suggested that the genus be considered as monotypic (with *C. umbellatum* as the only species) and that the African and American species currently included in *Cathormion* be transferred to *Albizia*. *C. umbellatum* is divided into two subspecies: subsp. *umbellatum* with small and oblong leaflets from Sri Lanka, India, Indo-China and Thailand, and subsp. *moniliforme* (DC.) Brummitt with larger and rhombic leaflets from Sumatra and Java to New Guinea and northern Australia.

Ecology *C. umbellatum* usually occurs in coastal regions, in particular in the drier parts of mangrove forest and along the seashore. However, it can also be found in humid locations along canal banks and in those submerged during the rainy season, up to 50(–150) m altitude.

Genetic resources and breeding *C. umbellatum* is widely distributed, not often felled for its timber, and it therefore does not seem to be liable to genetic erosion.

Prospects *C. umbellatum* is not to be recommended for planting as a timber, since its size is too small and the shape of the bole too poor. It is unlikely that the utilization of the timber will become more important in the near future.

Literature 70, 125, 153, 341, 343, 348, 436, 601, 861, 1039, 1163.

E. Boer (general part),
R.H.M.J. Lemmens (general part),
J. Ilic (wood anatomy)

Celtis L.

Sp. pl. 2: 1043 (1753); Gen. pl., ed. 5: 467 (1754).
ULMACEAE
$x = 10$; *C. australis* L.: $2n = 20, 40$, *C. laevigata* Willd., *C. philippensis* var. *wightii* (Planch.) Soepadmo, *C. sinensis* Pers.: $2n = 20$, *C. tetrandra*: $n = 10$

Vernacular names Celtis, nettle tree (En). Vietnam: s[ees]u.

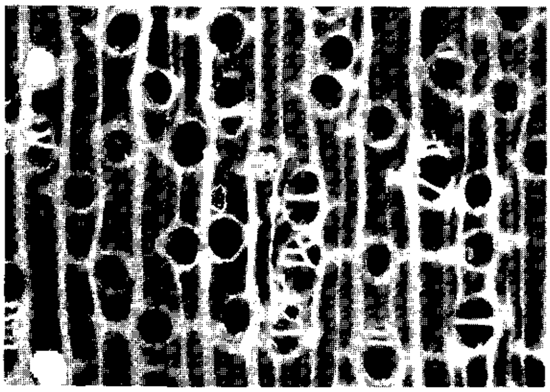
Origin and geographic distribution *Celtis* comprises about 60 species and is widely distributed in tropical and subtropical and even some temperate regions of the world. It is found throughout the Malesian region where 9 species are present.

Uses The heavier type of *Celtis* wood is used for general construction, wharf and bridge building, decking, industrial flooring, exterior joinery, window-sills, steps, treads, marine piles, wharf fenders, crossarms and railway sleepers. In Japan it has been used as a substitute for 'ramin' (*Gonystylus* spp.). The lighter and more elastic *Celtis* wood is used for light or temporary construction, mouldings, interior finish, furniture and cabinet work, tool handles, tennis rackets, horizontal bars, bentwork, posts, poles, boxes, vats, and plywood and veneer. The wood is suitable for the production of pulp for paper and is considered an excellent fuel.
Some species are planted as ornamental, and also as fodder for cattle. The pericarp of the fruit of several species is edible. Pounded roots of *C. latifolia* have been used medicinally against cholera,

colic and pleurisy. *C. philippensis* and *C. timorensis* occasionally form a type of wood (often after injury) used medicinally in Java and called 'kayu tahi'.

Production and international trade In 1987 and 1991, respectively, 1810 and 390 *Celtis* logs were exported from Papua New Guinea to Japan. Two trade groups are often distinguished: 'hard celtis' which includes *C. latifolia*, *C. paniculata* and *C. philippensis* and 'light celtis' which includes *C. rigescens*. In Papua New Guinea both groups have been assigned to MEP (Minimum Export Price) group 4 fetching a minimum export price of US\$ 43/m^3 for saw logs in 1992. In 1996 *Celtis* wood was assigned to MEP group 3 and the export of hard celtis logs from Papua New Guinea amounted to about 25 800 m^3 at an average free-on-board (FOB) price of US\$ 108/m^3 and that of light celtis amounted to about 33 600 m^3 at an average FOB price of US\$ 110/m^3.

Properties *Celtis* yields a lightweight to heavy hardwood with a density of 400–960 kg/m^3 at 15% moisture content. Heartwood usually pale brown to pale yellow-brown, occasionally with dark streaks, moderately distinct to indistinct from the wide, white or pale sapwood; grain usually interlocked, sometimes straight; texture fine to moderately fine, sometimes moderately coarse; wood of *C. philippensis* and *C. timorensis* has a strong foetid odour when fresh. Growth rings indistinct or distinct, when distinct marked by denser tissue or marginal bands; vessels moderately small to medium-sized, occasionally very small, solitary and in radial multiples of 2–5(–6), occasionally with chalky white deposits; parenchyma moderately abundant, paratracheal vasicentric, aliform and confluent, the latter irregular, and sometimes apotracheal in marginal or seemingly marginal bands at growth ring boundaries; rays medium-sized; ripple marks absent; occasionally pith flecks present.

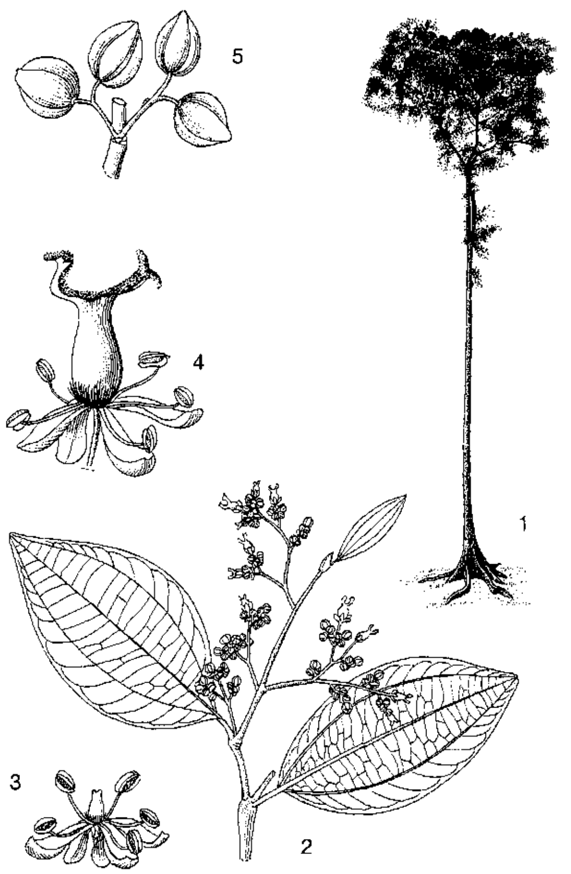


Celtis philippensis
transverse surface (×20)

Shrinkage is low to moderate and the wood can be seasoned without undue difficulty, with light celtis having a tendency to end-splitting. Tension wood may occur and causes twisting and warping. The wood is moderately soft (light celtis) or hard (hard celtis), moderately strong to strong and fairly tough to tough, although light celtis wood from near the centre of the tree is considerably more brittle. It is moderately easy to work if free of tension wood, though sometimes difficult due to crystalline deposits which blunt tools readily. Planing is difficult and usually gives a rough surface due to the interlocked grain. The wood is very suitable for bent work. It is non-durable and the average service life of *Celtis* test stakes in a graveyard test in the Philippines was 2 years and 4 months. The wood is readily attacked by fungi and insects when exposed to the weather or in contact with the ground; the heartwood of *C. luzonica* and *C. philippensis*, however, is resistant to drywood termites. Staining fungi can cause rapid degrade, even in the log; the sapwood is susceptible to *Lyctus*, but in some instances that of *C. luzonica* and *C. philippensis* is reported to be moderately resistant to *Lyctus*. Both sapwood and heartwood are permeable to pressure treatment; a retention of 515 kg/m^3 for sapwood and 320 kg/m^3 for heartwood of *C. latifolia* has been determined.

See also the tables on microscopic wood anatomy and wood properties.

Botany Evergreen to deciduous, monoecious or polygamo-monoecious, small to large trees up to 45 m tall; bole straight, cylindrical, branchless for up to 24(–35) m, up to 100(–200) cm in diameter, buttresses absent or up to 3(–6) m high; bark surface smooth to finely fissured, rarely peeling into thin flakes, often fairly lenticellate, grey to grey-white, grey-green or grey-brown, inner bark hard, cream to straw-coloured or pale yellow with distinctive 'salt and pepper' pattern, rapidly darkening upon exposure. Twigs yellow-brown or with rufous hairs, glabrescent. Leaves arranged spirally, simple, entire or serrate, generally 3-veined at base; stipules thick, often attached peltately. Flowers in an axillary or subterminal, branched raceme or panicle, male, funtionally female and bisexual in the same or different inflorescences, when in the same inflorescence the male flowers basal, white to yellow-green; perianth lobes 4–5, connate at base. Male flower pedicelled or sessile;



Celtis rigescens (Miq.) Planch. – 1, tree habit. Celtis philippensis Blanco – 2, flowering twig; 3, male flower; 4, bisexual flower; 5, fruits.

stamens 4–5; pistillode absent or present. Functionally female and bisexual flower pedicelled; ovary superior, sessile, 2-carpellate but 1-locular with a single ovule, stigmatic arms 2. Fruit a fleshy globose drupe, orange, reddish-green to bluish-black. Seed with endosperm scanty or absent; cotyledons variously folded. Seedling with epigeal germination; cotyledons emergent, 2-lobed; hypocotyl elongated; first 2 leaves opposite, subsequent ones arranged spirally.

Species occurring in areas with a strongly seasonal climate show flush-wise growth and are completely or partly deciduous. In East Java *C. tetrandra* fruits almost throughout the year. In Peninsular Malaysia *C. philippensis* flowers in November and December and fruits in March–May, in Papua New Guinea it flowers in June. Pollination is by insects or by wind; fruits may be dispersed by birds, rodents or water.

Ecology The Malesian *Celtis* species are found from sea-level up to 2000 m altitude and may be classified into 2 distinct ecological groups. The first group, which includes *C. hildebrandii*, *C. latifolia*, *C. luzonica*, *C. paniculata*, *C. philippensis* var. *philippensis* and *C. rigescens*, grows in lowland, primary or secondary forest and may form an important constituent of the understorey in humid areas. The second group includes *C. philippensis* var. *wightii*, *C. rubrovenia*, *C. tetrandra* and *C. timorensis* and is confined to areas with a pronounced dry season or, if found in more humid areas, the trees grow on well-drained substrate like limestone or rocky shores.

Silviculture *Celtis* can be propagated by seed. *C. philippensis* has about 13 500 dry seeds/kg and *C. tetrandra* about 12 500 dry fruits/kg. Seed is difficult to collect as it does not ripen simultaneously within one infructescence. Cleaning the ground under fruiting trees may enhance the establishment of seedlings that can be used for planting. *Celtis* needs fertile soils for optimal development and is very shade-tolerant. In a trial in Indonesia *C. philippensis* was planted at 1 m × 2 m and in the best locations the canopy closed two years after planting. It recovers quickly from pruning and is not resistant to fire.

Genetic resources and breeding Meiotic irregularities and pollen sterility have frequently been observed in *C. occidentalis* L. This may be the cause of the very high percentage of barren seeds among *Celtis* species.

Prospects Light celtis will probably be used increasingly as core stock for the production of common grade plywood. Due to its toughness and permeability to pressure treatment, hard celtis has excellent potential for many exterior application; moreover, it seems suitable for the production of charcoal.

Literature 40, 48, 125, 152, 235, 259, 261, 300, 304, 341, 346, 348, 360, 364, 405, 423, 436, 463, 464, 482, 487, 488, 513, 536, 632, 780, 861, 933, 934, 955, 974, 1012, 1038, 1048, 1052, 1104, 1169, 1221, 1232, 1248, 1268.

Selection of species

Celtis hildebrandii Soepadmo

Vernacular names Indonesia: biempai (Biak, Irian Jaya), sehiega (Manikiong, Irian Jaya), walik (Mooi, Irian Jaya).

Distribution The Moluccas (Buru), New Guinea and the Solomon Islands.

Celtis latifolia (Blume) Planch.

Synonyms *Celtis kajewskii* Merr. & L.M. Perry, *Celtis zippelii* (Blume) Planch., *Solenostigma latifolium* Blume.

Vernacular names Indonesia: tohu (Morotai).

Distribution The Philippines (Palawan), the Moluccas, New Guinea and the Solomon Islands.

Celtis luzonica Warb.

Vernacular names Philippines: magabuyo (Filipino), daloo (Todaya).

Distribution The Philippines.

Celtis paniculata (Endl.) Planch.

Synonyms *Celtis ingens* F. v. Mueller, *Celtis pacifica* Planch., *Celtis vitiensis* A.C. Smith.

Vernacular names Silky celtis (En).

Distribution Borneo (Sabah, rare), the Lesser Sunda Islands (Wetar), the Moluccas, New Guinea, north-eastern Australia, the Solomon Islands, Vanuatu, New Caledonia, Polynesia and Micronesia.

Celtis philippensis Blanco

Synonyms *Celtis collinsae* Craib, *Celtis strychnoides* Planch., *Celtis wightii* Planch.

Vernacular names Indonesia: ki endog (Sundanese), (pen)jalinan, sentok (Javanese). Malaysia: nyelepi (Sabah). Philippines: malaikmo (Filipino), maragaoed (Iloko), narabagsay (Tagalog). Thailand: thalai khao (south-western).

Distribution From tropical Africa to Madagascar, India, Burma (Myanmar), Indo-China, southern China, Hongkong, Taiwan, Thailand, throughout the Malesian region, the Solomon Islands and north-eastern Australia.

Celtis rigescens (Miq.) Planch.

Synonyms *Celtis asperifolia* Merr., *Celtis nymanii* K. Schumann, *Celtis sumatrana* (Miq.) Planch.

Vernacular names Indonesia: ainam (Kai Islands), asin-asin (Anambas Islands), rempelas (Sumatra). Malaysia: mempelas bulan (Peninsular).

Distribution Peninsular Malaysia (rare), Sumatra, West Java, Borneo (Kalimantan), North Sulawesi, the Moluccas, New Guinea and the Solomon Islands.

Celtis rubrovenia Elmer

Synonyms *Celtis similis* Merr. & L.M. Perry.

Vernacular names Indonesia: doconi, niconi (Kebar, Irian Jaya). Philippines: palek (Bontok).

Distribution The Philippines and New Guinea.

Celtis tetrandra Roxb.

Synonyms *Celtis glabra* Planch., *Celtis napalensis* Planch., *Celtis serotina* Planch.

Vernacular names Indonesia: ki jeungkil (Sundanese), pusu (Sumbawa), teritih (Javanese). Burma (Myanmar): thipok. Thailand: hat (northern), khenon khai (eastern), ma haat (central).

Distribution From India to Burma (Myanmar), Indo-China, Thailand, northern Sumatra, Java and the Lesser Sunda Islands.

Celtis timorensis Spanoghe

Synonyms *Celtis cinnamomea* Lindl. ex Planch., *Celtis crenato-serrata* Merr., *Celtis waitzii* Blume.

Vernacular names Indonesia: cengkek (Javanese), ki tamiang (Sundanese), ki tondok (central Sumatra). Philippines: malatae (Filipino), malabutulan (Tagalog), takulao (Ibanag). Burma (Myanmar): kabaung. Laos: lep mèo. Thailand: kaeng khe phra ruang (northern), mon dong (central), tai mai than thao (peninsular). Vietnam: s[ees]u h[oo]i.

Distribution From Sri Lanka and India to Burma (Myanmar), Indo-China, Thailand, central Sumatra, Java, Borneo (Kalimantan, Sabah), the Philippines and the Lesser Sunda Islands.

S. Aggarwal

Ceratopetalum J.E. Smith

Spec. bot. New Holland 1: 9, t. 3 (1793).

CUNONIACEAE

x = unknown; *C. gummiferum* J.E. Smith: $2n$ = 32

Vernacular names Coachwood (En, trade name). Blood-in-the-bark, satin sycamore (En). Papua New Guinea: Papua New Guinea coachwood (En).

Origin and geographic distribution *Ceratopetalum* comprises 6 species distributed in eastern Australia and New Guinea. *C. succirubrum* C.T. White (synonym: *C. tetrapterum* Mattf.) is the only Malesian species occurring in New Guinea and north-eastern Australia (Queensland).

Uses *C. succirubrum* is widely used in furniture and cabinet work. It also finds many applications in house building where it serves for decorative wall panelling, interior trim, flooring, fine finish, light framing and shop and office fittings. It is also applied for boat building, joinery, mouldings, dowels, turnery, carving, rifle butts, brush backs, tool handles (non-impact) and for parts of various machinery. *C. succirubrum* is frequently used to make fruit cases and is claimed to be suitable for musical instruments. It is excellent for the production of plywood and is suitable for both core stock and face veneer.

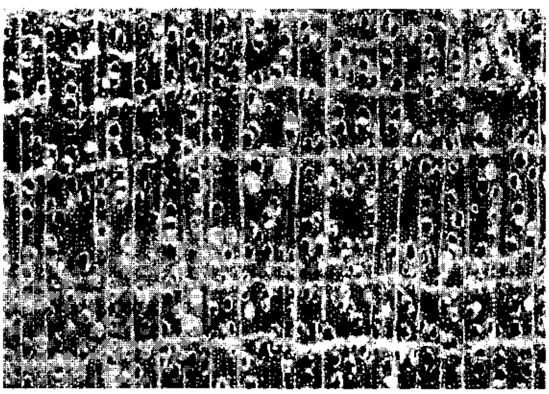
Production and international trade In 1996 Papua New Guinea exported 108 m^3 of *C. succirubrum* logs at an average free-on-board (FOB) price of US$ 92/m^3. In Australia *Ceratopetalum* is of considerable commercial importance on a local scale.

Properties *C. succirubrum* yields a medium-weight hardwood with a density of 600–825 kg/m^3 at 15% moisture content. Heartwood pale to dark pinkish-brown, not clearly differentiated from the straw or pale brown sapwood; grain straight to slightly interlocked; texture fine; wood with characteristic figure on tangential surface due to the parenchyma bands; wood with caramel-like odour. Growth rings indistinct; vessels moderately small, solitary and in radial multiples of 2–4, rarely in clusters, occasional tyloses and white deposits present; parenchyma abundant, apotracheal in narrow or rarely wide, regularly or irregularly spaced bands; rays fine; ripple marks absent.

Shrinkage upon seasoning is low to moderate and the wood requires careful seasoning as it is liable to twist in drying. The wood is moderately strong, tough and non-durable. The sapwood is non-susceptible to *Lyctus*. The wood is fairly resistant to pressure treatment.

The mean fibre length is 1.34–1.54 mm.

See also the tables on microscopic wood anatomy and wood properties.



Ceratopetalum apetalum D. Don transverse surface (×20)

Botany An evergreen, small to medium-sized tree up to 35 m tall; bole straight, cylindrical, branchless for up to 27 m, up to 100 cm in diameter, with small buttresses; bark surface smooth but flaky, brownish-grey and mottled, hoop-marked, inner bark reddish-brown, with little, thick dark red exudate; crown very light. Leaves decussate, (2–)3-foliolate; leaflets entire to serrate, prominently veined; stipules connate, enclosing the terminal bud, caducous. Inflorescence a terminal or axillary, corymbose panicle but dichasial in the apical branches. Flowers 4(–5)-merous; sepals valvate; petals absent; stamens 8(–10); disk annular; ovary semi-inferior, 2-locular with 4 ovules in each cell, styles 2, divergent. Fruit a dry, indehiscent, 2-seeded capsule with radiating persistent and enlarged sepals turning red. Seedling with orbicular cotyledons; hypocotyl glabrous; young leaves serrate.

In Queensland *C. succirubrum* flowers in November and December, fruits ripen in January and February. The fruits are dispersed by wind.

Ecology *C. succirubrum* is found in primary rain forest at 400–1200 m altitude where it favours fertile soils; it is especially abundant on granite substrates. In Papua New Guinea it also occurs near sea-level, in mixed gallery forest on the Oriomo plateau and in low hill forest dominated by dipterocarps in Kiunga, Western Province.

Silviculture In Australia *Ceratopetalum* can easily be grown from seed, but its growth is slow.

Genetic resources and breeding It is difficult to assess the risk of genetic erosion of *C. succirubrum* as on the one hand it is of local commercial importance and on the other hand it is locally abundant.

Prospects The commercial interest in *C. succirubrum* in Papua New Guinea will remain relatively important, but supplies are very limited.

Literature 124, 128, 215, 269, 270, 300, 304, 356, 446, 463, 464, 470, 568, 861, 1204, 1232.

W.C. Dickison

Cerbera L.

Sp. pl. 1: 208 (1753); Gen. pl., ed 5: 98 (1754).

APOCYNACEAE

x = unknown; *C. manghas*: $2n$ = 40, *C. odollam*: $2n$ = 40

Vernacular names Grey milkwood (En, trade name). Indonesia: bintaro (Java). Malaysia: pong-pong (Peninsular). Papua New Guinea: cerbera (general). Burma (Myanmar): kalwa. Cambodia: krapur. Thailand: teenpet (central). Vietnam: h[ar]i gu[ar] t[ur], mur[os]p sat, mur[os]p x[as]c.

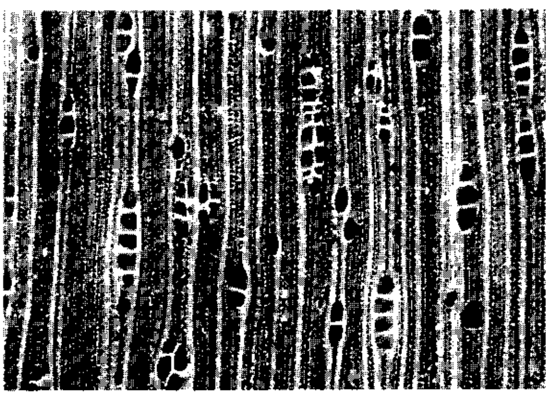
Origin and geographic distribution *Cerbera* comprises 7 species and is found from Madagascar and islands in the Indian Ocean to India, Burma (Myanmar), Indo-China, Taiwan and Thailand, throughout the Malesian region towards Melanesia and north-eastern Australia.

Uses The wood of *Cerbera* is used for mouldings, interior trim, fruit cases, core veneer, match splints, shuttering, clogs, plain furniture and carving. The wood of *C. manghas* yields a good charcoal.

Several species are applied medicinally against aches and sores. *C. manghas* and *C. odollam* are well-known for their poisonous seeds, used amongst others to stupefy fish in the Philippines, and an excellent purgative can be prepared from their root and bark. The seeds contain an oil which has been used for making candles. The oil from the seeds of *C. floribunda* is rubbed on the skin to cure itch and colds. *C. manghas* is also planted as an ornamental.

Production and international trade Small amounts of *Cerbera* logs are exported from Papua New Guinea and the Solomon Islands to Japan. In 1996 Papua New Guinea exported about 1000 m^3 of *Cerbera* logs at an average free-on-board (FOB) price of US$ 100/m^3. In other areas production is probably small and for local consumption only.

Properties *Cerbera* yields a lightweight to medium-weight timber with a density of 320–610 kg/m^3 at 15% moisture content. Heartwood white to pale yellow-brown, not demarcated from the white sapwood; grain straight to slightly interlocked; texture fine and uneven because of the banded parenchyma; wood with darker streaks on radial and tangential surfaces. Growth rings distinct, indicated by marginal parenchyma; vessels moderately small to medium-sized, tending to be radially aligned, mostly in radial multiples of 2–7(–12) and clusters, open; wood parenchyma moderately abundant, apotracheal in narrow continuous, concentric bands, distinct to the naked eye; rays very fine to moderately fine, visible with a hand lens, occasionally with radial latex tubes in *C. floribunda*; ripple marks absent; axial latex canals present.



Cerbera floribunda
transverse surface (×20)

Shrinkage upon seasoning is moderate; the wood seasons readily and well. It works easily. The wood is non-durable and resistant to preservative treatment under pressure. The wood is highly susceptible to blue-staining fungi, the sapwood is susceptible to *Lyctus*.

See also the tables on microscopic wood anatomy and wood properties.

Botany Evergreen shrubs or small to medium-sized trees up to 30 m tall; bole up to 90 cm in diameter, not buttressed; bark surface irregularly scaly or warty, peeling off in small flakes, light grey to brown or black-grey, inner bark cream to straw-brown or pale yellow-brown with a greenish tinge, exuding abundant white latex. Leaves arranged spirally, clustered at the apices of twigs, glabrous, entire or sinuate with a decurrent base. Inflorescence terminal, cymose, glabrous. Flowers 5-merous; calyx deeply divided or the sepals free; corolla hypocrateriform, white or light red, strongly scented, lobes overlapping to the left in bud; disk absent; anthers lanceolate, contiguous to the style head and with filiform appendages; carpels 2, free, with 4 ovules in each carpel, style-head composed of 2 annular swellings, surmounted by 2 thick appendages. Fruit apocarpous, with a fleshy exocarp, woody endocarp and 1 or 2 seeds. Seed compressed, not winged. Seedling with hypogeal germination; hypocotyl not elongated.

C. manghas develops according to Koriba's architectural tree model, characterized by orthotropic axes which branch to produce initially equivalent modules but one of these subsequently becomes dominant constituting one unit of the sympodial trunk. In Vietnam *Cerbera* spp. flower from February to October and bear ripe fruits from August to April. In Australia *C. manghas* flowers and fruits throughout the year. The flowers are pollinated by insects. The fruits are dispersed by water and are quite commonly washed up on the shores. There used to be considerable confusion about the correct names for *C. manghas* and *C. odollam*. As a result, it is often not possible to allot given information to one of these species.

Ecology *Cerbera* species are generally associated with water and occur along rivers or streams, in swamp forest and behind mangroves, but may also be found in shrubby savanna or in secondary forest edges. Some species, like *C. manghas* and *C. odollam*, are common elements of mangrove swamps and tidal river banks and may root in muddy locations but also in sandy coastal soils. Most species occur at low altitude in primary lowland rain forest, but some may ascend up to 2000 m.

Silviculture *Cerbera* can be propagated by seed.

Genetic resources and breeding There is no reason to believe that *Cerbera* species are vulnerable to genetic erosion.

Prospects *Cerbera* trees seldom grow to timber size. The wood might increasingly be used for veneer as it is soft and presumably easy to cut; the streaked figure which may be present may make its use for face veneer attractive.

Literature 40, 120, 151, 163, 209, 267, 300, 304, 340, 348, 350, 402, 436, 438, 464, 710, 723, 861, 883, 974, 1038, 1132, 1221.

Selection of species

Cerbera floribunda K. Schumann

Vernacular names Cassowary plum (En). Indonesia: babai (Biak, Irian Jaya), biegbau (Haltam, Irian Jaya), brebong (Kemtuk, Irian Jaya). Papua New Guinea: grey milkwood (En).

Distribution New Guinea, the Solomon Islands and north-eastern Australia.

Cerbera manghas L.

Synonyms *Cerbera lactaria* Buch.-Ham. ex Spreng., *Cerbera linnaei* Montrouz.

Vernacular names Indonesia: bintan (Manado), mangga brabu (Moluccas). Malaysia: bentan, bintaru (Peninsular). Philippines: baraibai (Tagalog). Burma (Myanmar): kalwa salat. Thailand: teenpet lek (central), teenpet sai (peninsular), rak khao (southeastern). Vietnam: h[ar]i gu[ar] t[ur] hu[owf]ng, mur[os]p sat hu[owf]ng, mur[os]p x[as]c hu[owf]ng.

Distribution From the Seychelles towards Indo-China, Taiwan, Thailand, throughout the Malesian area to north-eastern Australia and Melanesia.

Cerbera odollam Gaertn.

Vernacular names Malaysia: bintan (Peninsular). Thailand: sang la (peninsular), teenpet nam, teenpet thale (central). Vietnam: h[ar]i gu[ar] t[ur] v[af]ng, mur[os]p sat v[af]ng, mur[os]p x[as]c v[af]ng.

Distribution From Sri Lanka and India towards Burma (Myanmar), Indo-China and Thailand, throughout the Malesian area towards Melanesia.

Tran Dinh Ly

Chaetocarpus Thwaites

Hooker's Journ. Bot. Kew Gard. Misc. 6: 300, t. 10a (1854).

EUPHORBIACEAE

x = unknown; $2n$ = unknown

Vernacular names Kayu besi (trade name). Bur beam (En). Indonesia: besie (Sumatra), bukir (Kalimantan). Malaysia: bebatu, bedik (Peninsular), dusun dusun (Sabah). Laos: bok khay. Thailand: a kaang (peninsular), khe-non (central, peninsular), samphao (central). Vietnam: cay lo le, chimas, co kei.

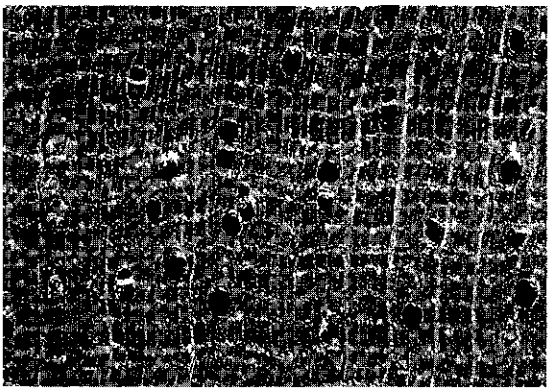
Origin and geographic distribution *Chaetocarpus* comprises about 11 species which are found in tropical South and Central America, West Africa, Madagascar and tropical Asia. The only Malesian species is *C. castanocarpus* (Roxb.) Thwaites (synonyms: *Regnaldia cluytioides* Baillon, *Regnaldia myrtioides* Baillon) which occurs in Sri Lanka, India, Burma (Myanmar), Indo-China, Thailand, Peninsular Malaysia, Bangka and Borneo.

Uses The wood of *C. castanocarpus* is used for temporary construction and tool handles in Borneo, for general building purposes in Sri Lanka, and for boat building and columns in Indo-China.

In north-eastern Peninsular Malaysia the young leaves are eaten as spinach or chopped through rice.

Production and international trade Utilization of the wood of *C. castanocarpus* is on a local scale only. In Peninsular Malaysia the trees are occasionally grown as a vegetable.

Properties *C. castanocarpus* yields a medium-weight to heavy hardwood with a density of (705–)880–1010(–1190) kg/m³ at 15% moisture content. Heartwood rose-brown or yellowish-brown, not differentiated from the sapwood; grain



Chaetocarpus castanocarpus
transverse surface (×20)

straight or interlocked; texture moderately fine and even. Growth rings indistinct; vessels medium-sized, solitary and in radial multiples of 2–3, sclerotic tyloses present; parenchyma abundant, apotracheal in narrow bands, just visible to the naked eye; rays very fine to moderately fine, visible with a hand lens; ripple marks absent.
The wood is moderately hard to hard, strong and, being non-siliceous, probably easy to saw despite its hardness. It is only moderately to slightly durable when exposed to the weather or in contact with the ground. Wood samples at the Forest Research Institute Malaysia had not been attacked by fungi or borers.
The mean fibre length in material from East Kalimantan is 1.46 mm.
See also the table on microscopic wood anatomy.

Botany An evergreen, dioecious, small to large tree up to 45 m tall; bole usually straight, branchless for up to 15 m, up to 60 cm in diameter, occasionally with buttresses; bark surface smooth to finely fissured, peeling off in 1–2 cm wide strips, coarsely granular, white to grey-brown, reddish-brown or deep purple-brown, inner bark hard, gritty, salmon to red or purplish-brown. Leaves distichous, simple, entire; stipules caducous. Flowers in an axillary cluster, small, yellow or greenish-yellow; sepals 4, distinctly imbricate; petals absent or occasionally 1 developed; disk dentate. Male flowers with 8–15 stamens, filaments connate in a column; pistillode present. Female flowers with a superior, 3(–4)-locular ovary with 1 ovule per cell, styles 3, deeply divided. Fruit a subglobose capsule, bristly hairy. Seed with the upper third covered by a thin aril. Seedling with epigeal germination; cotyledons emergent, leafy; hypocotyl elongated; leaves conduplicate, first 2 opposite, subsequent ones alternate.
Flowering and fruiting has been observed throughout the year.

Ecology *C. castanocarpus* is common but scattered in primary or secondary lowland or hill forest, up to 500 m altitude. It is present in dipterocarp forest, coastal peat-swamp forest, seasonal swamp forest, *Schima*-bamboo forest, along beaches and rivers, and in submontane scrub. It grows on various soil types, from yellow, brown or black sandy soils, sandy loam, clay, granite, limestone and coral.

Silviculture *C. castanocarpus* can be propagated by seed, which may achieve only about 5% germination in 20–34 days.

Genetic resources and breeding There are no records of *C. castanocarpus* in seed banks or germplasm collections. Regarding its wide distribution and frequent occurrence in secondary vegetation, it does not seem liable to genetic erosion.

Prospects *C. castanocarpus* will probably remain a timber of minor importance.

Literature 26, 28, 34, 162, 163, 209, 267, 364, 492, 672, 745, 829, 831, 861, 1038, 1153, 1169, 1195, 1221, 1242.

P.C. van Welzen

Chionanthus L.

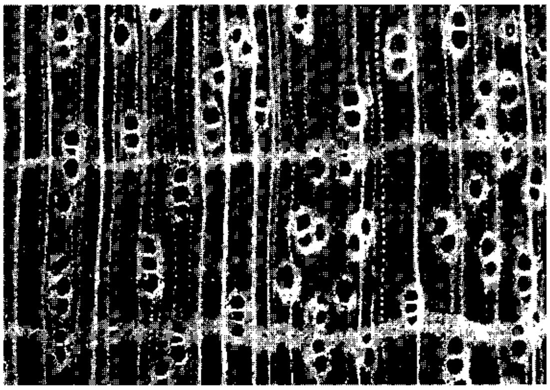
Sp. pl. 1: 8 (1753); Gen. pl., ed. 5: 9 (1754).
OLEACEAE
$x = 23$; $2n = 46$ for several non-Malesian species

Vernacular names Malaysia: kayu buda (Kayan, Sarawak), mok, sapah (Iban, Sarawak). Philippines: karaksan (Filipino). Vietnam: s[aw]ng.

Origin and geographic distribution *Chionanthus* comprises about 120 species mostly confined to the tropics and subtropics with a few representatives in temperate regions. Some 55 species occur within the Malesian region, which serves as a major centre of diversification.

Uses *Chionanthus* wood is used locally for general construction (planks, posts) and boat building and is suitable for small articles requiring a hard, heavy and fine-textured wood like chisel handles, bowling pins, boot and shoe lasts, bobbins, shuttles, spindles and piano parts. The heartwood of *C. laxiflorus* is used for carving tobacco pipes. *C. curvicarpus* provides an excellent firewood.

Production and international trade The use



Chionanthus ramiflorus
transverse surface (×20)

of *Chionanthus* wood is limited and on a local scale only.

Properties *Chionanthus* yields a medium-weight hardwood with a density of 480–865 kg/m^3 at 15% moisture content. Heartwood pale brown to red-brown, sometimes with darker streaks, generally sharply demarcated from the up to 3 cm wide, straw-coloured sapwood which occasionally has a pink tinge; grain straight to slightly interlocked; texture fine to moderately fine and even; wood with slight watered-silk figure on longitudinal surface. Growth rings indistinct to distinct, boundaries indicated by marginal bands of parenchyma; vessels moderately small to medium-sized, some solitary but mostly in radial multiples of 2–4(–12), sometimes in clusters, white or yellow deposits sometimes present; parenchyma moderately abundant, scanty paratracheal, vasicentric to aliform and apotracheal in marginal or seemingly marginal bands; rays very fine or moderately fine, visible with a hand lens; ripple marks absent.

The wood is moderately hard to hard and moderately strong. It is non-durable. The wood is susceptible to blue stain. The sapwood is probably susceptible to *Lyctus*.

The mean fibre length is 1.26–1.51 mm.

See also the table on microscopic wood anatomy.

Botany Evergreen, small to medium-sized or rarely large trees up to 30(–50) m tall, rarely shrubs or climbers; bole straight, up to 65 cm in diameter, occasionally slightly fluted or with small buttresses up to 1 m high; bark surface usually smooth, sometimes flaky or scaly, sometimes lenticellate, white to dark grey or brown, inner bark light to orange-brown or red, without exudate. Leaves opposite, simple, entire, exstipulate. Inflorescence axillary, paniculate or cymose, sometimes condensed and fasciculate. Flowers small, bisexual or rarely unisexual, white or yellow, rarely red; calyx 4-lobed; petals 4, usually basally fused in pairs or rarely with a short tube (*C. ramiflorus*); stamens 2 or rarely 4; ovary superior, 2-locular with 2 ovules in each cell, stigma almost sessile, capitate or obscurely 2-lobed. Fruit a 1(–3)-seeded drupe. Seed with thin testa. Seedling with hypogeal (*C. evenius*), semi-epigeal (*C. virginicus* L.) or epigeal (American and African species) germination. In *C. evenius* the cotyledons are not emergent, the hypocotyl not elongated and the epicotyl bears about 2 pairs of subopposite scales followed by opposite or subopposite leaves.

Some species (e.g. *C. laxiflorus*) produce flushes of new shoots throughout the year, with the flowers sometimes developing before the new leaves. Others (e.g. *C. ramiflorus*) flower and fruit throughout the year, whereas still others (e.g. *C. callophyllus*, *C. cuspidatus* Blume) flower in February–March and fruit in May to December. The fruits are probably dispersed by birds.

The genus *Linociera* has been incorporated into *Chionanthus*.

Ecology *Chionanthus* is generally encountered as an understorey tree in evergreen, primary, lowland or hill forest, but is never common. A few species are confined to peat-swamp forest (e.g. *C. evenius*) or montane forest, up to 2500 m altitude. The widespread *C. ramiflorus* also occurs in secondary and coastal forest.

Silviculture *Chionanthus* can be propagated by seed. In *C. ramiflorus* there are about 1300 dry stones/kg. Sown stones of *C. evenius* have a germination rate of about 95% in 24–81 days. *Chionanthus* is usually not fire-resistant.

Genetic resources and breeding Apart from some individual trees in botanic gardens there are no records of ex situ conservation of *Chionanthus*. As *Chionanthus* is used only locally, it does not seem liable to genetic erosion.

Prospects *Chionanthus* is hardly used locally, indicating poor potential. Other species within the *Oleaceae* such as *Fraxinus griffithii* C.B. Clarke (which is used for carving in the Philippines) or *Olea paniculata* R. Br. (which has potential as a timber in monsoon regions) may have better prospects.

Literature 67, 70, 163, 209, 235, 238, 267, 348, 405, 436, 553, 559, 560, 561, 562, 779, 780, 783, 829, 831, 1038, 1052, 1054, 1221, 1222.

Selection of species

Chionanthus callophyllus Blume

Synonyms *Chionanthus platycarpus* (King & Gamble) Kiew, *Linociera paludosa* King & Gamble, *Olea platycarpa* King & Gamble.

Distribution Peninsular Malaysia, south-eastern Sumatra and Borneo (Kalimantan, Sabah).

Chionanthus crispus Kiew

Distribution Borneo (Sabah).

Chionanthus curvicarpus Kiew

Vernacular names Malaysia: kayu bura apoi (Kelabit, Sarawak).

Distribution Peninsular Malaysia (rare), Sumatra and Borneo.

Chionanthus evenius (Stapf) Kiew

Synonyms *Linociera evenia* Stapf.

Distribution Peninsular Malaysia and Borneo (Brunei, Sarawak).

Chionanthus laxiflorus Blume

Synonyms *Linociera laxiflora* (Blume) Knobl.

Vernacular names Malaysia: kayu bura serang (Kelabit, Sarawak), kerdam (Iban, Sarawak).

Distribution Peninsular Malaysia, Sumatra, Borneo, Sulawesi, the Moluccas and New Guinea.

Chionanthus macrocarpus Blume

Synonyms *Chionanthus elaeocarpus* (Stapf) Kiew, *Chionanthus insignis* Miq., *Linociera macrocarpa* (Blume) Knobl.

Vernacular names Indonesia: medang-tui (Sumatra). Malaysia: kerdam (Melanau, Sarawak).

Distribution Peninsular Malaysia, Sumatra, Java and Borneo.

Chionanthus pluriflorus (Knobl.) Kiew

Synonyms *Linociera pluriflora* Knobl., *Linociera verruculosa* Merr.

Vernacular names Indonesia: ibun (Kutai, East Kalimantan). Malaysia: bukar (Murut, Sarawak), kayu bawang (Kenyah, Sarawak), kuku mendo (Iban, Sarawak).

Distribution Borneo (Brunei, Sabah, Sarawak, East Kalimantan).

Chionanthus porcatus Kiew

Vernacular names Malaysia: marilam (Kelabit, Sarawak).

Distribution Borneo.

Chionanthus ramiflorus Roxb.

Synonyms *Chionanthus luzonica* Blume, *Linociera cumingiana* S. Vidal, *Linociera pauciflora* (Wallich ex DC.) C.B. Clarke.

Vernacular names Malay olive (En). Indonesia: gofasa bobudo (Ternate). Philippines: karaksan (Filipino). Thailand: kluean, taachai bai yai, uap dam (peninsular).

Distribution From eastern India to Indo-China, Taiwan, Thailand, throughout the Malesian region (not yet in the Lesser Sunda Islands), Australia (Queensland) and the Solomon Islands.

R. Kiew

Chisocheton Blume

Bijdr. fl. Ned. Ind. 4: 168 (1825).

MELIACEAE

x = unknown; *C. cumingianus* subsp. *balansae* (C. DC.) Mabb.: $n = 23$, *C. cumingianus* subsp. *cumingianus*: $2n = 92$, *C. lasiocarpus*: $2n = 46$

Vernacular names Chisocheton (En, trade name). Malaysia: lantupak (Sabah). Papua New Guinea: kiso (Pidgin). Vietnam: qu[ees]ch.

Origin and geographic distribution *Chisocheton* comprises 50 species occurring from India to Indo-China, southern China, Thailand, the Nicobar and Andaman Islands and throughout Malesia to northern Australia, the Solomon Islands and Vanuatu. The highest number of species is found in Borneo (18) and New Guinea (13).

Uses The wood of *Chisocheton* is used for light construction, ship and boat building, interior finish, furniture and cabinet work, light flooring, mouldings, lining, wall panelling, brushware, sporting goods, boxes and crates, toys, turnery, rotary veneer and plywood. The wood has also been applied in the manufacture of blockboard and particle board and is suitable for the production of pulp.

The leaflets are used for wrapping sago, fish and other food for cooking. The seeds of some species yield an oil which has been used as an illuminant. In the Philippines the oil used to be used commercially to make soap and as a hair cosmetic. The fruits of some species are edible, but reputedly not tasty.

Production and international trade Small amounts of *Chisocheton* timber are imported into Japan from Papua New Guinea. In 1996 about 11 500 m^3 of *Chisocheton* logs was exported from

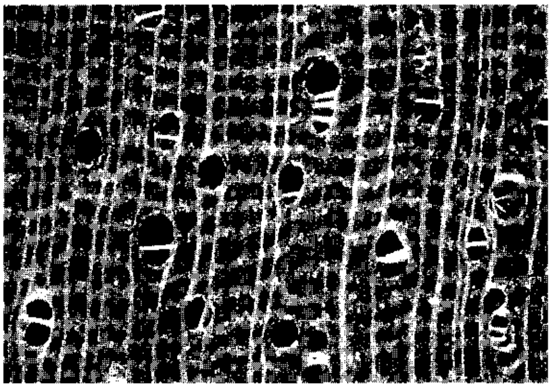
Papua New Guinea at an average free-on-board (FOB) price of US\$ 101/m^3. In 1987 0.3% of the timber exported from the Solomon Islands to Japan comprised *Chisocheton* timber. Its use in other countries is probably on a local scale only.

Properties *Chisocheton* yields a medium-weight hardwood with a density of 425–790 kg/m^3, sometimes to over 1000 kg/m^3 at 12% moisture content. Heartwood usually pale brown to pink-brown, fairly bright yellow in some species, not differentiated from the white to straw-coloured sapwood; grain fairly straight to slightly interlocked; texture moderately fine to moderately coarse, uneven because of abundance of wood parenchyma; prominent watered-silk figure on tangential surface and palisade marking on radial surface; freshly cut wood with strong onion smell. Growth rings indistinct but distinct in *C. lasiocarpus*, boundaries sometimes indicated by a zone of denser fibres; vessels medium-sized to moderately large, solitary and in radial multiples of 2–4(–5), open or filled with solid white or dark-coloured, gum-like deposits; parenchyma abundant, visible to the naked eye, scanty paratracheal and vasicentric, apotracheal in more or less continuous, wide, wavy bands close together, and sparse diffuse; rays moderately fine, visible with a hand lens; ripple marks absent.

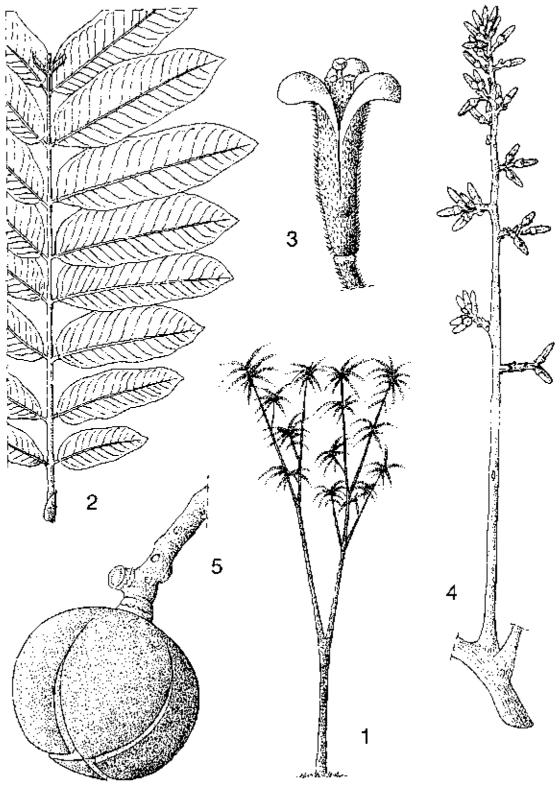
Shrinkage is moderate to high; kiln drying is fairly rapid and satisfactory, though with some tendency to distort, individual boards may collapse appreciably. The wood is moderately hard, moderately strong and moderately tough. It is fairly easy to work and a good finish can be obtained at a cutting angle of 20°; nailing, peeling and gluing properties are good and the wood polishes well. The wood is non-durable; sapwood is permeable to impregnation but heartwood is resistant. It is not resistant to blue stain. The sapwood is susceptible to *Lyctus*.

See also the tables on microscopic wood anatomy and wood properties.

Botany Dioecious or polygamous, small to medium-sized trees occasionally up to 30(–40) m tall; bole usually straight, branchless for up to 18 m, up to 75(–150) cm in diameter, sometimes fluted, stilt-rooted or with narrow buttresses up to 3 m high; bark surface variable, smooth to finely fissured or cracked or dippled, sometimes lenticellate, sometimes scaly or flaking, blackish-brown to red-brown or greenish-grey, inner bark pale fawn or pinkish to orange-red or dark red-brown, with white or watery exudate, often with strong onion or garlic-like odour. Leaves alternate, pinnate and pseudogemmulate or imparipinnate, exstipulate; leaflets opposite, entire. Inflorescence axillary, sometimes cauliflorous or epiphyllous, paniculate, thyrsoid or racemose on a long peduncle. Flowers usually unisexual; calyx cup-shaped, obscurely or rarely distinctly 3–6-lobed; petals



Chisocheton pentandrus
transverse surface (×20)



Chisocheton macrophyllus King – 1, tree habit; 2, leaf; 3, flower; 4, inflorescence; 5, fruit.

(3–)4–6(–14), in 1 or 2 whorls; stamens united into a cylindrical tube which bears (3–)4–10(–30) anthers; disk usually absent; ovary superior, 2–8-locular with 1 or 2 ovules in each cell, style head club-shaped or discoid. Fruit a 2–5(–8)-valved capsule with leathery to woody pericarp. Seed arillate or with a well-developed sarcotesta. Seedling with hypogeal, semi-cryptocotylar germination; cotyledons succulent, peltate; all leaves spiral, first few leaves scale-like, subsequent ones simple followed by compound ones.

The leaves of most species are pseudogemmulate, i.e. they have an indeterminate growth as a result of an apical bud which produces new leaflets over a period of several years, during which time the older leaflets are lost. The trees usually develop a sympodial crown, but are sometimes unbranched and sometimes pachycaul, i.e. develop a comparatively thick primary stem. The growth form corresponds to Champagnat's architectural tree model, characterized by the indefinite superposition of orthotropic axes, each axis becoming pendulous with a renewal shoot arising from the upper surface, or Corner's architectural tree model, characterized by a single unbranched axis with lateral inflorescences. Pollination is probably by insects. Some species have strongly scented flowers, particularly in the evening, suggesting moth pollination. Fruits are eaten by birds, e.g. hornbills, cassowaries and birds of paradise, who thus disperse the seeds.

C. cumingianus and *C. pentandrus* are both divided into 3 subspecies. *C. lasiocarpus* is highly polymorphic with a complex of local forms which were formerly given the status of species.

Ecology *Chisocheton* species are fairly common in the understorey of South-East Asian rain forest. The taller timber-producing species belong to the subcanopy and canopy layers. They occur in primary or less often secondary lowland and hill or rarely montane forest, up to 1500(–1800) m altitude. Individual species have been reported from riparian forest, floodplains, dipterocarp forest and from forest on limestone. *C. lasiocarpus* persists in logged-over forest and in forest subject to grazing. Some species have ants living in the twigs and sometimes also in the inflorescence axis and leaf rachis.

Silviculture *Chisocheton* can be propagated by seed. In germination tests in Peninsular Malaysia seeds of *C. ceramicus* had almost 100% germination in 1–2.5 months, *C. patens* seeds had 65% germination in 2–6 months, but seeds with pulp of *C. macrophyllus* had only 30% germination in 2–6 months.

Genetic resources and breeding Most of the timber-producing *Chisocheton* species are comparatively widespread. As they are usually not specifically sought after there seems no immediate danger of genetic erosion, although some rare species like *C. koordersii* and *C. stellatus* could easily become endangered.

Prospects Silvicultural information on *Chisocheton* is lacking, but as its wood properties are favourable it holds some potential for the future.

Literature 40, 70, 125, 162, 163, 238, 267, 300, 304, 341, 346, 347, 348, 389, 402, 403, 436, 467, 487, 536, 727, 780, 829, 831, 878, 933, 974, 1038, 1058, 1065, 1221, 1232.

Selection of species

Chisocheton ceramicus (Miq.) C. DC.

Synonyms *Chisocheton macrothyrsus* King, *Chisocheton sandoricocarpus* Koord. & Valeton, *Chisocheton spectabilis* (Miq.) C. DC.

Vernacular names Philippines: dagau (Mandaya).

Distribution Vietnam, Thailand, Peninsular Malaysia, Sumatra, Java, Borneo, the Philippines, the Moluccas, New Guinea and New Britain.

Chisocheton cumingianus (C. DC.) Harms

Synonyms *Chisocheton morobeanus* Harms, *Chisocheton paniculatus* Hiern, *Chisocheton thorelii* Pierre.

Vernacular names Philippines: balukanag (Filipino), batuakan (Igorot). Burma (Myanmar): tagat-pyu. Thailand: yom makok (northern). Vietnam: g[ooj]i chuy.

Distribution From India (Assam), Burma (Myanmar) and southern China through Indo-China towards the Philippines, Sulawesi, the Moluccas, New Guinea and the Bismarck Archipelago.

Chisocheton erythrocarpus Hiern

Vernacular names Malaysia: rongga (Peninsular).

Distribution Peninsular Malaysia, Borneo and the Philippines.

Chisocheton koordersii Mabb.

Distribution Borneo (Kalimantan, Sabah) and Sulawesi.

Chisocheton lasiocarpus (Miq.) Valeton

Synonyms *Chisocheton pachyrachis* Harms, *Chisocheton schumannii* C. DC., *Chisocheton weinlandii* Harms.

Distribution The Moluccas (Seram), New Guinea and the Solomon Islands.

Chisocheton longistipitatus (F.M. Bailey) L.S. Smith

Synonyms *Chisocheton polyanthus* Harms, *Rhetinosperma longistipitata* (F.M. Bailey) Radlk.

Distribution New Guinea, the Solomon Islands and Australia (northern Queensland).

Chisocheton macrophyllus King

Vernacular names Indonesia: gendis, gula (Javanese). Malaysia: bekak, pasak lingga (Peninsular). Thailand: ma aa, sai, ta suea (peninsular).

Distribution The Nicobar Islands, peninsular Thailand, Peninsular Malaysia, Singapore, Sumatra, Java and Borneo.

Chisocheton patens Blume

Synonyms *Chisocheton divergens* Blume, *Chisocheton glomeratus* Hiern, *Chisocheton tetrapetalus* (Turcz.) C. DC.

Vernacular names Malaysia: gerantong tengah, kedondong kerut, medang pasir (Peninsular). Philippines: agogoi (Tagalog), apo dagau (Mandaya), sapanauak (Subanun).

Distribution Peninsular Thailand, Peninsular Malaysia, Sumatra, Java, Borneo, the Philippines and Sulawesi.

Chisocheton pentandrus (Blanco) Merr.

Synonyms *Chisocheton beccarianus* Baillon, *Chisocheton microcarpus* Koord. & Valeton, *Chisocheton spicatus* Hiern.

Vernacular names Malaysia: jerai, sentol kera (Peninsular). Philippines: katong-matsin, katong maching (general).

Distribution Peninsular Thailand and throughout Malesia except for New Guinea.

Chisocheton stellatus P.F. Stevens

Distribution Northern New Guinea.

S.I. Wiselius (general part),
M.S.M. Sosef (selection of species)

Chrysophyllum L.

Sp. pl. 1: 192 (1753); Gen. pl., ed. 5: 88 (1754).

SAPOTACEAE

$x = 13$; *C. cainito*: $2n = 24, 26$, *C. oliviforme* L.: $2n = 52$

Vernacular names Nyatoh (trade name). Chrysophyllum, padang (En). Indonesia: nyatuh. Malaysia: pepulut (Peninsular). Philippines: nato, white nato. Thailand: masang. Vietnam: v[us] s[uwx]a.

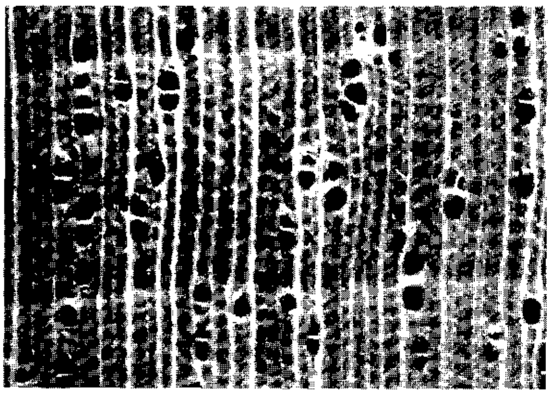
Origin and geographic distribution *Chrysophyllum* comprises about 70 species, 43 in the Neotropics, about 15 in Africa, about 10 in Madagascar and 3 in the Asiatic tropics from Sri Lanka and India to Indo-China, southern China, Thailand and the Malesian region, east to the Solomon Islands. Two of the latter three species, *C. cainito* and *C. oliviforme*, have been introduced from the Americas.

Uses The wood of *Chrysophyllum* is used for general construction under cover, such as planking, light framing, flooring, interior trim, lining, shelving, cladding, panelling and partitioning. It is also suitable for mouldings, light tool handles, dowels, inlaying, carving, joinery, furniture and cabinet making. Good quality veneer and plywood as well as a good quality paper can be obtained from *Chrysophyllum* wood.

C. cainito and *C. oliviforme* are primarily cultivated for their edible fruits ('star apple'). The first also yields useful timber; its branches are used as a medium to grow orchids, and it is appreciated as an ornamental. The fruits of *C. lanceolatum* are also edible but less tasty.

Production and international trade *Chrysophyllum* timber is not traded separately but generally mixed with timber from other *Sapotaceae* genera and sold as 'nyatoh'. Supplies are limited and it forms only a very minor proportion of the timber traded in this trade group. Very small amounts of *Chrysophyllum* are exported from New Guinea and the Solomon Islands to Japan in mixed log consignments of lightweight hardwood.

Properties The following description only refers to *C. lanceolatum*. It yields a medium-weight to heavy hardwood with a density of 450–935 kg/m^3 at 15% moisture content. A strikingly large difference was observed between samples from different regions: the average density of 6 samples from Peninsular Malaysia was 815 kg/m^3, whereas the average of 15 samples from Irian Jaya was only 530 kg/m^3. Heartwood yellow-



Chrysophyllum lanceolatum
transverse surface (×20)

white or yellow-brown, not sharply demarcated from the sapwood; grain straight or shallowly interlocked; texture very fine and even; wood with a faint sour scent. Growth rings visible with a hand lens as darker zones lacking parenchyma at the end of a growth ring; vessels very small to medium-sized, almost all in radial multiples of 2–11, aligned radially, or in occasional clusters, open, not visible to the naked eye; parenchyma moderately abundant, apotracheal in numerous narrow, regular bands (reticulate), usually only visible with a hand lens, and diffuse-in-aggregates; rays very fine or moderately fine, just visible to the naked eye; ripple marks absent.
Shrinkage upon seasoning is low. The wood seasons well with little degrade but is susceptible to blue stain. The wood is soft to hard, weak and brittle. The wood planes to a very smooth surface with little picking up even on radial faces, it needs little filling and polishes well. It is non-durable and the permeability for preservatives is low, but is satisfactory under pressure. The sapwood is non-susceptible to *Lyctus*.
See also the tables on microscopic wood anatomy and wood properties.

Botany Evergreen, small to very large trees (sometimes shrubs or rarely lianas in other continents) up to 55 m tall; bole usually straight, cylindrical but often fluted or spurred at base, branchless for up to 40 m, up to 85 cm in diameter, buttresses small or absent; bark surface smooth to irregularly fissured, grey or purplish grey to blackish, inner bark fibrous, orange-white mottled to yellow-white, exuding white latex. Leaves alternate, simple, entire, with numerous secondary veins connected by intramarginal ones, exstipulate. Flowers in an axillary fascicle; sepals 5; corolla 5-lobed; stamens 5, attached to the corolla tube, staminodes absent; ovary superior, 5–10-locular with 1 ovule per cell, style included. Fruit a 1-many-seeded berry with laterally compressed seeds. Seedling with epigeal germination; cotyledons emergent, leafy; hypocotyl elongated; all leaves alternate.
Growth form is according to Troll's architectural tree model, characterized by all axes being plagiotropic and the stem built up by continuous superposition of branches thus being sympodial. In Java *C. lanceolatum* flowers in May–August. The flowers are pollinated by insects. During maturation fruits of *C. lanceolatum* change from light brown to light green or butter-coloured. Fruits of *C. cainito* are dispersed by bats. Due to fragmentation of the Sungei Menyala forest (Peninsular Malaysia) the mammals that once ate and dispersed the seed of *C. lanceolatum* have disappeared and today piles of rotting fruits accumulate below the parent trees.
Three varieties have been distinguished within *C. lanceolatum*: var. *stellatocarpon* v. Royen ex Vink occurring from Sri Lanka to Sumatra, var. *lanceolatum* from Java, Borneo, the Philippines, Sulawesi and New Guinea, and var. *papuanum* C.T. White from Papua New Guinea and the Solomon Islands.

Ecology *C. lanceolatum* occurs scattered or in small groups in primary rain forest, from sea-level up to 1600 m altitude. It has been found on loam, clay, sandy clay, sand and volcanic tuff soils in perhumid to slightly seasonal conditions.

Silviculture *Chrysophyllum* can be propagated by seed. The fruit-producing species are propagated vegetatively. Natural regeneration is best at about 50% relative light intensity. Seeds of *C. cainito* cannot be stored. They have about 70% germination in 14–40 days and those of *C. lanceolatum* about 65% germination in 18–43 days.

Genetic resources and breeding The risk of genetic erosion of *C. lanceolatum* is determined by the conservation of primary forest habitats throughout its area of distribution.

Prospects The use of *Chrysophylum* wood is not expected to increase.

Literature 40, 71, 80, 125, 151, 162, 163, 169, 235, 267, 300, 343, 348, 360, 364, 389, 436, 464, 538, 640, 778, 780, 827, 829, 831, 877, 949, 1038, 1123, 1164, 1169, 1174, 1221, 1232, 1242.

Selection of species

Chrysophyllum cainito L.

Vernacular names Caimito, star apple (En). Caimite, pomme surette (Fr). Indonesia: sawo hejo (Sundanese), sawo ijo (Javanese), sawo kadu (Bantam). Malaysia: sawu duren (Peninsular). Philippines: kaimito (Filipino). Singapore: chicle durian. Laos: nam[2] nom. Burma (Myanmar): hnin-thagya. Thailand: sata appoen (central). Vietnam: c[aa]y v[us] s[uwx]a.

Distribution Indigenous to the West Indies; cultivated throughout the tropics, in South-East Asia most frequent in the Philippines, Thailand and southern Indo-China.

Chrysophyllum lanceolatum (Blume) DC.

Synonyms *Chrysophyllum javanicum* Steud., *Chrysophyllum roxburghii* G. Don, *Donella lanceolata* (Blume) Aubrév.

Vernacular names Indonesia: dondon gisalakino (Tobela, Sulawesi), ki baiyongbong (Sundanese), pelai eilin (Dayak, Kalimantan). Malaysia: pulut-pulut (Peninsular). Philippines: kalalang (general and Ibanag), buka-buka (Tagbanua). Burma (Myanmar): than-kya-pin. Cambodia: bai damnoeup. Thailand: hua tao, nam phueng (peninsular), khe phueng (eastern). Vietnam: s[af]ng s[as]p, c[aa]y s[aj]p, c[aa]y s[ow]n xa.

Distribution From Sri Lanka, India and Burma (Myanmar) to Indo-China, southern China, Hainan, Thailand, throughout the Malesian area except for the Lesser Sunda Islands, east to the Solomon Islands.

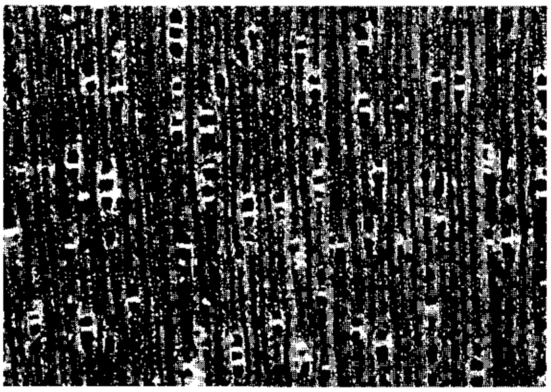
S.I. Wiselius

Cleistanthus Hook. f. ex Planch.

Hooker's Icon. pl. 8: t. 779 (1848).
EUPHORBIACEAE
$x = 11$; *C. collinus* (Roxb.) Benth.: $n = 11$

Vernacular names Indonesia: asam-asam (Sumatra), asam gunung (Indonesian, Kalimantan), bajar buhu (Kutai, Kalimantan). Vietnam: c[oj]c r[af]o, v[uwf]ng t[af]u.

Origin and geographic distribution *Cleistanthus* comprises over 100 species, 30 of which occur in Africa and Madagascar. The rest are found in tropical Asia from India to the Malesian region, Melanesia and northern Australia. The distribution of species within Malesia is as follows: Peninsular Malaysia 34 species, Sumatra 11, Java 3, Borneo 37, the Philippines 22, Sulawesi 4, the Lesser Sunda Islands 7, the Moluccas 5 and New Guinea 9.



Cleistanthus collinus
transverse surface (×20)

Uses The wood of *Cleistanthus* is used for temporary construction, native houses, tool handles and household utensils; possibly also for poles and fuel.

The toxic Indian species *C. collinus* (Roxb.) Benth. is planted for fuel, and its pulp, when mixed with that of other species, is suitable for the production of packaging paper.

Production and international trade As supplies are generally scarce and trees seldom reach commercial size, *Cleistanthus* timber is used on a local scale only.

Properties *Cleistanthus* yields a medium-weight hardwood with a density of 550–820 kg/m^3 at 15% moisture content. Heartwood pink-brown with a purple-grey tinge or reddish-grey, not clearly differentiated from the sapwood; grain wavy; texture moderately fine and even. Growth rings absent; vessels moderately small, mostly in radial multiples of 2–4; parenchyma sparse, apotracheal diffuse to diffuse-in-aggregates, difficult to see even with a hand lens; rays moderately fine, barely visible to the naked eye; ripple marks absent.

The wood is moderately hard and fairly strong. It is probably only slightly durable when exposed to the weather or in contact with the ground.

See also the table on microscopic wood anatomy.

Botany Monoecious shrubs and usually small or rarely medium-sized trees up to 20(–40) m tall; bole straight to crooked, up to 50 (very rarely to 150) cm in diameter, rarely with small buttresses. Leaves alternate, simple, entire, usually with lax and more or less reticulate tertiary venation, often glaucous below; stipules small. Inflorescence axillary, fasciculate-glomerate, male, female or bisexual. Flowers very small, 5-merous; sepals valvate; petals smaller than sepals; disk annular or cupular. Male flower with stamens united below into a column; pistillode very small, borne at the apex of the column. Female flower with a superior, (2–)3(–4)-locular ovary with 2 ovules in each cell, styles 3, simple, bifid or twice bifid. Fruit a lobed, mainly 3-locular capsule with 2 seeds per locule.

Ecology Most *Cleistanthus* species occur in the lower strata of primary evergreen rain forest or less often monsoon forest, up to 700(–1100) m altitude. They may be locally common but scattered in dipterocarp forest, kerangas, less frequently in swamp forest, and occur on a wide variety of soils including limestone soils.

Silviculture Most *Cleistanthus* species appear to be fire-resistant.

Genetic resources and breeding Deforestation may endanger those *Cleistanthus* species with a limited area of geographic distribution.

Prospects Since supplies are limited no increase in the use of *Cleistanthus* wood is foreseen.

Literature 26, 28, 31, 32, 33, 34, 36, 70, 162, 163, 174, 267, 391, 436, 481, 543, 795, 834, 835, 861, 883, 974, 1038, 1195, 1221, 1232.

Selection of species

Cleistanthus floricola Airy Shaw

Distribution The Lesser Sunda Islands (Flores).

Cleistanthus hirsutipetalus Gage

Distribution Peninsular Malaysia.

Cleistanthus hirsutulus Hook. f.

Synonyms *Cleistanthus cochinchinae* Jabl., *Cleistanthus penangensis* Jabl., *Cleistanthus siamensis* Craib.

Vernacular names Malaysia: kerudas bukit, tongmogu (Peninsular). Thailand: kaeo nam (south-eastern), khaang khaeng khae (northern), ta krim (peninsular). Vietnam: v[uwf]ng t[af]u.

Distribution Indo-China, Thailand, Peninsular Malaysia, Singapore, Sumatra and Borneo.

Cleistanthus insignis Airy Shaw

Distribution Papua New Guinea.

Cleistanthus myrianthus (Hassk.) Kurz

Synonyms *Cleistanthus cupreus* S. Vidal, *Cleistanthus pseudocanescens* Elmer, *Cleistanthus pseudomyrianthus* Jabl.

Vernacular names Indonesia: kakaduan, salam anjing (Sundanese). Malaysia: kurau, setong gajah, setong landak (Peninsular). Philippines: bakayau-dilau (Tagalog). Burma (Myanmar): chinmanan. Thailand: fai, thurian dong (northern). Vietnam: c[oj]c r[af]o l[oo]ng len.

Distribution From India, Burma (Myanmar), Indo-China, southern China and Thailand, throughout the Malesian region towards the Solomon Islands and northern Australia.

Cleistanthus pedicellatus Hook. f.

Synonyms *Cleistanthus dichotomus* J.J. Smith, *Cleistanthus integer* C.B. Rob., *Cleistanthus quadrifidus* C.B. Rob.

Vernacular names Philippines: anupag, mobatu (Cebu Bisaya).

Distribution Peninsular Malaysia, Borneo (Sabah, Sarawak), the Philippines and New Guinea.

Cleistanthus pubens Airy Shaw

Distribution Borneo.

Cleistanthus sumatranus (Miq.) Müll. Arg.

Synonyms *Cleistanthus heterophyllus* Hook. f., *Cleistanthus laevigatus* Jabl., *Cleistanthus oligophlebius* Merr.

Vernacular names Thailand: fin daeng (south-western). Vietnam: c[oj]c r[af]o l[as] du[oo]i d[af]i.

Distribution Indo-China, southern China, Thailand, Peninsular Malaysia, Singapore, Sumatra, Java, Borneo, Sulawesi and the Moluccas; possibly also in the Philippines.

Nguyen Nghia Thin

Colubrina Rich. ex Brongn.

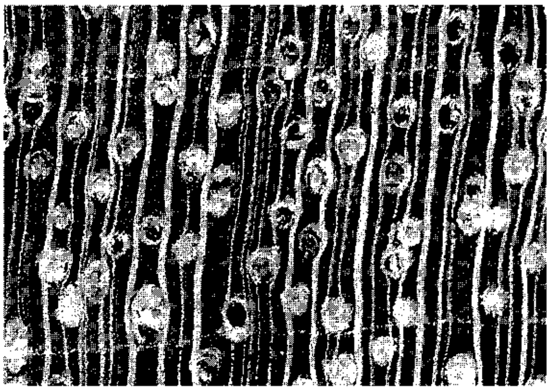
Mém. fam. Rhamn.: 61 (1826).

RHAMNACEAE

$x = 12$; $2n$ = unknown for Asiatic species

Origin and geographic distribution *Colubrina* comprises about 24 species, has a pantropical distribution, and is mainly centred in Central America. Three species are found throughout the Malesian region.

Uses The wood of *Colubrina* is used for general



Colubrina beccariana
transverse surface (×20)

construction and local house building.

Production and international trade The wood of *Colubrina* is probably rarely used and only on a local scale.

Properties *Colubrina* yields a heavy hardwood with a density of 1005–1065 kg/m^3 at 15% moisture content. Heartwood blood-red-brown, sharply differentiated from the narrow yellow sapwood; grain straight, but irregular in samples from small trees; texture fine and even. Growth rings visible, boundaries indicated by marginal parenchyma; vessels moderately small to medium-sized, solitary and in radial multiples of 2–8, the solitary ones typically larger than those in groups, open or filled with yellow-pink solid deposits; parenchyma moderately abundant, paratracheal scanty, vasicentric, and apotracheal in marginal or seemingly marginal bands, some diffuse; rays moderately fine to medium-sized, just visible to the naked eye on transverse and tangential surface; ripple marks absent.

The wood is very hard.

See also the table on microscopic wood anatomy.

Botany Deciduous or evergreen shrubs or small to medium-sized trees up to 30 m tall; bole branchless for up to 20 m, up to 50 cm in diameter, sometimes with small buttresses or stilt roots; bark surface smooth to slightly dimpled, brittle, reddish-brown to dark brown, inner bark light red, pale yellow near the cambium. Leaves alternate, simple, entire to finely serrate, 3-veined at base; stipules minute, caducous. Inflorescence an axillary cyme or small thyrse, sessile or shortly peduncled. Flowers small, bisexual, 5(–6)-merous; hypanthium hemispherical to saucer-shaped; sepals keeled inside, caducous; petals clawed, hooded, greenish-yellow to yellow or rarely whitish; disk massive, fleshy; ovary semi-inferior, (2–)3(–4)-locular with 1 ovule in each cell, style usually 3-lobed or 3-fid. Fruit a globose capsule, orange-red to black, dehiscing explosively into 3 ventrally dehiscent stones. Seed reddish-brown to black, glossy.

Colubrina is probably the most primitive genus within the *Rhamnaceae*. The related *Emmenosperma papuanum* (Merr. & L.M. Perry) M.C. Johnston (synonym: *Colubrina papuana* Merr. & L.M. Perry) is a lesser-known timber from New Guinea used for general construction.

Ecology *C. beccariana* is a typical representative of primary lowland rain forest, up to 200 m altitude.

Genetic resources and breeding Being restricted to primary forest, the risk of genetic erosion depends on the extent of destruction of the habitat. Despite the comparatively large distribution area the occurrence of *C. beccariana* is scattered and local.

Prospects Very little is known about the wood quality of *Colubrina*. It is unlikely that its use will increase in the near future.

Literature 163, 267, 505, 940, 1048, 1221, 1222.

Selection of species

Colubrina beccariana Warb.

Synonyms *Colubrina anomala* King.

Vernacular names Malaysia: obar-obar (Dusun, Sabah), sena hutan (Peninsular), udok-udok (Malay, Sabah).

Distribution Peninsular Malaysia, Borneo (Kalimantan, Sabah), the Moluccas and New Guinea (Irian Jaya).

Colubrina pedunculata Baker

Distribution Christmas Island, Sulawesi, the Lesser Sunda Islands and New Guinea.

C. Schirarend

Combretocarpus Hook. f.

Benth. & Hook. f., Gen. pl. 1: 683 (1865).

ANISOPHYLLEACEAE

x = unknown; $2n$ = unknown

Vernacular names Brunei: balak bekatan, keruntum, perapat hutan. Indonesia: perepat darat (general, trade name), marapat (Dayak Ngaju, Kalimantan), teruntum batu (Bangka).

Malaysia: keruntum (general, Sarawak), perapat paya, perapat perapat (Sabah).

Origin and geographic distribution *Combretocarpus* is a monotypic genus. The only species, *Combretocarpus rotundatus* (Miq.) Danser (synonym: *Combretocarpus motleyi* Hook. f.), is distributed in Sumatra, Borneo, and intervening islands (Riau Archipelago, Bangka, Belitung). It is most abundant in Sarawak and Brunei and has only once been collected in Peninsular Malaysia.

Uses The wood of *C. rotundatus* is locally highly favoured for heavy interior construction and railway sleepers, but needs preservation for the latter purpose. It is also used for temporary construction exposed to the weather, furniture, flooring, panelling, boat construction, agricultural implements, sliced veneer and firewood. Posts are sometimes used for live fencing.

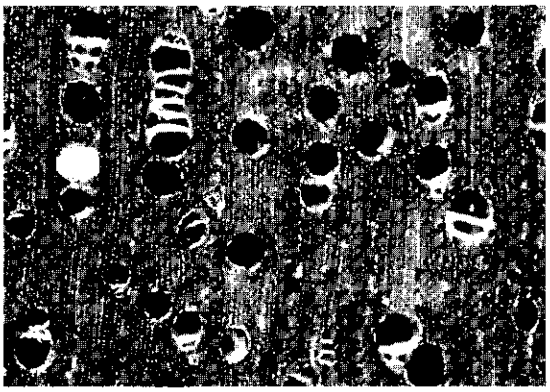
Production and international trade Owing to its abundance, *C. rotundatus* is potentially one of the most important timbers of Sarawak. However, so far only small amounts have been imported by Japan from Sarawak.

Properties *C. rotundatus* yields a medium-weight hardwood with a density of 635–870 kg/m^3 at 15% moisture content. The heartwood is reddish-brown and generally distinct from the grey-white sapwood, which turns grey-brown upon exposure; grain straight to interlocked; texture coarse and uneven; radial and tangential surfaces exhibit an attractive silver grain figure. Growth rings indistinct or absent; vessels medium-sized to moderately large, mostly solitary, less often in radial multiples of up to 4, white deposits commonly present; wood parenchyma variable, generally apotracheal diffuse-in-aggregates tending to arch between the broad rays; rays moderately broad to very broad, broad rays distinct; ripple marks absent; crystals visible on transverse section.

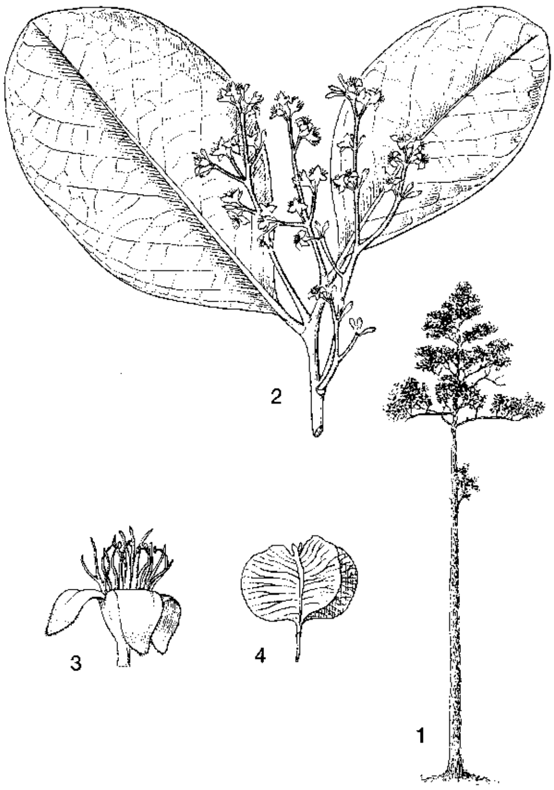
Shrinkage upon seasoning is low to rather high; there is a slight risk of warping, splitting or end-checking. The wood dries slowly and it takes 3 and 6 months to dry 13 mm and 38 mm thick boards, respectively. In Malaysia kiln schedule G is recommended. The timber is worked fairly easy with hand and machine tools, though has a tendency to spring during sawing. The nailing properties are rated as poor. The wood is rated as moderately durable for outside uses, but is durable under cover. It is not resistant to marine borer attack and absorbs a mixture of 50% creosote and 50% diesel oil moderately well (95–130 kg/m^3).

See also the tables on microscopic wood anatomy and wood properties.

Botany A medium-sized to fairly large tree up to 40 m tall; bole usually straight (sometimes crooked and twisted), up to 100 cm in diameter, without buttresses, clustered stilt roots sometimes present, in swamps sometimes with mats



Combretocarpus rotundatus
transverse surface (×20)



Combretocarpus rotundatus (Miq.) Danser – 1, tree habit; 2, flowering twig; 3, flower; 4, fruit.

of thread-like rusty brown aerial roots; bark surface irregularly and deeply fissured, fawn to greyish-brown, inner bark hard, orange-brown; crown usually irregular, with twisted branches. Leaves alternate, simple, entire, cuneate at base, rounded at apex; stipules absent. Flowers in a paniculate, axillary inflorescence, yellow, 3(–4)-merous; calyx lobes deltoid-ovate; petals linear, entire or sometimes laciniate; stamens twice the number of the petals; ovary inferior, 3(–4) locular with 2 ovules in each cell, styles 3(–4), free. Fruit dry, 1-seeded, broadly 3-winged. Seed spindle-shaped.

The young leaves are conspicuously bright crimson to dark red.

Combretocarpus is related to *Anisophyllea*. Both genera are often included in the family *Rhizophoraceae*. However, recent multidisciplinary research has shown that they can best be placed in a separate family *Anisophylleaceae*.

Ecology *C. rotundatus* grows on waterlogged soils of peat-swamp forest and kerangas up to 100(–300) m altitude. It occurs most abundantly in secondary forest or forest with an open canopy, but there the trees are often small and of poor form. In Sarawak well-developed trees are found in peat-swamp forest associated with alan (*Shorea albida* Sym.).

Silviculture Propagation and planting have not been practised, but as the tree coppices vigorously, regeneration of logged-over forest will pose no problem. Fallen trees usually develop adventitious shoots from the bole and these eventually develop into trees. Even posts used for fencing and similar purposes often root and sprout. In some localities the trunk of old trees is hollow. Green logs sink in water. In large areas of Sarawak and Brunei there are more than 5 large trees of *C. rotundatus* per ha on average.

Genetic resources and breeding *C. rotundatus* does not seem to be endangered as it is commonly found over large areas and regenerates particularly well after disturbance of the swamp forest.

Prospects As early as the 1950s it was recognized that this timber has good prospects. However, to date it does not seem to be exported in substantial quantities and is used only locally. Comparatively large supplies are available, and the wood shows good properties and an attractive silver grain figure. However, additional research is still needed on the proper management of swamp forest from which this timber can be sustainably harvested.

Literature 40, 61, 151, 162, 259, 267, 341, 464, 861, 1040, 1048, 1221, 1242.

E. Boer & R.H.M.J. Lemmens

Croton L.

Sp. pl. 2: 1004 (1753); Gen. pl., ed. 5: 436 (1754).

EUPHORBIACEAE

$x = 10$; $2n$ = unknown for Malesian species

Vernacular names Silver croton (En). Brunei: kemarik. Indonesia: caporimbo (Jambi, Sumatra), parengpeng (Sundanese), walik lar (Javanese). Malaysia: cheret budak, chenderai gajah, melokan (Peninsular). Philippines: tubang-puti (Filipino). Laos: khai[2] don[1], sa 'lot, 'sê 'lot. Thailand: plao (central).

Origin and geographic distribution *Croton* is a very large genus of at least 800 species, the majority in America, but with some 200 species in the Old World tropics. Some 45 species occur in Malesia, most of them in East Malesia. The only timber-yielding species is *C. argyratus* Blume (synonyms: *C. budopensis* Gagnep., *C. maieuticus* Gagnep., *C. tawaoensis* Croizat) which is found in Burma (Myanmar), Indo-China, Thailand, throughout the Malesian region (except for New Guinea), and in northern Australia.

Uses The wood of *Croton* is used for poles in house construction and for agricultural implements like tool handles.

The seeds yield an oil used in lamps. Some goat ranchers in the Philippines use live fences of *Croton*.

Production and international trade *Croton* wood is used rarely and on a local scale only.

Properties *C. argyratus* yields a medium-weight to heavy hardwood with a density of 735–930 kg/m^3 at 15% moisture content. Heartwood pale yellow, not clearly differentiated from the sapwood; grain straight; texture rather fine and even. Growth rings absent; vessels moderately small, mostly in radial multiples of 2–7; parenchyma abundant, apotracheal in narrow bands, and diffuse-in-aggregates, distinct with a hand lens; rays extremely fine or moderately fine, the latter visible to the naked eye; ripple marks absent; occasionally with traumatic vertical canals.

The wood seasons well and is hard. Its durability has not been well established. Discolouration by sap-stain has been reported.

See also the table on microscopic wood anatomy.

Croton argyratus
transverse surface (×20)

Botany An evergreen, monoecious, small to medium-sized tree up to 27 m tall; bole fairly straight, cylindrical, up to 70(–170) cm in diameter, without buttresses; bark surface finely fissured, greyish. Leaves arranged spirally, simple, entire to denticulate; blade cordate, with 2 glands at base, scaly below; stipules oblong, caducous. Flowers unisexual, in a terminal thyrse with female flowers solitary at base and male ones in cymules towards the apex; sepals 5, imbricate. Male flower with 5 petals; disk composed of 5 glands; stamens numerous, inflexed in bud; pistillode absent. Female flower without petals; disk annular; ovary superior, 3-locular with 1 ovule in each cell, styles 3, bifid. Fruit a capsule splitting into 3 or 6 parts, with a persistent calyx. Seed small, smooth. Seedling with epigeal germination; cotyledons emergent, leafy; hypocotyl elongated; all leaves arranged spirally.
In Java *C. argyratus* has been observed flowering throughout the year.

Ecology *C. argyratus* is found mainly in secondary rain forest and occasionally in monsoon forest including teak forest, up to 1000(–1500) m altitude. It usually occurs in well-drained locations on sandy clay, sandy loam, heavy loam with limestone, or basaltic soils.

Silviculture *C. argyratus* can be propagated by seed which has about 45% germination in 22–73 days.

Genetic resources and breeding There are no records of ex situ conservation of *C. argyratus*. Its wide area of distribution and occurrence in secondary vegetation make it unlikely to be at risk of genetic erosion.

Prospects No increase in the use of *Croton* wood is foreseen.

Literature 26, 28, 33, 34, 36, 70, 162, 163, 209, 267, 364, 436, 464, 543, 829, 831, 861, 963, 974, 1038, 1169, 1194, 1195, 1221, 1256.

C. Phengklai

Crudia Schreb.

Gen. pl. 1: 282 (1789).
LEGUMINOSAE
x = unknown; $2n$ = unknown

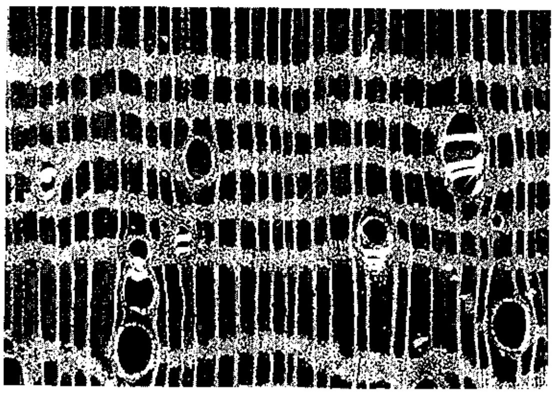
Vernacular names Malaysia: babi kurus, merbau kera (Peninsular).

Origin and geographic distribution The pantropical genus *Crudia* comprises about 50 species. Within the Malesian region 30 species occur which are distributed as follows: Peninsular Malaysia 11 species, Sumatra 3, Java 2, Borneo 13, the Philippines 3, the Moluccas 1 and New Guinea 5.

Uses The wood of *Crudia* is suitable for temporary construction or heavy construction under cover, flooring, door and window frames and interior finish. It is a useful local substitute for heavy tool handles.
In Borneo the boiled fruits of *C. teysmannii* serve as fish bait for small freshwater fish.

Production and international trade As supplies of *Crudia* timber are generally very limited, it is used on a local scale only.

Properties *Crudia* yields a medium-weight but usually heavy hardwood with a density of 740–1125 kg/m^3 at 15% moisture content. Heartwood dark chocolate-brown to purplish, with paler streaks, sharply differentiated from the up to 13 cm wide, red-brown, yellow-brown or straw-



Crudia scortechinii
transverse surface (×20)

coloured sapwood; grain interlocked and wavy; texture moderately fine and rather uneven. Growth rings not distinct to the naked eye, but distinct on thin sections; vessels medium-sized, solitary and in radial multiples of 2–4, occcasionally filled with yellow-white solid deposits; parenchyma abundant, apotracheal in narrow marginal or seemingly marginal bands and in more or less continuous narrow to moderately broad bands, the latter enclosing all vessels in *C. blancoi*; rays extremely fine, visible only with a hand lens; ripple marks absent, but the rays tending to be storeyed.

The wood is difficult to saw and plane and has a distinct dulling effect on tools. The wood is very hard and strong to very strong. It is very durable; in Peninsular Malaysia, however, it is rated as non-durable, which is questionable as in a graveyard test only 8 out of the 60 test stakes were severely attacked in 12 months. The sapwood of *C. curtisii* is susceptible to *Lyctus*.

See also the tables on microscopic wood anatomy and wood properties.

Botany Evergreen, small to medium-sized trees up to 25(–35) m tall, sometimes a shrub or climber; bole up to 60(–80) cm in diameter, with buttresses up to 2(–3.8) m high; bark surface smooth or dippled, brown or grey-brown, inner bark soft, fibrous, orange-brown or brown. Leaves arranged spirally, imparipinnate, 1–9(–13)-foliolate; leaflets alternate, entire, with short petiolules, secondary veins looping and joined well inside the margin; stipules intrapetiolar and connate at base or occasionally interpetiolar and free. Flowers in an axillary or terminal, solitary or fasciculate raceme, small, regular; hypanthium shallowly cupular or campanulate; calyx 4-lobed, reflexed; petals absent; disk absent; stamens 10 or fewer, filaments united at base; ovary superior, stalked, 1-locular with 1–6 ovules, style filiform. Fruit an obliquely orbicular to ellipsoid or ovoid, slightly woody, dehiscing, 2-valved, 1–4(–6)-seeded pod. Seed round or kidney-shaped, compressed. Seedling with hypogeal or semi-hypogeal germination; cotyledons not emergent; hypocotyl not elongated; epicotyl with several scale leaves followed by spirally arranged, pinnate leaves.

The cavity in the seed between the concave cotyledons may make the seeds buoyant and thus promote dispersal by water.

Crudia belongs to the subfamily *Caesalpinioideae*.

Ecology *Crudia* is encountered in primary or occasionally secondary, lowland rain forest, up to 550 m altitude. It is found in well-drained sites but also along rivers or even on periodically inundated soils. *C. tenuipes* is sometimes found on limestone.

Silviculture *Crudia* can be propagated by seed. Seeds of *C. curtisii* have a germination rate of 75–85% and they germinate in 1–9 months.

Genetic resources and breeding As *Crudia* species are generally rare and occur mainly in primary forest, they may be easily endangered by destruction of their habitat.

Prospects No change in the use of *Crudia* timber is anticipated.

Literature 163, 198, 252, 267, 341, 829, 831, 861, 933, 934, 974, 1163, 1242.

Selection of species

Crudia blancoi Rolfe

Synonyms *Apalotoa blancoi* (Rolfe) Merr.

Vernacular names Philippines: ulud (Tagalog).

Distribution The Philippines, the Moluccas (Tanimbar Island) and Papua New Guinea.

Crudia curtisii Prain

Synonyms *Crudia glauca* Ridley.

Vernacular names Malaysia: jering tupai, kempas rimau, merbau kera (Peninsular).

Distribution Peninsular Malaysia.

Crudia dewitii Kosterm.

Distribution New Guinea and the Solomon Islands.

Crudia katikii Verdc.

Distribution Papua New Guinea.

Crudia papuana Kosterm.

Distribution New Guinea and the Solomon Islands.

Crudia ripicola de Wit

Vernacular names Indonesia: jemlai, melapisau (Kutai, Kalimantan).

Distribution Borneo (Kalimantan).

Crudia scortechinii Prain

Vernacular names Malaysia: babi kurus (Peninsular).

Distribution Peninsular Malaysia.

Crudia tenuipes Merr.

Distribution Borneo.

Crudia teysmannii de Wit

Vernacular names Indonesia: empai tawang (Semitau, Kalimantan), kaliwung (Sungaibaru, Kalimantan), kayu lempai (Kapuas, Kalimantan).
Distribution Southern Sumatra and Borneo (Kalimantan).

Crudia velutina Ridley

Distribution Peninsular Malaysia and Borneo (Sarawak).

Crudia wrayi Prain

Synonyms *Crudia havilandii* Prain.
Vernacular names Malaysia: kaliwang (Mendawei, Sarawak).
Distribution Peninsular Malaysia and Borneo (Sarawak, Kalimantan).

E. Boer (general part),
M.S.M. Sosef (general part, selection of species)

Crypteronia Blume

Bijdr. fl. Ned. Ind.: 1151 (1826).
CRYPTERONIACEAE
x = unknown; $2n$ = unknown

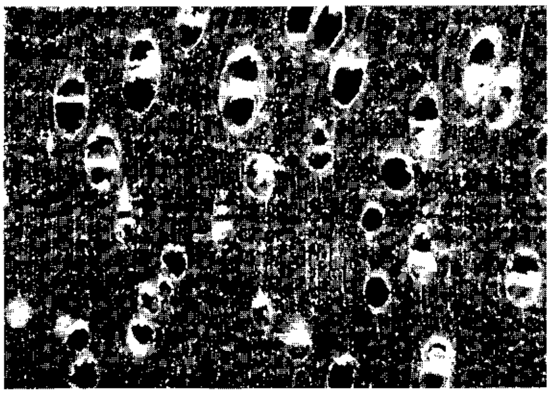
Vernacular names Malaysia: bekoi (Peninsular), rambai-rambai (Sabah). Philippines: tiaui (general). Burma (Myanmar): anambo yon (Tenasserim). Cambodia: trap toum. Laos: 'sa am. Thailand: ka-am (north-eastern), ka som (peninsular), khap (northern). Vietnam: loi.

Origin and geographic distribution *Crypteronia* comprises 7 species and is distributed from India (Assam and Bengal) to Burma (Myanmar), Indo-China, Thailand and throughout the Malesian region.

Uses The wood of *Crypteronia* is used for general construction and house building, furniture, often for flooring or interior finish. It is sometimes applied as a substitute for meranti (*Shorea* spp.). It may be useful as a fuelwood.
In Malaysia some species are planted for ornamental purposes. In Java young shoots have been eaten raw as a flavouring with rice.

Production and international trade Supplies are generally too limited for commercial trade in *Crypteronia* timber. Consumption is most probably only local.

Properties *Crypteronia* yields a medium-weight hardwood with a density of 500–805 kg/m^3 at 15% moisture content. Heartwood reddish or greyish-brown, or pale brown with a pinkish tinge, not clearly demarcated from the pale red sapwood; grain straight or slightly wavy; texture rather fine and even; taste astringent. Growth rings generally just discernible with a hand lens by the absence of the apotracheal parenchyma or presence of marginal parenchyma; vessels moderately small to medium-sized, solitary and in radial multiples of 2–3, open or filled with a yellow-white chalky substance; parenchyma moderately abundant, apotracheal diffuse and diffuse-in-aggregates, visible with a hand lens, and scanty paratracheal, indistinct; rays fine or moderately fine, visible with a hand lens; ripple marks absent.
The wood seasons well. It is moderately hard, tough and moderately strong and is easy to work. It is moderately durable under cover.
See also the table on microscopic wood anatomy.



Crypteronia griffithii
transverse surface (×20)

Botany Evergreen, medium-sized to large trees up to 45 m tall; bole columnar, up to 100 cm in diameter, often fluted at base, sometimes with steep buttresses; bark surface rugose to fissured, sometimes finely so, flaking in small pieces, brown or reddish-brown to grey, inner bark granular to fibrous, red to brown. Twigs with thickened nodes and longitudinal lines. Leaves opposite, simple, entire, with minute or rudimentary stipules. Inflorescence consisting of racemes aggregated in a large to poorly branched panicle. Flowers small, bisexual or unisexual and then trees dioecious (*C. paniculata*), 4–5(–6)-merous; receptacle puberulous; petals absent; stamens usually 5; ovary superior, 2–4-locular with many ovules; style 1. Fruit a small capsule with all floral parts persistent, splitting loculicidal. Seed with a narrow membranous wing.
Young leaves are deep blue. In the Malesian region trees appear to be flowering and fruiting

almost throughout the year, but especially at the beginning of the dry season. In Indo-China the flowering season is reported to be in November–December and the fruiting season in January–February. The seeds are dispersed by wind. *C. griffithii* is inhabited by non-aggressive ants of the genus *Cladomyrma*.
When still in the vegetative stage *Crypteronia* species are sometimes mistaken for those of *Syzygium* or *Memecylon*. They can, however, be distinguished from *Syzygium* by the lines present on the twigs and the scarcity of intramarginal veins, and from *Memecylon* by the usually thicker bark. Two varieties of *C. paniculata* are distinguished: var. *affinis* (Planch.) Beus.-Osinga with puberulous leaves and young twigs and var. *paniculata* with glabrous ones.

Ecology *Crypteronia* species are quite rare and found scattered in primary rain forest or monsoon forest under perhumid to subhumid conditions (the Lesser Sunda Islands), from the lowland up to 1300(–1800) m altitude. They are reported from both clayey and sandy soils and from river banks, slopes, ridges, ravines and forest margins.

Genetic resources and breeding Althought detailed information is lacking, the rare and scattered occurrence of *Crypteronia* species render them vulnerable to genetic erosion or extinction by habitat destruction.

Prospects Due to the limited supplies it is unlikely that the utilization of the wood will increase in the near future.

Literature 70, 93, 163, 198, 209, 267, 341, 343, 436, 464, 543, 632, 861, 933, 934, 1038, 1048, 1117, 1148, 1221, 1242.

Selection of species

Crypteronia borneensis J.T. Pereira & K.M. Wong

Vernacular names Malaysia: tampasu (Dusun, Sabah).

Distribution Borneo (Brunei, Sabah, Sarawak).

Crypteronia cumingii (Planch.) Planch. ex Endl.

Synonyms *Henslowia cumingii* Planch.

Vernacular names Indonesia: kumba-a, langori tauru, tomo wanna (Central Sulawesi). Philippines: tigaon (general), andalai (Tagalog), ugau (Bikol).

Distribution The Philippines, Sulawesi, the Moluccas and New Guinea.

Crypteronia elegans J.T. Pereira & K.M. Wong

Distribution Borneo (Brunei, Sarawak).

Crypteronia griffithii C.B. Clarke

Synonyms *Crypteronia cumingii* (Planch.) Planch. ex Endl. var. *griffithii* (C.B. Clarke) Beus.-Osinga.

Vernacular names Indonesia: panarahan (Sumatra). Malaysia: kelat tampoi, telinga badak (Peninsular), ubah semut (Iban, Sarawak). Singapore: talinga badak. Thailand: kratong-loi.

Distribution Southern Burma (Myanmar; rare), peninsular Thailand, Peninsular Malaysia, Singapore, central Sumatra and Borneo.

Crypteronia macrophylla Beus.-Osinga

Distribution Borneo (Kalimantan, Sarawak).

Crypteronia paniculata Blume

Synonyms *Crypteronia leptostachys* (Planch.) Planch. ex Endl., *Crypteronia lutea* (Blanco) Blume, *Crypteronia wallichii* DC.

Vernacular names Indonesia: kayu celeng (Javanese), kayu kapas (Sumatra), ki banen (Sundanese). Malaysia: bekoi, buah babi (Peninsular), ubah semut (Iban, Sarawak). Philippines: tiaui (general), barakbok (Iloko), malabayanas (Tagalog). Cambodia: anlouang, long loun, trap sar. Laos: 'sa am. Thailand: ka som, pi-kui (peninsular), khap (northern). Vietnam: m[uw][ow]ng, ch[af]p mai l[ox]i, dia t[aa]y.

Distribution India (Assam, Bengal), Burma (Myanmar), Indo-China, Thailand, Peninsular Malaysia, Sumatra, Java, Borneo, the Philippines and the Lesser Sunda Islands.

E. Boer (general part),
M.S.M. Sosef (general part, selection of species)

Ctenolophon Oliv.

Trans. Linn. Soc., London 28: 516 (1873).
CTENOLOPHONACEAE
x = unknown; $2n$ = unknown

Vernacular names Mertas (trade name). Brunei: adau. Indonesia: kalek bung cung, kayu bawang (Sumatra), latak manuk (East Kalimantan). Malaysia: besi besi (Sabah), litoh (Iban, Sarawak), mertas (Peninsular). Papua New Guinea: ctenolophon (En). Philippines: sudiang (Cebu, Samar-Leyte Bisaya).

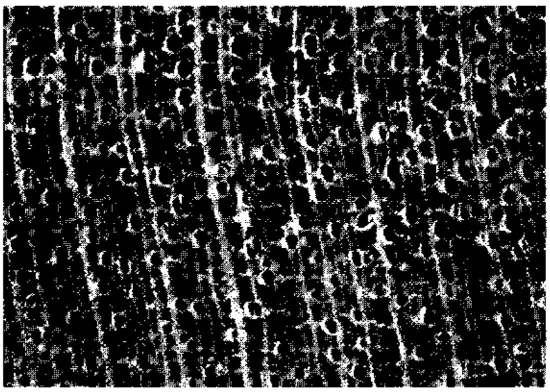
Origin and geographic distribution *Ctenolo-*

phon comprises 2 species with a disjunct distribution; one is found in West and Central tropical Africa, the other, *C. parvifolius* Oliv. (synonyms: *C. grandifolius* Oliv., *C. philippinensis* Merr.), occurs in Peninsular Malaysia, Sumatra, Borneo, the Philippines (Samar, Leyte, Mindanao) and New Guinea. Fossil pollen has been found in South America and India as well and the present distribution of the genus is considered a relic.

Uses The wood of *Ctenolophon* is used for medium to heavy construction, house building (posts, window frames, sills, beams, joists, rafters, staircases), bridge building, marine constructions, ship-building, heavy-duty flooring, parquet flooring, piling, power transmission posts, vehicle bodies, heavy-duty pallets, fences and tool handles.

Production and international trade Small quantities of *Ctenolophon* wood are sold in Malaysia in mixed consignments of medium hardwood. In 1996 Papua New Guinea exported 585 m^3 of *Ctenolophon* logs at an average free-on-board (FOB) price of US$ 103/m^3.

Properties *C. parvifolius* yields a heavy hardwood with a density of 800–1090 kg/m^3 at 15% moisture content. Heartwood brown to purple-grey-brown, often streaked with very dark to almost black concentric bands, indistinctly to distinctly demarcated from the wide pale red sapwood; grain straight or interlocked, sometimes wavy; texture moderately fine and even; wood lustrous, dark-coloured bands oily to the touch. Growth rings indistinct, boundaries indicated by narrow dark-coloured bands with few vessels, 4–10 mm wide, producing alternating pale and dark stripes on radial surface; vessels very small to medium-sized, almost exclusively solitary, sometimes appearing as tangential pairs, occasionally filled with pale deposits, tyloses or dark oily substance, the latter particularly conspicuous on longitudinal surfaces; parenchyma sparse, unilaterally paratracheal tending to confluent in parts, and apotracheal diffuse and diffuse-in-aggregates, difficult to see; rays very fine or moderately fine to very broad; ripple marks absent.



Ctenolophon parvifolius
transverse surface (×18)

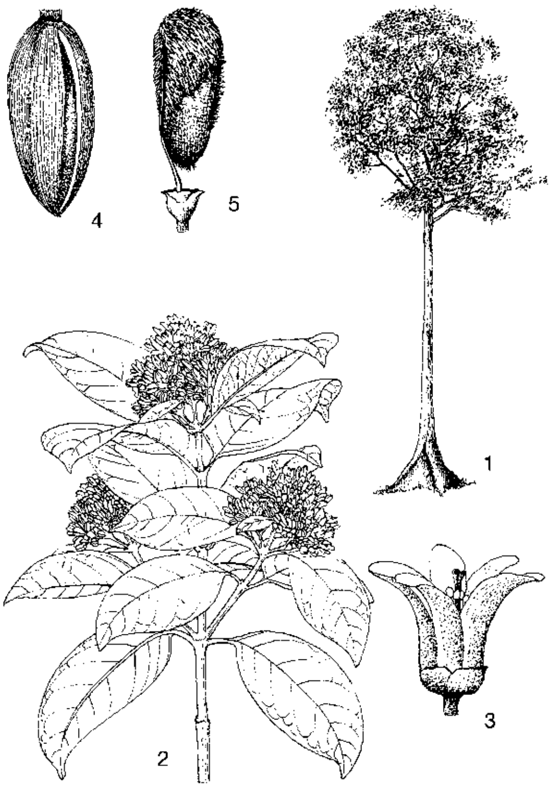
Shrinkage upon air drying is moderate and boards 13 mm and 38 mm thick take respectively about 1.5 and 4 months to air dry. The wood is prone to end-checking and to slight cupping, bowing and stain. The wood is very hard and very strong. It is difficult to work with hand and machine tools due to its hardness. The heartwood is very resistant to termites. The sapwood is non-susceptible to *Lyctus*. The wood is durable when exposed to the weather and in contact with the ground; in a graveyard test in the Philippines the average service life of test stakes was about 9 years. In Malaysia, however, it is reported to be only moderately durable.

See also the tables on microscopic wood anatomy and wood properties.

Botany A medium-sized to fairly large tree up to 40 m tall; bole slightly irregular or fluted, up to 120 cm in diameter, with buttresses up to 4 m high; bark surface cracked to scaly and peeling, lenticellate, reddish-brown to blackish, inner bark granular or fibrous, reddish-brown to pink, slowly exuding a clear, colourless to reddish-brown resin; crown dense, domed. Indumentum of simple and stellately tufted hairs. Leaves opposite, simple, entire, margin often wavy; stipules interpetiolar, caducous. Flowers in an axillary or terminal, cymoid panicle, bisexual, 5-merous, fragrant; sepals connate at base, hairy; petals free, contorted, caducous, pale yellow or pink, hairy outside; disk extrastaminal; stamens 10, alternately longer and shorter; ovary superior, 2-locular with 2 ovules in each cell, hairy, style 1, apically forked. Fruit a 1-celled, 1-seeded, woody capsule, splitting lengthwise, with persistent and enlarged calyx. Seed pendulous from a filiform columella, with a hairy-papillose aril.

In Peninsular Malaysia trees flower and fruit from April–November, from February–December elsewhere.

Ctenolophon is the only genus within the family *Ctenolophonaceae* and is sometimes treated as a monogeneric subfamily within the *Linaceae*, but wood and leaf anatomical, and pollen morphological characters support its exclusion from *Linaceae*. In the field *Ctenolophon* is often mistaken for a *Eugenia* species.



Ctenolophon parvifolius Oliv. – 1, tree habit; 2, flowering twig; 3, flower; 4, fruit; 5, seed.

Ecology *C. parvifolius* is found scattered but may be locally very common in primary lowland rain forest, up to 850(–1650) m altitude. It is found in mixed dipterocarp forest, kerangas, peat-swamp and swamp forest, also on hills and ridges, and prefers rather poor sandstone and ultrabasic soils.

Genetic resources and breeding Since *C. parvifolius* has a wide geographical distribution it seems little vulnerable to genetic erosion.

Prospects As the wood of *C. parvifolius* is fairly heavy, hard and strong, it is likely that it may be used as a substitute for e.g. 'keruing' (*Dipterocarpus* spp.) for heavy construction and bridges.

Literature 82, 163, 198, 267, 302, 341, 387, 464, 677, 678, 679, 740, 741, 862, 933, 934, 974, 1048, 1086, 1129, 1221, 1239, 1240, 1242, 1251.

S.C. Lim

Cubilia Blume

Rumphia 3: 100 (1847).
SAPINDACEAE
x = unknown; $2n$ = unknown

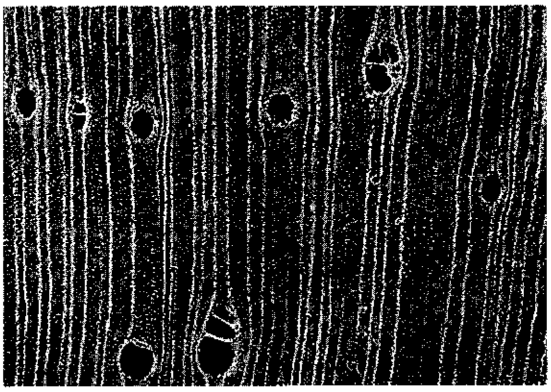
Vernacular names Indonesia: amasi (Ambon), kamesi raindang (Minahassa), saninten sabrang (Sundanese). Philippines: kubili (general), baksian (Manobo), malasaging (Tagalog).

Origin and geographic distribution *Cubilia* is a monotypic genus. Its single species is *C. cubili* (Blanco) Adelb. (synonyms: *C. blancoi* Blume, *C. rumphii* Blume) which occurs naturally in Borneo (East Kalimantan, Sabah), the Philippines, Sulawesi and the Moluccas, and is occasionally cultivated for its fruits in the Philippines, Sulawesi, the Moluccas and Java.

Uses The timber of *C. cubili* is used for interior construction and general carpentry.
The young leaves are eaten as a vegetable. The arillode is edible, as are the seeds, which taste like chestnuts when cooked or roasted. The use of the fruits is probably more important than that of the timber.

Production and international trade There are no records of the timber of *C. cubili* being traded commercially. In fact, the trees are seldom cut for timber because of the fruits, which are called 'castanas' in the Philippines, where they are sold in local markets.

Properties *C. cubili* yields a medium-weight hardwood with a density of 520–730 kg/m^3 at 15% moisture content. Heartwood whitish to reddish brown. Vessels moderately small.
The wood is moderately strong and moderately durable under cover. It is resistant to dry-wood termites. The sapwood is resistant to *Lyctus*.



Cubilia cubili
transverse surface (×20)

The edible portion of the fruit contains 48.3% water, 5.2% protein, 1.9% fat, 23.1% starch, 18.8% other carbohydrates, 1.2% crude fibre and 1.5% ash. The energy value is 861 kJ/100g.
See also the table on microscopic wood anatomy.

Botany An evergreen, monoecious, small to medium-sized or rarely large tree up to 25(–50) m tall; bole straight, branchless for up to 12 m, up to 75 cm in diameter, with buttresses up to 6 m high; bark surface smooth, reddish-brown or greyish-brown; crown globose. Branches cinnamon or red-brown to purplish black. Leaves arranged spirally, paripinnate, 3–7-jugate, exstipulate; leaflets opposite to alternate, entire, often with naked glands in the vein axils below. Flowers in a terminal or pseudo-terminal panicle, unisexual, small, 5-merous; calyx with 5 small lobes; petals very small, included in the calyx, with 2 minute auricles at base inside; disk annular; stamens 5(–6); ovary superior, 2-locular with 1 ovule in each cell, stigma sessile, 2-lobed. Fruit composed of 2 parts, densely prickly. Seed dark brown, enveloped in the thin, entire arillode up to about halfway; testa shiny dark brown. Seedling with hypogeal germination; cotyledons not emergent, succulent; hypocotyl not elongated; first 2–4 leaves scale-like, first developed leaf often 1-jugate, subsequent ones with more leaflets.
Trees bearing flowers or fruits have been reported throughout the year. Flowers are pollinated by insects, probably bees. The seeds are probably dispersed by birds.

Ecology *C. cubili* occurs in primary and secondary rain forest, often on poorly aerated, basic soils, often along rivers, up to 600(–1700) m altitude.

Silviculture In the nursery the germination of *C. cubili* seed is fair and usually within a week.

Genetic resources and breeding In the Philippines *C. cubili* trees are occasionally planted for their fruits, but there are no records of breeding.

Prospects The wood properties of *C. cubili* are very poorly known and its use for timber is limited. Its use as a fruit tree is probably more important, but more research is needed on its cultivation.

Literature 70, 150, 238, 341, 436, 594, 632, 861, 907, 934, 1048.

U.A. Dasuki

Cyathocalyx Champ. ex Hook. f. & Thomson

Fl. ind. 1: 126 (1855).

ANNONACEAE

$x = 8$; *C. martabanicus* Hook. f. & Thomson, *C. zeylanicus* Champ.: $2n = 16$

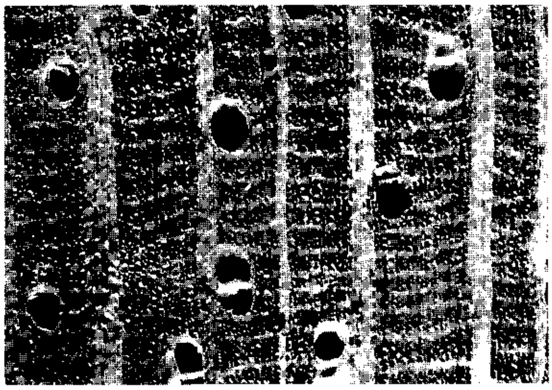
Vernacular names Mempisang (trade name). Brunei: karai. Malaysia: antoi (Peninsular), karai (Sabah), pisang-pisang (Peninsular & Sabah). Vietnam: b[as]t d[af]i.

Origin and geographic distribution *Cyathocalyx* comprises about 35 species occurring from India to Indo-China, Thailand, Peninsular Malaysia, Sumatra, Java, Borneo, the Philippines, New Guinea, Australia and Fiji. About 25 species occur within the Malesian region.

Uses The wood of *Cyathocalyx* is used for general and temporary construction, house building (beams, joists), door and window frames, submerged piles, agricultural implements, tool handles, toys, packing cases and crates, matchboxes and splints. It is also suitable for sliced veneer and as firewood.
The inner bark of *C. bancanus* has been used to make rope. The fruits of *C. globosus* are used in the Philippines as a substitute for betel nut (*Areca catechu* L.).

Production and international trade 'Mempisang' is a general trade name comprising most of the species of *Annonaceae*, and *Cyathocalyx* probably comprises only a minor proportion of the wood traded under this name. In 1992 the export of mempisang wood from Sabah amounted to 25 000 m^3 of sawn timber and 42*500 m^3 of logs with a total value of about US$ 7.2 million. Small amounts of mempisang are imported into Japan, originating mainly from Sabah and Sarawak.

Properties *Cyathocalyx* yields a lightweight to heavy hardwood with a density at 15% moisture content of about 450 kg/m^3 for *C. pruniferus*, 460–650 kg/m^3 for *C. bancanus*, 905–945 kg/m^3 for *C. globosus* and 865–980 kg/m^3 for *C. sumatranus*. Heartwood pale to dark brown with a reddish tinge, clearly differentiated from the pale yellowish-brown, fairly wide sapwood; grain straight; texture moderately fine; wood lustrous and with silver grain. Growth rings generally distinct; vessels moderately small to medium-sized, solitary and in radial multiples of 2–3, occasional hard white deposits and gum present; parenchyma abundant, apotracheal in regular, narrow bands (scalariform), distinct; rays medium-sized to moderately broad; ripple marks absent.



Cyathocalyx polycarpus
transverse surface (×20)

The wood of *C. globosus* seasons well, with little or no warping; it is very hard and very strong and somewhat difficult to work. The heartwood of *C. globosus* is resistant to insect attack and fungi. Its sapwood is non-susceptible to *Lyctus*; in a graveyard test in the Philippines the average service life of sapwood stakes was about 17 months. The wood of the lighter species is rated as non-durable to slightly durable and must be treated with anti-stain chemicals immediately after sawing.
The gross energy value of the wood of *C. sumatranus* is about 19 760 kJ/kg.
See also the table on microscopic wood anatomy.

Botany Evergreen, small to medium-sized trees up to 30(–35) m tall; bole straight, cylindrical, up to 60(–90) cm in diameter, without buttresses; bark surface smooth, dark grey or grey-brown to purple-brown, inner bark fibrous, yellow to light yellow; crown small, dense, with spreading branches. Leaves alternate, simple, entire, often leathery, exstipulate. Flowers extra-axillary, solitary or in fascicles, bisexual; sepals 3, valvate, free or joined into a cup; petals 6, valvate, in 2 rows, cream or yellow to green or brownish-green, outer ones free but inner ones connate and appressed over the sexual organs below and spreading above; stamens many, with flat-topped connective; carpels 1 to several, each with the 2–7 ovules in 1(–2) rows, stigma discoid. Fruit apocarpous; monocarps sessile to shortly stalked, transversely ellipsoid to oblong or obovoid. Seed with ruminate endosperm. Seedling with epigeal germination; cotyledons emergent, leafy; hypocotyl elongated; leaves arranged spirally on the leader shoot, alternate on the branches.
Early growth is reported to be slow, but in Peninsular Malaysia *Cyathocalyx* is reported to be capable of a sustained annual diameter increment of 1.1–1.6 cm. Trees develop according to Cook's architectural tree model, characterized by growth of a monopodial trunk with continuously produced phyllomorphic branches, the inflorescences not influencing the architecture. In Peninsular Malaysia *C. pruniferus* flowers annually and generally abundant fruit is set, ripening in about 4 months.

Ecology *Cyathocalyx* species are found scattered, but may be locally common, in lowland, primary, evergreen or occasionally monsoon forest, up to 1000 m altitude. They occur most frequently in dipterocarp forest.

Silviculture *Cyathocalyx* can be propagated by seed. In a germination experiment in Peninsular Malaysia 40–60% of the seed of *C. pruniferus* germinated in 16 days to 4 months.

Genetic resources and breeding Most *Cyathocalyx* species have a small area of distribution and are uncommon, rendering them vulnerable to genetic erosion by destruction of their habitat.

Prospects Extremely little is known about the ecology, regeneration and silviculture of *Cyathocalyx*. Wood supply is very limited and it is unlikely that its use will increase in the near future.

Literature 70, 150, 163, 209, 235, 238, 267, 402, 406, 436, 468, 672, 673, 707, 740, 770, 829, 830, 831, 837, 861, 863, 883, 934, 1017, 1038, 1126, 1134, 1218, 1221, 1242.

Selection of species

Cyathocalyx bancanus Boerl.

Vernacular names Indonesia: antoi tembaga, tulin (Bangka).
Distribution Bangka (Indonesia).

Cyathocalyx globosus Merr.

Vernacular names Philippines: dalinas (general), alinau (Iloko), damarau (Bisaya).
Distribution The Philippines.

Cyathocalyx petiolatus Diels

Distribution New Guinea.

Cyathocalyx polycarpus C.T. White & W.D. Francis

Distribution New Guinea.

Cyathocalyx pruniferus (Maingay ex Hook. f. & Thomson) J. Sinclair

Synonyms *Drepananthus pruniferus* Maingay ex Hook. f. & Thomson.

Vernacular names Malaysia: antoi beludu, antoi putih (Peninsular).
Distribution Peninsular Malaysia.

Cyathocalyx ramuliflorus (Maingay ex Hook. f. & Thomson) R. Scheffer

Synonyms *Drepananthus ramuliflorus* Maingay ex Hook. f. & Thomson.
Vernacular names Malaysia: antoi itam (Peninsular).
Distribution Peninsular Malaysia, Singapore, Sumatra and Borneo.

Cyathocalyx sumatranus R. Scheffer

Synonyms *Xylopia curtisii* King, *Xylopia tembelingensis* M.R. Hend.
Vernacular names Indonesia: kalak kunir, kalak lawe (Javanese). Thailand: kradangnga dong (peninsular).
Distribution Peninsular Thailand, Peninsular Malaysia, Singapore, Sumatra and Java.

Nguyen Tien Ban

Cyrtostachys Blume

Bull. Sci. Phys. Nat. Néerl. 1: 66 (1838).
PALMAE
$x = 16$; *C. renda*: $2n = 32$

Vernacular names Lipstick palm, scarlet palm, sealing wax palm (En). Indonesia: pinang merah (general). Malaysia: pinang raja (general). Thailand: mak daeng.

Origin and geographic distribution *Cyrtostachys* comprises about 8 species. The majority are found in New Guinea and the Solomon Islands with 1 in western Malesia.

Uses Laths from the outer part of the trunk of *C. renda* are used locally to support *Nypa* leaf thatch. Its wood is also used for flooring and piling. The larger New Guinean species are applied in local house building.
C. renda is a commercial ornamental plant valued for its attractive crown-shafts which are usually bright orange-red and occasionally crimson or scarlet.

Production and international trade *Cyrtostachys* wood is used on a local scale only. About 1990 the price of *C. renda* in local nurseries in Malaysia and Indonesia was about US$ 15–20 for a 2 m high plant.

Properties The wood of the periphery of the stem of *Cyrtostachys* is hard.

Botany Unarmed, monoecious, pleonanthic, solitary or clustered, small to medium-sized palms, up to 20(–30) m tall; pole straight, slender, unbranched, up to 30 cm in diameter, conspicuously ringed with leaf scars, often with a mass of adventitious roots at base. Leaves pinnate; sheaths tubular, forming a well-defined crown-shaft; leaflets entire, single-fold. Inflorescence below the leaves, bisexual, branched to 3 orders; peduncle very short; prophyll enclosing the inflorescence until leaf fall; peduncular bract completely enclosing the inflorescence; rachillae bearing spiral, protandrous triads of 2 male flowers and 1 female flower borne in pits. Flowers globose; sepals 3; petals 3, united in the basal third. Male flower with 9–15 anthers, filaments connate at base. Female flower with a superior, 1-locular ovary with a single ovule, stigmas short, recurved. Fruit a broadly to narrowly ellipsoid drupe, usually black, smooth; mesocarp thin, with abundant fibre bundles. Seed globose or ellipsoid; endosperm homogeneous. Seedling with adjacent-ligular germination; eophyll bifid with narrow lobes.
Cyrtostachys is the only genus of the subtribe *Cyrtostachydinae* which belongs to the tribe *Areceae* of the subfamily *Arecoideae*, and is due for a taxonomic revision as the status of most of the eastern Malesian species is unclear.

Ecology Most *Cyrtostachys* species are found in lowland rain forest, up to 500 m altitude. *C. renda* is characteristically found in peat-swamp forest at low altitude, where it may form a conspicuous component of the vegetation.

Silviculture *C. renda* is propagated mainly by suckers that appear at the base of mature plants, as it grows very slowly from seed. Seeds remain viable for only 2–3 weeks. It can also be grown in pots.

Genetic resources and breeding Commercial collecting of *C. renda* from the wild is rare. It is conserved via extensive cultivation, but natural populations seem to be seriously threatened by destruction of their habitat. All other *Cyrtostachys* species appear to be rare endemics.

Prospects It is very unlikely that the wood of *Cyrtostachys* will be increasingly used. *C. renda* will probably continue to be an important ornamental palm.

Literature 70, 86, 151, 163, 229, 236, 499, 563, 856, 873, 978, 1038, 1059, 1110, 1176, 1210.

Selection of species

Cyrtostachys brassii Burret
Distribution Papua New Guinea.

Cyrtostachys microcarpa Burret
Distribution Papua New Guinea.

Cyrtostachys phanerolepis Burret
Distribution Papua New Guinea.

Cyrtostachys renda Blume
Synonyms *Cyrtostachys lakka* Becc.
Vernacular names Lipstick palm, scarlet palm, sealing wax palm (En). Indonesia: pinang merah (general). Malaysia: pinang raja (general), pinang antan (Peninsular), pinang lakar (Sarawak). Philippines: red palm (En). Thailand: kap daeng, mak wing (peninsular), mak daeng (central).
Distribution Southern Thailand, Peninsular Malaysia, Sumatra and Borneo; extensively cultivated as an ornamental throughout the Malesian region and planted in many tropical countries.

L.G. Saw

Dacryodes Vahl

Skr. Naturhist.-Selsk. 6: 116 (1810).
BURSERACEAE
x = unknown; $2n$ = unknown

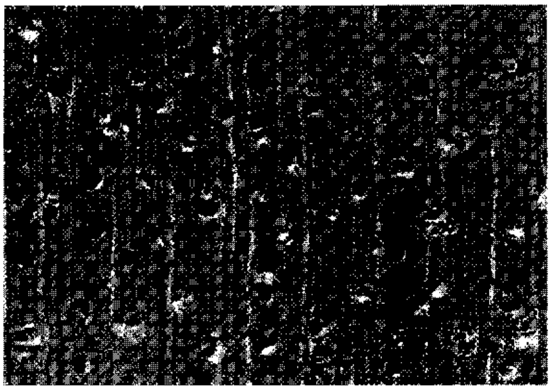
Vernacular names Kedondong (trade name). Indonesia: kenari. Malaysia: kerantai (Peninsular), seladah (Iban, Sarawak), upi (Sarawak). Philippines: kamingi (Tagalog).

Origin and geographic distribution *Dacryodes* comprises about 40 species distributed in tropical America (2 species), tropical Africa (about 22 species) and tropical Asia (16 species). In the latter area it occurs in the Nicobar Islands, southern Vietnam, Peninsular Malaysia, Singapore, Sumatra, western Java, Borneo, the Philippines and North Sulawesi.

Uses The wood of *Dacryodes* is used for general light or temporary construction under cover (e.g. for doors, window frames, planking, cladding, shuttering, light duty flooring) and for utility furniture, packing cases, pallets and agricultural implements like rice pounders. It is suitable for the production of veneer and plywood and has been applied for the manufacture of particle board.
The pulp of the fruit of *D. macrocarpa*, *D. expansa* (Ridley) Lam and *D. rostrata* is edible; in Brunei the latter has even been cultivated for its fruits whereas its resin is used to make torches. Leaves of *D. kingii* (Engl.) Kalkman are reputed to be used as thatch.

Production and international trade *Dacryodes* timber is traded together with that of many other *Burseraceae* genera as 'kedondong', but comprises only a small proportion of the total amount traded. In 1992 the export of kedondong from Sabah amounted to 2500 m^3 of sawn timber and 12 000 m^3 of logs with a total value of about US$ 1.3 million (US$ 170/m^3 for sawn timber, US$ 69/m^3 for logs).

Properties *Dacryodes* yields a medium-weight to heavy hardwood with a density of 520–1040 kg/m^3 at 15% moisture content. Heartwood pale pink-brown, slightly darkening on exposure, not clearly differentiated from the 2–4 cm wide paler sapwood; grain interlocked, occasionally straight or wavy; texture fine to moderately coarse and even; wood with red-brown speckles due to the rays. Growth rings indistinct; vessels moderately small to medium-sized, solitary or rarely in radial multiples of 2–4, tyloses present; parenchyma sparse, paratracheal vasicentric but inconspicuous; rays extremely fine to moderately fine; ripple marks absent; radial canals containing a black, oily substance present in *D. incurvata*, *D. rostrata* and *D. rubiginosa*.
Shrinkage of the wood upon seasoning is low; the wood seasons well but is liable to warp and check if not carefully handled. The wood is hard, fairly strong and tough. It is difficult to saw as it contains silica but it planes well and takes a very high polish. Immediately after sawing the wood should be treated with anti-stain chemicals. The



Dacryodes incurvata
transverse surface (×18)

wood is non-durable when exposed to the weather or in contact with the ground. The heartwood is very resistant to impregnation, the sapwood is permeable. The heartwood is susceptible to dry-wood termites. The sapwood is susceptible to *Lyctus*.

See also the table on microscopic wood anatomy.

Botany Evergreen, dioecious, small to fairly large trees up to 30(–45) m tall; bole usually cylindrical, straight, up to 100(–120) cm in diameter, sometimes with small thin buttresses up to 2(–3.5) m high, sometimes stilt-rooted; bark surface smooth to scaly, lenticellate, greenish-brown, inner bark orange, yellowish-white or pink, with little clear or rarely white exudate. Leaves arranged spirally, imparipinnate, exstipulate; leaflets 3–15(–31), entire; petiolules swollen at both ends. Flowers in an axillary or terminal panicle, unisexual, 3-merous, small; sepals free or connate, caducous in fruit; petals thickened and inflexed at apex; stamens 6, filaments free or connate with the disk; disk intrastaminal; ovary superior, (2–)3-locular with 2 ovules in each cell, stigma sessile. Fruit an oblong to ellipsoid, 1-seeded drupe; pericarp thick and fleshy, wrinkled when dry. Seedling with epigeal germination; cotyledons emergent, palmately lobed; hypocotyl elongated; first 2 leaves opposite, subsequent ones arranged spirally, at first simple, eventually imparipinnate. In Borneo *Dacryodes* flowers in (February–) March–November and bears fruit from (March–) April–December. The flowering-to-fruiting period of *D. kingii* and *D. rostrata* is 3 months, that of *D. costata* 4 months. The fruits are eaten and dispersed by animals.

Dacryodes has been divided into 3 sections, one in each continent. The Asian representatives belong to the section *Tenuipyrena* Engl.

Ecology *Dacryodes* is found in primary or sometimes secondary, evergreen or monsoon forest, often on hills and ridges, occasionally in freshwater or peat-swamp forest, up to 1500 m altitude.

Silviculture *Dacryodes* can be propagated by seed. In a germination trial in Peninsular Malaysia sown fruits of several species showed 15–45% germination in 18–76 days.

Genetic resources and breeding As *Dacryodes* is not rare and species have a fairly wide geographical distribution, there is no risk of genetic erosion.

Prospects *Dacryodes* will probably continue to be traded as a minor component of the kedondong trade group.

Literature 15, 46, 70, 151, 162, 163, 198, 238, 267, 341, 436, 512, 526, 543, 553, 651, 740, 749, 780, 800, 829, 830, 831, 861, 934, 974, 1048, 1221, 1242.

Dacryodes costata (Benn.) H.J. Lam– 1, flowering twig; 2, female flower with petal removed; 3, sectioned male flower; 4, infructescence.

Selection of species

Dacryodes costata (Benn.) H.J. Lam

Synonyms *Canarium costatum* (Benn.) Ridley, *Santiria costata* Benn.

Vernacular names Indonesia: binyau (Bangka), kedondong besi, kening kerak (Sumatra). Malaysia: kedondong mata hari (Peninsular). Philippines: kalaua (Bagobo).

Distribution Peninsular Malaysia, Sumatra, Borneo and the Philippines (Leyte).

Dacryodes incurvata (Engl.) H.J. Lam

Synonyms *Canarium nitens* (Merr.) Merr., *Dacryodes angulata* (Ridley) H.J. Lam, *Santiria nitida* Merr.

Vernacular names Indonesia: balau pelapah, bantan burung, kedondong kijai (Sumatra). Malaysia: jelmu pipit, kembayau, resak merkuyung (Peninsular). Philippines: kamingi (Tagalog).

Distribution Peninsular Malaysia, Sumatra, Borneo and the Philippines.

Dacryodes laxa (Benn.) H.J. Lam

Synonyms *Canarium laxum* Benn., *Santiria forbesii* Baker f., *Santiria laxa* (Benn.) King.

Vernacular names Indonesia: ibabu (South Kalimantan). Malaysia: kedondong bulan, kedondong bulu laxa, kedondong mempelas (Peninsular).

Distribution Peninsular Malaysia, Singapore, Sumatra and Borneo.

Dacryodes longifolia (King) H.J. Lam

Synonyms *Curtisina penangensis* Ridley, *Santiria longifolia* King.

Distribution Peninsular Malaysia, Sumatra, Borneo and the Philippines.

Dacryodes macrocarpa (King) H.J. Lam

Synonyms *Dacryodes kostermansii* Kalkman, *Santiria elliptifolia* Merr., *Santiria macrocarpa* King.

Vernacular names Brunei: pasoh-pasoh (Malay), sabal (Iban), sibut (Tutong, Dusun). Indonesia: bantar burung, lentambung (Sumatra), rarawa pipit (Kalimantan). Malaysia: asam-asam (Dusun, Sabah), icerawas burung (Malay, Sarawak). Philippines: marangub (Filipino), kaminging-lakihan, Merrill kamingi (Tagalog).

Distribution Peninsular Malaysia, Sumatra, Borneo and the Philippines (rare).

Dacryodes nervosa (H.J. Lam) Leenh.

Synonyms *Santiria nervosa* H.J. Lam.

Vernacular names Indonesia: asam-asam (Bangka), bantan burung, kedondong tunjuk (Sumatra).

Distribution Peninsular Malaysia, Sumatra and Borneo.

Dacryodes rostrata (Blume) H.J. Lam

Synonyms *Canarium cuspidatum* (Blume) Merr., *Canarium kadondon* Benn., *Hemisantiria rostrata* (Blume) H.J. Lam.

Vernacular names Brunei: kebayan ajer, kebayan burong. Indonesia: asem begomdang, kembayan bekuwak, kembayan tikus (Sumatra). Malaysia: kedondong kerut, mansipot (Peninsular), salong banggi (Malay, Sabah). Philippines: kaminging-lakihan (Tagalog), lunai (Lanao), palaspas (Bikol).

Distribution Southern Vietnam, Peninsular Malaysia, Singapore, Sumatra, Borneo, the Philippines and North Sulawesi.

Dacryodes rubiginosa H.J. Lam

Vernacular names Indonesia: bengaya, kembayau, kerambu bulu (East Kalimatan). Malaysia: suryan (Peninsular).

Distribution Peninsular Malaysia and Borneo.

Dacryodes rugosa (Blume) H.J. Lam

Synonyms *Canarium moultonii* Ridley, *Hemisantiria rugosa* (Blume) H.J. Lam, *Santiria fasciculata* Benn.

Vernacular names Indonesia: gita cilok, kayu manau, kayu napo (Sumatra). Malaysia: kedondong balau puteh, kedondong mata hari (Peninsular).

Distribution Peninsular Malaysia, Sumatra, western Java and Borneo.

K.M. Kochummen

Dactylocladus Oliv.

Hook. Icon. Pl.: t. 2351 (1895).
CRYPTERONIACEAE
x = unknown; $2n$ = unknown

Vernacular names Jongkong (trade name). Merubong (En, Fr). Brunei: medang tabak, tabak. Indonesia: mentibu (Indonesian), merebung, sampinur (Kalimantan). Malaysia: medang miang (Kedayan, Sabah), medang tabak, tabak (Sabah, Sarawak), merebong (Iban, Sarawak).

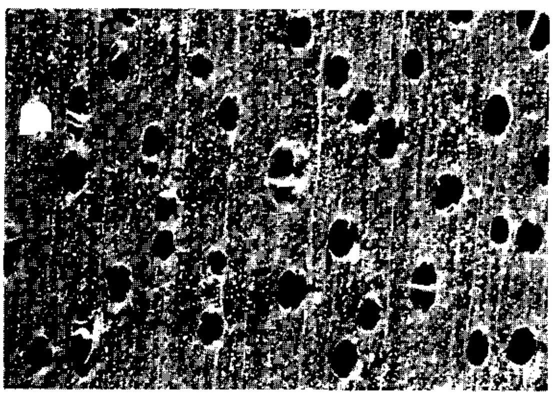
Origin and geographic distribution *Dactylocladus* is a monotypic genus endemic to Borneo. The only species, *D. stenostachys* Oliv., is especially abundant in Sarawak. This species, or one closely related to it, may be present in Irian Jaya.

Uses Exported wood of *Dactylocladus* is mainly used for furniture, drawers and interior construction. Local uses include concrete shuttering, weatherboard, flooring, interior construction, utility furniture, shopfitting, partitioning and occasionally the production of veneer and plywood. Its specialty applications include broomheads, seats of plush furniture, Venetian blind slats and boat building. Treated the wood has been used for shingles and window frames. It is also suitable for the manufacture of particle board.

Production and international trade *D.*

stenostachys is the third most important swamp timber exported from Sarawak, after ramin (*Gonystylus* spp.) and meranti (*Shorea* spp.), and is traded as a 'light hardwood'. In 1987 exports from Sarawak to Japan comprised 41,500 logs, which is 5.2% of the total export from Sarawak to Japan. In 1988 the total export of *D. stenostachys* sawlogs from Sarawak was 254 650 m^3 (with a value of about US$ 10.2 million) but this decreased steadily to 186 750 m^3 in 1993 (about US$ 15.5 million). The majority (90%) was exported to Japan, the rest to Taiwan, Singapore, Denmark, China, Australia and Kuwait. The export of *D. stenostachys* sawn timber from Sarawak amounted to 6020 m^3 (US$ 1.1 million) in 1988 but had fallen to 1720 m^3 (US$ 447 000) in 1993. In 1987 the export of *D. stenostachys* from Sabah was only 183 m^3 with a value of US$ 11 000, and in 1992 it amounted to 598 m^3 of sawn timber and 898 m^3 of logs with a value of US$ 141 500 and US$ 61 000 respectively. The comparatively high export figures are due not so much to the favourable properties of the timber as to its availability.

Properties *D. stenostachys* is a lightweight to medium-weight hardwood with a density of 410–610 kg/m^3 at 15% moisture content. Heartwood pale brown, almost white when fresh, darkening to pink-brown or red-brown, usually with white flecks, not clearly demarcated from the sapwood; grain straight to slightly interlocked; texture moderately fine and even, except for the radial breakdown areas. Growth rings indistinct; vessels moderately small to medium-sized, predominantly solitary, but also in radial multiples of 2–3, open; parenchyma scanty paratracheal, and aliform to confluent; rays fine and indistinct to the naked eye; ripple marks vague; radial breakdown areas characteristically appear as small lenticular flecks or holes on tangential surfaces, sometimes mistaken for pinhole borer attack.



Dactylocladus stenostachys
transverse surface (×20)

Shrinkage is low to moderate and the wood seasons fairly slowly: it takes about 3 months and 5 months respectively to air dry boards 13 mm and 38 mm thick. It seasons without serious degrade provided it is protected from sap-stain although some bowing and end-checking may occur in air drying and slight collapse in kiln drying; kiln schedule K is recommended in Malaysia. The wood is soft to moderately hard, and fairly weak. It is very easy to work, peels readily and phloem flecks do not pose problems. It can be planed to a fairly lustrous finish. The wood is non-durable, but can be treated with preservatives without difficulty. It is not resistant to termites and marine borers, but is rarely attacked by pinhole borers. The sapwood is susceptible to *Lyctus*.

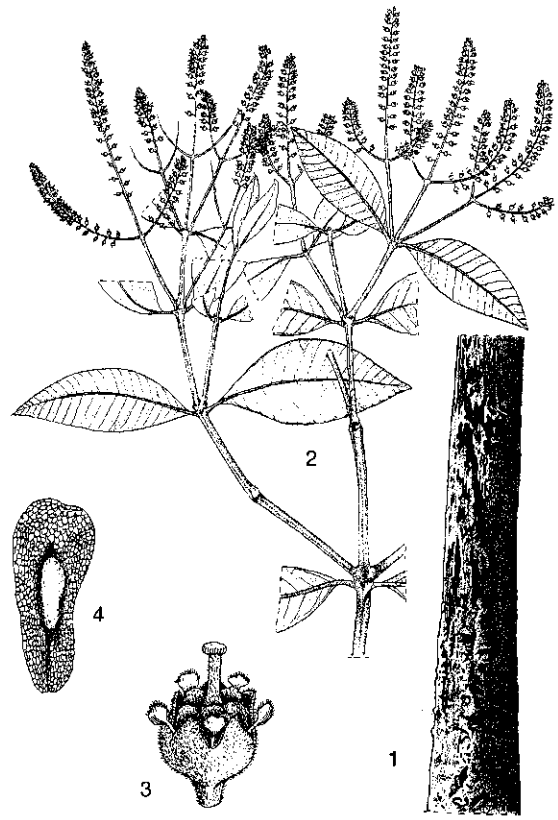
The energy value of the wood is 19 810 kJ/kg. Fibres from the inner bark may cause itching or may be painful to the skin. Sawdust may cause nasal irritation.

See also the tables on microscopic wood anatomy and wood properties.

Botany An evergreen, small to large tree up to 40 m tall; bole cylindrical or slightly fluted at base, usually short but sometimes branchless for up to 25 m, often with small burrs, up to 120(–150) cm in diameter, without buttresses, with many stout yellowish pneumatophores; bark surface becoming slightly to prominently fissured and scaly, red-brown to greyish-brown, inner bark fibrous, yellowish-brown and darkening upon exposure, without exudate; crown almost spherical with big branches. Twigs with swollen nodes and longitudinal lines. Leaves opposite, simple, margin entire, revolute, veins anastomosing in an indistinct intramarginal vein; stipules minute or rudimentary. Flowers in racemes united into an erect, poorly branched panicle, small, (4–)5-merous; receptacle puberulous; calyx with triangular lobes; petals spoon-shaped, white; stamens 5; ovary semi-inferior, (3–)4–5-locular with 3 ovules in each cell, stigma capitate. Fruit a many-seeded, almost inferior capsule, yellowish-green. Seed flat and surrounded by an almost rectangular membranous wing.

Flowers may be observed throughout the year, but most frequently in the middle of the dry season in June and July. Fruits take about 3 months to ripen and have been reported most often in September and October. The winged seeds are dispersed by wind.

Dactylocladus is sometimes treated as a member



Dactylocladus stenostachys Oliv. – 1, trunk; 2, flowering twig; 3, flower; 4, seed.

of the family *Melastomataceae*. Anatomical evidence seems to support this view, and it appears that the family *Crypteroniaceae* itself may be heterogenous. No definite decisions have been made yet on these complex matters.

Ecology *D. stenostachys* is one of the most abundant large canopy trees of peat-swamp forests in Sarawak and Brunei. It is represented in all types of swamp forest communities, but is most abundant and sometimes dominant in the *Gonystylus–Dactylocladus–Neoscortechinia* association (mixed swamp forest) and the *Combretocarpus–Dactylocladus* association. On the perimeter of peat-swamps *D. stenostachys* may attain a diameter of over 120 cm, while in the centre it may be very abundant but only rarely reaches 10 cm in diameter. In mixed peat-swamp forest especially the crowns of *D. stenostachys* trees are inhabited by many epiphytes and figs. *D. stenostachys* has also been found in kerangas vegetation on podzol soils, and in East Kalimantan it is an important element of the *Cratoxylum glaucum–Dactylocladus stenostachys* community. In general *D. stenostachys* demands an acid, poorly drained soil. It thrives in a perhumid climate, generally at low altitudes but sometimes up to 800 m.

Silviculture Natural regeneration is scarce in primary and secondary forests. Very few seedlings can be found immediately after felling, but 10 years after clear felling saplings are found in widely dispersed gregarious groups of up to 30 individuals. The form of these trees, however, is poor and trees are almost invariably forked. This species' demand for light is unclear; reports are contradictory, some stating that it probably tolerates shade as saplings do not appear to respond vigorously to full light and others nothing that it has some pioneer features like natural regeneration in open areas as after clear felling. For Sarawak an average of over 3 large trees per ha is given for natural peat-swamp forest, but exceptional densities of up to 12 mature trees per ha have been reported. In Sarawak the estimated harvesting costs are US\$ 11–14/m^3.

Genetic resources and breeding *D. stenostachys* has been heavily exploited for some decades, but still seems fairly abundant. In Sarawak its natural regeneration is stimulated and therefore the risk of genetic erosion is low.

Prospects Relatively little is known on the silvicultural management of peat-swamp forest for the production of *D. stenostachys*. Ramin (*Gonystylus* spp.) is economically much more important and silvicultural practices are primarily geared to this species. Increased knowledge on the treatment and use of *D. stenostachys* timber may lead to an increase in its use.

Literature 40, 45, 49, 51, 124, 151, 162, 190, 193, 341, 387, 526, 529, 536, 568, 675, 741, 756, 771, 861, 933, 1040, 1048, 1052, 1077, 1117.

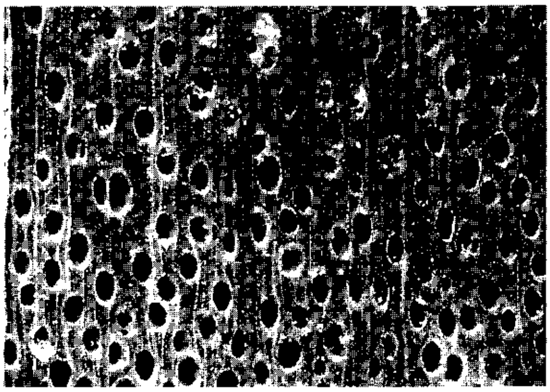
L.C.J. Julaihi

Decaspermum J.R. Forster & J.G. Forster

Charact. gen. pl.: 37 (1775).
MYRTACEAE
x = unknown; *D. parviflorum*: $n = 44$, $2n = 44$

Vernacular names Philippines: patalsik (Tagalog).

Origin and geographic distribution *Decaspermum* comprises about 30 species and is distributed from eastern India, Burma (Myanmar), Indo-China, south-eastern China and Thailand,



Decaspermum forbesii E.G. Baker
transverse surface (×20)

throughout the Malesian region to the Pacific islands and Australia.

Uses The wood of *Decaspermum* is used for small objects, tool handles, rice pounders, fences and sometimes in house building (posts) and light construction. It is also used as firewood.
In Indonesia it has been reported that shoots of *D. parviflorum* are eaten as a vegetable although they are astringent; the fruits are also eaten. The leaves have been used medicinally to treat diarrhoea, stomach-ache and swollen gums.

Production and international trade The timber of *Decaspermum* can only be obtained in small sizes and is therefore of no commercial importance. Utilization is local.

Properties *Decaspermum* yields a medium-weight to heavy hardwood with a density of (640–)670–930(–1165) kg/m^3 at 15% moisture content. Heartwood pink to reddish-brown, sapwood pale brown; texture fine and even. Growth rings indistinct; vessels small, predominantly solitary; parenchyma very sparse to abundant, apotracheal diffuse, some vasicentric; rays tending to be of 2 widths, narrower than the vessels; ripple marks absent.
During seasoning the wood splits and warps. The wood is strong to very strong, very hard and moderately durable for protected exterior use. The sapwood is susceptible to *Lyctus*.
See also the table on microscopic wood anatomy.

Botany Shrubs or small to medium-sized trees up to 30(–40) m tall; bole up to 50 cm in diameter; bark surface flaky, pale brown to reddish-brown; twigs and branches reddish. Leaves opposite, simple, entire, dotted with prominent glands, with an intramarginal vein; stipules small, early caducous. Flowers solitary or in a dichasium, raceme or thyrse in leaf axils, or in a terminal panicle, bisexual or sometimes male, 3–5-merous; calyx lobes persistent; petals free; stamens numerous; ovary inferior, 3–12-locular with 2–4 ovules in each cell, style 1. Fruit a globular or subglobular, (3–)8–10(–12)-seeded berry, crowned by the calyx. Seed enclosed by fibrous-leathery endocarp.
The flowers of *D. parviflorum* are of two structural types: bisexual and male, which are found on separate trees. Perhaps the bisexual flowers are functionally female (with non-functional stamens), which would imply dioecy.
Most species are shrubs or small trees and only about 8 species may reach over 20 m tall. *Decaspermum* resembles *Syzygium* but the ovary usually has more locules and the fruit more numerous seeds.

Ecology *Decaspermum* species occur in various types of forest, primary as well as secondary, often along streams and in swamp forest, but also on limestone ridges. In New Guinea they can also be found in *Castanopsis* forest, up to 2700 m altitude. Several species (e.g. *D. belense*, *D. parviflorum*) are generally found in secondary forest and at forest edges, and *D. neurophyllum* can be found in open scrub vegetation or in grassland. *D. parviflorum* is locally very common.

Silviculture *Decaspermum* can be propagated by seed. There are about 210 fresh fruits/kg for *D. parviflorum* and the pyrenes germinate for about 30% in 2–5 months. In Java *Decaspermum* is found as a second storey in forestry plantations. *D. parviflorum* is not resistant to fire and an unidentified fungus has been found to cause dieback of branches.

Genetic resources and breeding *Decaspermum* trees are rarely logged for their timber, so there is no reason to consider them as endangered. There are no records of ex situ conservation of *Decaspermum*.

Prospects The scattered occurrence of the trees and their relatively small size do not seem to allow for an increase in utilization of the wood.

Literature 163, 209, 235, 267, 304, 348, 405, 436, 464, 520, 772, 831, 861, 934, 952, 992, 1000, 1001, 1002, 1221, 1232.

Selection of species

Decaspermum belense Merr. & L.M. Perry

Distribution New Guinea.

Decaspermum blancoi S. Vidal

Synonyms *Decaspermum grandiflorum* Elmer.

Vernacular names Philippines: patalsik-pula (Tagalog).

Distribution The Philippines.

Decaspermum bracteatum (Roxb.) A.J. Scott

Distribution The Moluccas and New Guinea.

Decaspermum neurophyllum Lauterb. & K. Schumann

Distribution New Guinea.

Decaspermum parviflorum (Lamk) A.J. Scott

Synonyms *Decaspermum fruticosum* auct. non J.R. Forster & J.G. Forster, *Decaspermum paniculatum* (Lindl.) Kurz.

Vernacular names Indonesia: andolok pakal (northern Sumatra), kayu demang (southern Sumatra), tembagan (Javanese). Malaysia: kelentit kering, tukai benai, tuka benang (Peninsular). Philippines: patalsik (Tagalog). Burma (Myanmar): taung-thabye. Thailand: khee tai, krim (peninsular).

Distribution Eastern India, Burma (Myanmar), Indo-China, south-eastern China, Thailand, Peninsular Malaysia, Sumatra, Bangka, Java, Borneo, the Philippines, Sulawesi, Timor and the Caroline and Palau Islands.

Decaspermum prunoides Diels

Distribution New Guinea.

Decaspermum triflorum A.J. Scott

Distribution Throughout the Lesser Sunda Islands.

Decaspermum urvillei (DC.) A.J. Scott

Distribution The Bismarck Archipelago (New Britain, New Ireland and the Admiralty Islands).

Noorma Wati Haron (general part),
R.H.M.J. Lemmens (general part, selection of species)

Dehaasia Blume

Rumphia 1(8): 161 (1836).

LAURACEAE

x = probably 12 as in most other *Lauraceae* genera.

Vernacular names Medang (trade name). Burma (Myanmar): kyese. Thailand: rarechor.

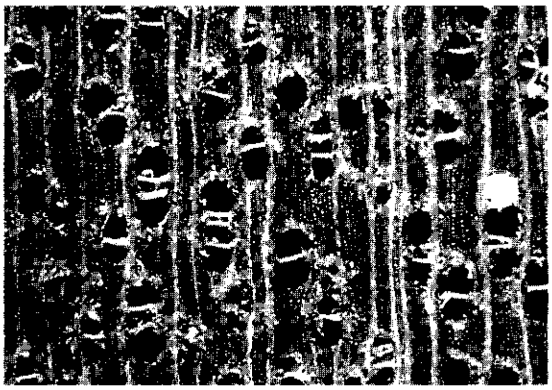
Origin and geographic distribution *Dehaasia* comprises about 35 species distributed from Burma (Myanmar), Indo-China and southern China to Thailand, the entire Malesian region, east to New Guinea (Irian Jaya). Most species are confined to western Malesia with a single species, *D. incrassata*, extending east to New Guinea.

Uses The wood of *Dehaasia* is used for light construction under cover, house posts, house piling, interior finish, panelling, partitioning and ceilings, furniture and cabinet work, turnery, carving, picture framing, musical instruments (pianos), tools, oars, boat building and knife sheaths. Veneer and plywood of varying quality can be manufactured from the wood.

D. subcaesia has been recommended for the afforestation of periodically inundated habitats.

Production and international trade Supplies of *Dehaasia* wood are small. It is generally traded together with that of many other *Lauraceae* genera as 'medang', and constitutes a small proportion of the total amount traded. In 1984 the total export of medang from Peninsular Malaysia to Singapore was 1500 m^3 with a value of US$ 62 000. In 1992 the export of medang from Sabah amounted to 52 000 m^3 (of which about 10% was sawn timber) with a total value of US$ 4.3 million.

Properties *Dehaasia* yields a medium-weight



Dehaasia cuneata
transverse surface (×20)

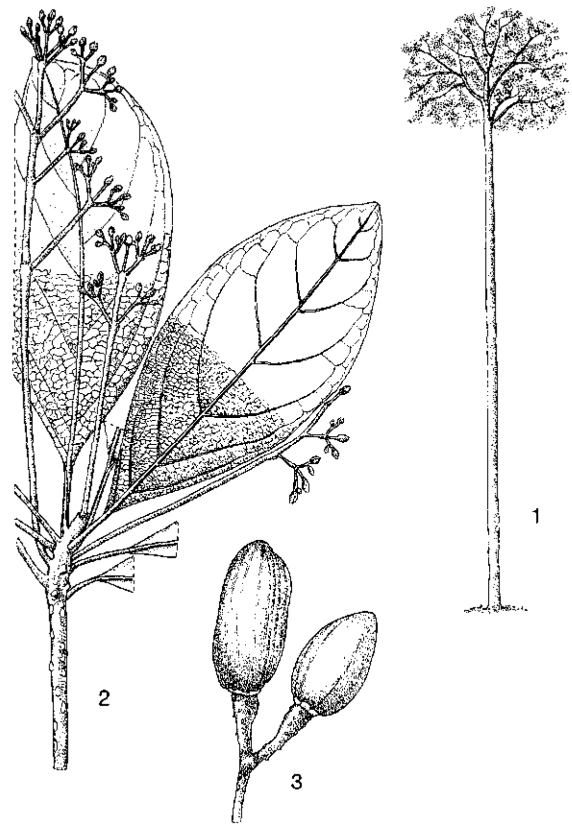
to heavy hardwood with a density of 580–900 kg/m^3 at 15% moisture content. Heartwood olive-green or yellow-green, darkening rapidly upon exposure, generally sharply demarcated (except in *D. incrassata*) from the narrow, up to 7 cm wide, pale grey-green or yellow-green sapwood; grain straight or slightly interlocked; texture fine to moderately fine and even; wood lustrous or with a silky sheen; planed or pared surfaces greasy to the touch; occasionally with streaked figure and silver grain; odour described as vinegar-like or sweet when fresh, faintly fragrant when dry. Growth rings indistinct to distinct, differences in density between earlywood and latewood visible due to colour differences; vessels very small to medium-sized, solitary and in radial, sometimes diagonal multiples of 2–5 (up to 13 in *D. caesia*), occasionally in clusters, tyloses rare to frequent; parenchyma sparse, paratracheal vasicentric, visible with a hand lens; rays extremely fine to moderately fine, visible with a hand lens; ripple marks absent; pith flecks present in most species.

Shrinkage upon seasoning is low and the wood seasons well with little degrade. The wood is moderately hard to hard and fairly strong. It is moderately durable to very durable (e.g. *D. caesia*) when exposed to the weather or in contact with the ground, comparable to 'ulin' (*Eusideroxylon zwageri* Teijsm. & Binnend.). In a graveyard test in the Philippines the average service life of test stakes of *D. cairocan* was 5 years and 9 months. The heartwood of *D. cairocan* is very resistant to dry-wood termites, its sapwood is susceptible to *Lyctus*.

The fruits of *D. incrassata* are reported as very poisonous and irritating to the skin. The leaves of the same species contain alkaloids.

See also the table on microscopic wood anatomy.

Botany Evergreen, small to medium-sized trees up to 35(–40) m tall, rarely shrubs; bole usually fairly straight, branchless for up to 15(–25) m, up to 70(–100) cm in diameter, buttresses generally absent; bark surface smooth to cracking, often lenticellate, papery, smooth or flaky, white or greyish, fresh surfaces dark brown, inner bark yellowish or yellowish-brown, granulate. Leaves arranged spirally, crowded at the end of twigs, simple, entire, with either lax or fine reticulate venation, exstipulate; terminal buds with 1–2 small caducous scales. Flowers in an axillary panicle, small; tepals 6, united below in a tube, the outer 3 smaller than the inner 3; fertile stamens 9, in 3 whorls, those of the inner whorl with 2 glands each, anthers 2-celled, opening by valves; ovary superior, 1-locular with a single ovule, stigma small. Fruit a black or purplish-black, 1-seeded berry on an enlarged red, yellow or green, warty pedicel, the tepals usually caducous, rarely subpersistent. Seedling with hypogeal germination; cotyledons not emergent, peltate; hypocotyl not developed; epicotyl with a few scales, all leaves arranged spirally.



Dehaasia caesia Blume – 1, tree habit; 2, flowering twig; 3, fruits.

Branching is generally sympodial. The mean annual diameter increment estimated from wood samples of *D. cairocan* and *D. incrassata* from the Philippines is 0.4–2 mm, which is very low. In Java *D. incrassata* has been observed flowering in February–March and July–November, and fruiting in February, April, July and August. Trees seldom produce much fruit. The seeds are dispersed by birds.

Dehaasia is closely related to *Alseodaphne* which differs only in the presence of 4 anther cells instead of 2. It is in need of a thorough taxonomic revision because the status of many species is still unclear.

Ecology Timber-producing *Dehaasia* species are usually understorey trees and occur scattered in primary evergreen rain forest. They are found in lowland and hill forest, sometimes ascending into the lower montane forest up to 1200 m altitude. Habitat types include dryland forest, swamp forest (e.g. *D. subcaesia*) or peat-swamp forest and coastal forest.

Silviculture *Dehaasia* can be propagated by seed. Seeds of *D. incrassata* have about 75% germination in 2 months up to 1.5 years.

Genetic resources and breeding The risk of genetic erosion of the presently recognized *Dehaasia* species is small, as most species do not have a very restricted area of distribution.

Prospects The very durable wood of some of the *Dehaasia* species may be increasingly used, but proper identification may present problems.

Literature 70, 101, 162, 163, 209, 218, 235, 267, 302, 304, 364, 436, 464, 536, 595, 605, 614, 625, 632, 756, 780, 829, 831, 861, 933, 934, 955, 974, 1221, 1242.

Selection of species

Dehaasia caesia Blume

Vernacular names Indonesia: huru kacang (Sundanese), madang intalo (Kalimantan), medang batu (Sumatra).

Distribution Sumatra, Java and Borneo (Sabah, Kalimantan).

Dehaasia cairocan (S. Vidal) Allen

Synonyms *Beilschmiedia cairocan* S. Vidal, *Beilschmiedia nigrifolia* Elmer.

Vernacular names Philippines: malakadios (general), kalagingin (Iloko), kubi (Basilan).

Distribution The Philippines and Sulawesi.

Dehaasia celebica Kosterm.

Distribution Sulawesi, including the Sula and Talaud Islands.

Dehaasia cuneata (Blume) Blume

Synonyms *Cryptocarya cuneata* Blume, *Cyanodaphne cuneata* (Blume) Blume.

Vernacular names Indonesia: medang kelaban, medang telur (Sumatra), medang penguan (Kalimantan). Malaysia: medang payong (Peninsular).

Distribution Peninsular Malaysia, Sumatra and Borneo (Kalimantan); probably extinct in Java.

Dehaasia firma Blume

Synonyms *Haasia firma* (Blume) Miq.

Distribution Borneo (Brunei, Kalimantan, Sabah).

Dehaasia incrassata (Jack) Kosterm.

Synonyms *Dehaasia media* Blume, *Dehaasia microcarpa* Blume, *Dehaasia triandra* Merr.

Vernacular names Indonesia: belumbang taloi (Lampung, Sumatra), guli kunyit (Aceh, Sumatra), medang mesang (Palembang, Sumatra). Malaysia: medang batu, medang payong, medang tandok (Peninsular). Philippines: margapali (Filipino), paitan (Laguna), panulauen (Cagayan).

Distribution Peninsular Thailand, Peninsular Malaysia, Sumatra, Java, Borneo, the Philippines, Sulawesi, the Moluccas and New Guinea (Irian Jaya).

Dehaasia longipetiolata Kosterm.

Distribution Peninsular Thailand and Peninsular Malaysia.

Dehaasia membranacea Kosterm.

Distribution Borneo (Sabah, Sarawak).

Dehaasia palembanica Kosterm.

Distribution Sumatra; possibly also in Borneo (Kalimantan).

Dehaasia pauciflora Blume

Synonyms *Dehaasia curtisii* Gamble.

Distribution Peninsular Malaysia, Sumatra and Borneo (Kalimantan).

Dehaasia polyneura (Miq.) Kosterm.

Synonyms *Alseodaphne polyneura* Miq., *Dehaasia elliptica* Ridley.

Distribution Peninsular Malaysia, Sumatra and Bangka.

Dehaasia pugerensis Koord. & Valeton

Distribution East Java.

Dehaasia subcaesia (Miq.) Kosterm.

Synonyms *Haasia subcaesia* Miq.

Distribution Sumatra.

Dehaasia sumatrana Kosterm.

Distribution Sumatra.

Dehaasia tomentosa (Blume) Kosterm.

Synonyms *Cyanodaphne tomentosa* Blume, *Dehaasia cuneata* auct. non Blume.

Vernacular names Indonesia: madang tanahan (Sumatra). Malaysia: medang ketanah, medang kunyit, serai tandok (Peninsular).

Distribution Peninsular Malaysia, Sumatra and Borneo (Sabah, Kalimantan).

S.I. Wiselius

Deplanchea Vieill.

Bull. Soc. Linn. Normandie 7: 96 (1862).

BIGNONIACEAE

x = unknown; $2n$ = unknown

Vernacular names Papua New Guinea: deplanchea.

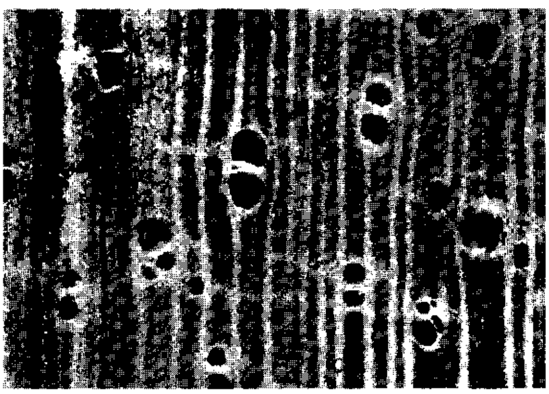
Origin and geographic distribution *Deplanchea* comprises 5 species. One species is found in western Malesia, 2 in New Guinea (1 of which extends to northern Australia), and 2 in New Caledonia.

Uses The wood of *Deplanchea* is used for canoes by local people in Irian Jaya (Fak Fak). In Papua New Guinea it is used for light temporary construction.

D. bancana and *D. tetraphylla* are potential ornamentals with very attractive flowers grouped in pyramids and pagodas, whereas the former might also be useful for reforestation and erosion control.

Production and international trade Utilization of *Deplanchea* wood is only local and there are no reports of trade.

Properties *Deplanchea* yields a lightweight to medium-weight hardwood with a density of 410–550 kg/m^3 at 15% moisture content. Heartwood pale brown or yellow-brown, not distinctly demarcated from the straw-coloured sapwood; grain straight; texture rather fine and even. Growth rings indistinct; vessels medium-sized to moderately large, solitary with occasional radial or tangential multiples of 2–4; parenchyma moderately abundant, paratracheal vasicentric, aliform to confluent in discontinuous layers, distinct with a hand lens; rays very fine or moderately fine, hardly visible to the naked eye; ripple marks absent.



Deplanchea tetraphylla
transverse surface (×20)

Shrinkage upon drying is moderate. The wood is soft and non-durable. The sapwood is susceptible to *Lyctus*.

See also the tables on microscopic wood anatomy and wood properties.

Botany Evergreen, small to large trees up to 45 m tall; bole branchless for up to 20 m, up to 150 cm in diameter, sometimes with steep buttresses or fluted at base; bark surface scaly or slightly fissured, lenticellate, pale brownish to grey or grey-brown, inner bark yellow to pale brown. Leaves tufted at the end of branches, simple, in whorls of 3 (*D. bancana*) or 4 (*D. tetraphylla*), entire, often with fine dots below, above with a few large glands at base, exstipulate. Inflorescence terminal, erect, flat-topped, thyrsoid. Flowers 5-merous, showy, yellow; calyx closed in bud, lobed or tearing into 2–5 irregular lobes at anthesis; corolla irregular, funnel-shaped; stamens 4(–5), exserted, inserted just above the base of the tube; disk annular, crenate; ovary superior, 2-locular with many ovules, style long and exserted. Fruit an ellipsoid, 2-valved capsule with a lens-shaped septum and many hyaline-winged seeds. Seedling with hypogeal germination; hypocotyl elongated; first leaves decussate.

D. bancana flowers from January to October, *D. tetraphylla* from May to November. Fruits develop in about 2 months. The flowers of *D. tetraphylla* show a highly elaborated syndrome for bird pollination (probably lorikeets in northern Australia). Birds sit on top of the truncated cone-like inflorescence and bend down to collect the copious nectar presented on the lowermost corolla lobe, thereby touching the vertically exposed anthers and style with their neck and breast. Dispersal of the winged seeds is by wind.

Ecology *Deplanchea* species are light-demanding and found in open and secondary rain forest, often nearby swampy locations or streams, in kerangas, but also in woodland savanna and sometimes invading grassland. They occur on sandy (usually podzolic) soils, up to 1000(-1200) m altitude.

Silviculture *Deplanchea* can be propagated by seed. Being light-demanding pioneers, they may have good silvicultural characteristics for plantation establishment and erosion control.

Genetic resources and breeding There are no records of ex situ conservation of *Deplanchea* species. As they are not particularly sought after and occur in secondary vegetation as well, it is unlikely that they are endangered.

Prospects The silvicultural characteristics, as yet ill-known, merit further attention for possible pulpwood plantation establishment and erosion control.

Literature 124, 163, 209, 267, 304, 341, 348, 464, 527, 568, 790, 829, 861, 1048, 1193, 1221.

Selection of species

Deplanchea bancana (R. Scheffer) v. Steenis

Synonyms *Diplanthera bancana* R. Scheffer, *Diplanthera coriacea* v. Steenis.

Vernacular names Yellow pagoda flower tree (En). Indonesia: kayu si martim (Batak, Sumatra), labu (Palembang, Sumatra), mengkubeng (Indonesian, Bangka). Malaysia: kayu chenderu (Peninsular).

Distribution Peninsular Malaysia, Singapore, Sumatra, Borneo and Sulawesi.

Deplanchea tetraphylla (R. Br.) F. v. Mueller

Synonyms *Deplanchea hirsuta* (F.M. Bailey) v. Steenis, *Diplanthera tetraphylla* R. Br., *Faradaya chrysoclada* K. Schumann & Lauterb.

Vernacular names Indonesia: bas (Mooi, Irian Jaya), kapul (Indonesian, Irian Jaya), laargola (Trangan, Aru Islands).

Distribution New Guinea, the Aru Islands and northeastern Queensland.

S.H. Widodo

Dichrostachys (DC.) Wight & Arn.

Prodr. fl. Ind. orient.: 271 (1834).

LEGUMINOSAE

x = unknown; *D. cinerea*: $n = 26$, $2n = 50, 56$

Vernacular names Indonesia: epung (Javanese), pereng (Madurese), pung (Sundanese). Thailand: hang suea, nom suea (central), krathin wiman (peninsular).

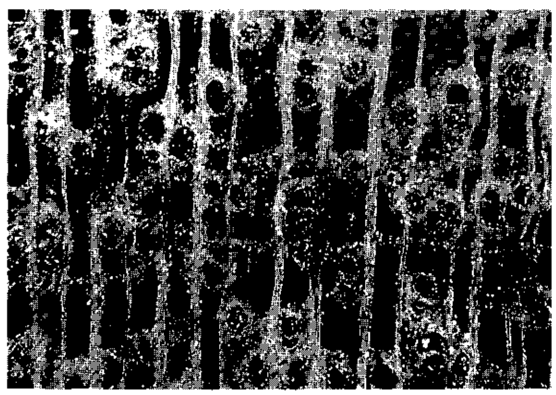
Origin and geographic distribution *Dichrostachys* comprises about 12 species and is widespread in Africa and Madagascar, with one species extending its range to Asia and Australia: *D. cinerea* (L.) Wight & Arn. (synonym: *D. nutans* (Pers.) Benth.). It has a wide distribution: Africa, India, Burma (Myanmar), Java, the Lesser Sunda Islands and northern Australia. It has been introduced into Florida and Cuba, and is locally planted in Thailand as an ornamental.

Uses The wood is used for small objects, particularly where strength and durability are needed, e.g. for gear-wheels, pegs, tool handles and walking sticks, but also for luxury objects because of its beautiful colour.

In Java the pods and the roots are reported to be used as vermifuge. The plant is used as a veterinary medicine in India. It may be useful on poor soils as a cover plant; it is used in agroforestry systems in Africa and India. It is considered to have potential for fuel and forage production. In Africa foliage and pods are used as fodder for small ruminants such as goats, and the trees as live fences.

Production and international trade The timber of *D. cinerea* has no importance because it is only available in small sizes; it is occasionally used by the local population for specific purposes.

Properties *D. cinerea* yields a medium-weight to heavy hardwood with a density of 600–1190 kg/m^3 at 15% moisture content. Heartwood red or dark purple with darker streaks, sharply differentiated from the yellowish-brown sapwood; grain straight or slightly interlocked; texture rather fine



Dichrostachys cinerea
transverse surface (×20)

and even. Growth rings distinct, the boundary indicated by a continuous line of marginal parenchyma; vessels moderately small to medium-sized, solitary and in radial multiples of 2–3, often with orange-red or dark gum-like deposits, just visible to the naked eye; parenchyma paratracheal vasicentric to aliform, sometimes unilaterally paratracheal, and apotracheal in marginal or seemingly marginal bands; rays very fine to moderately fine, visible with a hand lens; ripple marks absent.

The wood is extremely hard, very tough and strong, and durable to very durable.

See also the table on microscopic wood anatomy.

Botany A shrub or small tree up to 8 m tall; bole often crooked and gnarled, up to 20 cm in diameter (but often less than 5 cm); bark surface rough. Short shoots often terminated by spines. Leaves alternate, distichous or fasciculate, bipinnate, rachis and pinnae with nectaries; pinnae in 2–11 pairs; leaflets opposite and up to 24 pairs per pinna, linear and sessile; stipules filiform. Flowers in an axillary, pendulous spike, 5-merous, sterile with filiform staminodes in the lower part of the inflorescence, male in the central part and bisexual in the upper part; calyx short-toothed; petals united below; stamens 10, free; ovary superior, sessile, style long and slender. Fruit a variably coiled, blackish pod, clustered, indehiscent or opening irregularly, many-seeded, compressed. Seed ellipsoid to subcircular, biconvex, glossy pale brown; endosperm absent; cotyledons large.

The roots show nodulation and atmospheric nitrogen fixation. In Indonesia *D. cinerea* has been found flowering from September to June and fruiting from March to May, only sporadically in other months. The structure of the inflorescence suggests pollination by bats. The infructescence has a strong aroma, which probably attracts animals to feed on the pods.

Dichrostachys belongs to the subfamily *Mimosoideae*. *D. cinerea* is extremely variable over its very large area of distribution. It has been subdivided into 10 subspecies and numerous varieties. In Malesia and Australia only subsp. *malesiana* Brenan & Brummitt occurs.

Ecology In Malesia *D. cinerea* occurs in areas with a strongly seasonal climate, usually on poor, occasionally clayey soils, in brushwood, thickets, hedges, teak forest and grassland, up to 700 (–1600) m altitude. It often grows in groups, and is locally common. In India it is found in dry deciduous forest.

Silviculture *D. cinerea* can be propagated by seed. There are 50 500–66 500 dry seeds/kg. Aerial sowing has been practised in India. Seeds need a pretreatment like mechanical or chemical scarification to overcome seed-coat dormancy. Untreated seeds have only 5–10% germination but 65–100% germination is achieved after treating the seeds with concentrated sulphuric acid for 20–25 minutes and washing and soaking them overnight. Seeds should be sown in a sandy potting mixture, in which seedlings attain a height of 60 cm in 5 months. Root suckers are produced freely and are often found at a considerable distance, up to several metres, from the main stem owing to the long spreading lateral roots. It is fire-resistant, but does not tolerate waterlogging. In South Africa and Cuba *D. cinerea* is known to cause problems by its rapid and uncontrollable spread.

Genetic resources and breeding *D. cinerea* is common in deforested and degraded areas and does not need protection measures. The uniform morphology in South-East Asia points to little genetic variation, and it has been postulated that the occurrence in this area could be the result of a single early introduction from Africa.

Prospects *D. cinerea* is recommended for planting on very poor soils in comparatively dry climates. Although the timber is only available in very small sizes, it may be useful for small objects and, moreover, the species can be used as a forage, fuel and cover plant.

Literature 70, 142, 163, 341, 342, 364, 398, 405, 420, 436, 772, 924, 925, 962, 1023, 1039, 1104, 1226, 1272.

D. Sasmitamihardja

Diploknema Pierre

Arch. Néerl. Sci. Exact. Nat. 19: 103 (1884).

SAPOTACEAE

x = unknown; $2n$ = unknown

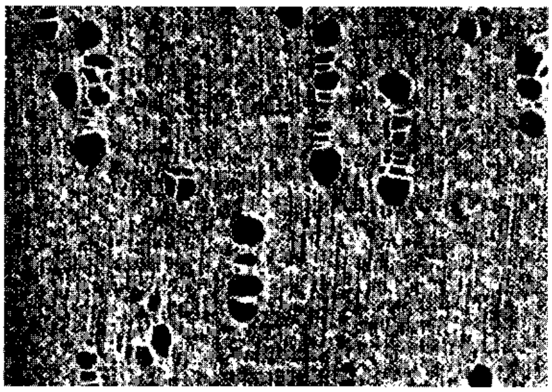
Vernacular names Nyatoh (trade name). Padang (En). Indonesia: nyatuh. Malaysia: nyatoh. Philippines: nato, red nato (En). Thailand: masang. All these names refer to most *Sapotaceae* genera.

Origin and geographic distribution *Diploknema* comprises about 10 species occurring from northern India and the Himalayas to Burma (Myanmar), Indo-China, the Andaman Islands, Thailand, Peninsular Malaysia, Borneo, the Philippines and the Moluccas (Ambon). The genus is quite rare within the Malesian region where it is represented by 3 species with restricted distribution.

Uses The wood of *Diploknema* is used like 'nyatoh', e.g. for interior finish, light flooring, joinery, cabinet and furniture making, pattern making, ship planking and cheap boxes. The wood is suitable for the manufacture of veneer and plywood, as well as for the production of pulp and paper.
The seeds of *D. sebifera* produce an oil often referred to as 'tengkawang' oil, as it closely resembles the real tengkawang oil from various *Shorea* species; it is used for making soap and candles.

Production and international trade Wood of *Diploknema* spp. is generally traded as 'nyatoh' mixed with that of other *Sapotaceae* genera. In the Philippines it is sometimes mixed with red meranti (*Shorea* spp.). Supplies are, however, very limited.

Properties *Diploknema* yields a medium-weight hardwood with a density of 460–580 kg/m^3 at 15% moisture content. The wood of *D. oligomera* is reportedly very heavy and weighs 1060–1170 kg/m^3 at 15% moisture content. Heartwood reddish-brown, not sharply demarcated from the pale red sapwood which is up to 4 cm wide; grain straight, occasionally wavy; texture rather fine to coarse, even. Growth rings indistinct; vessels moderately small to moderately large, almost all in radial multiples of up to 10, the vessels at both ends of a radial group being characteristically larger, tyloses occasionally present; parenchyma moderately abundant to abundant, apotracheal in narrow continuous or broken bands, not visible to the naked eye; rays fine, not visible to the naked eye; ripple marks absent.
Shrinkage of the wood is moderate; boards of *D. sebifera* take 2 months to air dry when 13 mm thick and 3 months when 38 mm thick. The wood seasons well with little or no checking and warping. It is soft and easy to work. It is moderately durable for interior use and non-durable to moderately durable when exposed to the weather or in contact with the ground. The average service life in graveyard tests with stakes of *D. sebifera* is 2.5 years. The heartwood is susceptible to dry-wood termites and the sapwood to *Lyctus*.
See also the tables on microscopic wood anatomy and wood properties.



Diploknema ramiflora
transverse surface (×18)

Botany Evergreen, medium-sized to large trees up to 48 m tall; bole columnar, up to 115 cm in diameter, without buttresses; inner bark fibrous, pinkish to reddish, exuding white latex. Leaves alternate, crowded towards the end of twigs, simple, entire; stipules caducous. Flowers fascicled, in axil of leaf scars, bisexual or unisexual and then trees dioecious; sepals (4–)5(–6); corolla 7–16-lobed; stamens (10–)16–30(–80), in 2–4 rows and inserted in the corolla throat, reduced to staminodes in female flowers; disk absent or small; ovary superior, 5–15-locular with 1 ovule per cell, style often exserted. Fruit a 1–3(–5)-seeded berry. Seeds large, with a broad scar. Seedling with semi-hypogeal germination; cotyledons emergent, fleshy; hypocotyl not elongated; first 2 leaves opposite, subsequent ones alternate-spiral; shoots orthotropic.
D. oligomera has been observed to flower in June and to bear fruits in September. *D. ramiflora* flowers in June. In Borneo *D. sebifera* bears fruits in May and June.

Ecology *D. sebifera* occurs in primary forest on sandy to loamy soils, sometimes with limestone, up to 300 m altitude.

Silviculture *Diploknema* may be raised from seed. The germination rate of seed of *D. sebifera* is about 75% in 21–39 days.

Genetic resources and breeding As logging of *Diploknema* is not important, genetic conservation depends on the conservation of the habitat.

Prospects It is very unlikely that the utilization of *Diploknema* timber will increase, since its supply is very limited and the properties of the wood are only moderate.

Literature 71, 156, 162, 163, 343, 387, 436, 778, 780, 829, 831, 861, 877, 934, 1131, 1221, 1241, 1267.

Selection of species

Diploknema oligomera H.J. Lam
Vernacular names Indonesia: tetah (Moluccas).
Distribution The Moluccas (Ambon).

Diploknema ramiflora (Merr.) H.J. Lam
Synonyms *Bassia ramiflora* (Merr.) Merr., *Illipe ramiflora* Merr., *Madhuca ramiflora* (Merr.) Merr.
Vernacular names Philippines: baniti (general), buluan, silang batu (Tagalog).
Distribution The Philippines.

Diploknema sebifera Pierre
Vernacular names Indonesia: merading, nyatoh kalan, putat (Kalimantan). Malaysia: nyatoh kekabu (Peninsular), nyatoh puteh (Sabah).
Distribution Peninsular Malaysia (rare) and Borneo.

A.S. Budi

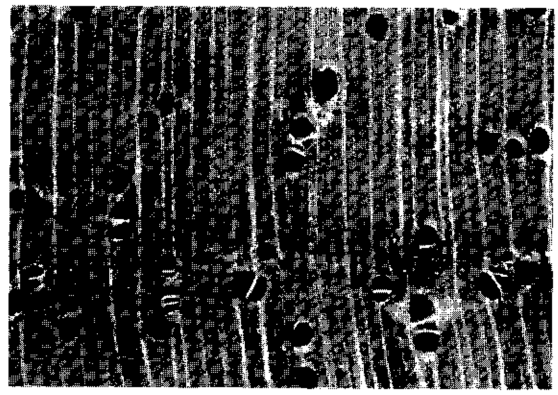
Dolichandrone (Fenzl) Seem.

Ann. Mag. Nat. Hist., Ser. 3, 10: 31 (1862).
BIGNONIACEAE
$x = 20$; *D. spathacea*: $2n = 40$

Vernacular names Mangrove trumpet tree (En). Indonesia: kayu kuda (general), ki jaran (Sundanese), tui (Sumatra). Malaysia: tui (general), daun tuwai, taring buaya (Peninsular). Philippines: pata (Pangasinan), tanghas, tiui (general). Burma (Myanmar): thakut. Laos: khê. Thailand: khae nam (peninsular), khae pa (central), khae thale (south-eastern). Vietnam: quao (Quang Nam-Da Nang).

Origin and geographic distribution *Dolichandrone* comprises 10 species, with 1 in tropical East Africa, 5 in tropical Asia, and 3 in northern Australia. There is additionally 1 widespread species ranging from India and Sri Lanka to Indo-China, Thailand and the whole of the Malesian region, east to the Solomon Islands and New Caledonia: *D. spathacea* (L. f.) K. Schumann (synonyms: *Dolichandrone longissima* (Lour.) K. Schumann, *Dolichandrone rheedii* (Spreng.) Seem.).

Uses The wood of *D. spathacea* is mainly used for floaters for fishing nets. Other reported applications are wooden shoes, household utensils, pattern making, scabbards and masks. It is suitable for the production of matches, pulp and paper, and has also been used as firewood.



Dolichandrone spathacea
transverse surface (×20)

In Madura the leaves have been used for making a mouthwash against thrush. Bark is eaten by elephants. A blackish fibre can be obtained from the bark.

Production and international trade As the available supplies and the size of the timber are generally small, utilization of the wood of *D. spathacea* is at a local scale only.

Properties *D. spathacea* yields a lightweight hardwood with a density of (300–)335–480 kg/m³ at 15% moisture content. Heartwood white to pale yellow or pinkish-buff, not distinct from the sapwood; grain straight; texture rather fine and even; wood with some wavy figure from banded parenchyma. Growth rings indistinct, irregular in width and with poorly defined boundaries, sometimes marked by marginal parenchyma or rows of larger vessels; vessels moderately small to medium-sized, solitary, in radial multiples of 2–3, open; parenchyma moderately abundant, apotracheal in marginal or seemingly marginal bands, and paratracheal vasicentric and aliform to confluent; rays extremely fine to very fine, visible with a hand lens; ripple marks absent.
Shrinkage is low and the wood seasons well but needs rapid drying to prevent blue stain. It is very soft, very easy to work, non-durable even under cover, but heartwood is resistant to dry-wood termites. The sapwood is non-susceptible to *Lyctus*.
The average fibre length is 0.71 mm.
See also the tables on microscopic wood anatomy and wood properties.

Botany An evergreen, small to medium-sized tree up to 25 m tall; bole short, often crooked, up to 45 cm in diameter, without buttresses, becoming fluted with age; bark surface smooth or shallowly fissured, slightly scaly, grey or pale brown, inner bark laminated, pink or reddish-pink; crown narrow, dark green. Leaves opposite, 1-pinnate, blackening upon drying, with hairy domatia underneath, exstipulate. Flowers in a 2–6-flowered terminal raceme, bisexual, 5-merous, white, large, conspicuous, fragrant; calyx closed in bud; corolla funnel-shaped, the lobes frilled; stamens 4 and a 5th rudimentary one, all included and inserted at the throat; disk present; ovary superior, 2-locular with many ovules, style 1. Fruit a many-seeded, elongated capsule with a narrow true septum and very broad false one, usually hanging in clusters. Seed rectangular with corky wings. Seedling with epigeal germination; first leaves simple, subsequent ones pinnate with successively more leaflets.

Flowering and fruiting is almost throughout the year. Trees are evergreen but fruiting, nearly leafless trees have been observed in areas with a pronounced dry season. Flowers open at dusk or at night and fall at dawn. Pollination is probably by hawk moths. The floating, corky seeds are dispersed by water.

Ecology *D. spathacea* is a common but not abundant element of the outer fringe of mangrove forest, waterlogged sites, tidal rivers and estuaries, and along coastal rice fields. It has been found in almost pure stands in Papua New Guinea.

Silviculture *D. spathacea* can be propagated by seed. In a germination trial in Malaysia 40% of the seeds sown germinated in 9–16 days. Its specialized ecology, however, makes it not very suitable for plantations. *D. spathacea* serves as an alternate host for the teak defoliator (*Hyblaea puera*) during the time teak is leafless: as such it is undesirable to plant it near teak plantations.

Genetic resources and breeding Given the common occurrence of *D. spathacea* there seems no real danger of genetic erosion.

Prospects The wood of *D. spathacea* is expected to be used as before for special purposes related to its very low density, like fishing net floats. As supplies are limited and plantation establishment is not anticipated, increased utilization is very unlikely.

Literature 151, 163, 198, 209, 267, 300, 341, 343, 436, 438, 464, 754, 772, 829, 831, 861, 934, 1038, 1039, 1048, 1169, 1198, 1221, 1232, 1242.

E. Boer & M.S.M. Sosef

Dryadodaphne S. Moore

Journ. Bot. 61: 109 (1923).

MONIMIACEAE

x = unknown; $2n$ = unknown

Vernacular names Papua New Guinea sassafras (En, trade name).

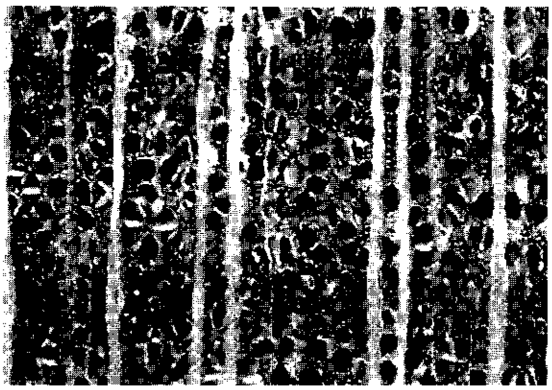
Origin and geographic distribution *Dryadodaphne* comprises 3 species occurring in New Guinea and northern Australia (Queensland).

Uses The wood of *Dryadodaphne* is used for joinery, cabinet making, drawer sides, turnery, carving, mouldings, brushware and small tool handles. It is also applied as core-stock for plywood and as veneer.

Production and international trade The wood of *Dryadodaphne* is mainly used on a local scale. In 1996 Papua New Guinea exported only 133 m³ of 'Papua New Guinea sassafas' logs at an average free-on-board (FOB) price of US$ 101/m³.

Properties *Dryadodaphne* yields a medium-weight hardwood with a density of 540–730 kg/m³ at 15% moisture content. Heartwood greyish-yellow-brown with greenish tinge, sapwood pale yellow to pale yellow-brown; wood with aromatic or sometimes foetid odour. Growth rings rarely distinct; vessels moderately small, mostly solitary, occasionally in short radial multiples of 2–3, with a tendency to ring porosity, open, indistinct to the naked eye; parenchyma absent; rays of variable widths, narrower or wider than the pores, rather distinct to the naked eye, prominent on radial surface; ripple marks absent.

Shrinkage upon seasoning is moderate. The wood is fairly strong and only slightly durable under cover. The heartwood is probably fairly permeable to pressure treatment. The sapwood is non-sus-



Dryadodaphne novoguineensis transverse surface (×20)

ceptible to *Lyctus*.
See also the tables on microscopic wood anatomy and wood properties.

Botany Evergreen, small to very large trees up to 50 m tall; bole straight, up to 60 cm in diameter, often with buttresses or spurs; bark surface grey to brown; crown not wide-spreading. Branches in an upright position. Leaves decussate, simple, dentate to almost entire, obovate to oblanceolate, top emarginate, exstipulate. Flowers in axillary dichasia or few-flowered pleiochasia, with broad bracteoles enclosing the flower bud; tepals 8, in 2 whorls; stamens many, with a pair of glands at base, anthers opening with valves; gynoecium with several free, 1-ovulate carpels. Nutlets enclosed in a hypanthium which splits into 4 (or rarely 2) valves; nutlets silky on one side, with a plumose persistent style.
The structure of the nutlets implies that their dispersal is by wind.
Dryadodaphne belongs to the subfamily *Atherospermatoideae* which has sometimes been regarded as a family of its own (*Atherospermataceae*). Specimens may be misidentified as *Lauraceae*, which is probably also the origin of the vernacular name 'sassafras', referring to *Sassafras*.
D. novoguineensis has been divided into 2 subspecies: subsp. *novoguineensis* from Papua New Guinea and subsp. *occidentalis* Schodde from Irian Jaya.

Ecology *D. crassa* is found in primary or old secondary montane rain forest at (1350–)1600–2800 m altitude. It occurs on well-drained sites, on slopes and ridges. It is generally found in *Nothofagus* forest and extends upwards into forest dominated by *Libocedrus*, *Phyllocladus* and *Podocarpus*. *D. novoguineensis* is less often associated with *Nothofagus* and occurs at 500–1950 m altitude.

Genetic resources and breeding The conservation of the montane forest habitats in New Guinea will at the same time safeguard the genetic base of *Dryadodaphne*.

Prospects The utilization of the wood of *Dryadodaphne* is limited and it is unlikely that this situation will change in the near future.

Literature 300, 341, 464, 790, 861, 1032, 1033.

Selection of species

Dryadodaphne crassa Schodde

Distribution New Guinea.

Dryadodaphne novoguineensis (Perkins) A.C. Smith

Synonyms *Daphnandra novoguineensis* Perkins, *Dryadodaphne celastroides* S. Moore, *Isomerocarpa novoguineensis* (Perkins) A.C. Smith.

Vernacular names Indonesia: gukai (Kapauku, Irian Jaya).

Distribution New Guinea.

E. Boer (general part),
M.S.M. Sosef (general part, selection of species)

Drymophloeus Zipp.

Algem. Konst- en Letter-bode 19: 297 (1829).
PALMAE

x = unknown; *D. beguinii* (Burret) H.E. Moore, *D. samoensis* (Rech.) Becc. ex Martelli: $n = 16$

Origin and geographic distribution *Drymophloeus* comprises about 15 species occurring in the Moluccas, New Guinea and east to the Solomon Islands, Fiji and Samoa. About 5 species are found in the Malesian region.

Uses The slender poles of these palms are scraped and used for e.g. spears, arrows and roofs of local houses.
Some species are grown as ornamentals.

Production and international trade Utilization of the wood of *Drymophloeus* is very limited and on a local scale only.

Properties The wood of *Drymophloeus* is blackish. It splits obliquely, rendering it unsuitable even for small planks. As traditional preservative treatment the wood is smoked.

Botany Unarmed, monoecious, pleonanthic, single-stemmed palms up to 12 m tall; pole straight, up to 10 m long, up to 15 cm in diameter. Leaves pinnate, sheaths with a slender crownshaft, leaflets alternate to subopposite, in one plane, simple, broadly to narrowly wedge-shaped with a ragged apex. Inflorescence below the leaves, branched to 1 or basally to 2–3 orders; peduncular bract terete and beaked; rachis basally bearing triads of 1 female and 2 male flowers basally and distally with pairs of a female and male flower or a single male flower. Flowers with 3 sepals and 3 petals. Male flowers with numerous stamens. Female flower with unilocular ovary containing a single ovule, stigmas 3. Fruit a drupe, smooth, with a thin exocarp, red when mature. Seed angled or grooved in cross section. Seedling with adjacent-ligular germination; eophyll bifid or entire with a toothed margin.

Drymophleus is botanically poorly known and in need of taxonomic revision.

Ecology *Drymophloeus* species occur as understorey palms in primary lowland rain forest in perhumid climates.

Silviculture *Drymophloeus* can be propagated by seeds which remain viable for only 2–3 weeks.

Genetic resources and breeding *D. olivaeformis* is only known from Ambon, where it is endangered. However, it is cultivated in the Botanical Garden in Bogor, Indonesia. The other Malesian *Drymophloeus* species have a restricted area of distribution and are rare.

Prospects As these palms are rare and have a restricted distribution, their present limited utilization is unlikely to increase. Moreover, the development of remote areas in New Guinea will probably lead to a decrease of their use.

Literature 236, 324, 436, 797, 805, 806, 1110.

Selection of species

Drymophloeus jaculatorius Mart.

Vernacular names Indonesia: nibung kecil (Indonesian, Moluccas).

Distribution The Moluccas (Halmahera) and New Guinea.

Drymophloeus olivaeformis (Giseke) Mart.

Synonyms *Areca olivaeformis* Giseke.

Vernacular names Indonesia: nibung kecil (Indonesian, Moluccas), palun maun (Ambon).

Distribution The Moluccas (Ambon).

E. Boer (general part),
M.S.M. Sosef (general part, selection of species)

Drypetes Vahl

Ecolog. amer. 3: 49 (1807).
EUPHORBIACEAE
$x = 10$; *D. roxburghii*: $n = 20$

Vernacular names Drypetes (En). Malaysia: arau (trade name), lidah-lidah (Peninsular), mentulang (Sabah). Philippines: tinaang-pantai (Filipino, trade name).

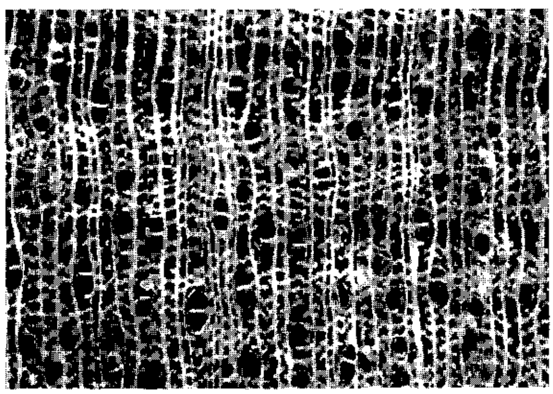
Origin and geographic distribution *Drypetes* comprises about 200 species and is pantropical. About 10 species are found in the New World, some 60 in Africa and Madagascar, and the remainder in Asia and Australia. The genus is found throughout the Malesian region where some 60 species occur.

Uses The exceptionally tough wood of *Drypetes* is used for general construction under cover (beams, joists, rafters, flooring), temporary construction, bridge and wharf superstructure, industrial flooring, furniture and cabinet making, rice mortars, tool handles, posts, piles, poles and railway sleepers. In the Philippines *D. longifolia* is considered useful for the manufacture of paper.

Production and international trade Supplies are limited and *Drypetes* wood seldom reaches the market. In the Philippines the wood is traded in mixed consignments of medium-weight hardwood. In Sarawak it is sold as 'arau', together with the wood of 2 other euphorbiaceous genera: *Austrobuxus* and *Cephalomappa*. In 1996 Papua New Guinea exported about 1220 m^3 of *Drypetes* logs at an average free-on-board (FOB) price of US$ 101/m^3.

Properties *Drypetes* yields a medium-weight to heavy hardwood with a density of (650–)740–1100 kg/m^3 at 15% moisture content. Heartwood pale yellow-brown occasionally mottled with dark or grey, not sharply demarcated from the paler sapwood; grain straight; texture very fine to moderately fine and even. Growth rings indistinct, boundaries marked by a narrow layer of dense, darker coloured tissue lacking parenchyma; vessels moderately small to medium-sized, mostly in radial multiples of 2–4, open; parenchyma abundant, apotracheal diffuse-in-aggregates forming a square mesh with the rays, distinct with a hand lens; rays moderately fine; ripple marks absent.

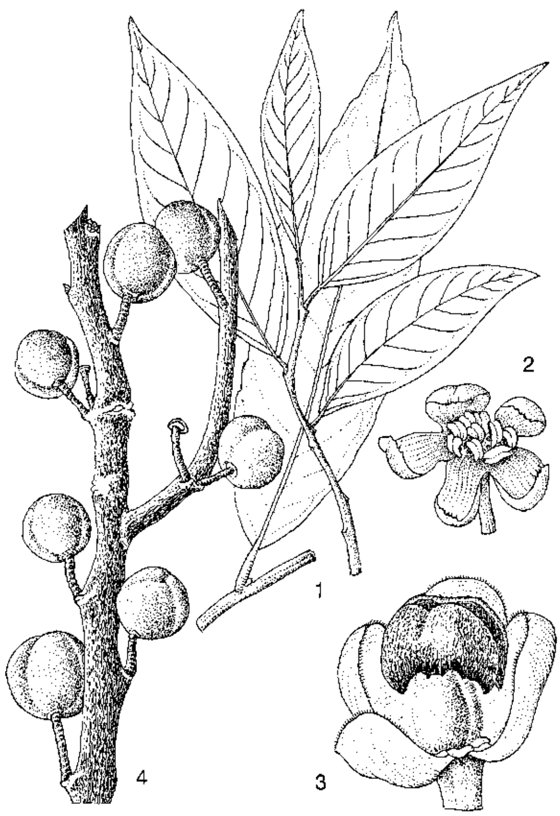
Shrinkage upon seasoning is high to very high. The wood stains readily and develops deep splits



Drypetes lasiogynoides
transverse surface (×20)

in the log when drying, but this problem does not occur when sawn fresh and stacked carefully. The wood is moderately hard to hard, strong and extremely tough. It is comparatively easy to work for a hard wood. The wood is durable under cover but perishable when in contact with the ground. The service life in a graveyard experiment in the Philippines was only 15 months. Impregnation of preservatives by pressure treatment is very good. The sapwood of *D. lasiogynoides* Pax & K. Hoffm. and probably *D. longifolia* occurring in Papua New Guinea is reported non-susceptible to *Lyctus*, but that of *D. microphylla* susceptible.
See also the tables on microscopic wood anatomy and wood properties.

Botany Generally evergreen, dioecious, small to medium-sized trees up to 30(–40) m tall; bole straight to somewhat sinuous in smaller trees, branchless for up to 20 m, up to 60(–80) cm in diameter, sometimes fluted or with short buttresses; bark surface smooth to finely fissured, often rugose or lenticellate, grey to grey-green, inner bark fibrous to granular, yellowish or pale brown to orange-brown or mottled orange-brown and fawn; crown usually dense, often rather small. Leaves arranged spirally, simple, entire or dentate, often unequal at base; stipules persistent or caducous. Flowers in an axillary or cauliflorous fascicle; sepals 4–5, imbricate, deciduous in fruit; petals absent. Male flowers with few to many, free stamens; disk annular or sinuate; pistillode small to obsolete. Female flower with an annular disk; ovary superior, 1–3-locular with 2 ovules in each cell, styles 1–3, very short, stigmas broad. Fruit drupaceous, leathery or fleshy, with 1–3 seeds each contained in an often thin stone (pyrene). Seedling with epigeal germination; cotyledons emergent, leafy; hypocotyl elongated; leaves alternate, involute.
In Java most *Drypetes* species can be observed flowering in August and September.
Drypetes forms a 'bridge' between the *Euphorbiaceae* and the *Flacourtiaceae*. There is little support for the suggestion that it should be placed in the latter family.



Drypetes polyneura Airy Shaw – 1, sterile twigs; 2, male flower; 3, female flower; 4, fruiting twig.

Ecology *Drypetes* is found scattered in primary lowland, evergreen rain forest, occasionally in monsoon forest, or in montane forest, up to 1700 m altitude. *D. longifolia* ascends up to 4000 m on Mount Kinabalu (Sabah). Most species occur in well-drained habitats on sandy to sandy loam soils, occasionally on clay or limestone, or in periodically flooded locations. *D. littoralis* is found on sandy beaches but also in inland hill forest. *D. sibuyanensis* is usually found in swamp forest or kerangas.

Silviculture *Drypetes* can be propagated by seed. Pyrenes of *D. kikir* sown with adhering pulp germinated for about 25% in one seed lot and about 95% in another in 1–3.5 months. Pyrenes of *D. longifolia* with adhering pulp germinated for about 90% in 42–89 days, whereas those of *D. pendula* germinated for about 30% in 24–68 days. *D. longifolia* is known to form root suckers.

Genetic resources and breeding Comparatively many *Drypetes* species are narrow endemics and therefore liable to genetic erosion or extinction through destruction of their habitat.

Prospects The extremely tough wood of *Drypetes* makes it very suitable for the handles of striking tools and is therefore likely to be increasingly utilized.

Literature 26, 28, 32, 33, 34, 36, 70, 125, 162, 163, 209, 235, 238, 267, 300, 301, 348, 436, 464, 525, 543, 553, 780, 829, 831, 861, 934, 955, 974, 1038, 1195, 1221, 1242.

Selection of species

Drypetes crassipes Pax & K. Hoffm.
Distribution Peninsular Malaysia and Borneo.

Drypetes cumingii (Baillon ex Müll. Arg.) Pax & K. Hoffm.
Synonyms *Cyclostemon cumingii* Baillon ex Müll. Arg.
Vernacular names Philippines: magataru (Lanao).
Distribution The Philippines and the Lesser Sunda Islands; possibly also in Borneo.

Drypetes fusiformis Airy Shaw
Distribution Borneo (Sabah, Kalimantan).

Drypetes grandifolia (C.B. Rob.) Pax & K. Hoffm.
Synonyms *Cyclostemon grandifolius* C.B. Rob., *Cyclostemon incarnatus* Elmer, *Drypetes ramiflora* (Merr.) Pax & K. Hoffm.
Vernacular names Philippines: banaui (Maguindanao, Sulu).
Distribution The Philippines.

Drypetes indica (Müll. Arg.) Pax & K. Hoffm.
Synonyms *Drypetes griffithii* (Hook. f.) Pax & K. Hoffm., *Drypetes lanceifolia* (Hook. f.) Pax & K. Hoffm., *Drypetes nienkui* Merr. & Chun.
Distribution From the eastern Himalayas to Burma (Myanmar), Hainan, Taiwan, Thailand and Peninsular Malaysia.

Drypetes kikir Airy Shaw
Vernacular names Indonesia: gambe, kayu kikir (Kalimantan). Malaysia: katong katong (Sabah).
Distribution Peninsular Malaysia and Borneo (Sabah, Kalimantan).

Drypetes laevis (Miq.) Pax & K. Hoffm.
Synonyms *Cyclostemon laevis* (Miq.) J.J. Smith.
Distribution Peninsular Malaysia, Sumatra and Borneo.

Drypetes lasiogynoides Pax & K. Hoffm.
Distribution New Guinea.

Drypetes littoralis (C.B. Rob.) Merr.
Synonyms *Cyclostemon littoralis* C.B. Rob., *Cyclostemon mindorensis* Merr., *Drypetes mindorensis* (Merr.) Pax & K. Hoffm.
Vernacular names Philippines: bato-bato (Filipino).
Distribution Java, Borneo (Sabah) and the Philippines; possibly also in Sulawesi and the Lesser Sunda Islands.

Drypetes longifolia (Blume) Pax & K. Hoffm.
Synonyms *Drypetes bordenii* (Merr.) Pax & K. Hoffm., *Drypetes macrophylla* (Blume) Pax & K. Hoffm., *Drypetes myrmecophila* Merr.
Vernacular names Indonesia: batung (Javanese), buniyaga (Sundanese), kikir daun besar (Kalimantan). Philippines: balikbikan (Filipino). Thailand: lang khao (peninsular).
Distribution From Sri Lanka and India to the Andaman Islands, Burma (Myanmar), Thailand and throughout the Malesian region.

Drypetes macrostigma J.J. Smith.
Vernacular names Indonesia: serampah (Kubu, Sumatra).
Distribution Sumatra and Borneo (Kalimantan).

Drypetes maquilingensis (Merr.) Pax & K. Hoffm.
Synonyms *Cyclostemon maquilingensis* Merr.
Distribution Borneo (Sabah) and the Philippines; possibly also in Sulawesi, the Moluccas and the Lesser Sunda Islands (Flores).

Drypetes microphylla (Merr.) Pax & K. Hoffm.
Synonyms *Cyclostemon microphyllus* Merr.
Vernacular names Philippines: butong-manuk (Bikol, Tagalog).
Distribution Peninsular Malaysia, Borneo and the Philippines.

Drypetes neglecta (Koord.) Pax & K. Hoffm.
Synonyms *Cyclostemon neglectus* Koord.
Distribution Java, Borneo (Sabah, Kalimantan), Sulawesi and the Lesser Sunda Islands.

Drypetes ovalis (J.J. Smith) Pax & K. Hoffm.
Synonyms *Drypetes calcicola* (Merr.) Pax & K. Hoffm., *Hemicyclia ovalis* J.J. Smith.
Vernacular names Indonesia: malaman (Bali), mentaos (Javanese), peutho (Kangean Archipelago). Philippines: puguran (Panay Bisaya).

Distribution Eastern Java, the Philippines, Sulawesi and the Lesser Sunda Islands.

Drypetes pendula Ridley

Synonyms *Drypetes gigantifolia* J.J. Smith.

Vernacular names Sabre leaf (En). Malaysia: lidah-lidah, gelugor salak (Peninsular).

Distribution Peninsular Thailand, Peninsular Malaysia, Singapore and Borneo (Sabah, Kalimantan).

Drypetes polyneura Airy Shaw

Vernacular names Indonesia: kikir putih, penjalin (Kalimantan), segan (Bangka). Malaysia: minyak burok (Sabah).

Distribution Bangka and Borneo (Sabah, Kalimantan).

Drypetes roxburghii (Wallich) Hurus.

Synonyms *Drypetes timorensis* (Blume) Pax & K. Hoffm., *Putranjiva roxburghii* Wallich.

Vernacular names Thailand: ma ong nok (northern), mak kho (north-eastern), makham kai (central).

Distribution From the western Himalayas, India and Sri Lanka to Burma (Myanmar), Indo-China, Thailand, Peninsular Malaysia, Sumatra, Java, Borneo (Sabah), Sulawesi, the Lesser Sunda Islands and the Moluccas; possibly also in New Guinea.

Drypetes sibuyanensis (Elmer) Pax & K. Hoffm.

Synonyms *Cyclostemon minahassae* Boerl. & Koord., *Cyclostemon sibuyanensis* Elmer, *Drypetes minahassae* (Boerl. & Koord.) Pax & K. Hoffm.

Vernacular names Indonesia: angrit, ki endog (Sundanese). Philippines: bagbog (Panay Bisaya).

Distribution Sumatra, Java, Borneo (Sarawak, Brunei), the Philippines and Sulawesi.

Drypetes simalurensis J.J. Smith.

Vernacular names Indonesia: ililsawali fatuh, lebul fatuh (Simeuluë), kayu bulan (Kubu, Sumatra).

Distribution Sumatra.

Drypetes subsymmetrica J.J. Smith.

Vernacular names Indonesia: elefen fatuh, seal etem, seal fatuh (Simeuluë).

Distribution Sumatra (Simeuluë).

E. Boer (general part),
M.S.M. Sosef (general part, selection of species)

Dysoxylum Blume

Bijdr. fl. Ned. Ind. 4: 172 (1825).
MELIACEAE

x = unknown; *D. excelsum*, *D. mollissimum*: n = 40 ($2n$ = 20 and 84 have been reported for extra-Malesian species)

Vernacular names Dysox, membalun (trade names). Onion wood, rose mahogany (En). Indonesia: cempaga (general), bangkiring payo (Sumatra), kapinango (Sundanese). Malaysia: jarum-jarum, pasak lingga (Peninsular), lantupak (Sabah). Papua New Guinea: red dysox (En), buk-buk (Pidgin). Thailand: ta suea. Vietnam: huynh d[uw][owf]ng.

Origin and geographic distribution *Dysoxylum* is a large genus comprising about 80 species occurring from India and Sri Lanka to Burma (Myanmar), Indo-China, southern China, Thailand and throughout the Malesian region, east towards the Pacific and south towards Australia and New Zealand. The highest number of endemic species are found in New Guinea and on islands in the Pacific. At least 46 species are present within Malesia.

Uses The wood of *Dysoxylum* is used for a wide variety of products such as general construction, boat construction, heavy decking, flooring, posts, foundation piles, doors, window frames and sills, mouldings, interior finish, decorative wall panelling, high grade furniture, cabinet work, coffins, vats, pallets, cart wheels, carving, turnery, tool handles, billiard cue butts, and match splints and matchboxes. It is also used for the production of sliced veneer, plywood and blockboard, and is suitable for the production of pulp. The wood of *D. acutangulum* (particularly that of its buttresses) is decoratively figured and has been used for furniture, cartwheels and coffins.

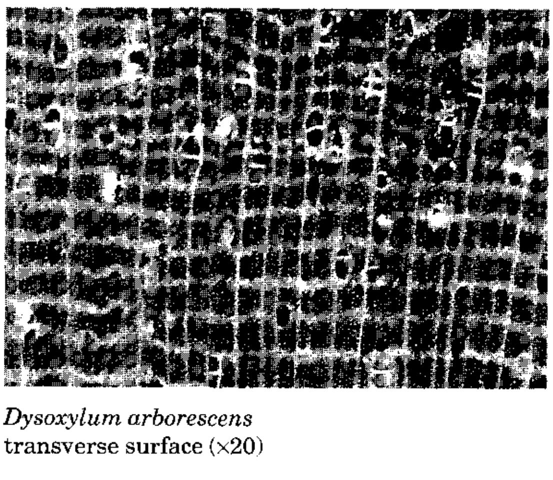
D. excelsum may be useful for reforestation purposes. *D. macrocarpum* has been planted as cover crop in Java at 600–1400 m altitude in forest plantations for soil protection and improvement. *Dysoxylum* species are well-known in the Philippines for their medicinal properties; an infusion of the bark is widely used as an emetic. The bark also shows piscidal and insecticidal properties and is sometimes poisonous to man. Seeds of some species are said to be poisonous, whereas those of others, e.g. *D. alliaceum*, smell of garlic and have been used in fish sauces. Young leaves of the same species smell of onions and have been cooked with fish. Fruits of *D. excelsum* are reported as edible, and those of several species are used as fish bait.

In Fiji the fruit of *D. mollissimum* is used for the treatment of wounds.

Production and international trade Small amounts of *Dysoxylum* are exported to Japan mainly from Papua New Guinea and the Solomon Islands. In 1996 Papua New Guinea a fair volume of about 23 650 m^3 of 'dysox' logs at an average free-on-board (FOB) price of US$ 109/m^3. In Irian Jaya *Dysoxylum* is traded mixed with *Aglaia* timber and is one of the principal commercial timbers.

Properties *Dysoxylum* yields a medium-weight to heavy hardwood with a density of (400–)440–1020 kg/m^3 at 15% moisture content. Heartwood pale reddish-brown or reddish-yellow, generally well or occasionally not distinctly demarcated from the up to 20 cm wide, white, yellowish or rather bright yellow or pale brown sapwood; grain interlocked or wavy, occasionally straight; texture fine to slightly coarse and uneven due to the abundance of wood parenchyma; wood with some watered-silk figure in material with broad rays; wood of some species with cedar-like or onion-like odour. Growth rings often indistinct, when distinct marked by dense wood and by a narrow layer of marginal parenchyma; vessels small to moderately large, solitary and in radial multiples of 2–4(–6), with occasional white deposits; parenchyma abundant, apotracheal in more or less continuous bands, wavy, occasional straighter bands indicating growth ring boundaries, visible to the naked eye; rays very fine to moderately broad, generally visible to the naked eye; ripple marks absent; pith flecks not unusual.

Shrinkage is moderate and the wood seasons well, but may check or twist slightly; preliminary air drying is recommended for 50 mm thick quarter-sawn material. Stock should be carefully stacked when kiln dried; the recommended kiln schedule consists of a temperature of 38–70°C and a relative humidity of 86–38%. The wood is moderately hard to hard and strong. It is moderately easy to easy to work and is satisfactory to machine and peel. The wood is reported to be non-durable to moderately durable when exposed to the weather or in contact with the ground. However, it is probably only moderately durable under exposed conditions. The wood is readily treated; the retention by the pressure method is 421–450 kg/m^3 for heartwood of *D. excelsum* and 536–549 kg/m^3 for heartwood of *D. gaudichaudianum*, but from Papua New Guinea it is reported that the heartwood is highly resistant to pressure impregnation. The resistance to fungal and insect attack is very variable but the sapwood of most species is susceptible to *Lyctus*.



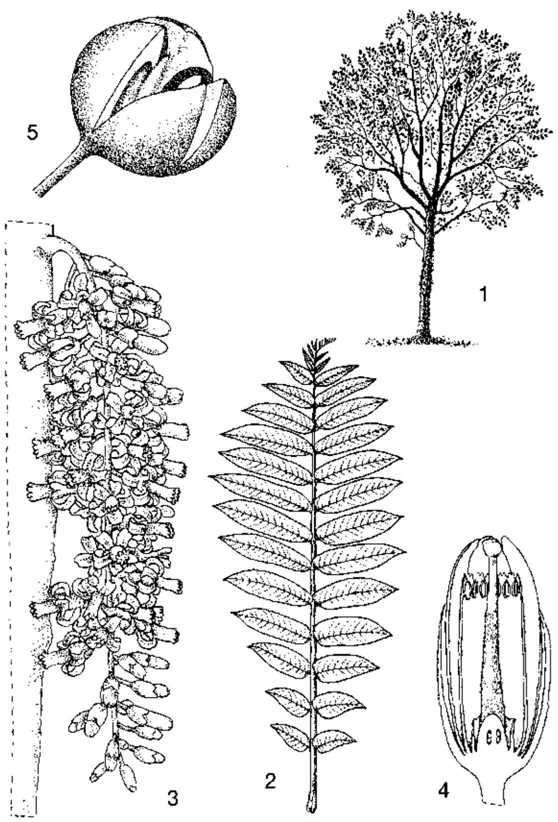
Dysoxylum arborescens
transverse surface (×20)

The sawdust of some species may cause irritation to mucous membranes. Seeds of several species contain the toxic dysoxylum acid.

See also the tables on microscopic wood anatomy and wood properties.

Botany Evergreen, dioecious (seldom with bisexual flowers) shrubs or small to fairly large or rarely large trees up to 35(–47) m tall; bole variable in shape, branchless for up to 20(–28) m, up to 80(–150) cm in diameter, sometimes with buttresses up to 3(–5) m high, sometimes fluted at base; bark surface smooth and lenticellate to fissured, becoming cracked, grey or grey-brown to blackish, inner bark often fibrous, straw-coloured to brown, sometimes with pinkish bands or mottled brown to orange, often fragrant or sometimes sour or pungent. Leaves arranged spirally or seldom opposite, paripinnate or rarely imparipinnate, exstipulate; leaflets opposite, entire. Flowers in an axillary to cauliflorous, paniculate to racemose inflorescence, sometimes reduced to a fascicle or solitary, functionally unisexual; calyx 3–5(–6)-lobed or with free sepals; petals 3–6, free or adnate to the lower half of the staminal tube; staminal tube cylindrical to urceolate with 6–16 anthers; disk free; ovary superior, 2–6-locular with 1–2 seeds in each cell, style head capitate to discoid. Fruit a 2–6-valved capsule. Seed usually with an opaque, orange-yellow to red aril or sarcotesta. Seedling with hypogeal germination; cotyledons occasionally emergent, peltate; hypocotyl not or only slightly elongated; first pair of leaves opposite or spiral, simple to 5-foliolate.

Flowers are pollinated by insects. In West Java flowering is generally from January–May, where-



Dysoxylum parasiticum (Osbeck) Kosterm. - 1, habit of young tree; 2, leaf; 3, inflorescence; 4, cross section of male flower; 5, dehisced fruit.

as fruits are found from April–December. The lipid-rich and colourful seeds are mainly dispersed by birds, e.g. hornbills and pigeons, occasionally by bats, and are also eaten by monkeys. Seeds of the rheophyte *D. angustifolium* King are eaten and dispersed by fish and render their flesh poisonous or unpalatable.

D. mollissimum has been divided into 2 subspecies, the first (subsp. *mollissimum*) occurring from India east to Bali and the second (subsp. *molle* (Miq.) Mabb.) occurring from Flores and Sulawesi eastward. *D. acutangulum* also comprises 2 subspecies, the typical one occurring in Peninsular Malaysia, Sumatra, Borneo and the Philippines, the second (subsp. *foveolatum* (Radlk.) Mabb.) in Sumatra, West Java, the Lesser Sunda Islands, the southern Moluccas and New Guinea.

Ecology *Dysoxylum* species are found scattered and are rarely common. Few reach the canopy top. They occur in evergreen or rarely semi-deciduous, primary or sometimes secondary forest and regrowth. Most species are found in well-drained habitats in the lowland on clayey to sandy soils, several extend into the montane zones, up to 2000(–2900) m altitude, in perhumid to seasonal climates. Forest types include swamp forest, coastal forest, riverine forest, ridge forest, kerangas and forest on limestone. *D. alliaceum* is found in *Agathis* forest on peat overlying sand. In Papua New Guinea some common associates of *Dysoxylum* are *Cinnamomum*, *Cryptocarya*, *Diploglottis*, *Heritiera* and *Sloanea* species.

Silviculture *Dysoxylum* can be propagated by seed. Per kg *D. parasiticum* has about 4400 dry seeds and *D. gaudichaudianum* about 1100 fresh seeds. Seeds sown without pulp generally germinate faster than those sown with pulp. Seeds of *D. arborescens* have a germination rate of 70% in 2–10 months, those of *D. cauliflorum* 95% in 1–3 months and those of *D. angustifolium* King 90–100% in 3 weeks to 2 months. When sown with adhering pulp, seeds of *D. cauliflorum* have a germination rate of 80% in 3.5–8 months, those of *D. densiflorum* 30–75% in 1.5–8.5 months, and those of *D. excelsum* 80% in 1–4 months. In Belitung Island, Indonesia, plantation trials revealed slow growth of *D. acutangulum* and planting was abandoned.

In natural forest in West Java at an altitude of 1100–1500 m *Dysoxylum* species were among the few major commercial species; their natural regeneration, however, was very erratic. The few seedlings which did come up, were found in open areas as well as under shade and had a height increment of only about 25 cm in three years. *Dysoxylum* species are not resistant to fire and seedlings die in 7–11 days when exposed to waterlogged conditions. Locally in Papua New Guinea *Dysoxylum* species may constitute 4% of the total exploitable timber volume of trees over 50 cm diameter.

Genetic resources and breeding Apart from some individual trees kept in botanical gardens and parks, none of the *Dysoxylum* species is conserved ex situ. Practically all rare and endemic species are found in New Guinea. As this is also the area with the highest trade figures for *Dysoxylum* timber, there is a potential risk of genetic erosion and maybe even extinction of some of the rarer species.

Prospects Although the quality of *Dysoxylum* wood is renowned, surprisingly little is known on silvicultural management of natural forest containing *Dysoxylum* species. Research is needed on their behaviour in plantations or enrichment plantings.

Literature 40, 57, 75, 101, 121, 125, 126, 161, 162, 209, 211, 235, 238, 259, 260, 267, 300, 302, 304, 341, 346, 348, 356, 364, 405, 423, 433, 438, 464, 487, 536, 568, 590, 632, 634, 694, 730, 757, 780, 825, 829, 831, 861, 878, 933, 934, 1012, 1052, 1065, 1086, 1123, 1209, 1218, 1221, 1232, 1242, 1248.

Selection of species

Dysoxylum acutangulum Miq.

Synonyms *Alliaria acutangula* (Miq.) Kuntze, *Dysoxylum foveolatum* Radlk., *Dysoxylum schultzii* C. DC.

Vernacular names Indonesia: ambalo, membalo (Bangka), ngersaweran (Aru Islands). Malaysia: pasak lingga (Peninsular). Philippines: miau-tilos (Tagalog). Thailand: ta suea (peninsular).

Distribution Throughout the Malesian region towards northern Australia and the Solomon Islands; possibly also in peninsular Thailand.

Dysoxylum alliaceum (Blume) Blume

Synonyms *Dysoxylum euphlebium* Merr., *Dysoxylum klemmei* Merr., *Dysoxylum thyrsoideum* Hiern.

Vernacular names Indonesia: kayu bawang (Moluccas), ki bawang (Sundanese), pela (Javanese). Malaysia: beka-beka bukit, kasai temaga, pasak lingga merah (Peninsular). Philippines: malaaduas, miao, paria (Filipino). Thailand: ta suea khao (peninsular).

Distribution The Andaman Islands, peninsular Thailand, throughout the Malesian region towards northern Australia and the Solomon Islands.

Dysoxylum annae Mabb.

Vernacular names Indonesia: seraka puteh (Manikiong, Irian Jaya).

Distribution New Guinea (Irian Jaya).

Dysoxylum arborescens (Blume) Miq.

Synonyms *Dysoxylum kunthianum* (A. Juss.) Miq., *Dysoxylum maingayi* Hiern, *Dysoxylum rubrum* Merr.

Vernacular names Indonesia: kayu kupang, kayu longgayan (Sumatra). Philippines: bungloi (Bisaya, Sulu), kalimutain (Tagalog).

Distribution The Nicobar and Andaman Islands, Taiwan, throughout the Malesian region towards Vanuatu, northern Australia and the Solomon Islands.

Dysoxylum brassii Merr. & L.M. Perry

Synonyms *Dysoxylum ledermannii* Harms.

Vernacular names Indonesia: meireit, merek (Manikiong, Irian Jaya).

Distribution New Guinea.

Dysoxylum carolinae Mabb.

Vernacular names Indonesia: embalau burung (Sumatra).

Distribution Vietnam, Peninsular Malaysia, Singapore (extinct), Sumatra and Borneo (Brunei, Sabah).

Dysoxylum cauliflorum Hiern

Synonyms *Dysoxylum beccarianum* C. DC., *Dysoxylum cuneatum* Hiern.

Vernacular names Stem dysoxylum (En). Indonesia: mensiah rima (Sumatra). Malaysia: dedali, langga ayer, pokok parong (Peninsular), uchong chit (Iban, Sabah).

Distribution Vietnam, Cambodia, Thailand, Peninsular Malaysia, Sumatra, Borneo and the Philippines; possibly also in Burma (Myanmar).

Dysoxylum crassum Mabb.

Vernacular names Malaysia: birar para (Sarawak).

Distribution Borneo (Sarawak).

Dysoxylum cyrtobotryum Miq.

Synonyms *Dysoxylum andamanicum* King, *Dysoxylum blumei* Miq., *Dysoxylum heyneanum* Valeton ex K. Heyne.

Vernacular names Indonesia: tungking kijang (Belitung). Malaysia: bebekeh (Peninsular). Philippines: ananangtang (Bikol), buahan (Manobo, Sulu), sasaba (Negrito). Thailand: khang khao ee lit (south-eastern), ma duk, mark duk (northern).

Distribution Indo-China, Thailand, the Nicobar and Andaman Islands, Peninsular Malaysia, Sumatra, Java, Borneo, the Philippines and the Lesser Sunda Islands (Bali); possibly also on Flores.

Dysoxylum densiflorum (Blume) Miq.

Synonyms *Dysoxylum elmeri* Merr., *Dysoxylum trichostylum* Miq.

Vernacular names Brunei: jolurut. Indonesia: cempaga (general), kapinango (Sundanese), kraminan (Javanese). Malaysia: menkuang (Sarawak), rambai chengkuang (Peninsular).

Distribution Southern Burma (Myanmar), China (Yunnan), Thailand, Peninsular Malaysia, Sumatra, Borneo, Java, Sulawesi and the Lesser Sunda Islands.

Dysoxylum excelsum Blume

Synonyms *Dysoxylum arnoldianum* K. Schumann, *Dysoxylum hasseltii* (Miq.) Koord. & Valeton, *Dysoxylum gobara* (Buch.-Ham.) Merr.

Vernacular names Indonesia: ki bawang, pingku (Sundanese), kraminan (Javanese). Malaysia: kasai tembaga, kasip hutan, kulim burong (Peninsular). Philippines: kulig-baboi (Filipino), kadangisol (Bikol). Laos: kong[1] ta 'sua.

Distribution Sri Lanka, India and Nepal towards Indo-China, southern China and throughout the Malesian region east to the Solomon Islands.

Dysoxylum flavescens Hiern

Synonyms *Dysoxylum griffithii* Hiern.

Distribution Peninsular Malaysia, Singapore, Sumatra and Borneo.

Dysoxylum gaudichaudianum (A. Juss.) Miq.

Synonyms *Didymocheton gaudichaudianum* A. Juss., *Dysoxylum amooroides* Miq., *Dysoxylum decandrum* (Blanco) Merr.

Vernacular names Indonesia: kedoya (Javanese), ki tai (Sundanese), mamalapa (Sulawesi). Papua New Guinea: red dysox (En). Philippines: igio (Filipino), manangtang (Bikol), taliktan (Tagalog).

Distribution The Philippines, Sulawesi, Christmas Island, Java, the Lesser Sunda Islands, the Moluccas, New Guinea, the Solomon Islands, Vanuatu, northern Australia and Samoa.

Dysoxylum grande Hiern

Synonyms *Dysoxylum corneri* Hend., *Dysoxylum interruptum* King, *Dysoxylum lukii* Merr.

Vernacular names Burma (Myanmar): tagatni.

Distribution From India (Assam) to Burma (Myanmar), southern China and Hainan through Indo-China towards Thailand, Peninsular Malaysia, Sumatra and Borneo (Sarawak, Sabah, Nukunan Island); possibly also in the Philippines (Leyte).

Dysoxylum inopinatum (Harms) Mabb.

Synonyms *Pseudocarapa inopinatum* Harms.

Vernacular names Indonesia: arabure (Biak, Irian Jaya), beor (Asmat, Irian Jaya), lessaa'i (Manikiong, Irian Jaya).

Distribution Northern and Central New Guinea.

Dysoxylum kaniense Harms

Vernacular names Indonesia: herrib (Manikiong, Irian Jaya).

Distribution New Guinea and the Solomon Islands.

Dysoxylum latifolium Benth.

Synonyms *Alliaria latifolia* (Benth.) Kuntze, *Dysoxylum confertiflorum* Merr. & L.M. Perry.

Vernacular names Indonesia: herrip (Manikiong, Irian Jaya).

Distribution New Guinea, northern Australia and the Solomon Islands; possibly also in Ternate.

Dysoxylum macrocarpum Blume

Vernacular names Indonesia: ki haji (Sundanese), kraminan, mentaos (Javanese).

Distribution Thailand, Peninsular Malaysia, Sumatra, Java, Borneo, the Philippines and Sulawesi.

Dysoxylum mollissimum Blume

Synonyms *Dysoxylum floribundum* Merr., *Dysoxylum muelleri* Benth., *Dysoxylum richii* (A. Gray) C. DC.

Vernacular names Australian pencil cedar, miva mahagony, saurauira (En). Indonesia: bawang (Sumatra), ki bawang (Sundanese), tumbawa sela (Minahassa, Sulawesi). Philippines: hairy-leaved himamau (Filipino), malaaduas (Bikol), mata-mata (Tagalog).

Distribution India, Burma (Myanmar), southern China and throughout the Malesian region towards Australia and the Pacific, east to Fiji and Samoa.

Dysoxylum oppositifolium F. v. Mueller

Synonyms *Dysoxylum capizense* Merr., *Dysoxylum turczaninowii* C. DC., *Dysoxylum wenzelii* Merr.

Vernacular names Philippines: abubuli (Panay Bisaya), kayatau (Sulu), ngarau (Samar-Leyte Bisaya).

Distribution Borneo (Sabah), the Philippines, New Guinea and north-eastern Australia; possibly also in the Lesser Sunda Islands (Sumba, Flores).

Dysoxylum papuanum (Merr. & L.M. Perry) Mabb.

Synonyms *Aglaia papuana* (Merr. & L.M. Perry) Harms, *Dysoxylum micranthum* Merr. & L.M. Perry, *Pseudocarapa papuana* Merr. & L.M. Perry.

Distribution New Guinea, northern Australia and the Solomon Islands.

Dysoxylum parasiticum (Osbeck) Kosterm.

Synonyms *Dysoxylum caulostachyum* Miq., *Dysoxylum ramiflorum* Miq., *Dysoxylum sericeum* (Blume) Adelb.

Vernacular names Indonesia: kulut (Sumatra), langsep alas (Javanese), maranginan (Sundanese). Papua New Guinea: red dysox (En). Philippines: bagolan (Samar-Leyte Bisaya), lambayan (Bagobo), malasaging (Tagalog).

Distribution Sumatra, Borneo, Java, Taiwan, the Philippines, Sulawesi, the Lesser Sunda Islands, the Moluccas, New Guinea, the Bismarck Archipelago and the Solomon Islands.

Dysoxylum pettigrewianum F.M. Bailey

Synonyms *Dysoxylum whiteanum* Merr. & L.M. Perry.

Vernacular names Spur mahagony (En). Indonesia: enetawe (Oeta, Irian Jaya).

Distribution The Moluccas, New Guinea, New Britain, northern Australia and the Solomon Islands.

Dysoxylum randianum Merr. & L.M. Perry

Synonyms *Dysoxylum sericopetalum* Harms.

Distribution New Guinea.

Dysoxylum rigidum (Ridley) Mabb.

Synonyms *Chisocheton rigidus* Ridley.

Distribution Peninsular Malaysia, south-eastern Sumatra and Borneo (Kalimantan, Sabah?); apparently rare.

Dysoxylum setosum (Spanoghe) Miq.

Synonyms *Dysoxylum cerebriforme* F.M. Bailey, *Dysoxylum lamproanthum* Merr. & L.M. Perry, *Dysoxylum thaumasianthum* Harms.

Distribution The Lesser Sunda Islands (Timor), New Guinea and northern Australia.

Dysoxylum stellatopuberulum C. DC.

Synonyms *Didymocheton stellatopuberulum* (C. DC.) Harms, *Dysoxylum carrii* Harms, *Dysoxylum hirtum* Ridley.

Vernacular names Indonesia: kiriopi, sewawarioram (Yapen Island).

Distribution New Guinea.

S. Aggarwal (general part, selection of species), M.S.M. Sosef (selection of species)

Ehretia P. Brown

Civ. nat. hist. Jamaica: 168 (1756).

BORAGINACEAE

x = unknown; *E. acuminata*: $n = 18$, $2n = 30$

Vernacular names Indonesia: kendal. Philippines: tanaua (general). Thailand: kom.

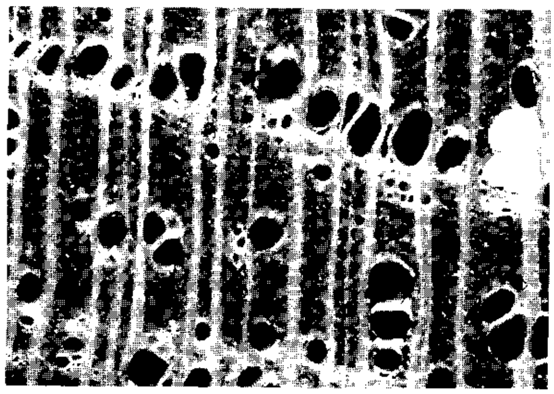
Origin and geographic distribution *Ehretia* comprises about 50 species. Three of these occur in Central America, the rest in the tropics and subtropics of Africa, Asia and Australia. Within the Malesian region 12 species are found.

Uses The wood of *Ehretia* is used for construction, furniture, household utensils, tool handles and for framing and decking of small boats. It may be suitable for sporting goods requiring a strong, tough wood.

The fruit of *E. acuminata* is edible and its foliage is used for fodder in India. The very young leaves used to be exported from India to Tibet, where they were mixed with tea.

Production and international trade Utilization of the wood of *Ehretia* is probably only local and on a small scale.

Properties *Ehretia* yields medium-weight hard-



Ehretia acuminata
transverse surface (×20)

wood with a density of 490–670(–715) kg/m^3 at 15% moisture content. Wood pale brown, pale yellow or yellowish-brown; grain interlocked; texture moderately coarse and uneven owing to wide growth rings; wood fairly lustrous. Growth rings distinct, ring-porous; vessels moderately small to moderately large, arranged more or less concentrically with growth rings, vessels in earlywood mostly solitary, in latewood often in radial multiples of 2–4 and in clusters, tyloses present; parenchyma apotracheal in irregularly spaced bands and diffuse and diffuse-in-aggregates; rays both wider and narrower than the vessels; ripple marks absent.

Shrinkage upon seasoning is low and the wood is not subject to checking. The wood works satisfactorily. The heartwood is very resistant to drywood termites. The sapwood is non-susceptible to *Lyctus*.

E. acuminata leaves contain 11–22% crude protein.

See also the tables on microscopic wood anatomy and wood properties.

Botany Evergreen or deciduous shrubs or small to medium-sized trees up to 30 m tall; bole straight, up to 65(–80) cm in diameter, fluted at base; bark surface brown or greyish, finely fissured, inner bark soft, fibrous, pale yellow. Leaves alternate, simple, entire or serrate, sometimes wavy, with reticulate venation; stipules absent. Flowers in a many-flowered cyme, corymb or panicle, 5-merous; calyx imbricate; corolla tubular to campanulate, white or pale yellow; ovary superior, 2-carpellate with 2 ovules in each cell; style 1, terminal, divided in 2 branches. Fruit a drupe with fleshy to mucilaginous mesocarp, splitting up into two 2-seeded or four 1-seeded pyrenes.

A mean annual diameter increment of 0.6–0.8 cm has been measured in wood samples. Trees of *E. javanica* flower when completely leafless. Pollination is by insects.

Ehretia is sometimes placed in the small family *Ehretiaceae*, a split off product from the *Boraginaceae*. *E. acuminata* is highly variable and formerly many varieties were distinguished. Records of *E. timorensis* Dcne from Peninsular Malaysia all refer to *E. dichotoma*, as *E. timorensis* is a rare endemic of Timor.

Ecology *Ehretia* trees occur scattered in well-drained lowland to montane forest, up to 2100 m altitude. *E. dichotoma* also occurs on limestone.

Silviculture *Ehretia* can be propagated by seed. The germination rate of untreated seeds of *E. acuminata* is about 50%, whereas it is about 90% for seeds treated for 10 minutes with concentrated sulphuric acid.

Genetic resources and breeding The timber-yielding *Ehretia* species have a fairly wide geographical distibution, but their scattered occurrence makes them vulnerable to genetic erosion. However, *E. philippinensis* has a narrow distribution, but is more abundant.

Prospects The wood seems to be of good quality and has even been compared with teak (*Tectona grandis* L. f.). It is unlikely to gain importance, however, as it is found only very locally.

Literature 70, 163, 436, 464, 465, 504, 568, 595, 772, 793, 821, 861, 934, 946, 971, 1038, 1104, 1164, 1169, 1221.

Selection of species

Ehretia acuminata R. Br.

Synonyms *Ehretia serrata* Roxb., *Ehretia ovalifolia* Hassk., *Ehretia polyantha* A. DC.

Vernacular names Silver ash, silky ash (En). Indonesia: kendal kebo, kendal maesa, sembung ijo (Java). Philippines: tanaua (general), balulai (Laguna), kalibuning (Zambales). Burma (Myanmar): taw-petsut. Laos: sang^2. Thailand: kaai kom, kom (northern). Burma (Myanmar): petthin.

Distribution From India, Burma (Myanmar), Indo-China and Thailand north to China and Japan and in the Philippines, Java, the Lesser Sunda Islands, the Moluccas, New Guinea and northern Australia.

Ehretia dichotoma Blume

Synonyms *Ehretia laurifolia* Dcne, *Ehretia laevis* Roxb. var. *timorensis* auct. non (Dcne) C.B. Clarke, *Ehretia timorensis* auct. non Dcne.

Vernacular names Indonesia: kayu balung, kayu watu, kendal prit (Java). Malaysia: gambak yem, medang seminyak, tebengau (Peninsular). Burma (Myanmar): gyaung-bgy. Thailand: kai kom (northern).

Distribution The Andaman Islands, Burma (Myanmar), Vietnam, Thailand, Peninsular Malaysia, Borneo, Java, Sulawesi and the Lesser Sunda Islands (Flores, Timor).

Ehretia javanica Blume

Vernacular names Indonesia: kendal kebo, ki bako, cabukan (Java).

Distribution Java and the Lesser Sunda Islands (Bali, Sumbawa, Flores); possibly also in Borneo.

Ehretia philippinensis A. DC.

Vernacular names Philippines: alibungog (general).

Distribution The Philippines (Luzon, Mindanao, Palawan).

E. Boer (general part),
M.S.M. Sosef (general part, selection of species)

Elaeocarpus L.

Sp. pl. 1: 515 (1753); Gen. pl., ed. 5: 230 (1754).
ELAEOCARPACEAE
x = unknown; $2n$ = unknown

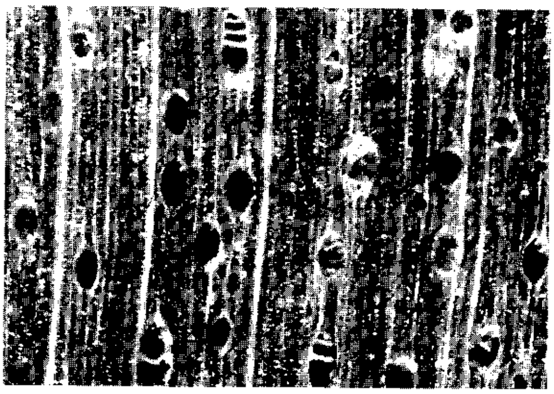
Vernacular names Jenitri, quandong (trade names). Oil-fruit (En). Brunei: perius-perius, sengkurat, suragam. Indonesia: bengkinang, mendang (Indonesian, Kalimantan), mentanahan (Kutai, East Kalimantan). Malaysia: sengkurat (general), kungkurad (Sabah), mendong (Peninsular). Papua New Guinea: Papua New Guinea quandong (En). Philippines: kalomala (general), hunggo (Filipino). Burma (Myanmar): thitpwe. Thailand: ma mun. Vietnam: c[oo]m.

Origin and geographic distribution *Elaeocarpus* comprises some 300 species occurring from Madagascar and Mauritius to Sri Lanka, India, Indo-China, China, Japan, Thailand, throughout the Malesian region, east to Hawaii and Polynesia (as far as Rarotonga), south to Australia and New Zealand. Malesia harbours the majority of species (some 250); Papua New Guinea alone has about 70 species, Borneo at least 50 and Peninsular Malaysia about 30.

Uses The wood of *Elaeocarpus* is used for light interior construction, weatherboard, boat building, aircraft building, furniture, joinery, scantlings, mouldings, boxes, pallets, shuttering, brushware, turnery, oars, match splints and carvings. It is occasionally used for the production of blockboard and as core stock and face veneer for plywood. It is suitable for the manufacture of particle board, fibreboard and pulp and paper.
E. angustifolius has been used for reforestation in Java whereas *E. grandiflorus* is planted as an ornamental. *Elaeocarpus* logs are suitable for the cultivation of shiitake mushrooms. The fruits of most species are edible. Leaves and seeds are sometimes applied medicinally, principally as a tonic, but also against sores, syphilis and as a diuretic. A decoction of the bark and leaves of *E. floribundus* has been used in Palembang, Sumatra to treat inflammation of the gums. The fruits of *E. angustifolius* are well-known in Hindu religion and the ancient Indian system of medicine in the treatment of mental diseases, epilepsy, hypertension, asthma and liver diseases. Stones are sometimes polished and used to make necklaces, bead chains or rosaries, formerly also for various buttons. Bark is used as twine in house construction.

Production and international trade As supplies are generally limited, *Elaeocarpus* wood is mainly sold in mixed consignments of medium-weight hardwood. In 1996 Papua New Guinea exported almost 7000 m^3 of 'quandong' logs at an average free-on-board (FOB) price of US\$ 99/m^3.

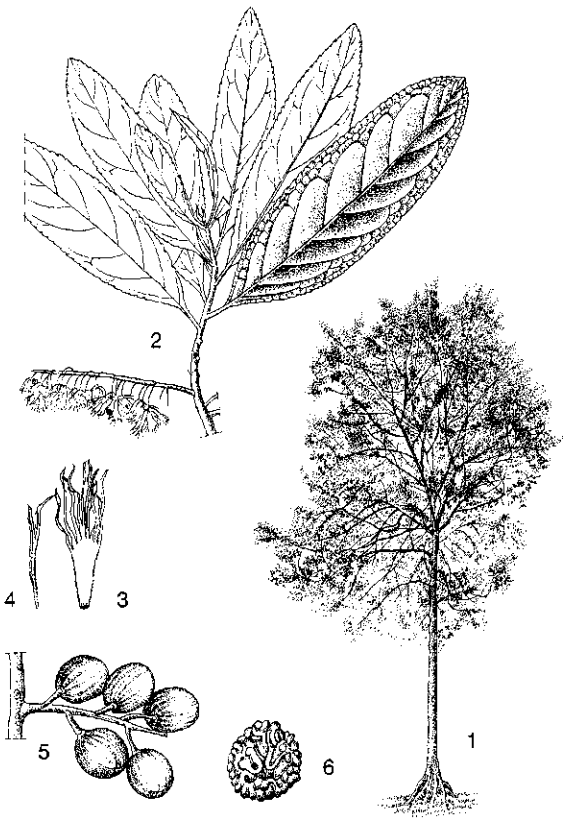
Properties *Elaeocarpus* yields a lightweight to medium-weight hardwood with a density of (265–)315–700(–820) kg/m^3 at 15% moisture content. Heartwood straw, yellowish-white to pale yellow-brown or pinkish-brown, not clearly differentiated from the white to pale grey-brown, 4–8 cm wide sapwood; grain usually straight, sometimes shallowly interlocked; texture very fine to moderately fine and even; wood lustrous. Growth rings indistinct to the naked eye but distinct with a hand lens, very variable in width, sometimes boundaries indicated by thicker-walled fibres in latewood and a band of marginal parenchyma in the earlywood; vessels moderately small to medium-sized, occasionally moderately large, solitary and in radial multiples of 2–4(–7), multiples predominating, with occasional clusters, tyloses present and abundant in some species including *E. calomala* and *E. undulatus*; parenchyma sparse to absent, apotracheal in marginal or seemingly marginal bands, just visible to the naked eye, sometimes paratracheal vasicentric, indistinct even with a hand lens; rays of 2 distinct sizes very dis-



Elaeocarpus angustifolius
transverse surface (×20)

tinct, moderately fine to medium-sized, visible on transverse section, and extremely fine, visible only with a hand lens; ripple marks absent; vertical traumatic canals present in tangential series in some species.
Shrinkage upon seasoning is low but the wood is prone to blue stain, sap-stain and insect attack. Prophylactic treatment should be undertaken prior to seasoning. Boards 13 mm and 38 mm thick of *E. angustifolius* take respectively 3 and 4.5 months to air dry. Back-sawn stock of 50 mm may develop slight warp and surface checks. The wood is soft to hard and very weak. It is generally easy to saw and work, takes a moderate to good finish and stock turns and moulds easily. It rotary peels well. The wood is non-durable when exposed to the weather or in contact with the ground. The sapwood is permeable, penetration of heartwood good in some material, patchy in others; the retention of *E. angustifolius* by the pressure treating method is 526 kg/m^3 for sapwood and 43 kg/m^3 for heartwood. The heartwood of *Elaeocarpus* is susceptible to dry-wood termites. The sapwood is susceptible to *Lyctus*.
The gross energy value of the wood of an unidentified *Elaeocarpus* species was reported to be about 20 535 kJ/kg.
See also the tables on microscopic wood anatomy and wood properties.

Botany Shrubs or small to fairly large, or occasionally large trees up to 40(–50) m tall; bole straight, cylindrical, columnar or poorly shaped, branchless for up to 18 m, up to 80(–160) cm in diameter, sometimes with steep buttresses up to 3(–5) m high, rarely with stilt roots; bark surface smooth to cracked or rugose or fissured, sometimes lenticellate, brown or grey, inner bark fibrous to granular, brown or yellowish-brown to reddish-brown or pink; crown often symmetrical. Leaves arranged spirally or alternate, simple, dentate or crenate or occasionally entire, with or without stipules; petiole often kneed at apex. Flowers in an axillary raceme, pendulous, 4–5-merous; sepals valvate; petals only slightly longer than the sepals, white, cream or greenish, generally toothed and/or fringed at apex; disk lobed, glabrous or hairy; stamens 10–many, inserted between disk and ovary or rarely on the disk, anthers with transverse apical slits; ovary superior, 2–7-locular with 2–12 ovules in each cell, style simple. Fruit an often bluish, purplish or brownish-green drupe; stone hard, with 1–7 seeds. Seedling with epigeal germination; cotyledons emergent, leafy; hypocotyl elongated; first 2 leaves opposite or alternate, subsequent ones alternate.



Elaeocarpus angustifolius Blume – 1, tree habit; 2, flowering twig; 3, petal; 4, anther; 5, infructescence; 6, pyrene.

E. angustifolius has been planted in trials in Java where the mean annual increment of 10.5-year-old trees planted at about 60 m altitude was 1.1–1.3 m in height and 1.9–2.1 cm in diameter. When planted at about 650 m altitude the mean annual increment of isolated trees was 2.5 m in height and 4.7 cm in diameter. In the Solomon Islands the annual increment of *E. angustifolius* in gaps in natural forest is 0.4 m in height and in plantations 2.9 m in height and 3.9 cm in diameter. Trees often show *Terminalia*-like branching. Growth form is according to Aubréville's architectural tree model, characterized by a monopodial trunk with rhythmic growth and spiral or decussate phyllotaxis bearing tiers of branches with similar phyllotaxis and indefinite growth of branches. Young leaves are red, pink or purple; old leaves wither red or occasionally yellow. Trees are generally evergreen, but some, e.g. *E. angusti-*

folius, are briefly deciduous. They flower at regular intervals, often after a dry period, sometimes 2–3 times a year. In Peninsular Malaysia flowering often takes place in March–May and August–October. In West Java *E. angustifolius* carries fruits more or less throughout the year, but in Sulawesi only in October–November. Birds (including cassowaries), bats, rodents and pigs eat the fruits and thus disperse the seeds.
Probably because of ongoing speciation processes and hybridization, some species groups are regarded as 'complexes' within which it is hard to recognize individual species. Several formerly recognized species have, for example, now been incorporated into one of the 7 subspecies of *E. submonoceras*. The genus *Acronodia* has been incorporated into *Elaeocarpus*. *Elaeocarpus* is occasionally regarded as a member of the tribe *Elaeocarpeae* within the family *Tiliaceae*.

Ecology *Elaeocarpus* may be encountered in primary but more often in secondary rain forest at low to medium altitudes, but sometimes as high as 3500 m and, in Papua New Guinea, can be locally common in montane forest in association with *Nothofagus*. It may occur gregariously and is found in a wide range of habitats including coastal forest, freshwater swamp forest, kerangas and on ultrabasic soils.

Silviculture *Elaeocarpus* can be propagated from seeds (which do not tolerate desiccation). *E. angustifolius* has about 510 dry stones/kg and *E. glaber* about 590 dry stones/kg. The stones should be sown in the shade and those of *E. floribundus* have about 15% germination in 4–8 months, those of *E. glaber* about 50% and those of *E. stipularis* about 15% in 2.5–4.5 months. Sown fruits of *E. petiolatus* (Jack) Wallich have about 50% germination in 2.5–4 months. It has been recommended to open the stones and to sow the seeds. *Elaeocarpus* is not resistant to fire.
There are techniques for partially ring-barking flowering branches of *E. angustifolius* which results in smaller fruits and stones. These stones are highly esteemed by trade, mainly in India and Peninsular Malaysia.

Genetic resources and breeding Most of the *Elaeocarpus* species are endemic and hence have a fair risk of genetic erosion.

Prospects The very fast growth of *Elaeocarpus* holds potential for increased use in plantations for the production of raw material for wood-based panels or paper manufacture.

Literature 40, 70, 101, 125, 130, 150, 151, 162, 163, 198, 202, 202a, 203, 209, 235, 238, 260, 267, 298, 300, 302, 304, 346, 348, 360, 387, 402, 403, 405, 406, 427, 436, 464, 487, 536, 553, 632, 678, 780, 829, 831, 861, 933, 934, 974, 1038, 1039, 1123, 1164, 1196, 1197, 1218, 1221, 1232, 1239, 1242, 1248.

Selection of species

Elaeocarpus amplifolius Schlechter

Distribution New Guinea.

Elaeocarpus angustifolius Blume

Synonyms *Elaeocarpus ganitrus* Roxb., *Elaeocarpus novoguineensis* Warb., *Elaeocarpus sphaericus* (Gaertn.) K. Schumann.

Vernacular names Bead tree, genitri, Indian oil-fruit (En). Indonesia: ganitri (Java), sima (Makassar). Malaysia: changkan, geniteri, rijaksa (Peninsular). Thailand: mamun dong (north-eastern), mun dong, mun khom (northern).

Distribution From India and Nepal through Indo-China to Malesia, Australia and east to Fiji.

Elaeocarpus apiculatus Mast.

Distribution Peninsular Malaysia.

Elaeocarpus batudulangii Weibel

Distribution The Lesser Sunda Islands (Sumbawa).

Elaeocarpus blepharoceras Schlechter

Synonyms *Elaeocarpus tafaensis* A.C. Smith.

Distribution Papua New Guinea.

Elaeocarpus brunneo-tomentosus Weibel

Distribution The Lesser Sunda Islands (Flores, Sumbawa).

Elaeocarpus calomala (Blanco) Merr.

Synonyms *Elaeocarpus pustulatus* Merr., *Elaeocarpus villosiusculus* Warb.

Vernacular names Philippines: hunggong-mabolo (Filipino), kalomala (Tagalog), karukatol (Negrito).

Distribution The Philippines.

Elaeocarpus candollei Elmer

Vernacular names Philippines: nangkaon (Cebu Bisaya).

Distribution The Philippines.

Elaeocarpus clementis Merr.
Vernacular names Malaysia: kulibobok (Sabah).
Distribution Borneo.

Elaeocarpus coloides Schlechter
Synonyms *Elaeocarpus ihuensis* O.C. Schmidt.
Distribution New Guinea and the Solomon Islands.

Elaeocarpus cumingii Turcz.
Vernacular names Philippines: hunggo (Bikol, Tagalog), rokambur (Bagobo).
Distribution The Philippines and Sulawesi.

Elaeocarpus densiflorus R. Knuth
Synonyms *Elaeocarpus archboldianus* A.C. Smith, *Elaeocarpus decorus* A.C. Smith.
Distribution New Guinea.

Elaeocarpus dolichostylus Schlechter
Synonyms *Elaeocarpus chloranthus* A.C. Smith, *Elaeocarpus ulapensis* R. Knuth.
Distribution New Guinea.

Elaeocarpus ferrugineus (Jack) Steud.
Synonyms *Elaeocarpus borneensis* R. Knuth, *Elaeocarpus elliptifolius* Merr., *Elaeocarpus glabrescens* Mast., *Elaeocarpus jackianus* King.
Vernacular names Rusty oil-fruit (En). Malaysia: medang asam, medang jentek-jentek, medang manik (Peninsular).
Distribution Peninsular Malaysia and Borneo.

Elaeocarpus floribundus Blume
Synonyms *Elaeocarpus tahanensis* M.R. Hend.
Vernacular names Rugged oil-fruit (En). Indonesia: hahauwan (Sundanese), kemesu (Javanese). Malaysia: medang biawak, medang teja, medang telur (Peninsular). Philippines: malangau (Manobo). Laos: ma moun[1], moun[1]. Thailand: muat doi (northern), man som (north-eastern), kalon (central).
Distribution From India and Burma (Myanmar) to Indo-China, Thailand, Peninsular Malaysia, Java, Borneo and the Philippines (Palawan).

Elaeocarpus floridanus Hemsl.
Synonyms *Elaeocarpus pseudosepicanus* O.C. Schmidt.
Distribution The Bismarck Archipelago and the Solomon Islands.

Elaeocarpus glaber Blume
Distribution Java.

Elaeocarpus grandiflorus J.E. Smith
Synonyms *Elaeocarpus lanceolatus* Blume.
Vernacular names Indonesia: anyang-anyang (Java), ki ambit (Sundanese), maitan (Javanese). Burma (Myanmar): ye-saga. Thailand: khrai yoi (northern), mun nam (north-eastern), phi nai (peninsular). Vietnam: c[oo]m hoa l[os]n.
Distribution From Burma (Myanmar) and Indo-China to Thailand, Peninsular Malaysia, Sumatra, Java, Bali, Borneo and the Philippines.

Elaeocarpus griffithii (Wight) A. Gray
Synonyms *Elaeocarpus paniculatus* Wallich ex Müll. Stuttg.
Vernacular names Griffith's oil-fruit (En). Malaysia: medang kelawar, medang musang, mendong musang (Peninsular). Burma (Myanmar): makuaksan. Thailand: pikun phru (peninsular), to sai (south-eastern), yong yo (eastern).
Distribution India, Burma (Myanmar), Indo-China, Thailand, Peninsular Malaysia, Singapore, Sumatra and Borneo.

Elaeocarpus gustaviifolius R. Knuth
Distribution Borneo (Sabah).

Elaeocarpus hochreutineri Weibel
Distribution Borneo.

Elaeocarpus kaniensis Schlechter
Distribution New Guinea.

Elaeocarpus ledermannii Schlechter
Synonyms *Elaeocarpus brevirostris* A.C. Smith, *Elaeocarpus confertifolius* R. Knuth, *Elaeocarpus idenburgensis* A.C. Smith.
Distribution New Guinea and the Bismarck Archipelago.

Elaeocarpus lingualis R. Knuth
Distribution New Guinea.

Elaeocarpus longifolius Blume
Distribution Java.

Elaeocarpus macranthus Merr.
Vernacular names Philippines: bayukbok (Tagalog).
Distribution The Philippines.

Elaeocarpus macrocerus (Turcz.) Merr.
Synonyms *Elaeocarpus littoralis* Kurz.
Vernacular names Stilted oil-fruit (En). Indonesia: bengkinang rawa (Kutai, East Kalimantan). Thailand: krasun phran (peninsular).
Distribution Burma (Myanmar), the Nicobar and Andaman Islands, Indo-China, Thailand, Peninsular Malaysia, Sumatra, Borneo and Java.

Elaeocarpus macrophyllus Blume
Vernacular names Indonesia: katulampa badak, ki kacapi (Sundanese).
Distribution Java.

Elaeocarpus marafunganus Coode
Distribution Papua New Guinea.

Elaeocarpus mastersii King
Synonyms *Elaeocarpus microphyllus* Warb., *Elaeocarpus octantherus* A. DC.
Vernacular names Small-leaved oil-fruit (En). Malaysia: lempedu burong, medang segueh, pokok rerak (Peninsular).
Distribution Peninsular Malaysia, Singapore, Sumatra and Borneo.

Elaeocarpus miegei Weibel
Distribution New Guinea and the Solomon Islands.

Elaeocarpus monocera Cav.
Vernacular names Philippines: tabian (Negrito).
Distribution The Philippines.

Elaeocarpus multiflorus (Turcz.) Fernandez-Villar
Synonyms *Elaeocarpus leytensis* Merr.
Vernacular names Philippines: bunsilak (Panay Bisaya), tigalot (Bisaya).
Distribution The Philippines.

Elaeocarpus murukkai Coode
Distribution Papua New Guinea.

Elaeocarpus mutabilis Weibel
Distribution Borneo (Brunei, Sarawak).

Elaeocarpus nervosus Elmer
Vernacular names Philippines: onas (Bagobo).
Distribution The Philippines.

Elaeocarpus nitidus Jack
Synonyms *Elaeocarpus parvifolius* Wallich ex Müll. Stuttg., *Elaeocarpus salicifolius* King, *Elaeocarpus wrayi* King.
Vernacular names Walnut oil-fruit (En). Malaysia: medang kelichi, medang pipit, mendong kelawar (Peninsular). Thailand: pho tha yae (peninsular).
Distribution Indo-China, Thailand, Peninsular Malaysia, Singapore and Borneo.

Elaeocarpus nouhuysii Koord.
Distribution The Moluccas and New Guinea.

Elaeocarpus obtusus Blume
Synonyms *Elaeocarpus miquelii* Hochr.
Vernacular names Indonesia: andul (Javanese), ki sikop, talangtang (Sundanese).
Distribution Sumatra, Java and Borneo.

Elaeocarpus pedunculatus Wallich ex Mast.
Vernacular names Blunt-leaved oil-fruit (En). Malaysia: derumun padi, jerumun padi (Peninsular), kulimbobok (Sabah).
Distribution Peninsular Malaysia, Sumatra, Borneo and the Philippines.

Elaeocarpus piestocarpus Schlechter
Synonyms *Elaeocarpus lamekotensis* R. Knuth.
Distribution Papua New Guinea and the Bismarck Archipelago.

Elaeocarpus poculiferus A.C. Smith
Distribution New Guinea.

Elaeocarpus polydactylus Schlechter
Synonyms *Elaeocarpus azaleifolius* R. Knuth, *Elaeocarpus florulentus* Ridley, *Elaeocarpus leptopus* A.C. Smith.
Distribution New Guinea.

Elaeocarpus polystachyus Wallich ex Müll. Stuttg.
Vernacular names Silky oil-fruit (En).
Distribution Peninsular Malaysia, Singapore and Borneo.

Elaeocarpus ptilanthus Schlechter
Synonyms *Elaeocarpus acutifidus* A.C. Smith, *Elaeocarpus aemulus* A.C. Smith, *Elaeocarpus multiscissus* R. Knuth.
Distribution New Guinea.

Elaeocarpus robustus Roxb.
Synonyms *Elaeocarpus dongnaiensis* Pierre,

Elaeocarpus helferi Kurz, *Elaeocarpus lucidus* Roxb.

Vernacular names Great oil-fruit (En). Malaysia: medang kelawar, pokok kunkunang jantan, setoi tupai (Peninsular). Burma (Myanmar): kaya-hmwe. Laos: bi 'mi, pao^2 thong, sa^2 tong^2. Thailand: samohin, sathon rok (peninsular).

Distribution India, Burma (Myanmar), Indo-China, Thailand, Peninsular Malaysia and Sumatra.

Elaeocarpus roslii Coode

Distribution Borneo.

Elaeocarpus rugosus Roxb.

Synonyms *Elaeocarpus aristatus* Roxb., *Elaeocarpus grandifolius* Kurz, *Elaeocarpus kunstleri* King.

Vernacular names Thailand: phi nai (central), phi phai (peninsular).

Distribution India, Burma (Myanmar), Thailand, Peninsular Malaysia and Singapore.

Elaeocarpus sallehiana Ng

Distribution Peninsular Malaysia.

Elaeocarpus schoddei Weibel

Distribution Papua New Guinea.

Elaeocarpus sericoloides A.C. Smith

Distribution New Guinea.

Elaeocarpus stipularis Blume

Synonyms *Elaeocarpus brevipes* Merr., *Elaeocarpus scortechinii* King, *Elaeocarpus tomentosus* Blume.

Vernacular names Benzoin oil-fruit (En). Malaysia: medang api, medang merebok (Peninsular). Thailand: samat, ton lot (peninsular).

Distribution Burma (Myanmar), Indo-China, Thailand, Peninsular Malaysia, Sumatra, Java and Borneo.

Elaeocarpus subglobosus Merr.

Vernacular names Philippines: lanauti (Bagobo).

Distribution The Philippines.

Elaeocarpus submonoceras Miq.

Synonyms *Elaeocarpus lasionyx* Stapf ex Ridley, *Elaeocarpus longifolius* Blume var. *fusiformis* Corner, *Elaeocarpus oliganthus* Merr., *Elaeocarpus oxypyren* Koord. & Valeton.

Vernacular names Indonesia: katulampa (Sundanese). Philippines: nabol-tilos (Tagalog), pagapos (Bukidnon, Magindanao), tabung-hangin (Cebu Bisaya).

Distribution Peninsular Malaysia, Sumatra, Java, Bali, Borneo and the Philippines.

Elaeocarpus teijsmannii Koord. & Valeton

Synonyms *Elaeocarpus celebesianus* Baker f., *Elaeocarpus rhizophorus* Koord.

Distribution Sulawesi and the Moluccas (Halmahera).

Elaeocarpus undulatus Warb.

Synonyms *Elaeocarpus comatus* C.T. White & W.D. Francis

Distribution New Guinea and the Solomon Islands.

Elaeocarpus valetonii Hochr.

Synonyms *Elaeocarpus atrescens* R. Knuth, *Elaeocarpus longibarbatus* Warb.

Vernacular names Indonesia: bengkinang gunung (Kutai, East Kalimantan), rempudung (Bangka).

Distribution Peninsular Malaysia, Sumatra and Borneo.

Elaeocarpus venosus C.B. Rob.

Vernacular names Philippines: buslung (Igorot).

Distribution The Philippines.

Elaeocarpus verticillatus Elmer

Vernacular names Philippines: malakrot (Filipino).

Distribution The Philippines.

Elaeocarpus wenzelii Merr.

Vernacular names Philippines: Wenzel hunggo (Filipino).

Distribution The Philippines.

Elaeocarpus womersleyi Weibel

Distribution The Moluccas and New Guinea.

W.G. Keating (general part, selection of species), M.S.M. Sosef (selection of species)

Elateriospermum Blume

Bijdr. fl. Ned. Ind. 12: 620 (1826).
EUPHORBIACEAE
x = unknown; $2n$ = unknown

Vernacular names Tapus (trade name). Indonesia: kedui (Sumatra), tapos (Sundanese). Malaysia: perah (general), dungku, kelampai (Sarawak). Thailand: pee-ra, pra (peninsular).

Origin and geographic distribution *Elateriospermum* is a monotypic genus occurring in peninsular Thailand, Peninsular Malaysia, Sumatra, Java and Borneo. Its only species is *E. tapos* Blume.

Uses The wood of *E. tapos* is suitable for medium and heavy construction under cover and parquet flooring. When treated it can be applied for outdoor construction and in contact with the ground, as railway sleepers and fence posts. It has been the most popular wood for handles of tapping knives, especially in Peninsular Malaysia. The wood makes an excellent firewood.
The tree is sometimes cultivated as an ornamental. The seeds are edible when boiled, roasted, or pounded and fermented; sometimes they are made into small toys. The fermented paste has been used for fish bait.

Production and international trade Fair supplies of *E. tapos* are available from Peninsular Malaysia but supplies are small elsewhere. The wood is mainly used on a local scale.

Properties *E. tapos* yields a medium-weight to heavy hardwood with a density of 730–1230 kg/m^3 at 15% moisture content. Heartwood dark brown with a red tinge, streaked, sharply differentiated from the about 5 cm wide, pale brown sapwood; grain straight or only shallowly interlocked; texture moderately fine to medium and even; corewood may be darker; heartwood lustrous. Growth rings usually indistinct, occasionally darker coloured layers suggest growth rings; vessels medium-sized to moderately large, solitary and in radial multiples of 2–4, sometimes radially aligned, open or filled with yellow-white, gum-like deposits or blocked by sclerotic tyloses; parenchyma abundant, apotracheal in narrow regularly spaced bands, visible to the naked eye; rays very fine to moderately fine, visible with a hand lens; ripple marks absent.
Shrinkage upon seasoning is moderate to high. The wood air dries fairly fast with no defects; boards 13 mm and 38 mm thick take respectively 2.5 and 4 months to air dry. There is a high risk of sap-stain and a moderate risk of insect attack during seasoning. Splitting and surface checking may only be slight. The wood is very hard and strong. It is difficult to saw, as saw teeth gum up rapidly. It should be treated immediately after sawing, to prevent stain. It is difficult to bore, but moderately easy to plane, producing a smooth finish. It is not durable. In a graveyard test stakes were destroyed in 1–6.5 years and only 5% were serviceable after 2 years; the dark coloured corewood may be more durable. The wood is easily treated with preservatives and an absorption of a mixture of 50% creosote and 50% fuel oil of 90–200 kg/m^3 has been determined using the open tank method. The corewood, however, is very difficult to treat. The wood is susceptible to termite attack. The sapwood is susceptible to *Lyctus*.
The gross energy value of the wood is 19 695–20 640 kJ/kg. The mean fibre length of Indonesian material is 1.502 mm. The fresh seeds contain hydrocyanic acid.
See also the tables on microscopic wood anatomy and wood properties.

Elateriospermum tapos
transverse surface (×20)

Botany A deciduous or semi-deciduous, monoecious, small to medium-sized tree up to 30(–39) m tall; bole often poorly shaped, sometimes sinuous, up to 60 cm in diameter, fluted at base or with small buttresses; bark surface finely fissured and flaky with irregular scales, pale brown to grey, inner bark fibrous, medium brown, with sticky, white latex; crown narrow, dense, lower branches drooping. Leaves arranged spirally, simple, entire, drooping, drip-tipped; petiole long, with 2 glands at apex; stipules caducous. Inflorescences axillary or terminal, crowded near twig tips, cymose with central flower female and remainder male. Flowers with 4–5 imbricate sepals; petals absent. Male flower with a lobed disk; stamens 10–20; pistillode rudimentary or absent. Female flower with a cupular disk; ovary superior, 2–4-locular with 1 ovule in each cell, styles 2–4, stigmas large. Fruit a large capsule with fleshy exocarp, usually splitting into 6 parts. Seed (pyrene) large, oblong, shiny. Seedling with epigeal germination; cotyledons emergent, fleshy; hypocotyl elongated; first 3–4 leaves in a whorl, subsequent ones arranged spirally.

In sample plots in Peninsular Malaysia the largest trees had attained 31 m in height and 42 cm in diameter after 36 years. The crown shows monopodial branching. The trees shed their leaves during the dry season, although defoliation twice a year is also reported; young leaves are strikingly bright pink. Flowers appear on the bare twigs, in Peninsular Malaysia in February–March and in July–August. It is unknown whether the same tree flowers twice a year. The flowers spread a musty fragrance, suggesting they are pollinated by insects. The fruits explode and thus scatter the seeds, but seeds are also dispersed by wild pigs and probably rodents feeding on the fruits.

Elateriospermum is the only genus within the tribe *Elateriospermeae* of the subfamily *Crotonoideae*. The 'seed' released from the fruit is actually a pyrene.

Ecology *E. tapos* is fairly common, in Peninsular Malaysia even common and gregarious. It occurs as an element of primary, evergreen or semi-evergreen, lowland and hill forest, up to 600 m altitude. It is found in well-drained localities on yellow loam, clay loam, yellow sandy clay, sandstone screes, shale or basalt.

Silviculture *E. tapos* can be propagated by seeds, which show 40–70% germination in 14–42 days. The large seeds can be collected from underneath the trees. In Peninsular Malaysia *E. tapos* regenerates profusely in the shade, it grows up in small gaps and is strongly clumped. The trees coppice freely. In a survey of natural forest in Peninsular Malaysia an average of 0.83 trees/ha was found.

Genetic resources and breeding As *E. tapos* is common, it does not seem to be vulnerable to genetic erosion.

Prospects *E. tapos* seems a promising timber as it is available in sufficient quantities in Peninsular Malaysia and impregnation is easy. The apparently bad shape of the bole does, however, make it less attractive. Its coppicing capacity and fairly rapid growth are good for fuelwood production.

Literature 6, 26, 28, 34, 57, 70, 151, 162, 163, 209, 238, 267, 387, 406, 440, 571, 677, 678, 679, 740, 741, 745, 770, 829, 831, 832, 1004, 1038, 1047, 1195, 1218, 1221, 1239, 1242.

F.M. Setyowati

Eleutherandra v. Slooten

Bull. Jard. Bot. Buitenzorg, sér. 3, 7: 328, f. 6–7 (1925).

FLACOURTIACEAE

x = unknown; $2n$ = unknown

Vernacular names Indonesia: asahan landak (south-eastern Kalimantan), gistang, kecintang (Palembang, Sumatra).

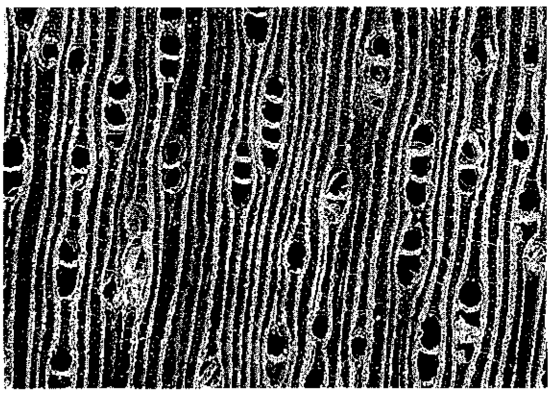
Origin and geographic distribution *Eleutherandra* is a monotypic genus occurring in southern Sumatra and Borneo. The only species is *E. pes-cervi* v. Slooten. A second, still undescribed species may be present in Sarawak and Brunei.

Uses The wood of *E. pes-cervi* has been used for house and bridge construction.

Production and international trade The wood of *E. pes-cervi* is used on a local and small scale only.

Properties *E. pes-cervi* yields a heavy hardwood with a density of 950–1090 kg/m^3 at 15% moisture content. Macroscopic features of the wood of *Flacourtiaceae* are remarkably similar: vessels small to medium-sized, solitary and in radial multiples, oval to markedly angular; parenchyma sparse, either paratracheal or apotracheal; rays fine and numerous; ripple marks absent.

The wood is very strong and probably durable as it is used in exposed conditions for house and bridge construction.



Eleutherandra pes-cervi
transverse surface (×20)

See also the table on microscopic wood anatomy.

Botany An evergreen, small to medium-sized tree up to 35 m tall; bole straight, cylindrical, up to 60 cm in diameter, with buttresses up to 1 m high; bark surface greyish-white to pale pink-brown, flaking in large patches. Leaves alternate, simple, entire, laxly pilose below, exstipulate. Flowers unisexual, in an axillary, many-flowered, spike-like or sometimes sparingly branched raceme, 5-merous; calyx lobes minute; petals with a scale at base inside; disk absent. Male flower with 5 stamens and rudimentary ovary. Female flower with 5 staminodes; ovary superior, 1-locular with 2(–3) ovules, styles 2(–3), very short. Fruit a dry berry. Seed arillate, with a hard testa. Flowering takes place from May to November; ripe fruits have been observed from July to March. The as yet undescribed species from Sarawak and Brunei occupies an intermediate position between *Eleutherandra* and *Trichadenia* which suggests the two genera might have to be united.

Ecology *E. pes-cervi* occurs scattered. It has been found in primary rain forest on well-drained sandy soil, up to 150 m altitude. The undescribed species from Sarawak and Brunei occurs on yellow, usually sandy soils in dipterocarp evergreen rain forest on low hills in subcoastal areas.

Genetic resources and breeding As *E. pes-cervi* is probably quite rare it is likely to be threatened by destruction of its habitat.

Prospects The scanty information available on properties of the wood of *E. pes-cervi* as well as the lack of silvicultural information indicate its very minor importance as a timber. This is not expected to change in the near future.

Literature 61, 162, 198, 267, 341, 436, 861, 1135.

E. Boer & M.S.M. Sosef

Endiandra R. Br.

Prodr.: 402 (1810).

LAURACEAE

x = probably 12 as in most other *Lauraceae* genera; $2n$ = unknown

Vernacular names Medang (trade name). Endiandra (En).

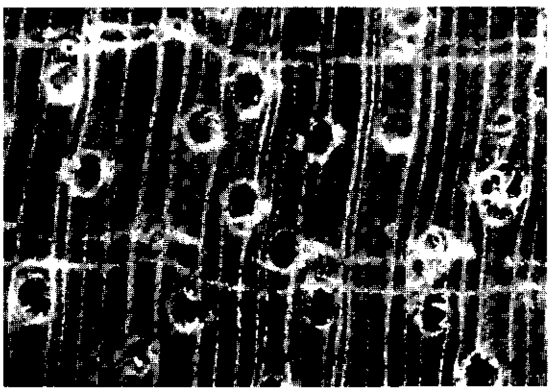
Origin and geographic distribution *Endiandra* comprises about 100 species occurring in Peninsular Malaysia (10 species), Sumatra, Java (1 species), Borneo, the Philippines (3 species), the Moluccas, New Guinea (many species), Australia (38 species) and the Pacific, east to Fiji. Its centre of diversity is found in northern Australia and New Guinea.

Uses The wood of *Endiandra* is used for general construction, house building (posts), light framing, moulding, interior trim, flooring, fittings, furniture and cabinet work, joinery and turnery. Good quality veneer and plywood can be manufactured from some *Endiandra* species.

E. macrophylla is especially recommended for reforestation in Java at 800–1000 m altitude.

Production and international trade In Malaysia and Indonesia *Endiandra* wood is traded in mixed consignments together with that of many other *Lauraceae* genera as 'medang'. It constitutes only a minor proportion of the total amount traded. In 1984 the total export of medang from Peninsular Malaysia to Singapore was 1500 m^3 with a value of US$ 62 000. In 1992 the export from Sabah amounted to 52 000 m^3 (of which about 10% was sawn timber) with a total value of US$ 4.3 million. In Papua New Guinea 'endiandra' is sometimes sold as a separate trade group. In 1992 it was grouped in MEP (Minimum Export Price) group 4 and fetched a minimum price of US$ 43/m^3 for saw logs. In 1996 Papua New Guinea exported about 4400 m^3 of endiandra logs at an average free-on-board (FOB) price of US$ 112/m^3.

Properties *Endiandra* yields a medium-weight hardwood with a density of 510–870 kg/m^3 at 15% moisture content. Heartwood brown or pale red-brown, occasionally orange, with pink streaks, not differentiated from the pale yellow to pale pink sapwood; grain straight to slightly interlocked; texture moderately fine to moderately coarse; planed surface of some species greasy to



Endiandra flavinervis
transverse surface (×20)

the touch; wood usually with fruity odour. Growth rings distinct or indistinct, when distinct, the boundaries indicated by marginal parenchyma; vessels medium-sized to moderately large, solitary and in radial multiples of 2–4, tyloses often abundant, dark red deposits present; parenchyma sparse to moderately abundant, paratracheal vasicentric and aliform, sometimes confluent in parts, visible with a hand lens, and paratracheal in marginal bands visible to the naked eye; rays very fine to moderately fine, visible to the naked eye; ripple marks absent.

Shrinkage upon seasoning is low to moderate. The wood is moderately hard to hard, but only of moderate strength. It is easy to work provided cutting edges are kept sharp. As most species contain silica they easily blunt cutting edges of tools. It is moderately durable for use under cover. The heartwood of medang timber is generally resistant to preservative treatment but the sapwood is amenable. The sapwood is susceptible to *Lyctus*.

See also the table on microscopic wood anatomy.

Botany Evergreen, small to medium-sized trees up to 35(–40) m tall, rarely shrubs; bole often quite straight, branchless for up to 25 m, up to 70(–100) cm in diameter, sometimes with buttresses up to 4 m high; bark surface smooth to cracking, sometimes scaly with small thin pieces, often lenticellate, grey-brown to yellowish-grey, inner bark fibrous and corky, brown or pale red-brown to red or pink. Leaves arranged spirally, simple, entire, with areolate reticulation and minute oil-glands, exstipulate. Flowers in an axillary and subterminal panicle, rarely in a raceme or cyme; tepals 6 (rarely 4), in 2 whorls, not persistent in fruit; stamens usually 3 (6 in *E. montana*) with 2 basal glands each, anthers 2-celled, opening by valves; ovary superior, 1-locular with a single ovule, stigma usually inconspicuous. Fruit a 1-seeded, black berry. Seedling with hypogeal germination; cotyledons not emergent, peltate; hypocotyl not developed; epicotyl with a few scales, all leaves arranged spirally.

In Java *E. macrophylla* flowers throughout the year. In northern Australia *E. glauca* flowers from January to June whereas mature fruits are present from July to October. The seeds are dispersed by birds.

E. palmerstonii (F.M. Bailey) C.T. White & W.D. Francis is a popular and valuable Australian cabinet and veneer timber marketed as 'Queensland walnut'.

The Malesian species of *Endiandra* are in desperate need of a taxonomic revision. The lack of proper botanical information makes it almost impossible to identify trees at the species level.

Ecology Timber-yielding *Endiandra* species are found scattered but may be locally common in evergreen, primary or sometimes secondary rain forest, up to 1200(–1600) m altitude. They occur in well-drained hill or ridge forest but also in riverine forest, forest on alluvial plains, in swamp forest and on a wide range of soils, including limestone soils.

Silviculture *Endiandra* may be raised from seed. Seeds of *E. glauca* germinate in 35–75 days and of *E. montana* in 36–98 days. *E. macrophylla* planted in Java in mixed teak plantations reportedly grows fast and yields a highly valued timber.

Genetic resources and breeding As many *Endiandra* species have a very limited area of distribution, many being restricted to New Guinea, genetic erosion by destruction of the habitat may easily occur.

Prospects It is unlikely that the importance of *Endiandra* as one of the *Lauraceae* genera yielding medang timber will increase.

Literature 40, 41, 70, 162, 163, 267, 300, 302, 304, 334, 348, 363, 436, 462, 553, 595, 603, 605, 614, 618, 622, 623, 785, 829, 934, 1094, 1221, 1274.

Selection of species

Endiandra archboldiana Allen

Distribution Papua New Guinea.

Endiandra beccariana Kosterm.

Distribution The Moluccas (Morotai) and New Guinea (Irian Jaya).

Endiandra brassii Allen

Synonyms *Endiandra acuminata* Teschner non C.T. White & W.D. Francis, *Endiandra clemensii* Allen.

Distribution New Guinea.

Endiandra bullata (Allen) Kosterm.

Synonyms *Beilschmiedia bullata* Allen.

Distribution New Guinea (Irian Jaya).

Endiandra carrii Kosterm.

Distribution Papua New Guinea.

Endiandra coriacea Merr.

Synonyms *Endiandra arborea* Elmer.

Vernacular names Philippines: magarilau,

usau (Tagalog), marabuneg (Iloko).
Distribution The Philippines.

Endiandra dielsiana Teschner
Synonyms *Beilschmiedia pustulata* Kosterm., *Endiandra glandulosa* Allen.
Distribution New Guinea and north-eastern Queensland (Australia).

Endiandra engleriana Teschner
Distribution Papua New Guinea.

Endiandra flavinervis Teschner
Distribution Papua New Guinea.

Endiandra forbesii Gamble
Distribution Papua New Guinea.

Endiandra fulva Teschner
Distribution New Guinea.

Endiandra glauca R. Br.
Synonyms *Endiandra merrilliana* Allen.
Vernacular names Brown walnut (En).
Distribution The Aru Islands, New Guinea and the Cape York Peninsula (Australia).

Endiandra grandifolia Teschner
Distribution Papua New Guinea.

Endiandra impressicostata Allen
Distribution New Guinea.

Endiandra inaequitepala Kosterm.
Distribution Papua New Guinea.

Endiandra kingiana Gamble
Distribution Peninsular Malaysia (rare) and Borneo.

Endiandra latifolia Kosterm.
Distribution Papua New Guinea.

Endiandra ledermannii Teschner
Distribution Papua New Guinea.

Endiandra macrophylla (Blume) Boerl.
Synonyms *Dictyodaphne macrophylla* Blume, *Dictyodaphne variabilis* Meisn.
Vernacular names Indonesia: wuru pinggang (Javanese).
Distribution Java.

Endiandra maingayi Hook. f.
Distribution Peninsular Malaysia.

Endiandra montana C.T. White
Synonyms *Brassiodendron fragrans* Allen, *Endiandra fragrans* (Allen) Kosterm.
Vernacular names Brown walnut (En).
Distribution The Moluccas (Morotai), New Guinea and north-eastern Queensland (Australia).

Endiandra ochracea Kosterm.
Distribution Borneo (Kalimantan).

Endiandra papuana Lauterb.
Distribution Papua New Guinea.

Endiandra rubescens (Blume) Miq.
Synonyms *Dictyodaphne rubescens* Blume.
Vernacular names Indonesia: kawoyang, ki bangkong (Sundanese).
Distribution Peninsular Malaysia, Bangka, Sumatra and Borneo.

Endiandra scrobiculata Kosterm. ex Kochummen
Distribution Peninsular Malaysia (rare).

Endiandra sleumeri Kosterm.
Distribution New Guinea.

Endiandra solomonensis Allen
Vernacular names Papua New Guinea: cumcogilu, mu-eh (Bougainville).
Distribution The Solomon Islands (Bougainville).

Endiandra sulavesiana Kosterm.
Distribution North Sulawesi.

Endiandra xylophylla Kosterm.
Distribution Papua New Guinea.

S.I. Wiselius (general part),
M.S.M. Sosef (selection of species)

Endocomia W.J. de Wilde

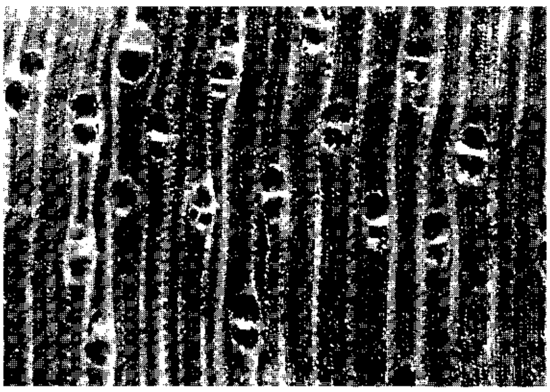
Blumea 30: 179 (1984).
MYRISTICACEAE
x = unknown; $2n$ = unknown
Vernacular names Penarahan (trade name). Malaysia: darah-darah (Sabah), darah kerbau (Peninsular), kumpang (Sarawak).

Origin and geographic distribution *Endocomia* comprises 4 species and occurs from the Andaman Islands, Burma (Myanmar) and Indo-China to southern China, Thailand, the entire Malesian region (except for Central and East Java and possibly in Sulawesi) and the Lesser Sunda Islands. All 4 species occur within Malesia.

Uses The use of *Endocomia* wood is probably similar to that of other *Myristicaceae* genera which are used for partitioning, flooring, light temporary construction, concrete shuttering, cladding, matchboxes and match splints, pattern making, packing cases and crates. In Papua New Guinea *Endocomia* is reported to be used for house building. The wood is suitable for the production of plywood.

Production and international trade The wood of *Endocomia* is mixed with that of other *Myristicaceae* genera like *Gymnacranthera*, *Horsfieldia*, *Knema* and *Myristica* and traded as 'penarahan' or 'nutmeg', but constitutes only a very minor proportion of the total amount.

Properties *Endocomia* yields a lightweight hardwood with a density of 245–425 kg/m^3 at 15% moisture content. Heartwood sometimes not well developed but large trees often with dark central core, wood yellow-brown with a slight pink tinge; grain straight or sometimes slightly wavy; texture rather fine to moderately coarse and even. Growth rings usually distinct to the naked eye, boundaries indicated by marginal parenchyma; vessels small to medium-sized, solitary and in radial multiples of 2–3(–5), open; parenchyma moderately abundant, apotracheal in marginal or seemingly marginal bands, and scanty paratracheal to vasicentric; rays moderately fine to medium-sized, just visible to the naked eye on transverse section; ripple marks absent; tanniferous tubes occasionally visible on the radial surface as dark lines in the rays.



Endocomia macrocoma
transverse surface (×20)

No specific information on the wood properties of *Endocomia* is available, but it can be assumed that these are similar to those of *Horsfieldia* which are cited here. Shrinkage is low and the wood seasons slowly but well; only thin boards may warp. The wood is soft to moderately hard and weak. It saws easily and its turning and moulding properties are satisfactory. It can be planed to a smooth finish and the dark core takes a high polish. The wood is non-durable, readily attacked by fungi when exposed to the weather or in contact with the ground and to dry-wood termites and ambrosia beetles. The sapwood is extremely susceptible to *Lyctus*. The sapwood is permeable, the heartwood is moderately resistant to impregnation.

The seeds have a fat content of nearly 45% on a dry-weight basis.

See also the table on microscopic wood anatomy.

Botany Monoecious, small to medium-sized or sometimes large trees up to 50 m tall; bole columnar, up to 60 cm in diameter, sometimes with short buttresses up to 2 m high; bark surface smooth or shallowly fissured, slightly to profusely scaly with thin scales, greyish to dark or blackish-brown, inner bark salmon pink, pale red or pinkish-ochre, with pale reddish watery exudate; branches spreading horizontally or drooping. Leaves distichous, simple, entire, exstipulate. Inflorescence axillary or pseudo-terminal, paniculate, male or bisexual with preponderance of male flowers. Flowers small; perianth 3–5-lobed, spreading or reflexed, inside yellowish to bright red and papillose or papillose-hairy; stamens 2–6, filaments completely fused to a central column; ovary superior, 1-locular with a single ovule, stigma sessile, 2–5-lobed. Fruit a glabrous, 1-seeded follicle splitting on 1–2 sides. Seed with variegated testa; aril completely or incompletely covering the seed, coarsely lobed. Seedling with hypogeal germination; cotyledons not emergent; hypocotyl not elongated; epicotyl with a few scale leaves followed by spirally arranged, conduplicate leaves.

Growth is intermittent. Branches are positioned in pseudowhorls, plagiotropic, bearing distichous leaves. The leader shoot is orthotropic with leaves arranged spirally. Flowering and fruiting is almost throughout the year.

E. macrocoma is quite variable and has been subdivided into 3 subspecies.

Ecology *Endocomia* is mainly encountered as a scattered, middle-storey tree of lowland and lower montane, primary or occasionally secondary, evergreen to semi-deciduous forest, up to 1000 m altitude. It grows on a wide range of soils, on dry land as well as in periodically inundated locations.

Silviculture *Endocomia* can be propagated by seed.

Genetic resources and breeding The risk of genetic erosion of *Endocomia* depends on the conservation of its habitat.

Prospects It is unlikely that *Endocomia* timber, supplies of which are very limited, will be increasingly used.

Literature 59, 163, 244, 267, 386, 801, 829, 1038, 1221, 1232, 1242.

Selection of species

Endocomia canarioides (King) W.J. de Wilde

Synonyms *Horsfieldia canarioides* (King) Warb., *Horsfieldia macrocoma* (Miq.) Warb. var. *canarioides* (King) J. Sinclair, *Horsfieldia racemosa* (King) Warb.

Vernacular names Indonesia: pianggu talang (Palembang, Sumatra). Thailand: kruai pa (northern), lueat khwaai baiyai, tum-phra (peninsular).

Distribution Peninsular Thailand, Peninsular Malaysia, Singapore and Sumatra.

Endocomia macrocoma (Miq.) W.J. de Wilde

Synonyms *Horsfieldia macrocoma* (Miq.) Warb., *Horsfieldia merrillii* Warb., *Horsfieldia prainii* (King) Warb.

Vernacular names Indonesia: kamorree (Biak, Japen Island), kelapa tiyung (West Java), mandarahan payo (Simeuluë Island). Malaysia: kumpang lumau (Iban, Borneo).

Distribution The Andaman Islands, Burma (Myanmar), Indo-China, southern China, Thailand, Sumatra, West Java, Borneo, the Philippines, the Moluccas and New Guinea; possibly also in Sulawesi.

Endocomia rufirachis (J. Sinclair) W.J. de Wilde

Synonyms *Horsfieldia macrocoma* (Miq.) Warb. var. *rufirachis* J. Sinclair.

Vernacular names Malaysia: sikut nabalu (Sabah).

Distribution Borneo.

W.J.J.O. de Wilde

Engelhardtia Lesch. ex Blume

Bijdr. fl. Ned. Ind. 10: 528 (1826).

JUGLANDACEAE

$x = 16$; *E. roxburghiana*, *E. spicata*: $n = 16$

Vernacular names Kayu hujan (trade name). Malay beam (En). Indonesia: ki hujan (Sundanese). Malaysua: dungun paya (general), sansanglang, tansanglang (Sarawak). Papua New Guinea: engel. Philippines: lupisan (Filipino). Thailand: kha hot (general). Vietnam: ch[ej]o.

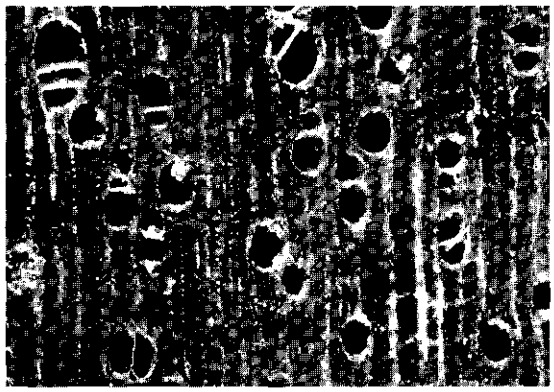
Origin and geographic distribution *Engelhardtia* comprises 12 species, 3 of which occur in Central America and the remainder in the Old World tropics from the western Himalayas and northern India to Burma (Myanmar), Indo-China, southern China, Taiwan, Thailand and throughout the Malesian region. All 9 Asian species are present in Borneo.

Uses The wood of *Engelhardtia* is used for light construction under cover (planking, posts), weatherboard, cartwheels, agricultural implements, mouldings, turnery, gunstocks, packing cases and crates, and canoe building. In India the wood has been used for tea boxes and in Burma (Myanmar) for the production of matches. The darker corewood may be used for furniture. The wood is suitable for the production of plywood, and is occasionally used for fuel.

The bark of *E. roxburghiana* has been used as a fish poison. It repels leeches.

Production and international trade Supplies of *Engelhardtia* timber are sometimes fair but use is generally limited and on a local scale only. It is reputed to be commercially traded in Taiwan. Occasionally, small amounts may be exported from Papua New Guinea in mixed consignments of logs.

Properties *Engelhardtia* yields a lightweight to medium-weight hardwood with a density of 380–715 kg/m^3 at 15% moisture content. Heartwood pink-brown to greyish-brown, not clearly differentiated from the whitish, pale grey or pale brown, 3 to over 10 cm wide sapwood; grain straight or interlocked or slightly wavy; texture moderately fine to slightly coarse and even; wood lustrous; corewood up to 30 cm in diameter, black or streaked in some trees. Growth rings sometimes distinct, boundaries indicated by darker-coloured tissue; vessels medium-sized to moderately large, solitary and in radial multiples of 2–3(–6), occasionally also in clusters, usually open, rarely with tyloses; parenchyma moderately abundant, scanty paratracheal and apotracheal in



Engelhardtia serrata
transverse surface (×20)

narrow, interrupted bands, sometimes diffuse-in-aggregates, parenchyma indistinct due to lack of contrast with fibres; rays extremely fine or moderately fine; ripple marks absent.

The wood seasons well, although end-splitting and some surface checking have been reported for *E. roxburghiana*. It is moderately soft to moderately hard, moderately strong and rather tough. It saws easily but planes to a slightly rough surface. Sawing slightly blunts the saw teeth. The wood is non-durable. Graveyard test stakes of *E. roxburghiana* were destroyed in 3 years. Large or over-mature logs may sometimes be defective. The heartwood of *E. spicata* is moderately resistant to dry-wood termites. The sapwood is susceptible to *Lyctus*.

See also the tables on microscopic wood anatomy and wood properties.

Botany Evergreen or deciduous, monoecious or dioecious, small to medium-sized or occasionally large trees up to 35(–50) m tall; bole straight, cylindrical, or sometimes poorly shaped, branchless for up to 15 m, up to 90(–280) cm in diameter, with buttresses up to 3(–4) m high; bark surface smooth to fissured, peeling off in often papery flakes, pale grey or brown-grey to red-brown, inner bark fibrous, yellow to pinkish or brown. Indumentum of golden yellow glandular scales. Leaves arranged spirally, paripinnate, exstipulate; leaflets 4–17, opposite to subopposite, entire or serrate, asymmetrical at base. Inflorescence an axillary or occasionally terminal panicle of catkins, unisexual. Flowers tiny, fused with a 3-lobed bract; perianth 4-lobed and persistent in fruit. Male flower often with a reduced perianth; stamens 4–13, sessile or on short filaments. Female flower with perianth lobes in 2 whorls and partly connate with the ovary; ovary inferior, 2-carpellate, each carpel 1-locular with a single ovule, style 1 with 2–4 stigmas. Fruit a small, indehiscent, 1-seeded nut attached to the base of the enlarged, dry, prominently veined bract. Seedling with epigeal germination; cotyledons emergent, palmately 4-lobed; hypocotyl elongated; all leaves arranged spirally, simple at first, then 3-foliate, then 5-foliate, and finally paripinnate with a small terminal appendage.

In India the mean annual diameter increment of *E. spicata* trees of up to 57 years old is 0.7–1.0 cm. Trees are often briefly deciduous and then flower. The inconspicuous flowers suggest pollination is by wind, but the male catkins of *E. roxburghiana* are reputed to be slightly fragrant and may be pollinated by insects. The winged fruits are adapted to wind dispersal, spinning and tumbling when they fall.

Sterile trees can easily be mistaken for a member of the *Sapindaceae* because of the similar leaves. Blume originally spelled the generic name as '*Engelhardia*' which is an orthographic error and

Engelhardtia roxburghiana Wallich – 1, twig with male inflorescence; 2, fruiting twig; 3, part of male inflorescence; 4, fruit.

should be corrected according to botanical nomenclatural rules, but some authors still use the original spelling. A recent proposal to incorporate *E. roxburghiana* into the South American genus *Alfaroa* has not been accepted yet.

Ecology *Engelhardtia* is found scattered in evergreen, primary, lowland or montane rain forest to more open bush-savanna vegetation, often on leached acid yellow soils, up to 2000(–2700) m altitude. It occurs on dry land as well as in swamp forest and is a regular constituent of the montane oak-laurel forest. *E. spicata* locally forms pure stands in East Java and is especially frequent in *Casuarina* forest. *E. rigida* may be locally common in New Guinea in lower montane rain forest in association with *Castanopsis*, *Lithocarpus* or *Nothofagus*.

Silviculture *Engelhardtia* can be propagated by seed. *E. spicata* has 89 000–123 000 dry nuts without wings/kg and these can be stored in airtight containers for only 2 months. Sown dewinged nuts of *E. roxburghiana* had about 65% germination in 17–34 days in a germination trial in Peninsular Malaysia. In a trial in Indonesia those of *E. spicata* showed only 2–15% germination. Nuts should be sown in the shade. Seedlings of *E. roxburghiana* never survived in the nursery.

Genetic resources and breeding Several recently described and narrowly defined *Engelhardtia* species from Borneo are very rare and known from only single collections. Some species may become endangered through destruction of their habitat.

Prospects No increase in the use of *Engelhardtia* wood in the near future is foreseen.

Literature 61, 70, 101, 130, 162, 163, 198, 209, 238, 260, 261, 267, 304, 341, 343, 348, 403, 405, 436, 458, 464, 466, 536, 553, 632, 748, 785, 829, 831, 861, 882, 933, 934, 974, 1038, 1221, 1242.

Selection of species

Engelhardtia apoensis Elmer ex Nagel

Vernacular names Mountain Malay beam (En). Philippines: apo lupisan (Filipino).

Distribution Peninsular Malaysia, Borneo and the Philippines (Mindanao).

Engelhardtia rigida Blume

Synonyms *Engelhardtia lepidota* Schlechter, *Engelhardtia subsimplicifolia* Merr., *Engelhardtia zambalensis* Elmer.

Vernacular names Philippines: buntan (Manobo).

Distribution Sumatra, West Java, Borneo, the Philippines, Sulawesi, the Moluccas and New Guinea.

Engelhardtia roxburghiana Lindl. ex Wallich

Synonyms *Engelhardtia chrysolepis* Hance, *Engelhardtia polystachya* Radlk., *Engelhardtia wallichiana* Lindl. ex C. DC.

Vernacular names Golden Malay beam (En). Malaysia: lampai bukit, pa'ar, teraling (Peninsular). Laos: phao[1]. Vietnam: c[aa]y ch[ej]o, cheo t[is]a.

Distribution From north-eastern India to Indo-China, southern China, Taiwan, Peninsular Malaysia, Sumatra and Borneo (Brunei, Sabah, Sarawak).

Engelhardtia serrata Blume

Synonyms *Engelhardtia nudiflora* Hook. f., *Engelhardtia parviflora* C. DC., *Engelhardtia permicrophylla* Elmer.

Vernacular names Brown Malay beam (En). Indonesia: (be)beri, (lang)kedi (Java), tambun rangas (Kutai, Kalimantan). Malaysia: entalul (Iban, Sarawak), kedi (Peninsular), pusing-pusing (Malay, Sabah). Philippines: lupisan-liitan (Filipino), small-leaved lupisan (En). Thailand: lop leep, pha hot (northern).

Distribution Burma (Myanmar), Indo-China, Thailand, Peninsular Malaysia, Sumatra, West Java, Borneo, the Philippines, Sulawesi and the Moluccas.

Engelhardtia spicata Lesch. ex Blume

Synonyms *Engelhardtia aceriflora* (Reinw.) Blume, *Engelhardtia colebrookeana* Lindl. ex Wallich, *Engelhardtia esquirolii* Lév.

Vernacular names Great Malay beam (En). Indonesia: ki keper (Sundanese), marasawa, mesawa (Javanese). Philippines: ped-ped (Iloko). Burma (Myanmar): thitswelve. Thailand: duuk naao (northern), ket lin (south-eastern). Vietnam: ch[ej]o l[oo]ng.

Distribution From northern India to Indo-China, Hainan, Thailand, Peninsular Malaysia, Sumatra, Java, Borneo, the Philippines and the Lesser Sunda Islands.

J.S. Rahajoe

Eriobotrya Lindl.

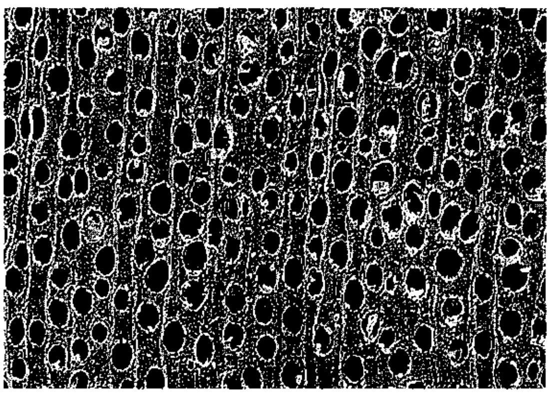
Trans. Linn. Soc., London 13: 96, 102 (1821).
ROSACEAE
$x = 17$; *E. bengalensis*, *E. elliptica* Lindl.: $n = 17$; *E. japonica*: $2n = 34$

Origin and geographic distribution *Eriobotrya* comprises about 20 species which are distributed from India and the Himalayas to China and Japan, Burma (Myanmar), Thailand and Indo-China towards Peninsular Malaysia, Sumatra and Borneo. Within Malesia only one species is indigenous and a second is cultivated in mountainous regions.

Uses The wood of *Eriobotrya* is in demand for making stringed musical instruments and may do well as a substitute for pear wood (*Pyrus* spp.). In Indo-China the wood of several non-Malesian species, e.g. *E. serrata* S. Vidal and *E. deflexa* (Hemsl.) Nakai, is of good quality and valued for general construction.
E. japonica is more important as a fruit tree, producing the well-known, sweet-sour, juicy 'loquat'. Fruits of *E. bengalensis* are also edible.

Production and international trade Utilization of the wood of *Eriobotrya* is very limited and supplies are scarce.

Properties *Eriobotrya* yields a medium-weight to heavy hardwood with a density of 655–950 kg/m^3 at 15% moisture content. Heartwood pale purple-brown with darker streaks, not clearly differentiated from the sapwood; grain straight; texture fine and even; wood with attractive silver grain; occasionally slightly fragrant. Growth rings visible with a hand lens or to the naked eye, the boundary indicated by a zone without vessels; vessels very small to moderately small, exclusively solitary, distinctly oval, dark gum-like or pale solid deposits present; parenchyma sparse, some paratracheal but mainly apotracheal diffuse to diffuse-in-aggregates; rays very fine, visible with a hand lens; ripple marks absent.
The wood has very little tendency to split or check. It is hard and takes a good polish.
See also the tables on microscopic wood anatomy and wood properties.


Eriobotrya bengalensis
transverse surface (×20)

Botany Evergreen shrubs or small to medium-sized trees up to 30 m tall; bole up to 70 cm in diameter, slightly fluted at base or rarely with buttresses; bark surface cracking and scaly, dark coloured, inner bark reddish. Leaves arranged spirally, simple, entire to dentate, secondary veins terminating in the margin; stipules free or intrapetiolarly connate. Inflorescence a terminal, compound raceme. Flowers 5-merous; hypanthium elongated above the ovary; sepals persistent in fruit; petals white; stamens 15–40; ovary semi-inferior to inferior, with 2–5 connate carpels and 2 ovules per carpel, styles connate at base. Fruit a pome.
E. japonica develops according to Fagerlind's architectural tree model, characterized by a monopodial, orthotropic and rhythmically growing trunk which produces tiers of plagiotropic, sympodial branches. In Indo-China *E. bengalensis* flowers from November to February and *E. japonica* in October to November. Pollination is by various kinds of insects. The fruits take about 3 months to mature. Animals and bats are known to disperse the fruits of *E. japonica*.
Eriobotrya belongs to the tribe *Maleae* within the subfamily *Maloideae*.

Ecology *E. bengalensis* is found scattered in primary forest, from sea-level up to 1200(–1500) m altitude. It is often associated with limestone. In Indo-China it also inhabits drier and more open forest on various soil types. *E. japonica* usually grows well under mild humid conditions in tropical highlands at 700–2000 m altitude.

Silviculture *E. japonica* is usually propagated by air layering, budding or grafting to obtain fruit of better quality than when seedlings are used. *E. bengalensis* is not cultivated.

Genetic resources and breeding A germplasm collection of *E. japonica* as a fruit crop is held at the Horticultural Research Institute, Saharanpur, India. The scattered occurrence of *E. bengalensis* in primary forest could make it vulnerable, due to destruction of the habitat.

Prospects The wood quality of *Eriobotrya* is poorly known, but seems promising and attractive. Supplies from natural sources are, however, very limited.

Literature 70, 163, 267, 294, 341, 343, 346, 402, 436, 515, 889, 1009, 1038, 1039, 1123, 1164, 1169, 1221.

Selection of species

Eriobotrya bengalensis (Roxb.) Hook. f.

Synonym *Eriobotrya dubia* Dcne.

Vernacular names Malaysia: paginggong (Peninsular). Cambodia: keu cheun (Kampot), koen prok (Siem Reap), sron (Pursat). Laos: 'khon[2] dok. Burma (Myanmar): maksawt. Thailand: sisiat nam (eastern), takrao nam (south-eastern). Vietnam: gian d[e], s[ow]n (Bien Hoa), song trang (Ba Ria).

Distribution From the eastern Himalayas (Sikkim, Assam) to Burma (Myanmar), Indo-China, Thailand, Peninsular Malaysia, Sumatra and Borneo (Kalimantan, Sarawak).

Eriobotrya japonica (Thunb.) Lindl.

Vernacular names Loquat (En). Neflier du Japon (Fr). Indonesia: lokwat, papalaan (Sundanese). Malaysia: lokwat, paginggong (Peninsular). Cambodia: tôn leap. Thailand: pipae (central). Vietnam: s[ow]n tr[af] nh[aaj]t b[ar]n, ti b[af] di[eej]p.

Distribution Probably originated in south-eastern China but at present cultivated for its fruits throughout the tropics and subtropics; in Malesia at least in Peninsular Malaysia, Java and the Philippines.

E. Boer (general part),
M.S.M. Sosef (general part, selection of species)

Erythrina L.

Sp. pl. 2: 706 (1753); Gen. pl., ed. 5: 316 (1754).
LEGUMINOSAE

$x = 21$; *E. fusca, E. subumbrans*: $2n = 42$, *E. variegata*: $2n = 42, 44$

Vernacular names Coral tree (En). Arbre au corail (Fr). Indonesia: dadap (general). Malaysia: dedap (general), dadap (Sabah), derdap (Peninsular). Philippines: dap-dap (Filipino). Burma (Myanmar): kathit. Thailand: thong lang.

Origin and geographic distribution *Erythrina* comprises about 110 species distributed pantropically. Tropical America is richest in species (about 70), followed by Africa (32), whereas Asia has 18 species. Some 6 to 8 species occur in Malesia, but many more are planted as ornamentals.

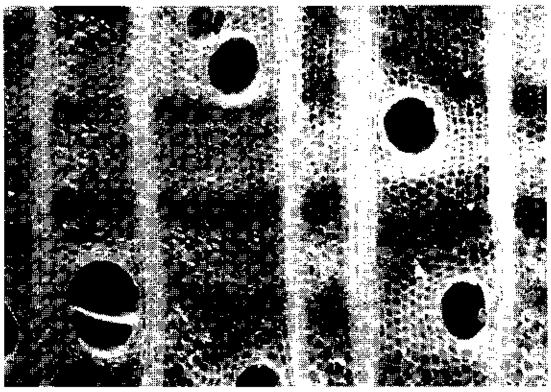
Uses The usually lightweight wood of *Erythrina* is used by the local population for floats for outrigger canoes and fishing-nets, surf boards, dugout canoes, shields, spears, helmets, insulator boards, wooden shoes, carving, cheap artifacts, kitchen utensils and packing cases. It may be used for match splints. The pulp of some species (e.g. *E. variegata*) may be suitable for making paper.

Their conspicuous red flowers make many *Erythrina* species popular as ornamentals, and they are commonly planted in gardens and parks. They are also widely planted as shade trees, e.g. in cacao, coffee and tea plantations, and as living stakes to support black pepper (*Piper nigrum* L.), betel (*Piper betle* L.), yams (*Dioscorea* spp.) and vanilla (*Vanilla planifolia* H.C. Andrews). They are additionally used as green manure because they can fix atmospheric nitrogen in symbiosis with rhizobia. The more prickly forms are often planted as live fences. Several species are used in a variety of traditional medicine, e.g. for poulticing wounds, against toothache, cough and colds and in Java to temper or relieve fever of children ('dadap srep'). The leaves of some species (e.g. *E. fusca* and *E. variegata*) are eaten as a vegetable, and also used as fodder. The shiny red seeds are often used to decorate clubs or are made into necklaces, rosaries and good-luck charms. In Thailand the flowers of *E. variegata* have been used to dye clothes red.

Production and international trade Within Malesia the wood of *Erythrina* is not harvested commercially and utilization is on a local scale only.

Properties *Erythrina* yields a lightweight hardwood with a density of 240–380 kg/m^3 at 15% moisture content. Heartwood pale straw or buff-coloured, not clearly differentiated from the white sapwood; grain straight, slightly interlocked or wavy; texture coarse and uneven; rays producing a faint check-pattern on radial surface. Growth rings usually indistinct; vessels moderately large to extremely large and characteristically few, solitary and in radial multiples of 2–3, also in small clusters, open; parenchyma abundant, paratracheal in confluent wide bands, conspicuous, also aliform; rays extremely broad; ripple marks present, but only from wood parenchyma and visible only with a hand lens, it is reported that all elements are storied in *E. subumbrans*.

Shrinkage upon seasoning is moderate to high.



Erythrina variegata
transverse surface (×20)

The wood is extremely soft, very weak but fairly tough. It is easy to work but difficult to finish because of the coarse texture. The wood is non-durable and susceptible to sap-stain fungi and dry-wood termites. The sapwood is susceptible to *Lyctus*. Wood of *E. variegata* absorbed about 215 kg/m^3 of Wolman salt when soaked in hot water for 3 hours and then soaked in the Wolman salt solution for 2 hours.
See also the tables on microscopic wood anatomy and wood properties.

Botany Mostly deciduous shrubs or small to medium-sized trees up to 27 m tall, occasionally small subshrubs or perennial herbs; bole and branches often armed with conical spines, bole often short and bifurcating but sometimes branchless for up to 21 m, sometimes crooked or fluted, up to 90(–170) cm in diameter, occasionally with buttresses up to 2 m high; bark surface cracked and flaky or fissured or furrowed, greenish-grey, grey to olive-brown, inner bark often yellowish; slash orange-brown or deep straw-coloured with orange tinge, sometimes with blackish streaks; crown often much branched. Leaves arranged spirally, pinnately 3-foliolate; leaflets entire, lateral ones often asymmetrical; stipules persistent or caducous, stipels usually fleshy and glandular. Flowers solitary, paired or fascicled in an axillary or terminal, racemose, inverted inflorescence, bisexual, often scarlet or red; calyx tubular-campanulate, bilabiate or spathe-like with a slit down to the base on the lower side, 5-lobed, sometimes inconspicuously so; corolla papilionaceous, often showy, keel and wings usually much smaller than standard; stamens 10, upper one free or partly connate with the staminal tube; ovary superior, stipitate, many-ovuled, style incurved. Fruit a stipitate pod, often constricted between the seeds, usually dehiscent, 1–14-seeded. Seed ovoid or ellipsoid, often red or orange, some with a black spot; cotyledons fleshy, endosperm absent. Seedling with epigeal or semi-hypogeal germination; cotyledons emergent or not emergent, fleshy; hypocotyl elongated; first 2 leaves opposite and simple, subsequent ones alternate and 3-foliolate.
Most species are deciduous during or after the dry season, and flower when leafless. The pendulous flowers are scentless, strong and elastic, and are typically pollinated by birds, particularly by passerines such as *Chloropsis* species and crows. They visit the flowers in the morning collecting the copious nectar. The seeds of *E. fusca* and *E. variegata* float and are distributed by sea currents.
The timber of *E. vespertilio* Benth. is traded as 'grey corkwood' in Australia; the lightweight wood is used for model-making, insulating boards, light planking, surf boards, floats and shields. In India *E. suberosa* Roxb. is an important lightweight wood. *E. sandwicensis* O. Deg. is a favourite canoe wood in Polynesia.
Erythrina belongs to the tribe *Phaseoleae*, subtribe *Erythrininae*.

Ecology Most *Erythrina* species occur in a monsoon climate and on sandy soils. *E. fusca* prefers wetter locations such as freshwater swamps, stream banks and badly drained soils, up to 2000 m altitude; it may develop into almost pure stands in such locations. *E. insularis* is found in lowland rain forest, in secondary and coastal shrub vegetation, and in savanna with *Eucalyptus*, up to 1200 m altitude. *E. subumbrans* occurs in open places or in secondary forest, often near streams, up to 1500 m altitude. *E. stricta* is usually found on or near beaches, whereas *E. variegata* is adapted to coastal forest, but it is frequently cultivated inland, up to 1200 m altitude.

Silviculture *Erythrina* can be propagated by seed and by large stem cuttings. There are about 1450–5000 seeds of *E. fusca* per kg and germination is 80–95%. Seeds of *E. variegata* have about 30% germination in 6 days to 11 months but rapid germination in 8–10 days has also been recorded. Generally, large cuttings about 2–3 m long and 5–10 cm in diameter are used, these sprout easily in 2–4 weeks. They establish easily as the leafy twigs are out of reach of livestock. Cuttings of *E. subumbrans* up to 25 cm in diameter sprout readily. *E. fusca* has been recommended for reforestation in Java on very poor soils where *Paraserianthes falcataria* (L.) I.C. Nielsen fails to grow.

When *Erythrina* is planted for shade, trees are pollarded once every 6 months to 2 years, and when used to support vines the branches are lopped every 6 weeks to 6 months. The foliage is used as a green manure or for fodder. Stakes of *E. fusca* in pepper plantations in Sumatra are frequently attacked by a stem borer (*Bactocera* sp.) and by a ring borer (family *Lecanidae*). At the end of the 19th Century *E. subumbrans* was severely attacked by a still unknown root disease in Java, which locally destroyed all trees. Around 1930 it was infested by a *Fusarium* disease in Java and South Sumatra. A top-boring caterpillar (*Terastia meticulosalis*) has been observed in Indonesia in *Erythrina*.

Genetic resources and breeding *E. fusca*, *E. subumbrans* and *E. variegata* have large areas of distribution and are planted widely; they are not liable to genetic erosion. However, other species such as *E. insularis* occur only very locally, are rarely planted, and are much more vulnerable. Germplasm collections of *Erythrina* species including *E. fusca* and *E. variegata* are maintained in Hawaii and Costa Rica. There is a selection and breeding programme of *E. fusca* in the Centre for Tropical Agricultural Research and Trianing (CATIE) in Costa Rica, aiming at improving its shade tree characteristics.

Prospects The prospects of *Erythrina* for timber production are not promising. The wood, which is often of poor quality, will probably remain a secondary product, although it has shown some potential for paper production. The emphasis will probably continue to be on its uses for auxiliary and ornamental purposes. *Erythrina* can be very valuable as a multi-purpose tree, given its uses as a green manure, forage and medicine.

Literature 7, 70, 91, 161, 163, 187, 209, 235, 238, 267, 304, 333, 343, 436, 464, 476, 519, 536, 637, 700, 780, 829, 831, 859, 933, 934, 975, 1163, 1221, 1242, 1264.

Selection of species

Erythrina fusca Lour.

Synonyms *Erythrina atrosanguinea* Ridley, *Erythrina glauca* Willd., *Erythrina ovalifolia* Roxb.

Vernacular names Coral bean, purple coral tree, swamp immortelle (En). Bois immortel, immortelle blanche (Fr). Indonesia: cangkring (Javanese, Sundanese), kane (Sulawesi). Philippines: anii (Tagalog), korung-korung (Bisaya). Cambodia: rolouohs p-ông'. Laos: thong 'lang. Thailand: thong lang nam, thong long (central). Vietnam: v[oo]ng d[oo]ng (Ho Chi Minh), v[oo]ng gai (Quang Nam), c[aa]y son dong (Anamese).

Distribution Probably native to Asia and the Pacific Islands; planted throughout the humid tropics.

Erythrina insularis F.M. Bailey

Synonyms *Erythrina merrilliana* Krukoff.

Vernacular names Papua New Guinea: balbal (Pidgin).

Distribution New Guinea and Australia (Queensland: Turtle Island).

Erythrina stricta Roxb.

Synonyms *Erythrina microcarpa* Koord. & Valeton, *Erythrina stipitata* Merr., *Erythrina suberosa* Roxb.

Vernacular names Indonesia: dadap bong (Javanese). Philippines: Lubang dap-dap (Filipino).

Distribution From India and Nepal to Burma (Myanmar), Indo-China, Thailand, the Langkawi Islands, eastern Java, the Philippines (Lubang) and the Lesser Sunda Islands.

Erythrina subumbrans (Hassk.) Merr.

Synonyms *Erythrina lithosperma* Miq. non Blume.

Vernacular names December tree (En). Indonesia: dadap duri, dadap ri (when thorny), dadap srep (when thornless). Malaysia: dadap dorri, dadap minyak, dadap srep. Papua New Guinea: dadap. Philippines: anii (Bisaya), rarang (Bikol). Burma (Myanmar): ye-katit. Laos: tawng lan. Thailand: thong lang pa, thong meet khut (northern).

Distribution Native in India, Sri Lanka, Burma (Myanmar), Indo-China and Thailand, throughout Malesia (except for New Guinea) to Fiji and Samoa; planted throughout the tropics.

Erythrina variegata L.

Synonyms *Erythrina indica* Lamk, *Erythrina orientalis* (L.) Murr.

Vernacular names Indian coral tree, variegated coral tree (En). Arbre au corail, arbre immortel (Fr). Indonesia: dadap ayam (Javanese), dadap blendung (Sundanese), galala itam (Moluccas). Malaysia: chengkering. Philippines: andorogat (Bikol), bagbag (Ilokano). Burma (Myanmar): penglay-kathit. Cambodia: rolouohs bay. Laos: dok 'kho, thong ban[2]. Thailand: thong lang lai (central), thong phueak (northern). Vietnam: c[aa]y v[oo]ng nem, h[af]i d[oof]ng b[if] (Anamese), dan ro (Thuân Hai).

Distribution Native to eastern Africa, Madagascar, the Indian Ocean Islands, Sri Lanka, India, Bangladesh, Burma (Myanmar), Indo-China, southern China, Thailand, throughout Malesia, and the Pacific Islands; widely cultivated throughout the tropics.

Umi Kalsom Yusuf

Erythroxylum P. Brown

Civ. nat. hist. Jamaica: 278 (1756).
ERYTHROXYLACEAE
$x = 12$; *E. coca*, *E. novogranatense*: $2n = 24$

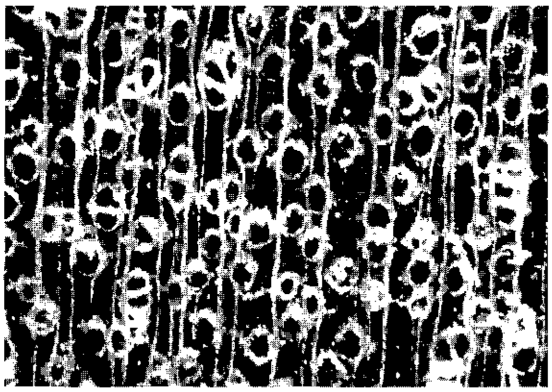
Vernacular names Merpitas (trade name). Malaysia: chinta mula, ketai mula (Peninsular), perapat burong (Malay, Sabah).

Origin and geographic distribution *Erythroxylum* comprises about 200 species which occur throughout the tropics, but most of them are found in South America. The genus is present throughout the Malesian region with only 4 native species and 2 introduced ones.

Uses The wood of *Erythroxylum* has been applied for fence posts and poles, flooring and sometimes for local house building, bridges, boat building and tool handles.
The leaves of *E. cuneatum* are used as a fish poison in the Philippines. Leaves of *E. ecarinatum* have been used medicinally. *E. cuneatum* is also planted as an ornamental. The introduced species *E. coca* Lamk and *E. novogranatense* (Morris) Hieron. are well-known sources of cocaine that is used as a stimulant and as an anaesthetic, especially in eye surgery.

Production and international trade *Erythroxylum* timber is of local use only, as the supplies are very limited.

Properties *Erythroxylum* yields a medium-weight to heavy hardwood with a density of 720–1010 kg/m^3 at 15% moisture content. Heartwood rose-brown, sharply demarcated from the pale yellow-brown sapwood, which is 2.5 cm wide; grain straight or shallowly interlocked; texture rather fine and even. Growth rings indistinct, although occasional darker lines (zones without vessels) suggest growth ring boundaries; vessels moderately small to medium-sized, very numerous, solitary, in radial multiples of 2–4(–8) and in clusters, tyloses present; parenchyma rather sparse, paratracheal vasicentric, aliform to confluent, indistinct with a hand lens; rays very fine, just visible with a hand lens; ripple marks absent.



Erythroxylum ecarinatum
transverse surface (×20)

The wood is hard and is easy to work and to saw, although cutter knives are rapidly blunted due to the abundance of crystals. It is non-durable. The sapwood is rarely susceptible to *Lyctus*.
The mean fibre length of *E. cuneatum* from Sumatra is 1.295 mm. Leaves of *E. cuneatum* contain alkaloids. The principal alkaloid in leaves of *E. ecarinatum* is tropacocaine.
See also the table on microscopic wood anatomy.

Botany Evergreen or sometimes deciduous, small to fairly large trees up to 40(–45) m tall, with white latex in leaves and ripe fruits; bole often short and gnarled, up to 55(–65) cm in diameter, sometimes with buttresses; bark surface smooth to closely longitudinally fissured or scaly, somewhat flaky, whitish-brown to greyish or reddish-brown, inner bark fibrous, yellow to pink or reddish-brown mottled; young branches compressed, lenticellate. Leaves alternate, often distichous, simple, entire, often with 2 longitudinal lines on the upper surface; stipules triangular, clasping the twig, caducous. Flowers axillary, solitary or in a cluster, small, bisexual, often heterostylous, 5-merous; calyx campanulate; petals white to yellow, with appendages on the inner side; stamens 10, fused below into a tube; ovary superior, (1–)3-locular with 1 ovule in each cell, styles 3. Fruit a drupe with 1 fertile and 2 enlarged sterile locules, ripening bright red. Seed flattened, curved. Seedling with epigeal germination; cotyledons emergent, linear; hypocotyl elongated; leaves arranged spirally at first, becoming distichous later.
In Peninsular Malaysia trees of *E. cuneatum* flower for a month during the dry season in April or May, with a possible second flowering period in November to February. In Papua New Guinea *E. cuneatum* flowers mostly from September to

February and fruits from March to September, whereas *E. ecarinatum* bears flowers and fruits throughout the year. Fruits ripen in 3–4 months. They float in water but are probably mainly dispersed by monkeys, porcupines and cassowaries.

Ecology *Erythroxylum* trees occur scattered or sometimes gregariously in primary and secondary forest, up to 2000 m altitude, from the seashore inland, including beach forest, evergreen rain forest, limestone forest, peat-swamp forest and kerangas. In Johore (Peninsular Malaysia) *E. cuneatum* is a characteristic element of the *Syzygium grande* (Wight) Walp. coastal forest.

Silviculture In a germination trial in Peninsular Malaysia 6 out of 9 seeds of *E. cuneatum* germinated in 39–75 days.

Genetic resources and breeding There are no records of *Erythroxylum* in seed or germplasm banks. As the utilization of its timber is limited, present logging will hardly affect the genetic resource base.

Prospects The utilization of *Erythroxylum* wood is insignificant and will not be encouraged since tools are rapidly blunted when working this timber.

Literature 61, 162, 163, 198, 209, 267, 304, 310, 341, 403, 436, 464, 745, 770, 824, 829, 831, 861, 1037, 1038, 1048, 1221, 1232, 1242.

Selection of species

Erythroxylum cuneatum (Miq.) Kurz

Synonyms *Erythroxylum burmanicum* Griffith, *Erythroxylum densinerve* O.E. Schulz, *Erythroxylum platyphyllum* Merr.

Vernacular names Wild cocaine (En). Indonesia: kayu mutoh (Bangka), kayu urang (Sumatra), ki beureum (Sundanese). Malaysia: inai inai (Peninsular), tebakan (Sarawak). Philippines: baransiagau (Iloko), manambo (Bikol), saleng (Tagalog). Thailand: kaen daeng, krai thong (south-eastern and peninsular), tan huan pet (northern).

Distribution From Burma (Myanmar) and the Andaman Islands through Indo-China towards Thailand and throughout the Malesian area but not yet reported from the mainland of New Guinea.

Erythroxylum ecarinatum Burck

Synonyms *Erythroxylum salomonense* C.T. White.

Vernacular names Indonesia: dodoyo (Tobelo, Moluccas), naniwar (Moluccas), samainding (Madi, Sulawesi).

Distribution Sulawesi, the Moluccas, New Guinea, the Solomon Islands and northern Australia (Queensland).

Isa Ipor

Eucalyptopsis C.T. White

Journ. Arn. Arb. 32: 139, t. 1 (1951).

MYRTACEAE

x = unknown; $2n$ = unknown

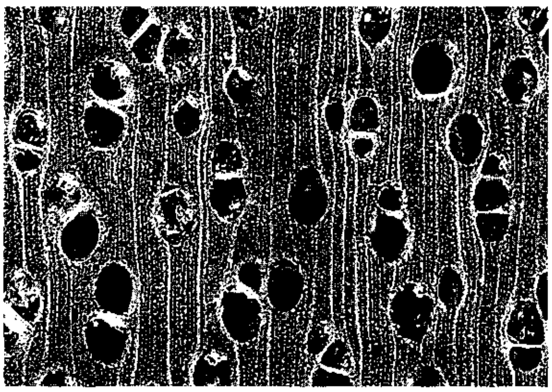
Vernacular names Indonesia: ohong gawa, ohong nikat (Moluccas). Papua New Guinea: malaha (trade name).

Origin and geographic distribution *Eucalyptopsis* is a genus of only one or perhaps two species. *E. papuana* C.T. White occurs in the Moluccas and New Guinea.

Uses The wood of *E. papuana* is used for general construction, furniture, flooring, joinery, interior trim, panelling, mouldings, turnery and veneer.

Production and international trade In 1996 Papua New Guinea exported about 2490 m^3 of 'malaha' logs at an average free-on-board (FOB) price of US$ 89/m^3.

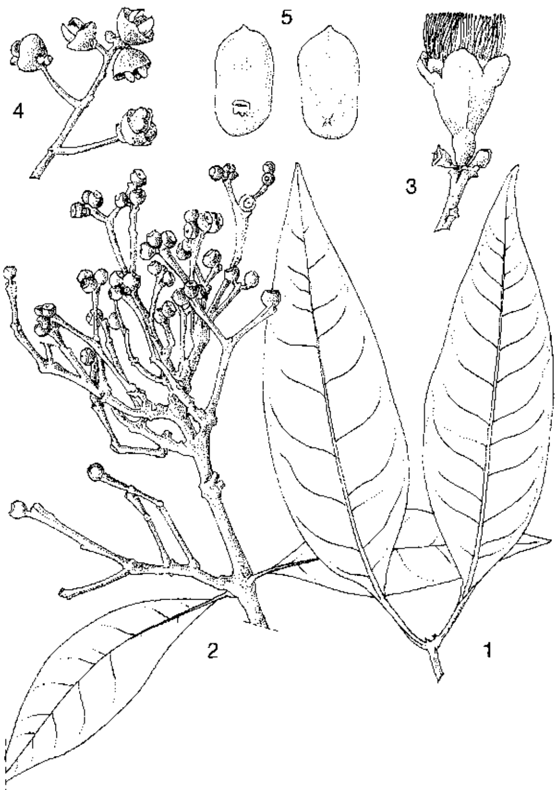
Properties *E. papuana* yields a lightweight to heavy hardwood with a density of 370–970 kg/m^3 at 12% moisture content. Heartwood pinkish-brown to dark red-brown, sapwood straw to pale pink-brown; grain straight to slightly interlocked; texture moderately fine and even. Growth rings moderately well defined; vessels small to medium-sized, arranged obliquely, solitary and in radial multiples of 2–3(–4), with a few clusters, tyloses



Eucalyptopsis papuana transverse surface (×20)

abundant; parenchyma predominantly scanty paratracheal, vasicentric to aliform tending to confluent, apotracheal diffuse, sparse; rays not visible to the naked eye; ripple marks absent.
Shrinkage upon drying is moderate; occasionally boards show a slight tendency to develop twist. The wood can be kiln dried from 30% to 12% moisture content in 3–4 days at a dry-bulb temperature of 60–70°C; drying rates differ considerably due to large density variations between individual trees. A high-humidity treatment should be given after kiln drying, to relieve stresses. The wood is moderately durable. The heartwood is very difficult to treat with preservatives. The sapwood is sometimes susceptible to *Lyctus*.
See also the table on microscopic wood anatomy.

Botany A fairly large to large tree up to 50 m tall; bole straight, up to 70 cm in diameter, with or without buttresses; bark surface somewhat scaly or fissured, brown. Leaves subopposite, simple, lanceolate, entire, petiolate. Flowers sessile, in clusters at the end of the branches of a terminal panicle, white; calyx tube campanulate, with articulation immediately above the ovary and with 4 irregular lobes at apex; petals absent; stamens numerous, attached in 4 groups high up in the calyx tube; ovary inferior or semi-inferior, 2-locular with many ovules, style 1. Fruit a woody capsule, base adnate to the persistent lower part of the calyx tube, apex free and opening with 2 valves. Seed usually 1, oblong, plano-convex.



Eucalyptopsis papuana C.T. White – 1, sterile twig; 2, twig with young infructescence; 3, flower; 4, part of infructescence; 5, seed front and back view.

Eucalyptopsis differs from *Eucalyptus* by the absence of an intramarginal vein in the leaves, and by the less strictly opposite leaves (subopposite). It is possibly most closely related to *Pleurocalyptus* from New Caledonia.

Ecology *E. papuana* is locally plentiful in the canopy layer of lowland and lower montane rain forest in New Guinea, up to 1500 m altitude.

Genetic resources and breeding Although it is stated that *E. papuana* is locally common, so little is known about its distribution and ecology that it is difficult to judge the danger of genetic erosion.

Prospects Since the wood of *E. papuana* can be used for many purposes and is of good quality, research on its silviculture is desirable. It might be a timber of future importance.

Literature 216, 297, 300, 302, 304, 348, 861, 1206, 1232.

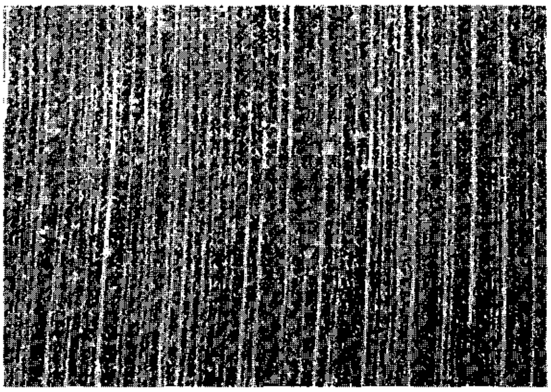
I. Samsoedin, E. Boer & R.H.M.J. Lemmens

Euonymus L.

Sp. pl. 1: 197 (1753); Gen. pl., ed. 5: 91 (1754).
CELASTRACEAE
x = 16 (or 8?); *E. japonicus* Thunb.: $2n$ = 32, many extra-Malesian species have $2n$ = 32 or 64

Vernacular names Spindle tree (En). Bonnet de prêtre (Fr). Indonesia: awa kudang-kudang (Sumatra), jerukan (Javanese), ki keuyeup (Sundanese). Malaysia: belimbing hutan, belungkas, kemuning ayer (Peninsular). Philippines: malasangki (Filipino), talangutingon (Cebu Bisaya). Thailand: khao kwang, kraduuk kai (peninsular).

Origin and geographic distribution *Euonymus* comprises some 180 species, most of which occur in the Himalayas, China and Japan. Europe has 4 species, Africa 1, Madagascar 2, North and Central America 9, Australia 2, and Malesia 12. The only Malesian species yielding timber is *E. javanicus* Blume (synonyms: *E. coriaceus* Ridley, *E. micropetalus* Ridley, *E. sumatranus* Miq.), which



Euonymus javanicus
transverse surface (×20)

occurs in the Andaman and Nicobar Islands, southern Burma (Myanmar), southern Vietnam, peninsular Thailand, and throughout the Malesian region, east to western New Guinea (Vogelkop).

Uses The wood of *E. javanicus* has been used for house building, temporary constructions, bridges and small furniture. In India its wood and that of several other *Euonymus* species is suitable for carving and turnery and may be used as a substitute for boxwood (*Buxus* spp.) for making small articles such as spindles, pegs, spoons and toothpicks.

Production and international trade Supplies of wood of *E. javanicus* are very limited, and it is used on a local scale only, if at all.

Properties *E. javanicus* yields a medium-weight hardwood with a density of 620–760 kg/m^3 at 15% moisture content. Heartwood white to pale yellowish-brown, not clearly differentiated from the sapwood; grain straight; texture very fine and even. Growth rings distinct, demarcated by denser fibres; vessels extremely small, solitary and in radial pairs, individually indistinct, even with a hand lens, open; parenchyma not visible with a hand lens; rays extremely fine; ripple marks absent.
The wood is fairly strong, but only moderately durable when in contact with the ground. It is reputed to be very resistant to weathering and insects.
See also the tables on microscopic wood anatomy and wood properties.

Botany An evergreen, small to medium-sized tree up to 25 m tall; bole up to 50 cm in diameter, without buttresses; bark surface smooth, grey-brown, inner bark pinkish. Leaves opposite, often decussate, simple, entire or crenate; stipules lanceolate, caducous. Flowers bisexual, in an axillary fascicle or a simple cyme, 5-merous; calyx deeply lobed; petals imbricate, fimbriate, pale green or yellowish; disk 5-angular; stamens inserted on or near the margin of the disk; ovary superior, partly sunken in the disk, 5-locular with 2 ovules in each cell, style short. Fruit a usually clavate or broadly obovoid capsule, red, splitting into valves. Seed black, partly covered by an orange aril. Seedling with epigeal germination; cotyledons emergent; hypocotyl elongated.
In the Philippines *E. javanicus* has been observed flowering in February and March.

Ecology *E. javanicus* occurs scattered in primary and secondary, lowland to montane forest, up to 2400 m altitude. It has been found in well-drained locations on comparatively basic soils including limestone.

Silviculture *E. javanicus* is not resistant to fire.

Genetic resources and breeding The wide geographical distribution of *E. javanicus* and its insignificant use for timber suggest that there is no risk of genetic erosion.

Prospects Due to its frequently small size, the use of *E. javanicus* for timber will remain very restricted. It has been suggested for soil protection at altitudes of 1000–1500 m.

Literature 61, 70, 116, 163, 198, 235, 238, 259, 341, 371, 436, 772, 861, 974, 1038, 1048, 1221.

K.M. Kochummen

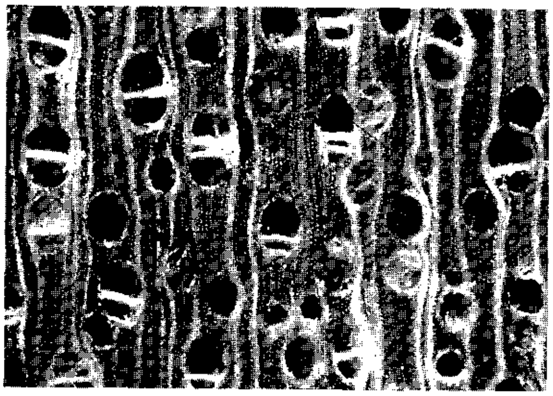
Euroschinus Hook. f.

Benth. & Hook. f., Gen. pl. 1: 417, 422 (1862).
ANACARDIACEAE
x = unknown; $2n$ = unknown

Vernacular names Pink poplar (En). Indonesia: talak (Sko, Irian Jaya).

Origin and geographic distribution *Euroschinus* comprises 6 species, 4 of which occur in New Caledonia, 1 in Australia, and *E. papuanus* Merr. & L.M. Perry in New Guinea, New Britain and the D'Entrecasteaux Islands.

Uses The wood of *E. papuanus* is used for light construction, house building, furniture, shelving, interior finish and as a firewood. In Australia *Euroschinus* wood has been used for brake blocks, coffins and cases. In New Caledonia selected pieces of decorative wood are used for polished panels.



Euroschinus papuanus
transverse surface (×20)

Production and international trade As supplies of *E. papuanus* are very limited, the wood is used on a local scale only.

Properties *E. papuanus* yields a lightweight to medium-weight hardwood with an average density of 450 kg/m³ at 15% moisture content. Heartwood pinkish-brown or pinkish-grey, frequently with yellowish or greenish streaks especially in seasoned timber, probably due to staining organisms, not clearly differentiated from the straw-coloured sapwood; grain slightly interlocked; texture fine and even; wood with distinctive silken sheen. Growth rings not marked, indistinct; vessels small and indistinct to the naked eye, solitary and in radial multiples of 2–4(–6), occasionally in clusters, tyloses sparse, vessel lines distinct; parenchyma usually scanty paratracheal to vasicentric, sometimes slightly aliform; rays extremely fine to moderately fine; ripple marks absent; horizontal gum canals present, occasionally large and distinct to the naked eye on tangential faces.
Shrinkage upon seasoning is low to moderate. The wood dries readily with little degrade, though some warp may occur; it is very susceptible to blue stain. The wood is soft, of low strength and moderately fissile. It is easy to saw but difficult to dress smoothly because of its woolly nature. The wood glues well, is easy to nail and screw and has good peeling properties. It is moderately durable. The heartwood is resistant to pressure impregnation. The sapwood is highly susceptible to *Lyctus*.
See also the table on microscopic wood anatomy.

Botany A polygamous, medium-sized tree up to 30 m tall; bole usually straight, up to 65 cm in diameter, occasionally with buttresses up to 1.5 m high; bark surface finely fissured, brownish-grey, inner bark pale brown, pinkish-brown, dark red-brown or cream with pale yellowish or greyish-brown markings. Leaves arranged spirally, paripinnate, exstipulate; leaflets in (3–)5–6(–8) pairs, alternate or subopposite, petioluled, entire. Inflorescence axillary, rarely cauliflorous, paniculate. Flowers unisexual or bisexual; calyx (4–)5-lobed; petals (4–)5, imbricate, white; stamens twice the number of petals; disk intrastaminal, shortly cupular; ovary superior, 1-locular with a single ovule, style short, with 3 stigmas. Fruit a drupe with an excentric style scar, blackish-purple when ripe. Seed with testa free from the endocarp.
The twigs are sometimes hollowed out and inhabited by ants. *E. papuanus* flowers in March–September and fruits from March to October. The fruits are dispersed by birds and possibly bats.
Euroschinus belongs to the tribe *Rhoeae*, together with e.g. *Pistacia* and *Rhus*. Its leaves are invariably paripinnate, but the rachis shows a distinct apical extension which is unique among Malesian *Anacardiaceae*.

Ecology *E. papuanus* occurs in primary forest or forest edges, up to 1000 m altitude. It is found on river banks, in inundated areas, dryland forest, ridge forest, sometimes associated with *Anisoptera*.

Genetic resources and breeding As the timber of *E. papuanus* is little used there seems to be hardly any risk of genetic erosion.

Prospects Due to the limited occurrence of *E. papuanus*, and the fact that its wood is fibrous and woolly with relatively inferior physical properties, it is unlikely that it will gain any commercial importance. It may have some potential as corestock for plywood manufacture and with selected boards for decorative work. Very little is known of its silvicultural aspects.

Literature 122, 304, 341, 348, 464, 788, 1132, 1232.

P.J. Eddowes

Exbucklandia R.W. Br.

Journ. Wash. Acad. Sci. 36: 348 (1946).
HAMAMELIDACEAE
$x = 32$; *E. populnea*: $n = 32$

Vernacular names Malayan aspen (En). Indonesia: hapas-hapas (North Sumatra), sigadaungdueng (Minangkabau, Sumatra), tapatapa leman (West Sumatra). Malaysia: derok, gerok, tiga sagi (Peninsular). Thailand: pho sam hang (northern). Vietnam: m[oo]c h[uw][ow]ng.

Origin and geographic distribution *Exbucklandia* comprises 2 species, one in Indo-China and the other is distributed from the Himalayas to Burma (Myanmar), Indo-China, southern China, Thailand, Peninsular Malaysia and Sumatra. The latter is *E. populnea* (R. Br. ex Griffith) R.W. Br. (synonyms: *Bucklandia populnea* R. Br. ex Griffith, *Bucklandia tricuspis* Hallier f., *Symingtonia populnea* (R. Br. ex Griffith) v. Steenis).

Uses The wood of *Exbucklandia* is used for light and medium heavy construction under cover (beams, scantlings, planks), joinery, furniture, millwork, flooring and interior work. In India it is also used for bridges, door and window frames, general carpentry and tea chests. The wood is recommended for the production of veneer and plywood.

E. populnea is planted in parks and along roads for its handsome foliage, and in North Sumatra for afforestation. In India *E. populnea* has been planted to stabilize slopes and to prevent soil erosion, especially in the Darjeeling Hills, whereas its leaves serve as fodder for goats. Its bark yields a little tannin.

Production and international trade Supplies of *E. populnea* timber are very limited, but it has some local importance in montane regions.

Properties *E. populnea* yields a medium-weight to heavy hardwood with a density of (650–)740–950 kg/m^3 at 15% moisture content. Heartwood deep red-brown with a purplish tinge, not clearly differentiated from the paler sapwood; grain shallowly to broadly interlocked; texture fine and even; wood with broad stripes on quarter-sawn surface due to the interlocked grain, planed surfaces lustrous. Growth rings usually indistinct, occasionally indicated by a narrow layer of denser tissue; vessels very small to moderately small, almost exclusively solitary, angular, open; parenchyma sparse, apotracheal diffuse; rays fine, not always visible to the naked eye due to lack of contrast in colour; ripple marks absent.

Exbucklandia populnea
transverse surface (×20)

The wood air seasons very slowly with the average moisture content dropping from 81% to 32% in 14 months in 17.5 cm × 15 cm stock. It is liable to end-splitting when seasoned in the log. The wood is moderately hard and fairly strong and elastic. Sawing is moderately easy to easy and it is easy to plane, it finishes exceptionally well and takes a high polish. The wood is easy to peel and yields a good-quality veneer. It is slightly to moderately durable. The wood is slightly susceptible to ambrosia beetle attack, the sapwood is non-susceptible to *Lyctus*.

The average fibre length is 2.342 mm.

See also the tables on microscopic wood anatomy and wood properties.

Botany An evergreen, polygamo-monoecious, medium-sized tree up to 36 m tall; bole branchless for up to 24 m, up to 110(–210) cm in diameter, not buttressed; bark surface fissured with fine adhering scales, dark brown, inner bark fibrous, pink; crown deep, dense. Leaves arranged spirally, simple, entire but palmately 3–5-lobed in saplings, on long petioles; stipules large, joined face to face. Flowers in a peduncled, 7–20-flowered head, bisexual or female. Bisexual flower without sepals; petals 2–7, linear; stamens 10–14; disk 5–10-lobed; ovary semi-inferior, 2-locular with 6–8 ovules in each cell, styles 2. Female flower as the bisexual one but with 0–4 petals and no stamens. Infructescence a woody head of 4-valved capsules. Seeds 6–8 in each cell but only the lower 1–2 fertile and winged. Seedling with epigeal germination; cotyledons emergent, leafy; hypocotyl elongated; all leaves arranged spirally.

In India 38-year-old trees showed a mean annual increment of 0.8 cm in diameter and 0.6 m in height. A second and third branch may develop from an axil (sylleptic branching) giving the crown extreme plasticity in response to variable illumination. In Thailand flowering and fruiting is concentrated in January–June. Pollination is presumably by wind. The winged seed is dispersed by the wind.

Although the generic name *Exbucklandia* was originally rejected in favour of *Symingtonia* because of its apparent invalid publication, it is accepted under the present rules of botanical nomenclature.

Ecology *E. populnea* is an early successional tree occurring locally common or even gregariously in evergreen, disturbed or secondary, hill to montane rain forest at (800–)1000–3000 m altitude.

Silviculture *E. populnea* can be propagated by seed. The seed shows about 30% germination in 17–73 days. There is no difference in viability between seeds collected off the trees and those collected from the ground, provided the capsules of the latter have not yet opened. There are about 247 000 seeds/kg. Seedlings develop very slowly in the nursery during the first 2 years, reaching 10–25 cm height in India. *E. populnea* is a light-demander and easily colonizes clearings, especially those made by man. In India it is planted fairly densely at 1.8 m × 1.8 m to produce long clean boles. In a 38-year-old plantation the mean annual volume increment was 5.3 m^3/ha. *E. populnea* does not coppice or produce root suckers.

Genetic resources and breeding *E. populnea* is rather common in hill to montane forest and there is no danger of genetic erosion.

Prospects Increased use of hill and montane forest for timber may also induce an increased use of *E. populnea* timber.

Literature 163, 193, 209, 212, 267, 341, 343, 436, 535, 747, 829, 831, 861, 874, 886, 914, 1104, 1218, 1221, 1242.

H.C. Ong

Excoecaria L.

Syst. nat., ed. 10, 2: 1288 (1759).

EUPHORBIACEAE

x = unknown; *E. agallocha*: $2n$ = c. 70, 140, 168, *E. cochinchinensis* Lour.: $2n$ = 22, *E. indica*: n = 32

Vernacular names Ludai (trade name). Milky mangrove (En). Indonesia: bintaos laut (Sundanese), menengan (Bali), penggung (Java). Malaysia: ludai (general), bebuta (Peninsular), buta-buta (Sabah, Sarawak). Philippines: buta-buta (Filipino). Thailand: tatum. Vietnam: gia.

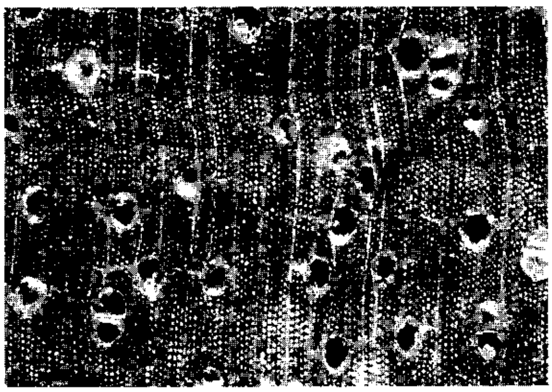
Origin and geographic distribution *Excoecaria* comprises about 40 species occurring in tropical Africa, Madagascar, and from India and Sri Lanka east to Indo-China, southern China, Taiwan, the Ryukyu Islands, Thailand, throughout the Malesian region, northern Australia and the Pacific islands. Most species are found in the Asiatic tropics; 12 in Malesia.

Uses The wood of *Excoecaria* is weak and used for utility furniture, interior finish, mouldings, canoes, packing cases, clog soles, toys, and matches. It is suitable for light construction when properly treated. It yields a good quality charcoal and is frequently used for firewood, although the wood of some species gives off an unpleasant and irritating smoke. It yields good raw material for the production of kraft pulp. The wood of *E. indica* has been used as core veneer.

Trees of *E. agallocha* growing along the coast may form pieces of resinous, aromatic wood called 'garu laut' or 'garu mata buta' on Ternate and 'menengan' on Bali. It serves as a substitute for 'gaharu' (incense) from *Aquilaria* spp. An oil obtained from this wood is applied medicinally against sores, eczema and scabies. The leaves of *E. agallocha* and *E. indica* contain tannin and are used to prepare a dye. The bark of the former and young fruits of the latter are used as fish poison but seeds of *E. indica* are edible. The bark of *E. agallocha* is also used as an ingredient for dart poison and as a purgative. Its leaves are poisonous to cattle.

Production and international trade *Excoecaria* wood is rarely used for timber, mainly due to its toxic sap. In 1996 Papua New Guinea exported only 3 m^3 of 'milky mangrove' logs at an average free-on-board (FOB) price of US\$ 100/m^3.

Properties *Excoecaria* yields a lightweight to medium-weight hardwood with a density of 340–780 kg/m^3 at 15% moisture content. Heartwood pink-white to pale brown or pale yellow-brown, not clearly differentiated from the straw-coloured sapwood; grain straight or interlocked; texture moderately fine and even. Growth rings usually visible; vessels very small to medium-sized, in radial multiples of 2–4 sometimes over 4, tyloses rare or absent; parenchyma abundant, apotracheal in narrow, closely spaced bands, visible with



Excoecaria agallocha
transverse surface (×20)

a hand lens; rays very fine; ripple marks absent. Shrinkage upon seasoning is moderate. The wood is soft to moderately hard and weak. It is easy to work and carve. The wood is non-durable and susceptible to sap-stain fungi, dry-wood termites and ambrosia beetles. The sapwood is susceptible to *Lyctus*.

The average fibre length of *E. agallocha* is 1.07 mm. The abundant white latex in bark and fruits blisters human skin and causes blindness in contact with the eyes.

See also the table on microscopic wood anatomy.

Botany Evergreen or briefly deciduous, usually dioecious, small to medium-sized trees up to 25(–40) m tall, occasionally shrubs; bole cylindrical, sometimes poorly shaped, up to 60(–100) cm in diameter, without buttresses; bark surface smooth to finely fissured or with lenticels frequently joining up to form vertical or diagonal stripes, grey-brown, inner bark pinkish, exuding abundant dirty white to pale yellow latex. Leaves arranged spirally or opposite, simple, entire or crenulate, shortly petioled, with two glands at the base of the blade; stipules small. Flowers unisexual, small, in an axillary or terminal, unisexual or androgynous raceme or spike; bracts small, biglandular; sepals (2–)3, free or shortly connate; petals absent; disk absent. Male flowers 1–3 together; stamens (2–)3; pistillode absent. Female flowers at the base of the raceme or on separate inflorescences; ovary superior, 3-locular with 1 ovule in each cell, styles simple, connate at base, recurved. Fruit a small, smooth, green to dark brown, dehiscing capsule with 3 bivalved parts. Seed without caruncle. Seedling with epigeal germination; cotyledons emergent; hypocotyl elongated; all leaves arranged spirally, conduplicate.

In Bangladesh the mean annual diameter increment of *E. agallocha* in different plots in mangrove forest ranged from 0.05–0.18 cm. Young leaves are pink. Old trees of *E. indica* have branches drooping to the ground. The seeds are probably dispersed by water.

E. parvifolia Müll. Arg. seems to be a promising timber species of northern Australia.

Ecology *E. agallocha* is frequently found in the drier parts of mangrove swamps and along rocky shores, and may occur in pure stands. The other species occur in primary or occasionally secondary, evergreen rain forest, up to 800 m altitude. *E. indica* is additionally found in sago swamps, gallery forest and on the inland edge of mangrove swamps.

Silviculture *Excoecaria* can be propagated by seed. Sown fruits of *E. indica* have only 5% germination in 318–413 days. In India direct sowing by broadcasting the viable seeds of *E. agallocha* has proven very satisfactory. The species has become more common in Indian mangrove forest because the trees coppice well and can survive repeated felling. Special precautions must be taken when logging *Excoecaria* trees, because of their aggressive latex. In North Sumatra and Peninsular Malaysia localized mass defoliation of *E. agallocha* by caterpillars of the noctuid *Achaea janata* has been observed, but trees survived the attack.

Genetic resources and breeding Apart from a few individuals in botanical gardens, there are no records of ex situ conservation of *Excoecaria* species. *E. myrioneura* and *E. virgata* are rare.

Prospects As *Excoecaria* wood is of inferior quality, its future use will probably be limited to the production of pulp and charcoal.

Literature 26, 28, 32, 33, 34, 36, 70, 151, 162, 163, 209, 238, 267, 300, 348, 436, 464, 696, 717, 829, 831, 853, 861, 974, 1038, 1195, 1218, 1221, 1232, 1242.

Selection of species

Excoecaria agallocha L.

Synonyms *Excoecaria affinis* Endl., *Excoecaria camettia* Willd., *Stillingia agallocha* (L.) Baillon.

Vernacular names Blind-your-eyes, milky mangrove (En). Indonesia: kayu buta-buta (Indonesian), kayu betah (Javanese), menengan (Java, Bali). Malaysia: buta-buta (general), bebuta (Peninsular). Philippines: buta-buta (Filipino). Burma (Myanmar): kayaw taway. Thailand: buu-to (peninsular), tatum thale (central). Vietnam: gia.

Distribution Along the coasts of southern India and Sri Lanka to Burma (Myanmar), Indo-China, China, Taiwan, the Ryukyu Islands, Thailand, throughout the Malesian region, northern Australia and the Pacific.

Excoecaria indica (Willd.) Müll. Arg.

Synonyms *Excoecaria diversifolia* (Miq.) Müll. Arg., *Sapium indicum* Willd., *Stillingia indica* (Willd.) Baillon.

Vernacular names Mock willow (En). Indonesia: ai tui (Ambon), gurah (Kalimantan), tagewa (northern Halmahera). Malaysia: apid-apid, gurah (Sabah), ludai (Peninsular). Thailand: krahut, samo thale (central), ku-ra (Malay, peninsular). Vietnam: xoi-an.

Distribution From India to Indo-China, Thailand, Sumatra, Borneo, the Lesser Sunda Islands (Sumbawa), the Moluccas, New Guinea and the Solomon Islands.

Excoecaria myrioneura Airy Shaw

Distribution The Moluccas (Morotai) and New Guinea (Irian Jaya).

Excoecaria virgata Zoll. & Moritzi ex Miq.

Synonyms *Sapium virgatum* (Zoll. & Moritzi ex Miq.) Hook. f., *Stillingia virgata* (Zoll. & Moritzi ex Miq.) Baillon.

Vernacular names Indonesia: dawolang (Sundanese), derwolo, getahan (Javanese).

Distribution Java and the Moluccas (Halmahera).

Purwaningsih

Fernandoa Welw. ex Seem.

Journ. Bot. 3: 330, t. 37–38 (1865).

BIGNONIACEAE

$x = 20$; *F. adenophylla*: $2n = 40$

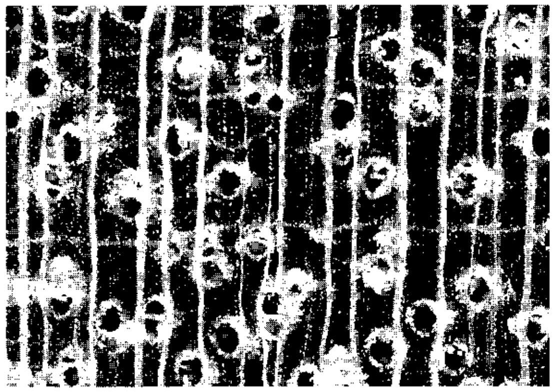
Origin and geographic distribution *Fernandoa* comprises 15 species, 8 of which occur in tropical Africa and Madagascar. The other 7 are found from India to Indo-China, China, Thailand, Peninsular Malaysia and northern Sumatra. Only 2 species are present in the Malesian region.

Uses The wood of *Fernandoa* is used for house building (e.g. beams, posts) and for boats (especially *F. macroloba*) and is suitable for furniture, cabinet making and mouldings (especially *F. adenophylla*). It has been used as fuelwood in India.

The flowers are edible. In Laos a decoction of the bark is given after childbirth.

Production and international trade Utilization of the wood of *Fernandoa* is probably on a local scale only.

Properties *Fernandoa* yields a medium-weight (*F. macroloba*) to heavy (*F. adenophylla*) hardwood with a density of 610–1000 kg/m^3 at 15% moisture content. Heartwood orange-yellow with occasional darker streaks or brownish-white, sapwood pale yellow; texture fine; wood with conspicuous silver grain; oily or greasy to the touch. Growth rings indistinct or sometimes distinct, marked by marginal parenchyma; vessels moderately small to medium-sized, solitary and in radial multiples of up to 4, occasionally running in more or less concentric lines, with a sulphur-yellow substance; parenchyma apotracheal in irregularly spaced bands, and paratracheal vasicentric, aliform or confluent; rays fine to moderately broad; ripple marks absent.



Fernandoa adenophylla
transverse surface (×20)

The wood is moderately hard to hard and durable unless exposed to the weather or in contact with the ground. It is resistant to termite attack.

See also the table on microscopic wood anatomy.

Botany Evergreen or deciduous, small to fairly large trees up to 40 m tall; bole branchless for up to 20 m, up to 70 cm in diameter, without buttresses; bark surface scaly, grey, inner bark laminated, pink. Leaves decussate, pinnate, with 2–5 pairs of leaflets, terminal leaflet largest, with glands and hairy domatia in the vein axils beneath; stipules absent. Flowers in a terminal or axillary thyrse, densely to sparsely stellate hairy; calyx with 2–5 unequal lobes, with warty or prominent glands in the upper half; corolla trumpet-shaped, white to yellow-brown, the 5 lobes undulate to crenate; stamens 4 and a 5th rudimentary one; disk annular; ovary superior, 2-locular with many ovules, style long. Fruit a capsule, terete, smooth or ribbed, sometimes flattened, with a flat septum, many-seeded. Seed rather rectangular, with narrow membranous wings. Seedling with epigeal germination.

Flowering and fruiting may occur at an early age and is from March to December in Peninsular Malaysia and Sumatra. Flowers are nocturnal and pollination might be by bats. Seed dispersal is by wind.

The Asian *Fernandoa* species formerly comprised a distinct genus, *Haplophragma*. Several authors still consider the differences in inflorescence and flower structure significant enough to justify the recognition of two distinct genera, in which case *Fernandoa* is confined to Africa and Madagascar.

Ecology The Malesian species of *Fernandoa* are generally uncommon but may be locally abundant. They occur in evergreen monsoon to mixed deciduous, primary or sometimes secondary rain forest, sometimes in bamboo forest or even savanna, up to 850 m altitude. *F. adenophylla* prefers limestone or siliceous soils.

Silviculture *Fernandoa* can be raised from seed.

Genetic resources and breeding The limited geographic distribution of *F. macroloba* may make it vulnerable to genetic erosion through destruction of its habitat, although at present it does not seem to be endangered.

Prospects Very little is known on the properties of *Fernandoa* wood from South-East Asia, except that *F. macroloba* yields good-quality timber. Information from India indicates that *Fernandoa* timber has good prospects for furniture and cabinet-work.

Literature 113, 163, 329, 341, 343, 364, 436, 464, 790, 861, 1038, 1039, 1144, 1221.

Selection of species

Fernandoa adenophylla (Wallich ex G. Don) v. Steenis

Synonyms *Haplophragma adenophyllum* (Wallich ex G. Don) Dop, *Heterophragma adenophyllum* (Wallich ex G. Don) Seem. ex Bonpl. & Humb., *Spathodea adenophylla* (Wallich ex G. Don) DC.

Vernacular names Laos: kh'ê: hla:w. Thailand: khae hang khang (general), khae khon (northern), khae phong (peninsular). Vietnam: ng[oj]t nai (Bihn Tri Thiên), s[of]do (An Giang).

Distribution India (Assam), Burma (Myanmar), Indo-China, the Andaman and Cocos Islands, Thailand and Peninsular Malaysia.

Fernandoa macroloba (Miq.) v. Steenis

Synonyms *Haplophragma macrolobum* (Miq.) v. Steenis, *Heterophragma macrolobum* (Miq.) Backer ex K. Heyne, *Spathodea macroloba* Miq.

Vernacular names Indonesia: sungkai chirit (Padang, Sumatra), sungkai rimbo (Minangkabau, Sumatra), tuwé (Aceh, Sumatra).

Distribution Northern half of Sumatra.

S.H. Widodo

Ficus L.

Sp. pl. 2: 1059 (1753); Gen. pl., ed. 5: 482 (1754).
MORACEAE
$x = 13$; $2n = 26$ for the vast majority of species, $2n = 52$ for few species

Vernacular names Ficus, fig (En). Figue (Fr). Indonesia: ara, bunut, karet. Malaysia: ara, ara kelumpong (stem figs), ara tanah (geocarpic figs), nunok (strangling figs, Dusun, Sarawak), giwit (geocarpic figs, Dusun, Sarawak). Papua New Guinea: Papua New Guinea fig (trade name). Philippines: balete (Filipino). Burma (Myanmar): nyaung. Thailand: sai. Vietnam: chi da, d[eef], sung.

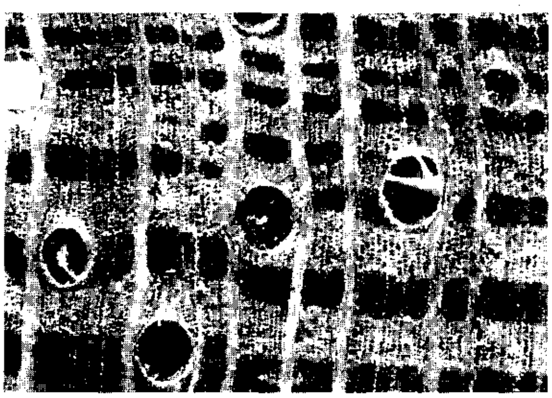
Origin and geographic distribution *Ficus* comprises about 1000 species and occurs in tropical and subtropical regions, about half of them in Malesia. Few species are found in warm temperate areas.

Uses Few *Ficus* species become large enough to be useful for timber. The wood of these is used for temporary construction, mouldings, interior work, cladding, drawers, concrete formwork, dugouts, laundry tubs, small domestic articles, fruit crates, floats and firewood. The wood of some species is suitable for the production of matches and matchboxes. A low grade plywood can be manufactured from the wood. It may become valuable for the production of fibreboard.

The fruits of some species are edible but are generally not sought after or prized. Some species have poisonous fruits. The latex has been used medicinally, mainly to cover and cure wounds, and as a wax in dyeing batik cloth; that of *F. elastica* Roxb. ex Hornem. is the source of India rubber and was once cultivated before para rubber (*Hevea brasiliensis* (Willd. ex A.L. Juss.) Müll. Arg.) was introduced to the region. The latex is also used as birdlime and in Papua New Guinea for sealing leaks in canoes, whereas that of some species is highly toxic and applied as dart poison. The tough and fibrous bark of a few species is a well-known raw material for rough cordage and matting and used to be used for clothing; it is still used for bow strings. Young leaves of several species are eaten raw in salads or cooked with meat wrapped in them, the latter dish is considered a delicacy in the highlands of New Guinea. They have also been used as fodder, and leaves of other species are applied as sandpaper or to scour cooking pots. Several species are planted as wayside trees. One of these is *F. benjamina* which is often regarded as a sacred tree and is a popular pot plant in temperate regions. *F. benghalensis* is sacred to Hindus and Buddhists. *F. racemosa* and *F. nota* (Blanco) Merr. are used for slope, gully and river bank stabilization as they produce a deep and wide-spreading root system. As natural regeneration of *F. variegata* is easy, it has been proposed as green manure and cover crop.

Production and international trade Small amounts of *Ficus* timber are traded, most often in mixed consignments of lightweight hardwood. In 1987 Japan imported 442 logs from Papua New Guinea comprising 0.7% of the total of imports from that country. In the same year, Japan imported very small amounts of ficus from the Solomon Islands. In Papua New Guinea ficus timber is ranked in MEP (Minimum Export Price) group 5 and fetched a minimum export price of US\$ 40/m^3 for logs in 1992. In 1996 Papua New Guinea exported a volume of about 12 000 m^3 of ficus logs at an average free-on-board (FOB) price of US\$ 100/m^3.

Properties *Ficus* yields a lightweight to medium-weight hardwood with a density of 190–740 kg/m^3 at 15% moisture content. Heartwood pale yellow-brown or various shades from yellow to pink-grey, not clearly differentiated from the sapwood; grain straight, interlocked to deeply interlocked; texture moderately coarse to coarse and uneven due to abundant parenchyma; darker-coloured streaks produced by parenchyma giving rise to watered-silk figure on tangential surfaces and palisade effect on radial surfaces. Growth rings indistinct, when present marked by marginal parenchyma; vessels medium-sized to very large, solitary and in radial multiples of 2–3(–6), occasionally filled with gum-like deposits and tyloses; parenchyma abundant, in wide apotracheal bands, conspicuous, and paratracheal vasicentric; rays medium-sized to moderately broad; with a tendency to ripple marks in some species and observed in *F. benjamina*, but usually absent.



Ficus variegata
transverse surface (×20)

Shrinkage of the wood upon air drying is low to medium. The wood seasons well, but is susceptible to sap-stain and slight degrade in the form of twisting, cupping and bowing. The sawn timber should be treated immediately with anti-stain chemicals. It takes about 2.5 months to air dry boards 13 mm thick, and about 3 months for boards 38 mm thick, which is fairly rapid. The wood is soft and not strong. It is very easy to work, and although a little woolly; a fairly smooth finish can be obtained. The wood is non-durable and not resistant to termite and fungal attack. The sapwood is susceptible to *Lyctus*. It is extremely easy to treat with preservatives.

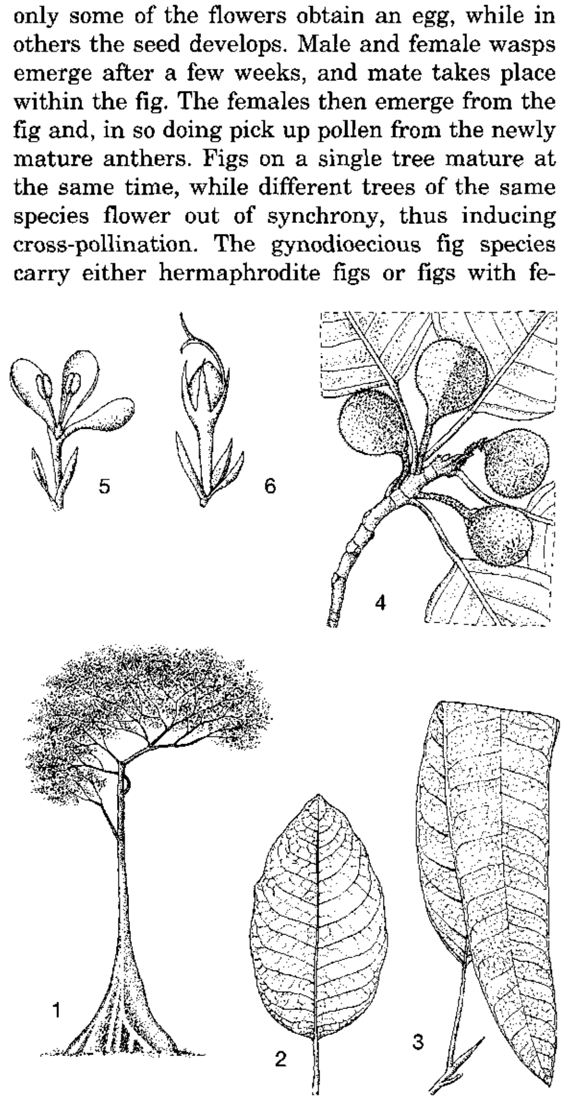
The sapwood of *F. benghalensis* has a gross energy value of 18 565 kJ/kg.

See also the tables on microscopic wood anatomy and wood properties.

Botany Evergreen or sometimes deciduous, woody, epiphytic climbers or stranglers, creepers, shrubs or small to large, trees up to 40(–50) m tall, or banyans, i.e. trees whose branches send down aerial roots that thicken ('pillar-roots') which function as props; bole fairly straight in tree-like species, sometimes fluted, up to 100(–190) cm in diameter, sometimes heavily buttressed; bark surface smooth, often pale grey, sometimes whitish or brown, sometimes lenticellate, inner bark yellowish, exuding white or yellow latex. Leaves arranged spirally, alternate or opposite, simple or palmately lobed, symmetrical to asymmetrical, dentate to entire, often with glands below in the axil of the lateral or basal veins or abaxial at the apex of the petiole; stipules free or connate. Inflorescence axillary or rami- to cauliflorous, sometimes subterranean, solitary or clustered, monoecious or gynodioecious, with the flowers set inside an urn-shaped receptacle (syconium; a fig). Flowers unisexual; tepals 2–8, free or joined; stamens 1–7; ovary unilocular with a single ovule, style single. Infructescence a more or less fleshy fig; individual fruit a drupelet. Seedling with epigeal germination; cotyledons emergent; hypocotyl elongated; all leaves arranged spirally.

The strangling figs start as epiphytic plants and send down aerial roots that eventually form a false trunk composed of a trellis-work of interlacing and anastomosing roots. Many species have more than one kind of leaf (heterophylly).

The symbiotic relation of figs with specialized wasps is well-known. Figs can only be pollinated by female agaonid wasps (*Hymenoptera, Chalcidoidea, Agaonidae*). The wasp species are highly species-specific. Fig species are divided into 2 groups: monoecious species and gynodioecious ones. In the first the wasps arrive when only female flowers are receptive. They enter the fig via the osteole, a bract-covered apical pore. Once inside they pollinate the female flowers and deposit their eggs in the ovaries. As style length varies greatly within these figs and because the wasp can only reach the ovary of short-styled flowers, only some of the flowers obtain an egg, while in others the seed develops. Male and female wasps emerge after a few weeks, and mate takes place within the fig. The females then emerge from the fig and, in so doing pick up pollen from the newly mature anthers. Figs on a single tree mature at the same time, while different trees of the same species flower out of synchrony, thus inducing cross-pollination. The gynodioecious fig species carry either hermaphrodite figs or figs with female flowers only. In hermaphrodite ones the styles are uniformly short. Wasps can oviposit every female flower and such trees rear the pollinators' offspring and function as pollen donors. Figs with female flowers have long-styled flowers only. The wasps can only deposit pollen and such figs produce large amounts of seed.



Ficus callosa Willd. – 1, tree habit; 2, leaf of young tree; 3, sapling leaf; 4, fruiting twig; 5, male flower; 6, female flower.

An individual *F. virens* tree in Peninsular Malaysia flowered at intervals varying from 5 months to 3.5 years, whereas *F. sumatrana* Miq., a large strangler, flowered in a regular cycle of 4–5 months, apparently under endogenous control. During daytime the figs are eaten by birds (e.g. pigeons, hornbills, bulbuls, cassowaries), monkeys and squirrels. At night they are visited by bats and civet cats. Cauliflorous figs are eaten by deer and pigs. The latter also uproot the geocarpic figs. Even elephants, rhinoceros, tapir and wild cattle have been reported to feed on figs. As fig fruits are often available year-round, they constitute an extremely important forest food, a so-called keystone resource that sustains frugivorous animals at the famine period of the year when few species if any are fruiting.

F. obscura Blume forms cavities in parts of its twigs which open via slits and are inhabited by non-specific tree-dwelling ants. The plant produces a sugary secretion from extra-floral nectaries on the lower leaf surface.

In Asia and Australia the large genus *Ficus* has been subdivided into 4 subgenera and 14 sections and numerous smaller taxonomic groups.

Ecology *Ficus* species are common and form an important element of lowland rain forest, both as canopy and understorey trees. Most species prefer perhumid forest, but several are found in areas with a monsoon climate and in teak forest, also in locations where the soil dries out. *Ficus* does not occur in mangrove vegetation but is often present in brackish swamps behind the mangrove. *Ficus* species are generally found below 1500 m altitude, some between 1500 and 2750 m or rarely up to 3200 m. Many species are epiphytic and/or strangling.

Silviculture *Ficus* can be propagated from seed and vegetatively. Per kg there are about 1.9–2.3 million dry seeds of *F. racemosa* and 2.1–2.5 million seeds of *F. benghalensis*. The drupelets are usually the unit of sowing. These cannot be stored without a serious decrease in viability. An 8% germination rate is achieved in 16–87 days in *F. benjamina*, in 8–40 days in *F. grossularioides*, in 18–34 days in *F. microcarpa*, in 11–12 days in *F. sundaica* and in 11–55 days in *F. virens*. In India pretreatment with hot water of 60°C for 10 minutes was found to increase the germination of seed of *F. benghalensis* from 20% to 24% and of *F. racemosa* from 19% to 28% in 7–15 days. The tiny seedlings are pricked out twice, first in clumps and later individually. The young seedlings are sensitive to excess of water. Both large and small cuttings are used in vegetative propagation, but small cuttings are less successful. Except for *F. racemosa* and *F. virens*, most species are not resistant to fire. In the transition zone from mangrove to inland forest in Peninsular Malaysia, *F. microcarpa* makes up an important part of the trees over 5 cm in diameter, accounting for about 123 trees/ha (14% of the total) with a basal area of 2.4 m^2/ha (12% of the total).

Genetic resources and breeding There are no records of ex situ conservation of *Ficus* species, except for some, like *F. benghalensis* and *F. benjamina*, which are widely planted or cultivated. As most of the species are fairly common and widespread, the risk of genetic erosion seems comparatively low.

Prospects It is unlikely that its importance as a timber tree will increase, because of the growth form of many *Ficus* species and the poor quality of the wood.

Literature 40, 70, 124, 146, 151, 163, 182, 206, 209, 260, 267, 300, 340, 348, 375, 387, 405, 406, 436, 464, 525, 543, 568, 678, 694, 740, 741, 760, 770, 780, 829, 831, 861, 889, 921, 933, 934, 955, 974, 1038, 1123, 1169, 1198, 1221, 1242.

Selection of species

Ficus adenosperma Miq.

Synonyms *Ficus chaetophora* Warb., *Ficus pauper* King, *Ficus turbinata* Ridley.

Vernacular names Indonesia: fangkis (Maibrat, Irian Jaya), nusu, tintinalino (Sulawesi).

Distribution Sulawesi, the Moluccas, New Guinea, east to the Solomon Islands and Vanuatu, south to northern Australia.

Ficus albipila (Miq.) King

Synonyms *Ficus colossea* F. v. Mueller ex Benth., *Ficus microtricherinos* Backer.

Vernacular names Abbey tree (En). Indonesia: lelas, leles (Java). Thailand: laeng, liang phueng (general).

Distribution Thailand, Peninsular Malaysia, Singapore, Sumatra, Java, Borneo (Kalimantan), the Lesser Sunda Islands (Timor), New Guinea, New Britain and northern Australia (Queensland).

Ficus annulata Blume

Synonyms *Ficus balabacensis* Quisumb., *Ficus flavescens* Blume, *Ficus valida* Blume.

Vernacular names Indonesia: bulu emprit (Javanese), kiara koneng (Sundanese), nunu-lewui (Manado, Sulawesi). Malaysia: ara bungkus, ara kebangan, ara kubong (Peninsular). Philippines: sininsing (Tagalog). Burma (Myanmar): nyaung-thapan. Thailand: hai (north-eastern), sai (south-east and peninsular).

Distribution From Burma (Myanmar), Indo-China and China (Yunnan) towards Thailand, Peninsular Malaysia, Singapore, Sumatra, Java, Borneo, the Philippines (Balabac Island) and Sulawesi.

Ficus benghalensis L.

Synonyms *Ficus banyana* Oken, *Ficus indica* L.

Vernacular names Indian banyan (En). Malaysia: banyan (general), ara tandok, bohdi (Peninsular). Burma (Myanmar): pyi-nyaung. Thailand: krang, ni khrot (central).

Distribution Originally from India and Pakistan but widely planted in the Malesian region and locally naturalized.

Ficus benjamina L.

Synonyms *Ficus cuspidato-caudata* Hayata, *Ficus parvifolia* Oken, *Ficus umbrina* Elmer.

Vernacular names Golden fig (En). Indonesia: beringin (general), caringing (Sundanese), waringin (Javanese). Malaysia: beringin, waringin (general). Philippines: salising-haong, salising-hubad (Filipino), salisi (Isinai, Subanun). Laos: [ooxlng^2 n[oox]k. Burma (Myanmar): kyet-kadut. Thailand: sai yoi bai laem (central and south-eastern), sai (peninsular).

Distribution From India to Burma (Myanmar), Indo-China, southern China and Thailand, throughout the Malesian region, east to the Solomon Islands and south to northern Australia. It is also commonly planted as a roadside tree and is a popular pot plant in temperate regions.

Ficus callosa Willd.

Synonyms *Ficus longespathulata* Sata, *Ficus malunuensis* Warb., *Ficus porteana* Regel.

Vernacular names Hard fig (En). Indonesia: ilat-ilatan (Javanese), lassi (Timor), pangsar (Sundanese). Philippines: kalayokai, kalukoi (Tagalog). Laos: mi^2 pa^1, 'nong^2 noua^1. Thailand: maduea kwang (general).

Distribution From Sri Lanka and India to Burma (Myanmar), Indo-China, the Andaman Islands, Thailand, Peninsular Malaysia, Sumatra, Java, Borneo (Sabah), the Philippines, Sulawesi and the Lesser Sunda Islands.

Ficus drupacea Thunb.

Synonyms *Ficus chrysochlamys* Lauterb. & K. Schumann, *Ficus chrysocoma* Blume, *Ficus payapa* Blanco, *Ficus pilosa* Reinw. ex Blume.

Vernacular names Brown-woolly fig (En). Indonesia: kalihi, melitih (Sumba), nabu (Timor). Philippines: payapa (Tagalog), teha (Manokwari). Thailand: krang bai khon (central), lung khon (northern).

Distribution From Sri Lanka, India, Bangladesh and Burma (Myanmar) to Indo-China, Thailand, throughout the Malesian region, the Solomon Islands and Australia (Queensland).

Ficus erythrosperma Miq.

Synonyms *Ficus lachnocarpa* Warb., *Ficus pycnoneura* Lauterb. & K. Schumann, *Ficus xanthoxyla* Summerh.

Vernacular names Indonesia: ngiesingies (Seram).

Distribution North Sulawesi, the Moluccas, New Guinea, east to the Solomon Islands.

Ficus fistulosa Reinw. ex Blume

Synonyms *Ficus grandidens* Merr., *Ficus harlandii* Benth., *Ficus rubrovenia* Merr.

Vernacular names Common yellow stem-fig (En). Indonesia: beunying (Sundanese), kujajing (Kalimantan), wilada (Javanese). Malaysia: ara serapat, kelampong bukit (Peninsular). Philippines: tibig (Tagalog). Thailand: ching, ching khao (peninsular), maduea plong (south-eastern).

Distribution From India (Assam), Burma (Myanmar), Indo-China, southern China, Taiwan, Thailand and the Nicobar Islands to Peninsular Malaysia, Singapore, Sumatra, Java, Borneo, the Philippines, and the Lesser Sunda Islands.

Ficus grossularioides Burm. f.

Synonyms *Ficus alba* Reinw. ex Blume, *Ficus hunteri* Miq., *Ficus lobata* Hunter ex Ridley

Vernacular names White-leaved fig (En). Indonesia: hamberang leutik (Sundanese), kebek (Javanese), modang susu (Batak, Sumatra). Malaysia: ara perak, kelumpong burong, sepedeh jantan (Peninsular).

Distribution Thailand, Peninsular Malaysia, Singapore, Sumatra, Java and Borneo (Kalimantan, Sarawak).

Ficus hadroneura Diels

Distribution New Guinea and New Britain.

Ficus hesperidiiformis King

Synonyms *Ficus myrmekiocarpa* Summerh., *Ficus sclerotiara* Diels.

Distribution New Guinea.

Ficus hombroniana Corner

Vernacular names Indonesia: ai lauwani (Moluccas), terkeen, ubuwak (Asmat, Irian Jaya).

Distribution The Moluccas, New Guinea and Bougainville Island.

Ficus ihuensis Summerh.

Distribution Papua New Guinea.

Ficus kerkhovenii Valeton

Synonyms *Ficus lamaoensis* Merr.

Vernacular names Johore fig, Kerkhoven fig (En).

Distribution Peninsular Malaysia, Singapore, Sumatra, Bangka, western Java, Borneo (Kalimantan) and the Philippines (Luzon).

Ficus lamponga Miq.

Synonyms *Ficus balansae* Gagnep., *Ficus lepidosa* Wallich ex Kurz.

Vernacular names Indonesia: seabu (Sulawesi).

Distribution From India (Assam) to Burma (Myanmar), Indo-China, Thailand, the Andaman Islands, Peninsular Malaysia, Singapore, Sumatra, Borneo (Kalimantan, Sarawak) and North Sulawesi.

Ficus magnoliifolia Blume

Synonyms *Ficus apoensis* Elmer, *Ficus edelfeltii* auct. non King, *Ficus nervosa* auct. non Heyne ex Roth.

Vernacular names Indonesia: caliling (Sundanese), kopeng (Javanese), mara gatal (Kalimantan). Philippines: kanapai (Tagalog).

Distribution The Andaman and Nicobar Islands, Peninsular Malaysia, Sumatra, Java, Borneo, the Philippines and Sulawesi.

Ficus melinocarpa Blume

Synonyms *Ficus alnifolia* (Miq.) Miq., *Ficus haggeri* Merr., *Ficus irosinensis* Elmer.

Vernacular names Indonesia: darangdan, hampelas tangkal (Sundanese), rempelas (Javanese). Papua New Guinea: sag (Jal, New Britain). Philippines: upli (Tagalog).

Distribution Sumatra, Java, Borneo (Kalimantan, Sabah), the Philippines, Sulawesi, the Moluccas, the Aru Islands, New Guinea, east to the Solomon Islands and south to northern Australia (Queensland).

Ficus microcarpa L. f.

Synonyms *Ficus cairnsii* Warb., *Ficus prolixa* Vieill. & Depl., *Ficus retusiformis* Lév. & Vaniot.

Vernacular names Chinese banyan, laurel fig, Malayan banyan (En). Malaysia: jawi jawi, jejawi (general). Philippines: baleteng-liitan (Filipino). Thailand: sai yoi bai thu (central).

Distribution From Sri Lanka, India and Burma (Myanmar) to Indo-China, southern China, the Ryukyu Islands and Thailand, throughout the Malesian region, east to Micronesia and the Solomon Islands, and south to northern Australia.

Ficus nodosa Teijsm. & Binnend.

Synonyms *Ficus du* K. Schumann & Lauterb.

Vernacular names Indonesia: laura (Moluccas), manseke (Irian Jaya).

Distribution The Moluccas, New Guinea, east to the Solomon Islands and south to northern Australia (Queensland).

Ficus polyantha Warb.

Synonyms *Ficus frondosa* S. Moore.

Vernacular names Indonesia: bobahika (Morotai).

Distribution The Philippines, the Moluccas, the Kai Islands, New Guinea, east to the Solomon Islands.

Ficus primaria Corner

Distribution Papua New Guinea including New Britain.

Ficus pseudojaca Corner

Distribution New Guinea.

Ficus pubinervis Blume

Synonyms *Ficus crassitora* Elmer, *Ficus sibulanensis* Elmer, *Ficus similis* Merr.

Vernacular names Indonesia: harama jara (Sumba), kajeng sampeyan (Javanese). Philippines: dapasan (Bagobo), dungo (Tagalog), gatil (Luzon).

Distribution Sumatra, Java, Borneo, the Philippines, Sulawesi, the Lesser Sunda Islands and the Moluccas.

Ficus racemosa L.

Synonyms *Ficus glomerata* Roxb., *Ficus semicostata* F.M. Bailey, *Ficus vesca* F. v. Mueller ex Miq.

Vernacular names Blue fig, figwood, red river fig (En). Indonesia: arah (Madura), lo (Javanese), lowa (Sundanese). Laos: dua^1 kièng^2. Burma (Myanmar): mayen. Thailand: duea kliang (central, northern), duea nam (peninsular), maduea uthumphon (central).

Distribution From Ethiopia to India, Pakistan, Sri Lanka, Burma (Myanmar), Indo-China, southern China, Thailand, Peninsular Malaysia, Sumatra, Java, Borneo, Sulawesi, the Lesser Sunda Islands, New Guinea and northern Australia.

Ficus robusta Corner

Distribution New Guinea.

Ficus semivestita Corner

Distribution New Guinea.

Ficus subcuneata Miq.

Synonyms *Ficus formosa* Summerh., *Ficus stoechotricha* Diels, *Ficus trichoneura* Diels non Summerh.

Distribution Sulawesi, the Moluccas, New Guinea and New Britain.

Ficus sundaica Blume

Synonyms *Ficus korthalsii* Miq., *Ficus pyrifolia* (Miq.) Boerl., *Ficus rubescens* Blume.

Vernacular names Sunda fig (En).

Distribution Burma (Myanmar), Indo-China, Thailand, Peninsular Malaysia, Singapore, Sumatra, Java and Borneo.

Ficus superba (Miq.) Miq.

Synonyms *Ficus pritzelii* Warb., *Ficus subpisocarpa* Gagnep., *Ficus tenuipes* S. Moore.

Vernacular names Sea fig (En). Indonesia: gedat, jerakah bulu (Javanese), kekalampa (Roti). Thailand: krai, sai liap (central), pho sai (eastern).

Distribution From Japan, Taiwan and China towards Thailand, Peninsular Malaysia, Singapore, the Anambas and Natuna Islands, Java, the Lesser Sunda Islands, Sulawesi (Salayar Island), the Moluccas (Seram) and Australia.

Ficus tinctoria J.G. Forst.

Synonyms *Ficus chlorosykon* Rechinger, *Ficus gibbosa* Blume, *Ficus neoebudarum* Summerh.

Vernacular names Humped fig-tree (En). Indonesia: ara kuning (Kalimantan), bunut, karang (Java). Malaysia: ara bereteh (Peninsular), sinu (Dayak, Sarawak). Burma (Myanmar): mai-hai. Laos: hai. Thailand: hai (north-eastern), krang (central).

Distribution From India, Sri Lanka and Burma (Myanmar) to southern China, Taiwan, Indo-China, Thailand, the Andaman and Nicobar Islands, throughout the Malesian region towards Micronesia, Polynesia and northern Australia.

Ficus trachypison K. Schumann

Synonyms *Ficus lima* K. Schumann & Lauterb., *Ficus pteleaephylla* S. Moore, *Ficus xanthosyce* Summerh.

Distribution The Moluccas (Ambon), the Aru and Kai Islands, New Guinea, east to the Solomon Islands.

Ficus variegata Blume

Synonyms *Ficus cordifolia* Blume, *Ficus laevigata* Blanco, *Ficus sum* Gagnep.

Vernacular names Common red stem-fig (En). Indonesia: gondang (Javanese, Balinese), kanjilu (Sumba), kondang (Sundanese). Malaysia: ara kelepong, ara kelumpong (Peninsular). Philippines: tangisang-bayauak (Tagalog). Thailand: phuuk (peninsular).

Distribution From India and Burma (Myanmar) to Indo-China, China, the Ryukyu Islands, Taiwan, the Andaman Islands, Thailand, throughout the Malesian region, east to the Solomon Islands and south to northern Australia (Queensland).

Ficus vasculosa Wallich ex Miq.

Synonyms *Ficus championi* Benth., *Ficus renitens* Miq., *Ficus variabilis* Miq.

Vernacular names Indonesia: bunut, huru awis, ki kopeng (Sundanese). Malaysia: ara nasi, mentakil, tampang burong (Peninsular). Thailand: maduea thong (peninsular).

Distribution Burma (Myanmar), Indo-China, southern China, Thailand, Peninsular Malaysia, Singapore, Sumatra, Java and Borneo.

Ficus virens Aiton

Synonyms *Ficus carolinensis* Warb., *Ficus glabella* Blume, *Ficus infectoria* Roxb.

Vernacular names Grey fig, white fig (En). Indonesia: ampulu (Madura), bulu bras, wunut banyu (Javanese). Malaysia: ara nasi (Peninsular). Burma (Myanmar): nyaung-pan. Thailand: phak hee, phak hueak (northern), phak lueat (central).

Distribution From Sri Lanka, India and Burma (Myanmar) to Indo-China, southern China, the Andaman Islands, Thailand, throughout the Malesian region towards the Solomon Islands and northern Australia.

Ficus virgata Reinw. ex Blume

Synonyms *Ficus decaisneana* Miq., *Ficus philippinensis* Miq., *Ficus trymatocarpa* Miq.

Vernacular names Indonesia: lumaput (Sulawesi), nunok (Ambon). Philippines: balete (Negros), kalapak-kahoi (Tagalog), magulapi (Bagobo).

Distribution From the Ryukyu Islands and Taiwan to Micronesia, the Philippines, Sulawesi, the Lesser Sunda Islands, the Moluccas, New Guinea, east to the Solomon Islands, New Caledonia and Vanuatu, south to northern Australia (Queensland).

Ficus viridicarpa Corner

Vernacular names Green stem-fig (En). Thailand: duea phlong (peninsular).

Distribution Peninsular Thailand, Peninsular Malaysia and West Java.

Ficus xylophylla (Miq.) Wallich ex Miq.

Vernacular names Wooden-leaf fig (En). Malaysia: ara daun lebar, pulut-pulut (Peninsular).

Distribution Laos, Thailand, Peninsular Malaysia, Singapore, Sumatra, Borneo and intervening islands.

E. Boer (general part),
M.S.M. Sosef (general part, selection of species)

Firmiana Marsili

Saggi Sci. Lett. Accad. Padova 1: 114, 116 (1786).

STERCULIACEAE

$x = 20$; all non-Malesian species examined: $2n = 40$

Vernacular names Papua New Guinea: firmiana (En).

Origin and geographic distribution *Firmiana* comprises about 15 species and is distributed in India, Burma (Myanmar), Indo-China, China, Thailand, throughout Malesia (except for the Lesser Sunda Islands and the Moluccas), the Solomon Islands and east to Fiji. *F. simplex* (L.) W.F. Wight is planted outside this area, e.g. in Japan, Europe and northern America, and occasionally naturalized. In Malesia 3 species occur, one in western Malesia, one in the Philippines and Sulawesi, and one in New Guinea.

Uses In Papua New Guinea the wood of *Firmiana* has been used for interior finish, veneer and other light construction. In Thailand it is applied for concrete shuttering and as core stock for plywood.

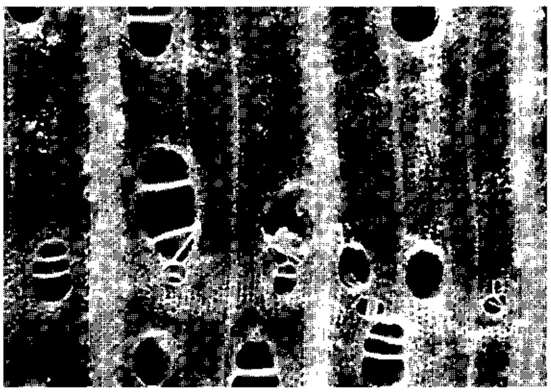
F. malayana is occasionally planted as a roadside tree in Peninsular Malaysia.

Production and international trade *Firmiana* wood is used rarely and mainly on a local scale. In 1996 Papua New Guinea exported 85 m^3 of *Firmiana* logs at an average free-on-board (FOB) price of US$ 103/m^3.

Properties *Firmiana* yields a lightweight hardwood with a density of 355–400 kg/m^3 at 15% moisture content. Heartwood cream-coloured, not clearly differentiated from the sapwood. Growth rings indistinct, occasionally semi-ring-porous; vessels medium-sized to very large, solitary, in radial multiples of 2–4(–5) and in clusters, visible to the naked eye, open; parenchyma vasicentric, aliform or confluent, and apotracheal in irregularly spaced bands; rays narrower than the vessels; ripple marks present. The wood anatomy of *Firmiana* is similar to that of *Pterocymbium* and *Sterculia*.

The wood is soft, very weak and non-durable. It is highly susceptible to sap-stain. The sapwood is susceptible to *Lyctus*.

See also the table on microscopic wood anatomy.



Firmiana papuana
transverse surface (×20)

Botany Deciduous, monoecious, small to medium-sized or occasionally fairly large trees, rarely up to 40 m tall; bole branchless for up to 20 m, up to 80(–100) cm in diameter, sometimes hoop-marked, buttressed up to 2 m high and up to 2 m wide; bark surface smooth, pale grey to grey or grey-green, inner bark pale straw-coloured to orange or brownish-yellow with distinct 'flames' of fibres; crown irregularly hemispherical. Leaves arranged spirally, simple, cordate to ovate, lobed or entire, palmately veined, with long petioles; stipules present. Flowers in an axillary panicle or raceme, unisexual, orange to purple or pinkish-mauve; perianth urceolate to tubular, 5-lobed, stellate hairy; androgynophore long. Male flower usually with 10 subsessile stamens and minute rudimentary ovaries. Female flower with large staminodes; carpels 5, conglutinate, each with 2 or 4 ovules, styles short. Fruit composed of up to 5 papery follicles, soon dehiscing along the inner suture and exposing the 1–2 glossy black or olive-green seeds attached at both sides of the suture. Seedling with epigeal germination; cotyledons emergent; hypocotyl elongated.

The trees show Aubréville's architectural model, characterized by a monopodial trunk with rhythmic growth and whorled plagiotropic branches. In Peninsular Malaysia *F. malayana* trees are leafless for 6–8 weeks during which they flower and fruit. Flowering trees are very conspicuous because of the brilliant orange masses of flowers, and somewhat resemble *Erythrina*. Pollination is by birds. Fruits mature in only 4–5 weeks, and are dispersed by wind, spinning as they fall.

Ecology *F. malayana* grows particularly on river banks, in forest fringes and open forest, up to 1200 m altitude. In Peninsular Malaysia it is locally common in areas with a slightly seasonal climate (particularly in the north). In Sarawak it is uncommon and found on limestone hills. *F. papuana* occurs at 600–1200(–2500) m altitude, usually in lower montane forest on dry ridges.

Silviculture *Firmiana* may be raised from seed. There are about 7900 fresh fruits of *F. malayana* per kg. Due to the presence of tension wood, logs of *F. papuana* split readily upon felling.

Genetic resources and breeding In many areas *Firmiana* is uncommon. However, usually it is not cut under selective cutting systems because the timber is not valuable, although it might be cut to favour the growth of more valuable timbers. Altogether, its conservation status is uncertain.

Prospects The wood quality of *Firmiana* is ill-known; therefore, it is unlikely that it will gain importance as a timber. In Papua New Guinea *F. papuana* has no potential for timber as it is highly susceptible to sap-stain and to splitting when felled. *F. malayana* has potential as an ornamental.

Literature 61, 70, 163, 209, 300, 348, 402, 405, 464, 606, 611, 830, 888, 1221, 1232.

Selection of species

Firmiana malayana Kosterm.

Synonyms *Firmiana colorata* auct. non (Roxb.) R. Br., *Firmiana fulgens* auct. non (Wallich ex Mast.) Corner, *Sterculia colorata* auct. non Roxb.

Vernacular names Malaysia: anting melayu, kekabu hutan (Peninsular), mata lembu (Sarawak).

Distribution Peninsular Malaysia, Sumatra (rare), western Java and Borneo (Sarawak).

Firmiana papuana Mildbr.

Vernacular names Papua New Guinea: lacewood (En).

Distribution New Guinea.

E. Boer (general part),
R.H.M.J. Lemmens (general part, selection of species)

Flindersia R. Br.

Flinders, Voy. Terra austr. 2 (App. 3): 595 (1814).

RUTACEAE

$x = 18$; *F. schottiana*: $2n = 36$

Vernacular names Papua New Guinea: silkwood (En).
- Hickory ash (En): *F. ifflaiana*.
- Scented maple (En): *F. laevicarpa*.
- Silver ash (En): *F. amboinensis*, *F. schottiana*.
- Silkwood maple, Queensland maple (En): *F. brayleyana*, *F. pimenteliana*.

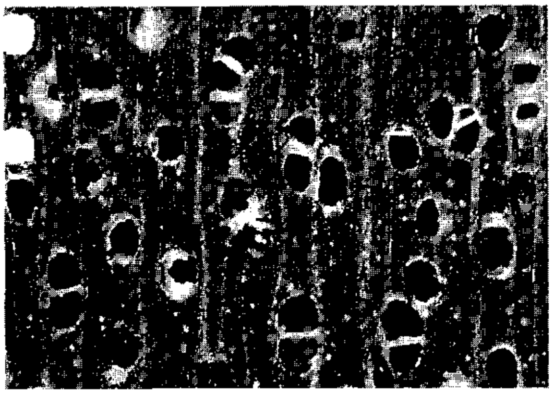
Origin and geographic distribution *Flindersia* comprises 17 species occurring in the Moluccas (Seram and Tanimbar Islands), New Guinea, New Caledonia and eastern Australia. Most of the species are found in eastern Australia; only 5 are present in the Malesian region. The Australian species *F. brayleyana* has been introduced into Peninsular Malaysia, Hawaii and tropical Africa.

Uses The wood of *Flindersia* has been used for general construction, fine finish, mouldings, bent work, boat building, aircraft construction, oars, cooperage, furniture, cabinet work, dowels, joinery, wall panelling, doors, framing, flooring, cladding, lining, tool handles, turnery and sporting goods. It is also suitable for the production of veneer and plywood. The wood is especially suitable for purposes where great strength and toughness is required. There are fairly large differences in density between the individual species, hence their application differs as well. 'Hickory ash' is especially suitable for gymnasium floors and has been applied as mine timber and for railway sleepers. 'Scented maple' yields the heaviest wood and is used for high class cabinet work, decorative work, brush backs, linen boxes, turnery and stairs, but especially for ship and aircraft construction. 'Silver ash' is reported to be one of the best timbers for boat ribs, masts, oars and sculls. The comparatively lightweight 'silkwood maple' is used primarily for furniture and cabinet work, but is also suitable for rifle stocks, aircraft construction, cooperage, ruddles and joinery.

The sometimes coarse fruit rind has been used as a rasp.

Production and international trade Small amounts of *Flindersia* wood are imported into Japan from Papua New Guinea. In Papua New Guinea, the wood is ranked in MEP (Minimum Export Price) group 3, and saw logs fetched a minimum export price of US\$ 50/m^3 in 1992. In Australia and recently also in Papua New Guinea, the trade group 'silkwood' is subdivided into smaller groups as indicated above. In 1996 the export of hickory ash, scented maple, silkwood maple and silver ash logs amounted to about 500 m^3, 1000 m^3, 9600 m^3 and 4100 m^3 and at average free-on-board (FOB) prices of US\$ 93/m^3, 99/m^3, 100/m^3 and 109/m^3, respectively.

Properties *Flindersia* yields a lightweight to heavy hardwood with a density of 300–985 kg/m^3 at 12% moisture content. Heartwood white, pale yellow-brown, pale pink-brown or red-brown, not distinct from the up to 2.5 cm wide, white, pale pink or pale brown sapwood; grain fairly straight, occasionally wavy or interlocked; texture fine to medium and even; *F. brayleyana* and *F. pimenteliana* with figure and silky lustre; sometimes with sweet honey-like fragrance, *F. laevicarpa* with persistent almond scent; *F. ifflaiana* greasy to the touch. Growth rings indistinct or distinct as in *F. schottiana*, boundaries indicated by marginal parenchyma; vessels moderately small to medium-sized, solitary and in radial multiples of 2–4,



Flindersia brayleyana
transverse surface (×20)

seldom more, just visible to the naked eye, with white, pinkish-brown or yellowish deposits; parenchyma sparse, scanty paratracheal, apotracheal diffuse, and in marginal or seemingly marginal bands or irregularly spaced bands, only the banded parenchyma visible to the naked eye; rays very fine to moderately fine; ripple marks absent; some species with occasional traumatic axial canals.

Shrinkage upon seasoning is moderate to high and stock generally seasons well, but slowly. Only boards of *F. pimenteliana* with a relatively high density and interlocked grain warp when seasoned. The wood of most species is hard, strong, tough and elastic. It is generally easy to work with hand and machine tools, but interlocked grain may pick up in planing; the wood of *F. ifflaiana*, however, is rather difficult to work. It slices readily and glues well. The wood is very durable when not in contact with the ground. The heartwood is extremely resistant to impregnation with preservatives, the sapwood is permeable. The wood is susceptible to ambrosia beetles. The sapwood of *F. ifflaiana* and *F. schottiana* is susceptible to *Lyctus*; other species are non-susceptible. The wood of *F. laevicarpa* is moderately resistant to termite and marine borer attacks.

See also the tables on microscopic wood anatomy and wood properties.

Botany Small to large trees up to 45(–50) m tall; bole usually straight and cylindrical, branchless for up to 21 m, up to 100(–220) cm in diameter, sometimes with buttresses up to 2 m high; bark surface smooth to fissured, sometimes flaky, sometimes lenticellate, pale brown or mottled brown or grey, inner bark yellow, pink or red grading to whitish or pale yellow towards the cambium, often flecked with orange or red. Indumentum absent or composed of simple, stellate or scale-like hairs. Leaves alternate to opposite, simple to paripinnate or imparipinnate, with 1–8 pairs of opposite or subopposite and pellucid-dotted leaflets, exstipulate. Inflorescence terminal or in the upper leaf axils, paniculate. Flowers bisexual but often functionally unisexual, 5-merous; sepals free or connate at base; stamens opposite the sepals, anthers cordate, staminodes 5; disk present; ovary superior, 5-locular with 2–6 ovules per cell, style short. Fruit a septicidal capsule, the wall with coarse prickles or low mound-like protuberances. Seeds 2–6 per locule, with a terminal wing or winged all around.

F. schottiana develops according to Scarrone's architectural tree model, characterized by an indeterminate trunk bearing tiers of orthotropic branches, which branch sympodially as a result of terminal flowering. In a trial planting in Peninsular Malaysia *F. brayleyana* first flowered 25 years after planting. A 9-year-old *F. brayleyana* tree in the arboretum of the Forest Research Institute Malaysia, Kepong measured 10.4 cm in diameter. In trials in Australia the mean height and the mean diameter of 19-year-old trees were 15.2–16.7 m and 14.8–17.0 cm for *F. ifflaiana* and 16.8–18.3 m and 12.4–14.5 cm for *F. schottiana*, whereas the mean diameter of *F. brayleyana* was 19.3–19.8 cm.

F. laevicarpa has been divided into 2 varieties: var. *laevicarpa* is confined to Australia, var. *heterophylla* (Merr. & L.M. Perry) Hartley is found in New Guinea and Misool Island.

Ecology Timber-yielding *Flindersia* species are generally found scattered in well-drained evergreen rain forest or monsoon forest, from sea-level up to 2700 m altitude. *F. pimenteliana* seems to be best developed in regions with high rainfall (in Australia in areas with a mean annual rainfall of 1100–3800 mm) and relatively high temperatures (in Australia with a mean of 29–32°C in the hottest month and a mean of 10–17°C in the coldest month). It occurs on skeletal to deep loams and in montane forest it is sometimes associated with *Castanopsis* and *Lithocarpus*. *F. ifflaiana* occurs in monsoon forest in association with *Proteaceae*, up to 400 m altitude. *F. laevicarpa* often occurs on poorer clays of granitic origin or on red basaltic loams, in association with *Proteaceae*.

Silviculture *Flindersia* may be propagated by seed. Wildlings have been successfully used in Australia. There are about 13 500 dried seeds of *F. brayleyana* in one kg. After 8 years of storage in closed tins at −15°C, seeds of *F. brayleyana* had lost little of their original viability, but they rapidly deteriorate at room temperature. In Peninsular Malaysia seeds of *F. brayleyana* showed 90% germination within 1 week and this species has been used in line planting trials in old secondary growth. In Australia it also proved particularly suited for underplanting in natural stands in which the existing trees were gradually removed over a period of 5 years. Promising results were also obtained in a similar silvicultural system with *F. schottiana*, but *F. ifflaiana* grew too slowly to be of economic importance. In a monoculture of *F. ifflaiana* in Australia planted at 2.7 m × 2.7 m it developed multiple leaders and persistent branches. Both *F. brayleyana* and *F. schottiana* are considered to be late successional tree species.

Genetic resources and breeding Many *Flindersia* species are sought after and as they are comparatively rare and occupy only limited areas they may easily become endangered by logging.

Prospects *Flindersia*, and more in particular *F. brayleyana*, is suited for timber plantations, as is known from northern Australia. Silvicultural systems need to be developed and potential yield to be assessed.

Literature 40, 57, 121, 124, 125, 193, 300, 348, 360, 402, 411, 421, 436, 464, 487, 536, 555, 568, 571, 632, 658, 832, 1167, 1232.

Selection of species

Flindersia amboinensis Poir.

Synonyms *Flindersia macrocarpa* Lane-Poole ex C.T. White & W.D. Francis, *Flindersia radulifera* Spreng.

Vernacular names Silver ash (En). Indonesia: iskumun (Mejach, Irian Jaya), kayu parudan (Seram), sugwa (Manikiong, Irian Jaya).

Distribution The Moluccas (Seram & Tanimbar Islands) and New Guinea.

Flindersia brayleyana F. v. Mueller

Synonyms *Flindersia chatawaiana* F.M. Bailey.

Vernacular names Silkwood maple, Queensland maple (En).

Distribution Australia (Queensland and New South Wales); introduced in the early 1950s in trial plantings in Peninsular Malaysia and tropical Africa.

Flindersia ifflaiana F. v. Mueller

Synonyms *Flindersia brachycarpa* Merr. & L.M. Perry.

Vernacular names Hickory ash (En).

Distribution Southern Papua New Guinea and Australia (Queensland).

Flindersia laevicarpa C.T. White & W.D. Francis

Synonyms *Flindersia heterophylla* Merr. & L.M. Perry.

Vernacular names Scented maple (En).

Distribution New Guinea, Misool Island and Australia (Queensland).

Flindersia pimenteliana F. v. Mueller

Synonyms *Flindersia chrysantha* Merr. & L.M. Perry, *Flindersia mazlini* F. v. Mueller.

Vernacular names Silkwood maple, Queensland maple (En).

Distribution New Guinea and Australia (Queensland).

Flindersia schottiana F. v. Mueller

Synonyms *Flindersia pubescens* (F. v. Mueller) F.M. Bailey.

Vernacular names Silver ash, northern silver ash (En). Indonesia: fenum (Kebar, Irian Jaya), iskumun, mejernana (Mejach, Irian Jaya).

Distribution New Guinea and eastern Australia.

W.G. Keating (general part),
E. Boer (general part),
M.S.M. Sosef (selection of species)

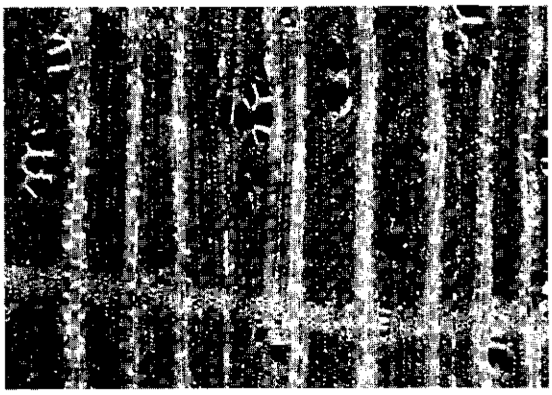
Galbulimima F.M. Bailey

Bot. Bull. Dept. Agric. Brisbane 9: 5 (1894).
HIMANTANDRACEAE
x = unknown; *G. belgraveana*: $2n = 24$

Vernacular names White magnolia (En, trade name).

Origin and geographic distribution *Galbulimima* comprises 2 closely related species. The only Malesian species is *G. belgraveana* (F. v. Mueller) Sprague (synonyms: *Himantandra belgraveana* (F. v. Mueller) F. v. Mueller ex Diels). It is found in the Moluccas, New Guinea and northern Australia (Queensland).

Uses The wood of *G. belgraveana* is used for light framing, moulding, dowels, interior trim, wall panelling, cabinet work, joinery, plywood,



Galbulimima belgraveana transverse surface (×20)

clog soles, boat building, fruit cases and brushware.
Leaves and bark contain alkaloids which are both narcotic and hallucinogenic, and are used in New Guinea in combination with the leaves of a *Homalomena* species (*Araceae*); the fruit has also narcotic properties and is chewed.

Production and international trade *Galbulimima* is a commercial timber in Papua New Guinea, but actual trade is very limited. In 1996 Papua New Guinea exported only 72 m^3 of 'white magnolia' logs at an average free-on-board (FOB) price of US$ 103/m^3.

Properties *G. belgraveana* yields a lightweight to medium-weight hardwood with a density of 370–680 kg/m^3 at 15% moisture content. Heartwood off-white to pale brown, sapwood white; wood with fragrant odour when fresh, rarely persistant in dry material. Vessels medium-sized, solitary and in radial multiples of 3–4(–6) or in irregular clusters; parenchyma apotracheal in narrow irregularly spaced bands, conspicuous; rays medium-sized; ripple marks absent.
Shrinkage upon seasoning is low. The wood is of moderate strength and hardness and non-durable. Its rotary peeling properties are good. It is probably moderately resistant to pressure treatment with preservatives. The sapwood is susceptible to *Lyctus*.
The fruits and other parts (e.g. leaves, bark) contain alkaloids and the family is one of the most alkaloid-rich groups among the Angiosperms.
See also the tables on microscopic wood anatomy and wood properties.

Botany An evergreen, small to fairly large tree up to 40 m tall; bole up to 100 cm in diameter, sometimes with buttresses; bark surface shallowly, irregularly fissured and ridged, or pustular, sometimes irregularly peeling, greyish-brown or brown and grey mottled, inner bark pale grey-brown becoming red-brown upon exposure, with a resinous smell. Twigs, petioles, lower leaf surfaces and inflorescences covered with peltate scales. Leaves alternate, simple, entire, exstipulate. Flowers on short axillary shoots, usually solitary, shoots with 2(–3) bracts; calyx calyptrate with the upper part deciduous; corolla calyptrate; narrowly lanceolate sporophylls (stamens) numerous, arranged spirally along the elongated receptacle, those towards the apex and base sterile; carpels many, free at first, later connate, ovules 1(–2) per carpel; style plumose. Fruit a fleshy syncarp with cartilaginous endocarp.
The generic name *Himantandra* was invalidly published and has been replaced by *Galbulimima*. *Galbulimima* is the only genus of the family *Himantandraceae*. This primitive family is closely related to *Annonaceae*, *Degeneriaceae*, *Eupomatiaceae* and *Magnoliaceae*. *G. baccata* F.M. Bailey, closely related to (and sometimes thought to be synonymous with) *G. belgraveana*, occurs in Queensland (Australia).

Ecology *G. belgraveana* is widespread and locally common in primary rain forest, occurring on hill slopes and ridges, up to 2700 m altitude, but mostly between 1000 m and 2000 m in montane forest in association with *Nothofagus*. Also common in *Fagaceae* (oak) forest.

Genetic resources and breeding There is little risk of genetic erosion of *G. belgraveana* at present, since it is widespread and locally common.

Prospects In Papua New Guinea there may be an increasing market for *G. belgraveana* wood for the production of wood-based panels, given its good bole form and rotary peeling qualities, and its availability.

Literature 74, 300, 313, 315, 348, 464, 496, 568, 861, 901, 1132, 1232.

E. Boer & M.S.M. Sosef

Ganophyllum Blume

Mus. Bot. Lugd.-Bat. 1: 230 (1850).
SAPINDACEAE
x = unknown; $2n$ = unknown

Vernacular names Mangir (trade name). Scaly ash (En). Indonesia: kayu mangir (Indonesian), ki angir (Sundanese), tapus (Sumatra). Malaysia:

panapok ayer (Dusun, Sabah). Philippines: arangen (general), lulibas (Tagalog), salngen (Iloko).

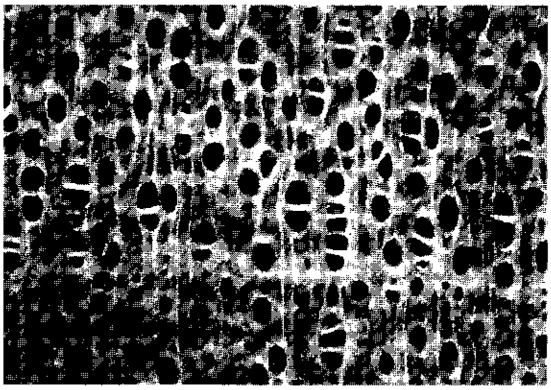
Origin and geographic distribution *Ganophyllum* comprises 2 species, one in West and Central Africa, the other, *G. falcatum* Blume (synonym: *Dictyoneura integerrima* Radlk.), is found from the Nicobar and Andaman Islands, throughout the Malesian region towards the Solomon Islands and northern Australia.

Uses The strong and fairly durable wood of *Ganophyllum* is used for house and bridge construction, scantlings, lining, light framing, panelling, flooring, door and window frames, furniture, cabinet work, moulding, boat building (decking, planking), poles for transmission lines, fresh and salt-water piling, railway sleepers, mine timber, vehicle bodies, striking tool handles, sporting goods (e.g. badminton rackets), pestles, archery bows, brush ware, clog soles, toys, match splints and matchboxes, pattern making and turnery. It is suitable for the manufacture of plywood, face veneer, and pulp and paper. It has been used for fuel.

The wood and the bark contain saponin and have been used to make soap, against head lice and as a fish poison. The sawdust has been proven to be an appropriate medium for oyster mushroom (*Pleurotus ostreatus* Fries) cultivation. The seed yields a solid fat used for illumination and to make a hard soap.

Production and international trade *G. falcatum* is generally traded in mixed consignments of medium-weight hardwood. Small amounts are occasionally imported in such consignments into Japan from Papua New Guinea and the Solomon Islands. In 1996 Papua New Guinea exported 2785 m^3 of 'scaly ash' logs at an average free-on-board (FOB) price of US\$ 100/m^3.

Properties *G. falcatum* yields a medium-weight to heavy hardwood with a density of 650–1000 kg/m^3 at 15% moisture content. Heartwood pale yellow-brown to pale brown, not clearly differentiated from the pale yellow-white to pale brown, 1.3–3.0 cm wide sapwood; grain usually straight, occasionally slightly interlocked; texture moderately fine and even; sometimes with slight flame figure on back-sawn face; fresh wood occasionally with unpleasant smell. Growth rings indistinct to very distinct; vessels very small to medium-sized, solitary and in radial multiples of 2–3, barely visible to the naked eye, chalky white deposits present; parenchyma paratracheal vasicentric tending to aliform and confluent, apotracheal in marginal or in seemingly marginal bands, or diffuse;



Ganophyllum falcatum
transverse surface (×20)

rays extremely fine to very fine; ripple marks absent to irregular.

Shrinkage of the wood is high, it seasons well, but checks negligibly when back-sawn. It takes about 8 weeks to air dry boards 25 mm thick from green to air dry, and 5–8 days to kiln dry them. The wood is moderately hard, strong and tough. It is usually fairly easy to saw and machine, but some trees are considerably harder than others. The peeling properties are good and the bond strength of both steamed and unsteamed veneer using casein glue meets standard requirements. The wood is durable under cover, but non-durable when exposed to the weather or in contact with the ground. The sapwood is permeable, the heartwood is extremely resistant to preservative treatment. The wood is resistant to dry-wood termites when under cover; the sapwood is non-susceptible to *Lyctus*. Sawdust and exudate from the wood may cause irritation to the eyes and throat whereas splinters may cause skin infection.

The energy value of the wood is 17 785 kJ/kg. Wood extractives have been proved to possess termiticidal activity.

See also the tables on microscopic wood anatomy and wood properties.

Botany A possibly monoecious, medium-sized to large tree up to 43 m tall; bole usually straight and cylindrical, sometimes poorly shaped with flutes or bosses, branchless for up to 30 m, up to 150 cm in diameter, sometimes with small, thick buttresses; bark surface scaly, red-brown to dark grey-brown or dark purple-brown, paler where it peels off in papery scales, inner bark pinkish to pale yellow or yellowish-brown; slash with some watery exudate; crown spreading. Twigs, leaves and inflorescence with glandular scales. Leaves

Ganophyllum falcatum Blume – 1, flowering twig; 2, female flower; 3, male flower; 4, fruit.

arranged spirally, paripinnate, (4–)5–8(–10)-jugate, exstipulate; leaflets alternate or rarely opposite, entire, distinctly oblique at base. Flowers in an axillary inflorescence, solitary or in cymules on racemoid branches, unisexual, male and female ones in different inflorescences; sepals (4–)5(–7), almost free to connate up to half of their length; petals absent; disk annular, short-haired. Male flower with 5(–7) stamens; pistillode well-developed. Female flower with a superior, 2(–3)-locular ovary with 2 ovules in each cell, style short, columnar. Fruit a 1–2-seeded drupe. Seed without arillode. Seedling with epigeal germination; cotyledons emergent; hypocotyl elongated; first 2 leaves opposite or subopposite, paripinnate, petiole and rachis channelled, subsequent leaves alternate, leaflets crenate, not or only slightly oblique at base.

Early growth is rapid with an average height of 8.2 m and an average diameter of 6.0 cm at the age of 2.5 years. When planted in a mixed plantation with *Tristaniopsis* at 1500 m altitude, growth was slower with an average height of 19 m and an average diameter of 22 cm at the age of 22 years. The main flowering period is from August to November. Flowers are pollinated by insects, probably bees. Fruits occur in November–March, and are eaten and dispersed by birds.

In the Philippines the name *Ganophyllum obliquum* (Blanco) Merr. has sometimes been applied erroneously to *G. falcatum*. The name actually refers to a species of *Dysoxylum* (*Meliaceae*).

Ecology *G. falcatum* is scattered in primary and secondary, evergreen to monsoon rain forest, sometimes in savanna vegetation or along forest edges, up to 700(–1200) m altitude. It is generally found in well-drained locations on clay, sand, or rocky soils overlying limestone but is also found on river banks, along the inner edge of mangrove forest and on floodplains. In Java it may be quite common in teak forest.

Silviculture *G. falcatum* can be raised from seed. The fruit pulp should be removed by maceration and the seeds dried. Fresh seeds have a germination rate of about 80% in 2–4 weeks. When stored under ambient conditions, viability drops fairly rapidly and seeds stored for 10 weeks have only 20% germination. Seedlings are not resistant to oxygen deficiency of the soil and die after 8 days. In a trial in West Java containerized planting stock of *G. falcatum* planted at 3 m × 1 m grew satisfactorily on only moderately fertile soil. It tolerated a fairly large amount of shade, but only a few stems were well-formed and most had overheavy branches. The canopy closed at the age of 2.5 years. On the basis of this trial it was recommended to use a spacing of 2 m × 1 m. For the production of sawn timber the estimated rotation is 100 years with an estimated annual production of 0.9 m^3/ha of sawn timber, 0.7 m^3/ha of wood for poles and 1.6 m^3/ha of fuelwood. *G. falcatum* is not fire-resistant.

Genetic resources and breeding There are no records of present-day ex situ conservation of *G. falcatum*. As it is quite common and relatively widespread there seems to be no risk of genetic erosion.

Prospects *G. falcatum* may have potential for increased use from natural sources. Its potential as a plantation crop deserves increased attention.

Literature 40, 70, 119, 124, 125, 161, 163, 260, 300, 302, 304, 340, 341, 346, 348, 405, 436, 464, 488, 533, 536, 595, 780, 861, 868, 908, 933, 934, 947, 1048, 1074, 1083, 1132, 1199, 1221, 1261.

U.A. Dasuki

Garcinia L.

Sp. pl. 1: 443 (1753); Gen. pl., ed. 5: 202 (1754).

GUTTIFERAE

$x = 8, 16$; *G. atroviridis* Griffith ex T. Anderson: $2n = 60$, *G. cowa*: $n = 26$, *G. hanburyi* Hook. f.: $2n = 44$, *G. hombroniana*: $2n = 48, 76$, *G. mangostana*: $2n = 56$–76, 88–90, 96, 98–110, 120–130, *G. nervosa*: $2n = 56$, *G. parvifolia*: $2n = 44, 72, 88$, *G. prainiana* King: $2n = 60$, *G. xanthochymus* Hook. f.: $2n = 72, 80, 96$

Vernacular names Kandis (trade name). Garcinia (En). Philippines: bunog. Thailand: cha muang. Vietnam: b[uws]a.

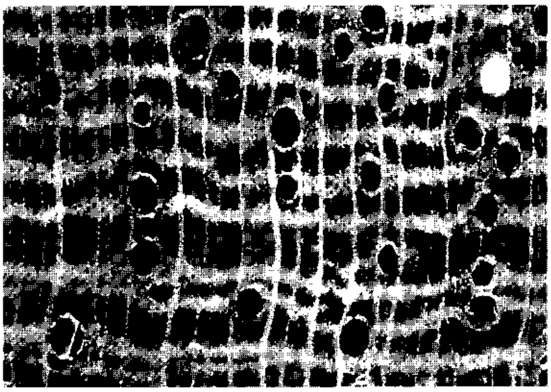
Origin and geographic distribution *Garcinia* probably comprises some 200 species, mainly in the Old World tropics and a few species in tropical America. South-East Asia is the main centre of diversity, with around 100 species.

Uses *Garcinia* is used for temporary construction, poles, interior trim, furniture and fencing. The heavier species are suitable for semi-permanent constructions, posts, beams, joists, rafters, bridge building, piling, flooring, paving blocks, vehicle bodies, shingles, tool handles, wooden pegs, rulers, turnery, chessmen and pallets. The wood yields a very good charcoal.

Several species are well-known fruit trees, the most important being the mangosteen (*G. mangostana*). Fruits of some species are sour and made into jams, used as a substitute for tamarind or to fix dyes. The rind of the green fruit is often dried and used as a condiment. The seed of some species contains an edible oil. The yellow latex of *G. hanburyi* from Thailand and *G. morella* (Gaertn.) Desr. from India is the source of 'gamboge' paint. Leaves of *G. cowa* can be eaten as a vegetable either raw or in curries and have a sour taste. A decoction of the roots of *G. hombroniana* is given after childbirth; both roots and leaves have been applied for itch.

Production and international trade *Garcinia* wood generally enters the market in mixed consignments of medium-weight hardwood. In 1992 only 116 m^3 of logs with a value of about US$ 50 000 was exported from Sabah. In 1996 the export of *Garcinia* logs from Papua New Guinea amounted to 30 000 m^3 with an average free-on-board (FOB) price of $98/m^3$.

Properties *Garcinia* yields a medium-weight to heavy hardwood with a density of 690–1120 kg/m^3 at 15% moisture content, although for *G. parvifolia* 410 kg/m^3 has also been recorded. Heartwood variable in colour, yellow in many species but red to dark red-brown in a few others (e.g. *G. hombroniana* and *G. malaccensis*), usually not clearly differentiated from the paler, rather wide sapwood, in *G. hombroniana* the red-brown sapwood is distinct from the dark red-brown heartwood; grain straight or slightly irregular; texture fine to moderately fine and even; parenchyma conspicuous in yellow timbers on tangential surface. Growth rings indistinct or visible due to colour differences or fewer parenchyma bands; vessels very small to medium-sized, solitary and in radial multiples of 2–5 and with occasional clusters, reddish-yellow gum deposits sometimes abundant, tyloses very rare; parenchyma moderately abundant to abundant, apotracheal in interrupted, narrow bands, and paratracheal vasicentric, aliform or confluent; rays very fine to medium-sized; ripple marks absent; radial canals observed in *G. cowa*.



Garcinia dulcis
transverse surface (×20)

Shrinkage of the wood when seasoned is high to very high and it is susceptible to checking; backsawn boards are particularly likely to warp considerably. The wood is moderately hard to very hard and moderately strong to very strong. It is easy to saw and finishes well, but the harder timber is difficult to work and dulls cutting edges of tools. The wood is usually moderately durable but is very durable in some species like *G. ituman*. The heartwood is reportedly resistant to pressure treatment although for *G. latissima* a retention of about 320 kg/m^3 has been determined. The heartwood is moderately resistant to resistant to dry-wood termites. The sapwood is non-susceptible to *Lyctus* in some species but susceptible in others.

See also the tables on microscopic wood anatomy and wood properties.

Botany Evergreen, generally dioecious shrubs or small to medium-sized trees up to 25(–33) m tall; bole straight, branchless for up to 18 m, up to 60(–100) cm in diameter, occasionally with small buttresses, often knobbly; bark surface smooth to adherent scaly, dark brown or black, inner bark yellow, with often copious yellow or sometimes white exudate; crown dense, often narrowly conical. Twigs square. Leaves decussate, but successive pairs in 1 plane by torsion of the twig, simple, entire, clasping the twig at base and the uppermost pair concealing the terminal bud; stipules absent. Inflorescence axillary. Flowers solitary or in small clusters or occasionally short racemes, unisexual, 4–5-merous; sepals rather fleshy, persistent in fruit; petals rather fleshy, white, yellow or reddish. Male flower with many stamens which are united in 4–5 bundles or a lobed ring or in a central globose mass, anthers sessile, with 2 or 4 cells; ovary present or absent. Female flower with a superior, 4–5(–12)-locular ovary with a single ovule in each cell, stigma large and often conspicuous. Fruit a leathery to woody berry with 1 to several seeds, tipped with the stigmatic remains. Seed with arillode. Seedling with hypogeal germination; cotyledons not emergent; hypocotyl elongated; the shoot emerging from one end of the seed, the root from the other; first few leaves scale-like, all leaves decussate, conduplicate.

Trees show monopodial growth. Branches arise from the trunk at an acute angle, then curve horizontally or droop. Growth is generally slow. Young leaves are pink. Apomixis is common in *Garcinia*: many species can produce seed asexually as well as sexually. Polyembryony is also quite common. Wild species flower at night and have a characteristic strong odour. Nectar is secreted on stigmas and pollination is by insects; *G. hombroniana* is pollinated by *Trigona* bees. Flowering is seasonal, usually after a period of pronounced dry weather. In Peninsular Malaysia *G. parvifolia* flowers regularly in February–April, *G. hombroniana* from January to June. In Papua New Guinea *Garcinia* species flower in May–July. The flowering-to-fruiting period of unidentified *Garcinia* trees in Peninsular Malaysia is 2–6 months. Seed dispersal is among others by orang-utans.

Garcinia includes the former genera *Pentaphalangium*, *Septogarcinia* and *Tripetalum* and is placed in the subfamily *Clusioideae*. Together with the subfamily *Calophylloideae* it is sometimes regarded as a distinct family: *Clusiaceae*. A taxonomic revision of *Garcinia* was in progress at the time of writing, but until it is published the status of many species remains doubtful: estimates of the total number of species range from 100 to 400.

Ecology Wild *Garcinia* species are generally found scattered and are second storey trees of primary, lowland or, less often, montane rain forest, up to 900(–2100) m altitude. Some species may be encountered in secondary forest (e.g. *G. hombroniana*, *G. parvifolia*) where they may be gregarious. *Garcinia* generally occurs in well-drained habitats, but e.g. *G. bancana*, *G. maingayi*, *G. nigrolineata* and *G. parvifolia* have been reported from swamp forest as well. Several species grow on limestone soils.

Silviculture *Garcinia* can be propagated by seed, although vegetative propagation is also used for cultivated fruit species. *G. xanthochymus* has about 200 seeds/kg. The seed is considered 'recalcitrant' and thus sensitive to desiccation and chilling, and can only be stored for a few weeks. Many germination trials have been conducted on *Garcinia* species in Peninsular Malaysia. It appeared that a few species, including *G. mangostana*, started germinating after about 3 weeks and germination was completed about 2.5 months after sowing. In most species, however, germination did not start until after about 3 months and in some species was not completed until after 1.5 years. Usually, the germination rate is over 50% and there are indications that germination is enhanced by removing the arillode. In a 676 ha sample of rain forest in Peninsular Malaysia an average of only 2.3 *Garcinia* trees measuring over 40 cm in diameter per 100 ha was found. *Garcinia* is not fire-resistant and can stand considerable shade.

Genetic resources and breeding It is difficult to assess the risk of genetic erosion of *Garcinia* as no reliable taxonomic treatment is available. Some of the species presented below have a narrow geographical distribution and may be vulnerable due to destruction of their habitat. In Songkhla, southern Thailand, 118 accessions belonging to 8 *Garcinia* species are maintained for their horticultural value.

Prospects Those *Garcinia* species with very hard and durable wood have potential for specialty use, but very little is known of their silvicultural aspects.

Literature 40, 61, 70, 150, 151, 162, 163, 193, 209, 235, 259, 264, 267, 300, 304, 348, 396, 436, 464, 536, 543, 595, 628, 657, 668, 672, 694, 696, 704, 713, 740, 741, 770, 785, 800, 829, 831, 852, 861, 889, 934, 935, 936, 1023, 1032, 1038, 1164, 1218, 1221, 1239, 1242, 1248, 1259.

Selection of species

Garcinia archboldiana A.C. Smith
Distribution Papua New Guinea.

Garcinia bancana (Miq.) Miq.
Synonyms *Garcinia curtisii* Ridley.
Vernacular names Banca mangosteen (En). Brunei: manggis hutan. Indonesia: katuri, kelabang, selapan (Sumatra). Malaysia: chempurah (Peninsular), sebalau (Rejang, Sarawak).
Distribution Peninsular Malaysia, Singapore, Sumatra, Bangka and Borneo (Brunei, Sarawak).

Garcinia beccarii Pierre
Synonyms *Garcinia forbesii* King, *Garcinia sizygiifolia* Pierre.
Vernacular names Ros kandis (En). Brunei: asam aur-aur. Indonesia: funi (Sula). Malaysia: asam kendong (Malay, Sarawak), kedang (Iban, Sarawak).
Distribution Peninsular Malaysia and Borneo.

Garcinia binucao (Blanco) Choisy
Synonyms *Garcinia duodecandra* Pierre.
Vernacular names Philippines: binucao (Tagalog), buragris (Bikol), haras (Panay Bisaya).
Distribution The Philippines.

Garcinia brevirostris R. Scheffer
Synonyms *Garcinia eugeniaefolia* Wallich ex T. Anderson, *Garcinia gitingensis* Elmer.
Vernacular names Malaysia: lulai (Peninsular). Philippines: ayusayan (Negrito), basal (Tagalog), batuhan (Cebu Bisaya).
Distribution Peninsular Malaysia, Singapore, Sumatra, Bangka and the Philippines.

Garcinia celebica L.
Synonyms *Garcinia fabrilis* Miq., *Garcinia jawoera* Pierre, *Garcinia rumphii* Pierre.
Vernacular names Indonesia: baros (Javanese), kirasa (Makassar, Sulawesi), manggu leuweung (Sundanese).
Distribution Sumatra, Java, Borneo, Sulawesi, the Lesser Sunda Islands and the Moluccas.

Garcinia cornea L.
Vernacular names Indonesia: husur (Ambon).
Distribution The Moluccas.

Garcinia cowa Roxb.
Synonyms *Garcinia lobulosa* Wallich ex T. Anderson, *Garcinia roxburghii* Wight, *Garcinia umbellifera* Roxb.
Vernacular names Cowa mangosteen (En). Burma (Myanmar): pala-kye. Thailand: mak mok (north-eastern), muang som (peninsular). Vietnam: tai chua.
Distribution India, Burma (Myanmar), Thailand and Peninsular Malaysia.

Garcinia dulcis (Roxb.) Kurz
Synonyms *Garcinia longifolia* Blume, *Xanthochymus javanensis* Blume.
Vernacular names Indonesia: mundu (general). Malaysia: mundu, munu (general). Philippines: taklang anak (general). Burma (Myanmar): madaw. Thailand: ma phut (peninsular).
Distribution Java, Borneo and the Philippines; widely cultivated throughout the Malesian region and occasionally in other South-East Asian countries.

Garcinia engleriana A.C. Smith
Distribution Papua New Guinea.

Garcinia hombroniana Pierre
Vernacular names Seashore mangosteen (En). Malaysia: beruas, buras, manggis hutan (Peninsular). Thailand: wa (peninsular).
Distribution The Nicobar Islands, Peninsular Thailand, Peninsular Malaysia, Singapore and Borneo (Sarawak).

Garcinia hunsteinii Lauterb.
Distribution New Guinea.

Garcinia idenburgensis A.C. Smith
Distribution New Guinea (Irian Jaya).

Garcinia ituman Merr.
Vernacular names Philippines: haras (Tagalog), ituman (Bisaya).
Distribution The Philippines.

Garcinia latissima Miq.
Synonyms *Pentaphalangium latissimum* (Miq.) Lauterb.
Distribution The Moluccas and New Guinea.

Garcinia macrophylla Miq.
Synonyms *Garcinia griffithii* T. Anderson var. *brevipetiolata* Boerl.
Vernacular names Indonesia: gelugur, gelugur babi, sibangor (Sumatra).
Distribution Sumatra.

Garcinia maingayi Hook. f.

Vernacular names Malaysia: kandis gajah (Peninsular).

Distribution Peninsular Malaysia and Borneo (Brunei, Sarawak).

Garcinia malaccensis Hook. f.

Vernacular names Malaysia: manggis burong, manggis hutan (Peninsular).

Distribution Peninsular Malaysia and Borneo (Brunei).

Garcinia mangostana L.

Synonyms *Mangostana garcinia* Gaertn.

Vernacular names Mangosteen (En), mangoustan (Fr). Indonesia: manggis (general). Malaysia: manggis (general). Philippines: manggis, manggustan (general). Burma (Myanmar): mingut. Cambodia: mongkhut. Laos: mangkhut. Thailand: mangkhut. Vietnam: c[aa]y m[aw]ng c[uj]t.

Distribution Possibly originally native in Peninsular Malaysia, but commonly cultivated for its fruit in Burma (Myanmar), Indo-China, Thailand and throughout the Malesian region, more recently also planted in India, Sri Lanka, northern Australia and tropical America.

Garcinia nervosa Miq.

Synonyms *Garcinia andersonii* Hook. f., *Garcinia spectabilis* Pierre.

Vernacular names Pear mangosteen (En). Indonesia: anglau (Simeuluë), selapan (Kubu). Malaysia: asam garam, kandis gajah, pokok lapan taun (Peninsular). Philippines: buradgis (Bikol), gatatan (Tagbanua), kabal (Tagalog). Thailand: cha muang nam, phut, ma phut pa (peninsular).

Distribution Thailand, Peninsular Malaysia, Singapore, Sumatra, Borneo and the Philippines.

Garcinia nigrolineata Planch. ex T. Anderson

Synonyms *Garcinia kunstleri* King.

Vernacular names Wild beaked kandis (En). Malaysia: kandis keling (Peninsular). Singapore: kandis hutan.

Distribution Burma (Myanmar), Indo-China, Thailand, Peninsular Malaysia and Singapore.

Garcinia pachycarpum (A.C. Smith) Kosterm.

Synonyms *Pentaphalangium pachycarpum* A.C. Smith.

Distribution New Guinea (Irian Jaya).

Garcinia parvifolia (Miq.) Miq.

Synonyms *Garcinia dioica* Blume, *Garcinia globulosa* Ridley, *Garcinia motleyana* Pierre.

Vernacular names Wild yellow kandis (En). Malaysia: kandis burung (Peninsular), kedui, sempat tebu (Iban, Sarawak).

Distribution Peninsular Malaysia, Singapore, Sumatra and Borneo.

Garcinia petiolaris Pierre

Synonyms *Garcinia densiflora* King, *Garcinia pyrifera* Ridley.

Distribution Peninsular Malaysia and Borneo (Brunei, Sarawak).

Garcinia picrorrhiza Miq.

Vernacular names Indonesia: sesoot (Ambon).

Distribution The Moluccas and New Guinea.

Garcinia salakensis Pierre

Synonyms *Garcinia boerlagei* Pierre.

Vernacular names Indonesia: curi (Sundanese).

Distribution Java.

Garcinia schraderi Lauterb.

Distribution New Guinea.

Garcinia venulosa (Blanco) Choisy

Synonyms *Garcinia blancoi* Pierre, *Garcinia calleryi* Pierre.

Vernacular names Philippines: gatasan (Filipino), bago-bago (Bisaya), bilukau (Tagalog).

Distribution The Philippines.

Garcinia warburgiana A.C. Smith

Synonyms *Garcinia novoguineensis* (Warb.) Warb. ex Lauterb. non Vesque, *Xanthochymus novoguineensis* Warb.

Distribution The Aru and Kai Islands and New Guinea.

Normah Mohd. Noor

Gardenia Ellis

Philos. Trans. 51: 953, t. 23 (1761).

RUBIACEAE

$x = 11$; *G. tubifera*: $2n = 22$

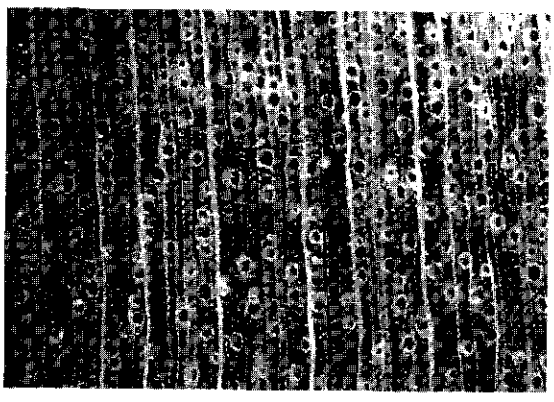
Vernacular names Malaysia: chempaka hutan, mentiong (Peninsular).

Origin and geographic distribution *Gardenia* comprises about 120 species and is distributed in Africa, and in India, Sri Lanka, Burma (Myanmar), Indo-China, southern China, Japan, Thailand and throughout Malesia, northern Australia and the Pacific islands. About 10 species occur within the Malesian region but only few reach timber size.

Uses The wood of *Gardenia* is suitable for turnery, carving, implements and specialty items such as mallet heads; it is locally used in house building.
Many species are beautiful ornamentals which flower profusely; both *G. carinata* and *G. tubifera* are planted along roads, in gardens and parks. Several species have significant medicinal value; the most important being the shrub *G. jasminoides* Ellis, the white gardenia, which is also much valued as ornamental and dye-producing plant. The fruits of some species (e.g. *G. carinata*) are edible.

Production and international trade *Gardenia* timber has no importance within Malesia, but in adjacent regions (e.g. in India and Thailand) it is occasionally traded commercially, e.g. as a substitute for boxwood (from *Buxus* spp.).

Properties *Gardenia* yields a medium-weight hardwood with a density of 630–830 kg/m^3 at 15% moisture content. Heartwood creamy-white to pale yellow-brown or pale brown, not distinct from the paler or straw-coloured sapwood; grain usually straight, occasionally irregular or wavy; texture very fine and even. Growth rings indistinct to sometimes distinct, boundaries indicated by denser wood with few vessels and without wood parenchyma; vessels very small to moderately small, predominantly solitary, indistinct to the naked eye; parenchyma rather sparse to moderately abundant, apotracheal diffuse, diffuse-in-aggregates less marked, and scanty paratracheal, indistinct with a hand lens; rays extremely fine to moderately fine; ripple marks absent.



Gardenia hansemannii K. Schumann
transverse surface (×20)

The wood is probably strong and durable under cover but only moderately durable when exposed to the weather or in contact with the ground. The sapwood is most probably non-susceptible to *Lyctus* due to the small size of the vessels.
See also the table on microscopic wood anatomy.

Botany Shrubs or small to medium-sized trees up to 25 m tall; bole up to 25(–35) cm in diameter; bark surface smooth to cracking or slightly scaly, sometimes lenticellate, greyish-brown, inner bark pale brown, shoots sometimes conspicuously resinous; young twigs and leaves often with a glossy wax-like layer. Leaves opposite or whorled, simple, entire or repand, usually obovate to elliptical, subsessile or stalked; stipules entire and connate into an amplexicaul ocrea or cup. Flowers solitary or sometimes in clusters, terminal, fragrant; calyx cylindrical, truncate or with 5–6(–10) linear lobes, sometimes ribbed; corolla with a long tube and 5–9 lobes, imbricate and contorted in bud, white to yellowish, often turning orange; stamens 5–9, anthers sessile, inserted below the sinuses of the corolla lobes; ovary inferior, unilocular with many ovules, style clavate. Fruit berry-like, globose to ellipsoid or obovoid, indehiscent but sometimes irregularly dehiscent (*G. tubifera*), with numerous seeds embbeded in a brightly coloured mass. Seedling with epigeal germination; cotyledons leafy, green.
The branching of the trees is sympodial, but *G. tubifera* develops according to Roux's architectural model, i.e. with a monopodial trunk showing continuous growth. Tree-like species can start flowering as early as about 3 years old. Most species can be found flowering and fruiting throughout the year. The fragrant flowers open during the night and are probably pollinated by moths; they last for about 3 days. The seeds are eaten and dispersed by birds and mammals such as squirrels which are attracted by the brightly coloured pulp.
Within the tribe *Gardenieae*, several genera which also have a unilocular ovary such as *Ceriscoides* and *Kailarsenia*, have recently been split off from *Gardenia*.

Ecology *Gardenia* trees are found in lowland and hill forest and can be locally common. *G. tubifera* occurs frequently on river banks near the coast.

Silviculture *Gardenia* may be propagated by seed. About 25% of the seeds of *G. carinata* germinated in 23–43 days after sowing. Seeds of *G. tubifera* have 55–90% germination with one seedlot germinating in 2–4 weeks, but another lot continued to germinate up to 9 months. *Gardenia* is comparatively immune to damage from grazing.

Genetic resources and breeding The tree-like *Gardenia* species seem not to be endangered or liable to genetic erosion because they are, at least locally, common and not much sought after for their timber. Moreover, they are rather commonly planted as an ornamental or a roadside tree.

Prospects *Gardenia* trees are usually too small to be of much importance for their timber. However, they might have good prospects for the production of wood for carving and turnery in combination with their great ornamental value.

Literature 70, 163, 209, 267, 348, 436, 527, 543, 715, 790, 810, 829, 831, 861, 1221.

Selection of species

Gardenia carinata Wallich ex Roxb.

Vernacular names Kedah gardenia (Fr). Indonesia: randa. Malaysia: chempaka tanjong, mentiong kedah, randa (Peninsular). Thailand: rak na, ranai, rattana (peninsular).

Distribution Thailand, Peninsular Malaysia; also planted as an ornamental elsewhere.

Gardenia longiflora S. Vidal

Vernacular names Philippines: balanigan (Tagbanua), kalumala, tapolau (Tagalog).

Distribution The Philippines.

Gardenia tubifera Wallich ex Roxb.

Synonyms *Gardenia elata* Ridley, *Gardenia resinifera* Korth.

Vernacular names Indonesia: cempaka hutan (Palembang, Sumatra), delima hutan (Bangka), piaweh (Simeuluë). Malaysia: delima hutan, mentiong bukit, randa burong (Peninsular). Thailand: champa (peninsular), phut pa (south-eastern), phut se (central).

Distribution Thailand, Peninsular Malaysia, Singapore, Sumatra and Borneo; planted in Java as an ornamental.

B. Ibnu Utomo W.

Garuga Roxb.

Pl. Coromandel 3: 5 (1811).

BURSERACEAE

$x = 13$; *G. gamblei*, *G. pinnata* Roxb.: $n = 13$

Vernacular names Kedondong (trade name). Garuga (En). Indonesia: kayu kambing (Sulawesi, Moluccas), ki langit (Sundanese), wiyu (Javanese). Papua New Guinea: garuga. Philippines: bogo (Filipino), burus (Iloko), (g)abilo (Tagalog).

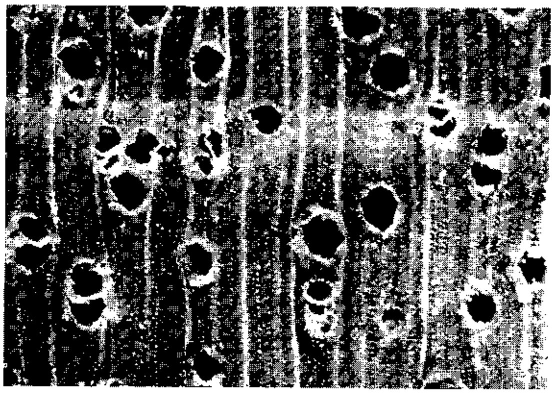
Origin and geographic distribution *Garuga* comprises 4 species, three of which are non-Malesian and occur from the Himalayas to Indo-China, southern China and Thailand. The only Malesian species is *G. floribunda* Decne (synonyms: *G. abilo* Merr., *G. littoralis* Merr., *G. pacifica* Burkill) which is found from the Himalayas to Bangladesh, south-western China, Hainan, throughout Malesia (except for Sumatra and very rare in Borneo (Sabah) and Peninsular Malaysia), the Solomon Islands, northern Australia, Vanuatu, Samoa and Tonga.

Uses The wood of *G. floribunda* is used for general construction, bridge building, posts, light duty flooring, furniture and cabinet work, interior trim, mouldings, shelving, skirting, sporting goods, agricultural implements, boxes and crates, carvings, toys and novelties, turnery and as a 'hot' firewood. It is also used for the production of veneer and plywood.

G. floribunda is occasionally planted as a shade tree. The leaves are used for fodder. A decoction of the bark has been given after childbirth. A decoction of the leaves has been used to dye mats made from *Corypha* leaves black. The fruit is edible.

Production and international trade *Garuga* timber is generally traded together with that of many other *Burseraceae* genera as 'kedondong', but comprises only a very small proportion of the total amount traded. *Garuga* timber sometimes enters the market in consignments of 'red canarium' (*Canarium* spp.). In 1996 Papua New Guinea exported about 1220 m^3 of 'garuga' logs at an average free-on-board (FOB) price of US$ 100/m^3.

Properties *G. floribunda* yields a medium-weight to heavy hardwood with a density of 500–900 kg/m^3 at 15% moisture content. Heartwood pale brown, pink-yellow-brown or dark red-brown, often with dark grey streaks or concentric bands, distinct from the up to 8 cm wide, pale yellow or pale yellow-green sapwood which turns greyish-brown upon drying; grain interlocked or sometimes wavy; texture moderately fine and



Garuga floribunda
transverse surface (×20)

even; wood slightly lustrous and with prominent 'ribbon' figure on radial surface due to interlocked grain. Growth rings indistinct; vessels moderately small to very large, solitary and in radial multiples of 2–3, sometimes in clusters of much smaller vessels, tyloses abundant and dark deposits present; parenchyma paratracheal vasicentric, but mostly indistinct or absent; rays moderately fine; ripple marks absent; radial canals containing dark gummy deposits clearly visible in the rays.

Shrinkage of the wood upon seasoning is low; it seasons well with little degrade and only slight end splitting. It is moderately hard and moderately strong. The wood is easy to saw and work with hand and machine tools. It can be planed to a relatively smooth finish but a reduced cutting angle is recommended to prevent grain picking up on the radial surface. The wood is slightly durable to non-durable. The sapwood is permeable to moderately resistant to pressure treatment, the heartwood is highly resistant. The wood is susceptible to dry-wood termites and liable to stain. The sapwood is susceptible to *Lyctus*.

See also the tables on microscopic wood anatomy and wood properties.

Botany A deciduous, small to medium-sized or occasionally fairly large tree up to 30(–40) m tall; bole usually straight, cylindrical, branchless for up to 12 m, up to 120(–225) cm in diameter, with buttresses up to 3 m high; bark surface with adhering scales, grey or grey-white, inner bark firmly fibrous, pink, with little clear, resinous exudate. Leaves arranged spirally, crowded at the apex of twigs, imparipinnate; stipules inserted on the petiole, caducous; leaflets 9–21(–31), subsessile, crenate-serrate; stipellae often present, caducous. Flowers in an axillary panicle, bisexual, 5-merous,

Garuga floribunda Decne – 1, leaf; 2, inflorescence; 3, sectioned flower; 4, infructescence.

with a cupular receptacle; sepals free; petals with inflexed tips; stamens 10, inserted on the margin of the receptacle; disk adnate to the receptacle, 10-lobed; ovary superior, 5-locular with 2 ovules in each cell, stigma lobed. Fruit a fleshy, blue drupe with 1–5 1-seeded pyrenes. Seedling with epigeal germination; cotyledons emergent, palmately 3- or 5-lobed; hypocotyl elongated; first 2 leaves opposite and with 3 leaflets, subsequent leaves arranged spirally and with increasing number of leaflets.

Flowers appear before the new leaves. In general, flowering is at the end of the dry season or the beginning of the rainy season. In Java *G. floribunda* flowers in June–November and fruits in October–April; in Sulawesi it flowers in September and October; in the Philippines it flowers in March–June and fruits in March–October.

G. floribunda has been divided into 2 varieties. Var. *gamblei* (King ex J.J. Smith) Kalkman (synonym: *G. gamblei* King ex J.J. Smith) occurs in continental South-East Asia, whereas var. *flori-*

bunda is found from Peninsular Malaysia (rare) eastward towards Melanesia. In Malesian literature *G. floribunda* is commonly erroneously referred to as *G. pinnata*, which is a continental species.

Ecology *G. floribunda* occurs in seasonal climates in primary and secondary, often periodically dry or very dry monsoon forest and thickets, and in lower montane rain forest, up to 1200 m altitude. It is also found in coastal forest, teak forest and on limestone hills, and grows on stony, sandy or clayey soils.

Silviculture *G. floribunda* can be propagated by seed. There are 15 500–23 000 dry seeds/kg. It is not fire-resistant and can tolerate a periodically high groundwater table.

Genetic resources and breeding There are no records of *G. floribunda* in seed or germplasm banks. Trees are occasionally cultivated in botanical gardens.

Prospects *Garuga* will probably continue to make up part of the kedondong timber trade group.

Literature 40, 70, 125, 150, 151, 161, 163, 198, 260, 300, 304, 340, 341, 348, 405, 436, 464, 511, 536, 651, 740, 772, 780, 861, 906, 934, 974, 1023, 1048, 1181, 1221.

S. Sunarti

Gastonia Comm. ex Lamk

Encycl. 2: 610 (1786).

ARALIACEAE

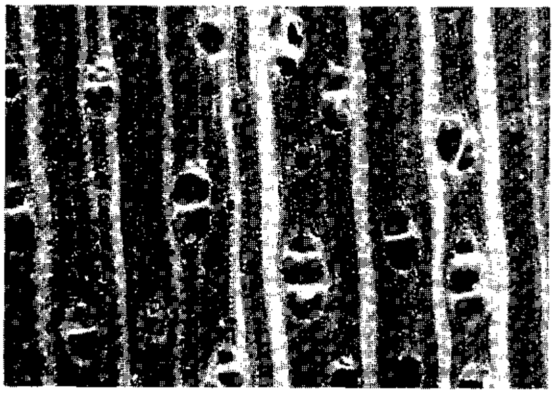
x = unknown; $2n$ = unknown

Vernacular names Indonesia: amoriga (Manikiong, Irian Jaya), jak (Karoon, Irian Jaya), tuyu (Mooi, Irian Jaya).

Origin and geographic distribution *Gastonia* comprises about 13 species occurring in East Africa, Madagascar, the Seychelles and Mascarenes, the Malesian region (in the Philippines only present on Palawan) and the Solomon Islands. Two species are found within Malesia and only one of these provides timber: *G. spectabilis* (Harms) Philipson (synonyms: *G. boridiana* Harms, *Peekeliopanax spectabilis* Harms) which occurs in New Guinea, the Bismarck Archipelago and the Solomon Islands.

Uses The wood of *G. spectabilis* is used for light carpentry, boxes and fencing. It has also been used as core stock material for plywood.

Production and international trade The wood of *G. spectabilis* is probably harvested on a local scale only.



Gastonia spectabilis
transverse surface (×20)

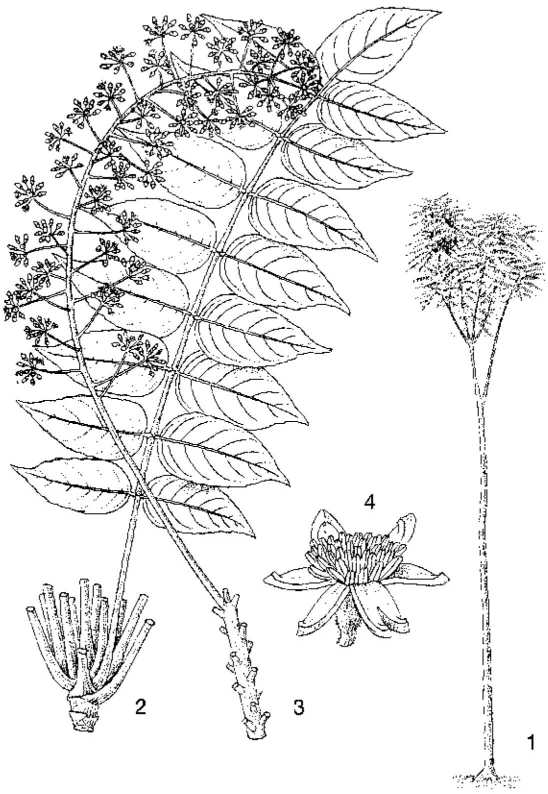
Properties *G. spectabilis* yields a lightweight hardwood with a density of 350–390 kg/m^3 at 11% moisture content. Heartwood white to creamy-white, not distinct from the sapwood; grain straight to occasionally wavy; texture moderately fine and even; wood highly lustrous. Growth ring boundaries absent; vessels medium-sized, just visible to the naked eye, solitary and in short radial multiples of 2–3 with clusters; parenchyma sparse, scanty paratracheal to vasicentric; rays medium-sized to moderately broad; ripple marks absent.

The wood is soft, splits easily and is liable to sap-stain.

See also the table on microscopic wood anatomy.

Botany A medium-sized to large tree up to 40 m tall; bole branchless for up to 28 m, up to 175 cm in diameter, sometimes with buttresses up to 1 m high and 2 m wide; outer bark with small shallow fissures and prominent lenticels, brown; exudate abundant, clear and aromatic; crown sparsely branched. Leaves arranged spirally, crowded at the end of branches, imparipinnate, exstipulate, large, the rachis articulated; leaflets crenate. Inflorescence axillary, situated well below the leaves on a strong peduncle. Flowers small, in umbellules arranged racemosely on whorled inflorescence branches, cream; calyx forming a straight rim; petals valvate, fleshy; disk fleshy; ovary inferior, (10–)16(–22)-locular with a single ovule in each cell, styles subulate. Fruit a dark red or red-brown berry with the calyx rim, disk and stigmas persistent.

G. spectabilis may be the largest araliad known. It develops according to Leeuwenberg's architectural



Gastonia spectabilis (Harms) Philipson – 1, tree habit; 2, leaf; 3, part of inflorescence; 4, flower.

tree model in which 2 or more orthotropic modules develop below an inflorescence and these are equivalent and determinate by terminal flowering. Several flushes of vegetative growth occur as an inflorescence matures, so that by anthesis it is situated well below the leaves.

Ecology *G. spectabilis* occurs in both primary and secondary rain forest at 200–2000 m altitude; also on cultivated and abandoned agricultural land.

Genetic resources and breeding It is unlikely that the use of the timber of *G. spectabilis* is leading to a decrease in genetic diversity.

Prospects The quality of the wood of *Gastonia* has never been fully studied and is little known, therefore it is very unlikely that its use will increase.

Literature 300, 341, 402, 403, 407, 423, 890, 1232.

E. Boer (general part),
M.S.M. Sosef (general part),
J. Ilic (wood anatomy)

Geijera Schott

Rutaceae: 7 (1834).
RUTACEAE
$x = 9$; *G. parviflora* Lindl.: $2n = 108, 162$

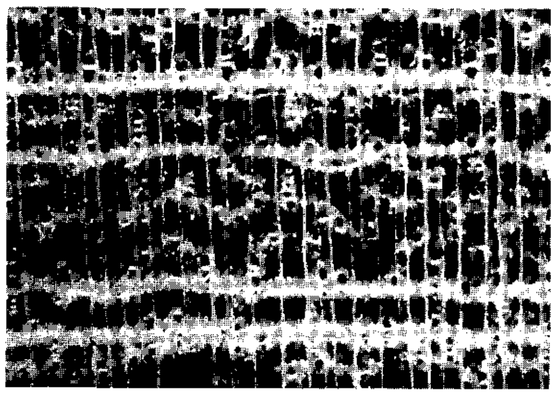
Vernacular names Green satinheart (En, trade name).

Origin and geographic distribution *Geijera* comprises about 7 species. A single species, *G. salicifolia* Schott, occurs in New Guinea, eastern Australia and New Caledonia, the others occur only in eastern Australia and New Caledonia.

Uses The wood of *G. salicifolia* is used for heavy construction, heavy flooring, scantlings, cross-arms, sills, bridge and wharf superstructure, boatbuilding, exterior decking, exterior joinery, bearings, railway sleepers and turnery. Because of its high density and resilience it is also suitable for specialty uses such as textile rollers, billiard cue butts, fishing rods, mallets, chisel and knife handles, engraving and precision equipment.

Production and international trade In 1996 Papua New Guinea exported only 160 m^3 of 'green satinheart' logs at an average free-on-board (FOB) price of US$ 101/m^3. Small amounts of the wood of *G. salicifolia* are traded in Australia.

Properties *G. salicifolia* yields a heavy hardwood with a density of 910–1140 kg/m^3 at 15% moisture content. Heartwood green-brown or yellow-brown with darker streaks, sapwood straw-coloured; grain usually straight; texture very fine and even; wood with leathery or lemon odour, greasy to the touch. Growth rings indistinct; vessels small, solitary and in radial multiples of up to 4, indistinct to the naked eye, with white deposits; parenchyma abundant, paratracheal vasicentric, aliform and confluent, and apotracheal in narrow



Geijera salicifolia
transverse surface (×20)

and irregularly spaced bands; rays fine and narrower than the vessels; ripple marks occasionally present.

Shrinkage upon seasoning is high and the wood is very hard, very tough, very strong and resilient. The wood is difficult to work but with care finishes smoothly to a lustrous surface. It has excellent turning properties and is very difficult to nail, rendering pre-boring essential. Wearing and weathering properties are rated as good. The wood is durable and can be used for exterior purposes. The heartwood is extremely difficult to impregnate, even under pressure. The wood is reported to be resistant to termites but the sapwood is susceptible to *Lyctus*.

See also the tables on microscopic wood anatomy and wood properties.

Botany A probably evergreen shrub or small to medium-sized tree up to 30(–38) m tall; bole irregularly cylindrical, branchless for up to 15 m, up to 100(–120) cm in diameter, not prominently flanged at base; bark surface peeling or shedding in coarse scales, bark with a strong, pleasant fruity odour; crown heavy, spreading. Leaves alternate, simple, elliptical to oblong, entire, with translucent dots, exstipulate. Flowers in a small, shortly stalked, terminal or axillary panicle, bisexual, 5–6-merous; sepals imbricate; petals valvate, white, the apex curved inward; disk prominent; ovary superior, consisting of completely united carpels, sunken in the disk, style short, stigma rounded. Fruit a 1–3-locular, leathery follicle or capsule, with 1-seeded endocarp. Seed with a shiny, black sarcotesta and resinous smell.

Ecology *G. salicifolia* is a subcanopy tree, rarely reaching the canopy layer. It occurs in monsoon forest and dry to wet lowland forest or lower montane rain forest from sea-level up to 1200 m altitude. It is more frequent in the drier habitats. In Papua New Guinea it commonly occurs in dry lower montane rain forest dominated by 'Klinkii pine' (*Araucaria hunsteinii* K. Schumann), or in association with *Firmiana* and *Pouteria* spp.

Silviculture *G. salicifolia* is a shade-tolerant tree.

Genetic resources and breeding Its restricted geographical distribution and its occurrence in primary forest conditions renders *G. salicifolia* vulnerable to genetic erosion through deforestation.

Prospects Its outstanding wood properties make *G. salicifolia* an interesting timber, but no silvicultural management techniques are available for this species. Therefore its increased utilization for purposes other than specialty products is not very likely.

Literature 280, 300, 321, 348, 423, 463, 464, 536, 568, 1139.

E. Boer & M.S.M. Sosef

Gironniera Gaudich.

Voyage Bonite, Bot. Atlas: t. 85 (1844).

ULMACEAE

$x = 14$?; *G. subaequalis*: $2n = 84$

Vernacular names Kasap (trade name). Rough laurel (En). Indonesia: ki bulu (Sundanese), siluk (Bangka, Sumatra). Malaysia: medang kasap (general), hampas tebu (Peninsular). Vietnam: ng[as]t.

Origin and geographic distribution *Gironniera* comprises 5 species occurring in Sri Lanka, the Andaman Islands, Burma (Myanmar), Indo-China, southern China, Thailand, throughout the Malesian region (except for eastern Java and the Lesser Sunda Islands), the Solomon Islands, Micronesia and Polynesia (Samoa, Fiji). All 5 species occur within Malesia.

Uses The wood of *Gironniera* is occasionally used for undercover elements in house building (planking, beams, flooring).

Production and international trade *Gironniera* wood is probably used on a local scale only.

Properties *Gironniera* yields a lightweight to medium-weight hardwood with a density of 390–750 kg/m^3 at 15% moisture content. Heartwood yellow-white, not clearly differentiated from the sapwood; grain straight; texture fine and even. Growth rings indistinct in *G. subaequalis*, distinct

Gironniera subaequalis
transverse surface (×20)

in *G. nervosa*, boundaries indicated by banded parenchyma; vessels moderately small to moderately large, solitary and in radial multiples of 2–3, open, occasional tyloses present; parenchyma moderately abundant, apotracheal in marginal or seemingly marginal bands in *G. nervosa*, conspicuous, paratracheal vasicentric, sometimes in short confluent layers, the latter type only visible with a hand lens; rays of 2 sizes, moderately fine to medium-sized, visible to the naked eye, and extremely fine, visible only with a hand lens; ripple marks absent.

The wood is reported to be liable to severe splitting when seasoned. It is soft to moderately hard, moderately strong and non-durable.

The average fibre length is 1.190–1.895 mm.

See also the table on microscopic wood anatomy.

Botany Evergreen, small to medium-sized or rarely large trees up to 40 m tall; bole straight, cylindrical, up to 60 cm in diameter, sometimes with buttresses; bark surface smooth to finely fissured or finely cracked, sometimes hoop-marked and lenticellate, greenish-grey to grey-brown or dark brown, inner bark fibrous inwards, granular outwards, usually pinkish. Innovations with normal and glandular hairs. Leaves alternate, simple, entire; stipules free but overlapping. Inflorescence axillary, 1–many-flowered, paniculate, racemose, thyrsoid or capitate, unisexual. Male flower sessile or short-stalked; perianth 5-lobed; stamens 5, anthers with an apical protuberance; pistillode developed to rudimentary. Female flower compressed; perianth lobes 4–5, usually unequal; staminodes absent; ovary superior, 2-carpellate but 1-locular with a single ovule, stigmatic arms 2, long. Fruit a compressed ovoid drupe, subtended by the persistent perianth, yellow or orange to red; endocarp stony. Seed without endosperm. Seedling with epigeal germination; cotyledons emergent, leafy; hypocotyl elongated; first 2 leaves opposite, subsequent ones alternate, young leaves toothed.

The new leaves and flowers are borne at regular intervals, during which the older leaves may fall so profusely that the tree is almost deciduous. They are able to produce flowers and fruits already in the sapling stage. Flowering and fruiting seem to be throughout the year. It is still uncertain whether the trees are dioecious or monoecious. Pollination is probably by wind. The brightly-coloured fruits are eaten and dispersed by birds.

Ecology *Gironniera* is often found gregarious or abundant in open country and secondary forest, occasionally also as understorey trees in primary forest, up to 1600 m altitude. It occurs on a wide range of soils, including limestone, rocky soils and sandy clay. In areas with a pronounced dry season it is mainly found in evergreen forest along streams.

Silviculture *Gironniera* can be propagated by seed. Pyrenes of *G. nervosa* show about 85% germination in 36–81 days, those of *G. parvifolia* Planch. germinate for about 65% in 46–68 days. A high proportion of the fruits may be sterile.

Genetic resources and breeding As the wood of *Gironniera* is seldom used and the trees are common, there seems to be no risk of genetic erosion.

Prospects The limited use of *Gironniera* timber is unlikely to change in the near future.

Literature 151, 163, 209, 267, 341, 436, 553, 829, 831, 861, 892, 1038, 1048, 1221, 1232, 1242.

Selection of species

Gironniera nervosa Planch.

Synonyms *Gironniera hirta* Ridley, *Gironniera penangiana* Gand., *Gironniera sponioides* Gand.

Vernacular names Common rough laurel (En). Indonesia: kayu bulu (Belitung), kayu ruas (Kalimantan), silep (Bangka). Malaysia: hugot-hugot (Dusun, Sabah), meparang kasap (Peninsular), selimpoh bukit (Sarawak). Thailand: cham (south-eastern), khenon khwai, khon non (peninsular).

Distribution Burma (Myanmar), Thailand, Peninsular Malaysia, Singapore, Sumatra and Borneo.

Gironniera subaequalis Planch.

Synonyms *Gironniera amboinensis* Lauterb., *Gironniera chinensis* Benth., *Gironniera sumatrana* Gand.

Vernacular names Greater rough laurel (En). Indonesia: bobohufeka (Manikiong, Irian Jaya), katul (Bulungan, Kalimantan), kayu gambir (Palembang, Sumatra). Malaysia: kuayun (Dusun, Sabah), medang belanak, medang berlapok (Peninsular). Vietnam: ng[as]t v[af]ng.

Distribution The Andaman Islands, Burma (Myanmar), Indo-China, southern China, Thailand and throughout the Malesian region except for eastern Java and the Lesser Sunda Islands.

E. Boer (general part),
M.S.M. Sosef (general part, selection of species)

Glenniea Hook. f.

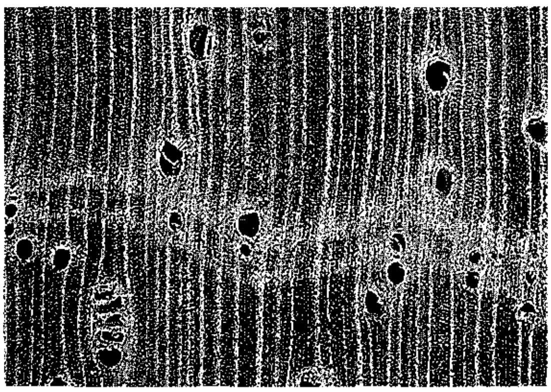
Benth. & Hook. f., Gen. pl. 1: 404 (1862).
SAPINDACEAE
x = unknown; $2n$ = unknown

Origin and geographic distribution *Glenniea* comprises 8 species, 3 of which are found in tropical Africa, 1 in Madagascar, 1 in Sri Lanka and 3 within the South-East Asian region in Vietnam, south-eastern Thailand, Peninsular Malaysia, Sumatra, Borneo, the Philippines and New Guinea.

Uses The wood of *Glenniea* is suitable for carving and fine furniture.
The bark is easily inflammable and used for kindling fires. *G. philippinensis* is a rare edible fruit tree.

Production and international trade *Glenniea* wood is probably used rarely and on a local scale only.

Properties *Glenniea* yields a medium-weight hardwood with a density of 630–705 kg/m³ at 15% moisture content. Heartwood pale yellow-brown or yellowish, not differentiated from the sapwood; grain straight; texture moderately fine and even; prominent vessel lines present as in *Pometia*. Growth rings distinct to the naked eye, boundary indicated by marginal parenchyma bands; vessels medium-sized, solitary and in radial multiples of 2–3, open or containing pale solid deposits; parenchyma moderately abundant, apotracheal in marginal or seemingly marginal bands, and paratracheal vasicentric, the latter form just visible to the naked eye; rays very fine to moderately fine, visible to the naked eye; ripple marks absent.
The wood is moderately hard and susceptible to sap-stain.



Glenniea penangensis
transverse surface (×20)

See also the table on microscopic wood anatomy.

Botany Monoecious or dioecious, small to medium-sized trees up to 36 m tall; bole straight, up to 70(–100) cm in diameter, fluted or sometimes with plank buttresses; bark surface smooth to slightly fissured, inner bark hard gritty, yellowish-brown. Leaves arranged spirally or partly decussate, unifoliolate or paripinnate, 1–6-jugate, exstipulate; leaflets opposite or alternate. Flowers in a terminal or axillary thyrse or panicle, unisexual, 4–5-merous; sepals connate at base, valvate to narrowly imbricate in bud; petals absent; stamens 6 or 7; disk annular; ovary superior, 2-locular with 1 ovule in each cell; style conical, stigma 2-lobed or grooved. Fruit a large berry. Seed without arillode. Seedling with hypogeal germination; cotyledons not emergent; hypocotyl not elongated; epicotyl strongly elongated and scaly; first 1–9 leaves simple and alternate-spiral, subsequent ones imparipinnate, followed by paripinnate ones.
Trees generally flower twice a year. Pollination is by insects, probably bees. The fruits are eaten and dispersed by birds and mammals.

Ecology *G. penangensis* and *G. thorelii* are found in primary lowland rain forest; the first up to 1000 m altitude, the second up to 200 m altitude on alluvial plains, river banks, slopes and ridges. *G. philippinensis* occurs in thickets and riverine forest at low altitude.

Silviculture *Glenniea* may be raised from seed. *G. penangensis* seeds show about 50% germination in 20–35(–124) days.

Genetic resources and breeding *G. philippinensis* is rare, whereas *G. penangensis* is endemic to Peninsular Malaysia. Both species are at risk of genetic erosion by habitat destruction.

Prospects Since the timber is seldom used and wood properties are poorly known the utilization of *Glenniea* is unlikely to increase in the near future.

Literature 151, 235, 267, 341, 686, 687, 829, 831, 934, 1048, 1164, 1221.

Selection of species

Glenniea penangensis (Ridley) Leenh.

Synonyms *Crossonephelis penangensis* (Ridley) Leenh., *Tristira penangensis* Ridley.
Distribution Peninsular Malaysia.

Glenniea philippinensis (Radlk.) Leenh.

Synonyms *Crossonephelis philippinensis* (Radlk.) Leenh., *Hedyachras philippinensis* Radlk.

Vernacular names Philippines: malachico, mamoko (Tagalog).
Distribution Vietnam, south-eastern Thailand, Borneo (Sabah) and the Philippines.

Glenniea thorelii (Pierre) Leenh.

Synonyms *Cnemidiscus thorelii* Pierre, *Crossonephelis palawanicus* (Radlk.) Leenh., *Lepisanthes palawanica* Radlk.
Vernacular names Philippines: Palawan sarakag (Negrito).
Distribution Southern Vietnam, Sumatra, Borneo (Kalimantan, Sabah), the Philippines (Palawan, Mindoro) and New Guinea.

E. Boer (general part),
M.S.M. Sosef (general part, selection of species)

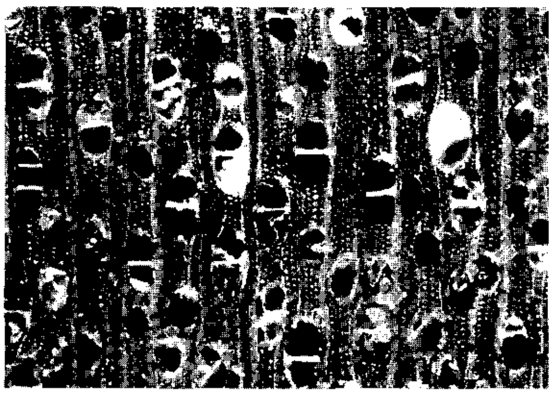
Glochidion J.R. Forster & J.G. Forster

Charact. gen. pl.: pl. 113, t. 57 (1775).
EUPHORBIACEAE
x = 13; *G. arborescens*, *G. velutinum* Wight: n = 26

Vernacular names Glochidion, pin-flower tree (En). Indonesia: dempul (Javanese), ki pare, ki timbel (Sundanese). Malaysia: obar nasi (Sabah), ubah, ubar (Peninsular). Philippines: bagna, salanisin (Filipino). Singapore: ubah merah. Thailand: khrai mot. Vietnam: b[oj]t [ees]ch, s[os]c.

Origin and geographic distribution *Glochidion* comprises about 280 species, most of which occur in the Old World tropics from India to Burma (Myanmar), Indo-China, southern China, Thailand, throughout the Malesian region, northern Australia and Polynesia. Few species are found in tropical America and Madagascar. Malesia harbours over 100 species.

Uses The wood of *Glochidion* is used to build native and temporary houses, mainly as poles and rafters, and for tool handles. In New Guinea it is used for light framing, flooring, moulding, interior trim and utility furniture. The trees yield a good 'hot' fuelwood and the boles have been used in mushroom cultivation.
The bark of several species has been used to tan fishing nets and also for fishing net floats. The leaves of several species are applied medicinally, e.g. in a decoction to treat stomach-ache, against diarrhoea and worms. The roots of *G. obscurum* have been applied similarly against stomach-ache. Young shoots of *G. borneense* are eaten as a vegetable.



Glochidion philippicum
transverse surface (×20)

Production and international trade Because the timber of *Glochidion* is generally of small size and supplies are limited, it is used mainly on a local scale. In 1996 Papua New Guinea exported only 34 m^3 of *Glochidion* logs at an average free-on-board (FOB) price of US$ 99/m^3.

Properties *Glochidion* yields a lightweight to medium-weight hardwood with a density of 440–890 kg/m^3 at 15% moisture content. Heartwood pale purple-grey-brown or red-brown, not clearly differentiated from the pale brown sapwood; grain straight; texture moderately fine and even. Growth rings indistinct, occasionally visible; vessels moderately small to medium-sized, mostly in radial multiples of 2–4(–more), occasional white deposits present; parenchyma sparse, paratracheal vasicentric, barely visible even with a hand lens; rays medium-sized, fairly conspicuous on radial surface; ripple marks absent. Intraspecific variation in wood anatomical characters is very large in *Glochidion*.
Shrinkage upon seasoning is moderate to very high, especially in the tangential direction. The wood is moderately hard and of low to medium strength. It is non-durable to moderately durable and pressure treatment is difficult. The sapwood is resistant to *Lyctus*.
See also the tables on microscopic wood anatomy and wood properties.

Botany Monoecious shrubs or small to occasionally medium-sized trees rarely up to 30 m tall; bole straight or sinuous, sometimes short, dividing low, up to 50(–70) cm in diameter, without buttresses; bark surface smooth to fissured or flaking, dark brown or grey-brown to blackish, inner bark soft, pale brown to purple or reddish, with a watery exudate. Leaves alternate, distichous, displayed in long sprays, simple, entire, often asymmetrical at base, with short petioles; stipules usually persistent. Flowers unisexual, in an axillary, unisexual or bisexual, small cluster below the leaves; sepals 4–6; petals absent; disk absent. Male flower with 3–8 stamens, filaments united into a column; pistillode absent. Female flower with a superior, 3–9-locular ovary with 2 ovules per cell, styles connate or rarely free, entire. Fruit a woody capsule, lobed or ribbed, splitting from the base upward, with persistent sepals and style. Seed with fleshy, red or orange sarcotesta. Seedling with epigeal germination; cotyledons emergent, leafy; hypocotyl elongated; leaves alternate or arranged spirally, conduplicate.

In secondary vegetation the mean annual diameter increment of *G. philippicum* for the diameter class 5–10 cm was 2 cm, which is very high. Trees develop according to Cook's architectural model, characterized by a monopodial trunk along which branches resembling compound leaves are produced continuously. *Glochidion* flowers throughout or several times a year. Pollination is by insects; seed dispersal presumably by birds.

Glochidion is closely related to and sometimes confused with *Phyllanthus*. Unlike the latter it has no disk glands but does have fused styles and colourful seeds.

Ecology *Glochidion* species are very common and characteristic elements of secondary forest and colonize cleared land, but also occur scattered in primary rain forest. They can be found in well-drained as well as swampy locations, from the lowland up to 2750 m altitude; most species show a comparatively wide altitudinal range.

Silviculture *Glochidion* can be propagated by seed and by cuttings; the latter have been used for the establishment of *Glochidion* as understorey crop in teak plantations. Seeds of *G. obscurum* still in their sarcotesta have about 60% germination in 12–49 days, whereas those of *G. sericeum* germinate for about 25% in 26–98 days. A top-boring *Rhodoneura* sp. has been observed on *Glochidion* sp., but damage seems to have been limited. Trees are not fire-resistant.

Genetic resources and breeding There are no records of *Glochidion* in germplasm banks. As most species occur commonly, they are unlikely to be endangered.

Prospects Those *Glochidion* species which are pioneers may prove useful in erosion control, but they have no outstanding wood qualities.

Literature 26, 27, 28, 30, 32, 33, 34, 36, 70, 101, 162, 163, 209, 238, 260, 267, 300, 348, 402, 436, 464, 484, 543, 829, 831, 860, 861, 974, 1038, 1195, 1221, 1222, 1242.

Selection of species

Glochidion arborescens Blume

Synonyms *Glochidion bancanum* Miq., *Glochidion silheticum* (Müll. Arg.) Croizat, *Phyllanthus arborescens* (Blume) Müll. Arg.

Vernacular names Indonesia: mareme gede (Sundanese), rebambong (Bangka). Malaysia: kayu ubah, pokok kerenam, ubah paya (Peninsular). Burma (Myanmar): yuandong.

Distribution India (Assam), Burma (Myanmar), peninsular Thailand, Peninsular Malaysia, Sumatra, Java and Borneo; possibly also in Sulawesi.

Glochidion borneense (Müll. Arg.) Boerl.

Synonyms *Glochidion microbotrys* Hook. f., *Glochidion trilobum* Ridley, *Phyllanthus borneensis* Müll. Arg.

Vernacular names Indonesia: dempul lelet (Javanese), mareme (Sundanese). Malaysia: obah nasi (Sabah).

Distribution Peninsular Malaysia, Sumatra, Java and Borneo.

Glochidion brunneum Hook. f.

Synonyms *Glochidion pedunculatum* Merr.

Vernacular names Malayan pin-flower tree (En). Malaysia: samak sebangau, ubah merah, ubah paya (Peninsular).

Distribution Peninsular Malaysia, Sumatra and Borneo.

Glochidion lucidum Blume

Synonyms *Phyllanthus lucidus* (Blume) Müll. Arg.

Vernacular names Mountain monkey apple (En). Indonesia: ki pare punung, mareme (Sundanese).

Distribution Peninsular Malaysia, Sumatra, Java, Sulawesi, the Moluccas (Morotai) and New Guinea.

Glochidion lutescens Blume

Synonyms *Glochidion breynioides* C.B. Rob., *Glochidion hypoleucum* (Miq.) Boerl., *Glochidion kollmannianum* (Müll. Arg.) J.J. Smith.

Vernacular names Blue-leaved pin-flower tree

(En). Indonesia: dempul lelet, kandri (Javanese). Malaysia: cheremai burong, rembang panas, ubah kechil (Peninsular). Philippines: salanisin (Bikol). Vietnam: b[oj]t [ees]ch b[owf] bi[eer]n, b[oj]t [ees]ch d[oo]i l[uw]ng b[aj]c.

Distribution Burma (Myanmar), Indo-China, southern China, Thailand and throughout the Malesian region.

Glochidion macrocarpum Blume

Synonyms *Phyllanthus macrocarpus* (Blume) Müll. Arg.

Vernacular names Indonesia: dempul lelet (Javanese), dulang-dulang rimba, kaleh bintungan (Sumatra).

Distribution Western Sumatra, Java, the Lesser Sunda Islands (subsp. *macrocarpum*) and New Guinea (subsp. *orientale* Airy Shaw).

Glochidion macrostigma Hook. f.

Synonyms *Glochidion capitatum* J.J. Smith.

Vernacular names Indonesia: cit manuk, dempul lelet (Javanese).

Distribution Peninsular Malaysia, Java and Borneo.

Glochidion obscurum (Roxb. ex Willd.) Blume

Synonyms *Glochidion glaucum* Blume, *Glochidion roxburghianum* Müll. Arg., *Phyllanthus obscurus* Roxb. ex Willd.

Vernacular names Yellow-leaved pin-flower tree (En). Indonesia: ki pare lalaki (Sundanese), uris-urisan (Javanese). Malaysia: cheremai antan, dulang-dulang, ubah paya (Peninsular). Thailand: khram, ma rua, ruat (peninsular). Vietnam: b[oj]t [ees]ch g[aa]n m[owf].

Distribution Burma (Myanmar), Indo-China, southern China, Thailand, Peninsular Malaysia, Sumatra, Java, Borneo and the Lesser Sunda Islands (Sumbawa); possibly also in Sulawesi.

Glochidion phellocarpum Airy Shaw

Vernacular names Indonesia: relai tolong (Sumatra).

Distribution Peninsular Malaysia and Sumatra; possibly also in Java.

Glochidion philippicum (Cav.) C.B. Rob.

Synonyms *Coccoglochidion erythrococcus* K. Schumann, *Phyllanthus philippensis* Müll. Arg.

Vernacular names Philippines: iba-ibaan (Tagalog).

Distribution Sumatra, Java, the Philippines, Sulawesi, the Lesser Sunda Islands, the Moluccas, New Guinea, the Solomon Islands and Australia (Queensland).

Glochidion pleiosepalum Airy Shaw

Distribution New Guinea (Irian Jaya).

Glochidion rubrum Blume

Synonyms *Glochidion cyrtostylum* Miq., *Glochidion leiostylum* Kurz, *Glochidion penangense* (Müll. Arg.) Airy Shaw.

Vernacular names Red-berried pin-flower tree (En). Indonesia: dempul lelet (Javanese), ki timbul (Sundanese). Malaysia: gambiran, senkam, tetimah (Peninsular). Philippines: bagnang-pula (Filipino). Thailand: chum set, khat na (peninsular). Vietnam: b[oj]t [ees]ch ven su[oos]i.

Distribution Burma (Myanmar), Indo-China, southern China, Thailand, Peninsular Malaysia, Singapore, Sumatra, Java, Borneo, the Philippines, Sulawesi and the Moluccas (Tanimbar Island).

Glochidion sericeum (Blume) Zoll. & Moritzi

Synonyms *Phyllanthus sericeus* (Blume) Müll. Arg.

Vernacular names Woolly pin-flower tree (En). Indonesia: mareme (Javanese). Malaysia: hujan panas puteh, kenidai bukit, sendarong (Peninsular).

Distribution Peninsular Thailand, Peninsular Malaysia, Singapore, Sumatra, Java and Borneo.

Glochidion stenophyllum Airy Shaw

Vernacular names Indonesia: katuk utan daun panjang, kayu kuda (Seram), malakoboliwi (Mooi, Irian Jaya).

Distribution The Moluccas and New Guinea (Irian Jaya).

Glochidion submolle (Lauterb. & K. Schumann) Airy Shaw

Synonyms *Glochidion magnificum* K. Schumann, *Phyllanthus submollis* Lauterb. & K. Schumann.

Distribution New Guinea.

Glochidion superbum Baillon. ex Müll. Arg.

Synonyms *Glochidion dasyphyllum* Miq. non K. Koch, *Phyllanthus superbus* (Baillon. ex Müll. Arg.) Müll. Arg.

Vernacular names Great-leaved pin-flower tree (En). Indonesia: muridung belukar (Indonesian, Palembang), repambong besar (Bangka), semunggak (Belitung). Malaysia: geremong betina, samak tebangau, temangau jantan (Peninsular, Sabah).

Distribution Peninsular Thailand, Peninsular Malaysia, Singapore, Sumatra and Borneo.

R.R.P. Irwanto

Gomphia Schreb.

Gen. pl., ed. 8: 291 (1789).
OCHNACEAE
x = unknown; $2n$ = unknown

Vernacular names Brunei: chenaga lampong (Iban). Indonesia: kayu ndolak (Batak, northern Sumatra), kayu sepat (southern Sumatra), tengkejing kering (Kalimantan). Malaysia: kelutan (Iban, Sarawak), magang-magang (Kadazan, Sabah), mata ketam batu (Peninsular). Philippines: minsaray (Mindoro), sasahit (Tagalog), simahima (Bikol). Cambodia: kongkea chhmôôl (general), ângkië sël (Kompong Thom), chiëm ântông (Koh Kong). Laos: huan² kouang, kouang non (Savannakhet). Thailand: hang kwang phu (north-eastern), kapito (south-eastern), thong pling (peninsular). Vietnam: c[aa]y d[ur]a b[aa]p, d[uj]c d[aj]c, mai c[as]nh l[owf]m.

Origin and geographic distribution *Gomphia* comprises some 30–36 species which, with one exception, are confined to tropical Africa and Madagascar. The only Asiatic species is *G. serrata* (Gaertn.) Kanis (synonyms: *Campylospermum serratum* (Gaertn.) Bittrich & M.C.E. Amaral, *G. sumatrana* Jack, *Ouratea angustifolia* (Vahl) Baillon & Lanessan) which occurs from Sri Lanka and India to Indo-China, southern China (Hainan), Thailand, Peninsular Malaysia, Singapore, Sumatra, Borneo, the Philippines and Sulawesi.

Uses The wood of *G. serrata* is used in house building (rafters, poles, planks) and has been used for boats, pumps and blocks.

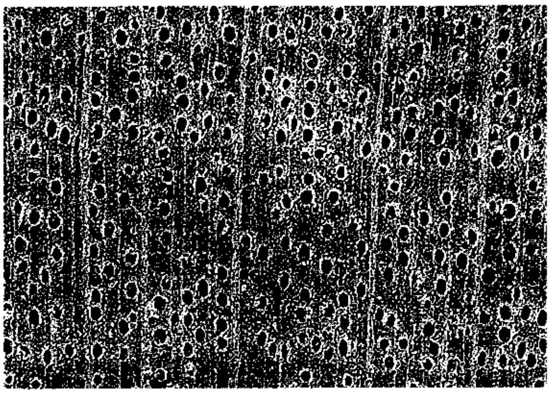
In Peninsular Malaysia the leaves are chewed by native people. In India a decoction of the bitter roots and leaves is applied medicinally as a stomachic and anti-emetic tonic. In Cambodia young branches are used against toothache.

Production and international trade The wood of *G. serrata* is used on a local scale only.

Properties *G. serrata* yields a medium-weight hardwood with a density of 830–870 kg/m³ at 15% moisture content. Heartwood dull red-brown or purple-grey-brown, not clearly differentiated from the sapwood; grain straight to shallowly interlocked; texture fine and uneven; wood with some silver grain. Growth rings indistinct; vessels very small to moderately small, solitary and in occasional radial or diagonal pairs, open; parenchyma moderately abundant, apotracheal diffuse to diffuse-in-aggregates, sometimes appearing as scanty paratracheal, indistinct even with a hand lens; rays of 2 distinct widths, extremely fine and medium-sized; ripple marks absent.

The wood is prone to splitting during drying. It is hard, strong and moderately durable.

See also the table on microscopic wood anatomy.



Gomphia serrata
transverse surface (×20)

Botany A small or medium-sized tree up to 25 m tall; bole up to 40 cm in diameter, slightly fluted at base; bark surface smooth or flaking into thin pieces, dark grey-brown, inner bark fibrous, pink. Leaves arranged spirally, simple, finely toothed, with 2–3 intramarginal veins; stipules united, early caducous. Flowers in an axillary or terminal panicle, 5-merous; sepals enlarged and persistent in fruit; petals yellow or cream; stamens 10, anthers opening by apical pores; gynophore columnar, ribbed; carpels 5, free but sharing a single style, each with a single ovule. Fruit with 1–2(–5) kidney-shaped drupelets, yellowish-green turning dark purple or blue-black when ripe.

In Borneo flowering and fruiting specimens have been collected throughout the year. Seed dispersal is probably effected by birds.

Gomphia belongs to the subfamily *Ochnoideae*. *G. serrata* shows considerable morphological variation, probably because of its wide ecological amplitude. It might be that the correct name for *G. serrata* is actually *Campylospermum serratum* which is related to the current issues concerning the correct typification of *Gomphia* and the distinction of *Campylospermum* from *Ouratea*.

Ecology *G. serrata* is found in primary and secondary, evergreen to semi-deciduous, lowland to submontane rain forest, up to 1500 m altitude, on well-drained infertile soils. It is confined to areas with an everwet to moderately dry monsoon climate, where it is found in a wide range of forest types including kerangas, mixed dipterocarp forest, limestone forest and peat-swamp forest.

Silviculture Attempts to propagate *G. serrata* by seed failed because of insect damage to the embryos in fresh fruitlets and to the few seedlings that germinated.

Genetic resources and breeding As *G. serrata* is not commercially exploited and has a wide ecological amplitude there is no risk of genetic erosion.

Prospects *G. serrata* is difficult to propagate from seed and it is unlikely that its timber will be increasingly used in the near future.

Literature 115, 198, 267, 341, 343, 436, 522, 523, 829, 831, 861, 1038, 1039, 1048, 1221.

K.M. Kochummen

Gonocaryum Miq.

Fl. Ind. Bat., Suppl. 1: 343 (1861).

ICACINACEAE

x = unknown; $2n$ = unknown

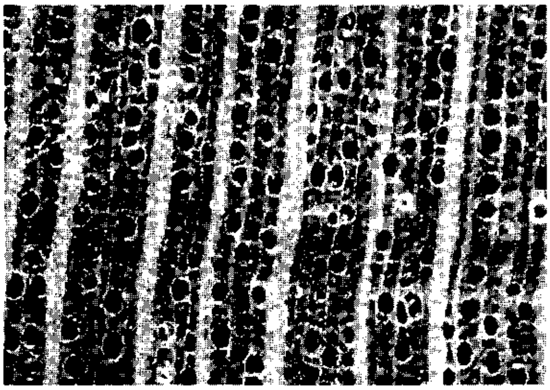
Vernacular names Philippines: taingang-babui (Filipino, trade name).

Origin and geographic distribution *Gonocaryum* comprises 9 or maybe 10 species occurring in Burma (Myanmar), Indo-China, south-eastern China, Taiwan, Thailand, throughout the Malesian region (except for Java and most of the Lesser Sunda Islands), east towards the Bismarck Archipelago.

Uses The wood of *Gonocaryum* is used in the Philippines for furniture and cabinet work, household utensils, bobbins, spindles and shuttles. It is suitable for veneer and plywood manufacturing.
In the Philippines wood of *G. calleryanum* is also used to produce charcoal, and the plant is said to be used as a medicine against stomach troubles.

Production and international trade In Papua New Guinea and the Philippines utilization of *Gonocaryum* wood is on a local scale only as supplies are small.

Properties *Gonocaryum* yields a medium-weight hardwood with a density of 615–820 kg/m^3 at 15% moisture content. Heartwood pinkish-buff, not sharply demarcated from the sapwood; grain straight; texture fine to moderately fine; wood with silver grain due to broad rays. Growth rings indistinct; vessels very small to small, barely visible to the naked eye, mostly solitary, radial pairs rare, open; parenchyma visible with a hand lens, apotracheal diffuse as dots or very fine lines between the rays; rays of 2 sizes, broad and conspicuous and fine; ripple marks absent.



Gonocaryum litorale
transverse surface (×20)

The wood seasons well and is moderately hard and moderately strong. It works and finishes well and is moderately durable for interior work, but non-durable when exposed to the weather or in contact with the ground. The heartwood is moderately resistant to dry-wood termites, the sapwood is susceptible to *Lyctus*.
See also the table on microscopic wood anatomy.

Botany Dioecious, small to medium-sized trees up to 15(–20) m tall; bole straight, branchless for up to 10 m, up to 30(–50) cm in diameter, slightly buttressed; bark surface greyish. Leaves arranged spirally, simple, entire, with a yellow and characteristically wrinkled petiole, exstipulate. Flowers in an axillary, interrupted, solitary or fascicled, sometimes elongated spike, or congested to a fascicle or glomerule, often on defoliated twigs, rarely on the trunk, unisexual, sessile or short-stalked; calyx deeply 5-lobed; petals 5, united, tip inflexed. Male flowers with 5 stamens connate to the petals for most of their length. Female flowers with a thin to inconspicuous disk; ovary superior, 2-locular (one cell empty), with 2 apical ovules, style short. Fruit a subglobose to ellipsoid drupe with few to many longitudinal ribs and a single seed. Seed with a thin testa. Seedling with hypogeal germination; cotyledons not emergent, hypocotyl not developed; epicotyl with a few scales; leaves appearing in flushes of 3–5.

G. litorale develops according to Nozeran's architectural tree model, which is determined by an orthotropic, sympodial trunk and inflorescences borne on the leafless parts of the branches which do not influence the tree architecture. In the Philippines *G. calleryanum* flowers in February and June to August. It bears fruit in April and August to December. Fruits are eaten by animals (e.g. deer).

Ecology *G. calleryanum* is found in primary and secondary forest, up to about 750 m altitude. It occurs in the subcanopy layer of dipterocarp forest and occasionally also in littoral forest, on clayey and volcanic soils. *G. litorale* is also found scattered but locally frequent in primary and secondary evergreen forest, up to 1200 m altitude (in Papua New Guinea up to 1650 m). It occurs in coastal and swamp forest, generally near rivers or temporarily inundated alluvial flats, on sandy and clayey soils.

Silviculture A germination rate of about 25% has been reported for fruits of *G. gracile* Miq., but germination did not start until after two years. Germination of *G. litorale* is also reported to be poor.

Genetic resources and breeding *Gonocaryum* is probably not subject to genetic erosion as the timber-yielding species have a fairly wide geographical distribution and are rarely harvested.

Prospects As supplies are small, no increase in the utilization of the wood is envisaged. Its suitability for the manufacturing of plywood and/or wood-based panels may attract more attention in the near future.

Literature 235, 238, 341, 402, 632, 780, 829, 831, 861, 934, 955, 1026, 1221, 1232.

Selection of species

Gonocaryum calleryanum (Baillon) Becc.

Synonyms *Gonocaryum diospyrosifolium* Hayata, *Gonocaryum tarlacense* S. Vidal, *Gonocaryum teysmannianum* R. Scheffer.

Vernacular names Philippines: taingang-babui (Filipino), malapinggan (Tagalog), malatapai (Bikol).

Distribution Southern Taiwan, Central Kalimantan (Sampit), the Philippines, North Sulawesi and the Moluccas.

Gonocaryum litorale (Blume) Sleumer

Synonyms *Gonocaryum affine* Becc., *Gonocaryum macrocarpum* (R. Scheffer) R. Scheffer ex Warb., *Gonocaryum pyriforme* R. Scheffer.

Vernacular names Indonesia: kartomadin (Aru Islands), kondo (Topadu, Sulawesi), rasui (Ambai, Japen Island).

Distribution The Lesser Sunda Islands (Timor), Sulawesi, the Moluccas, New Guinea and the Bismarck Archipelago.

R.E. Nasution

Gordonia J. Ellis

Phil. Trans., London 60: 518, t. 11 (1771).

THEACEAE

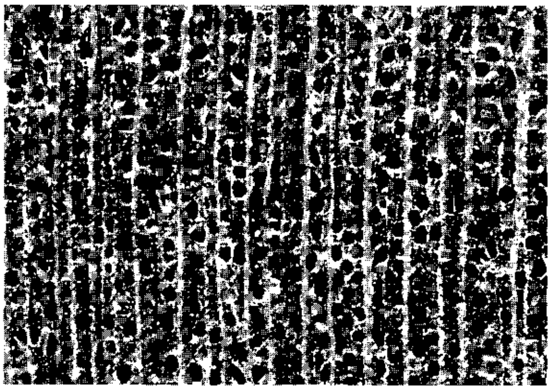
$x = 15$; *G. axillaris* (Roxb. ex Ker-Gawl.) Dietr.: $2n = 30$, *G. excelsa*: $2n = 30$

Vernacular names Samak (trade name). Gordonia (En). Malaysia: meluluk (Sabah), samak pulut (Peninsular), tekoyong-koyong (Sarawak).

Origin and geographic distribution *Gordonia* comprises about 70 species occurring in tropical Asia and tropical America with a single species in the south-eastern part of the United States. Some 40 species are Asian and are found in India, Sri Lanka, Burma (Myanmar), Indo-China, southern China, Taiwan, Thailand, throughout the Malesian region, east to the Bismarck Archipelago. Within Malesia 21 species are recognized, distributed as follows: Peninsular Malaysia 9 species, Sumatra 4, Java 2, Borneo 6, the Philippines, Sulawesi and the Lesser Sunda Islands 2, and the Moluccas and New Guinea 1 species.

Uses The wood of *Gordonia* is used for general construction under cover, e.g. door and window frames, flooring, planking, beams, weather boarding, mouldings, cheap furniture and brushware. A good-quality plywood can be manufactured from the wood and it is suitable for the production of particle board. The wood is also used as fuelwood and for the production of charcoal.

The bark yields tannin which has been used in Peninsular Malaysia to dye and tan fishing nets and rough clothing. The flowers of *G. excelsa* are used medicinally instead of those of *Schima wallichii* (DC.) Korth. subsp. *noronhae* (Reinw. ex Blume) Bloembergen, together with many other ingredients, in a draught applied after childbirth. The leaves are said to be boiled and used as a beverage to cure diarrhoea and dysentery. The bark of *G. amboinensis* has been used as a fish poison.



Gordonia amboinensis
transverse surface (×20)

Production and international trade 'Samak' is the trade name for timber of the genera *Gordonia*, *Adinandra* and *Schima*. Utilization is probably mainly on a local scale. In 1996 Papua New Guinea exported about 2300 m^3 of *Gordonia* logs at an average free-on-board (FOB) price of US$ 104/m^3.

Properties *Gordonia* yields a medium-weight hardwood with a density of 480–840 kg/m^3 at 15% moisture content. Heartwood yellow-rose, grey-brown, red-brown or red-brown with a purple tinge, not clearly differentiated from the paler sapwood; grain interlocked, occasionally straight; texture fine and even; brown silver grain often present. Growth rings mostly indistinct; vessels moderately small, typically angular, mostly solitary with radial pairs frequently showing radial or oblique divisions from perforation plates, occasionally with red-brown deposit; parenchyma sparse, apotracheal diffuse tending to diffuse-in-aggregates, hardly discernable; rays moderately fine, visible with a hand lens; ripple marks absent.
Shrinkage of the wood upon seasoning is high. It seasons readily and well with only slight surface and end checking. The wood is moderately hard and strong. It works fairly easy and planes to a smooth surface. It is moderately durable under cover. The heartwood is difficult to impregnate with preservatives and susceptible to shot-hole borer attack. The sapwood is non-susceptible to *Lyctus*.
See also the table on microscopic wood anatomy.

Botany Evergreen, small to medium-sized or rarely large trees up to 30(–50) m tall, rarely shrubs; bole straight or sometimes sinuous, branchless for up to 18(–27) m, up to 70(–130) cm in diameter, without buttresses, often spurred; bark surface fissured or irregularly flaky or scaly, greyish or brownish, mottled with pale patches, inner bark fibrous, red, red-brown or pink. Leaves arranged spirally, simple, entire or serrate, exstipulate. Flowers axillary, solitary or in a few-flowered fascicle, with bracts and bracteoles; sepals 5 or 6, persistent in fruit; petals 5 or 6, rarely 9 or 10, more or less unequal, usually connate at base; stamens many, in 3 or 4 whorls or indistinct fascicles, shortly connate at base and briefly adnate to the corolla; ovary superior, usually 5-locular with (2–)3–5(–8) ovules in each cell; styles 3 or 5, free or variably fused. Fruit a woody capsule, dehiscing with 5 valves from the apex to the base along a persistent column; seed with a unilateral wing. Seedling with epigeal germination; cotyledons emergent, leafy; hypocotyl elongated; all leaves arranged spirally.
A 43-year-old *G. multinervis* tree in the Arboretum of the Forest Research Institute Malaysia, Kepong attained 26 m in height and 34 cm in diameter. Flowering is generally seasonal and occurs once or twice a year. Flowers of *G. singaporeana* proved nocturnal with the corolla and stamens falling after flowering for 1 night. The fruits usually take 2–4 months to mature. The winged seeds are dispersed by wind.

Ecology Most *Gordonia* species are found in primary lowland evergreen rain forest to lower and occasionally upper montane forest, up to 1700(–2300) m altitude. They usually occur in well-drained sites in flat country but also on hillsides and ridges. Individual species have been reported from permanent and periodic swamp forest, kerangas, more open forest and old secondary forest. In Papua New Guinea *Gordonia* is common in the mixed monsoon forest of the Western Province.

Silviculture In the mountains of Java *G. excelsa* has been recommended as one of the large trees in mixed timber plantations. Natural regeneration of *G. excelsa* in montane forest can sustain in open areas as well as in dense shade.

Genetic resources and breeding Most *Gordonia* species do not seem to be at immediate risk of genetic erosion, but some of the rarer ones occurring in more specialized habitats, such as *G. grandiflora* and *G. hirtella*, may easily become endangered by habitat destruction.

Prospects As supplies are somewhat limited there appears to be little scope for increased utilization of *Gordonia* except on a local scale.

Literature 70, 75, 92, 101, 161, 163, 198, 209,

267, 300, 348, 436, 438, 542, 634, 701, 832, 861, 974, 1039, 1221, 1232, 1239, 1242.

Selection of species

Gordonia amboinensis (Miq.) Merr.
Synonyms *Gordonia brassii* Kobuski, *Gordonia papuana* Kobuski, *Gordonia rumphii* Merr.
Vernacular names Indonesia: adikelp (Yapen Island), kerkebo (Flores), reik (Biak).
Distribution The Lesser Sunda Islands (Bali, Flores), Sulawesi, the Moluccas, New Guinea and the Bismarck Archipelago.

Gordonia borneensis H. Keng
Vernacular names Indonesia: rawali batu (Kalimantan). Malaysia: obah (Sabah).
Distribution Borneo (Brunei, Kalimantan, Sabah).

Gordonia excelsa (Blume) Blume
Synonyms *Gordonia acuminata* Choisy.
Vernacular names Indonesia: ki manjel, ki sapi (Sundanese), madang kataping (Minangkabau, Sumatra).
Distribution Sumatra and Java.

Gordonia grandiflora Merr.
Distribution Borneo (Sabah).

Gordonia hirtella Ridley
Vernacular names Malaysia: medang lenggundi (Peninsular).
Distribution Peninsular Malaysia.

Gordonia integerrima (Miq.) H. Keng
Synonyms *Haemocharis integerrima* (Miq.) Koord. & Valeton, *Laplacea integerrima* Miq., *Laplacea serrata* (Koord. & Valeton) Melchior.
Vernacular names Indonesia: huru manjel, manjel (Sundanese).
Distribution Java, the Lesser Sunda Islands (Bali) and Sulawesi.

Gordonia luzonica S. Vidal
Synonyms *Gordonia benguetica* Burkill, *Gordonia fragrans* Merr., *Gordonia welbornei* Elmer.
Vernacular names Philippines: kalambug (Filipino).
Distribution The Philippines.

Gordonia marginata (Korth.) Endl. ex Walp.
Synonyms *Haemocharis marginata* (Korth.) O. Kuntze, *Laplacea marginata* (Korth.) Choisy.
Vernacular names Indonesia: penagit (Kalimantan).
Distribution Borneo (Kalimantan).

Gordonia multinervis King
Synonyms *Gordonia concentricicatrix* Burkill.
Vernacular names Malaysia: kelak merah, samak pulut, samak samak (Peninsular).
Distribution Peninsular Malaysia and Singapore.

Gordonia ovalis (Korth.) Korth. ex Walp.
Synonyms *Haemocharis aromatica* (Miq.) Szyszyl., *Haemocharis ovalis* (Korth.) O. Kuntze, *Haemocharis subintegerrima* (Miq.) Burkill.
Vernacular names Indonesia: pelempang putih (Sumatra).
Distribution Sumatra.

Gordonia sarawakensis H. Keng
Vernacular names Malaysia: entuyut (Sarawak).
Distribution Borneo (Sabah, Sarawak).

Gordonia singaporeana Wallich ex Ridley
Vernacular names Malaysia: kayu kelat asam, kayu kelat putih, sawak pulot (Peninsular).
Distribution Peninsular Malaysia and Singapore.

E. Boer (general part),
M.S.M. Sosef (general part, selection of species)

Grevillea R. Br. ex Knight

Cult. Prot.: 120 (1809).
PROTEACEAE
$x = 10$; *G. banksii*, *G. robusta*: $2n = 20$

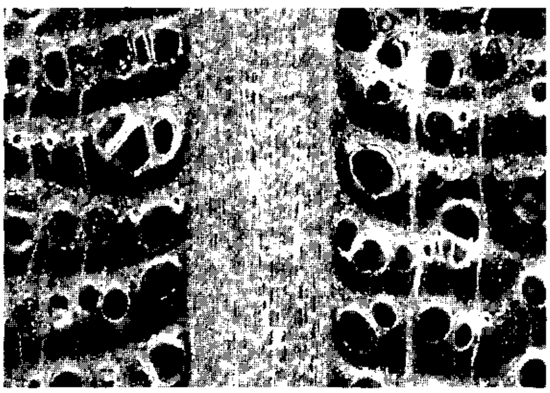
Vernacular names Silky oak (En, trade name), grevillea (En). Lacewood (Am).

Origin and geographic distribution *Grevillea* comprises about 270 species ocurring mainly in Australia, 9 occur in New Caledonia and 4 are native to the Malesian region. The latter are found in Sulawesi, the Moluccas and New Guinea. A few Australian species are cultivated within Malesia.

Uses The wood of *Grevillea* is used for light construction, boat building, interior trim, fine finish, furniture, cabinet work, parquet flooring, panelling, turnery, boxes, toys and novelties. It is also applied as decorative veneer and for the production of blockboard, particle board and hardboard, and is suitable as a pulpwood. It also yields a high-quality firewood, particularly in semi-arid regions.
G. robusta is a well-known auxiliary plant used widely throughout Asia and Africa in agroforestry systems (e.g. as a shade tree). It is also widely planted as an ornamental because of its attractive fern-like foliage and bright orange inflorescences. *G. banksii* is also planted as wind-break, for firewood, to provide fodder for goats, and as an ornamental.

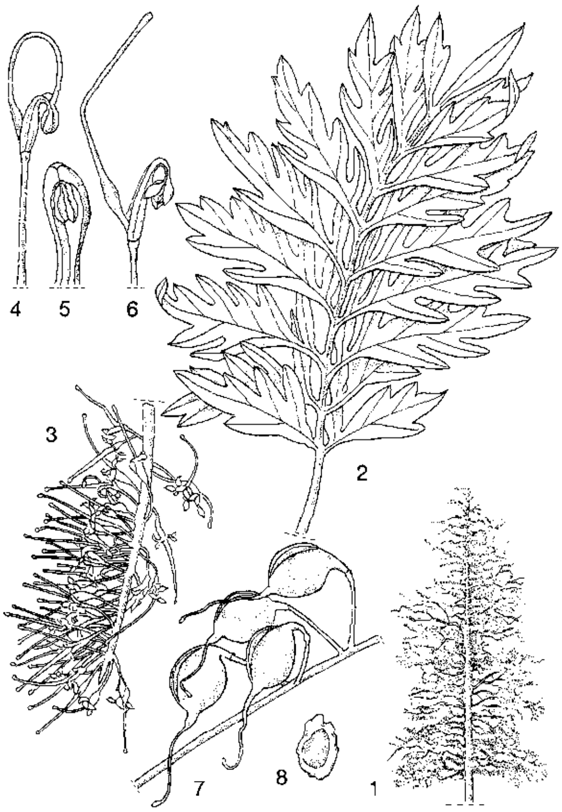
Production and international trade In 1996 only 58 m^3 of 'silky oak' logs were exported from Papua New Guinea at an average free-on-board (FOB) price of US$ 102/m^3.

Properties *Grevillea* yields a medium-weight hardwood with a density of 540–720 kg/m^3 at 15% moisture content. Heartwood pale pink-brown turning to yellow-brown or red-brown upon exposure, moderately clearly differentiated from the cream-coloured to pale pink, up to 4 cm wide sapwood; grain straight to wavy; texture medium to coarse and uneven; wood lustrous; prominent silver grain on radial surface. Growth rings indistinct; vessels moderately small to moderately large, solitary and in short radial multiples, in tangential arrangement, also in clusters, vessels with white, infrequent yellowish or pinkish to dark brown substances present; parenchyma apotracheal in narrow regularly spaced bands looping from ray to ray, paratracheal vasicentric, aliform or confluent; rays of 2 sizes, moderately fine and moderately broad to extremely broad, prominent on all surfaces; ripple marks absent; axial canals occasionally present.
Shrinkage upon seasoning is low to moderate; seasoning properties are rated from good to poor; wood air dries slowly. It has a tendency to warp and check and thick material should be air dried slowly followed by a mild kiln schedule to avoid honeycombing. When used as a firewood it needs only a few days drying. The wood is hard, of low strength, but elastic. It is easy to work with hand and machine tools but a cutting angle of 10° is required to obtain a good finish on quarter-sawn faces. Some fair-skinned people are allergic to the sawdust which can cause skin irritation. The wood can be peeled and sliced satisfactorily. It is moderately durable to non-durable and the heartwood of *G. robusta* shows an absorption of creosote of 128 kg/m^3 and 321 kg/m^3, respectively, when treated by the open tank method and pressure treatment. The wood is susceptible to marine borer, pinhole borer and termite attack. The sapwood is susceptible to *Lyctus*.
The gross energy value of *G. robusta* wood is about 20 400 kJ/kg. The average fibre length of *G. robusta* is 1.50–1.75 mm and it is suitable as a raw material to produce chemical pulp.
See also the tables on microscopic wood anatomy and wood properties.



Grevillea robusta
transverse surface (×20)

Botany Small to medium-sized shrubs or trees up to 25(–40) m tall; bole straight, branchless for up to 15 m, up to 80(–120) cm in diameter, usually without buttresses; bark surface fissured, sometimes pustulate, dark grey to dark brown, inner bark reddish-brown; crown conical, dense, with branches projecting upwards. Leaves arranged spirally to alternate, simple to pinnate with linear to pinnatifid segments, often dimorphous even within a single tree, exstipulate. Flowers in a terminal or axillary, simple or branched raceme, often in pairs, protandrous; tepals 4, united into a tube that is mostly recurved under the broadened apex (limb), eventually splitting open; stamens 4, sessile in the concave limb segments; disk annular or semi-annular, sometimes bi-lobed; ovary superior, 1-locular with 2 ovules, style curved and protruding from a slit in the perianth tube before the apex is free from the limb, eventually straight, persistent. Fruit a coriaceous to woody follicle, usually oblique and opening along the ventral margin. Seeds 1–2, flat, generally winged all around. Seedling with epigeal germination; cotyledons emergent; hypocotyl elongated.



Grevillea robusta A. Cunn. ex R. Br. – 1, tree habit; 2, leaf; 3, inflorescence; 4, 5, 6, flowers and flower parts; 7, fruits; 8, seed.

In its natural range *G. robusta* is semi-deciduous, shedding most of its leaves in the dry season. Trials in Java have confirmed that under suitable circumstances *G. robusta* may show an annual height and diameter increment of about 2 m and 2 cm, respectively, during the first 10 years. On the most favourable sites height increments of 3 m have been observed. In Thailand the average height and diameter 1 year after planting of *G. baileyana* are 0.5–1.6 m and 0.8–1.7 cm, respectively. It first flowers when about 6 years old; in October–November in its natural environment but sporadically throughout the year in equatorial latitudes. In Java *G. robusta* has mature fruits in September–January. The main flowering period of *G. banksii* in Australia is from August to October, whereas in Java and Peninsular Malaysia it flowers throughout the year. In Papua New Guinea *Grevillea* flowers mainly in April–September particularly in the monsoonal areas. It may produce viable seeds already when 3–4 years old. Flowers contain nectar and pollination is presumably by birds and/or arboreal marsupials (*Phalangeridae*). Seed dispersal is by wind. *Grevillea* is known to form vesicular-arbuscular mycorrhizae.

Grevillea belongs to the tribe *Grevilleeae* and is closely related to *Finschia* which differs mainly by the indehiscent fruits.

Ecology Malesian *Grevillea* species generally occur in dry savanna forest, up to 1800 m altitude. They are found on well-drained sites on slopes and ridges, but also along rivers, sometimes associated with *Melaleuca* or *Eucalyptus*. *G. baileyana* also occurs in monsoon forest.

Silviculture *Grevillea* can be propagated by seed and by vegetative techniques (cuttings, air layering). Wildlings of *G. robusta* are used by farmers as planting stock. *G. robusta* has 24000–110000 seeds/kg. Seeds can be stored for at least 2 years when dried to below 8% moisture content and stored cool (20°C or less). Seeds do not need a pretreatment before sowing and have 60–80% germination starting approximately 2 weeks after sowing. Seedlings are pricked out when their second leaf pair starts to develop. The fast-growing taproot needs to be pruned several times in the nursery. *G. robusta* is usually planted at 2.5–3 m × 3–4 m. The survival rate of *G. baileyana* 1 year after planting in a trial in Thailand was 56–73%. For optimal development *G. robusta* needs deep and loose soils and is not very demanding with regard to soil fertility. The relative open canopy of *G. robusta* plantations make it less suitable for areas with erosion hazard. *G. robusta* coppices poorly, but can be pruned and pollarded with good regrowth. It also easily regenerates naturally, especially in agricultural fields. Older trees are fairly resistant to frost and wind. For firewood production rotations of 10–20 years are applied and annual volume increments of 5–15 m^3/ha may be expected. A growth reduction after 20 years is reported for *G. robusta*. *G. robusta* is known to produce substances toxic to its own seedlings.

Genetic resources and breeding The Australian Tree Seed Centre of the Commonwealth Scientific and Industrial Research Organization (CSIRO) and the Queensland Forest Service have distributed seed from 27 natural provenances of *G. robusta*, covering the altitudinal and geographical range of sites where it occurs, for evaluation in other countries. *G. banksii* cv. Fosteri is a dense shrub planted in fences, whereas several hybrids of *G. banksii* are planted as an ornamental.

Prospects The conspicuous silver grain of *Grevillea* wood makes it attractive for decorative purposes. *G. robusta* has potential as a multipurpose tree in the highlands of South-East Asia.

Literature 124, 163, 193, 209, 238, 265, 300, 301, 304, 333, 341, 343, 348, 364, 403, 406, 418, 419, 436, 464, 488, 493, 536, 658, 660, 697, 736, 768, 817, 861, 896, 1177, 1199.

Selection of species

Grevillea baileyana McGill.

Synonyms *Grevillea pinnatifida* (F.M. Bailey) F.M. Bailey non Jacques.

Distribution Papua New Guinea and northern Australia (Queensland).

Grevillea banksii R. Br.

Vernacular names Banks' grevillea (En).

Distribution Native to northern Australia (Queensland); introduced into Indonesia, Malaysia, South Africa and Madagascar, naturalized in the latter.

Grevillea papuana Diels

Synonyms *Grevillea subargentea* C.T. White.

Distribution New Guinea.

Grevillea robusta A. Cunn. ex R. Br.

Vernacular names Silky oak, silver oak (En). Indonesia: salamandar (Sundanese). Burma (Myanmar): khadaw hmi. Thailand: son india (central). Vietnam: ng[aa]n hoa (northern), tr[ax]i b[af]n (southern).

Distribution Native to eastern Australia (Queensland, New South Wales); widely introduced into tropical and subtropical regions throughout the world.

W.G. Keating (general part),
E. Boer (general part),
M.S.M. Sosef (general part, selection of species)

Grewia L.

Sp. pl. 2: 964 (1753); Gen. pl., ed. 5: 412 (1754).
TILIACEAE

$x = 9$; *G. abutifolia* Vent. ex Juss.: $n = 9$, *G. asiatica*: $2n = 36$, *G. hirsuta* Vahl: $n = 9$, *G. laevigata*: $n = 9$

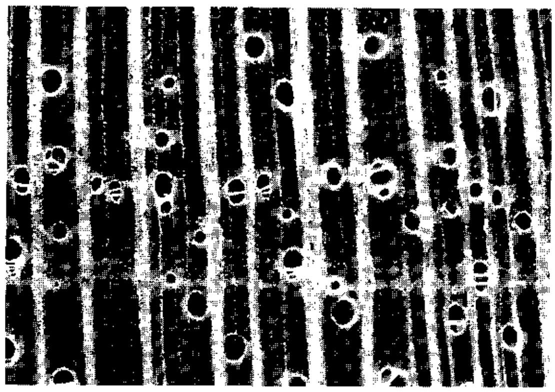
Vernacular names Indonesia: talok (general), darowak (Sundanese). Malaysia: chenderai (general), bunsi (Iban, Sarawak), damak-damak (Peninsular). Philippines: danglin (Filipino). Burma (Myanmar): tayaw. Thailand: po-lai, po-muen, yap. Vietnam: c[aa]y long man duc, c[of] ke.

Origin and geographic distribution *Grewia* comprises about 200 species and is confined to the Old World tropics. The genus extends north to the Himalayas, China and Taiwan, east to Tonga and Samoa and south to northern Australia. It occurs throughout the Malesian region where about 30 species are found.

Uses The wood of *Grewia* is generally used for small articles where toughness is required, like tool handles, spades, shafts of golf sticks, shoulder poles for carrying small loads, pestles, bows, billiard cues and shingles. In the Philippines it is regarded as a good substitute for 'lanutan' (*Hibiscus campylosiphon* Turcz.) used for vehicle bodies.
The fibrous bark is used to make ropes. The fruits of most species are edible; *G. asiatica* is a well-known fruit tree. The leaves of several species are used medicinally, chiefly for external applications.

Production and international trade As the size of the timber is generally small and the supply is limited, the wood of *Grewia* is used on a local scale only.

Properties *Grewia* yields a medium-weight to heavy hardwood with a density of 730–900 kg/m³ at 15% moisture content. Heartwood pale grey to pale brown, not sharply differentiated from the sapwood; grain interlocked; texture fine; wood with some silver grain. Growth rings indistinct, sometimes indicated by paler-coloured tissue; vessels very small to medium-sized, solitary, in radial multiples of 2–4 and in clusters, solitary vessels usually round and open; parenchyma paratra-



Grewia asiatica
transverse surface (×20)

cheal vasicentric, narrow, visible with a hand lens, and apotracheal in marginal or seemingly marginal bands; rays moderately fine to moderately broad, rather conspicuous on radial surface; ripple marks absent, although very fine ripple marks evident on radial surface due to storied parenchyma and fibres.

The wood seasons well. It is moderately soft to moderately hard, tough and moderately strong. The wood works satisfactorily with hand and machine tools. It is non-durable when exposed to the weather or in contact with the ground, but durable for interior use. Under cover, the heartwood is moderately resistant to dry-wood termites and the sapwood is susceptible to *Lyctus*.

See also the table on microscopic wood anatomy.

Botany Evergreen or deciduous shrubs or small trees up to 15 m tall or rarely climbers; bole frequently poorly shaped, up to 35 cm in diameter, without buttresses; bark surface smooth to shallowly fissured, sometimes obscurely hoop-marked, grey-brown, inner bark fibrous, pale cream. Indumentum of stellate and simple hairs. Leaves alternate, distichous, entire, serrate or double serrate, 3- or 5-veined from the base, often whitish below; stipules entire or divided. Flowers in axillary or sometimes terminal cymes arranged in panicles, 5-merous; sepals free; petals shorter than the sepals or sometimes absent, whitish or yellowish; stamens many, on a raised torus; ovary superior, (1–)2(–5)-locular with 2–8 ovules in each cell, style with a thickened or lobed stigma. Fruit a fleshy or pulpy drupe, usually 2–4-lobed, with 1–4 pyrenes containing 1–2 seeds. Seedling with epigeal germination; cotyledons emergent, leafy; hypocotyl elongated; all leaves alternate or sometimes the first pair subopposite.

Most of the species flower and fruit in the second half of the year, some bear flowers and fruits throughout the year. Maturation of the fruits takes about 1–2 months. The fruits are eaten by birds which may thus disperse the seeds.

Various authors disagree about whether the genera *Grewia* and *Microcos* should be united or kept separate. The main differences between the two are the unlobed stigma, the terminal paniculate inflorescence, the involucral bracts and the unlobed fruit of *Microcos* versus the thickened or lobed stigma, the often axillary inflorescence, the absence of involucral bracts and the usually lobed fruit of *Grewia*.

Ecology *Grewia* species are fairly common elements of the understorey of primary and secondary, deciduous or evergreen, lowland to montane forest, up to 1700 m altitude. They are also found in open dry deciduous forest, scrub vegetation, forest edges and hedges, where they may be encountered as pioneers. They occur on a wide variety of soil types.

Silviculture *Grewia* may be raised from seed, whereas *G. asiatica* can also be propagated vegetatively by cuttings, layering and budding. *G. eriocarpa* has been recommended for afforestation in the dry regions of the Lesser Sunda Islands, where it appears spontaneously in regenerating woodland. Its natural regeneration is generally good, but it is not resistant to fire.

Genetic resources and breeding *Grewia* species are generally not threatened by harvesting or cutting, as they are only seldom used, often occur in secondary vegetation and even exhibit a weedy nature. They are incidentally grown in botanical gardens.

Prospects *Grewia* wood is only used for special purposes and will remain important in this respect.

Literature 61, 70, 161, 163, 164, 188, 192, 209, 218, 235, 267, 436, 438, 672, 772, 780, 861, 887, 889, 934, 963, 974, 1038, 1039, 1164, 1169, 1221, 1222.

Selection of species

Grewia asiatica L.

Synonyms *Grewia conferta* Warb. ex Burret, *Grewia humilis* Wallich ex Mast., *Grewia vestita* Mast.

Vernacular names Phalsa (En). Philippines: bariuan-gulod (Tagalog). Cambodia: pophliě. Laos: nhap. Thailand: lai khon (central), po tao hai (northern), yap khee thao (eastern). Vietnam: c[of]-ke-[as].

Distribution Indigenous to the Himalayas, but widely cultivated for its edible fruits in India, Sri Lanka, Pakistan, Bangladesh, Thailand and the Philippines, where it is naturalized in Luzon.

Grewia eriocarpa Juss.

Synonyms *Grewia celtidifolia* Juss., *Grewia hypotephra* Pierre, *Grewia koordersiana* Burret.

Vernacular names Indonesia: talok, talok wingka (Javanese), tanglok (Madura). Philippines: bariuan (Iloko). Cambodia: bai kriem. Thailand: hang nok kaling (south-western), po kaen thao (north-eastern), po tao hai (northern).

Distribution From Bangladesh to Burma (Myanmar), Indo-China, Hainan and Thailand,

and in the Philippines, Java and the Lesser Sunda Islands.

Grewia laevigata Vahl

Synonyms *Grewia disperma* Rottl. ex Spreng., *Grewia glabra* Blume, *Grewia sepiaria* Roxb. ex G. Don.

Vernacular names Indonesia: kakeni (Sulawesi), torhoi (Sumatra), uris-urisan (Javanese). Burma (Myanmar): thayaw. Thailand: phaya daphak (peninsular), po huu (south-western), po khee kai (northern).

Distribution India, Nepal, Burma (Myanmar), Laos, Thailand and Java; possibly also in Sumatra.

Grewia rolfei Merr.

Synonyms *Grewia petitiana* Turcz., *Grewia rizalensis* Merr., *Grewia tilaefolia* Rolfe.

Vernacular names Philippines: maladanglin (general), bago (Bataan), bagokong (Tayabas).

Distribution The Philippines.

C. Phengklai

Gronophyllum R. Scheffer

Ann. Jard. Bot. Buitenzorg 1: 135 (1876).

PALMAE

x = unknown; $2n$ = unknown

Vernacular names Indonesia: nibung merah kecil, pingang salea, pinang utan buwah kecil (Ambon).

Origin and geographic distribution *Gronophyllum* comprises about 25 species distributed from Sulawesi, the Moluccas and New Guinea to the Bismarck Archipelago and northern Australia. New Guinea harbours most of the species. The wood of only a single species, *G. microcarpum* R. Scheffer from the Moluccas, has been reported to be used, but it is likely that various other, very similar species (e.g. *G. brassii* Burrett, *G. sarasinorum* Burrett) or other large palms like *G. chaunostachys* (Burrett) H.E. Moore and *G. ledermannianum* (Becc.) H.E. Moore are used for the same purpose.

Uses The bole is scraped and used for roofing in local house construction in the Moluccas and New Guinea.

The young leaf buds are edible and used as a vegetable. The small fruits can be used for chewing with 'betel pepper' (*Piper betle* L.) leaf and as a substitute for 'betel nut' (*Areca catechu* L.). The edible starch from the trunk is used as an emergency food and an edible sap is tapped from the inflorescence stalk. The leaf-sheath fibres are used for thatching.

Production and international trade Utilization of the wood of *G. microcarpum* is apparently very limited and on a local scale only.

Properties The wood is pale pink and hard. Traditionally, the smoke inside houses makes the wood very durable and hard.

Botany A monoecious, pleonanthic, unarmed, single-stemmed or clustered, small to large palm, up to 30 m tall; poles straight, up to 15(–30) cm in diameter. Leaves pinnate, sheaths with a crownshaft, leaflets few to many, linear-lanceolate to cuneate, apically acute, bifid or ragged truncate. Inflorescence borne below the leaves, solitary at each node, branching to 1–3 orders or rarely spicate, protandrous, with a prophyll and about equally large peduncular bract, rachis bearing whorled or decussate triads of flowers. Flowers unisexual, with 3 sepals and 3 petals, all free. Male flowers asymmetrical to a greater or lesser degree, with 6–9 stamens. Female flowers smaller than the male ones; ovary unilocular with a single ovule, stigmas 3. Fruit a drupe, smooth, with a thin epicarp, red to purplish black when mature. Seed laterally attached, with ruminate or homogeneous endosperm. Seedling with adjacent-ligular germination; eophyll bifid.

The staminate flowers reach anthesis soon after bract fall and are shed after 1 day. The next day the female flowers reach anthesis.

Gronophyllum is botanically poorly known and is in need of taxonomic revision. The formerly recognized genera *Leptophoenix* and *Nengella* are now included in *Gronophyllum*.

Ecology *Gronophyllum* species are found in a wide range of habitats, from lowland rain forest to montane mossy forest up to 2000 m altitude. They occur as elements of the understorey or canopy layer, scattered in almost pure stands, and on various soil types including limestone and ultrabasic soils.

Silviculture *G. microcarpum* can be propagated from seed which remains viable for only 2–3 weeks.

Genetic resources and breeding As *Gronophyllum* is botanically poorly known, it is not possible to assess the degree of threat with certainty, but the generally restricted areas of distribution of the now recognized taxa suggest a fair risk of genetic erosion.

Prospects The wood of *Gronophyllum* is rarely used and there seems no scope for increased utilization.

Literature 165, 166, 236, 326, 430, 436, 797, 1110.

E. Boer & M.S.M. Sosef

Guettarda L.

Sp. pl. 2: 991 (1753); Gen. pl., ed. 5: 428 (1754).
RUBIACEAE
x = unknown; *G. speciosa*: $2n = 44$

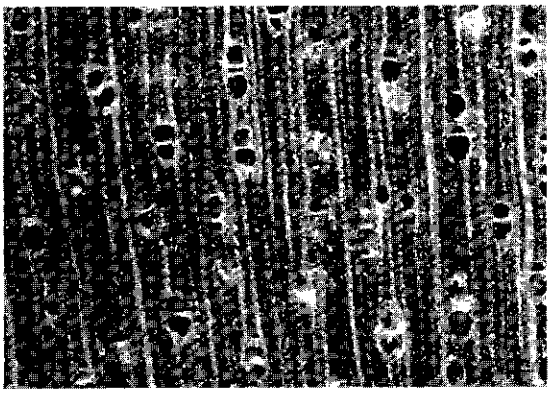
Vernacular names Sea randia (En). Indonesia: jati pasir, titi laut (Ambon, Moluccas), kenjang-kenjang (Madura). Malaysia: baru-baru laut, ketapang pasir, selar makan (Peninsular). Philippines: tabug (Ibanag, Sulu). Thailand: kadon, kong-kang huchang (south-eastern), sada (peninsular).

Origin and geographic distribution *Guettarda* comprises approximately 80 species, most of which occur in South and Central America, and New Caledonia. A few species are found in South-East Asia. Only *Guettarda speciosa* L. is widespread and occasionally considered as useful for its timber. It occurs from eastern Africa to the coasts and islands of the Indian and Pacific Oceans, and is found throughout Malesia.

Uses The timber of *Guettarda* is rarely used in South-East Asia. However, it is reported to be used in Fiji for house-blocks, which are considered very durable, and for heavy furniture.
The bark is used locally in Indonesia to cure chronic dysentery and has been applied to wounds and abscesses. The fragrant flowers are used in the Pacific Islands as decoration (garlands).

Production and international trade The wood of *G. speciosa* is probably used on a local scale only.

Properties *G. speciosa* yields a medium-weight hardwood with a density of 640–840 kg/m³ at 15% moisture content. Heartwood orange-brown, not distinct from the paler sapwood; grain slightly interlocked; texture very fine and even. Growth rings mostly indistinct; vessels solitary and in radial multiples of 2–4(–9), not visible to the naked eye; parenchyma absent to sparse, apotracheal diffuse; rays narrow to moderately wide and numerous; ripple marks absent.
See also the table on microscopic wood anatomy.



Guettarda speciosa
transverse surface (×20)

Botany A small tree up to 12(–18) m tall; bole often crooked and frequently many-stemmed, up to 30 cm in diameter; bark surface smooth or slightly rough, greyish-brown; twigs with large leaf scars. Leaves opposite, simple, entire, broadly obovate, rounded to cordate at base, blunt at apex, with short hairs below; stipules caducous. Flowers sessile, in an axillary, cymose inflorescence with long peduncle, fragrant; calyx cup truncate or undulate; corolla trumpet-shaped, whitish, silky pubescent outside, 4–9-lobed; stamens as many as corolla lobes, with sessile anthers inserted at corolla throat; ovary inferior, 4–9-locular with a single ovule in each cell, style slender, with a capitate stigma. Fruit drupe-like, depressed globose, slightly lobed, sessile. Seed strongly curved. Seedling with epigeal germination; cotyledons minute.
G. speciosa develops according to Aubréville's architectural tree model, characterized by a monopodial trunk with rhythmic growth, branches with rhythmic growth and modular, each branch plagiotropic by apposition. The tree flowers throughout the year. The flowers are heterostylous. They open about one hour after sunset and are probably pollinated by moths; the corollas fall off the next morning. The fruits are buoyant and dispersed by seawater, probably also by fruit-eating bats.

Ecology *G. speciosa* is a fairly common tree of sandy seashores and coral rocks, often within the reach of the highest tides. It is occasionally encountered in mangrove vegetation.

Silviculture *G. speciosa* may be propagated by seed. About 80% of stones collected from the ground germinated in 18–46 days after sowing.

Genetic resources and breeding *G. speciosa* is widespread, locally common, and is not easily liable to genetic erosion.

Prospects Increased utilization of the timber of

G. speciosa is not foreseen, because of its poor habit and ecological preference. However, wood tests are recommended to elucidate the conflicting reports on wood quality.

Literature 70, 163, 209, 267, 342, 402, 436, 716, 829, 831, 861, 1123, 1221, 1238.

H.C. Ong

Guioa Cav.

Icon. 4: 49, t. 373 (1798).
SAPINDACEAE
x = unknown; $2n$ = unknown

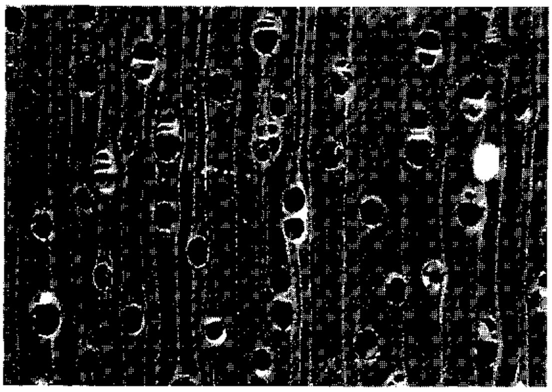
Vernacular names Malaysia: senyamok (Peninsular).

Origin and geographic distribution *Guioa* comprises 65 species which occur in peninsular Burma (Myanmar), Cambodia, southern Vietnam, Thailand, throughout the Malesian archipelago towards north-eastern Australia and into the Pacific, east to Samoa. It is a typical eastern Malesian genus with its centre of diversity in New Guinea (25 species). The distribution of species within the rest of Malesia is as follows: Peninsular Malaysia 4 species, Sumatra 4, Java 2, Borneo 6, Sulawesi 2, the Lesser Sunda Islands 1, the Moluccas 4 and the Philippines 12.

Uses The wood of *Guioa* is used for house construction, agricultural implements (wagon shafts, ploughs), tool handles (especially axe handles), and for firewood.
The arillode of the seed of several species is edible, but sour. Boiled roots of *G. diplopetala* have been used medicinally against blennorrhoea, i.e. a suppurating inflammation of mucous membranes, and those of *G. pleuropteris* against fever, stomach-ache and to exterminate intestinal worms. The seed oil of *G. koelreuteria* has been used in the treatment of certain skin diseases.

Production and international trade There are no records of the wood of *Guioa* being commercially traded. Its utilization is probably on a local scale only.

Properties *Guioa* yields a medium-weight hardwood with a density of 530–740 kg/m^3 at 15% moisture content. Heartwood pale brown with a pink or reddish tinge, not clearly demarcated from the sapwood; grain usually straight; texture fine and even. Growth rings distinct to the naked eye, boundaries indicated by the denser latewood and marginal parenchyma; vessels moderately small to medium-sized, solitary and in radial multiples of 2–3, occasional clusters in *G. bijuga*; parenchyma sparse, apotracheal in marginal or seemingly marginal bands, scanty paratracheal to vasicentric in *G. diplopetala*; rays extremely fine; ripple marks absent.



Guioa aryterifolia Radlk.
transverse surface (×20)

The wood is soft to hard and tough, and fairly strong. It is probably not very durable when exposed, but fairly durable under cover. It has been recorded as being resistant to termites, but contradictory statements are found in the literature. Its susceptibility to *Lyctus* is also indeterminable.
See also the table on microscopic wood anatomy.

Botany Shrubs or small to medium-sized trees up to 30 m tall; bole straight to crooked, up to 80(–130) cm in diameter, occasionally with buttresses; bark surface smooth to finely fissured, rarely deeply fissured or finely pustulated, flaky, whitish to dark grey with darker or lighter patches to red-brown, inner bark fibrous, whitish or yellow to red, pink or brown. Leaves alternate, paripinnate, 1–9-jugate, exstipulate; leaflets opposite or rarely alternate, lower surface usually with domatia along the midrib. Flowers in an axillary, few-flowered thyrse, seemingly bisexual but probably functionally unisexual, slightly zygomorphic; sepals 5(–6), free; petals (4–)5(–6), usually distinctly clawed, usually with scales on the inner side; disk entire to interrupted; stamens (7–)8; ovary superior, 3-locular with 1 ovule in each cell, style persistent in fruit, stigma sessile. Fruit a 3-lobed capsule with flattened lobes, red. Seed blackish-brown, completely enveloped by an orange arillode, dangling from the open fruit. Seedling with hypogeal germination; cotyledons borne at soil level, not emergent; hypocotyl not elongated; first pair of leaves opposite, paripinnate, with serrate leaflets, subsequent leaves

arranged spirally, rachis slightly winged.
A single tree of *G. pleuropteris* in the arboretum of the Forest Research Institute Malaysia, Kepong developed very slowly and measured only 9.9 m in height and 9.6 cm in diameter at the age of 19 years. Trees usually flower once or twice a year. Flowers appear in phases within the same inflorescence: the first phase being male, the second one being female, and the third phase occurring after fruit set and appearing hermaphrodite but in fact male. The latter phase probably provides most of the pollen for pollination, carried out mainly by *Trigona* bees. Fruits take 1–2 months to develop. The seeds are eaten and dispersed by larger birds like parakeets and pigeons.

Ecology *Guioa* species are fairly common elements of secondary forest but also occur in primary forest on ultrabasic soils, up to 1000(–1800) m altitude.

Silviculture *Guioa* can be propagated by seed, but longevity of the seed is probably low. The germination rate of *G. pleuropteris* is high: 90–100% may be achieved in 8–28 days. Seeds with the arillode still attached take slightly longer to germinate than those without.

Genetic resources and breeding There are no records of ex situ conservation, with the exception of some individual trees in botanic gardens. Since many of the species endemic to New Guinea have a narrow geographical distribution, they are vulnerable to genetic erosion or extinction by destruction of their habitat.

Prospects As *Guioa* wood is seldom used and not of high quality, it is unlikely that its utilization will increase in the near future.

Literature 150, 163, 209, 267, 341, 436, 672, 825, 829, 831, 832, 861, 934, 974, 1038, 1048, 1152, 1221, 1232.

Selection of species

Guioa bijuga (Hiern) Radlk.

Synonyms *Guioa pleuropteris* (Blume) Radlk. var. *bijuga* (Hiern) King.

Vernacular names Indonesia: kayu asibang, kayu pinggul-pinggul, kayu si margalagala (Sumatra). Malaysia: bengkulat (Dusun Labuk, Sabah), ilat (Iban, Sarawak). Philippines: busikag (Sulu).

Distribution Thailand, Peninsular Malaysia, Singapore, Sumatra, Borneo and the Philippines (Palawan).

Guioa diplopetala (Hassk.) Radlk.

Synonyms *Guioa bullata* Radlk., *Guioa fuscidula* (Kurz) Radlk., *Guioa squamosa* Radlk.

Vernacular names Indonesia: ki bayawak (Sundanese), mentuga (Tunjung Dayak, East Kalimantan), penjalinan (Javanese). Malaysia: belimbing talun (Bajau, Sabah), gulambir ayam (Tidong, Sabah). Cambodia: chran, ko dang bai, tap yor (Moi).

Distribution Peninsular Burma (Myanmar), Cambodia, southern Vietnam, Thailand, Peninsular Malaysia, Sumatra, Java, Borneo and Sulawesi.

Guioa koelreuteria (Blanco) Merr.

Synonyms *Guioa mindorensis* Merr., *Guioa perrottetii* (Blume) Radlk., *Guioa salicifolia* Radlk.

Vernacular names Malaysia: saksah, sasa, sasah (Bajau, Sabah). Philippines: alahan (general), angset (Iloko), salab (Tagalog, Bikol).

Distribution Borneo (islands north and north-east of Sabah) and the Philippines.

Guioa patentinervis Radlk.

Synonyms *Guioa multipunctata* Radlk.

Vernacular names Indonesia: tofiri (Ternate, Moluccas).

Distribution The Moluccas.

Guioa pleuropteris (Blume) Radlk.

Synonyms *Guioa aptera* Radlk., *Guioa lasiothyrsa* Radlk., *Guioa subapiculata* Radlk.

Vernacular names Brunei: munggulan, tanking manok, tarik kakang. Indonesia: kayu lentadak, kayu lulup (Sumatra), tapanggang gunung (Kalimantan). Malaysia: penyamok (Peninsular), tanggianuk (Dusun, Sabah). Philippines: bunsikag-buhukan (Filipino), dayendingan (Bisaya), malasikag (Tagbanua). Cambodia: phnum, pongro phnum. Thailand: som ling (peninsular), taet ling (south-eastern, peninsular).

Distribution Peninsular Burma (Myanmar), Cambodia, southern Vietnam, Thailand, Peninsular Malaysia, Singapore, Sumatra, Borneo and the Philippines.

Guioa pseudoamabilis v. Welzen

Distribution Papua New Guinea.

Guioa pubescens (Zoll. & Moritzi) Radlk.

Synonyms *Arytera silaka* Miq., *Cupania pallidula* Hiern, *Guioa diplopetala* (Hassk.) Radlk. forma *dentata* Radlk.

Vernacular names Indonesia: marapinang (East Kalimantan), pulas (Bangka), silaka (western Sumatra). Malaysia: angir manuk (Kedayan, Sabah), chenderai kayu (Peninsular). Philippines: alahan-mabolo (Filipino).

Distribution Peninsular Malaysia, Singapore, Sumatra, West Java, the northern half of Borneo and the Philippines (Palawan).

Guioa subsericea Radlk.

Distribution New Guinea.

P.C. van Welzen

Gymnostoma L.A.S. Johnson

Telopea 2: 83 (1980).

CASUARINACEAE

$x = 8$; *G. papuanum*: $2n = 16$

Vernacular names Agoho (trade name). Brunei: sempilau. Indonesia: cemara (general). Malaysia: ru (general), aru (Sabah), sempilau (Sabah, Sarawak). Papua New Guinea: she-oak (En).

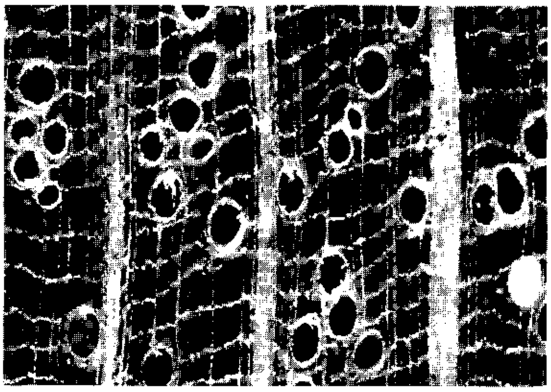
Origin and geographic distribution *Gymnostoma* comprises 18 species and is found in Sumatra, Borneo, the Philippines, the Moluccas, New Guinea, the Solomon Islands, north-eastern Australia, New Caledonia and Fiji. Within Malesia 4 species are native.

Uses The use of *Gymnostoma* wood is similar to that of *Casuarina*. It is used for house building under cover (beams, joists, rafters), masts, tools handles, shuttles, oars, cartwheels and, when treated, also for shingles, power line transmission poles, mine props and for salt-water and freshwater piling including fish traps (but only when permanently submerged). It yields a very good firewood and produces a high quality charcoal.

Several species are planted for ornamental purposes. *G. rumphianum* is considered to be an atmospheric nitrogen-fixer, with potential for intercropping.

Production and international trade *Gymnostoma* wood is sold together with that of *Casuarina*. It occasionally reaches the market, but is traded only locally. In 1996 Papua New Guinea exported about 530 m^3 of 'she-oak' (*Casuarina* and *Gymnostoma*) logs at an average free-on-board (FOB) price of US$ 100/m^3.

Properties *Gymnostoma* yields a heavy hardwood with a density of 910–1220 kg/m^3 at 15% moisture content. Heartwood red to dark red or



Gymnostoma sumatranum
transverse surface (×20)

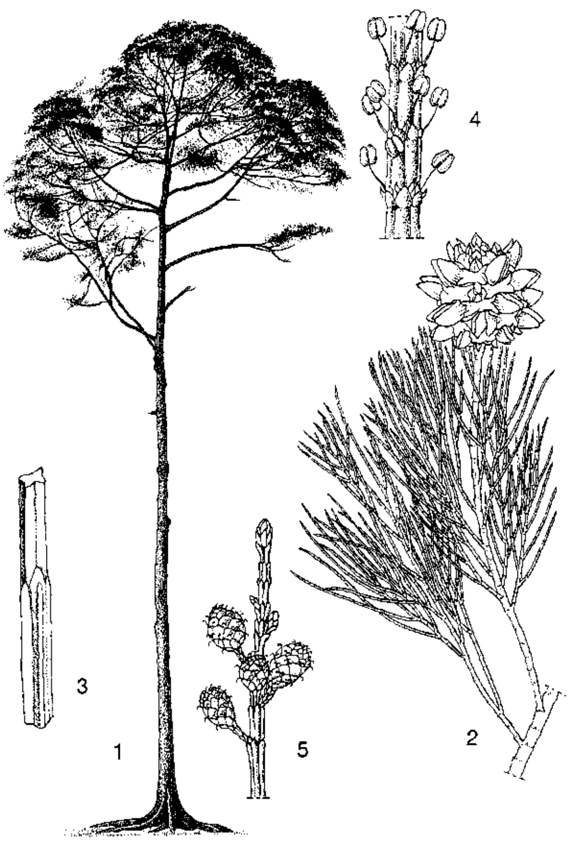
dark brown, usually not clearly differentiated from the sapwood which is about 3 cm wide; grain straight or slightly interlocked; texture moderately fine to moderately coarse due to the broad rays, even; wood with conspicuous silver grain, somewhat lustrous. Growth rings indistinct; vessels medium-sized to moderately large, mostly solitary but with a tendency to oblique arrangement, sometimes with white or yellowish deposits; parenchyma abundant, apotracheal in narrow continuous or interrupted bands; rays of two distinct sizes, the broad ones visible to the naked eye; ripple marks absent.

The wood is very strong and very hard. It is moderately durable when exposed to the weather or in contact with the ground. The heartwood is highly resistant to pressure treatment but sapwood is amenable. The sapwood is non-susceptible to *Lyctus*.

The mean fibre length of *G. sumatranum* from Indonesia is 1.086 mm.

See also the table on microscopic wood anatomy.

Botany Evergreen, dioecious or monoecious trees up to 35 m tall; bole cylindrical, up to 75 cm in diameter, occasionally with small buttresses or stilt roots; bark surface longitudinally fissured, with elongated flakes, brown. Branchlets slender and wiry, articulated, quadrangular, either deciduous or persistent. Leaves reduced to scales, in whorls of 4. Flowers unisexual; perianth absent, replaced by 2 bracteoles. Male flowers in terminal, bracteate spikes, with a single stamen. Female flowers in condensed spikes on short or elongated branchlets, with woody bracts; ovary composed of 2 fused carpels, with 2 ovules and a 2-branched style. Infructescence a woody cone-like structure. Fruit a yellow-brown or greyish winged nut



Gymnostoma sumatranum (Jungh. ex de Vriese) L.A.S. Johnson – 1, tree habit; 2, twig with infructescence; 3, part of twig; 4, male inflorescence; 5, female inflorescence.

(samara). Seed solitary. Seedling with epigeal germination.

G. sumatranum planted on podzolic soil was 0.6 m tall 1.5 years after planting. The shape of the crown is conical at first, becoming umbrella-like with age. *Gymnostoma* forms root nodules with the symbiont *Frankia* in which atmospheric nitrogen is fixed. *G. sumatranum* flowers annually during the dry season and starts to flower at an age of 12–15 years. Pollination and seed dispersal are by wind.

Gymnostoma was recently split off from the genus *Casuarina* and differs in its whorls of 4 scale leaves and broad and woody cone bracts.

Ecology *Gymnostoma* is often found gregarious or even in pure stands on poor, sandy soils and exposed locations. *G. sumatranum* typically grows on podzolic soils up to 2000 m altitude. *G. nobile* is found in kerangas forest on leached sand, peat and limestone. *G. papuanum* is locally dominant on soils derived from ultrabasic rock, from near sea-level to the lower montane zone.

Silviculture *Gymnostoma* can be propagated by seed and possibly also by shoot cuttings, as is the case for *Casuarina*. *G. rumphianum* has about 1.4 million dry seeds/kg and *G. sumatranum* 35500–37500. Wildlings of *G. papuanum* are collected from landslides and planted by the local population. Trees are ringed before being felled for firewood. *G. nobile* and *G. sumatranum* have been recommended for reforestation of highly acidic and poor kerangas soils after clear felling and burning of the kerangas vegetation. Under these circumstances, *G. sumatranum* still has 50% survival of the planted seedlings and displays moderate growth. *G. nobile* is one of the first tree species to develop in fire-induced grasslands on kerangas soil.

Genetic resources and breeding The interest in *Gymnostoma* for planting limits the risk of genetic erosion.

Prospects The potential of *Gymnostoma* for reforestation of degraded kerangas vegetation deserves further investigation, as most other species fail to grow under these difficult site conditions.

Literature 57, 151, 162, 198, 209, 235, 260, 261, 300, 304, 333, 340, 405, 436, 501, 745, 780, 861, 934, 985, 1040, 1048, 1218.

Selection of species

Gymnostoma nobile (Whitmore) L.A.S. Johnson

Synonyms *Casuarina nobilis* Whitmore.

Vernacular names Malaysia: rhu ronang (Sarawak).

Distribution Borneo and the Philippines (Palawan).

Gymnostoma papuanum (S. Moore) L.A.S. Johnson

Synonyms *Casuarina papuana* S. Moore.

Distribution Papua New Guinea.

Gymnostoma rumphianum (Miq.) L.A.S. Johnson

Synonyms *Casuarina rumphiana* Miq.

Vernacular names Weeping ru (En). Indonesia: ila (Weda, Halmahera), pohon kasawari, pohon kasuwari (Moluccas). Philippines: mountain agoho (En), agoho del monte (Sp).

Distribution The Philippines, Sulawesi and the Moluccas.

Gymnostoma sumatranum (Jungh. ex de Vriese) L.A.S. Johnson

Synonyms *Casuarina sumatrana* Jungh. ex de Vriese.

Vernacular names Sumatran ru (En). Indonesia: cemara sumatra (general), anturmangan (Batak Toba, North Sumatra), pitungang pipi (western Sumatra). Malaysia: rhu bukit, rhu ronang (Sarawak). Philippines: maribuhok (general). Thailand: son pattaawia (central).

Distribution Sumatra, Borneo and the Philippines; sometimes planted in other South-East Asian regions.

Suhardi (general part),
E. Boer (general part),
M.S.M. Sosef (general part, selection of species)

Gynotroches Blume

Bijdr. fl. Ned. Ind. 5: 218 (1825).
RHIZOPHORACEAE
x = unknown; $2n$ = unknown

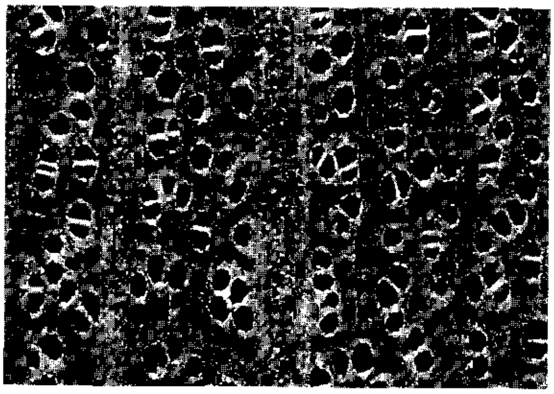
Vernacular names Brunei: kerakas payau (Kedayan), kerakas payoh (Dusun), kupi-kupi (Malay). Indonesia: kayu bulu (Sumatra), kukuran (Javanese), mengkeli (Bangka). Malaysia: bulu-bulu (Peninsular, Sabah), mata keli (Peninsular), sawar bubu (Iban, Sarawak). Philippines: kibal, malakulambisan (Tagalog), talingan (Cebu Bisaya). Thailand: ai kraek (peninsular).

Origin and geographic distribution *Gynotroches* is a monotypic genus. The only species is *G. axillaris* Blume found in southern Burma (Myanmar), southern Thailand, throughout Malesia (but absent in Central and East Java and the Lesser Sunda Islands), east to the Solomon and Caroline Islands.

Uses The wood of *Gynotroches* is only occasionally used under cover for rafters and house posts; it is sometimes used for firewood.
The leaves have been used in local medicine as a febrifuge by applying poultices to the head.

Production and international trade *Gynotroches* wood is of very little importance and is probably used on a local scale only.

Properties *G. axillaris* yields a medium-weight hardwood with a density of 540–710 kg/m^3 at 15% moisture content. Heartwood pale brown with a pink or red hue or red-brown, not clearly demarcated from the sapwood; grain straight or interlocked; texture moderately coarse to coarse and uneven due to the presence of broad rays. Growth rings usually indistinct; vessels moderately small to medium-sized, solitary and in tangential or radial multiples of 2–3, tyloses sparse and occasional white deposits; parenchyma moderately abundant, paratracheal vasicentric or confluent in very narrow bands; rays of 2 distinct sizes, moderately broad or very broad, over 1 mm high, conspicuous on radial surface; ripple marks absent.
The wood is non-durable. The sapwood is non-susceptible to *Lyctus*.
See also the table on microscopic wood anatomy.



Gynotroches axillaris
transverse surface (×20)

Botany A dioecious, small to medium-sized or fairly large tree up to 35(–45) m tall; bole up to 50(–70) cm in diameter, with stilt roots and sometimes with small buttresses up to 1 m high; bark surface smooth and prominently hoop-marked or finely transversely fissured, grey to chocolate-brown and often grey-mottled, inner bark fibrous, red-brown. Twigs hollow with swollen internodes. Leaves decussate, simple, variable in shape, entire; stipules present, imbricate and lanceolate. Flowers in a dense axillary cluster, small, greenish-white, 4–5-merous; calyx deeply lobed; petals clawed, long-fimbriate at apex. Male flower with stamens twice the number of petals. Female flower with a superior, 4–6-locular ovary with 3–8 ovules in each cell, stigma 4–8-lobed. Fruit a globose, few to many-seeded berry, shiny black when mature, with persistent calyx. Seedling with opposite, finely serrate leaves.
G. axillaris grows according to Massart's architectural tree model, characterized by a monopodial trunk with rhythmic growth that produces regular tiers of plagiotropic branches.

G. axillaris is highly polymorphic. In Sarawak at least 2 ecotypes have been distinguished and closer study may reveal that even several distinct species are involved.

Ecology *G. axillaris* occurs in lowland to lower montane forest up to 1400(–2250) m altitude. It is particularly common in secondary forest, often in swamps and along streams, but it is also found on slopes in open primary forest. In Micronesia it is locally common in mossy hill forest.

Genetic resources and breeding *G. axillaris* is not considered to be endangered as it is widely distributed, locally common, and not much logged for its timber.

Prospects The use of the wood of *G. axillaris* is unlikely to increase as the wood is of poor quality and small.

Literature 61, 70, 151, 163, 267, 304, 341, 402, 436, 464, 510, 829, 861, 1048, 1221, 1242.

Cheksum Tawan

Gyrocarpus Jacq.

Select. stirp. amer. hist.: 282 (1763).

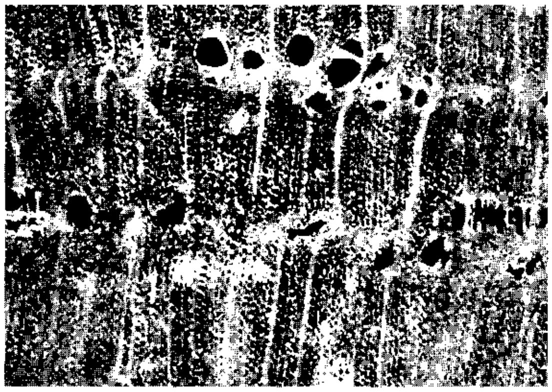
HERNANDIACEAE

x = unknown; *G. americanus*: $n = 15$

Vernacular names Indonesia: bonak busuk (Timor), ganggangan, gedreg (Javanese), hambui (Alor). Philippines: gyrocarpus (general), lapolapo (Iloko), malasapsap (Nueva Ejica and Rizal). Burma (Myanmar): pinle-thikauk. Thailand: puu le (peninsular), sao (south-western).

Origin and geographic distribution *Gyrocarpus* is a pantropical genus comprising 3 species. The only Malesian species, *Gyrocarpus americanus* Jacq. (synonyms: *Gyrocarpus acuminatus* Meissn., *Gyrocarpus asiaticus* Willd., *Gyrocarpus jacquinii* Gaertn.), has a pantropical distribution and occurs from Mexico to northern South America, in the drier parts of tropical Africa and in Madagascar, India, Sri Lanka, Burma (Myanmar), Indo-China, Thailand, Peninsular Malaysia (Langkawi Islands), the Philippines, East Java, the Lesser Sunda Islands, Papua New Guinea, northern Australia and into the Pacific towards Tahiti.

Uses The wood of *G. americanus* has been used for boat and canoe building in Java and the Lesser Sunda Islands, and also for low-quality boxes and crates. In the Philippines it is regarded as a suitable substitute for kiri wood (*Paulownia* spp.) which is prized for wooden clogs, light furniture and floats. In India it has been used for boxes, toys and trays and is preferred for catamaran construction.



Gyrocarpus americanus
transverse surface (×20)

Production and international trade *G. americanus* wood is seldom brought to the market and trade is on a local scale only.

Properties *G. americanus* yields a lightweight hardwood with a density of 190–230 kg/m³ at 15% moisture content. The wood of Indian samples is recorded at 290–415 kg/m³. Heartwood cream to straw, darkening to a greyish-brown upon age, not clearly demarcated from the buff-coloured sapwood; grain straight with a tendency to be wavy; texture moderately coarse to coarse; wood very lustrous and with conspicuous silver grain. Growth rings often distinct, delimited by concentric rings of vessels, with a strong tendency to align tangentially, sometimes diffuse-porous; vessels moderately large to large, solitary and in multiples of 2–3, open; parenchyma paratracheal vasicentric, aliform and sometimes confluent; rays moderately broad; ripple marks absent.

The wood seasons well. It is soft, not strong and not tough. The wood is non-durable and susceptible to dry-wood termites and the sapwood is susceptible to *Lyctus*; its resistance to insect attacks is probably erroneously reported.

See also the table on microscopic wood anatomy.

Botany A deciduous, small to medium-sized tree up to 25(–30) tall; bole up to 100 cm in diameter, without buttresses; bark surface smooth to moderately rough or occasionally scaly or flaky and/or finely and irregularly cracking, pale cream to greenish-brown or pale grey; slash exuding a cream to yellowish or orange sap. Leaves arranged spirally, clustered at the apex of fleshy twigs, simple, entire or 3(–5)-lobed, heart-shaped to attenuate and 3-veined at base, acuminate, exstipulate. Flowers in a corymbose cyme borne axillary, bisexual and male ones on the same individual; perianth lobes (6–)7(–8); stamens 4, opening by 2 valves and with 2 glands at base; ovary inferior, 1-locular with 1 ovule; style simple. Fruit a samara, nut with 2 large wings on the persistent calyx tube which surrounds it. Seed with spongy testa. Seedling with epigeal germination; cotyledons emergent, bilobed, conduplicate; first few leaves entire, subsequent ones 3-lobed, leaves of mature trees entire.

Fast growth is reported from Timor. Trees often flower while leafless. In East Java trees flower in April and May. In the monsoon area around Port Moresby, Papua New Guinea, trees flower in April and May and mature fruits are found in July and August. Trees in the Andaman Islands are leafless from January to March, new leaves appear in April, flowering takes place in December and January and the fruits are mature in April to May. Pollination is probably by wind. The winged fruits are an obvious adaptation for wind dispersal in the same manner as those of the *Dipterocarpaceae*: they rotate when falling. Dispersal may also be by water as the fruits can float for several months.

Hernandiaceae forms a small family of primitive Angiosperms showing affinities with both *Lauraceae* and *Monimiaceae*. *Gyrocarpus* is sometimes treated as a separate family, the *Gyrocarpaceae*. *G. americanus* has been subdivided into 8 subspecies. Within the Malesian region the subsp. *americanus* and subsp. *sphenopterus* (R. Br.) Kubitzki occur.

Ecology *G. americanus* is generally found scattered near the shore, on the beach, on rocky slopes and dune scrub. It also occurs in inland localities, on well-drained or rocky sites, in savanna, sclerophyll forest on calcareous soils, poor monsoon forest, stony crests and on river banks, up to 200 m altitude. It is confined to areas with a pronounced dry season.

Silviculture In India *G. americanus* is propagated by seed and one kg contains about 2650 fruits without wings. Seeds remain viable for one year if stored properly and the viability of fruits having floated in water for 2 months was not affected. Seeds do not need any pretreatment, although improved germination is reported from Madagascar after soaking seed in water for 24 hours. Germination starts 10 days after sowing and attains about 60% of the seeds sown in full light, but in a trial in Peninsular Malaysia seeds germinated much later: about 70% germination was achieved from 11 months to almost 3 years. In India germination decreased when seeds were sown under shade. Seedlings attain 40 cm and more in a year and seedlings over 30 cm tall tolerate planting out best (about 60% survival) either as containerized plants or as bare-rooted stock. Stumping of seedlings failed completely. For Indonesia *G. americanus* is recommended for planting in areas with an annual rainfall of 1000–1200 mm. It is not fire resistant, does not tolerate periodic waterlogging and easily regenerates naturally in the degraded woodland of Timor, provided heavy grazing is absent.

Genetic resources and breeding Since *G. americanus* is little exploited its genetic resource base is not at risk.

Prospects Commercial interest in *G. americanus* is unlikely to increase as the wood quality is insufficiently known. Its utilization for carving in cottage industry may attract interest in the future.

Literature 70, 163, 341, 343, 364, 436, 638, 772, 829, 831, 927, 934, 1007, 1038, 1115, 1221.

E. Boer & M.S.M. Sosef

Haldina Ridsd.

Blumea 24: 360 (1978).

RUBIACEAE

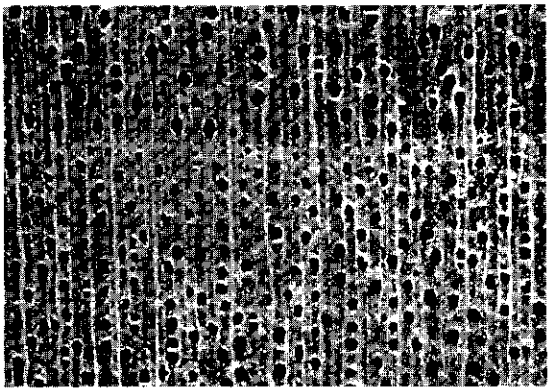
x = unknown; *H. cordifolia*: $n = 22$

Vernacular names Haldu (En, India). Burma (Myanmar): hnaw, nhan-ben, nhing-pen. Cambodia: khvao. Laos: 'khao, 'thom. Thailand: kwao, tong lueang, tum kwao (northern). Vietnam: g[as]o l[as] tim.

Origin and geographic distribution *Haldina* is a monotypic genus. The species *H. cordifolia* (Roxb.) Ridsd. (synonyms: *Adina cordifolia* (Roxb.) Hook. f., *Nauclea cordifolia* Roxb.) occurs in India, Sri Lanka, Burma (Myanmar), Indo-China, southern China, Thailand and Peninsular Malaysia (very rare).

Uses The wood of *H. cordifolia* is used for house construction (doors, windows, stairs and flooring), boat building, and for furniture, implements and face veneer. It is also suitable for fine turnery work, rulers, pencil slats, bobbins, boxes and piano keys. The wood is reported as acid-resistant and could be suitable for laboratory bench tops and similar uses.

In Burma (Myanmar) it is used as ground cover in teak (*Tectona grandis* L. f.) plantations.



Haldina cordifolia
transverse surface (×20)

Production and international trade The wood of *H. cordifolia* is usually traded locally and is rarely exported. In most countries the production is small, but an annual production of 20 000 m^3 was reported for Thailand in the 1970s.

Properties *H. cordifolia* is a medium-weight to heavy hardwood with a density of 570–895 kg/m^3 at 15% moisture content. Heartwood yellow when fresh, turning pale yellow or reddish-brown on exposure, not clearly defined from the very wide, yellowish-white sapwood; grain fairly straight, occasionally interlocked or spiral; texture very fine and even; wood lustrous. Growth rings not always distinct; vessels moderately small, solitary, occasionally in radial multiples of 2–3 or in small clusters, visible only with a hand lens, open; parenchyma scarce, paratracheal vasicentric, apotracheal diffuse and diffuse-in-aggregates, not visible even with a hand lens; rays moderately fine; ripple marks absent.

Shrinkage is high and the wood has a slight tendency to check and split during air seasoning, therefore kiln drying is advisable. The wood is not very stable in use. It is moderately hard and strong. The wood is easy to work with hand and machine tools, but should be planed with care to avoid picking up of grain, it polishes well and takes a high lustrous finish. The wood is moderately durable, preservative treatment by pressure impregnation of both sapwood and heartwood is easy. The heartwood is resistant to fungi, the sapwood is susceptible to *Lyctus*.

The gross energy value of the wood is 18 460 kJ/kg.

See also the tables on microscopic wood anatomy and wood properties.

Botany A deciduous, small to medium-sized, sometimes fairly large tree up to 30(–40) m tall; bole branchless for up to 20(–25) m, up to 110(–150) cm in diameter, with buttresses and often fluted; bark surface scaly, dippled, greyish-brown to reddish-brown, inner bark dark red to brown. Terminal vegetative bud flattened. Leaves opposite, simple, entire, broadly ovate, cordate at base; stipules appressed, markedly keeled. Flowers in an axillary, stalked, yellowish head, 5-merous, heads (2–4)–10 from an axil; interfloral bracteoles present; calyx with a short tube and oblong lobes; corolla hypocrateriform, with valvate lobes (but strongly imbricate at apex); stamens inserted in the upper part of the corolla tube; ovary inferior, 2-locular with many ovules, style exserted, stigma ovoid to subglobose. Fruit in a head-like infructescence, free, splitting into 4 parts, with persistent central axis and calyx. Seed ovoid, slightly bilaterally compressed, narrowly winged. Seedling with epigeal germination; cotyledons leafy.

Haldina is related to *Adina* and a group of 4 small 'satellite' genera (including *Adinauclea*, *Metadina* and *Pertusadina*) in the tribe *Naucleeae*. It can be recognized particularly by the flattened terminal vegetative bud, the lateral flower heads and the appressed, keeled stipules.

Ecology *H. cordifolia* occurs frequently but scattered in deciduous forest in the lowland and lower hills. In Burma (Myanmar) and Thailand it is often associated with teak (*Tectona grandis* L. f.).

Silviculture Most information on propagation and planting of *H. cordifolia* originates from India and Burma (Myanmar). It can be raised from seed, but direct seeding failed as the seed is minute (about 11 million seeds/kg). Ripe fruit heads should be collected before seeds are shed, when the dry separation of seeds from the heads is easy. Seeds can be stored for at least one year in an airtight receptacle; during the first year the germination capacity increases to 13% due to after-ripening. A pretreatment by soaking the seeds in water for 12 hours and then drying them slightly to facilitate sowing has been recorded. As with other very fine seeds, they should be sown in very fine sand, covered very lightly with fine soil or sand and watered by spraying frequently but lightly. They should be protected from direct sunlight and rain. Mulching the seedbeds proved better than using raised screens for this. Damping-off has been observed in the nursery. When 2–3 months old, seedlings are pricked out into containers. As young plants are fragile, bare-rooted planting stock is not recommended. Stumps of two-

year-old seedlings, however, are very successful as planting stock. One-year-old seedlings can be planted at 2 m × 2 m. Wildlings have also been used successfully. Although light-demanding, *H. cordifolia* needs light shade in the first few years. Good drainage and weeding after planting are essential for optimal development of the plants. In agroforestry trials its leaves and leaf extracts proved to have a serious allelopathic effect on associated crops. Protection from grazing and the occurrence of bare soil are essential for the establishment of natural regeneration. *H. cordifolia* coppices easily.
Debarking immediately after felling is recommended to prevent fungal attack of the sapwood. In India girdling before harvest is practised to improve wood quality, as stems can slowly air dry before actually being harvested. Trial plantations have been established in Nigeria and South Africa, but results are not known.

Genetic resources and breeding As *H. cordifolia* is common in a large area and occasionally planted, it does not seem to be endangered.

Prospects Although *H. cordifolia* is not known in Malesia (except for a single collection from northern Peninsular Malaysia), it might be a promising timber for planting in areas with a seasonal climate because it has favourable wood properties. Trial plantations using the information available from India are needed to confirm its potential.

Literature 102, 110, 218, 306, 364, 405, 464, 536, 642, 697, 736, 874, 913, 933, 943, 1064, 1098, 1104, 1177, 1221.

Cheksum Tawan

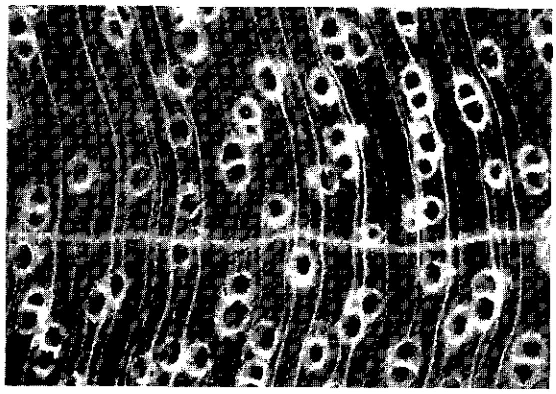
Halfordia F. v. Mueller

Fragm. 5: 43 (1865).
RUTACEAE
x = unknown; $2n$ = unknown

Vernacular names Saffronheart (En, trade name).

Origin and geographic distribution *Halfordia* comprises 4 species occurring in Papua New Guinea, Australia and New Caledonia. In New Guinea 2 species occur of which only one, *H. papuana* Lauterb. which is endemic to this region, yields timber.

Uses The wood of *H. papuana* is used for heavy construction, decking, crossarms, bridge and wharf superstructure, industrial flooring, exterior joinery, window-sills and as a mine timber. Its hardness and resilience render it suitable for specialty uses such as thresholds, fishing rods, archery bows, billiard cue shafts, bearings, textile rollers and golf club shafts. It is an excellent fuelwood.



Halfordia papuana
transverse surface (×20)

Production and international trade In 1996 Papua New Guinea exported only 15 m^3 of 'saffronheart' logs at an average free-on-board (FOB) price of US\$ 74/m^3. Supplies are very small.

Properties *H. papuana* yields a heavy hardwood with a density of 800–1040 kg/m^3 at 12% moisture content. Heartwood and sapwood pale saffron to yellowish-brown; grain straight or interlocked; texture fine and even; fiddleback figure may be present; wood oily to the touch. Growth rings indistinct; vessels small, solitary and in radial multiples of 2–4, indistinct to the naked eye, with white and pale yellow deposits; parenchyma apotracheal in narrow irregularly spaced bands, paratracheal vasicentric; rays narrower than the vessels; ripple marks absent.
Shrinkage upon seasoning is high. Quarter-sawn stock must be seasoned with great care to prevent checking and splitting. Straight-grained material is extremely strong and resilient, but material with interlocked grain tends to be brittle and is likely to pick up. The wood polishes well, it holds nails well, but pre-boring is necessary. The wood is very durable when exposed to the weather or in contact with the ground but is extremely resistant to preservative treatment. The sapwood is non-susceptible to *Lyctus*. Splinters of the wood cause festering if they penetrate the skin. Sawdust may cause congestion of the lungs.
See also the tables on microscopic wood anatomy and wood properties.

Botany A small to medium-sized tree up to 30

m tall; bole branchless for up to 12 m, up to 50 cm in diameter, often irregular and fluted, sometimes with small buttresses; bark surface brown to black. Leaves alternate or whorled, simple, entire, densely set with translucent dots, lateral veins looping; stipules absent. Inflorescence a terminal or axillary panicle, corymb or cyme. Flowers bisexual, 5-merous; sepals free; petals valvate; stamens 10, dimorphic; disk present; ovary superior, 5-locular with 1 ovule in each cell, style short. Fruit a fleshy, indehiscent drupe with a persistent calyx. Seedling with oblong to almost linear cotyledons.
H. papuana has been observed flowering in February to May.

Ecology *H. papuana* is found in mixed montane rain forest in high rainfall areas, at 1200–3000 m altitude. It occurs on limestone hills, in riparian forest and on sandy clay soils.

Genetic resources and breeding The conservation of the genetic resources of *H. papuana* is directly dependent upon the conservation of its habitat, the montane rain forest of New Guinea.

Prospects The very hard, strong and resilient wood of *H. papuana* is used for specialty purposes, but as supplies are extremely limited and stem form is poor, its use will probably remain only of local importance.

Literature 300, 321, 348, 463, 464, 536, 667, 861, 1232.

E. Boer & M.S.M. Sosef

Haplolobus H.J. Lam

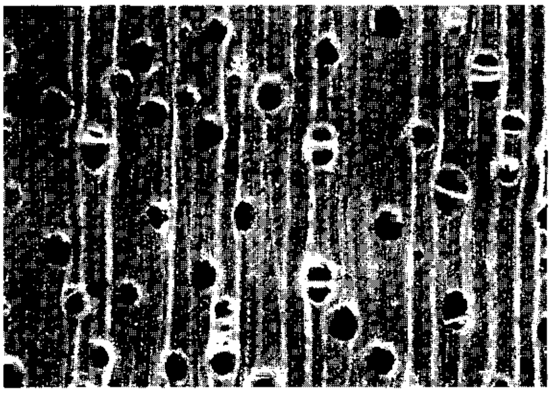
Ann. Jard. Bot. Buitenzorg 42: 25, 26 (1931).
BURSERACEAE
x = unknown; $2n$ = unknown

Origin and geographic distribution *Haplolobus* comprises about 19 species occurring in Borneo, Sulawesi, the Moluccas, New Guinea, the Solomon Islands, and east towards Fiji and Samoa. Most species are found in New Guinea.

Uses The wood of *Haplolobus* is used for general light construction and is probably suitable for the production of veneer and plywood. Wood of *H. floribundus* is suitable for the production of wood-wool board.

Production and international trade *Haplolobus* wood is seldom used as supplies are generally very limited. Some of it may occasionally be mixed in consignments of 'kedondong' timber comprising the wood of most *Burseraceae* genera.

Properties *Haplolobus* usually yields a medium-weight hardwood with a density of 410–730 kg/m³ at 15% moisture content, but *H. floribundus* shows an exceptionally wide density range of 340–1240 kg/m³ at 15% moisture content. Heartwood pale brown to pink brown, denser material usually a little darker in colour, not clearly demarcated from the sapwood; grain straight to wavy alternating to produce coarse stripe figure; texture medium coarse to coarse and even. Growth rings indistinct; vessels medium-sized to large, solitary and in radial multiples of 2–3(–5), tyloses present, but not abundant; parenchyma absent to scanty paratracheal; rays fine, not visible to the naked eye; ripple marks absent.
The wood is fairly soft and weak. It is slightly durable to non-durable and should be treated with anti-stain chemicals immediately after sawing. The sapwood is susceptible to *Lyctus*.
See also the tables on microscopic wood anatomy and wood properties.



Haplolobus floribundus
transverse surface (×20)

Botany Dioecious, small to medium-sized trees up to 30(–45) m tall; bole straight, branchless for up to 20 m, up to 60(–80) cm in diameter, sometimes with small buttresses; bark surface scaly, greyish. Leaves arranged spirally, imparipinnate, exstipulate; leaflets 1–9(–13), opposite, entire, often with galls. Inflorescence axillary or rarely terminal, or borne on leafless twigs, paniculate. Flowers functionally unisexual, 3-merous, small; calyx cup-shaped, 3-dentate to subtruncate; petals free, with inflexed tips. Male flower with 6 or rarely 3 stamens; disk annular. Female flower with a superior, 3-locular ovary with 2 ovules in each cell, stigma sessile or subsessile, 3-lobed to subglobular. Fruit an ovoid to subglobular, 1(–2)-seeded drupe with dry, thin, smooth pericarp; stigmatic remains terminal. Seedling with hypogeal

germination; cotyledons entire, not emergent; hypocotyl not elongated; first pair of leaves opposite, subsequent ones alternate, simple at first.
H. floribundus has been observed flowering throughout the year and fruiting in February–May and September–October.
Haplolobus species may be taken for those of *Santiria* which differ in their saucer-shaped calyx, the fruit having strongly excentric stigmatic remains, and the lobed cotyledons. *H. floribundus* is highly polymorphic with 4 recognized subspecies.

Ecology *Haplolobus* is found scattered or occasionally gregariously (e.g. *H. floribundus*) in primary or rarely secondary rain forest, from sea-level up to 1950 m altitude. The species are most common on hills and ridges and generally occur on well-drained, alluvial or clayey soils, but e.g. *H. floribundus* has also been reported from coral limestone. *H. furfuraceus* also grows in open forest or even open grassland.

Genetic resources and breeding Most *Haplolobus* species are very rare and narrowly endemic. Most are also confined to primary forest and seem vulnerable to genetic erosion or extinction through destruction of their habitat.

Prospects As a timber *Haplolobus* is poorly known and its increased use seems highly unlikely.

Literature 126, 341, 456, 582, 652, 685, 692, 740, 861, 1048, 1072, 1232.

Selection of species

Haplolobus floribundus (K. Schumann) H.J. Lam

Synonyms *Haplolobus celebicus* H.J. Lam, *Haplolobus leeifolius* (Lauterb.) H.J. Lam, *Haplolobus moluccanus* H.J. Lam.

Vernacular names Indonesia: enei (Sulawesi), lian(a) (Morotai), ode mayoko (Halmahera).

Distribution Sulawesi, the Moluccas, New Guinea, the Solomon Islands, the Santa Cruz Islands, Vanuatu, Fiji and Samoa.

Haplolobus furfuraceus (Lauterb.) H.J. Lam

Synonyms *Canarium furfuraceum* Lauterb., *Haplolobus glandulosus* Husson.

Distribution New Guinea.

Haplolobus kapitensis Kochummen

Distribution Borneo (Sabah, Sarawak).

Haplolobus lanceolatus H.J. Lam ex Leenh.

Distribution New Guinea (Irian Jaya).

Haplolobus pubescens H.J. Lam ex Leenh.

Distribution New Guinea.

K.M. Kochummen (general part, selection of species),
J. Ilic (wood anatomy)

Harpullia Roxb.

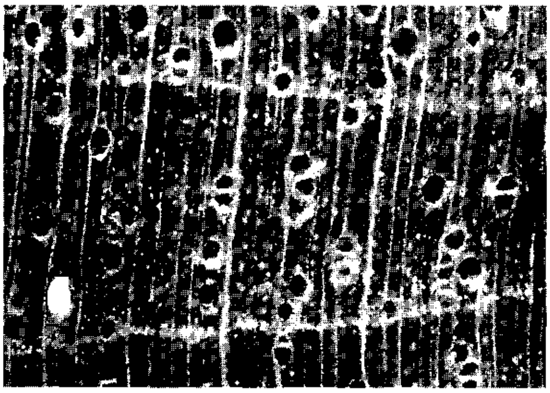
Fl. ind. 2: 441 (1824).
SAPINDACEAE
$x = 14, 15$; *H. arborea*: $2n = 28$, *H. cupanioides*, *H. pendula*: $n = 15$

Origin and geographic distribution *Harpullia* comprises 26 species ranging from Sri Lanka and India to Burma (Myanmar), south-eastern China, Laos, Vietnam and Thailand, towards the entire Malesian region, northern and eastern Australia, New Caledonia and Tonga. The centre of diversity is located in New Guinea (17 species); only 2 comparatively widespread species are found in West Malesia.

Uses The wood of *Harpullia* is used for house construction (mainly rafters), furniture, packing cases, fence posts, plywood, and also for the production of charcoal and as firewood.
The chopped bark of *H. arborea*, *H. cupanioides* and *H. petiolaris* Radlk. has been used as a fish poison. The watery exudate of the bark of *H. arborea* and sometimes that of the fruit is used for washing, as a hair tonic, to keep away leeches, or is drunk to relieve pain. The oil from its seed is used medicinally as an anti-rheumatic. *H. cupanioides* has been suggested as an ornamental tree as it is attractive when fruiting.

Production and international trade In Malesia wood of *Harpullia* is not traded commercially and is probably utilized on a local scale only.

Properties *Harpullia* yields a medium-weight hardwood with a density of 510–895 kg/m³ at 15% moisture content. Heartwood pale brown with a purple-red hue or yellow-brown, not differentiated from the paler or straw-coloured sapwood; grain straight to slightly wavy; texture fine to moderately fine and even; contents of radial canals visible to the naked eye as dark dots on tangential surface. Growth rings indistinct to occasionally distinct due to marginal parenchyma; vessels



Harpullia arborea
transverse surface (×20)

medium-sized to moderately large, solitary and in radial multiples of 2–4, occasional clusters, multiples more numerous, usually open but sometimes with chalky deposits; parenchyma rather sparse, apotracheal in marginal or seemingly marginal bands, and paratracheal vasicentric to aliform; rays very fine to medium-sized; ripple marks absent.

Shrinkage of the wood upon seasoning is low. The wood is moderately soft to hard and moderately strong. It is relatively durable under cover or in protected situations. The sapwood is susceptible to *Lyctus*.

See also the tables on microscopic wood anatomy and wood properties.

Botany Dioecious, small to medium-sized trees up to 33(–40) m tall; bole straight to crooked, 80(–100) cm in diameter, sometimes fluted at base, sometimes with small buttresses up to 2 m high; bark surface smooth to slightly cracking or fissured, sometimes peeling off in thin sheets, lenticellate, dark grey to dark brown or greenish, inner bark fibrous, whitish to yellowish-brown. Indumentum consisting of solitary and stellate tufts of hairs. Leaves alternate, paripinnate, 1–9-jugate, exstipulate; leaflets alternate or rarely opposite, entire. Inflorescence terminal or axillary, sometimes cauliflorous, usually thyrsoid. Flowers greenish-yellow to white; sepals 5, imbricate; petals 5, clawed and with 2 auricles above the claw or sessile without auricles; disk entire to 5-lobed. Male flowers with 5–8 stamens. Female flowers with a superior, 2–3(–4)-locular ovary with 1 or 2 ovules per cell, style often hooked and twisted. Fruit a 2–3-lobed, inflated capsule, red. Seed with a small sarcotesta at base or covered by an arillode which is free in the upper half of the seed. Seedling with semi-hypogeal germination; cotyledons emergent, fleshy; hypocotyl not elongated; epicotyl with 2 opposite or subopposite, simple, conduplicate leaves in *H. cupanioides* or with a series of scales in *H. arborea*, subsequent leaves arranged spirally, pinnate after several nodes.

H. cupanioides produces about 4 flushes per year and flowers mainly in April–July; fruits are generally found in April–October. *H. arborea* flowers and fruits throughout the year. The flowers are pollinated by insects, probably bees. The seeds are most probably eaten and dispersed by birds, possibly also by mammals and lizards.

Harpullia has been divided into 2 subgenera: subgenus *Harpullia* comprising most of the species and subgenus *Otonychium* (Blume) Radlk. with only 2 species among which *H. arborea*.

The Australian species *H. pendula* Planch. ex F. v. Mueller and *H. hillii* F. v. Mueller provide excellent and decorative timber used particularly for handicraft articles and traded as 'tulipwood'. They are also very suitable as an ornamental for street planting, since they do not produce troublesome roots.

Ecology Timber-yielding species of *Harpullia* are found in primary or sometimes secondary rain forest up to 1200(–1850) m altitude. Ecologically *H. arborea* and *H. cupanioides* are extremely tolerant, both occurring on level land as well as on ridges, inland and along beaches, in dry to swampy habitats on a wide variety of soils, including limestone. Both species are, however, rarely found in deciduous forest or other more open vegetation.

Silviculture *Harpullia* can be propagated by seed. Seeds of *H. cupanioides* with adhering arillode show about 90% germination in 16–52 days.

Genetic resources and breeding There are no records of ex situ conservation of *Harpullia*. Many endemic species of New Guinea have a narrow geographic distribution and are vulnerable to genetic erosion as a result of the destruction of their habitat.

Prospects An increase in the use of *Harpullia* wood in the near future is not to be expected, as the wood is seldom used and the bole is not always well-shaped. The Australian *Harpullia* species may be considered for planting for their decorative timber.

Literature 62, 150, 163, 238, 267, 341, 348, 371, 436, 438, 464, 595, 689, 691, 825, 829, 831, 933, 934, 974, 1037, 1038, 1048, 1221.

Selection of species

Harpullia arborea (Blanco) Radlk.

Synonyms *Harpullia imbricata* (Blume) Thwaites, *Harpullia pedicellaris* Radlk., *Harpullia tomentosa* Ridley.

Vernacular names Indonesia: buluan (Kalimantan), pelos, pelus (Javanese). Malaysia: apoh (Iban, Sarawak), lalilali (Dusun, Sabah), sakubing (Melanau, Sabah). Philippines: uas (general), magalad (Tagbanua), puas (Tagalog). Thailand: hang kaen, hom klai dong (northern), krapok ling (northeastern, central).

Distribution Sri Lanka, India, southern Vietnam, Thailand, throughout the Malesian region towards Australia (Queensland) and into the Pacific, east to Samoa and Tonga.

Harpullia cupanioides Roxb.

Synonyms *Harpullia confusa* Blume, *Harpullia rupestris* (Blume) Blume, *Harpullia thanatophora* Blume.

Vernacular names Indonesia: jeliru, kindag (Javanese), kunter gauwa (Lobo, Irian Jaya). Malaysia: kalinga (Dusun Banggi, Sabah), kesemak, kesmak (Peninsular). Philippines: uas-bundok (Filipino), buka-buka (Sulu, Tagbanua). Burma (Myanmar): tagat-kwedaung. Thailand: khang khao (northern), mai phrik paa (south-eastern), ngonkai dong (peninsular). Vietnam: lon til, x[ow] (Moi).

Distribution From eastern India, Bangladesh to southern China, Burma (Myanmar), the Andaman Islands, Laos, Vietnam and Thailand, throughout the Malesian region towards Australia (Northern Territory).

Harpullia giganteacapsula Vente

Distribution Papua New Guinea.

P.C. van Welzen

Helicia Lour.

Fl. cochinch. 1: 83 (1790).

PROTEACEAE

$x = 14$; *H. excelsa*: $n = 14$

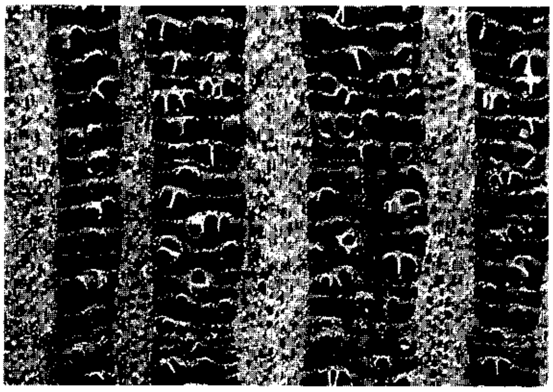
Vernacular names Indonesia: kendung (general). Malaysia: sawa luka (general). Papua New Guinea: high mountain silky oak (trade name). Thailand: mueat khon.

Origin and geographic distribution *Helicia* comprises some 90 species occurring in Sri Lanka, southern India, Burma (Myanmar), Indo-China, southern China, Japan, Taiwan, Thailand, throughout the Malesian region towards the Bismarck Archipelago and eastern Australia. It is centered in Malesia where some 65 species occur; New Guinea is especially rich in species (almost 50).

Uses The nicely figured and hard wood of *Helicia* is used for superior joinery, high class furniture, cabinet work and interior finish, flooring and also (but rarely) for axe handles, house building and as a mine timber.
In Peninsular Malaysia *H. petiolaris* has occasionally been planted for ornamental purposes. In Java young shoots of *H. robusta* and *H. serrata* are eaten raw as a vegetable.

Production and international trade Because of the limited supplies and the generally small size of *Helicia* trees, trade is on a local scale only. Edible shoots have been reported occasionally from markets in Java.

Properties *Helicia* yields a medium-weight hardwood with a density of 505–790 kg/m^3 at 15% moisture content. Heartwood brown with a pink tinge, sharply differentiated from the yellow-pink, 5–8 cm wide sapwood; grain straight; texture moderately coarse and uneven; wood with conspicuous silver grain on radial surface and rays also conspicuous on tangential surface as lens-shaped slits. Growth rings indistinct; vessels moderately small to medium-sized, solitary, in tangential multiples of 2–4(–6), or in tangential clusters, tangential arrangement of vessels conspicuous, vessels open; parenchyma moderately abundant, paratracheal vasicentric and in confluent, hammock-shaped layers from ray to ray; rays of 2 distinct sizes, very fine to moderately fine and mod-



Helicia latifolia
transverse surface (×20)

erately broad to very broad, the latter type conspicuous on all surfaces; ripple marks absent.
The wood seasons slowly to moderately fast with little end splitting and slight surface checking on the heart side. The wood is moderately hard to hard, is of moderate strength, is easy to saw and with care can be planed and worked to a smooth surface except for the 'open' nature of the rays. The wood is moderately durable. It is resistant to pressure impregnation. The sapwood is susceptible to *Lyctus*.
See also the table on microscopic wood anatomy.

Botany Shrubs or small to medium-sized trees up to 30 m tall; bole branchless for up to 15 m, up to 60 cm in diameter, sometimes slightly fluted or with slight buttresses up to 1.5 m high; bark surface smooth to scaly or finely fissured, often lenticellate, grey or pale brown to dark brown, inner bark fibrous, brown or pale orange-brown to yellow, sometimes mottled pink or red. Leaves arranged spirally or rarely subopposite or 3–4-verticillate, simple, sessile or petiolate, entire or dentate, exstipulate. Flowers in an axillary or ramiflorous or rarely subterminal, many-flowered, simple raceme, often paired, protandrous; pedicels of a pair free or united below, rarely entirely fused; tepals 4, united into a straight, slender tube which is swollen towards the top (limb), segments eventually splitting and coiled back; stamens 4, almost sessile and inserted in the concave limb segments, connective pointed; disk glands free or connate into a cup; ovary superior, 1-locular with 2 ovules, style slender. Fruit a nut, not or tardily dehiscent along 1 line, 1(–2)-seeded. Seed often subglobose; testa thin. Seedling with hypogeal germination; cotyledons not emergent; hypocotyl not elongated; leaves arranged spirally, serrate.
Vesicular-arbuscular mycorrhizae have been observed in *Helicia*. The hollow twigs of some species are often inhabited by ants. Flowering is generally seasonal, although in Papua New Guinea it is relatively constant all year round and fruiting is mainly in May–October. In Java *H. attenuata* flowers in May–August and fruits in September–December, *H. serrata* flowers in August–November and *H. robusta* in May–July. In Peninsular Malaysia *H. rufescens* flowers in April. Flowers contain nectar and are predominantly pollinated by birds and arboreal marsupials (*Phalangeridae*). Only few flowers per inflorescence set fruit. Fruits take about 2 months to mature.
Helicia has been subdivided into 3 sections and belongs to the tribe *Grevilleeae*. The fruits of *H. robusta* are reported to be poisonous.

Ecology *Helicia* species are found scattered in lowland to montane rain forest, up to 2000(–3350) m altitude. Some (e.g. *H. robusta*) prefer habitats along streams but others (e.g. *H. excelsa*) are found on hill tops or ridges.

Silviculture *Helicia* can be propagated by seed. *H. attenuata* has about 165 dry fruits/kg.

Genetic resources and breeding The risk of genetic erosion of those *Helicia* species with a narrow geographical distribution depends on the protection of their habitat.

Prospects *Helicia* is not an important timber-producing genus although some species yield hard wood.

Literature 61, 70, 101, 163, 267, 299, 304, 341, 343, 403, 405, 436, 829, 860, 974, 1025, 1038, 1039, 1221, 1242.

Selection of species

Helicia albiflora Sleumer

Distribution Papua New Guinea.

Helicia attenuata (Jack) Blume

Synonyms *Helicia bennettiana* Miq., *Helicia obovata* Benn., *Helicia suffruticosa* Ridley.

Vernacular names Indonesia: kayu pinang (Batak Karo, Sumatra), ki geuntul (Sundanese), serantie (Palembang, Sumatra). Malaysia: golang paya, kani batu puteh buaya (Peninsular), ringin (Sarawak). Thailand: mueat khon nam (peninsular).

Distribution Peninsular Thailand, Peninsular Malaysia, Sumatra, Java, Borneo and Bali.

Helicia excelsa (Roxb.) Blume

Synonyms *Alseodaphne crassipes* Hook. f., *Helicia oblanceolata* Merr., *Helicia salicifolia* Presl.

Vernacular names Indonesia: krinjing daun (Palembang, Sumatra), marabomban (Kutai), tutun lasurimanu etem (Simeuluë). Malaysia: medang layang (Peninsular), pasir-pasir (Sabah). Burma (Myanmar): kywedanyin. Cambodia: luöt chôm'. Thailand: mueat khon tua mae (northern). Vietnam: gium.

Distribution From Bangladesh to Indo-China, Thailand, Peninsular Malaysia, Sumatra and Borneo.

Helicia latifolia C.T. White

Distribution Papua New Guinea including New Britain.

Helicia moluccana (R. Br.) Blume

Synonyms *Helicia amboinensis* Miq., *Helicia obtusidens* Miq., *Roupala moluccana* R. Br.

Vernacular names Indonesia: ay lomamar dawon kecil (Ambon), dito ro (Halmahera), suling (Ternate).

Distribution The Moluccas; possibly also in New Guinea (Irian Jaya).

Helicia obtusata Sleumer

Synonyms *Helicia clemensiae* Sleumer.

Distribution Papua New Guinea.

Helicia petiolaris Benn.

Synonyms *Helicia kingiana* Prain, *Helicia obscurinervis* Chatterjee.

Vernacular names Malaysia: gong, putat tepi, sangka tua (Peninsular). Thailand: mueat khon doi (north-eastern).

Distribution Burma (Myanmar), Vietnam, Thailand, Peninsular Malaysia, Singapore and Borneo (Brunei, Sarawak).

Helicia robusta (Roxb.) R. Br. ex Wallich

Synonyms *Helicia cumingiana* Presl, *Helicia integrifolia* Elmer, *Helicia javanica* (Blume) Blume.

Vernacular names Indonesia: kayu maributan (Palembang, Sumatra), kendung (Javanese, Sundanese), watutu (Dayak, West Kutai). Malaysia: jaring jaringan jawa (Sabah), medang keladi, medang layang (Peninsular). Philippines: malaantigan (Samar-Leyte Bisaya), salimai (Manobo), salimai-lakihan (Tagalog). Burma (Myabmar): tauk yat. Thailand: duei, hang krakok (peninsular), meat khon (northern).

Distribution Southern India, Bangladesh, Burma (Myanmar), peninsular Thailand, Peninsular Malaysia, Sumatra, Java, Borneo and the Philippines.

Helicia rufescens Prain

Vernacular names Malaysia: sida barak (Peninsular).

Distribution Peninsular Malaysia, Sumatra and Borneo (Brunei).

Helicia serrata (R. Br.) Blume

Synonyms *Helicia brachyantha* Merr., *Helicia curtisii* Gamble, *Helicia scortechinii* Gamble.

Vernacular names Indonesia: barbeuyeuy (Sundanese). Malaysia: kayu sippur, kayu sippur gading, kayu si hondung (Peninsular).

Distribution Peninsular Malaysia, Sumatra, Java, Borneo and the Moluccas (Ambon).

U.A. Dasuki

Heliciopsis Sleumer

Blumea 8: 79 (1955).

PROTEACEAE

x = unknown; $2n$ = unknown

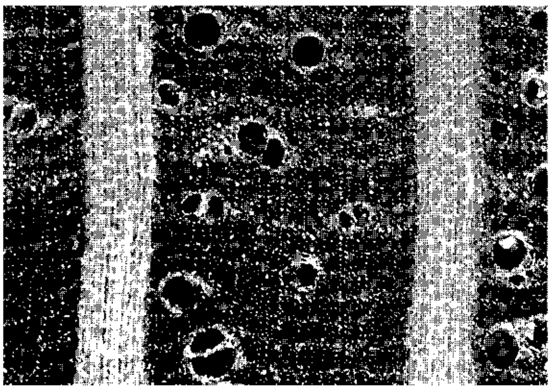
Vernacular names Malaysia: sawa luka (trade name).

Origin and geographic distribution *Heliciopsis* comprises 11 species occurring from Burma (Myanmar), Indo-China and south-eastern China to Thailand, Peninsular Malaysia, Sumatra, Java, Borneo and the southern Philippines (Palawan, Mindanao). Eight species occur within the Malesian region.

Uses The wood of *Heliciopsis* has a nice oak-like silver grain figure and is therefore used for cabinet and high-class furniture, superior joinery, interior finish and veneer.

Production and international trade In Peninsular Malaysia the wood of *Heliciopsis* is traded together with that of *Helicia* as 'sawa luka'.

Properties *Heliciopsis* yields a medium-weight hardwood with a density of 560–630 kg/m^3 at 15% moisture content. Heartwood brown with a pink tinge, clearly differentiated from the yellow-pink, up to 7 cm wide sapwood; grain straight; texture coarse and uneven due to the extremely broad rays; wood with conspicuous silver grain. Growth rings indistinct or absent; vessels moderately large, solitary and in tangential multiples of 2–4,



Heliciopsis montana
transverse surface (×20)

with gum deposits; parenchyma moderately abundant, apotracheal in narrow bands and in bands wider than 3 cells, hammock-shaped on transverse section; rays of two distinct sizes, very fine and broad to very broad; ripple marks absent.
There is only a slight risk of checking during seasoning. The wood is weak to moderately strong. It is easy to work and planes to a smooth surface. The wood is only slightly durable to non-durable; in a graveyard test sticks remained sound for 2 years. The sapwood should be removed when taking *Heliciopsis* wood in stock as it is very susceptible to *Lyctus*.
See also the table on microscopic wood anatomy.

Botany Dioecious, small to medium-sized trees up to 35 m tall, rarely shrubs; bole generally straight, up to 90 cm in diameter, without buttresses, sometimes fluted at base; bark surface smooth to rugose with minute fissures, with small lenticels, sometimes with hoop marks, usually pale, inner bark fibrous, usually yellowish to orange-brown. Leaves arranged spirally, often of 2 kinds, simple and entire or lobed to rarely pinnatisect, exstipulate. Inflorescence axillary or ramiflorous, racemose. Flowers unisexual but both sexes similar in appearance, in pairs with free to almost completely fused pedicels, 4-merous; tepals valvate, recurved; stamens sessile or nearly so, inserted on the tepals; disk consisting of 4 glands; ovary superior, 1-celled with 2 ovules, style simple, clavate. Fruit a drupe with 1–2 seeds and fibrous mesocarp. Seedling with hypogeal germination; cotyledons not emergent, peltate, succulent; hypocotyl sometimes slightly elongated; first pair of leaves opposite, subsequent ones spiral.
The flowers contain nectar and are presumably pollinated by birds.

Ecology Timber-yielding *Heliciopsis* species occur scattered in primary, lowland to lower montane rain forest, up to 1500 m altitude. They are often associated with small streams. *H. montana* is confined to montane forest.

Silviculture *Heliciopsis* can be propagated by seed. Stones of *H. velutina* germinated for about 65% in 13–24 days.

Genetic resources and breeding Some species are rare and indiscriminate logging of *Heliciopsis* may endanger these.

Prospects Although the wood is very attractive due the silver grain, its utilization is still limited and is unlikely to increase.

Literature 70, 198, 238, 267, 341, 343, 829, 831, 861, 933, 974, 1025, 1039, 1221, 1242.

Selection of species

Heliciopsis artocarpoides (Elmer) Sleumer
Synonyms *Helicia artocarpoides* Elmer.
Vernacular names Malaysia: kurunguh (Dusun Kinabalu, Sabah), putat (Sabah). Philippines: gunsili (Subanun).
Distribution Borneo and the Philippines (Palawan, Mindanao).

Heliciopsis cockburnii Kochummen
Distribution Peninsular Malaysia (rare).

Heliciopsis lanceolata (Koord. & Valeton) Sleumer
Synonyms *Helicia lanceolata* Koord. & Valeton.
Vernacular names Indonesia: kendung (Sundanese).
Distribution Java (rare).

Heliciopsis montana Sym. ex Kochummen
Distribution Peninsular Malaysia.

Heliciopsis rufidula Sleumer
Vernacular names Malaysia: belembang, mempening (Peninsular).
Distribution Peninsular Malaysia.

Heliciopsis velutina (Prain) Sleumer
Synonyms *Helicia velutina* Prain.
Vernacular names Indonesia: kedalai (Kalimantan).
Distribution Peninsular Malaysia and Borneo (Kalimantan, Sabah).

E. Boer (general part),
M.S.M. Sosef (general part, selection of species)

Hernandia L.

Sp. pl. 2: 981 (1753); Gen. pl., ed. 5: 421 (1754).
HERNANDIACEAE
$x = 20$; *H. nymphaeifolia*: $2n = 40$

Vernacular names Hernandia (En). Indonesia: bengkak (Javanese). Malaysia: buah keras laut (Peninsular).

Origin and geographic distribution *Hernandia* comprises about 25 species and is found in Central America, northern South America, tropical Africa (Gulf of Guinea and on the east coast), Madagascar towards Sri Lanka, the Nicobar and

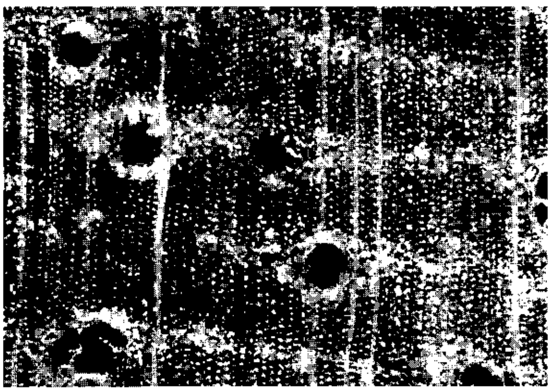
Andaman Islands, Vietnam, Thailand, the Ryukyu Islands, Taiwan, throughout the Malesian area towards north-eastern and eastern Australia into the Pacific, east to about 120° W. The genus probably originated in the areas adjacent to the Indian Ocean.

Uses The wood of *Hernandia* has been used for furniture and cabinet work, light interior construction, mouldings, canoe building, fishing net floats, wooden sandals, drawing boards, carving, model making, chopsticks, musical instruments and for core veneer.

The fruit is edible. The seeds contain an oil which has been used locally for illumination. In Java the blackish corewood of *H. nymphaeifolia* present at the base of the trunk has been used as an ingredient in a mixture to cure haemorrhaging. In Sarawak purgatives have been made from the leaves and the fruit. An extract of the leaves has also been applied as a painless depilatory. The bark of *H. nymphaeifolia* has been added to pig fodder for fattening. *H. ovigera* is planted as an ornamental and lawn tree.

Production and international trade The wood of *Hernandia* is mainly used local, but in 1996 Papua New Guinea exported about 935 m^3 of *Hernandia* wood at a price of US$ 103/m^3.

Properties *Hernandia* yields a lightweight hardwood with a density of 225–435 kg/m^3 at 15% moisture content. Heartwood whitish to greyish-brown with pinkish streaks, not sharply demarcated from the buff, pale yellow or pale grey sapwood; grain straight; texture moderately coarse to coarse and even; wood with pungent odour when fresh, a slight fragrance remaining after drying. Growth rings indistinct with a hand lens; vessels mostly diffuse-porous, but sometimes forming loose concentric rings, medium-sized to moderately large, solitary, in radial multiples of 2–3(–4) and occasionally in clusters, in tangential arrangement; parenchyma moderately abundant, paratracheal vasicentric, aliform and tending to confluent, and apotracheal in irregular bands, sometimes indistinct with a lens due to lack of contrast in colour with fibres; rays medium-sized and distinct to the naked eye; ripple marks absent.



Hernandia ovigera
transverse surface (×20)

Shrinkage upon seasoning is moderate and the wood seasons well but is susceptible to blue stain. It is very soft to soft, extremely weak and not tough. The wood is very easy to work. It is non-durable when exposed to the weather or in contact with the ground, but durable under cover. Preservative treatment by the pressure method is very easy. The sapwood is occasionally susceptible to *Lyctus*.

Seeds contain alkaloids and about 50% of a reddish-brown oil which contains stearin. When used for illumination the oil produces much smoke.

See also the table on microscopic wood anatomy.

Botany Evergreen or sometimes deciduous, monoecious, small to medium-sized trees up to 30(–40) m tall; bole up to 100(–200) cm in diameter, sometimes with small buttresses; bark surface cracked to shallowly fissured, slightly warty, greenish-yellow with a silvery sheen, inner bark corky or fibrous, pale yellowish-brown with distinct white streaks. Leaves arranged spirally, simple, entire or rarely 3–5-lobed, palmately veined, with rounded to slightly heart-shaped base, peltate or basifixed, exstipulate. Flowers in an axillary thyrse, white, scented, composed of groups of one female and two male flowers surrounded by 4 bracts, regular; perianth in two rows of 3–6 elements. Male flowers with 3–5(–6) stamens, opening by 2 valves and with 2 glands at base. Female flowers with an inferior, 1-locular ovary with a single ovule, style simple. Fruit a ridged drupe enclosed in an inflated cup. Seedling with hypogeal germination; cotyledons ruminate, not emergent; all leaves arranged spirally, first few scale-like, subsequent ones gradually increasing in size.

Flowering and fruiting of *H. ovigera* is throughout the year. Pollination is probably by insects. The buoyant fruits are dispersed by rivers and sea currents. Those of *H. nymphaeifolia* float for at least 2 months, but are also eaten and dispersed by bats.

H. nymphaeifolia has sometimes been confused in the literature with *H. ovigera*. They are easily distinguished by the leaves being peltate (*H. nym-*

phaeifolia) or not (*H. ovigera*). Hybrids between the two have been reported, mainly from coastal forests in New Guinea. Several subspecies have been distinguished within *H. moerenhoutiana*, but this classification needs confirmation.

Ecology *H. nymphaeifolia* is a fairly common element of coastal forest, notably the *Barringtonia* formation and the *Terminalia* zone. It grows on sandy soils or sometimes coral limestone. *H. ovigera* occurs in primary or sometimes old secondary, usually well-drained forest, from sea-level up to 1000 m altitude, also in coastal forest and on river banks. It has been reported from peat, clay and sandy clay soils. *H. moerenhoutiana* is found in primary and secondary lowland rain forest on limestone ridges at 100–900 m altitude.

Genetic resources and breeding As most *Hernandia* species are fairly common and widespread, the risk of genetic erosion is most probably negligible.

Prospects It is not very likely that the utilization of *Hernandia* timber will increase in the near future.

Literature 70, 151, 163, 209, 235, 238, 267, 300, 301, 304, 341, 343, 348, 403, 436, 438, 464, 487, 496, 632, 638, 639, 927, 933, 934, 1038, 1115, 1122, 1123, 1221, 1232.

Selection of species

Hernandia moerenhoutiana Guillem.

Distribution Papua New Guinea (Manus Island, New Britain), the Solomon Islands, Vanuatu and Samoa.

Hernandia nymphaeifolia (Presl) Kubitzki

Synonyms *Hernandia peltata* Meissn.

Vernacular names Jack in a box, sea-hearse (En). Indonesia: kampak, kampis (Sundanese). Malaysia: baru laut (Peninsular), kementing laut (Sarawak). Philippines: koron-koron (general), banung-kalawai (Tagbanua), malatangan-tangan (Tagalog). Thailand: kong pha mao, pho kring, pong (peninsular). Vietnam: tung.

Distribution From eastern Africa and Madagascar through the Indian Ocean towards Sri Lanka, the Andaman and Nicobar Islands, Indo-China, Taiwan, the Ryukyu Islands, Thailand, throughout Malesia, Queensland (Australia) and the majority of the Pacific Islands including Vanuatu.

Hernandia ovigera L.

Synonyms *Hernandia javanica* Tuyama, *Hernandia labyrinthica* Tuyama, *Hernandia papuana* C.T. White.

Vernacular names Indonesia: mahandap, mapopo (Sulawesi).

Distribution Islands west of Sumatra, Java, Christmas Island, the Philippines, Sulawesi, the Lesser Sunda Islands, the Moluccas, New Guinea, the Bismarck Archipelago, the Solomon Islands and the Mariana Islands.

R.R.P. Irwanto

Hibiscus L.

Sp. pl. 2: 693 (1753); Gen. pl., ed. 5: 310 (1754).
MALVACEAE
x = 8, 9, 12, 18, 21; *H. tiliaceus*: $2n \approx 86, 92$, $2n$ = 96

Vernacular names Hibiscus, roselle, rose mallow (En). Roselle (Fr). Indonesia: baru, waru. Malaysia: baru, bebaru bulu (Peninsular), baru laut (Sarawak). Thailand: ehaba. Vietnam: d[aa]m b[uj]t, ph[uf] dung.

Origin and geographic distribution *Hibiscus* comprises about 275 species occurring in tropical and subtropical regions of the world, with only 3 of them in temperate zones. Within the Malesian region 43 species are found, of which a minority yields timber.

Uses Although soft and comparatively weak, the wood of *Hibiscus* is quite attractive and used for local house building, interior trim, moulding, wagon frames, vehicle shafts, spokes and rims of wheels, gunstocks, household implements, tool handles, scabbards, musical instruments, picture frames, carving, package and fittings, toothpicks, matches and matchboxes, fencing and occasionally also for marquetry and barrel hoops. It has been reported to last very long in contact with water and has been applied for ship and boat building (frames and keels). The wood is also suitable for the manufacture of plywood, hardboard and probably also for that of paper. It yields a good firewood. The flexible branches have been used as fishing rods.

The bark of several timber-yielding species, notably from that of *H. tiliaceus*, can be used to manufacture a good quality rope which is also used for caulking boats. In Java the bark fibres are called 'lulub waru' and in southern Sumatra they are also used for plaiting mats. *H. macrophyllus* and *H.*

tiliaceus have been used to reforest eroded land, the latter also as a shade tree, hedge or windbreak, especially along the seashore, and, because of its showy yellow flowers with a purple centre, also as an ornamental. The bark and leaves of *H. tiliaceus* are used medicinally, especially to relieve coughs, sore throats and tuberculosis.

Production and international trade As the supply is very limited and sizes are small, *Hibiscus* wood is used on a local scale only; it may prove useful for specialty purposes.

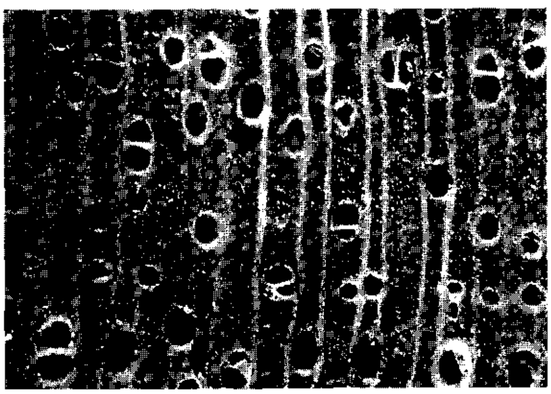
Properties *Hibiscus* yields a lightweight to medium-weight hardwood with a density of (335–) 370–720 kg/m^3 at 15% moisture content. Heartwood pale or dark yellow, brown, pale brown-grey or blue-grey with purplish tinge, grey-black, purple-black, sharply differentiated from the white or pale yellow, generally wide sapwood; grain straight, interlocked or alternating; texture fine to moderately fine, even; silver grain distinct. Growth rings indistinct to distinct indicated by colour differences or occasional marginal parenchyma; vessels moderately small to moderately large, solitary and in radial or occasionally tangential multiples of 2–4(–6) or in clusters, open; parenchyma moderately abundant, paratracheal vasicentric, and apotracheal diffuse-in-aggregates, variable in distinctness; rays extremely fine to medium-sized, distinct to the naked eye; ripple marks present and distinct; traumatic canals occasionally present.

Shrinkage of wood during seasoning is low in *H. tiliaceus*, moderate to high in *H. campylosiphon*. The wood seasons well but is highly susceptible to blue stain. It is soft to moderately hard, weak, but tough and elastic. It is easy to work and generally produces a smooth finish. The wood is non-durable when exposed to the weather or in contact with the ground although *H. d'albertisii* is reported durable. Under cover, the heartwood is resistant to dry-wood termites. The sapwood is susceptible to *Lyctus*.

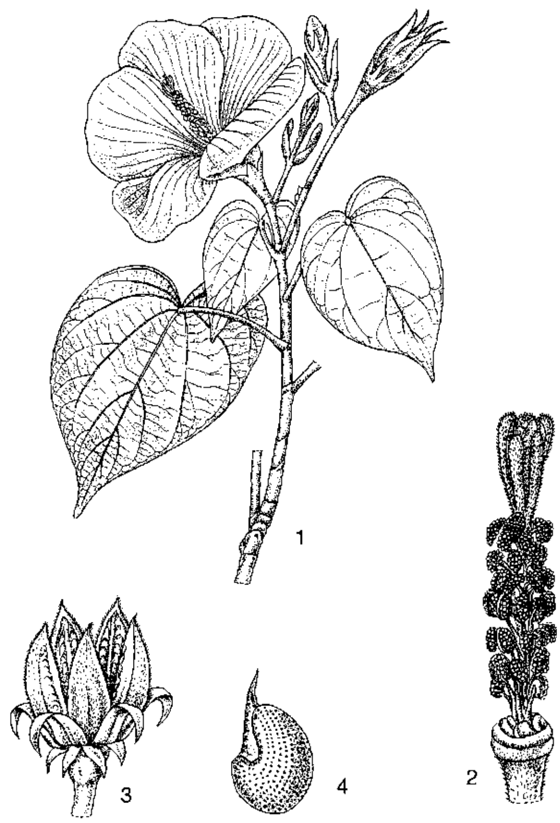
Paper manufactured from *H. tiliaceus* pulp is of low quality as the fibres are short (0.7–1.3 mm) and is only suitable for wrapping paper. Acetone extracts from the leaves of *H. tiliaceus* showed antibacterial activity.

See also the tables on microscopic wood anatomy and wood properties.

Botany Deciduous or evergreen, small to medium-sized trees up to 30 m tall, or shrubs or herbs; bole branchless for up to 12 m, up to 80 cm in diameter, sometimes with small buttresses; bark surface smooth to shallowly cracked or minutely fissured, lenticellate, grey or grey-fawn, inner bark fibrous, pinkish-brown, wood with slight, clear, slimy sap. Indumentum with stellate hairs and/or scales. Leaves arranged spirally, simple, entire to deeply lobed, palmately veined, stipu-



Hibiscus tiliaceus
transverse surface (×20)



Hibiscus tiliaceus L. – 1, flowering twig; 2, stamens and styles; 3, fruit; 4, seed.

late. Flowers axillary, solitary or in a raceme or panicle, 5-merous; epicalyx with 3-many free or almost free segments; calyx 5-lobed or 5-parted; petals free, often large; staminal column bearing anthers throughout or in the upper half; ovary superior, 5- or 10-locular with 3-many ovules per cell, style 1, apically divided into 5 branches. Fruit a dehiscent capsule with a persistent calyx and epicalyx. Seed globose to kidney-shaped. Seedling with epigeal germination; cotyledons emergent; hypocotyl elongated; all leaves arranged spirally.

Root nodules have been observed in *H. tiliaceus* in the Solomon Islands, where it is explicitly used for soil restoration during fallow, but atmospheric nitrogen fixation has not been confirmed. Early growth of *H. tiliaceus* is rapid and in 2–3 years the tree is large enough to provide shade. In Java it attained a diameter of 42 cm in 15 years, with sapwood being 3–5 cm in width for *H. tiliaceus* subsp. *tiliaceus* and 6–7 cm for subsp. *similis* (Blume) Borss. Waalk. On moderately fertile to fertile soils *H. tiliaceus* attained a mean diameter of 24–31 cm and a mean height of 20–28 m in 11 years. *H. tiliaceus* develops according to Scarrone's architectural tree model, characterized by an orthotropic rhythmically active terminal meristem which produces an indeterminate trunk bearing tiers of branches, each branch-complex orthotropic and sympodially branched as a result of terminal flowering. In Java *H. tiliaceus* flowers more or less throughout the year, but on other Indonesian islands flowering is restricted to 1–3 months/year. Flowers are pollinated by insects and birds. Seeds of *H. tiliaceus* can float in seawater for several months and are commonly found along the shore.

H. tiliaceus is very polymorphic and has been divided into 5 subspecies. The name *H. papuodendron* Kosterm. ('bulolo ash') occasionally appears in literature concerning Papua New Guinea timbers. The correct name is probably *Papuodendron lepidotum* C.T. White. Although *Papuodendron* is hardly distinct from *Hibiscus*, it is placed by some in the *Malvaceae* and by others in the *Bombacaceae*.

Ecology Timber-yielding *Hibiscus* species are usually found in secondary lowland forest, forest edges and waste sites, sometimes also in primary forest, up to 1500 m altitude, rarely in montane forest up to 2400 m. They often occur in moist locations and along rivers or even in swamps. *H. tiliaceus* is a well-known and common element of the *Barringtonia* formation along sandy shores and tidal creeks. It sometimes occurs in higher sites in mangrove vegetation or further inland along rivers and lakes. *H. tiliaceus* subsp. *similis*, however, is never found along or near the shore.

Silviculture *Hibiscus* is easily raised from seed or by cuttings and air layering, although for *H. macrophyllus* propagation by cuttings has been reported as difficult. *H. tiliaceus* subsp. *similis* apparently rarely sets seed, and is propagated by cuttings. It may be a hybrid. The only seed count available is for *H. macrophyllus*: about 146 000 dry seeds/kg. Seeds cannot be stored, although those of *H. tiliaceus* may still germinate after floating at sea for months. Seed of *H. tiliaceus* shows about 30% germination in 23–48 days. Cuttings are generally very successful and a trial plantation using cuttings planted at 3 m × 1 m was established in Java. There, the canopy had closed after only 2 years and the first thinning was done at the age of 5. As it has a tendency to develop many low and thick branches, gradual opening of the canopy is essential. It also proved susceptible to damage by wind and did not suppress 'alang-alang' (*Imperata cylindrica* (L.) Raeuschel) satisfactorily. In Peninsular Malaysia *H. tiliaceus* is recommended for planting on poor soils for firewood production. In general, it can be planted on a wide range of soils and is highly salt tolerant. *H. tiliaceus* coppices readily and, when cut back, produces many long, vigorous shoots with a high fibre production. In the Solomon Islands, however, coppicing reduced vigour. In some areas *H. tiliaceus* can form dense thickets over large areas, where trees regenerate by layering and new erect shoots from the branches of old trees. This habit of regeneration can be common especially after cyclones.

Genetic resources and breeding *H. campylosiphon* is rare and its use may reduce its genetic resource base. Other Malesian species, apart from *H. tiliaceus*, have a restricted distribution, but some are planted outside their natural area of distribution which thus contributes to their genetic conservation.

Prospects Due to its relative abundance along the shore, *H. tiliaceus* will probably continue to be used on a local scale for a wide array of purposes, but the use and trade of the timber of *Hibiscus* are unlikely to increase in the near future.

Literature 70, 101, 151, 160, 161, 163, 192, 209, 235, 260, 267, 300, 304, 346, 402, 405, 431, 436, 443, 464, 488, 495, 532, 568, 632, 633, 671, 818, 829, 831, 861, 889, 893, 934, 955, 974, 1023, 1038, 1048, 1118, 1169, 1221, 1232, 1242.

Selection of species

Hibiscus borneensis Airy Shaw

Distribution Borneo (Kalimantan, Sarawak).

Hibiscus campylosiphon Turcz.

Synonyms *Bombycidendron campylosiphon* (Turcz.) Warb. ex Perkins, *Bombycidendron parvifolium* Warb. ex Perkins, *Bombycidendron vidalianum* (Naves ex S. Vidal) Merr. & Rolfe.

Vernacular names Philippines: lanutan-buhukan, Vidal's lanutan (Filipino).

Distribution The Philippines; planted locally in Sumatra and Peninsular Malaysia.

Hibiscus d'albertisii F. v. Mueller

Synonyms *Hibiscus cardiostegius* Hochr., *Hibiscus fluminis-idenburgii* Borss. Waalk.

Distribution New Guinea; also planted near villages.

Hibiscus decaspermus Koord. & Valeton

Synonyms *Hibiscus flavotrichus* C.E. Fischer.

Vernacular names Indonesia: tangkoro, waru lot (Sundanese).

Distribution Southern Burma (Myanmar), peninsular Thailand, West Java, the Philippines, Sulawesi and the Lesser Sunda Islands.

Hibiscus floccosus Mast.

Vernacular names Malaysia: kangsar, kapas-kapas, pokok unchang (Peninsular). Thailand: chabaa dong (peninsular).

Distribution Peninsular Thailand and Peninsular Malaysia.

Hibiscus macrophyllus Roxb. ex Hornem.

Synonyms *Hibiscus spathaceus* Nees & Blume, *Hibiscus vestitus* Griffith, *Triplochiton spathacea* (Nees & Blume) Alefeld.

Vernacular names Bristly tree-hibiscus, large-leaved hau (En). Indonesia: anuk-anuk (Batak Karo, Sumatra), tisuk (Sundanese), waru payung (Javanese). Malaysia: baru, tutok (Peninsular), randog (Dusun Ranau, Sabah). Philippines: danglug (Tagbanua). Burma (Myanmar): dawng-hku. Laos: po 'khao. Thailand: ai-chong (peninsular), po hu (central), thong to (northern).

Distribution India (Assam), Bangladesh, Indo-China, Thailand, Peninsular Malaysia, Sumatra, Java and Borneo (Kalimantan, Sabah); planted as an ornamental in Palawan and the Hawaiian Islands.

Hibiscus pleijtei Borss. Waalk.

Distribution Irian Jaya.

Hibiscus schizopetalus (Mast.) Hook. f.

Synonyms *Hibiscus rosa-sinensis* L. var. *schizopetalus* Mast.

Vernacular names Coral hibiscus, Japanese hibiscus, shoe flower (En). Indonesia: kembang sepatu. Malaysia: bunga sepatu (Peninsular). Philippines: gumamela de araña (Filipino). Burma (Myanmar): pan-swe-le. Laos: deng soy. Thailand: chumba hoi (peninsular), hang hong, phu rahong (central).

Distribution Eastern Africa (Kenya and Tanzania); regularly planted as an ornamental and for live fences in the Malesian region and elsewhere.

Hibiscus tiliaceus L.

Synonyms *Hibiscus celebicus* Koord., *Hibiscus hastatus* L. f., *Hibiscus similis* Blume.

Vernacular names Mahoe, sea hibiscus (En). Indonesia: baru, waru (general), babaru (Halmahera). Malaysia: baru-baru (general), bebaru bulu (Peninsular), baru laut (Sarawak). Philippines: malabugo (Filipino), danglin (Tagalog), ragindi (Bisaya). Burma (Myanmar): thinban. Laos: hou sua, ta sua. Thailand: khamin nang matse (north-eastern), po na (peninsular), po thale (central).

Distribution Coastal tropical and subtropical areas throughout the world; occasionally planted as an ornamental.

S.I. Wiselius

Horsfieldia Willd.

Sp. pl. 4: 872 (1806).

MYRISTICACEAE

x = unknown; *H. iryaghedhi* (Gaertn.) Warb.: n = 25

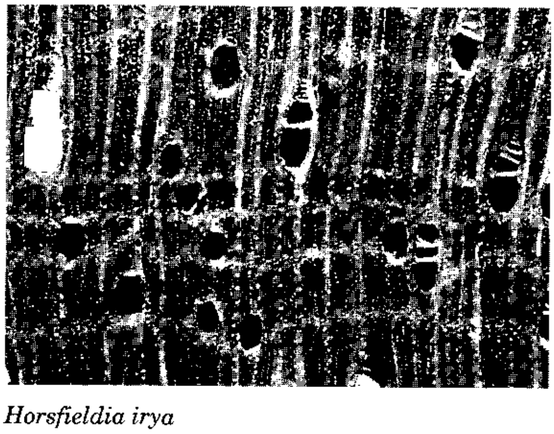
Vernacular names Penarahan (trade name). Horsfieldia (En). Brunei: kumpang. Indonesia: darah-darah, pendarah. Malaysia: dara kerbau (Peninsular), darah-darah (Sabah), kumpang (Sarawak). Papua New Guinea: horsfieldia, nutmeg (En). Philippines: duguan (Filipino).

Origin and geographic distribution *Horsfieldia* comprises about 100 species distributed from Sri Lanka and north-eastern India to Indo-China, southern China, Thailand, throughout the Malesian region (except for the Lesser Sunda Islands), the Caroline Islands, the Solomon Islands and northern Australia. Most of the species occur within Malesia and many, often endemic ones, are present in Borneo (40) and New Guinea (30).

Uses The wood of *Horsfieldia* is used for light or temporary construction, flooring, boat building, interior trim, joinery, wall panelling, shelving, lining, mouldings, sporting goods, packing cases, crates, matchboxes and match splints, and for the production of particle board and plywood.
The seed contains a high percentage of fat as well as a hallucinogenic substance. *H. sylvestris* is occasionally planted and recommended as an ornamental tree. The fruits of various species have been recorded as edible.

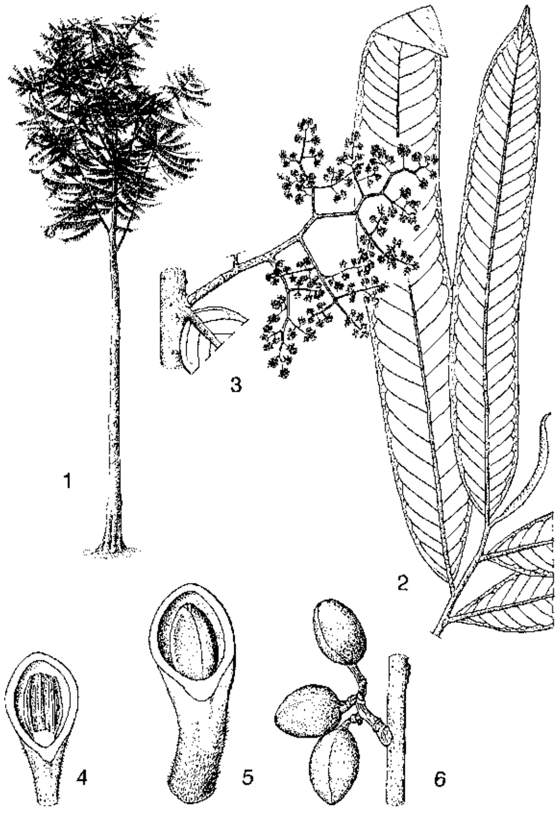
Production and international trade *Horsfieldia* wood may be traded in mixed consignments of medium-weight hardwood or occasionally mixed with 'red meranti', or together with that of other *Myristicaceae* genera like *Gymnacranthera*, *Knema* and *Myristica* as 'penarahan' or 'nutmeg'. It constitutes a minor proportion of the total amount of this timber traded. In 1996 Papua New Guinea exported about 14 200 m^3 of nutmeg logs, of which *Horsfieldia* makes up a fair portion, at an average free-on-board (FOB) price of US$ 100/m^3. In 1992 the export of penarahan from Sabah amounted to about 250 m^3 of sawn timber and about 6750 m^3 of logs at prices of US$ 140/m^3 and US$ 71/m^3 respectively.

Properties *Horsfieldia* yields a lightweight to medium-weight hardwood with a density of 295–650 kg/m^3 at 15% moisture content. Heartwood pink-brown, grey-brown or red-brown, sometimes not well developed but large trees often with dark central core, not clearly differentiated from the pale yellow-brown sapwood which has a pink or reddish tinge, large trees with a comparatively hard and heavy, dark purplish-brown or dark red core; grain straight or sometimes slightly wavy; texture rather fine to moderately coarse and even. Growth rings usually distinct to the naked eye, boundaries indicated by reddish marginal parenchyma; vessels moderately small to moderately large, solitary and in radial multiples of 2–3 (–5), open but deposits common in dark corewood; parenchyma moderately abundant, apotracheal in marginal or seemingly marginal bands, and scanty paratracheal to vasicentric; rays moderately fine to medium-sized, just visible to the naked eye on transverse section; ripple marks absent; tanniferous tubes occasionally visible on the radial surface as dark-coloured lines in the rays.
Shrinkage is low and the wood seasons slowly but well; only thin boards may warp. The wood is soft to moderately hard and weak. It can be easily sawn. Turning and moulding properties are satisfactory. It can be planed to a relatively smooth finish and the dark core takes a high polish. The wood is non-durable, readily attacked by fungi when exposed to the weather or in contact with the ground and by dry-wood termites and ambrosia beetles. The sapwood is extremely susceptible to *Lyctus*. The sapwood is permeable, the heartwood is moderately resistant to impregnation. Retention of copper-chrome-arsenic (CCA) preservative in the sapwood of *H. sylvestris* was about 345 kg/m^3 and in the heartwood 305 kg/m^3 but penetration in the heartwood was refractory.
See also the tables on microscopic wood anatomy and wood properties.



Horsfieldia irya
transverse surface (×20)

Botany Evergreen, dioecious, small to medium-sized or rarely large trees up to 30(–60) m tall; bole generally straight, cylindrical, up to 60(–90) cm in diameter, occasionally with small buttresses or stilt roots; bark surface smooth or rough with superficial cracks and fissures, sometimes flaking, dark greyish-brown or blackish, inner bark reddish-brown, with red watery exudate; branches spreading horizontally or drooping. Leaves often distichous, simple, entire, exstipulate. Flowers in an axillary, paniculate, unisexual inflorescence; perianth either 2(–3) or (2–)3–4-lobed with erect or suberect lobes. Male flower with few to many stamens, filaments entirely or largely fused into a central column. Female flower with a superior, 1-locular ovary with a single ovule, stigma 2-lobed. Fruit a glabrous or pubescent, 1-seeded follicle splitting on 1–2 sides. Seed with a subentire aril completely covering the seed, endosperm without starch. Seedling with hypogeal germination; co-



Horsfieldia sylvestris (Houtt.) Warb. – 1, tree habit; 2, sterile twig; 3, male inflorescence; 4, male flower; 5, female flower; 6, fruits.

tyledons not emergent; hypocotyl not elongated; epicotyl with a few scale leaves followed by spirally arranged, conduplicate leaves.

Branches bear distichous leaves, whereas the leader shoot bears leaves arranged spirally. Branching is monopodial. Tree form is according to Massart's architectural tree model, characterized by an orthotropic, monopodial trunk with rhythmic growth consequently producing tiers of plagiotropic branches. Flowering is at irregular but rather frequent intervals. In southern Papua New Guinea *H. hellwigii* and *H. sylvestris* flower in May–July. The seed of *H. irya* is reported to have an air chamber, facilitating dispersal by water. Seeds of *H. sylvestris* are eaten by birds (e.g. hornbills, pigeons, parrots).

Horsfieldia has been subdivided into 3 sections: sect. *Horsfieldia* with a single species in Sri Lanka, sect. *Irya* (Hook. f. & Thomson) Warb. with about 40 species and generally with a 2-lobed perianth, is mainly distributed in East Malesia, and sect. *Pyrrhosa* (Blume) Warb. with about 60 species and generally with a 3-lobed perianth, occurs mainly in West Malesia.

Ecology *Horsfieldia* is found scattered in lowland or lower montane or rarely montane rain forest, up to 1200(–2000) m altitude, on dry land as well as in swamp forest. They grow as canopy or subcanopy trees in primary forest but may persist in secondary growth. Most species are restricted to a certain soil type. *H. crassifolia* is a species of peat-swamp forest. The widespread *H. irya* has a preference for coastal areas or riverside habitats.

Silviculture *Horsfieldia* can be propagated by seed. Seeds of *H. brachiata* gave about 30% germination in 10–22 weeks, seeds of *H. fulva*, with aril, have about 85% germination in 7–12 weeks and those of *H. tomentosa* about 75% in 7–13 weeks.

Genetic resources and breeding Several of the narrowly endemic *Horsfieldia* species may easily become threatened by destruction of their habitat.

Prospects No increase in the use of the timber of *Horsfieldia* is foreseen in the near future. Some species which thrive in secondary growth (e.g. *H. hellwigii*, *H. sylvestris*) may have potential for reforestation.

Literature 40, 59, 125, 151, 162, 163, 209, 238, 245, 246, 247, 248, 250, 267, 300, 304, 348, 436, 536, 553, 596, 632, 765, 780, 801, 829, 831, 861, 934, 974, 1018, 1020, 1021, 1038, 1221, 1232, 1242.

Selection of species

Horsfieldia angularis W.J. de Wilde

Vernacular names Indonesia: bepus (Hattam, Irian Jaya), betelhoi, sebohonggwa (Manikiong, Irian Jaya).

Distribution New Guinea (Irian Jaya).

Horsfieldia borneensis W.J. de Wilde

Vernacular names Malaysia: kumpang balau (Iban, Sarawak).

Distribution Borneo.

Horsfieldia brachiata (King) Warb.

Synonyms *Horsfieldia subglobosa* (Miq.) Warb. var. *brachiata* (King) J. Sinclair.

Vernacular names Indonesia: kayu darodong (Tapanuli), peredah burung (Palembang, Sumatra). Thailand: phlao phra, thong phra (peninsular).

Distribution Peninsular Thailand, Peninsular Malaysia, Sumatra and Borneo.

Horsfieldia costulata (Miq.) Warb.

Synonyms *Horsfieldia confertiflora* Merr., *Horsfieldia megacarpa* Merr., *Horsfieldia pachythyrsa* Warb.

Vernacular names Indonesia: kayu ra (Central Sulawesi). Philippines: yabnob (Filipino), tadhok (Sulu).

Distribution The Philippines and Sulawesi.

Horsfieldia crassifolia (Hook. f. & Thomson) Warb.

Synonyms *Horsfieldia fulva* (King) Warb. var. *paludicola* (King) Warb., *Myristica paludicola* King, *Myristica subglobosa* Miq. p.p.

Vernacular names Indonesia: kayu haruya (Batak, Sumatra). Malaysia: jangkang paya (Peninsular), kumpang ensiline, kumpang sadara (Sarawak).

Distribution Peninsular Malaysia, Singapore, Sumatra and Borneo.

Horsfieldia fragillima Airy Shaw

Vernacular names Malaysia: kumpung pango (Iban).

Distribution Borneo.

Horsfieldia fulva (King) Warb.

Distribution Peninsular Malaysia and Sumatra.

Horsfieldia glabra (Blume) Warb.

Vernacular names Indonesia: klapa cung (Javanese), ki tungila (Sundanese), sumaralah silai delok (Simeuluë).

Distribution Sumatra and Java.

Horsfieldia grandis (Hook. f.) Warb.

Synonyms *Myristica rubiginosa* King.

Vernacular names Indonesia: cemanding (Palembang, Sumatra).

Distribution Peninsular Malaysia, Singapore, Sumatra and Borneo.

Horsfieldia hellwigii (Warb.) Warb.

Synonyms *Horsfieldia glabrescens* Warb.

Distribution Papua New Guinea and the Bismarck Archipelago.

Horsfieldia irya (Gaertn.) Warb.

Synonyms *Horsfieldia acuminata* Merr., *Horsfieldia congestiflora* A.C. Smith, *Horsfieldia subglobosa* (Miq.) Warb.

Vernacular names Indonesia: kalak pacung (Javanese), kalapa tiyung (Sundanese), peredah burung (Palembang, Sumatra). Malaysia: chendarah, lempoyang paya, pianggu (Peninsular). Philippines: anoniog (Filipino). Thailand: han, tum phra (peninsular), kruai nam (central).

Distribution Sri Lanka, the Andaman and Nicobar Islands, Burma (Myanmar), Indo-China, southern China, Thailand, throughout the Malesian region except for the Lesser Sunda Islands, the Caroline Islands and the Solomon Islands.

Horsfieldia laevigata (Blume) Warb.

Synonyms *Horsfieldia hellwigii* (Warb.) Warb. var. *novobritannica* J. Sinclair, *Horsfieldia nesophila* (Miq.) Warb., *Horsfieldia novae-lauenburgiae* Warb.

Vernacular names Indonesia: luhakon (Halmahera), samgoot (Kebar, Irian Jaya).

Distribution The Moluccas, New Guinea and the Bismarck Archipelago.

Horsfieldia lancifolia W.J. de Wilde

Vernacular names Indonesia: tabenu benu (Malili, Sulawesi).

Distribution Central and South Sulawesi.

Horsfieldia laticostata (J. Sinclair) W.J. de Wilde

Synonyms *Horsfieldia brachiata* (King) Warb. var. *laticostata* J. Sinclair.

Vernacular names Malaysia: piasau piasau (Kedayan, Sabah).

Distribution Borneo.

Horsfieldia leptantha W.J. de Wilde

Distribution New Guinea.

Horsfieldia moluccana W.J. de Wilde

Synonyms *Horsfieldia olivaeformis* Warb. p.p.

Vernacular names Indonesia: gosara (Ternate), kuleman (Morotai), pala hutan (Moluccas).

Distribution The northern Moluccas and New Guinea (Irian Jaya).

Horsfieldia motleyi Warb.

Synonyms *Horsfieldia macrobotrys* Merr., *Myristica motleyi* (Warb.) Boerl.

Distribution Borneo.

Horsfieldia olens W.J. de Wilde

Distribution New Guinea.

Horsfieldia polyspherula (Hook. f. emend. King) J. Sinclair

Synonyms *Horsfieldia brachiata* (King) Warb. var. *sumatrana* (Miq.) J. Sinclair, *Myristica collecttiana* King.

Vernacular names Indonesia: cemanding (Palembang, Sumatra), manggu mangkiras (Landak, Kalimantan). Malaysia: kajang, kumpang lusoh (Sarawak).

Distribution Peninsular Malaysia, Singapore, Sumatra, Borneo and the Philippines.

Horsfieldia punctatifolia J. Sinclair

Distribution Peninsular Malaysia, Singapore, Sumatra and Borneo.

Horsfieldia sabulosa J. Sinclair

Vernacular names Malaysia: kumpang perawan (Iban, Sarawak).

Distribution Borneo (Sarawak, Brunei, Sabah).

Horsfieldia sparsa W.J. de Wilde

Distribution Peninsular Thailand, Peninsular Malaysia, Singapore and Sumatra.

Horsfieldia sucosa (King) Warb.

Synonyms *Horsfieldia bracteosa* M.R. Hend.

Vernacular names Malaysia: merampat (Peninsular).

Distribution Peninsular Malaysia, Sumatra and Borneo (Kalimantan, Sabah).

Horsfieldia superba (Hook. f. & Thomson) Warb.

Vernacular names Cabbage-leaved nutmeg (En).

Distribution Peninsular Malaysia, Singapore and Sumatra.

Horsfieldia sylvestris (Houtt.) Warb.

Synonyms *Myristica pendulina* Hook. f., *Myristica pinnaeformis* Zipp. ex Miq., *Myristica salicifolius* Willd.

Vernacular names Indonesia: au-au (Ternate), luri ma toku (northern Halmahera), palala burung (Moluccas).

Distribution The Moluccas and New Guinea.

Horsfieldia tomentosa Warb.

Vernacular names Malaysia: manchong (Peninsular). Thailand: khe min, lueat khwai daeng, po daeng (peninsular).

Distribution Peninsular Thailand, Peninsular Malaysia and Sumatra.

Horsfieldia tuberculata (K. Schumann) Warb.

Synonyms *Horsfieldia novoguineensis* Warb. var. *moseleyana* Warb., *Horsfieldia solomonensis* A.C. Smith.

Distribution New Guinea, the Bismarck Archipelago, the Caroline Islands, the Admiralty Islands and the Solomon Islands.

Horsfieldia wallichii (Hook. f. & Thomson) Warb.

Vernacular names Indonesia: pianggu (Bangka), satim, sumaralah (Simeuluë).

Distribution Peninsular Malaysia, Singapore, Sumatra and Borneo.

W.J.J.O. de Wilde

Hydnocarpus Gaertn.

Fruct. sem. pl. 1: 288, t. 60, f. 3 (1788).

FLACOURTIACEAE

x = 12; *H. anthelmintica*: $2n$ = 24, *H. ilicifolia* King: $2n$ = 22, *H. kurzii* (King) Warb.: $2n$ = 24

Vernacular names Senumpul (trade name). Malaysia: karpus (Sabah), setumpol (Peninsular). Burma (Myanmar): kalaw. Thailand: krabao.

Origin and geographic distribution *Hydnocarpus* comprises about 40 species occurring in Sri Lanka, south-western India and Assam, Burma (Myanmar), Indo-China, southern China, Thailand (7 species), Peninsular Malaysia (12), Sumatra (12), Java (2), Borneo (17), the Philippines (5) and Sulawesi (2).

Uses The wood of *Hydnocarpus* is used for local house building (poles), temporary heavy construction, posts, fences, interior finishing, panelling and door and window frames. When available in sufficient quantities it may be suitable for furniture, flooring, mouldings and partitioning. It is also suitable for mathematical instruments, tripods and packing cases. Locally, it has been used as firewood.

The seeds of several species (notably *H. anthelmintica* and *H. kurzii*) yield an oil that is well-known as a cure for leprosy and skin diseases. In Cambodia this oil has also been used for illumination and applied for soap-making. The fibrous bark is made into cordage. The pulp of the fruits is edible. Occasionally, trees are planted as an ornamental.

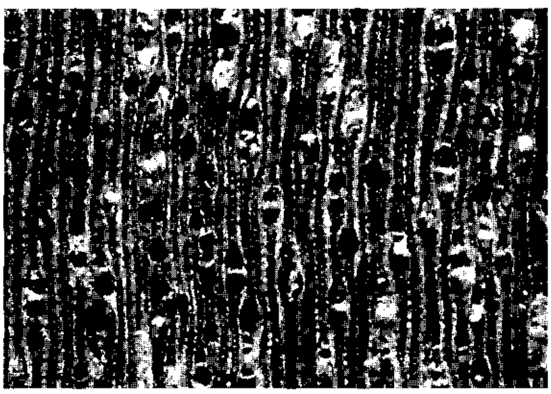
Production and international trade There are no specific records of trade of *Hydnocarpus* timber. It is most likely used on a local scale only, or traded in mixed consignments of medium-weight hardwood.

Properties *Hydnocarpus* yields a medium-weight to heavy hardwood with a density of 690–950 kg/m^3 at 15% moisture content. Heartwood pale yellow or yellow-brown, not clearly demarcated from the sapwood; grain straight or interlocked, sometimes deeply interlocked; texture fine or moderately fine and even. Growth rings usually indistinct; vessels very small to medium-sized, solitary or in radial multiples of 2–4, markedly angular, occasionally with pale deposits and tyloses; parenchyma absent; rays very fine to moderately fine, visible to the naked eye; ripple marks absent.

The wood is difficult to season and liable to check and split, but it is also reported to season well without serious defects. The wood is hard, but works well with hand machine tools. It is probably moderately durable under exposed conditions, but has also been reported as non-durable, even under cover. The wood is susceptible to termite attack. The average fibre length of *H. kunstleri* is 3.49 mm.

See also the table on microscopic wood anatomy.

Botany Evergreen, dioecious or occasionally monoecious shrubs or small to medium-sized or rarely large trees up to 25(–50) m tall; bole up to 85 cm in diameter, sometimes with low buttresses; bark surface usually smooth, sometimes cracking and scaly, pale brown to greyish, inner bark granular to fibrous, cream or sometimes with orange to yellow-brown spots or mottles. Leaves alternate, simple, entire or serrate, slightly asymmetrical at base; stipules early caducous. Flowers unisexual, 4–5-merous; sepals free or rarely slightly connate at base, imbricate; petals with a mostly densely pilose scale at base inside. Male flowers in an axillary cyme or rarely in a raceme-like cauliflorous or ramiflorous panicle; stamens 5–many. Female flowers 1–3 together; ovary superior, unilocular with many ovules, stigma sessile and with 3–5 spreading branches. Fruit an indehiscent, globose drupe with closely packed seeds. Seed with a membranous aril. Seedling with epigeal germination; cotyledons emergent or not, leafy; hypocotyl elongated; all leaves arranged spirally, conduplicate.



Hydnocarpus heterophylla
transverse surface (×20)

Tree architecture of *H. anthelmintica* is according to Roux's architectural model, characterized by a continuously growing monopodial orthotropic trunk with plagiotropic branches. Flowering is usually once a year, but the period differs per region. Fruit takes a long time to develop; for instance *H. woodii* fruits take about 7.5 months. Dispersal of the fleshy fruits by animals seems likely, but has to be confirmed by observations. In Java *H. alpina* Wight, reportedly originating from India and Thailand, has been planted in a trial and after 26 years trees were on average 18 m tall and 21 cm in diameter. It is uncertain whether the trees concerned were the true *H. alpina* from western India or *H. anthelmintica* from Thailand. A 45-year-old *H. woodii* tree in the arboretum of the Forest Research Institute Malaysia, Kepong measured 17 m in height and 40 cm in diameter.

Ecology Most timber-producing *Hydnocarpus* species are found scattered in primary rain forest, in well-drained level locations or on hillsides, on sandy or clayey soils, up to 1000(–1700) m altitude, occasionally in beach forest or rocky outcrops. *H. castanea* is also found along streams and rivers and in seasonal swamps. *H. heterophylla* usually occurs on calcareous soils.

Silviculture *Hydnocarpus* can be propagated by seed. Ripe fruits are collected and piled in heaps for 3–4 days. The seeds can then be separated from the pulp by washing. Seed of *H. kunstleri* has 50% germination in 4–8 months and that of *H. woodii* has about 50% germination in 5 months to over 2 years. Information on silvicultural aspects is scarce, though from Peninsular Malaysia it is reported that *H. woodii* is considered shade-tolerant and does not reach the upper canopy stratum.

Genetic resources and breeding Since there are many *Hydnocarpus* species, potentially important species should be collected and conserved. Further studies are needed to determine their suitability for plantation-grown cultivation.

Prospects Increased utilization of *Hydnocarpus* is unlikely to occur unless plantations are established.

Literature 61, 162, 163, 198, 267, 341, 343, 402, 436, 740, 741, 758, 829, 830, 831, 832, 861, 894, 974, 1028, 1038, 1169, 1219, 1221, 1239, 1242.

Selection of species

Hydnocarpus anomala (Merr.) Sleumer

Synonyms *Hydnocarpus lasionema* Airy Shaw, *Taraktogenos anomala* Merr.

Vernacular names Indonesia: jangan, payang balaan, tetek (Dayak, Kalimantan).

Distribution Borneo.

Hydnocarpus anthelmintica Pierre ex Lanessan

Synonyms *Hydnocarpus alpina* Wight var. *elongata* Boerl., *Hydnocarpus alpina* Wight var. *macrocarpa* Boerl.

Vernacular names Burma (Myanmar): kalaw-wa. Cambodia: krabaou (Kompong Thom), krabaou phlae thom (Cambodge), krabaou thom (Pursat). Laos: ka bao. Thailand: bao (peninsular), krabao yai (central). Vietnam: ch[oo]m h[oo]i (Thua Thien), ch[uf]m bao (Gia Dinh), phong tu-tu (Bien Hoa).

Distribution Burma (Myanmar), Indo-China and Thailand; also cultivated within this region for its medicinal seeds.

Hydnocarpus castanea Hook. f. & Thomson

Vernacular names Malaysia: pokok alai batu, tembikar periyok, tengkurak lang (Peninsular). Burma (Myanmar): kalaw-pya. Thailand: bao dong, krabao daeng, krabao khang (peninsular).

Distribution Peninsular Burma (Myanmar), the Andaman Islands, Thailand, Peninsular Malaysia and Sumatra.

Hydnocarpus filipes Symington & Sleumer

Distribution Peninsular Malaysia.

Hydnocarpus gracilis (v. Slooten) Sleumer

Synonyms *Taraktogenos gracilis* v. Slooten.

Vernacular names Indonesia: kayu sebiya (Sumatra), rasak lagar, umpasdungan (Kalimantan).

Distribution Sumatra and Borneo.

Hydnocarpus heterophylla Blume

Synonyms *Cyclostemon iwahigensis* Elmer, *Taraktogenos blumei* Hassk., *Taraktogenos heterophylla* (Blume) v. Slooten.

Vernacular names Indonesia: becampoih (Palembang, Sumatra), kandar lutung (Sundanese), luteng (Javanese). Philippines: balik (Panay Bisaya), butong-manok (Bikol), magluni (Tagbanua).

Distribution Southern Sumatra, West Java, south-east Borneo, the Philippines and North Sulawesi.

Hydnocarpus kunstleri (King) Warb.

Synonyms *Hydnocarpus kingii* Warb., *Taraktogenos kunstleri* King, *Taraktogenos scortechinii* King.

Vernacular names Indonesia: gambir-gambir (Batak Karo, Sumatra), kayu tanah (Palembang, Sumatra). Malaysia: tulang beliung, tupai (Peninsular).

Distribution Peninsular Malaysia, Sumatra and Borneo.

Hydnocarpus sumatrana (Miq.) Koord.

Synonyms *Hydnocarpus hutchinsonii* Merr., *Hydnocarpus pentagyna* v. Slooten, *Ryparosa sumatrana* (Miq.) Warb.

Vernacular names Indonesia: buntut kayu (Sumatra), limus buntu (Javanese), wulosu (Sulawesi). Philippines: bagarbas (Lanao), kamupang (Sulu), mangasaluka (Yakan).

Distribution Sumatra, Borneo, the southern Philippines and Sulawesi.

Hydnocarpus woodii Merr.

Vernacular names Indonesia: kayu tanah (Sumatra), kelapa jankai (Kalimantan), kerambil tupai (Riau Archipelago). Malaysia: kulau (Peninsular).

Distribution Peninsular Malaysia, Sumatra and Borneo.

H.C. Ong

Hymenodictyon Wallich

Roxb., Fl. ind. 2: 148 (1824).

RUBIACEAE

x = probably 11; *H. orixense*: $n = 22, 33$, $2n = 22$

Vernacular names Indonesia: bindung gelatah (Madura), jati awang, klepu sapi (Java). Malaysia: lepar, medang keladi (Peninsular). Philippines:

aligango, hibau (Tagalog), kukun-banuk (Panay Bisaya). Burma (Myanmar): kusan kuthan. Cambodia: oulok. Thailand: lata, som lu (peninsular), som kop (northern). Vietnam: c[aa]y tai ngh[es].

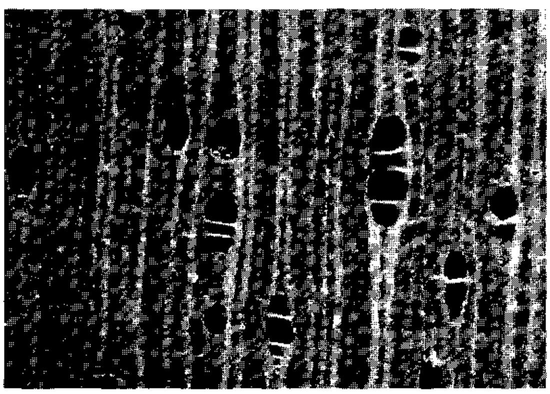
Origin and geographic distribution *Hymenodictyon* comprises about 20 species, most of which occur in tropical Africa and Madagascar. Only a few species are found in Asia. Probably the only Malesian species is *Hymenodictyon orixense* (Roxb.) Mabberley (synonyms: *Cinchona orixensis* Roxb., *Cinchona excelsa* Roxb., *Hymenodictyon excelsum* (Roxb.) Wallich ex Roxb.) which occurs in India, Burma (Myanmar), Indo-China, Thailand, Peninsular Malaysia, Sumatra, Java, the Lesser Sunda Islands, the Philippines, Sulawesi and the Moluccas.

Uses The wood of *H. orixense* is used locally in house building, e.g. for planks, and sometimes for boats; it is also used for boxes, scabbards, packing-cases, implements, toys and matches. In India it has been recommended for cheaper grades of furniture, warper bobbins and wood-wool board.

In India the bitter bark is used in local medicine as an astringent and febrifuge.

Production and international trade The wood of *H. orixense* is probably used rarely and on a local scale only, due to its comparative rareness and patchy occurrence.

Properties *H. orixense* yields a lightweight hardwood with a density of 370–540(–610) kg/m^3 at 15% moisture content, the higher value for a sample from Burma (Myanmar). Heartwood white when fresh, becoming yellow-grey or pale grey-brown on exposure, not clearly demarcated from the sapwood; grain straight; texture moderately fine to slightly coarse and even. Growth rings visible but inconspicuous, boundary marked by a narrow layer lacking parenchyma; vessels medium-sized to moderately large, solitary and in radial multiples of 2–3, occasionally in small clusters, open; parenchyma very abundant, apotracheal diffuse-in-aggregates, sometimes forming more or less continuous concentric layers, visible with a hand lens, occasionally paratracheal; rays extremely fine and moderately fine; ripple marks absent.



Hymenodictyon orixense
transverse surface (×20)

Air seasoning is easy: it takes 13 days to kiln dry boards 2.5 cm thick from 80% to 8% moisture content. The wood is soft to moderately hard and moderately strong. It works very easily and turns well. The wood is not durable when exposed to the weather or in contact with the ground and is moderately resistant to preservative treatment. It is somewhat liable to borers, especially when left debarked.

The bark contains scopoletin and a very bitter glycoside.

See also the table on microscopic wood anatomy.

Botany A small to medium-sized tree up to 25 m tall; bole usually rather straight, up to 50 cm in diameter; bark surface smooth, greyish-brown. Leaves opposite, simple, entire, obovate or ovate to elliptical-lanceolate, with scattered minute hairs all over the upper surface; stipules ovate, with tiny teeth-like glands on the margin. Inflorescence terminal, paniculate, reflexed but with the lateral branches curving upwards. Flowers 5-merous; calyx lobes minute; corolla trumpet-shaped, short-hairy outside; stamens inserted in the throat of the corolla tube, filaments minute; ovary inferior, 2-locular with many ovules. Fruit an ellipsoid, 2-valved, loculicidal capsule, many-seeded. Seed flat and winged all around. Seedling with epigeal germination.

Shoot development is very slow during the first year but the roots may attain 45 cm. Maximum height attained in 4 years in India was only 1.5 m. In India a wood sample from a 41-year-old tree showed a mean annual diameter increment of 0.8 cm, which is fairly high. Trees are only deciduous in very dry regions. Seed can be dispersed over a long distance by wind.

Hymenodictyon belongs to the tribe *Cinchoneae* of the subfamily *Chinchonoideae*. The three species of *Hymenodictyon* reported for the Malesian region may well prove to represent only a single one.

Ecology Regeneration is usually confined to open spaces in the forest, which may explain why *H. orixense* is more frequent in (but not restricted to) drier areas where the forest is more open than in the rain forest. In the Philippines it is often found in secondary forest at low and medium altitudes and on cliffs near the sea.

Silviculture *H. orixense* can be propagated by seed, but direct seeding is not recommended as the seed is very small (about 170 000 seeds/kg) and easily washed away. Seed usually germinates easily, but loses its viability within a year. It should be sown in seed-beds and lightly covered with fine soil or fine sand and watered frequently, but sparingly. The first seedlings appear after 10 days. When 2–3 months old they can be pricked out into containers. The more vigorous seedlings can be planted out after one year, others should be kept in the nursery for another year. *H. orixense* is suitable for plantations in areas with a mean annual rainfall of 1000–1200 mm. Seedlings are light-demanding and easily killed by weeds. Planting in the open may present some problems. *H. orixense* is not resistant to fire.

Genetic resources and breeding *H. orixense* is widespread although not common in many areas. In Malesia records are scarce and its distribution is very patchy. Some caution in logging this tree seems justified.

Prospects *H. orixense* is too scarce in Malesia to be of future importance. However, it might be worthwhile to establish trials of this timber tree, particularly in drier areas, as its timber is considered very useful in India and Burma (Myanmar).

Literature 70, 150, 163, 256, 267, 364, 436, 728, 772, 861, 933, 934, 1052, 1104, 1142, 1221.

E. Boer & R.H.M.J. Lemmens

Ilex L.

Sp. pl. 1: 125 (1753); Gen. pl., ed. 5: 60 (1754).
AQUIFOLIACEAE

$x = 9$, 10; no counts for Malesian species available but most other species have $2n = 36$ or 40

Vernacular names Mensira (trade name). Holly, ilex (En). Brunei: bengkulat. Malaysia: bangkulatan (Sabah), bengkulat (Sarawak), mensirah (Peninsular).

Origin and geographic distribution *Ilex* comprises about 400 species which occur in tropical, subtropical and temperate regions of the world with centres of diversity in North America and eastern Asia (mainly China). The number of Malesian species is roughly estimated to be about 80.

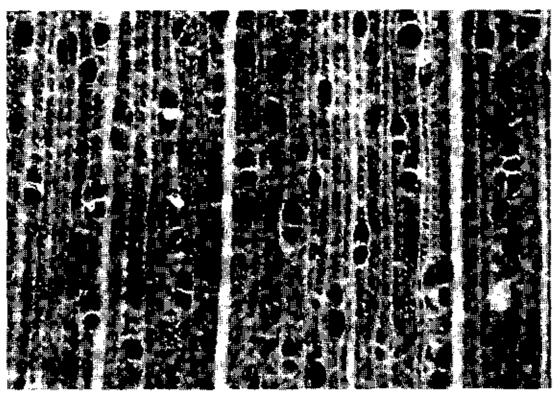
Uses The wood of *Ilex* is used for house building, door and window frames, interior finish, furniture, household utensils, turnery, carving, tool handles, pencils, chopsticks, matches, packing cases, and also for plywood and moulding.

The roots of *I. cymosa* have been used medicinally in a decoction for fever.

Production and international trade There are no exact figures on export and trade of 'mensira'. Mensira is not of commercial importance in Malaysia, but in Indonesia it is considered a commercial timber. Small amounts are occasionally imported in mixed parcels by Japan from Papua New Guinea and the Solomon Islands. In 1996 Papua New Guinea exported about 2630 m^3 of *Ilex* logs at an average free-on-board (FOB) price of US$ 99/m^3.

Properties *Ilex* yields a lightweight to medium-weight hardwood with a density of 490–680 kg/m^3 at 15% moisture content. Heartwood white to pale yellow, darkening to yellow-brown upon exposure, not clearly differentiated from the sapwood; grain straight; texture fine and uneven due to the broad rays; wood with conspicuous flecks on tangential surface and silver grain on radial surface. Growth rings generally indistinct, occasionally rather distinct as darker bands due to fewer parenchyma; vessels moderately small to medium-sized, mostly in radial multiples of 2–3, occasionally solitary, open; parenchyma moderately abundant, apotracheal diffuse-in-aggregates, moderately distinct with a hand lens; rays of 2 distinct sizes, very fine and moderately broad to very broad, the broad ones conspicuous to the naked eye; ripple marks absent.

Shrinkage is moderate to high and the wood is not easy to season as it tends to split slightly along the broad rays. The wood is easy to work. It is non-durable and is highly susceptible to sap-stain. The sapwood may be susceptible to *Lyctus*.



Ilex ledermannii
transverse surface (×20)

See also the tables on microscopic wood anatomy and wood properties.

Botany Evergreen, dioecious shrubs or trees up to 20(–40) m tall; bole sometimes with small buttresses, up to 70(–120) cm in diameter; bark surface smooth or warty, white to pale grey or grey-brown, inner bark thick, coarsely gritty, grey-brown to yellowish-brown, no exudate. Leaves arranged spirally, simple, often leathery, entire or toothed; stipules absent or minute. Flowers in an axillary cyme or fascicle, rarely solitary, 4–6-merous; sepals persistent; petals imbricate and joined at base, white or greenish; ovary superior, (2–)4–9(–22)-locular with 1–2 ovules in each cell, stigma sessile, persistent in fruit. Fruit drupaceous with 3–10(–16) stones containing 1–2 seeds, red, purple or black.

In Peninsular Malaysia *I. grandiflora* Ridley has been observed to flower and fruit in mast years. Seed dispersal is mainly by birds; pollination by insects.

The Asian *Ilex* species are in need of a thorough taxonomic revision as most of the present information is only on a local scale or seems outdated. Within Malesia *Ilex* is the only representative of the family *Aquifoliaceae*, sometimes referred to as *Ilicaceae*.

Ecology Most Malesian *Ilex* species are montane treelets or small trees. Several of them, among which most of the timber producers, form an exception and are found in primary or sometimes secondary lowland swamp and mangrove forest or in montane forest, particularly on poorly drained soils, up to 2400 m altitude. *I. macrophylla* prefers well-drained soils.

Silviculture Temperate *Ilex* species usually take 1–3 years to germinate and *I. cymosa* needs at least several months.

Genetic resources and breeding There is probably little risk of genetic erosion as *Ilex* is not commonly harvested for its timber.

Prospects Although *Ilex* wood may possess an attractive silver grain, its rareness and the generally small size of the trees limit its use.

Literature 40, 57, 66, 70, 151, 163, 209, 260, 267, 364, 373, 436, 526, 558, 595, 711, 829, 861, 933, 974, 1038, 1221, 1242.

Selection of species

Ilex archboldiana Merr. & L.M. Perry

Distribution Papua New Guinea.

Ilex cymosa Blume

Synonyms *Ilex bogorensis* Loes., *Ilex javanica* Koord. & Valeton, *Ilex pleiobrachiata* Loes.

Vernacular names Marsh holly (En). Brunei: bengkulat. Indonesia: mensira gunung (general), ki bonteng, ki sekel (Sundanese). Malaysia: bengkulat (Sarawak), timah-timah (Peninsular). Philippines: pait (Tagalog). Thailand: sai khe tai, se-ko (peninsular).

Distribution Thailand, Peninsular Malaysia, Sumatra, Java, Borneo and the Philippines.

Ilex ledermannii Loes.

Distribution New Guinea.

Ilex macrophylla Hook. f.

Synonyms *Ilex venulosa* Hook. f. var. *nervulosa* Loes.

Vernacular names Malay holly (En). Malaysia: gading, medang tulok, timah-timah bulan (Peninsular).

Distribution Thailand, Peninsular Malaysia, Singapore and Borneo.

Ilex maingayi Hook. f.

Vernacular names Glaucous holly (En).

Distribution Peninsular Malaysia.

S.I. Wiselius

Irvingia Hook. f.

Trans. Linn. Soc., London 23: 167 (1860).

SIMAROUBACEAE

x = unknown; *I. gabonensis* (Aubry-Lecomte ex O'Rorke) Baillon: $2n = 28$

Vernacular names Kabok (trade name). Barking deer's mango (En). Indonesia: bongin (general, trade name), kayu batu (Borneo), pauh kijang (Sumatra). Malaysia: pauh kijang (general), patok entilit (Sarawak), selangan tandok (Sabah). Burma (Myanmar): taung-thayet. Thailand: kra bok (central), ma muen (northern), maak bok (north-eastern).

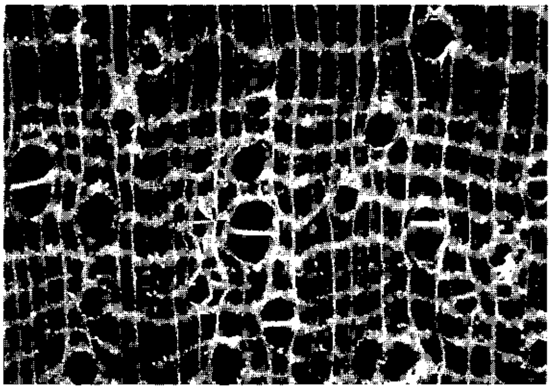
Origin and geographic distribution *Irvingia* comprises about 5 species, 4 of which occur in tropical Africa. In South-East Asia only *I. malayana* Oliv. ex A.W. Bennett (synonyms: *I. harmandiana* Pierre, *I. longipedicellata* Gagnep., *I. oliveri* Pierre) is found; it occurs in Indo-China, Burma (Myanmar), Thailand, Peninsular Malaysia, Sumatra, Bawean Island and Borneo.

Uses The wood of *I. malayana* is suitable for

heavy construction (but not in contact with the ground or weather, except when treated), wall panelling, cabinet work, furniture, piles, railway sleepers and sporting goods, possibly also for flooring; it is also used to make knife handles. Tests indicate that the wood might be suitable for pulp for making paper. In Thailand it is used for making charcoal.
The whitish or yellowish fat from the seeds has a pleasant taste and smell, and is used to produce soap, wax and candles, and as a substitute for cacao butter. The seeds are also eaten fresh or cooked.

Production and international trade The timber of *I. malayana* is often not exploited because of its hardness, density (logs sink in water), and the very tall buttresses. The trees are often left standing after the forest has been logged. Small amounts of timber are exported to Japan from Sabah and Sarawak.

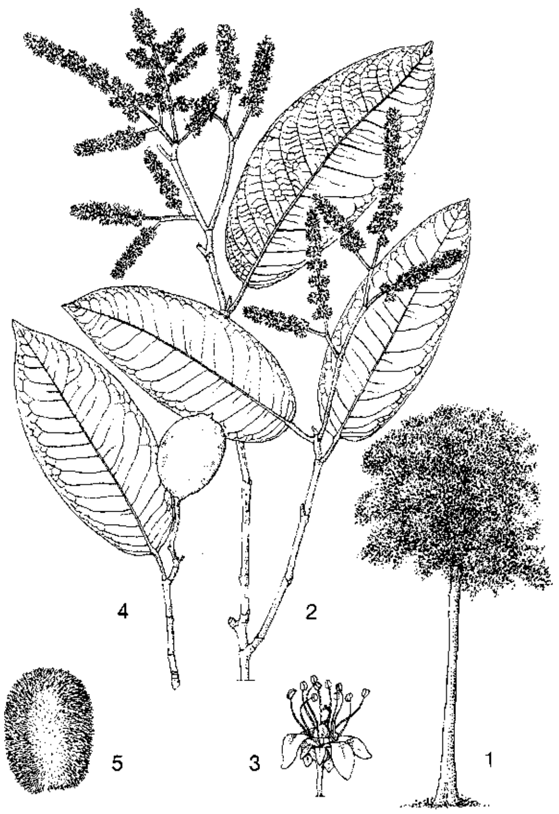
Properties *I. malayana* yields a heavy hardwood with a density of 930–1250 kg/m^3 at 15% moisture content. Heartwood yellow-brown with a greenish tinge, moderately sharply differentiated from the pale yellow-brown or pale brown, up to 7.5 cm wide sapwood; grain shallowly interlocked; texture moderately fine and even; wood with attractive fleck pattern on truly radial surface due to rays; some logs have a grey-brown striped core. Growth rings indistinct; vessels medium-sized, mostly solitary, some in radial multiples of 2–3, tyloses abundant; parenchyma abundant, apotracheal in narrow bands, distinct to the naked eye; rays moderately fine, just visible to the naked eye, but conspicuous on radial surface; ripple marks absent.
Shrinkage upon seasoning is moderate to high.



Irvingia malayana
transverse surface (×20)

The wood suffers severely from insect attack and stains moderately during drying. Surface- and end-checking occurs and the wood seasons slowly. Boards of 13 mm thick take 5 months to air dry and 38 mm thick boards take about 7 months; kiln schedule C is recommended in Malaysia. The wood is very hard and very strong. It is slightly difficult to work when green and difficult when dry. Planing is difficult, the wood turns well, and machining usually produces a moderately smooth to rough finish. The wood is moderately durable; in a graveyard test an average service life of 3.1 years was established. It absorbs preservatives moderately easy: an absorption of 128 kg/m^3 was obtained using a 50/50 creosote-diesel fuel mixture in the standard open-tank treatment, whereas the net dry salt retention using the vacuum-pressure method was 9.8 kg/m^3. The wood is not resistant to termites and slightly resistant to fungi.
See also the tables on microscopic wood anatomy and wood properties.

Botany A variably deciduous, large to very large tree up to 60 m tall; bole straight, up to 150 cm in diameter, with prominent, thin and steep buttresses up to 8 m high; bark surface smooth with widely spaced loose scales, sometimes peeling off in large pieces, grey or fawn-coloured, inner bark mottled, cream-yellow; crown shallowly domed with big limbs. Leaves arranged spirally, simple, entire, elliptical-oblong to lanceolate, glabrous, midrib grooved above; stipules large, forming a cap surrounding the terminal bud, caducous and leaving annular scars. Flowers in an axillary or terminal panicle, small, (4–)5-merous; sepals connate at base, imbricate; petals longer than sepals, imbricate, greenish-white or yellowish; disk large; stamens (8–)10, with long sinuous filaments; ovary superior, 2-locular with a single ovule in each cell, style 1, sinuous. Fruit a large drupe (resembling a mango) with thick, fleshy, very fibrous mesocarp, 1(–2)-seeded. Seed with leathery testa, endosperm absent or very little. Seedling with epigeal germination; cotyledons fleshy, whitish; first two leaves opposite, subsequent ones alternate.
The trees flower before or just after the appearance of new leaves. The fruits are reported to be eaten by barking deer.
Irvingia differs from most other *Simaroubaceae* in having stipules that leave an annular scar, and lysigenous mucilage cavities in the cortex and pith of branches and petioles. This has led to a separate family being distinguished: *Irvingiaceae*.



Irvingia malayana Oliv. ex A.W. Bennett – 1, tree habit; 2, flowering twig; 3, flower; 4, twig with fruit; 5, fibrous mesocarp of fruit.

However, *Irvingia* readily links up with some genera in *Simaroubaceae* morphologically, anatomically and chemically, and inclusion in this family seems justified. It is often placed in the subfamily *Irvingioideae* together with the entirely African genus *Klainedoxa*.
The tree's shape, flowers and fruits are reminiscent of those of wild mangoes (*Mangifera* spp.), the buttresses and hard pale wood are similar to those of *Dialium*, and the leafy twigs resemble those of figs (*Ficus* spp., but latex is absent).
Seeds of *I. gabonensis* are used in Africa in similar ways as *I. malayana*.

Ecology *I. malayana* occurs scattered in primary lowland rain forest in drier locations, up to 300 m altitude. In Thailand it is frequently present in dry deciduous and evergreen dipterocarp forest.

Silviculture *I. malayana* can be raised from seed. Stones germinate readily, with 90–100% germination in 4–9 weeks after sowing, but complete fruits have only about 15% germination in 5–11 weeks. Mature trees may be hollow. In Thailand structural timber has been attacked by the beetle *Stromatium longicorne*, but damage was limited.

Genetic resources and breeding *I. malayana* is usually not favoured in logging operations because of its large buttresses and hard, heavy wood, and is often left after logging. However, it seems slightly vulnerable because it occurs scattered in primary lowland rain forest in drier locations which are endangered in many regions.

Prospects The use of the timber of *I. malayana* will probably remain restricted, as the timber is only moderately durable, heavy and difficult to work.

Literature 40, 54, 162, 163, 198, 209, 238, 267, 341, 387, 436, 474, 553, 677, 678, 740, 741, 829, 831, 861, 885, 889, 972, 1048, 1221, 1239, 1242, 1266.

R. Yusuf

Itoa Hemsl.

Hooker's Icon. Pl. 27: t. 2688 (1901).
FLACOURTIACEAE
x = unknown; $2n$ = unknown

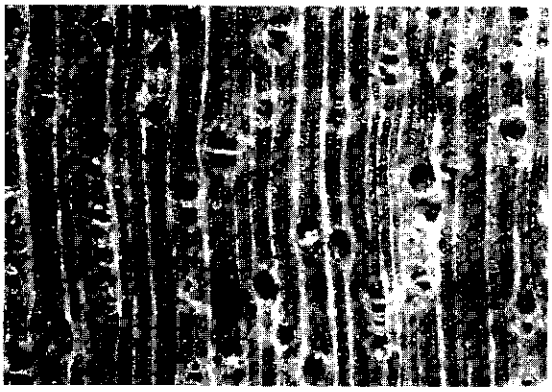
Vernacular names Indonesia: danoan (North Sulawesi), ramboni (Japen Island), usu tamau (Halmahera).

Origin and geographic distribution *Itoa* comprises only two species, one of which (*I. orientalis* Hemsl.) occurs in southern China and Vietnam, the other, *I. stapfii* (Koord.) Sleumer (synonyms: *Mesaulosperma stapfii* (Koord.) v. Slooten, *Polyothyrsis stapfii* Koord.), in Sulawesi, the Moluccas and New Guinea.

Uses The wood of *I. stapfii* is used for posts and beams in local house building.

Production and international trade The wood of *I. stapfii* is not traded. Its utilization is very limited and on a local scale only.

Properties *I. stapfii* yields a lightweight to medium-weight hardwood with a density of 390–580 kg/m^3 at 15% moisture content. Wood pale yellowish-brown to brown; grain straight or slightly interlocked; texture moderately fine and even. Macroscopic features of wood of *Flacourtiaceae* are remarkably similar: vessels small to medium-sized, solitary and in radial multiples of 2–4(–6), with clusters, oval to markedly angular; parenchyma absent or sparse, paratracheal vasicentric,



Itoa stapfii
transverse surface (×20)

with some tendency to aliform; rays fine; ripple marks absent.
The wood of *I. stapfii* is moderately strong and non-durable.
See also the table on microscopic wood anatomy.

Botany A dioecious, medium-sized to large tree up to 40 m tall; bole fairly straight, up to 100 cm in diameter, sometimes with small buttresses; bark surface flaking, grey. Leaves arranged spirally, crowded towards the top of branchlets, simple, long-petioled, crenate, exstipulate. Male flowers in a terminal panicle; stamens numerous. Female flowers solitary, axillary; calyx lobes 3(–4), valvate; petals absent; ovule superior, 1-locular with 5–8 placentas and many ovules. Fruit a capsule, tardily dehiscent from the apex in (5–)6–8 valves, many-seeded. Seed compressed and winged.
Flowering has been observed in July; fruiting in the months February, July and September.

Ecology *I. stapfii* occurs scattered in primary and secondary rain forest on level to hilly localities, sometimes in inundated sites, up to 1000 m altitude. In Papua New Guinea it also occurs in mid-montane forest.

Genetic resources and breeding Its scattered occurrence may render *I. stapfii* liable to genetic erosion.

Prospects As extremely little information is available on the wood quality of *I. stapfii* its utilization will probably remain very limited.

Literature 267, 300, 341, 436, 861, 1135, 1232.

E. Boer & M.S.M. Sosef

Ixonanthes Jack

Malayan Misc. 2(7): 51 (1822).
IXONANTHACEAE
x = unknown; $2n$ = unknown

Vernacular names Malaysia: pagar anak (general), inggir burung (Malay, Iban, Sarawak).

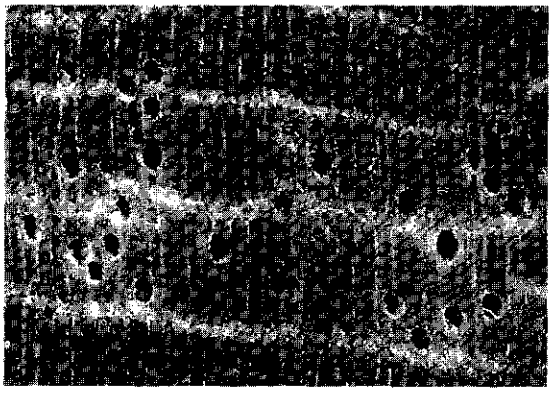
Origin and geographic distribution *Ixonanthes* comprises 3 species and is found in India (Assam), Burma (Myanmar), Vietnam, southern China, Thailand, Peninsular Malaysia, Sumatra, Borneo, the Philippines, Sulawesi and New Guinea. All 3 species occur within the Malesian region.

Uses The wood of *Ixonanthes* is used for temporary construction, tool handles and, generally in pole form, for local house building for purposes under cover and not in contact with the ground. It has also been used as firewood.
The bark of *I. icosandra* is rich in tannin and is used to tan fishing nets and leather. In Malaysia its leaves have been applied for poulticing the head for headache.

Production and international trade As supplies are limited and *Ixonanthes* timber is seldom available in sufficiently large sizes, it is used on a local scale only.

Properties *Ixonanthes* yields a medium-weight to heavy hardwood with a density of 650–1000 kg/m^3 at 15% moisture content. Heartwood pale yellow-brown with a pink tinge or brown with a purple-grey tinge, not clearly differentiated from the narrow sapwood; grain deeply interlocked; texture rather fine and even; wood with stripe figure on radial surface due to interlocked grain. Growth rings absent; vessels medium-sized to moderately large, exclusively solitary, open, with tendency to oblique arrangement; parenchyma moderately abundant to abundant, apotracheal in narrow or broad irregularly spaced bands, the broad ones conspicuous to the naked eye; rays extremely fine, just visible with a hand lens on transverse surface; ripple marks absent.
The wood is moderately hard to very hard and moderately strong. It is slightly durable to non-durable.
See also the table on microscopic wood anatomy.

Botany Evergreen or occasionally deciduous, small to medium-sized or rarely fairly large trees up to 30(–45) m tall; bole straight to poorly shaped, up to 100(–130) cm in diameter, fluted or with large buttresses or rarely stilt rooted; bark surface smooth becoming slightly fissured and flaky, sometimes lenticellate, pale grey to yellowish-brown or blackish, inner bark firmly fibrous, dark red-



Ixonanthes reticulata
transverse surface (×20)

brown, brick-red outwards. Buds resinous. Leaves arranged spirally, simple, entire or glandular-serrate; stipules scale-like, caducous. Flowers in an axillary, dichasial corymb, 5-merous; sepals united at base; petals white to greenish; stamens 10 or (15–)20; disk intrastaminal, bowl-shaped; ovary superior, 5-locular with 2 ovules in each cell, style 1, stigma mushroom-shaped. Fruit an ellipsoid capsule splitting into 5 parts, seated on the persistent sepals and petals. Seed 1–2 per locule, with a wing-like or 3-lobed arillode. Seedling with epigeal germination; cotyledons emergent, leafy; hypocotyl elongated; all leaves arranged spirally.
Growth is monopodial, in flushes. Flowering is seasonal. In Peninsular Malaysia the flowering-to-fruiting period of *I. icosandra* is 7–13 weeks.
Ixonanthes has been treated as a member of the family *Erythroxylaceae* and of the *Linaceae* subfamily *Ixonanthoideae*, but at present it forms a separate family with 5 genera.

Ecology *Ixonanthes* is found in evergreen, primary or occasionally secondary, lowland or occasionally montane rain forest, up to 2400 m altitude. It occurs on slopes and ridges, often on sandy and granitic soils, generally in well-drained locations but occasionally in swamp forest. *I. reticulata* also occurs in kerangas forest.

Silviculture *Ixonanthes* can be propagated by seed. Seeds of *I. icosandra* show about 50% germination in 32–48 days. *I. icosandra* is a light-demander.

Genetic resources and breeding The limited use of *Ixonanthes* as a timber suggests that there is no risk of genetic erosion.

Prospects No increase in the use of the wood of *Ixonanthes* is anticipated because of its limited supply, poor quality and often poor stem form.

Literature 151, 162, 163, 198, 209, 267, 304, 341, 349, 436, 589, 771, 800, 829, 831, 861, 974, 1038, 1048, 1129, 1221, 1242.

Selection of species

Ixonanthes icosandra Jack

Synonyms *Ixonanthes dodecandra* Griffith, *Ixonanthes lucida* (Blume) Blume, *Ixonanthes obovata* Hook. f.

Vernacular names Indonesia: kayu bulus (Bangka), kayu leja-leja, sase beranak (Sumatra). Malaysia: punggong kijang, sankau merah (Peninsular). Thailand: aa sai (peninsular).

Distribution Peninsular Thailand, Peninsular Malaysia, Singapore and Sumatra.

Ixonanthes petiolaris Blume

Synonyms *Ixonanthes multiflora* Stapf ex Ridley, *Ixonanthes philippinensis* Elmer.

Vernacular names Indonesia: mara bekang, mara jening, tinjau laut (Sumatra). Philippines: mahalan (Manobo).

Distribution Peninsular Thailand, Peninsular Malaysia, Sumatra, Borneo, the Philippines and Sulawesi; possibly also in New Guinea.

Ixonanthes reticulata Jack

Synonyms *Ixonanthes chinensis* (Hook. f. & Arn.) Champ., *Ixonanthes crassifolia* Hallier f., *Ixonanthes grandiflora* Hochr.

Vernacular names Brunei: kayu junong. Indonesia: jurung (Palembang, Sumatra), lura (Sulawesi), sentulu (West Kalimantan). Malaysia: inggir burong (Peninsular), redin (Sarawak). Philippines: mahalan-haba (Tagalog). Vietnam: h[af] nu trung hoa

Distribution From India (Assam) to Indo-China, southern China, Peninsular Malaysia, Sumatra, Borneo, the Philippines, Sulawesi and New Guinea.

F.I. Windadri

Ixora L.

Sp. pl. 1: 110 (1753); Gen. pl., ed. 5: 48 (1754).
RUBIACEAE
$x = 11$; for most species: $2n = 22$

Vernacular names Indonesia: areng-arengan (Javanese), ki soka (Sundanese). Malaysia: jarum-jarum, pechah periuk, todong periok (Peninsular).

Burma (Myanmar): pan, ponna. Cambodia: chann tanea, tè prey. Thailand: kheme (general).

Origin and geographic distribution *Ixora* comprises about 400 species and is distributed throughout the tropics. The Indo-Malesian region is richest in species. In Malesia about 160 species occur; the highest number of species is found in Borneo, about 65, most of them endemic. Only a few species reach timber size.

Uses The wood of *Ixora* is occasionally used, often for implements and comparatively small objects such as walking sticks, sometimes also for beams in house building.

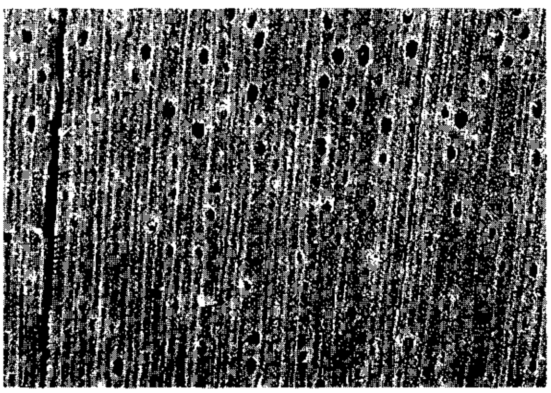
Some *Ixora* species are well-known as an ornamental (e.g. *I. chinensis* Lamk, *I. coccinea* L., *I. javanica* (Blume) DC.), commonly planted in gardens, parks and roadsides. Several species are used in traditional medicine, e.g. as an astringent and to treat dysentery and tuberculosis. Some species (e.g. *I. coccinea*) have shown anti-tumour and anti-mutagenic activity. The fruits of *I. philippinensis* Merr. are edible.

Production and international trade Utilization of the wood of *Ixora* is limited and on a local scale only.

Properties *Ixora* yields a heavy hardwood with a density of 940–1010 kg/m^3 at 15% moisture content. Heartwood pale brown with a pinkish tinge, not clearly differentiated from the sapwood; grain straight; texture very fine and even. Growth rings visible to the naked eye, defined by a layer of parenchyma; vessels moderately small, almost exclusively solitary with very occasional radial pairs, open; parenchyma moderately abundant, apotracheal diffuse and diffuse-in-aggregates, or in narrow or marginal bands, very occasionally scanty paratracheal; rays extremely fine or very fine; ripple marks absent.

The wood is very strong and durable. As the vessels are very small, the sapwood is probably non-susceptible to *Lyctus*.

See also the table on microscopic wood anatomy.



Ixora grandifolia
transverse surface (×20)

Botany Generally evergreen (in Malesia) shrubs or small to sometimes medium-sized trees up to 25 m tall; bark surface smooth, lenticellate, fissured or scaly, greyish-brown; twigs terete, often with series of rather close, leafless nodes especially at branching points. Leaves opposite or sometimes in whorls of 3, simple, entire; stipules connate at base, distinctly cuspidate or with a long, stiff, needle-like extension at the tip. Flowers in a terminal corymb or corymbose panicle, 4-merous, often 3 together; calyx often divided to the base; corolla with a cylindrical tube, lobes contorted in bud, often white but sometimes pink, yellow or red; stamens inserted at corolla throat, with short filaments, anthers sagittate and reflexed out of the open flower; disk annular; ovary inferior, 2(–3)-locular with 1 ovule per cell, style slightly exserted from the corolla tube, with 2-lobed stigma. Fruit a globose to 2-lobed drupe, ripening red to black, 1–2-seeded. Seedling with epigeal germination; cotyledons leafy, green.

Flowering is seasonal but cultivated varieties bloom throughout the year. The flowers are mainly pollinated by moths and butterflies probing for the nectar at the corolla base, but honey-suckers may also visit the flowers, particularly the reddish ones. The fruits are probably dispersed by fruit-eating birds.

Pavetta closely resembles *Ixora*, but can be distinguished by its long-exserted style with coherent stigmas.

Ecology *Ixora* species are usually confined to lowland and lower montane forest up to 1700 m altitude. Some species are also found in swampy locations in the vicinity of rivers or occasionally in rice fields (e.g. *I. grandifolia*).

Silviculture *Ixora* may be propagated by seed, although ornamental species are usually propagated by cuttings. Both seed and sown fruits of *I. lobbii* Loudon had about 25% germination in 1–3 months.

Genetic resources and breeding *Ixora* trees are not much sought after for their wood, since they are small in size. Therefore, logging for timber does not seem to affect the size of its population, except when an area is clear cut.

Prospects *Ixora* timber is seldom used, mainly because of its small dimensions. Its utilization is unlikely to increase.

Literature 70, 137, 163, 209, 267, 436, 790, 829, 831, 861, 1164, 1221.

Selection of species

Ixora amplexifolia K. Schumann & Lauterb.

Synonyms *Ixora coleopoda* K. Schumann & Lauterb.
Distribution New Guinea.

Ixora concinna R. Br. ex Hook. f.

Vernacular names Trogon ixora (En). Indonesia: jarum-jarum merah, menjarum merah. Malaysia: siantan hutan.
Distribution Peninsular Malaysia, Sumatra, Riau Archipelago, Lingga Island, and Borneo.

Ixora glomeruliflora Bremek.

Distribution Northern Borneo (Sarawak, Sabah).

Ixora grandifolia Zoll. & Moritzi

Synonyms *Ixora fluminalis* Ridley.
Vernacular names Pink river ixora (En). Malaysia: jarum hutan, kelat tandok, segading jantan (Peninsular). Thailand: khem yai (central, peninsular).
Distribution Sri Lanka, Burma (Myanmar), Indo-China, Thailand, Peninsular Malaysia, Singapore, Sumatra, Bangka and Borneo.

Ixora simalurensis Bremek.

Vernacular names Indonesia: rimpe-rimpe (Simeuluë).
Distribution Islands west of Sumatra: Simeuluë, Batu Islands.

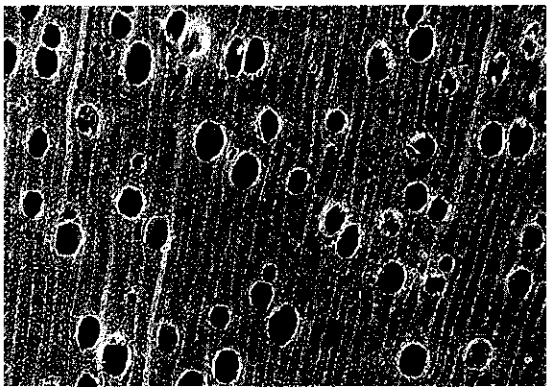
Ixora trichandra Bremek.

Distribution The Moluccas.

B. Ibnu Utomo W.

Jackiopsis Ridsd.

Blumea 25: 295 (1979).
RUBIACEAE
x = unknown; $2n$ = unknown
Vernacular names Malaysia: medang gambut, pokok segan paya, selumar (Peninsular).
Origin and geographic distribution *Jackiopsis* is a monotypic genus. The only species is



Jackiopsis ornata
transverse surface (×20)

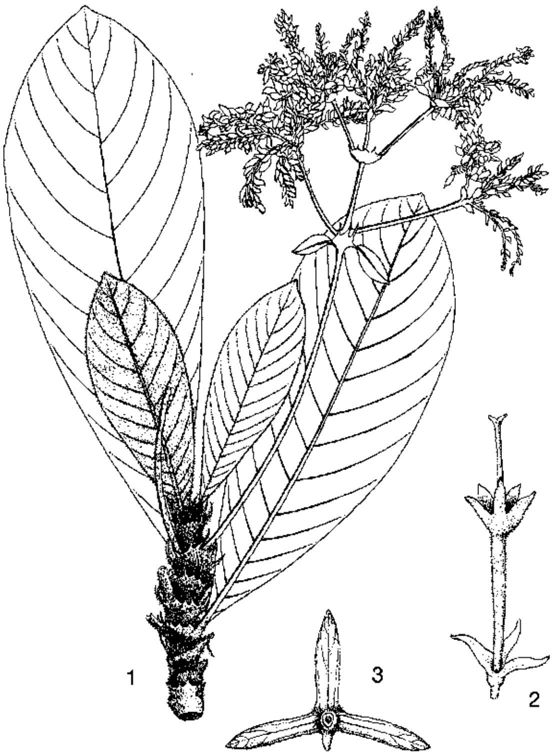
J. ornata (Wallich) Ridsd. (synonym: *Jackia ornata* Wallich) which occurs in Peninsular Malaysia, Singapore, Sumatra, the Riau Archipelago and Borneo.

Uses The wood of *J. ornata* is used locally in house building, e.g. for posts, and for furniture, paddles, fences and implements such as rice pounders and carrying poles.

Production and international trade The wood of *J. ornata* is used rarely and on a local scale only.

Properties *J. ornata* yields a heavy hardwood with a density of 820–990 kg/m^3 at 15% moisture content. Heartwood red to purple-red-brown or dark brown, not sharply differentiated from the sapwood; grain straight; texture moderately fine and even. Growth rings sometimes distinct to the naked eye, boundaries indicated by a zone with relatively few or no vessels; vessels rather variable in size, almost exclusively solitary, but with occasional radial or oblique pairs, open; parenchyma moderately abundant, but indistinct with a hand lens, paratracheal vasicentric tending to aliform, and apotracheal diffuse and diffuse-in-aggregates; rays extremely fine to moderately fine, indistinct; ripple marks absent.
The wood is hard and fairly strong and works easily. It is fairly durable when exposed to the weather or in contact with the ground but not resistant to pinhole borer attack.
See also the table on microscopic wood anatomy.

Botany A medium-sized tree up to 20(–35) m tall; bole straight, up to 50 cm in diameter, with steep or spreading buttresses up to 1(–3) m high; bark surface narrowly fissured to slightly flaky, brown, inner bark pale brown. Twigs stout. Leaves opposite, simple, entire, obovate, gradually nar-



Jackiopsis ornata (Wallich) Ridsd. – 1, twig with old inflorescence; 2, flower; 3, fruit.

rowed at base, shortly acuminate to obtuse at apex, shortly petiolate; stipules connate into a shallow cup with many linear lobes. Flowers in an axillary panicle which usually has 3 main, conspicuously bracteate branches, arranged alternately in 2 rows along the ultimate branches of the inflorescence, subsessile, fragrant; calyx usually 3-lobed, dull pink; corolla trumpet-shaped, 5-lobed with valvate lobes, villous hairy outside, cream-coloured to pink; anthers 5, inserted in corolla throat; ovary inferior, 2-locular with 2–5 ovules in each cell, style 1. Fruit a dry nutlet, usually 1-seeded, obconical, winged by the persistent and spreading calyx lobes. Seed ovoid, 2–3 mm long.

The tree is conspicuous when flowering, the crown being decorated with pink pendulous inflorescences. However, flowering is reported to occur infrequently.

Jackiopsis is the only representative of the tribe *Jackieae*; there are no obviously related genera. *J. ornata* resembles 'terentang' (*Campnosperma* spp.) but it can be distinguished by the peculiar stipules. The name *Jackia* Wallich was used for this genus for a long time, but it is illegitimate as *Jackia* Blume (*Polygalaceae*) was published one year earlier.

Ecology *J. ornata* is locally frequent but never abundant in lowland swamp forest and in riverine habitats. In northern Borneo it often occurs in peat-swamp forest.

Genetic resources and breeding As *J. ornata* is fairly common although occurring scattered in the forest, it seems not to be endangered.

Prospects Since so little is known about the silvicultural aspects of *J. ornata*, it is difficult to judge its prospects for timber production. The tree may be more promising as an ornamental than as a timber tree.

Literature 151, 162, 163, 209, 267, 436, 829, 861, 944, 1052, 1221.

E. Boer & R.H.M.J. Lemmens

Kalappia Kosterm.

Reinwardtia 1: 451 (1952).
LEGUMINOSAE
x = unknown; $2n$ = unknown

Vernacular names Indonesia: kalapi, nanakulahi, palapi (South Sulawesi).

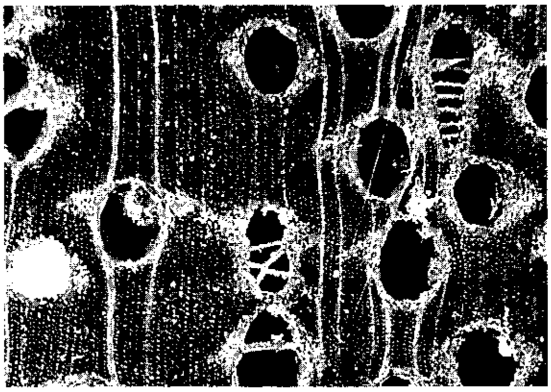
Origin and geographic distribution *Kalappia* is a monotypic genus occurring in South Sulawesi. The only species is *K. celebica* Kosterm.

Uses The wood of *K. celebica* is used for light construction (e.g. posts), flooring, fitting, panelling, ceiling and bridge and ship building. A form with a beautiful grain pattern used to be much sought after for cabinet work and furniture.

Production and international trade In the first half of the 20th Century considerable amounts of *Kalappia* timber were transported from the surroundings of Malili and Wotu (South Sulawesi), where *K. celebica* was common, to Ujung Pandang, where it was processed. At present, the supplies are probably very limited; no trade statistics are known.

Properties *K. celebica* yields a medium-weight hardwood with a density of 590–710 kg/m^3 at 15% moisture content. Heartwood brown, sharply differentiated from the 3–5 cm wide pale brown sapwood. Growth rings absent; vessels large and few, solitary and in radial multiples of 2–4, with occasional deposits; parenchyma paratracheal aliform to confluent, and apotracheal in marginal or seemingly marginal bands; rays very fine to medium-sized; ripple marks present.

The wood is fairly strong. The heartwood is



Kalappia celebica
transverse surface (×20)

durable in contact with the ground; the sapwood is very perishable.
See also the table on microscopic wood anatomy.

Botany A fairly large tree up to 40 m tall; bole straight, branchless for up to 20 m, up to 90 cm in diameter, with buttresses up to 3 m high; bark surface fissured, rather rough, flaking off, rusty brown, inner bark pinkish-red, whitish inside; crown thin in old specimens, with numerous subcrowns. Leaves alternate, imparipinnate, with (2–)5(–6) alternating, lanceolate to elliptical and stalked leaflets, conspicuously areolate; stipules absent. Flowers in an axillary or subterminal paniculate inflorescence, pedicelled, 5-merous; sepals densely silky outside; petals thin, 2 outer larger than 3 inner, clawed, with numerous veins, orange-yellow; fertile stamens 5, anthers opening by an apical pore, staminodes (2–)4; ovary superior, sessile, densely silky, style short, stigma minute. Fruit a flat, glabrous, reddish-brown, dehiscent pod, narrowly winged at ventral side, 1(–3)-seeded. Seed disk-like, with leathery testa; cotyledons thin.
K. celebica is reported to flower irregularly; years in which the trees do not flower are common.
Within the subfamily *Caesalpinioideae* and the tribe *Cassieae*, *Kalappia* seems to be most closely related to genera such as *Dialium* and *Koompassia*.

Ecology *K. celebica* grows scattered in rain forest from near the coast to up to 500 m altitude, but most commonly below 100 m. It usually occurs on poor rocky soils with a pH of about 4. The annual precipitation is about 3000 mm, with a minimum of about 150 mm in the driest month and a maximum of about 500 mm in the wettest month. It is one of the tallest trees in the forest where it grows. Very locally it can be one of the dominant species.

Kalappia celebica Kosterm. – 1, flowering twig; 2, flower; 3, pods.

Silviculture *K. celebica* may be propagated by seed, but there are no reports of planting activities. In closed forest the regeneration is poor and seedlings are few, which implies that *K. celebica* needs light to germinate and establish. In a *K. celebica* forest near Wotu with about 65 trees per ha there was no natural regeneration, but natural regeneration did occur in logged-over forest. Therefore, human interference is necessary to allow regeneration of *K. celebica* forest, e.g. by logging 5–10 ha patches of forest which are subsequently planted. With 4–5 trees per ha with a diameter of over 40 cm the yield can be 15–20 m^3.

Genetic resources and breeding By the beginning of the 1950s populations of *K. celebica* had already been considerably depleted by large-scale logging for its valuable timber. The wood has become rare and expensive on the local market. *K. celebica*, being endemic to South Sulawesi, is seriously in need of protection. Integral protection of large areas of forest where it grows is essential for

its survival, and may also serve to protect another superior timber, *Diospyros celebica* Bakh., which is often associated with *K. celebica*.
The variation in the figure of the wood might give opportunities for selection. As far as is known, no attempts have been made to bring *K. celebica* into cultivation.

Prospects Surprisingly little research has been done on wood properties, propagation, silviculture and forest management of such a valuable timber species. Tests with enrichment planting in logged-over forest might be worthwhile considering. The poor germination capacity in closed forest might require special forest management measures to be developed.

Literature 271, 599, 861, 1014, 1078.

B. Sunarno (general part),
J. Ilic (wood anatomy)

Khaya A. Juss.

Mém. Mus. Hist. Nat. Paris 19: 249 (1830).
MELIACEAE
$x = 25$; *K. anthotheca*, *K. grandifoliola*, *K. ivorensis*, *K. senegalensis*: $2n = 50$

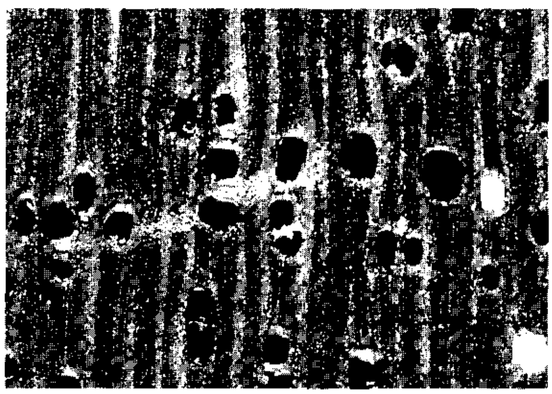
Vernacular names African mahogany (En). Acajou d'Afrique (Fr). Indonesia: kaya (general).

Origin and geographic distribution *Khaya* comprises 6 species, 4 in tropical Africa and 2 in Madagascar and the Comores. Several species have been introduced widely in other parts of both the wet and dry tropics for their timber. *K. ivorensis* is planted in trials in Peninsular Malaysia, whereas another 3 species have been planted in many trials in Indonesia.

Uses The wood of African sources of *Khaya* is used for furniture and cabinet work, high quality decorative interior finishing, high quality staircases, panelling, flooring, boat planking and cabins, banisters, handrails, carving, turnery and occasionally for construction, canoe building and boat decking. The wood is highly valued for the production of decorative veneer and plywood, which is also its main application in South-East Asia.
K. ivorensis and *K. senegalensis* have been used for enrichment planting (especially the former) and afforestation and the latter has also been planted in parks and along roads, e.g. in Jakarta and Singapore. *K. anthotheca* has been used in a taungya system. The wood produces a good quality charcoal. Seeds of *K. senegalensis* and *K. grandifoliola* yield an oil used in West Africa for cooking. The bark is used medicinally against fever.

Production and international trade In South-East Asia *Khaya* wood is not exported yet, all wood being sold on the domestic market. In trade *K. anthotheca* and *K. ivorensis* are considered as the lighter weight African mahogany species, *K. grandifoliola* and *K. senegalensis* as the heavier and somewhat darker coloured ones.

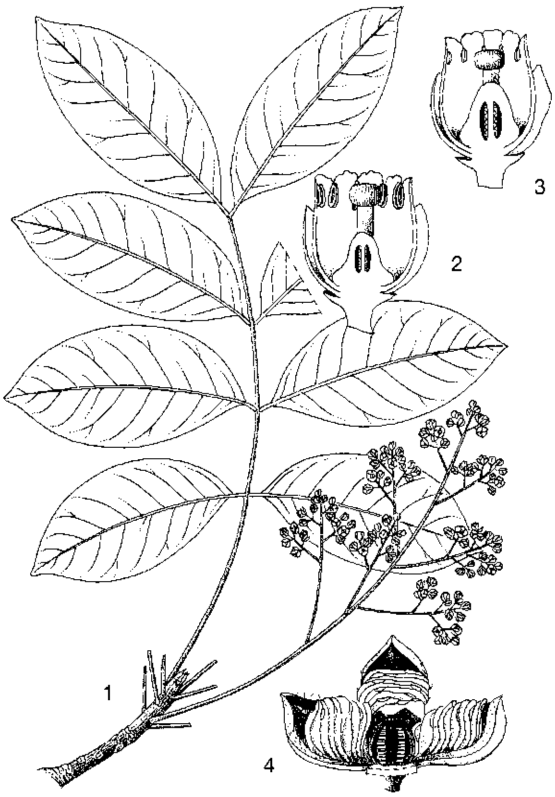
Properties No description of the wood properties of *Khaya* grown in South-East Asia exists; the following is entirely based upon African material. *Khaya* yields a medium-weight hardwood with a density of 460–800(–950) kg/m^3 at 12% moisture content with *K. senegalensis* and *K. grandifoliola* from relatively dry areas yielding the heavier timber; growing sites significantly influence the structure and density of the wood. Heartwood pink when freshly sawn, turning pale pink-brown or dark reddish-brown upon exposure, not well defined, or well defined in *K. grandifoliola* and *K. ivorensis*, from the yellowish-brown, up to 6 cm wide sapwood; grain interlocked, sometimes straight; texture moderately coarse; wood usually with attractive figure and lustre, sometimes with irregular streaks. Growth rings indistinct to distinct, boundaries indicated by denser fibres; vessels moderately small to moderately large, solitary and in radial multiples of 2–8 and in small clusters, vessel lines usually conspicuous and with reddish streaks, occasionally with white deposits; parenchyma sparse to moderately abundant, paratracheal vasicentric, occasionally apotracheal in marginal or seemingly marginal bands; rays of 2 distinct sizes, moderately fine and medium-sized, distinct to the naked eye; ripple marks mostly absent or when present, sometimes irregu-



Khaya ivorensis
transverse surface (×20)

lar, but not marked; traumatic gum ducts occasionally present in tangential rows.
Shrinkage upon seasoning is moderate, the lighter-weight stock dries fairly rapidly, the heavier seasons rather slowly, generally with little degrade but care is needed to prevent warp in larger sizes and splitting in heavier material. Kiln schedule F is recommended. The wood is moderately hard and of medium to fairly low strength but tough. It works fairly well to excellently (*K. grandifoliola*), although interlocked grain on quarter-sawn surfaces may give rise to woolly surface in planing, making it necessary to have sharp tools and to reduce the cutting angle to 15–20°. It can be peeled and sliced well to produce face veneer (except for *K. grandifoliola*), polishes and finishes well; the machining properties are medium to fairly good and slightly better for *K. senegalensis* than for *K. grandifoliola*. The wood is moderately durable. The heartwood is extremely resistant and the sapwood is moderately resistant to impregnation. Logs are susceptible to pinhole borer and longhorn beetle attacks, the wood of the lighter-weight species also to termite attack. The sapwood is susceptible to *Lyctus*. The sawdust may cause skin irritations to those people allergic to it.
The seeds of *K. senegalensis* have an oil content of 67% and are rich in oleic acid (66%). The gross energy value of the wood of *K. senegalensis* is about 19 990 kJ/kg.
See also the tables on microscopic wood anatomy and wood properties.

Botany Deciduous, monoecious, small to large or very large trees up to 50(–60) m tall; bole straight and cylindrical to slightly sinuous, branchless for up to 25(–30) m, up to 150(–400) cm in diameter, larger trees with prominent buttresses up to 7 m high; bark surface smooth but becoming scaly, the circular scales leaving shallow pits, grey and brown mottled. Leaves arranged spirally, in tufts at the end of twigs, paripinnate, exstipulate; leaflets entire. Flowers in an axillary large, much-branched thyrse, unisexual, 4–5-merous; calyx lobed almost to the base; petals free. Male flower with urceolate to cup-shaped staminal tube, bearing 8–10 anthers; disk cushion-shaped. Female flowers with a superior, 4–5-locular ovary with 12–16(–18) ovules in each cell, style-head discoid; disk indistinct. Fruit an erect, globose, woody capsule; columella sharply ridged. Seeds 8–18 per cell, in single rows, flattened and narrowly winged all around. Seedling with epigeal germination; cotyledons not emergent; hypocotyl slightly developed or absent; first 2 leaves opposite, simple, subsequent ones arranged spirally and trifoliate or imparipinnate, later paripinnate.



Khaya anthotheca (Welw.) C. DC. – 1, flowering twig; 2, sectioned male flower; 3, sectioned female flower; 4, dehisced fruit.

Early growth can be very rapid, namely 13 m in height in 4 years (*K. ivorensis*), but in enrichment planting trials and in taungya systems annual height increment in the first 2 years was only 0.3–0.5 m (*K. anthotheca*, *K. ivorensis*). Extensive trials with *K. anthotheca*, *K. grandifoliola* and *K. senegalensis* in Indonesia showed a mean annual increment of 0.8–2.4 cm in diameter and 0.5–1.5 m in height. In 26-year-old plantations of *K. ivorensis* in Peninsular Malaysia a mean annual increment of 1.7–1.9 cm in diameter and 1 m in height was achieved. In Nigeria growth of *K. grandifoliola* seedlings was promoted by inoculation with *Endogone* spores and they developed vesicular-arbuscular mycorrhizas. *K. anthotheca* and *K. ivorensis* are clearly the larger trees, while *K. grandifoliola* and *K. senegalensis* are much smaller. *K. ivorensis* develops according to Rauh's architectural tree model, characterized by a monopodial trunk which grows rhythmically and so develops tiers of branches. In *K. ivorensis* the monoaxial state may persist to a height of 10 m. In West Africa *K. anthotheca* flowers from January to February and again from September to October. Fruits develop in 2–3 months. Seeds are probably dispersed by wind.

Ecology *K. senegalensis* is a species of seasonal climates where it is found in a wide range of habitats, from closed deciduous forest to savanna, up to 1500 m altitude, with an annual rainfall 650–1300 mm and a dry season of 4–7 months. *K. anthotheca* and *K. ivorensis* occur in wet evergreen to semi-deciduous or deciduous forest. *K. anthotheca* is generally found scattered or rarely in small groups, often in the vicinity of water, in areas with an annual rainfall of 1200–1800 mm and a dry season of 2–4 months, up to 500 m altitude. Annual rainfall in areas where *K. ivorensis* occurs is 1600–2500 mm, and the dry season lasts 2–3 months. *K. grandifoliola* is found in dry evergreen forest, gallery forest and savanna woodlands at up to 1300 m altitude in areas with an annual rainfall of 1200–1800 mm and a dry season of 3–5 months.

Silviculture *Khaya* can be propagated by seed and by cuttings; tissue culture on an experimental scale is successful. In Indonesia direct sowing of *K. anthotheca* in the field failed. Seed counts range from 3200–8600 per kg, but counts from specimen in the Bogor Botanical Gardens average 2700–3450 seeds/kg. Seed viability drops sharply after only two weeks, but the germination rate of seed of *K. senegalensis* stored at 5°C and −15°C in airtight receptacles for 2 years was still 30%. Pretreatment is not necessary before sowing and the germination rate of fresh seed is high, being (55–)75–90% in 10–30 days. Young seedlings require light shading. Seedlings are left to grow fairly tall, 0.6–1.8 m, and stay for up to three years in the nursery before they are made into stumps or striplings. The latter perform better under South-East Asian conditions. Vegetative propagation of *K. anthotheca* by means of cuttings applying 50 mg of Rootone F/cutting showed a rooting of about 75%. Generally, *Khaya* is planted under light shade, but full overhead light is required for good growth. *K. anthotheca* requires fertile deep soils and plenty of water; *K. senegalensis* is very resistant to flooding and can be considered for planting on swampy soils. The stem form of *K. ivorensis* is variable and strong lateral competition is needed to obtain straight and upright trunks. When natural regeneration has become established under the canopy the old trees are harvested with various cutting and regeneration systems. Attacks of the shoot borer *Hypsipyla robusta* can be overcome by close spacing, admixing with other species which are planted 2–3 years later, or planting in the shade of a nurse crop. In the latter case, the nurse crop is removed when the desired clear bole length is achieved, after which *Khaya* can grow fast. There is some evidence that *Hypsipyla* attack is reduced by planting under shade, possibly because this suppresses lateral shoot growth which provide the best conditions for the multiplication of the borer, or because predators prefer shaded conditions. *K. ivorensis* proved more resistant to shoot borer than *Swietenia* spp. In Malaysia a final density of 80 trees/ha and a rotation of about 30 years for *K. ivorensis* in mixed plantations is recommended. In Malaysia the mean annual increment of 26–28-year-old plantations is 7.4–7.7 m^3/ha. *K. senegalensis* proved to be successful in enrichment planting of woodland in Vietnam.

Genetic resources and breeding Provenances of *Khaya* species, but mainly of *K. anthotheca* and *K. ivorensis*, are kept in various tropical countries. In Sabah selection of *K. ivorensis* is focussing on resistance to *Hypsipyla* and involves 9 provenances and 21 progenies.

Prospects In Malaysia *K. ivorensis* in particular is considered one of the most important species for enrichment planting or plantations. The other *Khaya* species also have the potential to become important for these purposes. When *Hypsipyla*-resistant trees can be bred, the importance of *Khaya* for plantations will increase, given its favourable growth rate and high quality timber.

Literature 57, 63, 80, 123, 136, 193, 220, 282, 334, 342, 375, 402, 405, 406, 459, 464, 571, 658, 669, 736, 758, 815, 878, 918, 929, 973, 1023, 1065, 1098, 1166, 1177, 1178, 1199, 1223, 1224, 1231.

Selection of species

Khaya anthotheca (Welw.) C. DC.

Synonyms *Khaya agboensis* A. Chev., *Khaya euryphylla* Harms, *Khaya nyasica* Baker f.

Vernacular names Uganda mahogany, white mahogany (En). Acajou blanc (Fr).

Distribution Tropical Africa, from Guinea and Liberia towards Uganda and Angola; introduced into many tropical countries, in South-East Asia in Indonesia (Java) and Peninsular Malaysia.

Khaya grandifoliola C. DC.

Synonyms *Khaya grandis* Stapf, *Khaya kerstingii* Engl., *Khaya punchii* Stapf.

Vernacular names African mahogany, Benin wood, heavy African mahogany (En). Acajou à grandes feuilles (Fr).

Distribution Tropical Africa from Guinea to Zaire, northern Uganda and Sudan; in South-East Asia introduced into Indonesia (Java).

Khaya ivorensis A. Chev.

Synonyms *Khaya caudata* Stapf ex Hutch. & Dalz., *Khaya klainei* Pierre ex Pellegr.

Vernacular names African mahogany (standard trade name).

Distribution West Africa, from Ivory Coast to Cameroon, Gabon and Angola (Cabinda); in South-East Asia introduced into Indonesia (Java) and Malaysia (Peninsular & Sabah).

Khaya senegalensis (Desr.) A. Juss.

Synonyms *Swietenia senegalensis* Desr.

Vernacular names African mahogany, Gambia mahogany, Senegal mahogany (En). Acajou du Sénégal (Fr). Vietnam: x[af] c[uwf].

Distribution Native to the drier parts of tropical Africa, from Senegal to Sudan and Uganda; in South-East Asia introduced into Indonesia (Java) and Vietnam.

S.I. Wiselius

Kibatalia G. Don

Gen. syst. 4: 86 (1837).
APOCYNACEAE
x = unknown; $2n$ = unknown

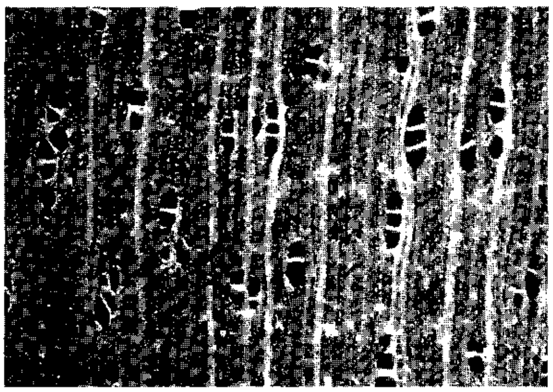
Vernacular names Indonesia: kayu santen (Javanese), ki benteli (Sundanese). Malaysia: jelutong pipit (Peninsular). Philippines: lanete (trade name which includes *Wrightia* spp.). Thailand: badu-bu-wae (peninsular).

Origin and geographic distribution *Kibatalia* comprises 15 species and is restricted to South-East Asia where it is found from southern China (Yunnan) to Indo-China, peninsular Burma (Myanmar), Thailand, Peninsular Malaysia, Sumatra, Java, Borneo, the Philippines and Sulawesi. Although only 2 species are confined to continental Asia, it is assumed that the genus originated from there and spread to the Malesian region afterwards.

Uses The wood of *Kibatalia* is used for medium-heavy construction under cover, but more often for small objects like musical instruments, picture frames, fixtures, pencil slats, toothpicks, knife sheaths, spools, polo balls, checker boards and pieces, tennis rackets, axe handles, sabre sheaths and wooden shoes. The timber is probably also suitable for cabinet making, fancy boxes, carvings, household utensils, pattern making and matches. The wood is occasionally used as firewood.
The latex of several species has medicinal properties and has been used against stomach disorder or worm diseases. In the Philippines the leaves are applied for spleenomegaly. The flowers are cooked and eaten as a vegetable. In Vietnam the latex of *K. anceps* (Dunn & R. Williams) Woodson has potential to treat haemorrhage.

Production and international trade In the Philippines 'lanete', of which *Kibatalia* wood probably makes up only a minor portion, reaches the market in the form of small logs 20–30 cm in diameter and 1.5–2 m long. Otherwise, it is usually processed locally and used particularly for carving.

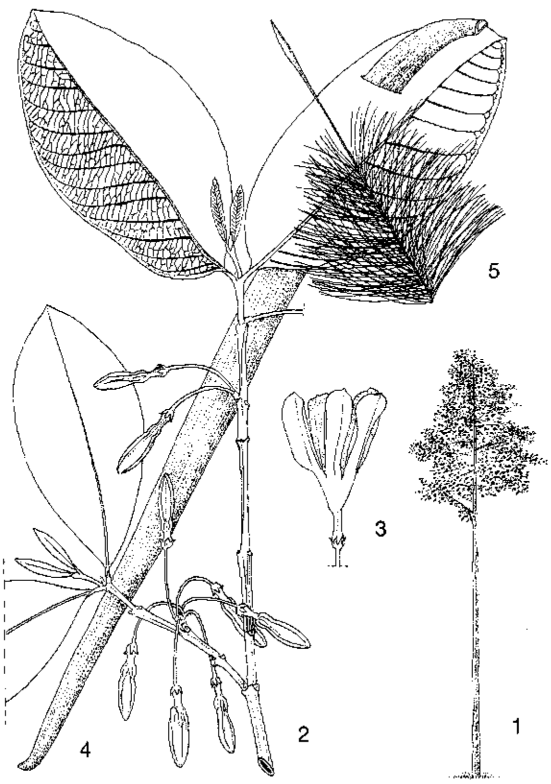
Properties *Kibatalia* yields a lightweight to medium-weight hardwood with a density of 385–610 kg/m^3 at 15% moisture content. Heartwood white, not clearly differentiated from the white to pale yellow sapwood; grain straight; texture fine and even. Growth rings occasionally just visible or distinct; vessels moderately small, mostly in radial multiples of 3–4, open; parenchyma moderately abundant, apotracheal in marginal or seemingly marginal bands, and diffuse tending to form tangential bands, visible with a hand lens; rays very fine to moderately fine, visible with a hand lens; ripple marks absent.
Shrinkage upon seasoning is low, but the wood



Kibatalia arborea
transverse surface (×20)

needs to be dried rapidly to prevent stain. The wood is soft and very easy to work. It is not durable (not recommended for permanent use) and it is readily attacked by sap-staining fungi.
The bark contains several medicinally potential alkaloids.
See also the tables on microscopic wood anatomy and wood properties.

Botany Evergreen or sometimes deciduous shrubs or small to large trees up to 45(–65) m tall; bole straight, branchless for up to 30(–40) m, up to 120 cm in diameter, sometimes with short buttresses up to 1.5 m high; bark surface smooth to fissured or sometimes cracked, lenticellate, grey-brown to black, sometimes mottled, inner bark granular, orange to white, often mottled, with copious white latex. Leaves decussate, simple, entire, often with domatia underneath, petioles of a pair connate to form a short cup. Flowers in a terminal or axillary, cymose cluster, 5-merous; calyx lobes imbricate, mostly with colleters inside at base; corolla gamopetalous, white to pale green, with a narrow tube, the lobes overlapping to the right in bud; stamens inserted on the corolla tube, anthers narrowly triangular with a sagittate base, adhering to the pistil head; disk present; ovary superior, 2-carpellate with free carpels and many ovules. Fruits consisting of 2 narrowly ellipsoid or cylindrical follicles with seeds in 2 ranks. Seed pointed or beaked, with a tuft of hairs.



Kibatalia arborea (Blume) G. Don – 1, tree habit; 2, flowering twig; 3, flower; 4, fruit; 5, seed.

Annual diameter increment of *K. arborea* in Java is about 2 cm. Flowering and fruiting seem to occur throughout the year, but in Java *K. arborea* flowers in June–July or October just after the leaves are shed. Dispersal of the seed bearing a coma is presumably by wind.
Kibatalia belongs to the tribe *Nerieae* of the subfamily *Apocynoideae*.

Ecology *Kibatalia* species are found scattered in the canopy or subcanopy layer of lowland and lower montane, primary rain forest on well-drained places like slopes, sometimes along streams or in swamp forest, up to 500(–1200) m altitude. They are found on a wide variety of soil types including sandy soils, limestone and volcanic soils. Occasionally individual species are found in freshwater swamp forest and savannas.

Silviculture *Kibatalia* can be raised from seed, although there are no precise data available.

Genetic resources and breeding There are no records of *Kibatalia* species in seed or germplasm banks. Trees are fairly common in the forest and are incidentally cultivated in botanical gardens. Local utilization can be, however, quite intensive and may deplete particular populations.

Prospects *Kibatalia* will probably continue to serve as a special purpose timber for small and decorative articles. The wood properties are similar to 'pulai' (*Alstonia* spp.) and potential uses are many and promising. Moreover, as *K. arborea* seems to show rapid growth, it is a potential timber plantation tree.

Literature 61, 267, 438, 672, 780, 861, 964, 965, 974, 1038, 1175, 1201, 1221, 1242, 1247.

Selection of species

Kibatalia arborea (Blume) G. Don

Synonyms *Hasseltia arborea* Blume, *Kickxia arborea* (Blume) Blume, *Tabernaemontana ovalis* Miq.

Vernacular names Indonesia: lingorumbolia (Sulawesi, Malibi). Malaysia: jelutong beruang, tamadak (Peninsular).

Distribution Peninsular Thailand, Peninsular

Malaysia, Sumatra, Java, Borneo (Sarawak, Sabah), the Philippines (Palawan) and Sulawesi.

Kibatalia blancoi (Rolfe ex Stapf) Merr.

Synonyms *Kickxia blancoi* Rolfe ex Stapf, *Kickxia merrittii* Merr.

Vernacular names Philippines: pasnit (general), baguibonlas (Panay), laniti itim (Rizal).

Distribution The Philippines.

Kibatalia gitingensis (Elmer) Woodson

Synonyms *Kickxia gitingensis* Elmer, *Vallaris angustifolia* Merr., *Vallaris gitingensis* (Elmer) Merr.

Vernacular names Philippines: laniting gubat (Filipino), laniti (Biliran).

Distribution The Philippines.

Kibatalia maingayi (Hook. f.) Woodson

Synonyms *Kibatalia daronensis* (Elmer) Woodson, *Paravallaris maingayi* (Hook. f.) Kerr, *Vallaris maingayi* Hook. f.

Vernacular names Indonesia: bentaos susuh (Palembang, Sumatra), mengkelai (Bangka), pulai liling (West Kalimantan). Malaysia: jelutong beruang (Peninsular). Philippines: melegates (Zamboanga).

Distribution Peninsular Thailand, Peninsular Malaysia, Sumatra, Borneo (Kalimantan, Sarawak) and the Philippines (Mindanao).

Kibatalia villosa Rudjiman

Vernacular names Indonesia: empaga (Simpang, West Kalimantan), mantaos (Kintap, South Kalimanatan), nyatu (Berau, East Kalimantan). Malaysia: uchong (Sarawak).

Distribution Peninsular Malaysia (rare), and Borneo (Kalimantan, Sarawak).

Rudjiman

Kingiodendron Harms

Engl. & Prantl, Nat. Pflanzenfam. Nachtr. II–IV: 194 (1897).

LEGUMINOSAE

x = unknown; $2n$ = unknown

Vernacular names Philippines: batete. Papua New Guinea: kingiodendron (En).

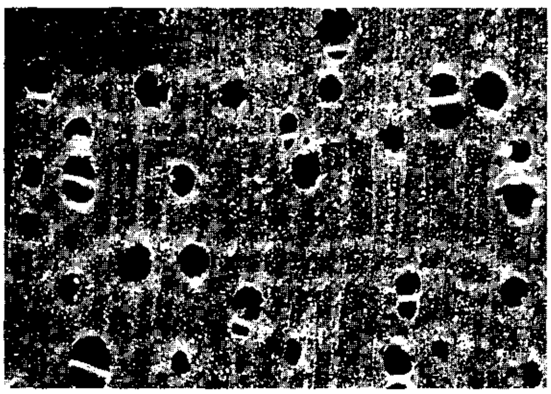
Origin and geographic distribution *Kingiodendron* comprises about 6 species, and is distributed in India (1 species), the Philippines (1 species), New Guinea (2 or 3 species), New Britain (1 or 2 species), the Solomon Islands (1 or 2 species) and Fiji (1 species).

Uses The wood of *Kingiodendron* is used for furniture, cabinet work, flooring, doors, beams, joists, rafters, cladding, interior finish and ground sills.

The dark green sap from the wood which thickens to a gummy consistency on exposure was formerly used as incense in the Philippines.

Production and international trade Small amounts of *Kingiodendron* timber are imported by Japan in consignments of mixed logs, mainly from Papua New Guinea and the Solomon Islands. In 1996 Papua New Guinea exported about 4390 m^3 of *Kingiodendron* logs at an average free-on-board (FOB) price of US$ 100/m^3. In the Philippines fairly large supplies used to be obtainable from Quezon and Masbate.

Properties *Kingiodendron* yields a medium-weight hardwood with a density of 450–760 kg/m^3 at 15% moisture content. *K. alternifolium* yields comparatively heavy wood, *K. micranthum* and *K. novoguineense* the lighter-weight wood. Heartwood pinkish-brown or red-brown, turning very dark brown with age, distinct from the yellow-brown or pale red-brown up to 5 cm wide sapwood; grain interlocked; texture moderately coarse; wood occasionally with streaks. Growth rings distinct, boundaries indicated by marginal parenchyma; vessels moderately small to moderately large, solitary and in radial multiples of 2–3(–4), chalky white deposits occasionally present; parenchyma paratracheal vasicentric, sometimes aliform and confluent, and apotracheal in marginal or seemingly marginal bands; rays moderately fine, visible to the naked eye; ripple marks absent; axial canals readily noticeable because of the patches of



Kingiodendron alternifolium
transverse surface (×20)

sticky oil or gum they secrete, about as large as vessels.

Shrinkage of the wood is moderate to high and seasoning needs to be performed with care. The wood of *K. alternifolium* is moderately soft to comparatively hard and fairly strong. It is easy to work and finishes reasonably well once the oil has dried up, and takes a high polish. The wood of *K. micranthum* and *K. novoguineense* is inferior in quality, moderately soft and of low strength. It is often difficult to work due to a sometimes fibrous nature. *Kingiodendron* wood is non-durable in contact with the ground or when exposed to the weather, *K. alternifolium* is moderately durable for interior use. The heartwood of *K. alternifolium* is moderately resistant to dry-wood termites but the wood of *K. micranthum* and *K. novoguineense* is highly susceptible to ambrosia beetles and sapstain. The sapwood of *Kingiodendron* is susceptible to *Lyctus*.

See also the tables on microscopic wood anatomy and wood properties.

Botany Evergreen, medium-sized trees up to 32(–40) m tall; bole straight, cylindrical, branchless for up to 22 m, up to 80(–150) cm in diameter, sometimes with short buttresses; bark surface smooth but often with horizontal rows of pustules, greyish-brown or brown to dark grey or blackish, inner bark reddish; slashed wood usually showing a thick, greenish, sticky exudate. Leaves arranged spirally, imparipinnate; leaflets alternating, (3–)5–6(–7), stalked, with transparent dots; stipules minute. Flowers in a lax, many-flowered panicle of spike-like raceme, small; sepals 5, ovate; petals absent; stamens 10; ovary superior, short-stalked, 1-locular with a single ovule, style obsolete to distinct. Fruit a somewhat compressed, brownish, 1-seeded, indehiscent pod. Seed ovoid or ellipsoid; cotyledons very strongly folded. Seedling with hypogeal germination; cotyledons not emergent or only 1 emergent; hypocotyl not elongated; first few leaves scale-like, subsequent ones 1-jugate. During germination, the pod dehisces slightly at the apex, enabling the radicle and plumule to emerge.

Kingiodendron belongs to the tribe *Detarieae* of the subfamily *Caesalpinioideae* and is related to genera such as *Crudia* and the African *Oxystigma*. It is uncertain whether specimens collected outside the Philippines and identified as *K. alternifolium* truly represent this species; collections from New Guinea and the Solomon Islands should possibly be assigned to *K. novoguineense* or *K. micranthum*. New Guinean specimens as *K. platycarpum* Burtt probably represent *K. novoguineense*, leaving the true *K. platycarpum* restricted to Fiji. The length of the style has often been used to distinguish species, but the possibility that long and short (or vestigial) styles represent functionally female and male flowers cannot be excluded. Sterile material is difficult or impossible to identify.

Ecology *Kingiodendron* occurs in evergreen, usually primary lowland forest up to 1800 m altitude; often on river floodplains, but also in undulating country. In Papua New Guinea *K. novoguineense* occurs in lower montane forest at 1500–1800 m altitude. The trees belong to the canopy or subcanopy.

Silviculture *Kingiodendron* can be propagated by seed.

Genetic resources and breeding Several *Kingiodendron* species are probably rare and vulnerable to genetic erosion or extinction through destruction of their habitat.

Prospects As supplies are limited, increased use of *Kingiodendron* is not likely, although the wood quality of *K. alternifolium* is fairly good.

Literature 40, 168, 304, 464, 574, 780, 861, 933, 934, 1086, 1162, 1163.

Selection of species

Kingiodendron alternifolium (Elmer) Merr. & Rolfe

Vernacular names Philippines: batete, danggai, magbalago (general).

Distribution The Philippines (Luzon, Masbate, Negros, Leyte, Samar); possibly also in New Guinea, Bougainville and the Solomon Islands.

Kingiodendron micranthum Burtt

Distribution Bougainville; possibly also in the Solomon Islands.

Kingiodendron novoguineense Verdc.

Distribution Papua New Guinea, including New Britain; possibly also in Irian Jaya.

E. Boer (general part),
R.H.M.J. Lemmens (general part, selection of species)

Knema Lour.

Fl. cochinch. 2: 604 (1790).

MYRISTICACEAE

x = unknown; *K. intermedia*: $n = 21$

Vernacular names Penarahan (trade name). Brunei: kumpang. Indonesia: darah-darah. Malaysia: dara kerbau (Peninsular), darah-darah (Sabah), kumpang (Sarawak). Philippines: duguan (Filipino). Vietnam: m[as]u ch[os].

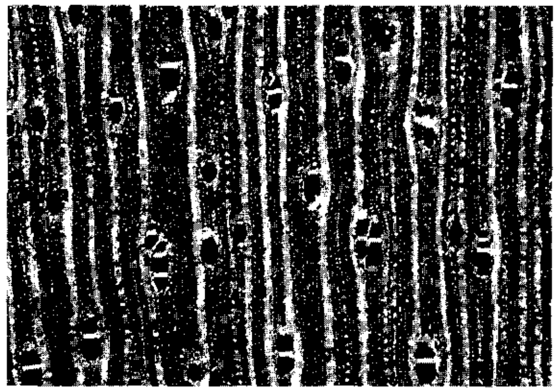
Origin and geographic distribution *Knema* comprises about 90 species occurring from India to Indo-China, southern China, Thailand and throughout the Malesian region except for Papua New Guinea. It is a typical West Malesian genus, with most species confined to Peninsular Malaysia, Sumatra and Borneo.

Uses The wood of *Knema* is used for light or temporary construction, house building (posts, beams, planks), flooring, boat building, interior trim, wall panelling, pattern making, packing cases, crates, matchboxes and match splints, and for the production of plywood. It is suitable for the manufacture of wrapping and writing paper, and is occasionally used as firewood.

The seeds contain an oil that has been used for illumination. The fruits of several species are edible. In Thailand the bark of *K. furfuracea* is used as a remedy for sores and pimples.

Production and international trade *Knema* wood may be traded in mixed consignments of medium-weight hardwood or occasionally mixed with 'red meranti', or together with that of other *Myristicaceae* genera like *Gymnacranthera*, *Horsfieldia* and *Myristica* as 'penarahan'. It constitutes a minor portion of the total amount of penarahan timber traded. In 1992 the export of penarahan from Sabah amounted to about 250 m^3 of sawn timber and about 6750 m^3 of logs, at prices of US$ 140/m^3 and US$ 71/m^3, respectively.

Properties *Knema* yields a medium-weight hardwood with a density of 495–880 kg/m^3 at 15% moisture content. Heartwood pale brown, grey-brown or red-brown, not clearly differentiated from the yellow-white sapwood which may have a pinkish tinge, large trees with a comparatively hard and heavy dark purplish-brown or dark red core; grain straight; texture moderately fine to slightly coarse; wood lustrous. Growth rings distinct to the naked eye, boundaries indicated by marginal parenchyma; vessels moderately small to medium-sized, solitary and in radial multiples of 2–3(–5), open, but deposits common in dark corewood; parenchyma moderately abundant, apotracheal in marginal or seemingly marginal bands or in groups of narrow, closely spaced bands, sometimes paratracheal vasicentric; rays moderately fine to medium-sized, just visible to the naked eye on transverse section; ripple marks absent; tanniferous tubes occasionally visible on the radial surface as dark lines in the rays.



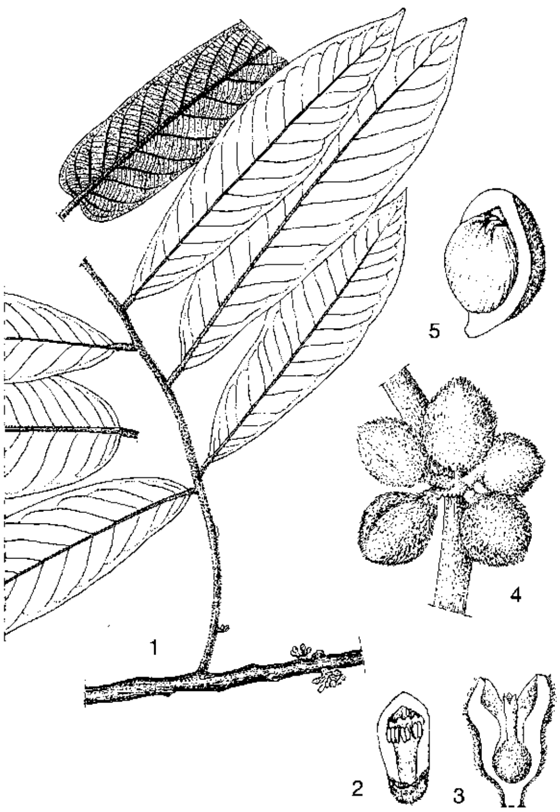
Knema conferta
transverse surface (×20)

Shrinkage upon seasoning is low and the wood seasons slowly but well; only thin boards may warp. The wood is soft and weak. It saws easily and turning and moulding properties are satisfactory. It can be planed to a smooth finish and the dark core takes a high polish. The wood is non-durable, readily attacked by fungi when exposed to the weather or in contact with the ground and susceptible to dry-wood termites and ambrosia beetles. The sapwood is extremely susceptible to *Lyctus*. The sapwood is permeable to impregnation, the heartwood is moderately resistant.

The gross energy value of the wood of a *Knema* species is about 19 885 kJ/kg.

See also the table on microscopic wood anatomy.

Botany Evergreen, dioecious, small to medium-sized or rarely large trees up to 40(–50) m tall; bole straight, cylindrical, branchless for up to 15 m, up to 60(–70) cm in diameter, sometimes with small buttresses or stilt roots; bark surface smooth to scaly or fissured, reddish- or greenish-brown to grey-brown or sometimes blackish, inner bark pink, with a red watery exudate. Leaves alternate, simple, entire, exstipulate, secondary veins often raised above. Flowers in clusters on short, simple or 2–3-furcate, woody knobs, unisexual; perianth with 3 spreading lobes. Male flower with a staminal column ending in a peltate or triangular disk with the free, stalked or sessile anthers along its margin. Female flower with a superior, 1-locular ovary with a single ovule, stigma



Knema laurina (Blume) Warb. – 1, twig with male flowers; 2, sectioned male flower; 3, sectioned female flower; 4, infructescence; 5, opened fruit.

disk-like, variously lobed, sessile or stalked. Fruit a variously hairy, 1-seeded follicle splitting on 1–2 sides. Seed enclosed in an aril that is lobed at the apex. Seedling with hypogeal germination; cotyledons not emergent; hypocotyl not elongated; epicotyl looped at first, without scale leaves; leaves alternate, conduplicate.

Branching is monopodial. Tree form is according to Massart's architectural tree model, characterized by an orthotropic, monopodial trunk with rhythmic growth consequently producing tiers of plagiotropic branches. Branches bear distichous leaves whereas the leader shoot bears spirally arranged ones. In the arboretum of the Forest Research Institute Malaysia, Kepong an individual *K. laurina* tree of 36 years old had attained 17 m in height and 31 cm in diameter. In a lowland forest in Peninsular Malaysia 5 species of *Knema* flowered synchronously in mast flowering years in the period December–March, with a peak from the end of January to early February. The coloured aril of the seed suggests dispersal by birds.

Knema has been subdivided into 12 series based mainly on the shape of the male flower bud, the shape of the androecium and mode of attachment of the anthers, the shape and position of the stigma, the indumentum on leaves and flowers, and the nature of the bark on the twigs.

Ecology *Knema* is found scattered in lowland to montane rain forest, up to 1700 m altitude, including peat-swamp forest and forest overlying limestone. In Malesia *K. globularia* prefers coastal areas.

Silviculture *Knema* can be propagated by seed. From tests with various species in Peninsular Malaysia it appeared that the germination rate can vary widely from 8–100% with an average of about 70%, with a germination period of 4–24 weeks.

Genetic resources and breeding Those *Knema* species with a narrow geographical distribution face the risk of genetic erosion by destruction of their habitat.

Prospects It is unlikely that *Knema* timber will gain importance, as supplies are very limited.

Literature 40, 57, 70, 162, 163, 194, 209, 238, 242, 243, 249, 267, 406, 436, 464, 632, 780, 801, 829, 831, 832, 934, 974, 1013, 1019, 1038, 1221, 1242, 1244, 1259.

Selection of species

Knema conferta (King) Warb.

Vernacular names Malaysia: penarahan batu, penarahan bukit (Peninsular).

Distribution Peninsular Malaysia, Singapore, Sumatra and Borneo.

Knema curtisii (King) Warb.

Vernacular names Malaysia: chendarahan tandok, penarahan tandok, sereteh (Peninsular).

Distribution Peninsular Malaysia, Sumatra and Borneo.

Knema furfuracea (Hook. f. & Thomson) Warb.

Vernacular names Scurfy nutmeg (En). Malaysia: penarahan arang (Peninsular). Thailand: chan dong, lueat khwai, lueat khwai baiyai (peninsular).

Distribution Peninsular Thailand, Peninsular Malaysia and Singapore; probably also in Sumatra.

Knema glauca (Blume) Warb.
Synonyms *Knema palembanica* (Miq.) Warb.
Vernacular names Indonesia: kayu bedarah (Palembang, Sumatra), ki mokla (Sundanese), theureu pote (Madura).
Distribution Peninsular Thailand, Peninsular Malaysia, Sumatra, Java, Borneo and the Lesser Sunda Islands (Bali).

Knema glaucescens Jack
Synonyms *Knema geminata* (Miq.) Warb.
Vernacular names Malaysia: pokok enggang (Peninsular).
Distribution Peninsular Malaysia, Singapore, Sumatra and Borneo.

Knema globularia (Lamk) Warb.
Synonyms *Knema corticosa* Lour., *Knema missionis* (Wallich ex King) Warb., *Knema sphaerula* (Hook. f.) Airy Shaw.
Vernacular names Small-leaved nutmeg (En). Malaysia: chendarah padi, merbatu kechil, penarahan padi (Peninsular). Thailand: han lat, lueat ma, lueat raet (peninsular). Vietnam: m[as]u ch[os] l[as] nh[or].
Distribution From north-eastern India to Indo-China, southern China, Thailand, Peninsular Malaysia, Singapore, Sumatra and West Java.

Knema glomerata (Blanco) Merr.
Synonyms *Knema acuminata* Merr., *Knema heterophylla* (Fernandez-Villar) Warb., *Knema vidalii* Warb.
Vernacular names Philippines: tambalau (Filipino), maragabulo (Tagalog).
Distribution Borneo (Sarawak) and the Philippines; possibly also in the Moluccas (Seram).

Knema hookeriana (Wallich ex Hook. f. & Thomson) Warb.
Vernacular names Great woolly nutmeg (En). Indonesia: selampan taon (Palembang, Sumatra). Malaysia: penarahan arang, penarahan daun besar (Peninsular). Thailand: lueat khwai (peninsular).
Distribution Peninsular Thailand, Peninsular Malaysia, Singapore and Sumatra.

Knema intermedia (Blume) Warb.
Vernacular names Lesser nutmeg (En). Indonesia: kajeng rah (Javanese), kayu simpai (Palembang, Sumatra), ki mokla (Sundanese). Malaysia: pala paya, pendarah paya, pendarahan kikek (Peninsular).
Distribution Peninsular Malaysia, Singapore, Sumatra, West Java and Borneo.

Knema korthalsii Warb.
Synonyms *Knema mindanaensis* auct. non (Warb.) Merr.
Vernacular names Philippines: bunud (Cebu Bisaya).
Distribution Borneo and the southern Philippines.

Knema kunstleri (King) Warb.
Synonyms *Knema cinerea* (Poir.) Warb. var. *alpina* J. Sinclair, *Knema coriacea* Warb., *Knema parvifolia* Merr.
Vernacular names Philippines: Kunstler tambalau (Filipino).
Distribution Peninsular Malaysia, Sumatra, Borneo and the Philippines.

Knema laurina (Blume) Warb.
Synonyms *Knema cantleyi* (Hook. f.) Warb. p.p.
Vernacular names Indonesia: huru tangkalak (Sundanese), kajeng rah (Javanese), pianggu pipit (Palembang, Sumatra). Malaysia: chendarahan hitam, penarahan hitam, penarahan samak (Peninsular). Thailand: han chang (peninsular).
Distribution Peninsular Thailand, Peninsular Malaysia, Sumatra, Java and Borneo.

Knema malayana Warb.
Vernacular names Malaysia: penarahan laut, penarahan pipit, penarahan samak (Peninsular).
Distribution Peninsular Thailand, Peninsular Malaysia and Singapore.

Knema pallens W.J. de Wilde
Distribution Borneo.

Knema pedicellata W.J. de Wilde
Distribution Borneo (Sarawak, Sabah).

Knema pubiflora W.J. de Wilde
Distribution Borneo.

Knema pulchra (Miq.) Warb.
Synonyms *Knema cinerea* (Poir.) Warb. var. *cordata* (J. Sinclair) J. Sinclair, *Knema glaucescens* Jack var. *cordata* J. Sinclair.
Distribution Peninsular Malaysia and Borneo; possibly also in Sumatra.

Knema scortechinii (King) J. Sinclair

Synonyms *Knema conferta* (King) Warb. var. *scortechinii* (King) Warb.

Distribution Peninsular Malaysia; possibly also in Sumatra.

Knema sumatrana (Blume) W.J. de Wilde

Synonyms *Knema cinerea* (Poir.) Warb. var. *sumatrana* (Blume) J. Sinclair, *Knema glauca* (Blume) Warb. var. *sumatrana* (Blume) Warb., *Knema wrayi* (King) Warb.

Distribution Peninsular Thailand, Peninsular Malaysia and Sumatra.

Knema viridis W.J. de Wilde

Distribution Borneo (Sarawak).

E.N. Sambas (general part),
M.S.M. Sosef (selection of species)

Koilodepas Hassk.

Versl. Meded. Afd. Natuurk. Kon. Akad. Wetensch. 4: 139 (1856).

EUPHORBIACEAE

x = unknown; $2n$ = unknown

Origin and geographic distribution *Koilodepas* comprises 11 species, 10 of which are present in the Malesian region. The genus is distributed from India to Indo-China, southern China, Thailand, Peninsular Malaysia, Sumatra, Java, Borneo and Papua New Guinea.

Uses The wood of *Koilodepas* is used locally for house construction (poles and posts), beams of charts, rice pounders, tool handles, wedges and pegs.

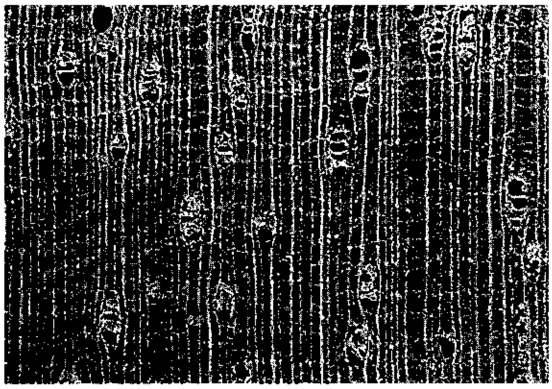
Production and international trade As supplies are very limited and the size is generally small, the wood of *Koilodepas* is used rarely and on a local scale only.

Properties *Koilodepas* yields a heavy hardwood with a density of 960–1020 kg/m^3 at 15% moisture content. Texture fine.

The wood is hard and very strong, difficult to saw and to split. It is probably resistant to termites and fungi.

See also the table on microscopic wood anatomy.

Botany Evergreen, monoecious, small to medium-sized trees up to 25(–30) m tall; bole often poorly shaped, branchless for up to 9(–18) m, up to 40 cm in diameter, not buttressed; bark surface papery flaky, brown or dark grey, inner bark laminated, red. Young parts stellate pubescent. Leaves arranged spirally, simple, entire to crenulate-serrate, short-petioled, shallowly blistered; stipules lanceolate, caducous. Inflorescence axillary, spicate, pendulous, male or bisexual with female flowers at base. Flowers in clusters, unisexual; petals absent; disk absent. Male flower with 3–4-lobed calyx; stamens 3–5, sometimes connate halfway; pistillode absent or small. Female flower with 8–10-lobed calyx, lobes imbricate; ovary superior, 3-locular with 1 ovule in each cell, styles 3, connate below, coarsely plumose or twice bifid at apex. Fruit a 3-coccous, dehiscing capsule, with persistent calyx. Seed smooth, mottled brown and ochre.



Koilodepas hainanense (Merr.) Croizat
transverse surface (×20)

In Java *K. bantamense* has been observed flowering in April and August.

The name of this genus was formerly often misspelled as *Coelodepas*.

Ecology *Koilodepas* occurs in the understorey of lowland, evergreen, primary and secondary rain forest, up to 400 m altitude. It is found on flat and undulating land, in well-drained habitats on sandstone, sandy or clayey loams, also on ultrabasic soils. *K. longifolium* has been observed in kerangas.

Silviculture In the Way Kambas Game Reserve, Lampung, Sumatra, *K. bantamense* was found to be dominant in logged-over and secondary forest.

Genetic resources and breeding As logging for *Koilodepas* timber is very limited and several species are found in both primary and secondary habitats, genetic erosion does not constitute an important risk.

Prospects *Koilodepas* is hardly known as timber; therefore, it is unlikely that its use will increase in the near future.

Literature 26, 28, 32, 34, 35, 70, 162, 163, 436, 438, 543, 595, 861, 1038, 1195, 1221.

Selection of species

Koilodepas bantamense Hassk.

Vernacular names Indonesia: kayu gading (Indonesian, Java).
Distribution West Java; probably also in northern Sumatra.

Koilodepas longifolium Hook. f.

Synonyms *Coelodepas glanduligerum* Pax & K. Hoffm., *Nephrostylus poilanei* Gagnep.
Vernacular names Malaysia: kilas (Sabah), memparang puteh, santai paya (Peninsular). Thailand: chee mut, ka raeng hin, yan hang yong (peninsular).
Distribution Vietnam, peninsular Thailand, Peninsular Malaysia and Borneo.

Koilodepas wallichianum Benth.

Vernacular names Malaysia: bunga bantor bateh, semantan, semantum (Peninsular).
Distribution Peninsular Malaysia.

Isa Ipor

Kostermansia Soegeng

Reinwardtia 5: 1 (1959).
BOMBACACEAE
x = unknown; $2n$ = unknown

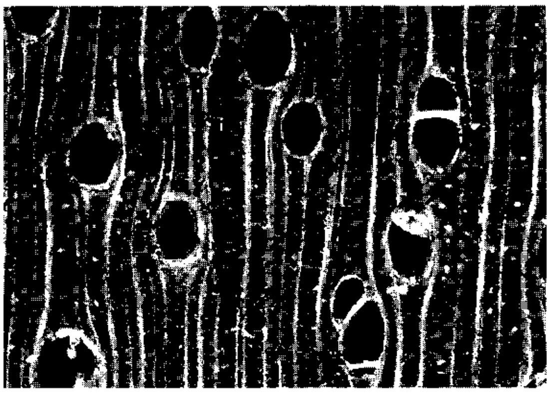
Vernacular names Malaysia: durian tuang, krepal, krepau (Peninsular).

Origin and geographic distribution *Kostermansia* is a monotypic genus endemic to Peninsular Malaysia; the only species is *K. malayana* Soegeng.

Uses The wood is suitable for light construction under cover, joists, flooring, joinery, cabinet making, furniture, pallets, panelling and partitioning and plywood.

Production and international trade *K. malayana* timber is traded together with that of the genera *Coelostegia*, *Durio* and *Neesia* as 'durian'. It comprises only a minor proportion within this trade group.

Properties *K. malayana* yields a medium-weight to heavy hardwood with a density of about 865 kg/m^3 at 15% moisture content. Heartwood pink-brown or deep red-brown and moderately



Kostermansia malayana transverse surface (×20)

sharply defined from the pale yellow sapwood; grain straight to slightly interlocked; texture moderately coarse to coarse and even. Growth rings present but indistinct, indicated by more thick-walled fibres; vessels medium-sized to very large, solitary and in radial multiples of 2–3(–6), tyloses absent; parenchyma paratracheal vasicentric, not visible with a hand lens, apotracheal diffuse-in-aggregates, tending to regular, narrow bands (scalariform); rays conspicuous; ripple marks absent.

Shrinkage is low to moderate and the wood can be seasoned without serious defects, although boards tend to cup. It is fairly soft and not very strong. The wood can be sawn easily, but fibres may pick up in planing. It is a non-durable timber which is fairly easy to moderately difficult to treat with preservatives. The wood is not resistant to dry-wood termites and pinhole borers. The sapwood is susceptible to *Lyctus*.

See also the table on microscopic wood anatomy.

Botany An evergreen, large tree up to 50 m tall; bole up to 125 cm in diameter, often fluted and with tall buttresses up to 7 m high; bark surface smooth and lenticellate or with rough scales, sometimes peeling off, brown to reddish-brown, inner bark fibrous, red grading to orange towards the cambium; crown golden brown below. Twigs densely covered with toothed scales. Leaves alternate, simple, leathery, entire, covered by scales below, midrib sunken above; stipules caducous. Flowers in an axillary or pseudoterminal, lax, scaly inflorescence, bisexual; epicalyx comprising 2 lobes enveloping the basal part of the bud; calyx 5-lobed; petals 5, shorter than the sepals; stamens about 20, short and united into an irregular tube at base, anthers 2-celled; ovary superior, spinose,

5-locular with 2 ovules in each cell, style very short, stigma peltate. Fruit a globose spiny capsule, splitting into 5 recurving valves almost to the base. Seed without an aril, glossy dark brown. Seedling with epigeal germination; cotyledons emergent, leafy, cordate at base; hypocotyl elongated.
Flowering seems to be rare and not confined to a particular period.
Kostermansia is intermediate between *Coelostegia* and *Durio*, both morphologically and anatomically. Distinguishing features are the epicalyx which partly envelops the calyx, the short stamens, the short style and the seed without aril.

Ecology *K. malayana* is found at low altitudes in primary forest. It is uncommon but can be locally frequent and may even become dominant, especially in freshwater swamp forest.

Silviculture In Peninsular Malaysia it is treated as a 'desired species', which means that it is liberated from competing trees.

Genetic resources and breeding *K. malayana* is threatened by the rapid conversion of its natural habitat into agricultural land and, therefore, ex situ conservation is desirable.

Prospects As the wood properties of *K. malayana* are satisfactory, its importance may increase in the near future, although supplies will remain very limited due to its infrequent occurrence.

Literature 65, 208, 209, 1042, 1219, 1221, 1245, 1250.

E. Soepadmo

Lagerstroemia L.

Syst. nat., ed. 10, 2: 1068, 1076, 1372 (1759).
LYTHRACEAE

$x = 24, 25$; *L. floribunda* Jack: $2n = 48$, *L. indica* L., *L. speciosa*: $2n = 48, 50$

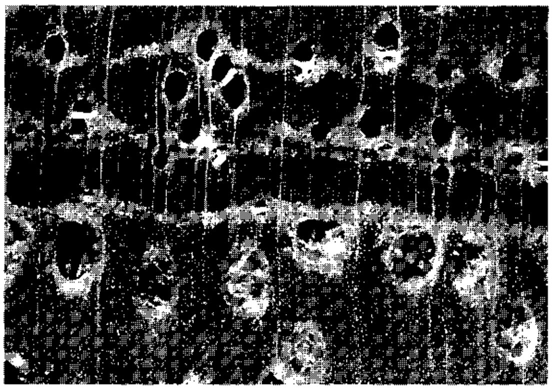
Vernacular names Banglang (Fr). Jarul (Am, En, Fr). Pyinma (Am, En). Brunei: kokonang. Indonesia: bungur (trade name). Malaysia: bungor (general). Philippines: banaba. Burma (Myanmar): pyinma. Cambodia: sralao. Laos: puay 'khao. Thailand: inthanin, tabaek. Vietnam: b[awf]ng l[aw]ng.

Origin and geographic distribution *Lagerstroemia* comprises about 55 species and is distributed from India and the Himalayas to Burma (Myanmar), Indo-China, China, Japan, Taiwan, Thailand, throughout the Malesian region and northern Australia. About 25 species occur within Malesia. A few species are cultivated as ornamentals in tropical and subtropical countries around the world.

Uses The wood of *Lagerstroemia*, which is often regarded as being similar in some respects to teak (*Tectona grandis* L. f.), is used for medium heavy construction under cover (posts, beams, scantlings, door and window frames), bridge and wharf building, boat building, vehicle bodies, mine timbers, railway sleepers, panelling, flooring, joinery, cooperage, agricultural and domestic implements, boxes, paddles, spear shafts, gunstocks, tool handles and sporting goods. The wood seems suitable for the production of sliced veneer and yields a good firewood.
Several species, notably *L. floribunda*, *L. indica* and *L. speciosa*, are cultivated for ornamental purposes, the latter also as a wayside tree and in Kalimantan as a support for rattan. It is also applied in erosion control as it produces a dense and widespread root system. A decoction of its bark has been applied in Java against diarrhoea and in Peninsular Malaysia for abdominal pains. Bark and leaves of *L. speciosa* contain tannin.

Production and international trade As *Lagerstroemia* seldom reaches large sizes and supplies within Malesia are small, trade is generally on a local scale only. However, considerable export takes place from Burma (Myanmar) and India.

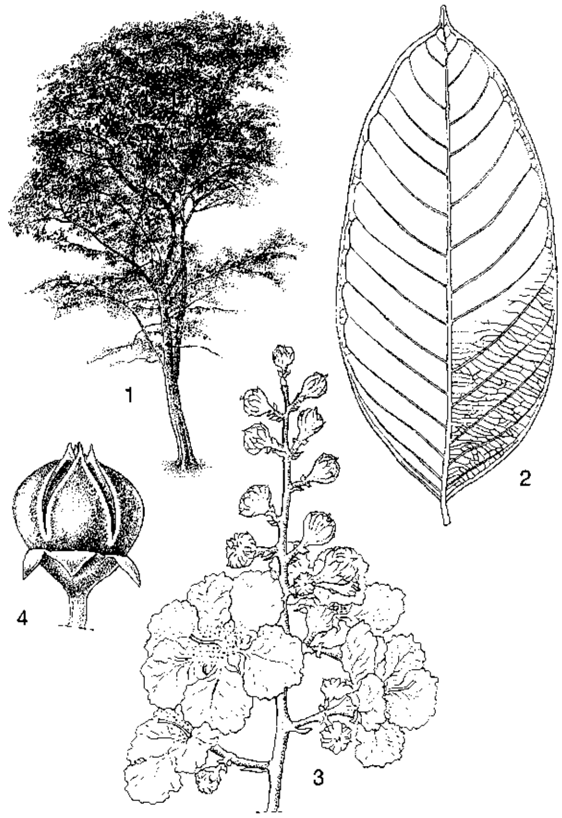
Properties *Lagerstroemia* yields a medium-weight hardwood with a density of 505–810 kg/m^3 at 15% moisture content. Heartwood pale brown, yellow-brown, greyish or reddish to red-brown, not clearly differentiated from the white or grey-white to yellow-brown, up to 8 cm wide sapwood; grain straight or slightly interlocked, occasionally con-



Lagerstroemia archeriana F.M. Bailey
transverse surface (×20)

spicuously wavy (fiddle back); texture moderately fine to rather coarse, uneven in material with distinct vessel rings; wood lustrous. Growth rings usually distinct as the wood tends to be ring-porous; vessels moderately small to very large, the larger vessels arranged in single, rarely double rows in concentric rings in the earlywood, usually solitary, also in radial multiples of 2–3(–8), tyloses abundant, rarely with red-brown deposits; parenchyma abundant, paratracheal aliform and confluent, the latter being conspicuous, decreasing in frequency and width from the inner side of a growth ring towards the outer side, and apotracheal parenchyma in marginal or seemingly marginal bands; rays very fine to moderately fine, indistinct to the naked eye; ripple marks absent; pith flecks observed in some samples.
Shrinkage upon seasoning is low, occasionally moderate. The wood seasons slowly with little degrade; boards 25 mm thick take 42 days (Indonesia) to air dry, but 6 months is also reported; boards 40 mm thick take about 3 months to air dry. Boards of *L. speciosa* 25 mm thick take about 6 days to kiln dry to a final moisture content of approximately 10% using a kiln schedule with a temperature of 43–72°C and a relative humidity of 84–38%. It is moderately hard to hard, strong, very tough and resistant to shock. The wood is easy to work, only boring gives poor results, and it takes a high finish. It is very difficult to peel, even after boiling for 48 hours. The wood is moderately durable to durable when exposed to the weather or in contact with the ground. In a graveyard test in the Philippines the average service life of test stakes of *L. speciosa* was about 7 years and of *L. piriformis* 5.8 years. The heartwood is resistant to preservative treatment but the sapwood is amenable. The heartwood is resistant to very resistant to dry-wood termites. The sapwood of *L. piriformis* is non-susceptible to *Lyctus*. The reported susceptibility of the sapwood of *L. speciosa* to *Lyctus* is contradictory.
The average fibre length of *L. piriformis* is 1.07 mm. The gross energy value of *L. speciosa* wood is 18 855–19 230 kJ/kg.
See also the tables on microscopic wood anatomy and wood properties.

Botany Deciduous or semi-deciduous shrubs or small to medium-sized or rarely large trees up to 40(–45) m tall; bole fairly straight to crooked, branchless for up to 18 m, up to 100 (–150) cm in diameter, often fluted and sometimes with small buttresses; bark surface smooth or with small papery flakes, grey to light fawn-brown mottled, inner bark fibrous, grey-fawn to yellow, turning dirty mauve or purple upon exposure; crown usually bushy and spreading. Axillary buds pointed. Leaves opposite, distichous, simple, entire; stipules minute or absent. Flowers in a large, axillary or terminal panicle, often showy; calyx funnel- or bell-shaped, 6(–9)-lobed; petals usually 6, inserted near the mouth of the calyx tube, white to pink or purple, clawed, wrinkled; stamens many, in several rows; ovary superior, 3–6-locular with many ovules in each cell, style 1. Fruit a large, woody capsule seated on the persistent calyx. Seed with an apical wing. Seedling with epigeal germination; cotyledons emergent, leafy, 2-lobed; hypocotyl elongated; first few leaves alternate, becoming subopposite and eventually opposite.



Lagerstroemia speciosa (L.) Pers. – 1, tree habit; 2, leaf; 3, inflorescence; 4, fruit.

In trials on fertile soil in East Java 15.5-year-old *L. speciosa* trees attained a mean annual increment of 0.9–1.1 cm in diameter and 0.7–0.9 m in height. The growth rate is slower at an older age. Three extra-Malesian species have been planted on an experimental scale in Java and have attained annual increments of 0.9–1.6 cm in diameter and 0.6–1.1 m in height for trees of 13–25 years old. Trees shed their leaves during the dry season. Saplings start to flower when only a few years old, but reportedly only start producing viable seed when 15 years old. Flowering is frequent, usually annually or even twice a year. Each flower lasts for only 2–3 days. In the Philippines *L. speciosa* flowers in April–June, in Java in July–October, and in Papua New Guinea in May–July, although flowers and fruits may be found throughout the year. Pollination is by large bees; seed dispersal is by wind.

Ecology Most *Lagerstroemia* species are found at low to medium altitudes in comparatively open habitats, in disturbed or secondary forest, grassland, and are especially common along rivers. *L. ovalifolia*, however, is a primary forest species. Most species are scattered but may become locally dominant. The habitat may vary from well-drained to occasionally flooded, but not peaty.

Silviculture *Lagerstroemia* can be propagated by seed. Branch and root cuttings have been used occasionally and tissue culture has been successful on an experimental scale. *L. speciosa* has 165 000–235 000 dry seeds/kg. Seeds can be stored without temperature control in airtight containers for about 2 years without a serious decline in viability; germination increases during the first 3 months to 1 year of storage. Seeds should be sown in the shade; those of *L. langkawiensis* Furtado & Srisuko show about 40% germination in 11–40 days and seeds of *L. speciosa* germinate in 15–56 days. After germination the small seedlings can be pricked out and transferred to containers. Stumps of *L. speciosa* with a shoot length of 5–10 cm, a root length of 10–20 cm and a diameter of 0.5–2.5 cm showed 90–100% survival. *Lagerstroemia* requires moderately fertile soil. In trials with *L. speciosa* planted at 3 m × 1 m on fertile soils in East Java the canopy closed after 6 years and the first thinning was necessary after 8 years. As growth is fairly slow and natural pruning poor, it is recommended to use a closer spacing, namely 2.5 m × 1 m. At 15.5 years the clear bole volume yield in these trials was 47–55 m^3/ha. It has been proposed to girdle trees 2 years before harvest to allow for easier seasoning. *Lagerstroemia* coppices freely and *L. speciosa* is fairly resistant to fire.

Genetic resources and breeding There is little risk of genetic erosion of *Lagerstroemia*.

Prospects Increased use of *Lagerstroemia* timber may be expected as growth is satisfactory and information on propagation and plantation establishment is becoming available.

Literature 11, 70, 101, 130, 151, 162, 163, 193, 198, 209, 218, 235, 259, 260, 267, 308, 309, 348, 354, 362, 365, 405, 434, 436, 477, 488, 536, 571, 644, 697, 736, 757, 758, 804, 823, 829, 831, 933, 934, 974, 1038, 1048, 1052, 1086, 1090, 1098, 1177, 1198, 1199, 1221, 1242.

Selection of species

Lagerstroemia borneensis Furtado & Srisuko

Distribution Borneo (Kalimantan).

Lagerstroemia koehneana K. Schumann

Distribution New Guinea.

Lagerstroemia moluccana Furtado & Srisuko

Distribution The Moluccas.

Lagerstroemia ovalifolia Teijsm. & Binnend.

Vernacular names Pahang bungor (En). Indonesia: benger (Sundanese). Malaysia: bungor balong, bungor melukut (Peninsular). Thailand: tabaek dong (peninsular).

Distribution Indo-China, Thailand, Peninsular Malaysia, Sumatra, Java, North Sulawesi and New Guinea (Irian Jaya).

Lagerstroemia paniculata (Turcz.) S. Vidal

Synonyms *Lagerstroemia calycina* Koehne.

Vernacular names Philippines: talulong (Tagalog).

Distribution The Philippines.

Lagerstroemia piriformis Koehne

Synonyms *Lagerstroemia batitinan* S. Vidal, *Lagerstroemia crassifolia* Furtado & Srisuko.

Vernacular names Philippines: batitinan (Bikol, Tagalog).

Distribution Borneo (Sabah), the Philippines, New Guinea and Melanesia.

Lagerstroemia speciosa (L.) Pers.

Synonyms *Lagerstroemia flos-reginae* Retz.

Vernacular names Pride of India, queen of flowers (En). Indonesia: bungur (general), bungur tekuyung (Palembang, Sumatra), ketangi (Javanese). Malaysia: bungor raya (Peninsular), bongor biru (Malay, Sarawak), tibabah (Dusun Banggi, Sabah). Philippines: banaba (Filipino). Burma (Myanmar): gawkng-uchyamang. Vietnam: b[awf]ng l[aw]ng n[uw][ows]c. Thailand: chuangmuu, tabaek dam (central), inthanin nam (central, peninsular).

Distribution Burma (Myanmar), Indo-China, China, Thailand, Peninsular Malaysia, Sumatra, Java, Borneo, the Philippines and Sulawesi; also cultivated within this region and in many other tropical countries.

Lagerstroemia subcostata Koehne

Synonyms *Lagerstroemia unguiculosa* Koehne.
Distribution China, Japan, Taiwan and the Philippines.

D.S. Alonzo

Lepisanthes Blume

Bijdr. fl. Ned. Ind. 5: 237 (1825).
SAPINDACEAE
x = 13, 14, 15; *L. rubiginosa*, *L. tetraphylla*: $2n$ = 26, *L. senegalensis*: $2n$ = 28, 30

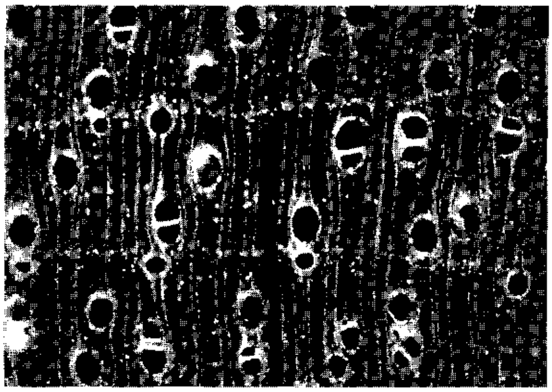
Vernacular names Indonesia: katilayu (Javanese), ki layu (Sundanese). Malaysia: mertajam (Peninsular).

Origin and geographic distribution *Lepisanthes* comprises 24 species and is found in tropical Africa, Madagascar, and from Sri Lanka and India to Indo-China, southern China, Thailand, throughout the Malesian region towards north-western Australia. Within Malesia 16 species are found; Borneo is the richest in species.

Uses The wood of *Lepisanthes* is used for house posts and occasionally for rice pounders and tool handles. It is also used as firewood.
Several species possess edible fruits. The young leaves of *L. rubiginosa* may be eaten as a vegetable. A decoction of its roots and leaves, occasionally also of fruits and seeds, is used medicinally against fever. Its astringent but sweet fruits are relished as a titbit, mainly by children. In the Philippines the leaves are also used for animal health care. The fruits and bark have been used as a soap or to make shampoo.

Production and international trade *Lepisanthes* wood is used on a local scale only. There are no records of any commercial trade.

Properties *Lepisanthes* yields a medium-weight hardwood with a density of 580–790 kg/m^3 at 15% moisture content. Heartwood dark pinkish-brown to deep red-brown or yellowish, sharply demarcated from the up to 1.3 cm wide, pale purplish-brown sapwood; grain straight; texture fine and even. Growth rings indistinct; vessels moderately small to medium-sized, solitary and in radial multiples of 2–3, with occasional white deposits; parenchyma sparse, paratracheal vasicentric with tendency to aliform, and apotracheal in bands, distinct; rays moderately fine to medium-sized, visible to the naked eye; ripple marks absent.
The wood is hard and strong. It is non-durable when exposed to the weather or in contact with the ground. The sapwood is susceptible to *Lyctus*.
See also the table on microscopic wood anatomy.


Lepisanthes senegalensis
transverse surface (×20)

Botany Evergreen or deciduous, usually monoecious shrubs or small to medium-sized trees up to 20(–30) m tall; bole usually short and often poorly shaped, up to 60 cm in diameter, without buttresses; bark surface greyish. Leaves arranged spirally, simple to imparipinnate or paripinnate, 1- to more than 40-jugate, pseudo-stipules sometimes present; leaflets opposite or alternate, entire. Inflorescence terminal, axillary, ramiflorous or cauliflorous. Flowers unisexual; sepals (3–)4–5(–6), free, often at least the inner ones petaloid; petals (3–)4–5(–7), often distinctly clawed and with a scale inside; disk interrupted or entire. Male flower with (4–)8(–18) stamens. Female flower with a superior, 2–3(–4)-locular ovary with 1 ovule in each cell, stigma sometimes sessile, slightly lobed. Fruit drupaceous, slightly to distinctly lobed. Seed shining brown or black, without an arillode. The seedling of *L. rubiginosa* shows hypogeal germination; cotyledons not emergent; hypocotyl not elongated; epicotyl with a pair of opposite, 3-foliolate leaves, subsequent ones pinnate and arranged spirally. The seedling of *L. senegalensis* differs in having the first few leaves simple, later ones 3-foliolate and subsequent ones pinnate.

L. rubiginosa flowers and fruits almost throughout the year, but preferably after a dry period. *L. senegalensis* flowers mainly from July–November and bears fruit from January to April. *L. tetraphylla* flowers and fruits almost throughout the year. The flowers are pollinated by insects, mainly bees. The seeds are eaten and dispersed by birds.

Lepisanthes has been divided into 4 subgenera, more or less coinciding with formerly recognized genera. These are subgenus *Lepisanthes* (genera *Lepisanthes* and *Hebecoccus*), subgenus *Otophora* (Blume) Leenh. (genus *Otophora*), subgenus *Erioglossum* (Blume) Leenh. (genus *Erioglossum*) and subgenus *Aphania* (Blume) Leenh. (genus *Aphania*).

Ecology The timber-yielding *Lepisanthes* species have a wide ecological amplitude. They are found in primary and secondary forest but also in forest edges, escarpments, river banks and more open localities, *L. rubiginosa* even along the inner fringe of mangrove forest. They occur in areas with seasonal or perhumid conditions, in dry as well as swampy localities, on a wide range of soils including limestone, up to 1200(–1400) m altitude.

Silviculture *Lepisanthes* may be raised from seed. Sown seeds or fruits of *L. rubiginosa* have 90% to almost 100% germination in 9–23 days and seeds of *L. senegalensis* have 80–95% germination in 10–32 days, but sown fruits have only about 45% germination in 11–31 days. *L. rubiginosa* is not fire-resistant and does not tolerate a periodically high groundwater table. In southern China *L. rubiginosa* is a major weed in pastures.

Genetic resources and breeding There are no records of ex situ conservation of *Lepisanthes*. Because all timber-yielding species are widespread, they do not seem to be endangered.

Prospects As *Lepisanthes* wood is not available in large sizes or in sufficient quantities, it is unlikely that its use will increase in the near future.

Literature 70, 163, 238, 267, 436, 438, 595, 684, 772, 829, 831, 861, 889, 934, 974, 1038, 1048, 1164, 1221.

Selection of species

Lepisanthes rubiginosa (Roxb.) Leenh.

Synonyms *Erioglossum edule* (Blume) Blume, *Erioglossum rubiginosum* (Roxb.) Blume, *Lepisanthes hirta* Ridley.

Vernacular names Indonesia: katilayu (Javanese), ki layu (Sundanese). Malaysia: kelat layu, mertajam (Peninsular), lipupudsu (Dusun, Sabah). Philippines: kulayo (general). Laos: 'houat, 'houat noy². Thailand: kamcham (peninsular), kamsam, ma huat (central). Vietnam: x[is] tai.

Distribution From northern India to Indo-China, south-east China, Thailand, and throughout the Malesian region towards north-western Australia.

Lepisanthes senegalensis (A.L. Juss. ex Poir.) Leenh.

Synonyms *Aphania montana* Blume, *Aphania paucijuga* (Hiern) Radlk., *Aphania senegalensis* (A.L. Juss. ex Poir.) Radlk.

Vernacular names Indonesia: kelayu gunung (general), ki layu gunung (Sundanese), wregil ireng (Javanese). Malaysia: kelinga gaba (Dusun Banggi, Sabah), melingkat (Iban, Sarawak). Philippines: balinono-kitid (Tagalog), onaba (Bikol). Thailand: ma wo (north-eastern).

Distribution From tropical Africa and Madagascar to Sri Lanka, India, Bangladesh, Burma (Myanmar), Indo-China, Hainan, Thailand, the Andaman and Nicobar Islands and throughout the Malesian region except for the Lesser Sunda Islands.

Lepisanthes tetraphylla (Vahl) Radlk.

Synonyms *Lepisanthes blumeana* Koord. & Valeton, *Lepisanthes montana* Blume, *Lepisanthes schizolepis* Radlk.

Vernacular names Indonesia: katilayu watu (Javanese), ki lalayu lalaki (Sundanese). Malaysia: arit-arit (Dusun, Sabah), bansisi (Dusun Labuk, Sabah), jung (Iban, Sarawak). Philippines: bayag-daga, sarakag-tilos (Tagalog), pospos (Bikol). Thailand: ma fueang chang, ma fueang pa (northern), ma kham de khwai (central).

Distribution From Sri Lanka and India to Burma (Myanmar), Indo-China, Hainan and Thailand towards Peninsular Malaysia, Sumatra, western Java, Borneo, the Philippines, North Sulawesi, Timor and New Guinea.

E. Boer (general part),
M.S.M. Sosef (general part, selection of species)

Leptospermum J.R. Forster & J.G. Forster

Charact. gen. pl.: 71, t. 36 (1775).
MYRTACEAE
$x = 11$; for all species investigated: $2n = 22$

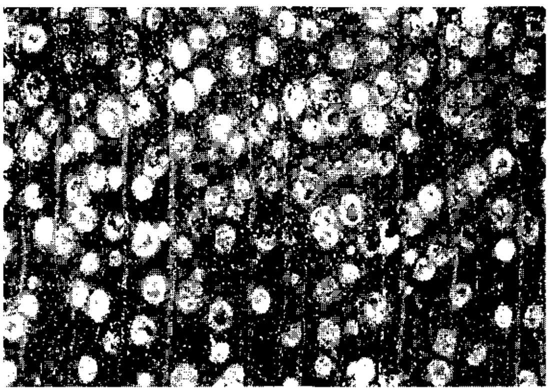
Vernacular names Mountain gelam, tea tree, ti tree (En). Malaysia: China maki, gelam bukit (Peninsular). Philippines: malasulasi (Filipino).

Origin and geographic distribution *Leptospermum* comprises about 80 species and occurs in Burma (Myanmar), southern Thailand, throughout Malesia to Australia, the Caroline Islands and New Zealand. Australia is richest in species (28, most of them in Queensland). In Malesia only 4 species are found, 2 of which occur only locally (*L. parviflorum* Valeton in the lowlands of New Guinea and *L. recurvum* Hook. f. on Mount Kinabalu, Sabah, and in the mountains of Sulawesi); the other 2 species (*L. amboinense* and *L. javanicum*) are widespread.

Uses The wood of *Leptospermum* is used for small objects such as tool handles and for firewood. It is suitable for rafters in house building because of its durability.
In the Moluccas small amounts of volatile oil are distilled from the leaves, which are inhaled against bronchitis and used as an embrocation against rheumatism. A tea made from the leaves is drunk as stimulant.

Production and international trade Due to its small size, utilization of *Leptospermum* timber is scarce and on a local scale only.

Properties *Leptospermum* yields a heavy hardwood with a density of 950–1040 kg/m^3 at 15% moisture content. Heartwood brown with darker streaks, moderately sharply differentiated from the paler sapwood; grain wavy or interlocked; texture rather fine and even. Growth rings distinct to indistinct, boundaries indicated by layers of denser fibres and fewer vessels; vessels variable in size from very small to medium-sized, predominantly solitary, sometimes in radial pairs, occasionally in vague tangential arrangement, open or filled with gum-like deposits; parenchyma moderately abundant, apotracheal diffuse tending to local aggregation, paratracheal scanty, with tendency to aliform, indistinct even with a lens; rays moderately fine, not visible to the naked eye; ripple marks absent.
The wood is hard, very strong and durable when exposed to the weather or in contact with the ground. The wood is probably resistant to sapstain fungi. The sapwood is non-susceptible to *Lyctus*.
See also the table on microscopic wood anatomy.



Leptospermum brachyandrum (F. v. Mueller) Druce
transverse surface (×20)

Botany Shrubs or small trees up to 12(–16) m tall; bole often crooked, sometimes straight, up to 20 cm in diameter; bark surface usually deeply fissured and flaky, greyish-brown; branches often gnarled and twisted. Twigs with raised ridges extending from the base of each leaf. Leaves arranged spirally, simple, sessile, entire, usually with 3 longitudinal veins, aromatic when crushed; stipules minute, caducous. Flowers axillary, usually solitary and sessile, with 2 bracteoles, 5-merous; calyx cup-shaped, lobed, swollen; petals free, white, caducous; stamens many, in a single whorl, free, shorter than petals, with versatile anthers; ovary semi-inferior, usually 5-locular with many ovules in each cell, style 1. Fruit a small woody capsule, seated in the persistent calyx cup, many-seeded, opening at the top with 5 slits. Seed linear. Seedling with epigeal germination; first few leaves opposite, subsequent ones arranged spirally.
Leptospermum is known to form ecto-mycorrhizae, but has also been observed to have vesicular-arbuscular endo-mycorrhizae simultaneously, which is extremely rare. Flowering is probably throughout the year. Some trees of *L. recurvum* exhibit andromonoecism, i.e. have bisexual and functionally male flowers on the same tree.
L. amboinense and *L. javanicum* have often been considered as conspecific; this species was then usually called *L. flavescens* J.E. Smith. Recently it was discovered that in Malesia 2 distinct species are involved which differ in the shape of the leaves (obovate and discolourous in *L. javanicum*, lanceolate and concolourous in *L. amboinense*),

the pubescence of the hypanthium (pubescent in *L. javanicum*, mostly glabrous in *L. amboinense*) and the size of the fruit (larger in *L. javanicum*). The 'true' *L. flavescens* is now considered a synonym of the Australian species *L. polygalifolium* Salisb.

Ecology *Leptospermum* species are light-demanding, colonizing clearings in upper montane forest. They usually grow on rocky cliffs or ridges in the mountains up to 3000(–4000) m altitude and are often gregarious. *L. amboinense* is found at altitudes of up to 2000 m, *L. javanicum* often occurs higher in the mountains at 1500–3000 m altitude and may become dominant. At higher altitudes and in exposed locations with shallow soils the habit is a heather-like bush, whereas in bogs the plants may look like a woody herb. However, they are reported as trees with a bole up to 20 cm in diameter locally in Peninsular Malaysia at 1000–1500 m altitude, and as a tree up to 15 m tall with a straight slender bole in the Moluccas at 250–400 m altitude. In South Sulawesi *Leptospermum* species thrive on soils degraded due to fire, grazing and erosion.

Silviculture *Leptospermum* species have pioneer characteristics but lack the aggressiveness of true pioneers. No seed counts are available for Malesian species, but *L. liversidgei* R.T. Baker & H.G. Smith from New South Wales (Australia) has about 1.5 million dry clean seeds/kg. The latter has been planted in Java, but all trees died.

Genetic resources and breeding Although some *Leptospermum* species have a very restricted area of distribution, they seem not to be endangered in South-East Asia because their timber is not in great demand and they often grow in inaccessible mountanous locations.

Prospects Since the size of *Leptospermum* trees is too small and the shape of the bole too poor it is unlikely that the use of the timber will increase.

Literature 95, 97, 163, 209, 267, 405, 427, 436, 674, 861, 1097, 1219, 1221, 1237, 1242.

Selection of species

Leptospermum amboinense Blume

Synonyms *Leptospermum annae* Stein, *Leptospermum flavescens* J.E. Smith var. *angustifolia* Ridley, *Leptospermum petersonii* F.M. Bailey subsp. *lanceolatum* Joy Thomps.

Vernacular names Indonesia: hulong, kayu papua, lelel (Moluccas).

Distribution Peninsular Malaysia, Sumatra, Borneo, the Philippines, Sulawesi, Flores, the Moluccas and Australia (northern Queensland).

Leptospermum javanicum Blume

Synonyms *Leptospermum alpestre* Blume, *Leptospermum flavescens* J.E. Smith var. *javanicum* (Blume) King, *Leptospermum floribundum* Jungh.

Distribution Burma (Myanmar), peninsular Thailand, Peninsular Malaysia, Sumatra, Java, Borneo, the Philippines and Sulawesi.

Noorma Wati Haron (general part),
R.H.M.J. Lemmens (selection of species)

Licania Aubl.

Hist. pl. Guiane 1: 119, t. 45 (1775).
CHRYSOBALANACEAE
x = unknown; $2n$ = unknown

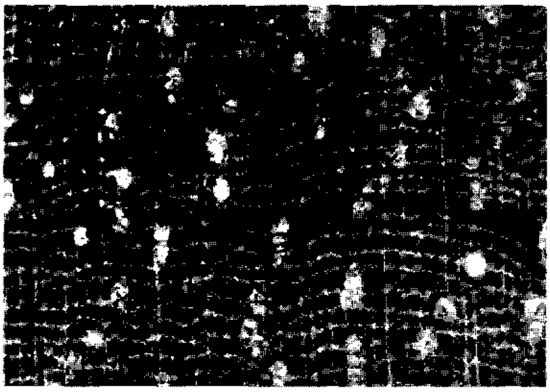
Vernacular names Red beam (En). Brunei: kayu agong, sampaluan (Malay), piasau-piasau (Kedayan). Indonesia: kayu besi (Bangka). Malaysia: merbatu kechil (Peninsular), sampaluan, tampaluan (Dusun, Sabah). Philippines: amayan (general), dagingan (Samar-Leyte Bisaya), gapus (Tagbanua). Thailand: khra, khru ra ton (peninsular).

Origin and geographic distribution *Licania* comprises over 200 species, the vast majority of which occurs in the Neotropics. One species is found in West Africa and three in the Malesian region, with a single timber-producing one: *L. splendens* (Korth.) Prance (synonyms: *Angelesia splendens* Korth., *Coccomelia nitida* (Hook. f.) Ridley, *Parinarium philippinense* Elmer). The latter occurs in peninsular Thailand, Peninsular Malaysia, Sumatra, West Java (rare), Borneo and the Philippines.

Uses The strong and durable wood of *Licania* is used for house posts, railway sleepers and saltwater piling. Because of its toughness it is suitable for tool handles; it is also used for charcoal production.
Though edible, the fruit is not often eaten.

Production and international trade *Licania* timber may occasionally be sold as 'merbatu', together with that of the genera *Atuna*, *Maranthes* and *Parinari*. Supplies, however, are limited.

Properties *Licania* yields a heavy hardwood with a density of 880–1130 kg/m^3 at 15% moisture content. Heartwood reddish or pale brown with a pink tinge, not clearly demarcated from the paler sapwood; grain straight; texture fine and even;



Licania splendens
transverse surface (×18)

wood with some watered-silk figure on radial surface. Growth rings indistinct, sometimes visible with a hand lens by dense tissue and parenchyma bands twice as far apart; vessels variable in size, from moderately small to moderately large, with oblique tendency, predominantly solitary, tyloses present, occasionally with chalk-white deposits; parenchyma abundant, apotracheal in narrow bands, evenly spaced except near growth ring boundaries, conspicuous; rays very fine, only visible with a hand lens; ripple marks absent.
The wood is apt to split in seasoning unless proper precautions are taken. It is very hard, very strong and tough. It is difficult to work due to the presence of silica, but a smooth finish is obtained with sharp tools. The wood is moderately durable to durable when exposed to the weather and is resistant to marine borer attack.
See also the table on microscopic wood anatomy.

Botany An evergreen, small to medium-sized tree up to 25 m tall; bole generally straight, cylindrical, up to 80 cm in diameter, with small buttresses; bark surface becoming irregularly cracked and flaking in small pieces, grey-brown, inner bark red-brown; crown rounded, dark green, young foliage covered with silvery silky hairs. Leaves arranged spirally, simple, entire, glabrous when mature; petiole canaliculate; stipules caducous. Inflorescence an axillary or terminal panicle of cymules. Flowers actinomorphic, with a campanulate tomentose receptacle; sepals 5, free; petals 5, about as large as the sepals; stamens 7–10, included and inserted unilaterally on the margin of the disk; ovary inserted at or near the base of the receptacle, 1-locular with 2 ovules, style basal. Fruit a small, stipitate, pear-shaped, bright red, fleshy drupe; endocarp hard, thin, splitting longitudinally upon germination.
In peninsular Thailand flowering takes place from March–April, whereas fruits have been observed in March–July; in Peninsular Malaysia flowering is in April–June. Other sources mention a period of 6–7 months for fruits to ripen. Single trees may not flower for 1–2 consecutive years. Fruits are dispersed by the fruit pigeon *Ducula aenea*.
The three Malesian species of *Licania* form the subgenus *Angelesia* (Korth.) Prance & F. White. The family *Chrysobalanaceae* is sometimes treated as a subfamily of the *Rosaceae*.

Ecology *L. splendens* is a fairly frequent tree of well-drained, primary and secondary lowland forest on hills and ridges, or sometimes in thickets, up to 400(–800) m altitude. It has been found in a wide variety of forest types including mixed dipterocarp forest, kerangas, peat-swamp forest, freshwater swamp forest, on seashores and rocky locations, but more frequently on sandy soils.

Silviculture *L. splendens* is known to coppice well.

Genetic resources and breeding The fairly common occurrence of *L. splendens* and its reasonably wide geographic distribution suggest that the risk of genetic erosion is small.

Prospects *L. splendens* is expected to continue to be used for marine constructions, but increased utilization for other purposes is unlikely as the wood is extremely hard and very difficult to cut and saw.

Literature 151, 163, 198, 209, 267, 341, 436, 464, 770, 830, 861, 903, 905, 933, 940, 1039, 1040, 1048, 1221.

G.T. Prance

Licuala Wurmb

Verh. Batav. Genootsch. Kunsten 2: 469, 473 (1780).

PALMAE

$x = 8, 14$; *L. grandis* H. Wendl., *L. paludosa*: $2n = 16$, *L. peltata* Roxb., *L. spinosa*: $2n = 28$

Vernacular names Licuala palm (En). Indonesia: palas (general). Malaysia: gerenis (Sarawak), loyar (Besisi, Peninsular), palas (Peninsular), silad (Sabah). Philippines: balatbat (Tagalog). Burma (Myanmar): salu. Thailand: ka pho. Vietnam: l[uj]i.

Origin and geographic distribution *Licuala* comprises about 130 species occurring in north-eastern India, Burma (Myanmar), Indo-China, southern China, Thailand, throughout the Malesian region, the Solomon Islands, northern Australia and Vanuatu. The largest diversity is found in Peninsular Malaysia, Borneo and New Guinea.

Uses The slender stems of some *Licuala* species were formerly popular as walking-sticks and are used to make bows. Larger stems are also applied as poles for local or temporary houses.
Several species, notably *L. grandis*, *L. peltata* and *L. spinosa*, are grown as ornamentals because of their beautiful shield-like leaves. Where *Licuala* is common the leaves are often used as temporary thatch, and in Sarawak also to weave mats. The young leaves are used to wrap food and wrap tobacco for smoking. The petioles are split for weaving baskets. The palm heart (pith) and palm cabbage (apex) are edible.

Production and international trade No trade of *Licuala* stems has been reported; use is local only. *L. grandis* is regularly encountered as a garden plant, but no trade figures are available.

Properties Cortex includes numerous fibrous and small vascular bundles, the latter with massive fibrous phloem sheaths; periphery of the central cylinder marked by numerous congested bundles each with numerous fibres sheathing the single small phloem strand; xylem sheathed by parenchyma only; central vascular bundles similar, often with conspicuous protoxylem elements; metaxylem with 1 wide vessel, phloem undivided; ground parenchyma uniform, without fibrous strands, not undergoing secondary expansion, although developing large intercellular spaces.

Botany Usually unarmed, pleonanthic, densely or diffusely clustered or solitary, usually small, stemless to shrubby or rarely tree-like palms up to 18 m tall; pole of tree-like species straight, slender, closely ringed with leaf scars, partly obscured by remains of leaf sheaths. Leaves palmate; sheaths disintegrating into fibres; petiole unarmed or armed with teeth or spines; blade many-folded, undivided or variously split along the ribs, the segments wedge-shaped, reduplicate, blunt. Inflorescence between the leaves, spicate to branched to 2(–3) orders; peduncle short to very long. Flowers bisexual, solitary or in groups of 2–3, crowded to distant; calyx fused at base, truncate, splitting irregularly or 3-lobed; corolla with 3 valvate lobes; stamens 6, filaments free or united in a tube; ovary superior, 3-carpellate with a single ovule in each carpel, carpels united distally, style columnar, stigma small. Fruit a 1-seeded, globose to ellipsoid or spindle-shaped drupe, maturing orange or red to black, 1–3 carpels developing, perianth persistent. Seed with homogeneous endosperm, intrusion of the integument conspicuous and lateral. Seedling with remote-tubular germination; eophyll strap-shaped, plicate, variably truncate and minutely lobed at apex.
The flowers produce nectar and are pollinated by insects. Fruits are reputed to be eaten and dispersed by birds.
Licuala is closely related to *Johannesteijsmannia* and *Livistona*, but can easily be recognized by the wedge-shaped, reduplicate segments of the leaf. It belongs to the subtribe *Livistoninae* of the tribe *Corypheae* within the subfamily *Coryphoideae*.

Ecology *Licuala* is generally found in primary or occasionally secondary rain forest undergrowth, at low altitudes, sometimes abundant. *L. spinosa* is known to survive well in the open. A few species are restricted to swampy habitats, several others are found in montane habitats.

Silviculture The slow growth and sometimes specific habitat requirements make *Licuala* difficult to handle as an ornamental; only *L. grandis* is easy to grow. *L. spinosa* can be propagated by seed. Seeds remain viable for 4–6 weeks. Most species take a long time to germinate, a germination period of over one year is not unusual; for *L. spinosa*, however, germination starts after about 30 days.

Genetic resources and breeding Several *Licuala* species (but not one of those treated below) are endangered in Peninsular Malaysia and Borneo. *L. spinosa* is greatly reduced in Palawan due to excessive collection for sale as an ornamental.

Prospects *Licuala* is a multipurpose palm; it is unlikely that use of its timber will increase.

Literature 70, 86, 98, 150, 163, 236, 287, 361, 430, 499, 563, 720, 873, 974, 986, 1006, 1038, 1059, 1100, 1110, 1176, 1210.

Selection of species

Licuala acutifida Mart.

Vernacular names Malaysia: palas padi, palas tikus (Peninsular).

Distribution Peninsular Malaysia.

Licuala paludosa Griffith

Synonyms *Licuala amplifrons* Miq., *Licuala paniculata* Ridley.

Distribution Indo-China, Thailand, Peninsular Malaysia, Siberut Island and Borneo.

Licuala spinosa Wurmb

Vernacular names Indonesia: palas duri (general).

Distribution Southern Burma (Myanmar), Indo-China, the Andaman Islands, Thailand, Peninsular Malaysia, Sumatra, Java, Borneo and the Philippines.

L.G. Saw

Lindera Thunb.

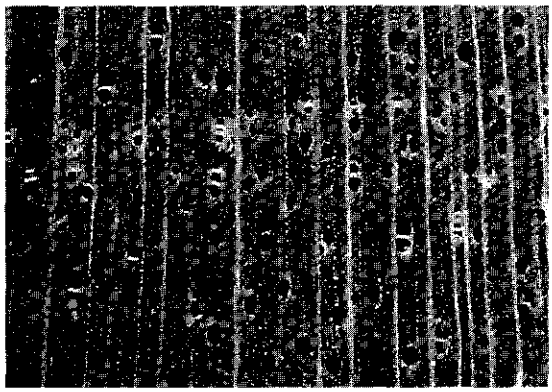
Nova gen. pl.: 64 (1783).
LAURACEAE
$x = 12$; *Lindera aggregata* (Sims) Kosterm., *Lindera glauca* (Siebold & Zucc.) Blume (and several other non-Malesian species): $2n = 24$

Vernacular names Medang (trade name). Lindera (En). Burma (Myanmar): kyese. Vietnam: [oo] d[uw][owj]c.

Origin and geographic distribution *Lindera* comprises about 100 species occurring from Sri Lanka and India to Indo-China, China, Korea, Japan and Taiwan to Thailand, the Malesian archipelago (about 30 species), northern Australia (1 species) and a few species in North America. The greatest species diversity is met with in China and northern Vietnam.

Uses *Lindera* wood has been used for house building, temporary construction, pallets and boxes. It has also been used for bridge building, railway sleepers, power line poles and tool handles, but is regarded as inferior for these purposes. The wood is also used as firewood. In general, 'medang' timber is also suitable for furniture, interior finish and ship and boat building, and a good-quality veneer and plywood can be manufactured from it.
The seeds of most species contain an oil that has been used in the soap industry. The leaves and bark contain an essential oil. The roots of several species, including *L. lucida*, contain alkaloids and have been applied medicinally against worm infections, insomnia and stomach-ache.

Production and international trade *Lindera* timber is traded together with that of many other *Lauraceae* genera as 'medang'. Because of its generally small dimensions, it probably constitutes only a very small portion of the total amount traded. In 1984 the total export of medang from Peninsular Malaysia to Singapore was 1500 m^3 with a value of US$ 62 000. In 1992 exports from Sabah amounted to 52 000 m^3 (of which about



Lindera umbellata Thunb.
transverse surface (×20)

10% was sawn timber) with a total value of US$ 4.3 million. In Papua New Guinea the minimum price for medang saw logs was US$ 43/m^3 in 1992.

Properties *Lindera* yields a lightweight hardwood with a density of 400–480 kg/m^3 at 15% moisture content. Heartwood whitish, probably not distinctly demarcated from the sapwood; grain straight to slightly interlocked; texture moderately fine and even; planed surface greasy to the touch. Growth rings distinct or indistinct; vessels medium-sized, solitary or in radial multiples of 2–4, tyloses abundant; parenchyma sparse to moderately abundant, paratracheal vasicentric, sometimes tending to aliform; rays very fine to moderately fine; ripple marks absent.
The wood is moderately hard to hard and of medium strength. It is easy to work and non-durable to slightly durable under cover. The heartwood is generally very resistant and the sapwood amenable to preservative treatment.
The energy value of oven-dry sapwood of *L. oxyphylla* is about 20 265 kJ/kg. The rind of the fruits of *L. caudata* (Wallich ex Nees) Hook. f. contains 3.1% essential oil and that of *L. communis* Hemsl. 0.2–0.5%. The oil content of the seed is 50% in *L. aggregata*, 40% in *L. caudata*, 50% in *L. communis*, and 60% in *L. kwantungensis* (Liou) Allen.
See also the table on microscopic wood anatomy.

Botany Evergreen, dioecious shrubs or small to medium-sized trees up to 30(–36) m tall; bole up to 60(–80) cm in diameter, sometimes with small buttresses up to 1.5 m high; bark surface smooth to fissured or sometimes reticulately fissured (*L. oxyphylla*), greyish to grey-brown, inner bark yellow or pale yellow, sometimes darkening to orange-brown upon exposure, with an aromatic odour. Leaves arranged spirally or subopposite to opposite, usually aromatic when crushed, exstipulate; buds naked or covered with scales. Flowers unisexual, in an axillary raceme or cluster of umbellules surrounded by an involucre of decussate bracts, 1–6 flowers per umbellule; tepals 6, with a short tube. Male flowers with 9 or 12 stamens in 3–4 rows, those of the inner 1–2 rows with 2 sessile glands each, anthers 2-celled, opening by valves. Female flowers with ovary superior, ovoid, unilocular with a single ovule, stigma peltate. Fruit a 1-seeded, blackish or red berry, seated on a shallow and enlarged perianth cup, the perianth lobes persistent or not. Seedling with hypogeal germination; cotyledons not emergent, peltate; hypocotyl not developed; epicotyl with a few scales; first few pairs of leaves arranged spirally and often pilose, subsequent ones spiral to opposite depending on the species.

The trunk of *L. lucida* is monopodial. In Java *L. bibracteata* flowers in May and November, *L. lucida* in April and *L. oxyphylla* from August to November. The seeds are dispersed by birds, possibly also by squirrels and monkeys, attracted by the glossy black or red berries.

Lindera has been subdivided into 2 subgenera: subgenus *Lindera* with many-flowered umbellules and subgenus *Iteadaphne* (Blume) Kosterm. with umbellules reduced to a single flower. Like many other *Lauraceae* genera, *Lindera* is in desperate need of a thorough taxonomic revision. Identification keys are lacking for most of the Malesian area and the taxonomy is outdated, making it often very difficult to correctly interpret data at species level.

Ecology Timber-yielding *Lindera* species are found scattered but may be locally common in primary or secondary evergreen rain forest, sometimes also in more open country and thickets (*L. lucida*). Most species favour well-drained and deep, rich soils. *L. oxyphylla* inhabits lowland and hill forest, *L. lucida* ascends to the montane forest up to 2000 m altitude. *L. bibracteata* is a hill and lower montane forest species found at 600–1400 m.

Silviculture *Lindera* may be raised from seed. For *L. oxyphylla*, there are about 85 000 dry seeds/kg. Seeds generally start germinating 1–6 weeks after sowing. Natural regeneration is usually good, but seedlings cannot persist in the dense shade of natural forest.

Genetic resources and breeding As timber-yielding *Lindera* species are locally common or occur in secondary forest and geographically relatively widespread, the risk of genetic erosion is very small.

Prospects As the wood qualities of *Lindera* are poorly known and information related to its silviculture is very meagre, its use will probably remain very limited and not reach beyond local importance in the near future.

Literature 70, 162, 163, 209, 238, 277, 405, 436, 595, 605, 614, 622, 623, 672, 829, 833, 861, 883, 947, 1179, 1221, 1232.

Selection of species

Lindera bibracteata (Blume) Boerl.

Synonyms *Daphnidium bibracteatum* (Blume) Nees, *Lindera acuminata* (Reinw. ex Nees) Villar, *Litsea tenuiramis* Miq.

Vernacular names Indonesia: ki sesemat (Sundanese).

Distribution Peninsular Malaysia, Sumatra, Java and Borneo.

Lindera lucida (Blume) Boerl.

Synonyms *Lindera malaccensis* Hook. f., *Lindera selangorensis* Ridley, *Litsea lucida* Blume.

Vernacular names Shiny laurel (En). Malaysia: medang paya, medang perawas (Peninsular), medang sarukan (Sabah).

Distribution Peninsular Malaysia, Sumatra, Java and Borneo.

Lindera oxyphylla (Meissner) Benth.

Synonyms *Lindera polyantha* (Blume) Boerl., *Lindera puberula* (Blume) Boerl., *Lindera salicifolia* (Blume) Boerl.

Vernacular names Indonesia: huru beyas, ki sapu (Sundanese), wuru janggeuy (Javanese). Malaysia: medang serai (Peninsular).

Distribution Peninsular Malaysia, Sumatra and Java.

Nguyen Kim Dao

Livistona R. Br.

Prodr.: 267 (1810).

PALMAE

$x = 18$; *L. australis* (R. Br.) Mart., *L. chinensis* (Jacq.) R. Br. ex Mart., *L. rotundifolia*: $n = 18$

Vernacular names Cabbage palm, fan palm (En). Indonesia: serdang (general). Malaysia: serdang (general). Philippines: anahau. Burma

(Myanmar): taung-htan. Vietnam: c[oj] s[er], l[as] n[os] s[er].

Origin and geographic distribution *Livistona* comprises about 28 species occurring in the Horn of Africa and adjacent Arabia, the Himalayas, Indo-China, China, the Ryukyu Islands, Taiwan, Thailand, throughout the Malesian region as far as the Solomon Islands and Australia; Australia harbours the greatest diversity of species.

Uses The trunks of *Livistona* are commonly used as house posts and for salt-water piling in the Philippines. Trunks may also be driven into the mud and used as structural support for fish cages established in freshwater lakes. The outer part of the trunk is sometimes stripped and used for wall covering, flooring, ceiling, but small pieces have also been used for small articles like suitcases, bows, walking-sticks and spear shafts. The wood of mature trunks is suitable for the manufacture of furniture.

Several species, but notably *L. chinensis* and *L. rotundifolia*, are commonly planted as ornamentals. The dried young leaves are used as a packing material, or stripped and woven into sun hats. The leaves are much prized by the indigenous people of Malesia and are commonly used to thatch roofs and may be sewn together and made into boat sails or raincoats; in the Philippines those of *L. saribus* are made into brooms. The palm cabbage (apex) is edible and resembles that of the coconut (*Cocos nucifera* L.). Palm heart and young fruits are occasionally eaten, the latter may also be made into sweets.

Production and international trade No exact figures are available, but in the Philippines there is much demand for *Livistona* poles for construction purposes. In North Sulawesi the leaves of *L. rotundifolia* are harvested commercially for roofing.

Properties A density of up to 880 kg/m^3 at 15% moisture content has been reported for the lower stem periphery of *L. rotundifolia*. Cortex 1–2 cm wide, black with whitish or yellow streaks; central vascular bundles each with numerous fibres sheathing the small phloem strand, xylem sheathed by parenchyma, metaxylem usually containing 2 wide vessels, in *L. rotundifolia* the number of vascular bundles per cm^2 rises from the base to 13 m height in the periphery from 125 to 175, in the transition zone from 60 to 105 and in the centre from 35 to 45; the vascular bundles are on their outer sides studded with rows of silica cells (stegmata); ground parenchyma cells isodiametric, elongated laterally near the vascular bundles. Shrinkage in the lower stem increases from 5% in the core to up to 7.7% in the periphery, degrade is only slight, mainly warping and checking; shrinkage of material from halfway up the pole is moderate. Boards 30 mm thick take about 3 months to air dry from the green condition. The wood is very hard and is considered one of the hardest palm woods. Saw blades are rapidly blunted when sawing *Livistona* wood. The wood is fairly easy to plane and takes a high polish. Other machining properties are rated as poor to fair; turning is rated as fair to very good. The wood is very durable in protected situations.

The average fibre length of *L. rotundifolia* is 1.90–2.25 mm and of *L. saribus* 1.35–1.80 mm.

See also the table on wood properties.

Botany Armed or unarmed, pleonanthic, solitary, shrub or tree-like palms up to 25(–40) m tall; pole straight, rather slender, up to 30 cm in diameter, conspicuously to obscurely ringed with leaf scars. Leaves palmate or costapalmate; sheath disintegrating into fibres; petiole armed or unarmed; blade many-folded, variously split along the ribs. Inflorescence borne between the leaves, solitary, branched to 5 orders; peduncle elongated. Flowers small, bisexual, solitary or in groups of up to 5, sessile on low tubercles or slender stalks; calyx with 3 triangular lobes; corolla with 3 valvate lobes, grooved inside; stamens 6, filaments connate to form a ring; ovary superior, 3-carpellate with a single ovule in each carpel, carpels united distally, style slender, stigma capitate or minutely 3-lobed. Fruit a smooth, 1-seeded, globose or ellipsoid to pyriform, green, scarlet, blue-green, dark brown or black drupe, only 1 carpel developing. Seed with homogeneous endosperm, intrusion of the integument lateral. Seedling with remote-tubular germination; eophyll lanceolate, plicate, minutely toothed apically.

The leaves are deciduous breaking off cleanly or persistent, hanging down long after they have died. Flowering of *L. endauensis* is seasonal; gregarious flowering has been observed in early April. Flowers produce nectar and are pollinated by insects. The fruits are eaten and dispersed by various animals and birds.

Livistona is closely related to *Licuala* and *Pholidocarpus*. It belongs to the subtribe *Livistoninae* of the tribe *Corypheae* within the subfamily *Coryphoideae*.

Ecology *Livistona* can be found in a wide variety of primary rain forest habitats including freshwater and peat-swamp forest (*L. saribus*), montane forest (*L. speciosa*, *L. tahanensis*), and lowland forest (*L. rotundifolia*); outside Malesia also in dry savanna woodland. *Livistona* species are frequently gregarious, e.g. *L. rotundifolia* in Sulawesi and *L. endauensis* in Peninsular Malaysia. The latter prefers shallow soils.

Silviculture *Livistona* can be propagated by seed, which remains viable for 4–6 weeks. *L. rotundifolia* seeds germinate in 31–50 days. In a study on wild *L. rotundifolia* in North Sulawesi where leaves are commercially harvested for roofing, an annual yield per palm of 2–3 leaves seemed sustainable, in combination with management of young, still non-productive palms. The coconut weevil (*Diocalandra frumenti*) attacks *Livistona* palms. Elephants feed on the cabbage of *L. tahanensis*.

Genetic resources and breeding *L. rotundifolia* is threatened in the Philippines and North Sulawesi due to over-exploitation of natural stands for posts, piles and roofing material. *L. tahanensis* and *L. endauensis* are rare but not endangered. In Peninsular Malaysia the former is endemic to the National Park Taman Negara, the latter is conserved in the Endau-Rompin State Forest Park.

Prospects Although it is unlikely that the use of *Livistona* wood will increase, plantations of *L. rotundifolia* in the Philippines and North Sulawesi may be feasible, as demand for construction wood and roofing material is still high.

Literature 70, 86, 98, 150, 163, 229, 236, 289, 323, 430, 436, 499, 563, 566, 742, 785, 808, 858, 955, 974, 1038, 1059, 1100, 1110, 1169, 1176, 1210.

Selection of species

Livistona endauensis J. Dransf. & K.M. Wong

Distribution Peninsular Malaysia.

Livistona hasseltii (Hassk.) Mart.

Synonyms *Livistona hoogendorpii* Teijsm. & Binnend. ex Miq.

Distribution West Java.

Livistona merrillii Becc.

Synonyms *Livistona whitfordii* Becc.

Vernacular names Philippines: Merrill anahau (Filipino), labik (Negrito), magalai (Bikol).

Distribution The Philippines (Luzon).

Livistona robinsoniana Becc.

Vernacular names Philippines: kayabing, pilig (Tagalog).

Distribution The Philippines.

Livistona rotundifolia (Lamk) Mart.

Synonyms *Livistona blancoi* Merr.

Vernacular names Anahaw palm, footstool palm, Java palm (En). Indonesia: samir (Bali), woka (North Sulawesi, Moluccas). Malaysia: serdang (Sabah). Philippines: anahau (Filipino), bahi (Bisaya), bulno (Bikol). Burma (Myanmar): taung-htan. Thailand: pam chawa, pam tan, pam yawa (central).

Distribution Borneo (Sabah), the Philippines, Sulawesi and the Moluccas; extensively planted in other South-East Asian regions.

Livistona saribus (Lour.) Merr. ex A. Chev.

Synonyms *Livistona cochinchinensis* Mart., *Livistona inaequisecta* Becc., *Livistona spectabilis* Griffith.

Vernacular names Indonesia: sadang (Javanese). Malaysia: sar (Peninsular). Philippines: tarau (Ibanag), tikal (Tagalog). Laos: kho². Thailand: chathang, rok (peninsular). Vietnam: k[ef] nam, l[as] g[oof]i, l[as] n[os]n.

Distribution Indo-China, Thailand, Peninsular Malaysia, Java, Borneo (Sabah) and the Philippines.

Livistona speciosa Kurz

Vernacular names Mountain serdang (En). Burma (Myanmar): tang-htan, taw-tan. Laos: kho². Thailand: ko lae, ma ko daeng (northern).

Distribution Burma (Myanmar), Indo-China, Thailand and Peninsular Malaysia.

Livistona tahanensis Becc.

Vernacular names Tahan serdang (En).

Distribution Peninsular Malaysia.

L.G. Saw

Lophostemon Schott

Wiener Z. Kunst 3: 772 (1830).

MYRTACEAE

x = unknown; $2n$ = unknown

Vernacular names Papua New Guinea swamp box (En, trade name).

Origin and geographic distribution *Lopho-*

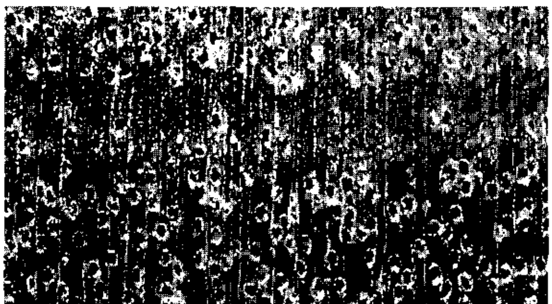
stemon comprises 4 species and is distributed in northern and eastern Australia, with one species, *L. suaveolens*, extending to southern New Guinea. *L. confertus* is planted in several tropical countries including Indonesia (Java).

Uses The hard and strong wood of *Lophostemon* is seldom milled and mainly used in the round with bark as a piling timber. In roughly hewn form it is used for marine structures including wharf and bridge decking and fencing. It is suitable for general construction, flooring, laminated beams, boat building (knees), railway sleepers, treads, sills, thresholds, cladding, fencing, bearings, mallets, mauls, tool handles, shuttles, turnery, carriage building and wedges.

L. confertus is considered suitable as an ornamental and for watershed protection.

Production and international trade The timber of *Lophostemon* is traded together with that of *Tristaniopsis* and *Welchiodendron* species as 'Papua New Guinea swamp box'. In 1996 Papua New Guinea exported only 150 m^3 of Papua New Guinea swamp box logs at an average free-on-board (FOB) price of US$ 101/m^3. It is occasionally exported from Papua New Guinea to Japan.

Properties *Lophostemon* yields a medium-weight to heavy hardwood with a density of (640–)715–970 kg/m^3 at 15% moisture content. Heartwood red, pink-brown or red-brown, turning greyish upon exposure, clearly demarcated from the pale brown or pale pink sapwood; grain interlocked, sometimes wavy; texture fine, occasionally medium, and even; wood sometimes with some silver grain. Growth rings indistinct; vessels extremely small to medium-sized, almost exclusively solitary, occasionally in oblique rows, tyloses and red to red-brown or occasionally chalky white deposits present; parenchyma sparse, scanty paratracheal and apotracheal diffuse, hardly visible; rays fine; ripple marks absent.



Lophostemon confertus
transverse surface (×20)

The shrinkage of the wood is very high and it has a tendency to twist in air drying and to warp both in kiln and air drying. The wood is liable to check in back-sawn material. Partial air drying to 30% moisture content before kiln drying and final reconditioning will give good results. The wood is hard and strong, its toughness is not well established. It is hard to work with hand and machine tools but plantation-grown material works somewhat easier, planes well (provided a low cutting angle is used to reduce picking up of fibres in material with interlocked grain), finishes well, but is difficult to nail. The wood is fairly durable to durable in contact with the ground or exposed to weather. The sapwood is permeable, the heartwood is extremely resistant to impregnation. The resistance to termites and marine borers varies with age and locality. The wood of *L. suaveolens* contains a waxy substance.

See also the tables on microscopic wood anatomy and wood properties.

Botany Small to medium-sized trees up to 40 m tall, occasionally arborescent shrubs; bole straight, occasionally crooked, up to 100 cm in diameter; bark surface smooth or more often deeply vertically fissured and broadly ridged, outer bark fibrous-papery, persistent or deciduous and then often with a rough 'sock' at the base of the trunk, pinkish-brown to reddish-brown. Leaves alternate (but juvenile leaves opposite), crowded in pseudoverticils at the end of twigs, simple, entire, with small oil glands, exstipulate. Flowers in an axillary dichasium, with turbinate-campanulate hypanthium; sepals persistent or caducous; petals 5, white or cream; stamens numerous, in several whorls, in fascicles opposite the petals; ovary half-inferior, 3-locular with many ovules, style with capitate stigma. Fruit a loculicidal capsule. Seed numerous, linear-cuneate.

Trees in a 24-year-old plantation of *L. confertus* in Java had a mean diameter of 18 cm and a mean height of 8.5 m. In West Java *L. confertus* fruits in August–September and in Central Java in November–April.

Lophostemon has recently been split off from the genus *Tristania* sensu lato and is related to the genera *Syncarpia* and *Welchiodendron*.

Ecology In Australia *Lophostemon* trees occur as mature residual trees in lowland rain forest and commonly extend to wet sclerophyll and moist open forest, often along watercourses or in floodplains. *L. suaveolens* is one of the principal trees of tree savannas of the southern dry belt in Papua New Guinea.

Silviculture *Lophostemon* can be easily propagated by seed. There are about 4.6 million dry seeds of *L. confertus* per kg. In Indonesia *L. confertus* has been successfully planted in reforestation programmes, generally at medium altitude. A mixed plantation with 'puspa' (*Schima wallichii* (DC.) Korth.) proved to be very satisfactory for reforestation of mountain slopes. However, in this case *L. confertus* did not regenerate. It has also been planted with good results on poor soils in the lowlands near Jakarta for the production of firewood.

Genetic resources and breeding As *L. confertus* is planted worldwide its genetic resources are considered to be satisfactorily conserved. No information is available on seed sources and seed selection, however. *L. suaveolens* has a fairly wide distribution and since it seems to be rarely logged there is no immediate danger of genetic erosion.

Prospects The use for sawn timber of *Lophostemon* is unlikely to increase due to its limited availabilty and processing difficulties. It will probably remain of interest for its specialty applications, due to its hardness and high density.

Literature 124, 267, 300, 302, 348, 360, 405, 464, 487, 536, 571, 632, 758, 933, 1230, 1242, 1274.

Selection of species

Lophostemon confertus (R. Br.) Peter G. Wilson & J.T. Waterhouse

Synonyms *Tristania conferta* R. Br.

Vernacular names Brush box (En).

Distribution Eastern Australia; planted elsewhere in the tropics, e.g. Java.

Lophostemon suaveolens (Soland. ex Gaertn.) Peter G. Wilson & J.T. Waterhouse

Synonyms *Melaleuca suaveolens* Soland. ex Gaertn., *Tristania suaveolens* (Soland. ex Gaertn.) J.E. Smith.

Vernacular names Swamp box (En). Indonesia: bus merah, peër (Irian Jaya).

Distribution Southern New Guinea and eastern Australia.

E. Boer (general part),
R.H.M.J. Lemmens (general part, selection of species)

Ludekia Ridsd.

Blumea 24: 334 (1978).
RUBIACEAE
x = unknown; $2n$ = unknown

Vernacular names Philippines: ludek.

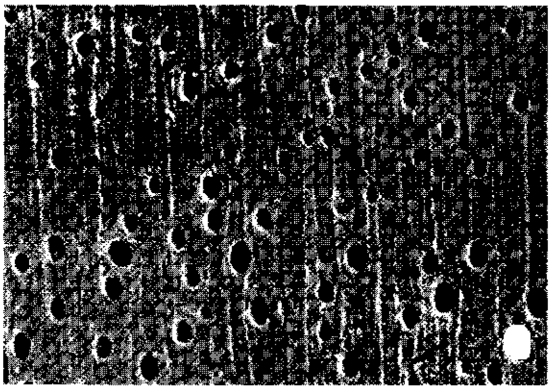
Origin and geographic distribution *Ludekia* comprises 2 species, one endemic to the Philippines and the other endemic to Borneo.

Uses The wood of *Ludekia* is used for house construction (e.g. for posts, beams, joists and rafters) and also for window-sills, flooring, cabinet work, furniture and turnery.

Production and international trade *Ludekia* timber is obtainable in small quantities only and has no importance on the international market.

Properties *Ludekia* yields a medium-weight hardwood with a density of 620–715 kg/m^3 at 15% moisture content. Heartwood pale orange, not clearly differentiated from the sapwood; grain interlocked; texture moderately fine. Growth rings indistinct, sometimes marked by narrow concentric bands of dense tissue; vessels moderately small to moderately large, almost all solitary, seldom with deposits, indistinct to the naked eye; parenchyma occasionally paratracheal vasicentric, generally apotracheal diffuse and diffuse-in-aggregates, visible with a hand lens; rays extremely fine; ripple marks absent.

The wood seasons well with little checking. It is moderately hard and moderately strong. It works easily. The wood is slightly durable to durable when exposed to the weather or in contact with the ground. The average service life of *L. bernardoi* stakes in a graveyard test in the Philippines is 22 months.

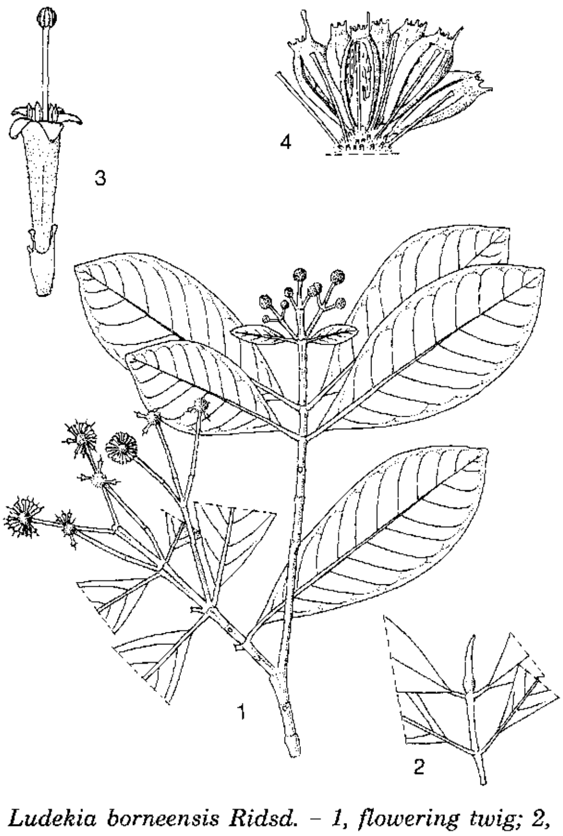


Ludekia bernardoi
transverse surface (×18)

See also the table on microscopic wood anatomy.

Botany Medium-sized to fairly large trees up to 35 m tall; bole branchless for up to 25 m, up to at least 60 cm in diameter, sometimes with spreading buttresses or fluted; bark surface slightly flaky, brownish. Terminal vegetative bud conical. Leaves opposite, simple, entire, obovate to elliptical; stipules appressed, deciduous. Inflorescence terminal, consisting of over 5 stalked flower heads; interfloral bracteoles absent. Flowers 5-merous; calyx with a short tube and spoon-shaped or elliptical-lanceolate to sword-shaped lobes; corolla hypocrateriform to narrowly funnel-shaped, with imbricate lobes; stamens inserted on the upper part of the corolla tube; ovary inferior, 2-locular with many ovules, style exserted, with obovoid stigma having 7–9 longitudinal ridges. Fruits in a head-like infructescence, free, splitting into 4 parts, with a persistent central axis. Seed ellipsoid, slightly bilaterally compressed, shortly winged at both ends. Seedling with epigeal germination; cotyledons leafy.

L. bernardoi has been observed flowering in April.



Ludekia borneensis Ridsd. – 1, flowering twig; 2, twig apex; 3, flower; 4, part of fruiting head.

Ludekia belongs to the tribe *Naucleeae*. It is most closely related to *Neonauclea* and differs from the latter genus by the non-flattened, terminal vegetative bud, the generally more numerous and smaller flowering heads, the structure of the stigma, and the comparatively shorter calyx lobes.

Ecology *Ludekia* trees occur scattered, mainly in primary lowland forest.

Genetic resources and breeding *Ludekia* trees occur in primary lowland forest often subject to logging, particularly in the Philippines. Its status in terms of threat is unknown and needs attention.

Prospects *Ludekia* might be regarded as a favourable timber in selective logging systems because of its good shape and size and fair wood properties. Since little information is available on ecological and silvicultural aspects it is premature to give an opinion on its prospects in sustainably managed natural forest or plantation forest.

Literature 235, 464, 715, 780, 934, 943.

Selection of species

Ludekia bernardoi (Merr.) Ridsd.

Synonyms *Nauclea bernardoi* Merr., *Neonauclea bernardoi* (Merr.) Merr.

Vernacular names Philippines: ludek (Negrito).

Distribution The Philippines (Luzon, Masbate, Samar, Leyte and Mindanao).

Ludekia borneensis Ridsd.

Distribution Borneo.

E. Boer (general part),

R.H.M.J. Lemmens (general part, selection of species)

Lumnitzera Willd.

Ges. Naturf. Freunde Berlin Neue Schriften 4: 186 (1803).

COMBRETACEAE

$x = 13$; *L. racemosa*: $2n = 26$

Vernacular names Teruntum (trade name). Indonesia: duduk, tarungtung (Java, Sumatra), sesop (Sumatra). Malaysia: geriting (Sabah), sop sop, teruntum (Peninsular, Sarawak). Papua New Guinea: brown mangrove (En). Philippines: tabau. Thailand: faat.

Origin and geographic distribution *Lum-*

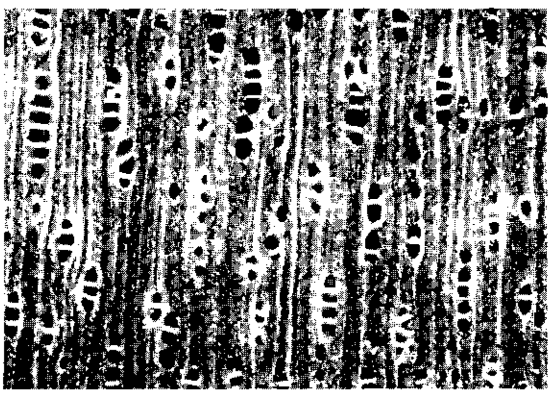
nitzera comprises 2 species found along the coasts of eastern Africa and Madagascar to tropical Asia, Japan, Polynesia and northern Australia. Both are found throughout the Malesian region.

Uses The timber of *Lumnitzera* is used for salt-water piling (with the bark on) and fencing and to a lesser extent for heavy construction, house posts, railway sleepers, boat building, tool handles, turnery, furniture, parquet flooring, panelling, mouldings, skirtings, door and window frames, wooden pallets and packing crates, and other purposes where toughness and hardness are required and small-sized timber can be applied. It is also used for chipboard and as firewood. The pale, hard and very fine-textured wood of *L. racemosa* could be used as a substitute for boxwood (*Buxus* spp.) for small articles such as rulers, canes, bobbins, shuttles and novelties.

The leaves are used as a remedy for sprue. The bark of *L. littorea* yields tannin used to dye clothes yellowish-brown and to tan nets and leather.

Production and international trade Supplies of *Lumnitzera* timber are generally limited. It has been logged commercially for wood chips in Sabah, but as the wood is generally mixed with that of other mangrove species no specific trade figures are available.

Properties *Lumnitzera* yields a medium-weight to heavy hardwood with a density of 750–970 kg/m^3 at 15% moisture content, *L. racemosa* having heavier wood than *L. littorea*. Heartwood pale brownish-red to pale grey-brownor yellowish-brown, not clearly differentiated from the narrow, paler sapwood; grain straight to shallowly interlocked; texture fine (*L. littorea*) or very fine (*L. racemosa*) and even; wood lustrous and that of *L. littorea* with a scent of roses or with spicy odour when freshly cut. Growth rings usually visible to the naked eye, prominent on radial surface, marked by denser and darker tissues; vessels moderately small, solitary and in radial multiples of 2–7(–9) fewer multiples in *L. racemosa*, radial pattern evident, occasionally with tyloses or chalky deposits; parenchyma sparse, sometimes apotracheal in marginal or seemingly marginal bands, paratracheal scanty to vasicentric and with some apotracheal diffuse; rays extremely fine to moderately fine; ripple marks absent.



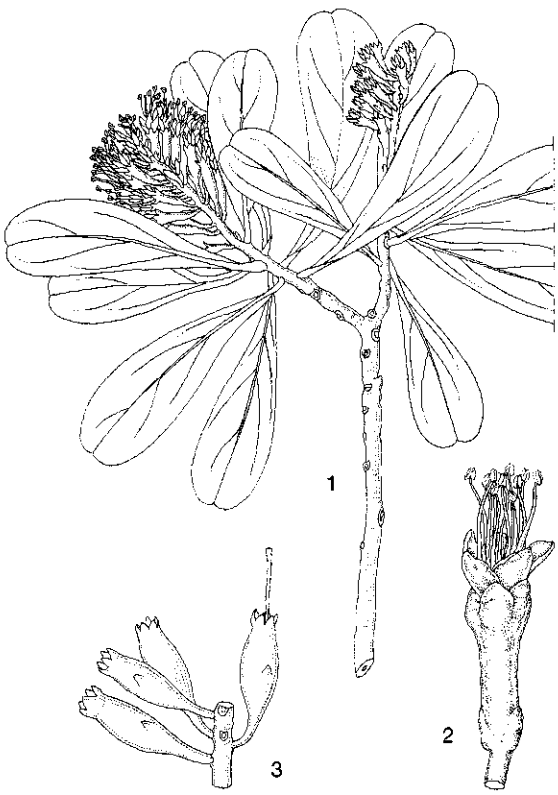
Lumnitzera littorea
transverse surface (×20)

Shrinkage is low and the wood seasons well with little degrade, but end splits may develop. The wood is very stable in use. It takes about 2 months and 3.5 months respectively to air dry 13 mm and 38 mm thick boards of *L. littorea*. The wood is hard, strong and tough, *L. racemosa* having harder and stronger wood than *L. littorea*. The bole of *L. littorea* is often of poor form and may be knotty. It is easy to saw and cross-cut and produces a good finish; planing produces a silky sheen and the wood turns excellently. The wood is moderately durable to durable and in the Philippines it had a service life of about 3.5 years in graveyard tests. In marine piling (with bark on) it is serviceable for about 7 years, but a range of 2–30 years has been reported, the wide range being attributed to local differences in marine borer attack and probably to salinity conditions. It is not resistant to termites, however. The sapwood is rarely susceptible to *Lyctus*. The wood, probably the heartwood of *L. littorea*, absorbed only about 46.5 kg/m^3 of a mixture of creosote and diesel fuel when treated with the open tank method.

The mean fibre lenght of *L. littorea* from Indonesia is 1.134 mm. The bark of *L. racemosa* contains about 19% tannin.

See also the tables on microscopic wood anatomy and wood properties.

Botany Evergreen, small to fairly large trees up to 37 m tall (*L. racemosa* usually much smaller); bole straight and cylindrical under favourable conditions, otherwise rather poorly shaped, often twisted, branchless for up to 12 m, up to 60(–100) cm in diameter, without buttresses but producing pneumatophores and sometimes stilt roots; bark surface shallowly fissured, lenticellate, fawn-brown to greyish, inner bark deep red outwards, orange within; crown pale green, irregular. Leaves arranged spirally, in tufts towards the end of twigs, simple, obovate, rather fleshy, margin slightly notched, subsessile, exstipulate. Flowers in a short, axillary or terminal spike or raceme, 5-merous; receptacle (calyx tube) bearing 2 adnate,



Lumnitzera littorea (Jack) Voigt. – 1, flowering twig; 2, flower; 3, fruits.

persistent bracteoles; petals free, scarlet or white, caducous; stamens 5–10, borne on the inner wall of the receptacle tube; disk absent or obscure; ovary inferior, 1-locular with 2–5 ovules, style 1, persistent. Fruit a more or less woody, compressed ellipsoid pseudocarp, 1-seeded, crowned by the persistent calyx. Seedling with epigeal germination; cotyledons emergent; hypocotyl elongated.

L. racemosa develops according to Attims' architectural model, characterized by axes with continuous growth, differentiated into a monopodial trunk and equivalent branches. *L. littorea* develops according to Scarrone's model with an indeterminate trunk bearing tiers of orthotropic branches, which branch sympodially as a result of terminal flowering. *L. littorea* flowers throughout the year; fruit development takes 3–4 months. The flowers of *L. racemosa* are pollinated predominantly by honey-eaters (*Melphagidea*), bees, wasps and presumably also by small birds sipping the nectar inaccessible to insects. The flowers of *L. littorea* are frequently visited by wasps, bees, butterflies and day-active moths. This difference is probably related to the fact that the flowers of the former are slightly zygomorphic whereas those of the latter are actinomorphic.

L. ×*rosea* Gaud., the hybrid of *L. littorea* and *L. racemosa*, has occasionally been observed. It is distinguishable by its pink flowers of intermediate length. Yellow-flowered plants of *L. racemosa* have been distinguished as var. *lutea* (Gaud.) Exell.

Ecology Both *Lumnitzera* species are frequent and sometimes even gregarious elements occurring in the dry inner fringe of mangrove vegetation and along tidal rivers, mainly associated with *Bruguiera* spp. and *Xylocarpus* spp. They occasionally occur on exposed beaches or on rocks along the coast. Although both species seem to prefer the same ecological conditions, they seldom co-occur. *L. littorea* appears to prefer less saline, well-drained sites, often in association with *Heritiera littoralis* Aiton.

Silviculture *Lumnitzera* can be propagated by seed. In Micronesia seeds are collected from nets placed under seed-bearing trees. They are then stored dry. There are about 22 500 dry fruits/kg. Large trees of *L. littorea* are often hollow and green logs are sinkers. Natural regeneration is good, with locally over 700 seedlings/ha.

Genetic resources and breeding *L. littorea* is becoming scarce because of its popularity for piling; it was already scarce in the 1960's in Sabah. In general, mangrove forests are fragmented because of exploitation for charcoal and firewood and conversion to other land uses.

Prospects *Lumnitzera* is considered inferior to *Rhizophora* spp. for the reforestation of mangrove areas.

Literature 61, 151, 162, 163, 238, 267, 305, 340, 341, 343, 402, 403, 405, 436, 464, 536, 703, 717, 740, 741, 745, 880, 889, 924, 934, 974, 1038, 1103, 1113, 1221, 1242.

Selection of species

Lumnitzera littorea (Jack) Voigt

Synonyms *Lumnitzera coccinea* Wight & Arn.

Vernacular names Indonesia: duduk agung (Javanese), randai (East Kalimantan), tarungtung (Sundanese). Malaysia: geriting merah (Sabah), teruntum merah (Peninsular, Sarawak). Philippines: tabao, tabau. Cambodia: kanhep, sdam'. Thailand: faat daeng (central, peninsular), tamsao thale (peninsular). Vietnam: c[oj]c do, c[os]c ken.

Distribution From India and Sri Lanka to Burma (Myanmar), Indo-China, Hainan, Thailand, throughout the Malesian region but rare on the coasts of the Java Sea, northern Australia and into Polynesia east to Tonga.

Lumnitzera racemosa Willd.

Vernacular names Brunei: landing. Indonesia: duduk (general), api-api jambu (Kalimantan), duduk laki-laki (Sumatra). Malaysia: sop sop (Peninsular), teruntum puteh (Peninsular, Sarawak). Philippines: kulasi. Burma (Myanmar): dawe-hmaing, yinye. Cambodia: kanhep. Thailand: faat (central, peninsular), faat khao (central), lamphaen hin (south-eastern). Vietnam: c[oj]c v[af]ng, c[os]c.

Distribution From eastern Africa and Madagascar towards India, Indo-China, southern Japan, throughout the Malesian region, northern Australia and the Pacific.

L.S.L. Chua

Macaranga Thouars

Gen. Nov. Madag.: 26 (1806).

EUPHORBIACEAE

$x = 11$; *M. denticulata* (Blume) Müll. Arg., *M. indica*, *M. peltata* (Roxb.) Müll. Arg., *M. tanarius*: $n = 11$

Vernacular names Mahang (trade name). Macaranga (En). Brunei: marakubong, sedaman. Indonesia: mahang kapur (general). Malaysia: benua (Sarawak), marakubong (Sabah). Papua New Guinea: macaranga (En). Philippines: hamindang (Filipino). Burma (Myanmar): petwaing. Thailand: lo.

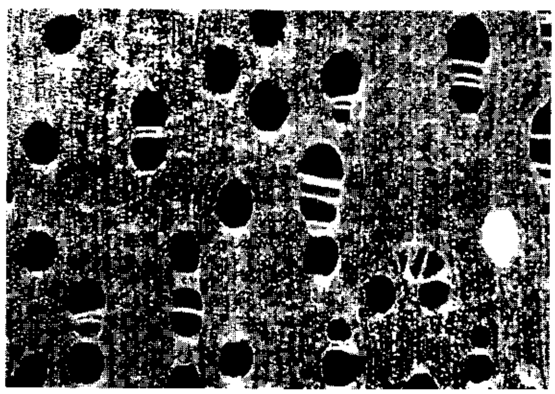
Origin and geographic distribution *Macaranga* comprises some 250 species. About 30 of these occur in tropical Africa and Madagascar, the rest in tropical Asia from India to Indo-China, China, Taiwan, the Ryukyu Islands, Thailand, throughout the Malesian region, northern Australia and the Pacific, east to Fiji. The main centre of diversity is found within Malesia where some 160 species occur, with an exceptionally high number of endemics in Borneo and New Guinea.

Uses Peeled *Macaranga* poles are frequently used for temporary construction and especially for parts of native houses not in contact with the ground. The wood is used for light framing, interior trim, moulding, shingles, packing cases, outriggers for canoes and, especially, match splints. In the Philippines it has been a favourite wood for wooden shoes. *M. indica* has been used to support pepper vines. Poles of *M. tanarius* have been used by pepper growers in southern Sumatra to make temporary ladders to harvest their crop. *Macaranga* yields a high-quality pulp and produces high-quality particle board, cement-bonded board and wood-wool board, and is suitable for the production of plywood. It provides good fuelwood.

The bark and pith or the fruit of several species produce a resin or gum called 'kino' or 'selaru' that can be used as a glue. The bark of some species has been used to tan fishing nets and in Papua New Guinea as twine for hut construction. Certain species are the most common hosts of the lac insect; production, however, is negligible. A decoction of the leaves or roots of various species is used as an internal medicine. In Malaysia a decoction of the root-bark of various species is drunk to treat diarrhoea, dysentery, fever, used to clean wounds and applied after childbirth. Large leaves of *M. gigantea* and *M. mappa* are used to wrap food, etc.

Production and international trade *Macaranga* is regarded as a commercial timber in Indonesia, but little is traded separately. When traded it is found in mixed consignments of lightweight hardwood. In 1996 Papua New Guinea exported 219 m^3 of *Macaranga* logs at an average free-on-board (FOB) price of US$ 98/m^3.

Properties *Macaranga* yields a lightweight hardwood with a density of 270–500(–590) kg/m^3 at 15% moisture content, but for *M. involucrata* densities of over 830 kg/m^3 and for *M. lowii* of 800–815 kg/m^3 are reported. Heartwood pale yellow-brown to pale brown or grey-brown, sometimes with a pinkish tinge, not clearly differentiated from the sapwood; grain straight or slightly



Macaranga gigantea
transverse surface (×20)

interlocked; texture moderately fine to moderately coarse and even; planed surfaces lustrous. Growth rings sometimes apparent; vessels moderately small to medium-sized, solitary and in radial multiples of 2–4(–6), tyloses few; parenchyma moderately abundant, apotracheal in narrow bands, visible with a hand lens, occasionally tending to diffuse or diffuse-in-aggregates; rays very fine, visible with a hand lens; ripple marks absent.
Shrinkage is moderate and in seasoning the wood is liable to sap-stain and is subject to insect attack. The wood is soft to moderately hard and fairly weak. It is very easy to work but somewhat fibrous. The wood is non-durable and permeable to pressure treatment. It is moderately resistant to susceptible to dry-wood termites, the sapwood is susceptible to *Lyctus*.
The medicinal properties are probably due to the tannin.
See also the tables on microscopic wood anatomy and wood properties.

Botany Evergreen, dioecious, small to medium-sized trees up to 30(–40) m tall; bole straight, up to 50(–70) cm in diameter, occasionally with stilt roots, rarely with buttresses; bark surface smooth or rough with lenticels, hoop-marked, stripping off easily, greyish or pinkish, inner bark pink to reddish-brown, sometimes exuding a colourless, pink or red-brown gum; crown open, often bluish-green. Leaves arranged spirally, simple, palmately or pinnately veined, the main veins joined by parallel, concentric veinlets giving the effect of spider-webbing, often prominently lobed, sometimes peltate; petiole often long and kneed; stipules often large and persistent. Flowers small, in a short, lateral raceme of small clusters subtended by often glandular bracteoles; petals absent; disk absent. Male flower with 2–5-lobed calyx, lobes valvate; stamens 1–20; anthers 3–4-celled; pistillode absent. Female flower with 3-5-lobed calyx; ovary superior, (1–)2–3(–6)-locular with 1 ovule in each cell, styles usually free and unlobed. Fruit a leathery or woody, often shouldered capsule, smooth to variously spiny, splitting into 2-valved parts leaving the central, commonly waxy column. Seed black, often with a thin orange to red aril. Seedling with epigeal germination; cotyledons emergent, leafy; hypocotyl elongated; all leaves arranged spirally, conduplicate to involute.
Macaranga species are short-lived pioneers becoming 15–20 years old. Most species develop according to Rauh's architectural model, characterized by a monopodial trunk with rhythmic growth and so developing tiers of branches that are themselves morphogenetically identical with the trunk. *M. conifera*, however, develops according to the Koriba's architectural model which is characterized by orthotropic axes which branch to produce initially equivalent modules but subsequently one of these becomes dominant constituting one unit of the sympodial trunk. Trees may flower when very young. Flowering and fruiting are fairly regular, several times a year. A few *Macaranga* species are either facultative or obligate myrmecophytes. The latter group of species provides specific nesting space, mainly hollow twigs, for ants of the genus *Crematogaster*. The ants protect the plants from herbivores.
The dimorphism of sapling leaves and those of mature trees renders identification difficult. *Macaranga* is very closely related to *Mallotus*, but differs in its 3–4-celled anthers and more conspicuously in its lateral inflorescences and the absence of stellate hairs.

Ecology Most *Macaranga* species are pioneers and form a characteristic element of secondary forest especially along roadsides in western Malesia and New Guinea, but are less common in Sulawesi, the Moluccas and Java. They are often found gregariously and may locally form pure stands. A few species (section *Pseudorottlera* (Rchb. f. & Zoll.) Pax & K. Hoffm.) are found in primary forest. Most species thrive in a perhumid climate, some also under slightly seasonal conditions. The altitudinal range is large, with a few species occurring up to almost 3000 m altitude in New Guinea. Some species may occur along rivers and streams, in secondary seasonal swamp forest (e.g. *M. recurvata*), secondary peat-swamp forest (e.g. *M. pruinosa*), and on a wide variety of soil types including sandy, tufa, and clayey soils and limestone.

Silviculture *Macaranga* can be propagated by seed. For *M. tanarius* there are about 54500 dry seeds/kg. Seeds of *M. tanarius* sown with adhering pulp have about 50% germination in 24–72(–265) days, whereas those of *M. triloba* have about 80% germination in 19–37 days. It is, however, difficult to get seedlings to grow. Most of the trees are very fast-growing pioneers but as they are small and low-branching, they are not interesting for the production of sawn timber. *M. tanarius* has been suggested as a shade and shelter tree to promote natural regeneration on deforested land. A few species reach 50 cm in diameter, e.g. *M. hypoleuca*.

Genetic resources and breeding Some species are narrow endemics, but the genetic resources of most *Macaranga* species are not in danger as trees are common and characteristic elements of secondary vegetation.

Prospects The fairly general occurrence of *Macaranga* and the long wood fibres make the exploitation for pulp and paper and the production of wood-based panels promising in the near future.

Literature 26, 33, 36, 70, 82, 83, 151, 162, 163, 209, 260, 267, 300, 337, 348, 402, 405, 428, 429, 436, 526, 543, 565, 678, 740, 741, 745, 780, 829, 831, 861, 934, 955, 966, 974, 1038, 1169, 1195, 1211, 1215, 1216, 1217, 1218, 1221, 1239, 1242, 1251.

Selection of species

Macaranga albescens L.M. Perry
Distribution New Guinea.

Macaranga aleuritoides F. v. Mueller
Synonyms *Macaranga riparia* Engl.
Distribution The Moluccas, New Guinea and the Solomon Islands.

Macaranga amissa Airy Shaw
Synonyms *Endospermum perakense* King ex Hook. f.
Vernacular names Shabby mahang (En).
Distribution Peninsular Malaysia, Sumatra and Borneo (Sabah).

Macaranga bicolor Müll. Arg.
Vernacular names Philippines: hamindang (Filipino).
Distribution The Philippines.

Macaranga brunneofloccosa Pax & K. Hoffm.
Distribution New Guinea.

Macaranga conifera (Zoll.) Müll. Arg.
Synonyms *Macaranga populifolia* (Miq.) Müll. Arg., *Mappa populifolia* (Miq.) Müll. Arg.
Vernacular names Poplar mahang (En). Malaysia: memaya, memaya jawa, mesepat (Peninsular).
Distribution Peninsular Malaysia, Singapore, Sumatra and Borneo.

Macaranga denticulata (Blume) Müll. Arg.
Vernacular names Mildew mahang (En). Malaysia: balik angin, mesepat (Peninsular). Laos: tong khôp, tong khôp 'hou sang², tong 'khao² 'san. Burma (Myanmar): nwong-kye, pet-waing. Thailand: po khee haet, tong taep (northern), salo kliang (peninsular).
Distribution From the eastern Himalayas to Indo-China, southern China, Thailand, Peninsular Malaysia, Sumatra and Java.

Macaranga diepenhorstii (Miq.) Müll. Arg.
Vernacular names Diepenhorst's mahang (En). Indonesia: kayu sepat, sape gadang, sape payo (Sumatra). Malaysia: setapu (Peninsular).
Distribution Peninsular Malaysia and Sumatra.

Macaranga gigantea (Rchb. f. & Zoll.) Müll. Arg.
Synonyms *Macaranga incisa* Gage, *Macaranga megalophylla* (Müll. Arg.) Müll. Arg.
Vernacular names Elephant's ear, giant mahang (En). Indonesia: biruwak, serkubung (Sumatra), dahan kagurangen (Sulawesi). Malaysia: kubin, mahang gajah, telinga gajah (Peninsular). Singapore: mahang gajah. Thailand: huu chang (south-eastern), ma hang (peninsular), tao luang (northern).
Distribution Thailand, Peninsular Malaysia, Singapore, Sumatra, Borneo and Sulawesi.

Macaranga glaberrima (Hassk.) Airy Shaw
Synonyms *Macaranga subfalcata* (Rchb. f. & Zoll. ex Zoll.) Müll. Arg.
Vernacular names Indonesia: bataruwa, ki harepang prongpeng (Sundanese), tanglar (Javanese).
Distribution Java, the Lesser Sunda Islands (Flores) and New Guinea (Irian Jaya).

Macaranga hispida (Blume) Müll. Arg.
Vernacular names Indonesia: bilang kinar, haleki daun besar (Ambon), wenang (Sulawesi). Philippines: lagapak (Tagalog).
Distribution The Philippines, Sulawesi and the Moluccas; cultivated in Java.

Macaranga hosei King ex Hook. f.
Synonyms *Macaranga pearsonii* Merr., *Macaranga pseudopruinosa* Pax & K. Hoffm.
Vernacular names Hose's mahang (En). Thailand: sow low.
Distribution Peninsular Thailand, Peninsular Malaysia, Singapore, Sumatra and Borneo.

Macaranga hypoleuca (Rchb. f. & Zoll.) Müll. Arg.

Vernacular names White mahang (En). Indonesia: mahang kapur (general). Malaysia: mahang puteh (Peninsular), sedaman, sedaman puteh (Sabah). Thailand: law.

Distribution Peninsular Thailand, Peninsular Malaysia, Singapore, Sumatra and Borneo.

Macaranga indica Wight

Synonyms *Macaranga flexuosa* Wight.

Vernacular names Greater mountain mahang (En). Thailand: hu chang (south-eastern), tao dong, tao lueam (northern).

Distribution From Sri Lanka, India and Burma (Myanmar) to Indo-China, the Andaman Islands, Thailand and Peninsular Malaysia.

Macaranga involucrata (Roxb.) Baillon

Synonyms *Macaranga dalechampioides* S. Moore, *Macaranga mallotoides* F. v. Mueller, *Macaranga schleinitziana* K. Schumann.

Vernacular names Indonesia: haleki daun kecil (Ambon), liwini (Halmahera), lowui (Ternate).

Distribution The Sula Islands, the Moluccas, New Guinea and Queensland (Australia).

Macaranga kingii Hook. f.

Synonyms *Macaranga insignis* Merr.

Vernacular names Devil's mahang (En).

Distribution Peninsular Malaysia, the Riau Archipelago and Borneo.

Macaranga lowii King ex Hook. f.

Synonyms *Macaranga auriculata* (Merr.) Airy Shaw, *Macaranga poilanei* Gagnep., *Mallotus affinis* Merr.

Vernacular names Malaysia: geresek padi, rami betina, resak pechah (Peninsular). Philippines: kamanian (Manobo). Thailand: hua ka, pling, ring (peninsular).

Distribution Indo-China, Hainan, Thailand, Peninsular Malaysia, Singapore, Borneo and the Philippines.

Macaranga mappa (L.) Müll. Arg.

Vernacular names Indonesia: hahuhun (Ambon), hulumutu (Halmahera), maro'oka nanau (Ternate).

Distribution The Sangihe and Talaud Islands and the Moluccas.

Macaranga motleyana (Müll. Arg.) Müll. Arg.

Synonyms *Macaranga griffithiana* Müll. Arg.

Vernacular names Griffith's mahang (En). Malaysia: mahang bulan, mahang tutup (Peninsular). Thailand: dok mai hu chang (south-eastern), ma hang (peninsular).

Distribution Thailand, Peninsular Malaysia, Singapore, Sumatra and Borneo.

Macaranga pruinosa (Miq.) Müll. Arg.

Synonyms *Macaranga formicarum* Pax & K. Hoffm., *Macaranga maingayi* Hook. f.

Vernacular names Maingay's mahang (En). Indonesia: mahang putih (Sumatra), mengkerang wurung (Bangka).

Distribution Peninsular Malaysia, Singapore, Sumatra and Borneo.

Macaranga recurvata Gage

Vernacular names Swamp mahang (En). Malaysia: kubin, mahang paya (Peninsular).

Distribution Peninsular Malaysia, Singapore and Borneo; possibly also in Sulawesi.

Macaranga rhizinoides (Blume) Müll. Arg.

Synonyms *Tanarius rhizinoides* (Blume) O. Kuntze.

Vernacular names Indonesia: huru angin, mara (Sundanese), tutup (Javanese).

Distribution Java.

Macaranga tanarius (L.) Müll. Arg.

Synonyms *Macaranga molliuscula* Kurz, *Macaranga tomentosa* Blume, *Mappa tanarius* (L.) Blume.

Vernacular names Hairy mahang (En). Indonesia: hanuwa (Ambon), mara (Sundanese), tutup ancur (Javanese). Malaysia: kundoh, mahang puteh, tampu (Peninsular). Philippines: binunga (Filipino), himindang (Bikol), kuyonon (Bisaya). Thailand: hu chang lek (south-eastern), lo khao, mek (peninsular).

Distribution From the Andaman and Nicobar Islands and Indo-China to China, Taiwan, the Ryukyu Islands, Thailand, throughout the Malesian region towards northern Australia and Melanesia.

Macaranga triloba (Blume) Müll. Arg.

Synonyms *Macaranga bancana* (Miq.) Müll. Arg., *Macaranga cornuta* Müll. Arg.

Vernacular names Common mahang (En).

Brunei: marakubong, sedaman. Indonesia: mahang kukur (Sumatra), mara bodas (Sundanese), tutup ancur (Javanese). Malaysia: landas bukit, mahang merah, mahang tekukur (Peninsular). Philippines: bula-bula (Tagbanua). Singapore: pahang merah. Laos: tong khôp 'hou sang[2]. Thailand: low khao, lo ngaam (peninsular), salapang (south-eastern).

Distribution Southern Burma (Myanmar), peninsular Thailand, Peninsular Malaysia, Singapore, Sumatra, Java, Borneo and the Philippines.

S.C. Lim

Maclurodendron T.G. Hartley

Gard. Bull. Sing. 35: 4 (1982).

RUTACEAE

x = probably 9 as in other related genera; $2n$ = unknown

Origin and geographic distribution *Maclurodendron* comprises 6 species occurring in southern Burma (Myanmar), China (Hainan), Vietnam, peninsular Thailand, Peninsular Malaysia, Singapore, Sumatra, Borneo and the Philippines. Five species are present in the Malesian region.

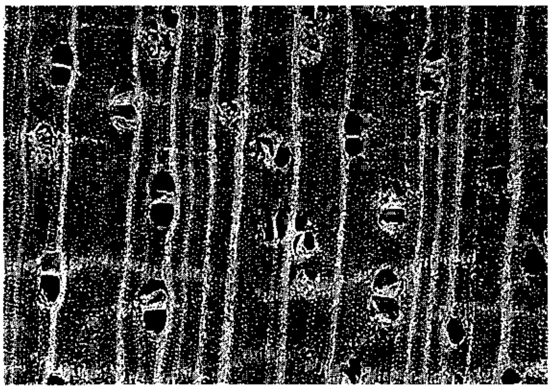
Uses The wood of *Maclurodendron* is used for construction purposes.

Production and international trade *Maclurodendron* wood is used rarely and on a local scale only.

Properties *Maclurodendron* yields a medium-weight hardwood with a density of 580–700 kg/m^3 at 15% moisture content. Heartwood pale yellow-brown, not clearly differentiated from the sapwood; grain straight; texture moderately fine and even; wood with watered-silk figure on tangential surface. Growth rings distinct with a hand lens, boundaries indicated by interrupted marginal parenchyma; vessels moderately small to medium-sized, solitary or in radial multiples of 2–3, open; parenchyma abundant, apotracheal in narrow interrupted marginal bands, paratracheal scanty to vasicentric; rays moderately fine, just visible on the transverse surface; ripple marks absent.

The wood is moderately hard and slightly durable.

See also the table on microscopic wood anatomy.



Maclurodendron porteri
transverse surface (×20)

Botany Dioecious, small to medium-sized trees up to 25(–30) m tall; bole branchless for up to 12 (–18) m, up to 40 cm in diameter, without buttresses; bark surface fawn to grey or whitish, inner bark fibrous, red, aromatic. Leaves opposite, 1-foliolate, entire, with pellucid dots, exstipulate; petiole swollen at apex and articulating with the blade. Flowers in an axillary, paniculate inflorescence, unisexual, 4-merous, globose in bud; sepals fused at base, valvate; petals free, imbricate, white, greenish or yellowish. Male flower with 8 stamens, alternately long and short, filaments glabrous; disk irregularly 8-lobed, ovary rudimentary. Female flower with a superior, 4-carpellate ovary, carpels fused, each with 2 ovules, style straight, stigma capitate, 4-lobed. Fruit a glabrous drupe, shallowly 4-lobed, exocarp thin, glandular, endocarp parchment-like, shiny. Seed dark brown to black, shiny, surface finely reticulate; endosperm present. Seedling with epigeal germination.

The small size and pale colour of the flowers suggest insect pollination.

Maclurodendron belongs to the subfamily *Toddalioideae* and has recently been set up to accommodate several species previously described under *Acronychia*. It mainly differs from the latter in its exclusively 1-foliolate leaves, unisexual flowers, imbricate petals, and the glabrous filaments, ovaries and fruits.

Ecology *M. porteri* is found scattered on hills and ridges in primary or occasionally secondary rain forest, up to 1400 m altitude. It occurs typically on well-drained, sometimes poor, organic soils; in Sarawak it has been observed in kerangas forest. *M. pubescens* occurs on hills and ridges in primary forest, up to 140 m altitude.

Silviculture *Maclurodendron* can be propagated by seed. In germination trials in Malaysia only 10% germination was attained after about 30 days. Pretreatment of the seed will probably improve the germination rate considerably.

Genetic resources and breeding *M. porteri* is fairly widespread and not threatened, but all other *Maclurodendron* species are quite rare and narrowly endemic, and may easily become endangered.

Prospects It is unlikely that the demand for *Maclurodendron* wood will increase in the near future.

Literature 46, 163, 267, 415, 861, 1048, 1221.

Selection of species

Maclurodendron porteri (Hook. f.) T.G. Hartley

Synonyms *Acronychia porteri* Hook. f., *Melicope unifoliolata* Merr.

Vernacular names Indonesia: pauh. Malaysia: ketiak, limau hutan (Peninsular), rawang (Malay, Sarawak).

Distribution Southern Burma (Myanmar), peninsular Thailand, Peninsular Malaysia, Singapore, Sumatra, Borneo and the Philippines.

Maclurodendron pubescens T.G. Hartley

Distribution Borneo (Sabah).

D.T. Jones

Magnolia L.

Sp. pl. 1: 535 (1753); Gen. pl., ed. 5: 240 (1754).
MAGNOLIACEAE
$x = 19$; *M. candollii*: $2n = 38$

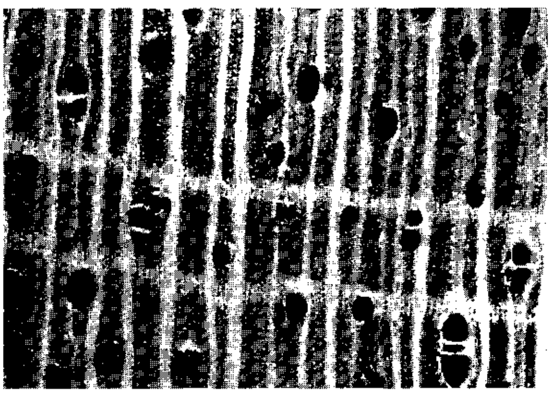
Vernacular names Chempaka (trade name). Magnolia (Am, En, Fr). Thailand: champe. Vietnam: d[aj] h[owj]p.

Origin and geographic distribution *Magnolia* comprises about 120 species. About one third of these are found from south-eastern North America to southern Brazil. The remainder occur in tropical South-East Asia from India and the Himalayas to Indo-China, China, Japan, Taiwan, Thailand and throughout the Malesian region. Within Malesia 17 species are found.

Uses The wood of *Magnolia* is used for general construction under cover, bridge building, interior finish, panelling, partitioning, flooring, door and window frames, furniture, mouldings, sporting goods, musical instruments, handicrafts, canoe building and pencil slats. It is also applied for the production of veneer, sometimes fancy veneer (e.g. *M. elegans*), and plywood.
Several species of *Magnolia* have been introduced into Malesia and are cultivated for their showy and fragrant flowers. In southern Sumatra the bitter leaves of *M. macklottii*, rubbed with salt, have been taken against fever. The fragrant flowers are sometimes worn in the hair or used to perfume clothing.

Production and international trade *Magnolia* timber is generally traded together with that of other *Magnoliaceae* genera as 'chempaka', although that of *Elmerrillia* is sometimes traded separately, e.g. in Papua New Guinea. Supplies are very limited and in 1992 only about 900 m^3 of chempaka timber with a value of about US$ 87 000 was exported from Sabah.

Properties *Magnolia* yields a lightweight to medium-weight hardwood with a density of 390–825 kg/m^3 at 15% moisture content. Heartwood white to pale brown with narrow, grey-brown layers of marginal parenchyma, occasionally with green tinge in *M. elegans*, not or only moderately clearly differentiated from the white to pale yellow sapwood; grain straight; texture moderately fine and even; wood slightly greasy and sometimes rough to the touch. Growth rings distinct, boundaries indicated by marginal parenchyma; vessels moderately small to medium-sized, solitary and in radial multiples of 2–4, open, tyloses infrequent, occasional white deposits; parenchyma sparse, apotracheal in marginal bands, producing distinctive markings on back-sawn surfaces; rays very fine to moderately fine; ripple marks absent.
The wood air seasons moderately fast. It is soft (e.g. *M. elegans*) to moderately hard (e.g. *M. candollii*) and relatively strong. When exposed to the weather or in contact with the ground, the wood of harder and heavier *M. candollii* is reported as non-durable, but that of other species (e.g. *M. elegans*)



Magnolia elegans
transverse surface (×20)

is moderately durable. It is very easy to work but material of *M. candollii* dulls tools readily due to some hard, chalky deposits in the vessels.
See also the tables on microscopic wood anatomy and wood properties.

Botany Shrubs or small to large trees up to 60 m tall; bole columnar to slightly crooked in small trees, up to 80(–115) cm in diameter, sometimes with small buttresses; bark surface smooth becoming scaly or fissured, sometimes hoop-marked, inner bark yellowish to fawn, often aromatic. Leaves arranged spirally, simple, entire; stipules large, adnate to or free from the petiole. Flowers terminal, solitary, enclosed in 2 bracts when young; tepals 9–21, in 3–5 whorls, white, creamy or greenish, occasionally the outer whorl forming a calyx; stamens many, arranged spirally, anthers usually with an elongated connective; gynoecium sessile or shortly stipitate, with few to many, usually free carpels which are arranged spirally, ovules 2(–5) in each carpel. Fruiting carpels free, woody, dehiscing along the dorsal suture. Seed with sarcotesta, often hanging from its funicle. Seedling with epigeal germination; cotyledons emergent, leafy; hypocotyl elongated; all leaves arranged spirally.
Growth is sympodial. A single 45-year-old *M. elegans* tree in the arboretum of the Forest Research Institute Malaysia, Kepong measured 28 m in height and 64 cm in diameter. The flowers are protogynous, i.e. the stigmas are receptive before the pollen is shed, and are pollinated by beetles which feed on the stigmas, pollen, nectar and secretion of the petals.
The genera *Aromadendron*, *Talauma* and several non-Malesian genera have all been united with *Magnolia*. *M. candollii* is highly variable and 5 varieties have been recognized.

Magnolia candollii (Blume) H. Keng – 1, flowering twig; 2, stamen; 3, gynoecium; 4, fruit.

Ecology *Magnolia* occurs scattered in lowland or montane, primary rain forest, up to 2800 m altitude. The habitat is usually well-drained but occasionally waterlogged and swampy.

Silviculture *Magnolia* can be propagated by seed. Seeds of *M. elegans* with the sarcostesta still attached show about 20% germination in 24–86 days, those of *M. candollii* about 45% in 24–34 days.

Genetic resources and breeding The risk of genetic erosion of timber-yielding *Magnolia* species is determined by the extent of deforestation of their habitat.

Prospects It is unlikely that the use of *Magnolia* wood will increase in the near future.

Literature 53, 101, 163, 198, 238, 260, 267, 341, 436, 464, 540, 829, 831, 832, 850, 851, 861, 933, 934, 1038, 1039, 1221, 1239, 1242.

Selection of species

Magnolia ashtonii Dandy ex Noot.
Distribution Sumatra and Borneo.

Magnolia bintuluensis (Agostini) Noot.
Synonyms *Aromadendron nutans* Dandy, *Magnolia nutans* (Dandy) H. Keng, *Talauma bintuluensis* Agostini.

Vernacular names Indonesia: kedondong kijai (Sumatra), medang pelam (West Kalimantan). Malaysia: kepayang ambok (Sabah), medang limo (Sarawak), triburus (Dayak, Sarawak).

Distribution Peninsular Malaysia, Sumatra and Borneo.

Magnolia borneensis Noot.
Distribution Borneo and the Philippines (Palawan).

Magnolia candollii (Blume) H. Keng

Synonyms *Talauma angatensis* (Blanco) S. Vidal, *Talauma beccarii* Ridley, *Talauma candollii* Blume, *Talauma singapurensis* Ridley.

Vernacular names Indonesia: cempaka gonda (Javanese), kembang tunjung (Sundanese), si tekwok (Pahang, Sumatra). Malaysia: tala umah (Iban, Sabah). Philippines: malapina (Filipino), patangis (Tagalog). Thailand: cham poon chang, montha (peninsular), ye hup (northern, central).

Distribution North-eastern India, the Andaman Islands, Cambodia, Thailand and throughout Malesia.

Magnolia carsonii Dandy ex Noot.

Distribution Borneo.

Magnolia elegans (Blume) H. Keng

Synonyms *Aromadendron elegans* Blume, *Manglietia oortii* Korth., *Talauma elegans* (Blume) Miq.

Vernacular names Indonesia: medang mempau (Sumatra), nona leuweung (Sundanese), ultup-ultup (Batak Karo, Sumatra). Malaysia: chempaka hutan (Peninsular).

Distribution Peninsular Malaysia, Singapore, Sumatra and West Java.

Magnolia macklottii (Korth.) Dandy

Synonyms *Magnolia eaquinoctialis* Dandy, *Magnolia javanica* Koord. & Valeton, *Michelia beccariana* Agostini.

Vernacular names Indonesia: campaka gunung, gempol (Sundanese), cempaka rimbo (Sumatra).

Distribution Peninsular Malaysia (rare), Sumatra, West Java and Borneo (Sabah).

E.N. Sambas (general part),
M.S.M. Sosef (selection of species)

Mallotus Lour.

Fl. Cochinch.: 635 (1790).

EUPHORBIACEAE

$x = 11$; *M. albus* Müll. Arg.: $n = 33$, *M. philippensis*, *M. repandus* (Willd.) Müll. Arg., *M. resinosus* (Blanco) Merr.: $n = 11$

Vernacular names Indonesia: balik angin (general), tutup, walik angin (Javanese). Malaysia: balek angin (general), enserai (Sarawak), mallotus (Sabah). Philippines: banato (general), hinlaumo (Cebu and Panay Bisaya). Vietnam: ba b[es]t, b[uj]c b[uj]c, b[uf]ng b[uj]c.

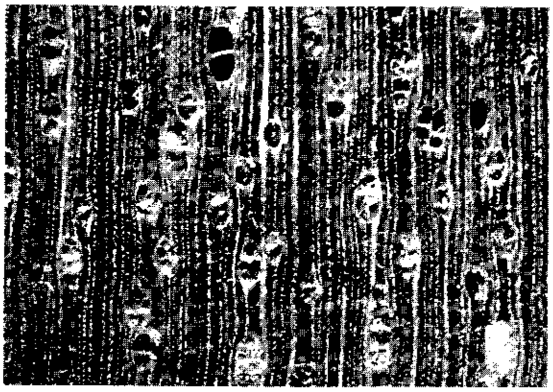
Origin and geographic distribution *Mallotus* comprises about 150 species. Only 2 of these occur in Africa and Madagascar, the rest are found from India and Sri Lanka to Indo-China, China, Taiwan, Japan, Thailand, throughout the Malesian region, northern Australia and the Pacific (east to Fiji). Some 50 species are found within Malesia.

Uses The wood of *Mallotus* is used for temporary construction (poles), non-striking tool handles, matches, disposable chopsticks, wooden shoes, packing cases, pegs and possibly for turnery articles. Due to its generally small size, the wood is probably more often used for particle board and fibreboard production, and for the production of pulp and paper. It yields a good firewood.

Some species are planted as live fences or as ornamentals and shade trees. In India *M. philippensis* is considered to be a valuable nurse tree for more important forest tree species, e.g. sal (*Shorea robusta* Gaertn. f.). The fibrous bark is used to make rope and artificial fur. The fruits and bark have been reported to be used medicinally to treat stomach ulcers and tapeworm. Logs of *M. paniculatus* proved suitable for shiitake mushroom cultivation. The granules covering the fruit of *M. philippensis* provide a bright orange dye; a red dye has been extracted from the roots. Seeds of this species, and probably also of others, yield an oil used as a substitute for tung oil (obtained from *Aleurites* spp.), in the production of paint and varnish. The oil is also used as a fixative in cosmetic preparations and for colouring foodstuffs and beverages. All parts of this tree can be applied externally to treat parasitic infections of the skin. Several other species are reported to contain tannins. Leaves of several species are used to make tea. Flowers of *M. floribundus* are fragrant and used to flavour food and in decorations. Foliage of *M. philippensis* is used for fodder.

Production and international trade The wood of *Mallotus* is used on a local scale only, mainly because the logs are small.

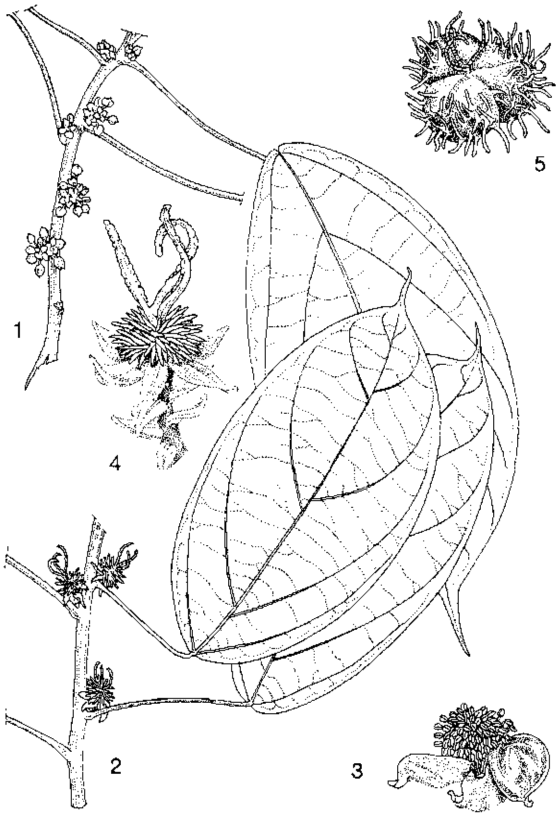
Properties *Mallotus* yields a lightweight to medium-weight hardwood with a density of 370–830 kg/m³ at 15% moisture content. Heartwood straw-coloured or pale brown, not clearly differentiated from the sapwood; grain straight; texture moderately fine to slightly coarse, even. Growth rings indistinct or visible (e.g. *M. muticus* and *M. philippensis*) due to darker bands with little or no parenchyma; vessels medium-sized, solitary and in radial multiples of 2–10, occasionally in



Mallotus floribundus
transverse surface (×20)

clusters of up to 4, often with a greater number of solitary vessels in comparison to other *Euphorbiaceae* spp., occasional tyloses present; parenchyma moderately abundant, apotracheal in narrow bands to diffuse to diffuse-in-aggregates; rays extremely fine or very fine, inconspicuous on radial surface; ripple marks absent; pith flecks sometimes present.
Shrinkage upon air drying is moderate (*M. muticus*) to very high (*M. floribundus*) with moderate risk of splitting, insect attack and staining, and with a slight risk of cupping, bowing and end-checking. It takes about 2 months and 3 months respectively to air dry boards of *M. muticus* 13 mm and 38 mm thick. The wood is soft to moderately hard and fairly weak to moderately strong. It is generally easy to work, but is reported to be difficult to resaw and cross-cut because it is fibrous; planing is easy to moderately easy giving a moderately smooth surface. The harder species (e.g. *M. philippensis*) are said to turn well. Durability is probably linked to the density of individual species and is classified as non-durable for the lighter species and slightly durable for the heavier ones. The wood is extremely easy to treat with preservatives. It is not resistant to termites and marine borers. The sapwood is susceptible to *Lyctus*.
See also the tables on microscopic wood anatomy and wood properties.

Botany Evergreen, dioecious or rarely monoecious shrubs or small to medium-sized trees up to 25(–35) m tall; bole straight to sinuous, up to 50(–80) cm in diameter, occasionally with short or steep buttresses; bark thin, surface smooth, white or pale grey, inner bark fibrous, brown to reddish or dark red. Indumentum often of stellate hairs. Leaves arranged spirally or opposite, simple, entire, sometimes peltate, often whitish and with glandular granules below, venation pinnate or palmate; stipules small. Flowers in a terminal or axillary raceme or spike, unisexual; petals absent. Male flower with 3–4-lobed calyx; stamens numerous; disk absent, lobed or annular. Female flower with 3–5-lobed calyx; disk absent; ovary superior, (2–)3(–4)-locular with 1 ovule in each cell, styles elongate, simple or plumose. Fruit a lobed, thinly woody, smooth to echinate capsule, splitting into 2-valved parts and a persistant central column. Seed smooth, shiny black, sometimes with a small aril. Seedling with epigeal germination; cotyledons emergent, leafy; hypocotyl elongated; first few leaves arranged spirally, decussate higher up in species with opposite leaves.



Mallotus subpeltatus (Blume) Müll. Arg. – 1, male flowering twig; 2, female flowering twig; 3, male flower; 4, female flower; 5, fruit.

In the Philippines a mean annual diameter increment of 1.4 cm has been recorded for *M. philippensis* trees in the diameter class 10–20 cm, whereas for *M. mollissimus* it is 1.7–1.9 cm and 3.6 cm for trees in the diameter classes 0–20 cm and 20–30

cm, respectively. In the Philippines *M. philippensis* flowers from March to April. *M. philippensis* has extrafloral nectaries attracting ants. The seeds of many *Mallotus* species are dispersed by birds.
Mallotus is closely related to *Macaranga*, the latter differing by its 3–4-celled anthers and more conspicuously by its lateral inflorescences and absence of stellate hairs.

Ecology Most *Mallotus* species occur in primary evergreen rain forest, but a few are abundant in secondary forest and in more open locations including savanna woodland, up to 2000 m altitude. They occur in dipterocarp, riverine and swamp forest. A few species (e.g. *M. philippensis*) are pioneers characteristic of secondary vegetation and may be gregarious elements in regenerated forest. They are among the first species appearing after fields are abandoned. Individual species have been found on a wide variety of soil types including limestone soils.

Silviculture *Mallotus* can be propagated by seed; the only available seed count is for *M. paniculatus* having about 115 000 dry seeds/kg. Seeds of *M. leucodermis* still embedded in their aril have about 45% germination in 5–20 days, those of *M. philippensis* about 5% in 65–82 days. In India shade and adequate moisture are considered important for the production of seedlings. Most *Mallotus* species are light-demanding, but some need shade in the early phases of establishment. In India established *M. philippensis* is frost-hardy and resistant to drought and it coppices well and is capable of producing root suckers. *M. philippensis* is not resistant to fire.

Genetic resources and breeding As most *Mallotus* species are light-demanding and exhibit pioneer characteristics, they are at little risk of genetic erosion by deforestation.

Prospects It has been suggested to use *M. philippensis* to protect soil and simultaneously produce wood, possibly for pulp, wood-based panels or firewood. Since little is known about the silviculture of *Mallotus* species that have potential for reforestation or for plantation establishment, more research is needed on specific silvicultural aspects.

Literature 26, 28, 32, 33, 34, 36, 70, 151, 162, 163, 174, 209, 235, 238, 260, 267, 387, 404, 405, 436, 464, 543, 571, 678, 696, 698, 712, 772, 829, 831, 834, 835, 861, 883, 889, 937, 955, 974, 1038, 1104, 1169, 1195, 1221, 1232, 1242.

Selection of species

Mallotus blumeanus Müll. Arg.

Vernacular names Indonesia: bungulang peucang, calik angin (Sundanese), katimuru (Javanese).

Distribution Sumatra, Java, Sulawesi and the Lesser Sunda Islands (Flores).

Mallotus floribundus (Blume) Müll. Arg.

Synonyms *Mallotus anamiticus* O. Kuntze.

Vernacular names Blue blade (En). Indonesia: nakau (Sumatra), tapen (Java). Malaysia: mallotus marambokan (Sabah), maya-maya, pasupasu (Peninsular). Philippines: tula-tula (Filipino). Burma (Myanmar): taung-kado. Thailand: lo khon, pik (peninsular), prik (peninsular, southwestern). Vietnam: b[aj]ch d[af]n, b[ow] l[as]ch, ba b[es]t hoa nhi[eef]u.

Distribution Burma (Myanmar), Indo-China, Thailand, throughout the Malesian region towards northern Australia and Melanesia.

Mallotus leucodermis Hook. f.

Synonyms *Coccoceras muticum* Müll. Arg. var. *pedicellatum* Hook. f.

Vernacular names Malaysia: balek angin bopeng (Peninsular).

Distribution Peninsular Malaysia, Simeulüë and Borneo (Sabah, possibly also in Sarawak).

Mallotus macrostachyus (Miq.) Müll. Arg.

Synonyms *Mallotus albus* Müll. Arg. p.p.

Vernacular names Common pom-pom tree (En). Malaysia: balek angin, berumbing (Peninsular), dau (Sabah). Thailand: famee, lo, plao yai (peninsular). Vietnam: b[uj]c ch[uf]m to, ba b[es]t ch[uf]m to.

Distribution Peninsular Thailand, Peninsular Malaysia, Singapore and Borneo.

Mallotus mollissimus (Geiseler) Airy Shaw

Synonyms *Croton mollissimus* Geiseler, *Mallotus ricinoides* (Pers.) Müll. Arg.

Vernacular names Vietnam: b[uj]c n[aa]u, b[uj]c qu[ar] th[aaf]u d[aaf]u, ba b[es]t n[aa]u.

Distribution Burma (Myanmar), Indo-China, southern China, Thailand, throughout the Malesian region, northern Australia and Melanesia.

Mallotus muticus (Müll. Arg.) Airy Shaw

Synonyms *Coccoceras borneense* J.J. Smith, *Coccoceras muticum* Müll. Arg., *Mallotus borneensis* Müll. Arg.

Vernacular names Malaysia: balek angin bopeng (Peninsular), mallotus paya, selung apid (Sabah).

Distribution Peninsular Malaysia and Borneo; possibly also in Sumatra.

Mallotus oblongifolius (Miq.) Müll. Arg.

Synonyms *Mallotus columnaris* Warb., *Mallotus porterianus* Müll. Arg., *Mallotus puberulus* Hook. f.

Vernacular names Water castor oil (En). Malaysia: jarak hutan, ludai api, pulut-pulut-hutan (Peninsular). Philippines: somau (Tagbanua). Thailand: duea kheon, lot thuean, phak wan chang khlong (peninsular). Vietnam: b[uj]c l[as] thu[oo]n, ba b[es]t l[as] thu[oo]n, ch[os]c m[or]n.

Distribution India, Burma (Myanmar), Indo-China, Thailand, throughout the Malesian region (except for the Lesser Sunda Islands) and northern Australia.

Mallotus paniculatus (Lamk) Müll. Arg.

Synonyms *Croton appendiculatus* Elmer, *Mallotus cochinchinensis* Lour.

Vernacular names Turn-in-the-wind (En). Indonesia: calik angin (Sundanese), tutup awu, tutup kancil (Javanese). Malaysia: balek angin (Peninsular), mallotus balabakan (Sabah). Philippines: anaplan (Bukidnon). Laos: 'khi[2] thao[1], lat koua, luat ma[2]. Thailand: saet (peninsular), sateton (north-eastern), soi daao (south-eastern). Vietnam: b[uj]c b[aj]c, ba b[es]t nam b[ooj], bai b[as]i.

Distribution India, Burma (Myanmar), Indo-China, southern China, Taiwan, Thailand, throughout the Malesian region (except for the Lesser Sunda Islands) and northern Australia.

Mallotus philippensis (Lamk) Müll. Arg.

Synonyms *Mallotus reticulatus* Dunn, *Rottlera tinctoria* Roxb.

Vernacular names Kamala tree, monkey face tree, red berry (En). Croton tinctorial, rottlière des teinturiers (Fr). Indonesia: galuga furu (Ternate), kapasan (Javanese), ki meyong (Sundanese). Malaysia: rambai kuching (general), kasirau, minyak madja (Peninsular). Philippines: banato (Tagalog), pangaplasin (Ilokano), tagusala (Bisaya). Burma (Myanmar): hpawng-awn. Cambodia: 'ânnadaa. Laos: kh'aay paax, khiiz moon, tangx thôôm. Thailand: kai khat hin, khee nuea (north-eastern), kham saet (central). Vietnam: c[as]nh ki[ees]n, c[aa]y m[oj]t, thu[oos]c s[as].

Distribution From India and Sri Lanka to Burma (Myanmar), Indo-China, Taiwan, the Ryukyu Islands, Thailand, throughout the Malesian region, northern Australia and Melanesia.

Mallotus subpeltatus (Blume) Müll. Arg.

Synonyms *Rottlera rhynchophylla* (Miq.) Miq.

Vernacular names Indonesia: ketapen, tapen (Javanese). Malaysia: jarak gajah, jarak hutan (Peninsular). Thailand: cha ngoh phee, dan mee, han ton (peninsular).

Distribution Southern Burma (Myanmar), Thailand, Peninsular Malaysia, Sumatra and Java.

Mallotus tiliifolius (Blume) Müll. Arg.

Synonyms *Mallotus papillaris* (Blanco) Merr., *Mallotus playfairii* Hemsl.

Vernacular names Linden-leaf, turn-in-the-wind (En). Indonesia: haleki laun ulu (Ambon), tapen (Sundanese), tutup ancur (Javanese). Malaysia: baru laut besar, bebaru, jarak biya (Peninsular). Philippines: alai (Tagalog, Tagbanua), kutulan (Tagalog).

Distribution Taiwan, Hainan, Peninsular Thailand, throughout the Malesian region, northern Australia, the Solomon Islands and Fiji.

Nguyen Nghia Thin & Tran Van On

Mammea L.

Gen. pl., ed. 5: 288 (1754).

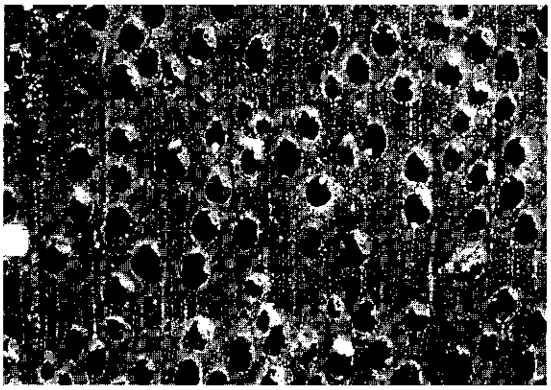
GUTTIFERAE

x = unknown; *M. siamensis*: $2n = 32$

Origin and geographic distribution *Mammea* comprises about 50 species. A single species is distributed in the West Indies, the Guianas and tropical West Africa, some 15 are present in Madagascar and about 35 occur in the Asiatic tropics from India and Sri Lanka to Burma (Myanmar), Indo-China, Thailand, throughout the Malesian region and the Pacific islands, east to New Caledonia and Samoa. Some 20 species are present within Malesia.

Uses The wood of *Mammea* is used for boat building (planks and pins), house posts, flooring and cabinet work.

M. americana is a fairly well-known fruit tree which has also been applied in Cuba as a wind-



Mammea cordata P.F. Stevens
transverse surface (×20)

break and shelter-belt. The flowers of *M. siamensis* contain an aromatic oil for which it is cultivated, especially near Buddhist temples. In Thailand the leaves of *M. siamensis* are used as a fish poison and its pollen as a cosmetic. The heartwood of *M. odorata* yields a red dye, similar to that of *Caesalpinia sappan* L.

Production and international trade Utilization of *Mammea* wood is very limited and on a local scale only.

Properties *Mammea* yields a heavy hardwood with a density of 920–1100 kg/m^3 at 15% moisture content. Heartwood with pink or red tints or red-brown. Growth rings indistinct; vessels small to intermediate, visible to the naked eye, predominantly solitary, sometimes with tyloses; parenchyma paratracheal vasicentric with occasional aliform tendency, and apotracheal diffuse and diffuse-in-aggregates; rays fine, narrower than the vessels, with radial canals; ripple marks absent.
The wood is very strong and very durable when exposed to the weather or in contact with the ground.
See also the table on microscopic wood anatomy.

Botany Glabrous, androdioecious shrubs or small trees up to 20 m tall; bole often gnarled, branchless for up to 5 m, up to 30 cm or rarely (*M. americana*) up to 100 cm in diameter, without buttresses; bark surface smooth, becoming fissured, scaly, lenticellate, brown or greyish-brown, inner bark brown or reddish-brown, exuding a little yellow or sometimes white latex; crown dense, irregular. Leaves decussate, simple, entire, leathery, with very close reticulation on both surfaces; stipules often reduced, needle-shaped, sometimes absent; interpetiolar leaves (hypsophylls) present. Flowers male or bisexual, solitary or fascicled in axils or on swellings on branches and/or the trunk; sepals fused but later splitting into 2 valves; petals usually 4, often white; stamens many, free; ovary superior, 4-locular with 1 ovule in each cell, style short, stigma peltate, 2(–4)-lobed. Fruit an indehiscent drupe, usually 1-seeded by abortion. Seed surrounded by a transparent pulp. Seedling with hypogeal germination; cotyledons not emergent; hypocotyl not elongated; all leaves decussate.
M. americana develops according to Rauh's architectural tree model, charachterized by a monopodial trunk which grows rhythmically and so develops tiers of branches. In Java trees of *M. odorata* flower almost throughout the year, whereas those of *M. americana* have been observed with flowers in December–June. Pollination is probably by insects and the fruits of *M. americana* and of the small *M. aruana* Kosterm. are dispersed by bats.
The genus *Ochrocarpos* Thouars has been included in *Mammea*.

Ecology *Mammea* occurs scattered in lowland rain forest, sometimes (notably *M. odorata*) along coasts.

Silviculture *M. americana* is propagated by seed or by cuttings.

Genetic resources and breeding Many *Mammea* species are apparently rare, so they may be vulnerable to genetic erosion.

Prospects It is unlikely that the use of *Mammea* wood, being still little known, will increase.

Literature 70, 163, 209, 238, 241, 402, 403, 436, 464, 610, 737, 861, 1038, 1057, 1123, 1164, 1169, 1221.

Selection of species

Mammea americana L.

Vernacular names American mammee tree, mammee apple, South American apricot (En). Abricotier d'Amérique, abricotier sauvage (Fr). Indonesia: manggis negri. Malaysia: aprikot.

Distribution Native to the West Indies and the Guianas; cultivated in the same region but also occasionally elsewhere in the tropics and subtropics; in South-East Asia particularly in Java and the Philippines.

Mammea novoguineensis (Kaneh. & Hatus.) Kosterm.

Synonyms *Mammea lancilimba* Kosterm., *Ochrocarpos novoguineensis* Kaneh. & Hatus.

Distribution New Guinea.

Mammea odorata (Raf.) Kosterm.

Synonyms *Ochrocarpos excelsus* (Zoll. & Moritzi) Vesque, *Ochrocarpos odoratus* (Raf.) Merr., *Ochrocarpos ovalifolius* (Choisy) T. Anderson ex Hemsley.

Vernacular names Indonesia: kapurancak (Javanese), lolang waran (Arafura, Ambon), kembang satu (Indonesian, Moluccas).

Distribution Throughout the Malesian region towards the Pacific, east to Fiji and Samoa; cultivated in Hawaii.

Mammea siamensis (Miq.) T. Anderson

Synonyms *Calysaccion siamense* Miq., *Ochrocarpos siamensis* (Miq.) T. Anderson.

Vernacular names Malaysia: belimbing Siam (Peninsular). Burma (Myanmar): tharapi. Laos: no. Thailand: saraphe (general), saraphee naen (northern), soi phe (peninsular). Vietnam: mun m[us]t, trau tr[as]u.

Distribution Burma (Myanmar), Indo-China, Thailand and Peninsular Malaysia (rare); cultivated in the same region.

S.I. Wiselius

Manglietia Blume

Verh. Bat. Genootsch. Kunsten 9: 149 (1823).

MAGNOLIACEAE

$x = 19$; *M. glauca* (and many other non-Malesian species): $2n = 38$

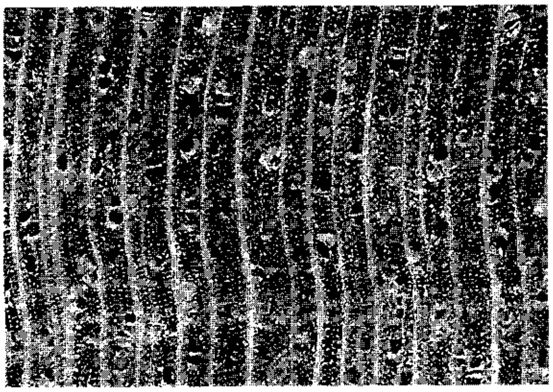
Vernacular names Chempaka (trade name). Indonesia: baros (general).

Origin and geographic distribution *Manglietia* comprises about 25 species and is distributed from the eastern Himalayas to Burma (Myanmar), Indo-China, southern China, Thailand, Peninsular Malaysia, Sumatra, Java, Borneo, Sulawesi and the Lesser Sunda Islands. Within Malesia 5 species occur.

Uses The good quality wood of *Manglietia* is used for house and bridge building, furniture, cement-bonded board, veneer and plywood. In Bali the wood of *M. glauca* is popular for making handicrafts and carvings.

In West Java *M. glauca* has been used for reforestation and in Vietnam it showed good potential in agroforestry.

Production and international trade Some of the wood of *Manglietia* will probably be traded together with that of other *Magnoliaceae* genera as 'chempaka'. A plantation of *M. glauca* exists on Bali, presumably for local consumption.



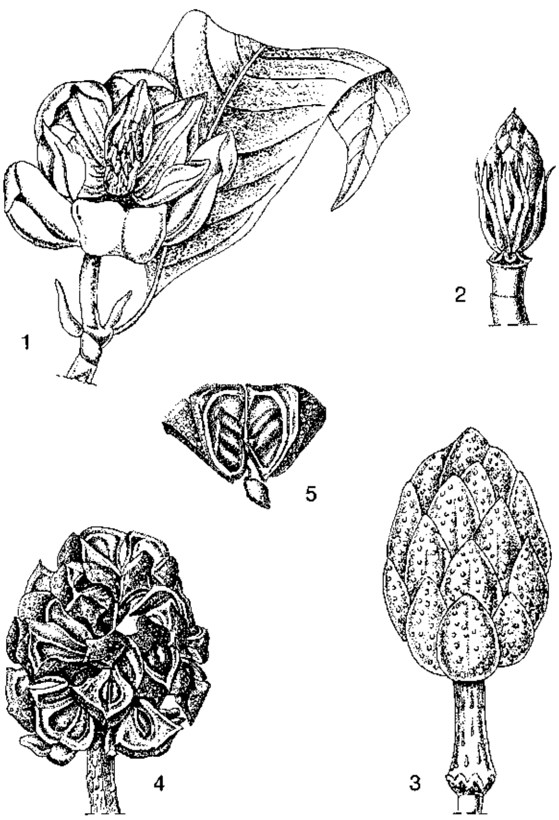
Manglietia fordiana Oliv.
transverse surface (×20)

Properties *Manglietia* yields a lightweight to medium-weight hardwood with a density of 320–580 kg/m^3 at 15% moisture content. Heartwood yellow-brown to pale green-brown or pale brown, clearly differentiated from the sapwood; grain straight or slightly interlocked; texture moderately fine. Growth rings moderately distinct to indistinct; vessels moderately small to medium-sized, solitary and in radial multiples of 2–5(–6), rarely in clusters, occasionally in tangential arrangement, tyloses rare; parenchyma apotracheal in marginal and mostly narrow bands; rays very fine to moderately fine, barely visible due to the lack of contrast with the fibres; ripple marks absent.

The wood seasons moderately slowly, i.e. about 4 months were required to air dry a board of 40 mm thick. The wood is soft, not strong and is easy to work. The wood is moderately durable and moderately resistant to termites.

The average fibre length of *M. glauca* is 1.702 mm. See also the tables on microscopic wood anatomy and wood properties.

Botany Small to medium-sized or fairly large trees up to 40 m tall; bole columnar, branchless for up to 25 m, up to 150 cm in diameter, sometimes with small buttresses; bark surface smooth, lenticellate, greenish or greyish-brown; crown dense, rounded. Leaves arranged spirally, simple, entire; stipules adnate to or free from the petiole. Flowers terminal, solitary, large; tepals 9–13, in 3 whorls, yellow to white; stamens many, arranged spirally, anthers with a long or short appendage; gynoecium sessile, with many, spirally arranged carpels which are free but often connate when young, ovules 4 or more in each carpel. Fruiting



Manglietia glauca Blume – 1, flowering twig; 2, flower with tepals removed; 3, immature fruit; 4, ripe fruit; 5, dehisced carpel with seeds.

carpels free, woody, dehiscing along the dorsal and sometimes also the ventral sutures. Seeds 2 or more, hanging from a long funicle. Seedling with epigeal germination; cotyledons emergent, leafy; hypocotyl elongated; all leaves arranged spirally.

In natural forest in West Java seedlings of *M. glauca* showed increments of up to 6 cm in diameter and up to 9 m in height over a period of 5 years. Growth is sympodial. The flowers are protogynous and pollinated by beetles which feed on the stigmas, pollen, nectar and secretion of the petals. In Java *M. glauca* has been observed with flowers and fruits all year round. *M. calophylla* flowers in October, *M. dolichogyna* in March–May and *M. lanuginosa* in February.

Ecology *Manglietia* is found scattered but may be locally common in primary, evergreen, lowland to montane rain forest, at 450–2400 m altitude.

Silviculture *Manglietia* can be propagated by seed. *M. glauca* has about 41 500 dry seeds without pulp per kg. Seeds can be stored for a maximum of 5 weeks and during the first 2 weeks of storage the germination rate increases. Seeds which float in water should be discarded, the remainder are sown in the shade. Seeds of *M. dolichogyna* with adhering pulp show about 60% germination in 14–48 days and seeds of *M. glauca* have 55–70% germination. In Java *M. glauca* has been planted at 3 m × 1–1.5 m and a rotation of 35 years is recommended. During this rotation the mean annual volume increment is estimated at 12.1 m^3/ha. Natural regeneration of *M. glauca* in West Java at 1100–1500 m altitude was optimal in open and slightly shaded locations. In Vietnam defoliation by a *Schizocera* species has been observed in *M. glauca*.

Genetic resources and breeding Resources of *M. glauca* are dwindling in Bali due to its use for handicrafts.

Prospects It is expected that the use of *Manglietia* wood, especially that of *M. glauca*, for carving will increase since growth rates are fairly high and the wood is of good quality. However, information on plantation establishment and yield is still scanty.

Literature 9, 58, 70, 94, 99, 101, 130, 161, 163, 170, 198, 260, 341, 373, 405, 436, 441, 485, 593, 634, 670, 738, 829, 831, 838, 848, 850, 861, 869, 870, 908, 1089.

Selection of species

Manglietia calophylla Dandy

Distribution West Sumatra.

Manglietia dolichogyna Dandy ex Noot.

Vernacular names Malaysia: chempaka hutan, ekur daun lesin, medang keladi (Peninsular).

Distribution Peninsular Malaysia and Borneo (Sabah).

Manglietia glauca Blume

Synonyms *Magnolia blumei* Prantl, *Manglietia singalanensis* Agostini, *Manglietia sumatrana* Miq.

Vernacular names Indonesia: baros (general), antuang (Sumatra), cempaka bulus (Javanese).

Distribution Sumatra, Java, Sulawesi and the Lesser Sunda Islands.

Manglietia lanuginosa (Dandy) Noot.

Synonyms *Manglietia glauca* Blume var. *lanuginosa* Dandy.

Vernacular names Indonesia: aduwang, antuang, medang sanggar (Sumatra).
Distribution North Sumatra.

U.A. Dasuki

Maniltoa R. Scheffer

Ann. Jard. Bot. Buitenzorg 1: 20 (1876).
LEGUMINOSAE
x = unknown; $2n$ = unknown

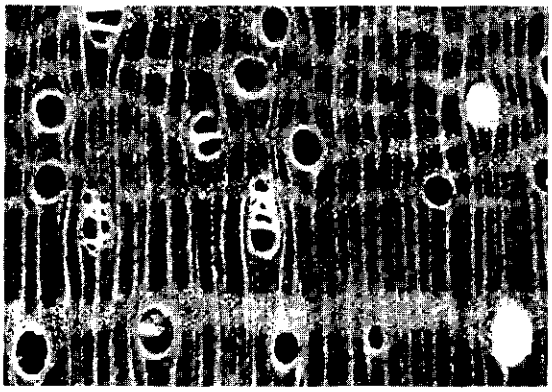
Vernacular names Papua New Guinea: maniltoa (En).

Origin and geographic distribution *Maniltoa* comprises about 20 species and is distributed in India, Bangladesh, Burma (Myanmar), Cambodia, Peninsular Malaysia, Sulawesi, the Moluccas, New Guinea, the Solomon Islands, northern Australia, the Caroline Islands and Polynesia (Fiji and Tonga). Some species are cultivated in Java and northern Sumatra. New Guinea is by far richest in species (about 12).

Uses The wood of *Maniltoa* is used for general construction, furniture, joinery, flooring, cladding, panelling, decking, lining, turnery, sliced veneer, tool handles and truck bodies. It makes good charcoal.
An extraction of the wood has been reported to be used to dye wool and silk yellow to reddish; it dyes only slightly. The trees are locally esteemed as ornamentals, e.g. in Java.

Production and international trade Limited amounts of *Maniltoa* timber are exported to Japan from Papua New Guinea and the Solomon Islands. In 1996 Papua New Guinea exported a fair volume of 6855 m^3 of *Maniltoa* logs at an average free-on-board (FOB) price of US$ 99/m^3.

Properties *Maniltoa* yields a medium-weight to heavy hardwood with a density of 740–1120 kg/m^3 at 15% moisture content. Heartwood brown or red-brown, sometimes with golden lustre, distinct but becoming indistinct from the straw-coloured or yellow-white sapwood, which turns grey-brown or brown upon exposure; grain straight or slightly interlocked; texture moderately fine to moderately coarse. Growth rings indistinct; vessels small to medium-sized, solitary and in radial multiples of up to 4, visible to barely visible to the naked eye; parenchyma paratracheal vasicentric, sometimes aliform and confluent, mostly apotracheal in bands both wider and narrower than the vessels; rays fine; ripple marks absent.



Maniltoa browneoides
transverse surface (×20)

The wood is moderately hard to hard and fairly strong. It is moderately durable, but not suitable for use in contact with the ground. The heartwood is resistant to pressure impregnation. The sapwood is susceptible to *Lyctus*.
See also the tables on microscopic wood anatomy and wood properties.

Botany Small to large trees up to 40(–48) m tall; bole branchless for up to 19 m, up to 90(–120) cm in diameter, sometimes with buttresses up to 2 m high; bark surface smooth but often lenticellate or with numerous pustules, pale grey, greyish-brown, reddish-brown to blackish, inner bark greenish-brown, greyish-brown or red-brown, non-fibrous. Buds large, covered by 2-ranked brown scales. Leaves developing in white or pink tassels, arranged spirally, paripinnate, (1–)2–15-jugate; leaflets opposite, asymmetrical; stipules small, caducous. Flowers in an axillary, sessile, dense and contracted raceme, usually with sturdy rachis and scale-like, usually persistent bracts; receptacle campanulate or tubular; sepals 4(–5), imbricate; petals 5, free, glabrous; stamens numerous, filaments often connate at base; ovary superior, sessile or stalked, unilocular with 1(–2) ovules, style slender. Fruit a short, broad, woody, indehiscent pod, 1-seeded. Seed globose, smooth.
Flowering may start at a very young age. In Java *M. browneoides* is found flowering throughout the year, whereas its seeds are reported to be dispersed by bats. In Papua New Guinea its leaf shedding an new leaf flushes were associated with stress.
Maniltoa is usually placed in the tribe *Detarieae* of the subfamily *Caesalpinioideae*, formerly in the tribe *Cynometreae*. It is closely related to (and perhaps even congeneric with) *Cynometra*, which

Maniltoa schefferi K. Schumann – 1, young flush of leaves; 2, flowering twig; 3, infructescence.

may look very similar. It differs from the latter genus in the more numerous stamens.

Ecology *Maniltoa* occurs in primary lowland forest up to 500(–1300) m altitude, often in swampy localities and is shade-tolerant. In New Guinea it is relatively common although never gregarious.

Silviculture *Maniltoa* may be raised from seed. *M. browneoides* has about 190 dry seeds/kg. The seeds can be sown in full sunlight as well as in shade. Seeds germinate readily with about 95% germination; germination starts after 10 days, and 15 days after sowing 80% of the germinating seeds have appeared. It seems to thrive best in a mixture of loam, peat and sand. In lowland forest in New Guinea a density of 0.5–2.1 trees of over 35 cm diameter per ha has been recorded.

Genetic resources and breeding Although *Maniltoa* trees are often common in New Guinea, they are virtually restricted to primary lowland forest. Moreover, several species are probably rare. Therefore, there is evidence to suspect that they are rather vulnerable to genetic erosion.

Prospects Little is known of the wood quality of *Maniltoa* in other parts of South-East Asia, but the timber is well-known in Papua New Guinea and Fiji. *M. browneoides* may have potential as an ornamental or shade tree.

Literature 40, 70, 80, 125, 163, 300, 304, 343, 348, 405, 464, 536, 574, 816, 861, 982, 1012, 1112, 1123, 1162, 1163, 1221.

Selection of species

Maniltoa browneoides Harms

Synonyms *Maniltoa gemmipara* R. Scheffer ex Back., *Maniltoa grandiflora* Back. & Bakh. f. non (A. Gray) R. Scheffer.

Vernacular names Indonesia: saputangan (general).

Distribution New Guinea; occasionally planted in northern Sumatra, Java and Papua New Guinea.

Maniltoa cynometroides Merr. & L.M. Perry

Distribution The Moluccas, New Guinea and Fiji.

Maniltoa lenticellata C.T. White

Distribution New Guinea and northern Australia.

Maniltoa plurijuga Merr. & L.M. Perry

Distribution New Guinea.

Maniltoa polyandra (Roxb.) Harms

Synonyms *Cynometra polyandra* Roxb.

Distribution India, Bangladesh, Burma (Myanmar), Cambodia and Peninsular Malaysia.

Maniltoa psilogyne Harms

Distribution New Guinea.

Maniltoa schefferi K. Schumann

Distribution Sulawesi, the Moluccas, New Guinea, New Britain, the Solomon Islands and northern Australia.

I. Samsoedin (general part, selection of species),
E. Boer (general part),
R.H.M.J. Lemmens (general part, selection of species)

Maranthes Blume

Bijdr. fl. Ned. Ind. 2: 89 (1825).
CHRYSOBALANACEAE
x = unknown; $2n$ = unknown

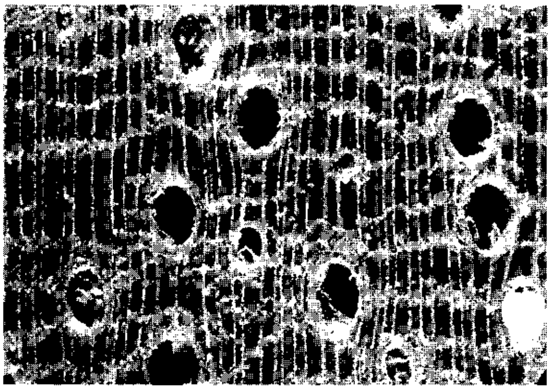
Vernacular names Merbatu (trade name). Liusin (En, Fr), sea beam (En). Indonesia: kayu batu (general), kalek kureseng (Sumatra), kolaka (Sulawesi). Malaysia: bangkawang (Dusun, Malay, Sabah), merbatu laut (Peninsular), nyalin laut (Sarawak). Papua New Guinea: busu plum (En). Philippines: liusin (general), alamag (Tagalog), bingas (Iloko). Thailand: chi khat phen, chi ot phen (peninsular).

Origin and geographic distribution *Maranthes* comprises 12 species, 10 of which occur in tropical Africa, one in Central America and one in peninsular Thailand, throughout the Malesian region, northern Australia, the Solomon Islands and the Caroline Islands. The latter species is *M. corymbosa* Blume (synonyms: *Parinarium corymbosum* (Blume) Miq., *Parinarium griffithianum* Benth., *Parinarium palauense* Kanehira).

Uses The wood of *Maranthes* is used for medium to heavy construction under cover, generally in the round, such as beams, columns and posts. It is also suitable for parquet flooring, cart poles and wheels, package for heavy articles, dunnage and plywood. When treated it can be used for salt-water piling and other marine constructions and ship building. The wood yields a good fuel and excellent charcoal.
The fruit is edible and the seed kernel contains 70–75% oil, which has been applied in the manufacture of paint. In Peninsular Malaysia the tree is planted as an ornamental along roads and avenues.

Production and international trade Wood of *Maranthes* is probably traded in mixed consignments of medium-weight timber, or together with that of the genera *Atuna* and *Parinari* as 'merbatu'. Production is generally limited, but a fairly large volume of merbatu is exported to Japan from Papua New Guinea and the Solomon Islands. In 1996 Papua New Guinea exported a fair volume of about 17 500 m^3 of 'busu plum' logs at an average free-on-board (FOB) price of US\$ 94/m^3.

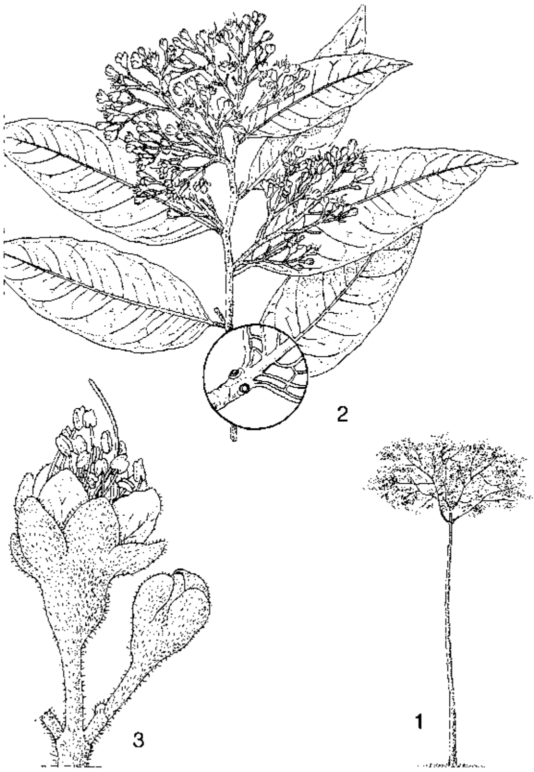
Properties *M. corymbosa* yields a medium-weight to heavy hardwood with a density of 680–1090 kg/m^3 at 15% moisture content. Heartwood red-brown to dark brown with occasional purplish tinge, not clearly demarcated from the pale brown to straw-coloured sapwood; grain straight to slightly interlocked, occasionally spiral; texture



Maranthes corymbosa
transverse surface (×20)

rather coarse but even; watered-silk figure may occur on tangential surface; wood with a sweet odour. Growth rings indistinct; vessels medium-sized to very large, exclusively solitary, with a tendency to oblique arrangement; parenchyma moderately abundant to abundant, apotracheal in narrow bands, distinct to the naked eye, and diffuse-in-aggregates; rays very fine and not distinct to the naked eye; ripple marks absent.
Shrinkage upon seasoning is high; the wood seasons fairly rapidly, but is liable to check and warp. It is very hard and strong. Because of its siliceous nature it is very difficult to saw and work with tools, especially when seasoned; it splits well. It is moderately durable in protected situations. The sapwood is permeable and the heartwood is moderately permeable to impregnation, with a retention of about 350 kg/m^3 under the pressure treating method. The wood is resistant to dry-wood termites and fairly resistant to marine borers after being pressure-treated, but an outer coat of creosote is recommended for salt-water piling. The sapwood is non-susceptible to *Lyctus*, but liable to pinhole borer attack.
See also the tables on microscopic wood anatomy and wood properties.

Botany A medium-sized to fairly large tree up to 40 m tall; bole straight, cylindrical, slightly tapering, branchless for up to 25 m, up to 100(–160) cm in diameter, without buttresses, sometimes spur-rooted; bark surface smooth to shallowly grooved, lenticellate, pale grey-brown, peeling off in large and thick pieces below the crown, inner bark fibrous, pink to red-brown, occasionally with a watery exudate. Leaves arranged spirally, simple, entire, glabrous when mature, with paired glands at the junction of blade and petiole; stip-



Maranthes corymbosa Blume – 1, tree habit; 2, flowering twig; 3, flower and bud.

ules caducous. Flowers in a many-flowered corymbose panicle, slightly zygomorphic, with an obconical receptacle; sepals 5, unequal; petals 5; stamens 25–35, inserted on one side of the throat of the receptacle and staminodes on the opposite side; ovary inserted laterally at the mouth of the receptacle, 2-locular with 1 ovule in each cell, style basal. Fruit a large, fleshy, smooth drupe, ripening dark purple and with hairs between seed-coat and endocarp. Seedling with epigeal germination; cotyledons emergent; hypocotyl elongated; scale leaves absent; first 2 leaves opposite, subsequent ones alternate.

In a perhumid climate trees measured on average 10.9 m in height and 9.6 cm in diameter after 6 years. For a seasonal climate these figures were 17.8 m and 18.5 cm respectively, after 10.5 years. In West Java flowering is from July to October and ripe fruits have been observed from September to December. In Peninsular Malaysia the trees may flower twice a year. Fruits are eaten and dispersed by birds, e.g. hornbills and fruit pigeons, and are also scatter-hoarded by squirrels.

The family *Chrysobalanaceae* has sometimes been treated as a subfamily of the *Rosaceae*.

Ecology *M. corymbosa* is generally found in sandy or rocky coastal areas, sometimes more inland in primary and secondary forest up to 600(–1500) m altitude. In Australia it has also been observed in gallery forest.

Silviculture *M. corymbosa* can be propagated by seed. There are about 335 dry seeds/kg. Germination tests in Peninsular Malaysia showed 22% germination of cleaned stones in 3–12 months and 14% germination of whole fruits in 5–12 months. Seeds are sown under shade and seedlings can be planted out 5 months later when they have attained 15 cm. Seedlings do not tolerate stumping before planting. In Indonesia the seedlings are planted at 1 m × 3 m with *Leucaena leucocephala* (Lamk) de Wit as a cover crop between the lines. The canopy closes at 2 years and the first thinning is done after 4 years. The mean annual increment excluding yield from thinnings for the first ten years is 8 m^3/ha. Under natural conditions, seedlings establish themselves and grow up in dense forest; therefore planting on open sites is not recommended.

Genetic resources and breeding As *M. corymbosa* occurs throughout and beyond Malesia, the risk of genetic erosion posed by logging is very low.

Prospects *M. corymbosa* is too hard and too difficult to work to become a valuable sawn timber. The use of round logs for marine construction and posts and poles, especially when pressure-treated, will probably remain important in the near future.

Literature 40, 151, 161, 162, 163, 198, 209, 267, 300, 301, 304, 341, 346, 348, 405, 426, 427, 464, 536, 615, 741, 757, 829, 831, 861, 905, 933, 934, 1039, 1048, 1221, 1239, 1242, 1248.

G.T. Prance

Mastixia Blume

Bijdr. fl. Ned. Ind. 13: 654 (1826).

CORNACEAE

x = unknown; *M. arborea* (Wight) Bedd.: $n = 13$, *M. trichotoma*: $2n = 22$

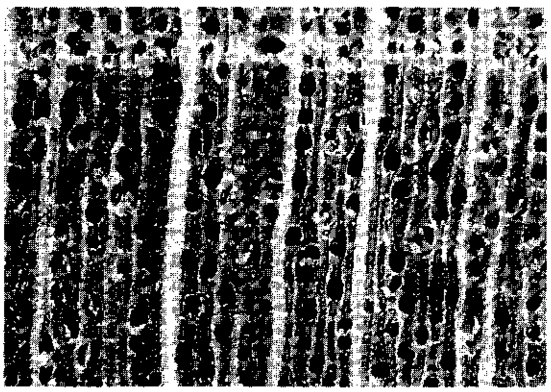
Vernacular names Kayu kundur (trade name). Indonesia: nyaling (Kutai, Kalimantan). Malaysia: tebu-tebu, tetebu (Peninsular). Philippines: apanit (Filipino).

Origin and geographic distribution *Mastixia* comprises about 17 species which occur in Sri Lanka and southern India, and from north-eastern India to Burma (Myanmar), Indo-China, southern China, Thailand and throughout the Malesian region towards the Solomon Islands. Within Malesia 10 species occur.

Uses The wood of *Mastixia* is used for temporary construction, packing cases, pallets and shuttering and is considered suitable for chopsticks, ice-cream spoons, toothpicks and for the production of pulp and paper.

Production and international trade The scattered occurrence of the trees does not contribute to the general utilization of *Mastixia* timber which has little commercial value.

Properties *Mastixia* yields a lightweight to medium-weight hardwood with a density of 380–770 kg/m^3 at 15% moisture content. Heartwood straw-coloured to yellow with a greenish tinge, not clearly differentiated from the white to pale yellow sapwood; grain straight or slightly interlocked; texture fine and even. Vessels moderately small to medium-sized, mostly solitary, some appear in radial pairs, only visible with a hand lens, open; parenchyma indistinct with a hand lens, apotracheal diffuse or diffuse-in-aggregates (the latter type very difficult to discern); rays of 2 distinct sizes, very fine and moderately broad; ripple marks absent; wood occasionally with axial intercellular canals in tangential series.
Shrinkage of the wood upon seasoning is moderate to high. It seasons slowly and is prone to stain; boards 25 mm thick take about 5 months to air dry. The wood is soft to moderately hard and of moderate strength. It is easy to saw and work and produces a smooth surface. The wood is non-durable but easy to treat with preservatives.
The mean fibre length of *M. trichotoma* is 2.478 mm.



Mastixia pentandra
transverse surface (×20)

See also the tables on microscopic wood anatomy and wood properties.

Botany Small to medium-sized or fairly large trees up to 40 m tall; bole up to 80(–150) cm in diameter, usually without buttresses; bark surface smooth or rarely cracked to shallowly fissured, hoop-marked, grey to grey-brown, often exuding white resin when bruised, inner bark gritty, granular, orange-yellow, with strong smell of sugarcane water. Leaves alternate, subopposite or opposite, simple, entire, exstipulate. Flowers in a terminal or sometimes axillary thyrse; calyx with 4–5(–7) teeth or lobes; petals 4–5(–6), valvate, thick, inflexed at apex; stamens 4–5(–6), in 1 whorl or rarely 8 in 2 whorls, short; disk lobed; ovary inferior, 1-locular with a single ovule, style short, stout. Fruit a drupe, crowned by the persistent disk; endocarp stony. Seed with membranous testa and copious endosperm. Seedling with epigeal germination; cotyledons emergent, leafy; hypocotyl elongated; first few leaves alternate, these or later ones sometimes slightly toothed at apex.
Mastixia has been divided into 2 subgenera: subgenus *Manglesia* Matthew having 8 stamens in 2 whorls and subgenus *Mastixia* with 4–5(–6) stamens in 1 whorl. When sterile, *Mastixia* can easily be confused with some *Dipterocarpaceae*, but differs in having a thick and gritty inner bark with a strong sugar-cane smell and soft wood. It may also be mistaken for a member of the *Lauraceae* ('medang') because of the similar inner bark, but medang has no resin. *M. pentandra* and *M. trichotoma* are highly variable and have been subdivided into 5 subspecies and 5 varieties, respectively.

Ecology *Mastixia* is generally found scattered in primary (often dipterocarp) and secondary forest in valleys, on slopes or ridges, up to 2400 m altitude. It is often found in moist habitats, e.g. waterlogged places, river banks, on a wide range of soils.

Silviculture *Mastixia* can be propagated by seed. Pyrenes of *M. pentandra* show about 95% germination in 39–116 days whereas sown fruits have about 80% germination in 23–61 days. In a 50-ha plot in lowland forest in Peninsular Malaysia, *M. pentandra* and *M. trichotoma* numbered respectively 20 and 8 stems over 1 cm in diameter, of which only 3 and 2 stems, respectively measured over 10 cm in diameter.

Genetic resources and breeding *Mastixia* is rare, but as it is seldom logged and occurs in a wide range of habitats the risk of genetic erosion seems low.

Prospects It is unlikely that the use of *Mastixia* timber will increase in the near future.

Literature 43, 70, 163, 195, 223, 238, 341, 343, 553, 630, 678, 745, 749, 763, 780, 829, 831, 861, 933, 955, 974, 1048, 1221, 1232, 1242.

Selection of species

Mastixia cuspidata Blume

Synonyms *Mastixia bracteata* C.B. Clarke, *Mastixia pentandra* Blume var. *cuspidata* (Blume) Miq.

Vernacular names Indonesia: bebung, kundur (Sumatra), mengkapas (Bangka). Malaysia: biansu gunong (Iban, Sarawak).

Distribution Peninsular Malaysia, Sumatra and Borneo.

Mastixia kaniensis Melch.

Synonyms *Mastixia ledermannii* Melch.

Vernacular names Indonesia: bie (Maju, Irian Jaya), labak-kobilien (Mooi, Irian Jaya), samuwin (Biak, Irian Jaya).

Distribution The Moluccas, New Guinea and the Solomon Islands.

Mastixia pentandra Blume

Synonyms *Mastixia philippinensis* Wangerin, *Mastixia poilanei* Tardieu, *Mastixia scortechinii* King.

Vernacular names Brunei: kayu wulu, medang surungan. Indonesia: huru lilin, tenyau (Java), mengkapas (Bangka). Malaysia: kayu wulu, medang surungan (Sabah, Sarawak), medang pisang (Peninsular). Philippines: apanit (Filipino), bakan (Ibanag), balikbikan (Tagalog). Vietnam: c[aa]y b[uu]i lua.

Distribution From north-eastern India to Bhutan, Burma (Myanmar), Indo-China, southern China, Thailand, Peninsular Malaysia, Sumatra, Java, Borneo, the Philippines, Sulawesi and the Moluccas.

Mastixia rostrata Blume

Synonyms *Mastixia caudatifolia* Merr., *Mastixia junghuhniana* Miq., *Mastixia margarethae* Wangerin.

Vernacular names Indonesia: bumis (Flores), daun kayu tenjo, daun kitajas (Java). Malaysia: patoli entelit (Iban, Sarawak).

Distribution Peninsular Malaysia, Sumatra, Java, Borneo and the Lesser Sunda Islands.

Mastixia trichotoma Blume

Synonyms *Mastixia clarkeana* King, *Mastixia korthalsiana* Wangerin, *Mastixia maingayi* C.B. Clarke.

Vernacular names Brunei: medang aima, medang kanigara. Indonesia: huru hiris (Java), medang kanigara (Kalimantan), medang keladi (Sumatra). Malaysia: kayu bengkal bukit (Peninsular), medang aima, medang kanigara (Sabah, Sarawak). Philippines: Mindanao apanit (Filipino).

Distribution Peninsular Thailand, Peninsular Malaysia, Sumatra, Java, Borneo, the Philippines (Mindanao), North Sulawesi, the Lesser Sunda Islands (Bali) and the Moluccas.

R.C.K. Chung

Mastixiodendron Melchior

Bot. Jahrb. Syst. 60: 167 (1925).

RUBIACEAE

x = unknown; $2n$ = unknown

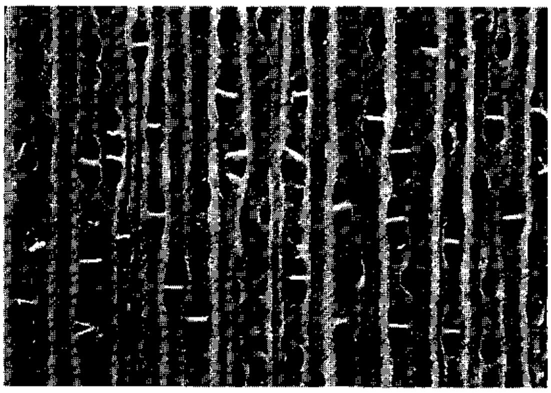
Vernacular names Papua New Guinea: garo garo.

Origin and geographic distribution *Mastixiodendron* comprises 7 species and is distributed from the Moluccas (1 species) eastward, through New Guinea (3 species), the Bismarck Archipelago (2 species) and the Solomon Islands (1 species), to Fiji (3 species, all endemic).

Uses The wood of *Mastixiodendron* is suitable for general construction, bridges and wharves, decking, crossarms, poles for transmission lines, furniture, joinery, cabinet work, windowsills, flooring, boat building, staircases, tool handles, drawer slides and other specialty uses. It has also been recommended for the production of veneer and plywood; it is unsuitable for the production of paper.

Production and international trade Small amounts of *Mastixiodendron* timber are exported from Papua New Guinea and the Solomon Islands, mainly to Japan. In Papua New Guinea it is regarded as a commercial hardwood and in 1992 the timber was ranked in MEP (Minimum Export Price) group 4, and fetched a minimum price of US\$ 43/m^3 for saw logs. In 1996 it was ranked in MEP group 3 and a volume of about 38 150 m^3 of logs was exported at an average free-on-board (FOB) price of US\$ 108/m^3.

Properties *Mastixiodendron* yields a medium-weight to heavy hardwood with a density of



Mastixiodendron pachyclados
transverse surface (×20)

675–990 kg/m³ at 15% moisture content. Heartwood pale yellow-brown, not clearly demarcated from the pale yellow sapwood; grain straight; texture fine and even; wood slightly greasy to the touch. Growth rings indistinct or just visible by a slight difference in colour between earlywood and latewood; vessels very small to medium-sized, generally in radial multiples of 2–3, occasionally more than 4, usually open, rarely with pale-coloured gum-like deposits; parenchyma absent or very scarce, scanty paratracheal or apotracheal diffuse; rays extremely fine to medium-sized, visible to the naked eye; ripple marks absent.

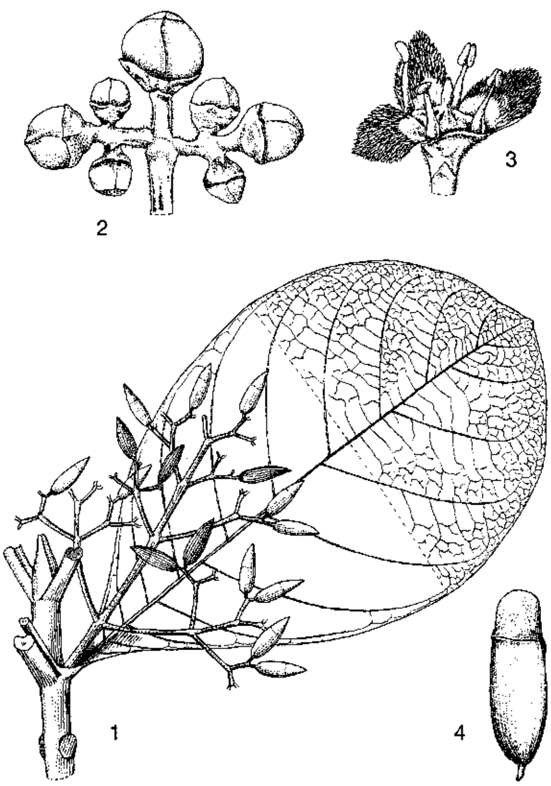
Shrinkage is rated from low to very high; quartersawn material seasons satisfactorily with only slight risk of checking, cupping or bowing. It takes 30 days to air dry 25 mm thick board of *M. pachyclados* from 60% to 20% moisture content; in a dehumidifier it takes 12 days. The wood is hard and moderately strong to strong. It is easy to saw and plane. It is slightly durable to moderately durable when exposed to the weather or in contact with the ground. The wood is susceptible to blue stain. The sapwood is non-susceptible to *Lyctus*. The sapwood is easy and the heartwood is moderately easy to treat with preservatives under pressure.

See also the tables on microscopic wood anatomy and wood properties.

Botany Small to large trees up to 55 m tall, rarely shrubs; bole straight or twisted, branchless for up to 30 m and up to 200(–300) cm in diameter, with buttresses up to 4 m high; bark surface smooth to fissured, flaky or pustular, greyish, brownish to blackish, inner bark grey-white to grey-brown; crown usually small, dense and rounded, with heavy, ascending branches. Twigs ringed by prominent stipule scars. Leaves opposite, simple, entire, decurrent on petiole at base; stipules prominent in terminal buds, caducous. Flowers in an axillary, thyrsoid inflorescence with opposite branches terminating in 3-flowered dichasia, 4-merous; calyx lobes short; petals free, fleshy, valvate in bud, papillate to pilose inside; stamens alternating with petals; ovary inferior to semi-inferior or nearly superior, 2-locular with 1 ovule in each cell, style short or long, often caducous. Fruit drupaceous, crowned or ringed by the perianth scar, often 1-locular by abortion, 1(–2)-seeded. Seed narrowly ellipsoid.

The trees can be found flowering and fruiting throughout the year.

Mastixiodendron is an aberrant genus within the *Rubiaceae* with its free petals and often semi-superior ovary. It has been placed in the families *Cornaceae* and *Loganiaceae*, but the large interpetiolar stipules and many anatomical characters point to *Rubiaceae*. It seems best to place it in the



Mastixiodendron pachyclados (K. Schumann) Melchior – 1, flowering twig with twig apex; 2, terminal portion of inflorescence with flower buds; 3, flower with 1 petal removed; 4, fruit.

tribe *Chiococceae* of the subfamily *Cinchonoideae*, but takes an isolated position.

Ecology *Mastixiodendron* occurs from sea-level up to 1100(–1900) m altitude, in primary as well as secondary forest, sometimes in swamp forest, frequently in pure or nearly pure stands (e.g. *M. pachyclados*).

Silviculture In the Oransbari forest complex in Irian Jaya the stocking of *M. pachyclados* is about 6 m^3/ha.

Genetic resources and breeding As *M. pachyclados* can be found in commercially interesting densities it may be at risk of genetic erosion.

Prospects The wide array of applications of *Mastixiodendron* timber, especially of *M. pachyclados*, will remain of interest for commerce. Nothing is known on silvicultural aspects, so it is difficult to assess the potential of *Mastixiodendron* for plantations.

Literature 40, 125, 224, 300, 304, 348, 360, 437, 464, 487, 513, 568, 571, 587, 861, 1052, 1084, 1232.

Selection of species

Mastixiodendron pachyclados (K. Schumann) Melchior

Synonyms *Fagraea pachyclados* K. Schumann.

Vernacular names Indonesia: koerdop (Samber, Irian Jaya), modjiu, raimagogo (Moluccas). Papua New Guinea: garo garo (general), aimo (New Britain).

Distribution The northern Moluccas, New Guinea and the Bismarck Archipelago.

Mastixiodendron plectocarpum S. Darwin

Vernacular names Indonesia: moapi (Samber, Irian Jaya), teitakka (Manikiong, Irian Jaya).

Distribution Western and central New Guinea.

Mastixiodendron smithii Merr. & L.M. Perry

Distribution New Guinea (mainly Papua New Guinea).

Mastixiodendron stoddardii Merr. & L.M. Perry

Distribution New Britain and the Solomon Islands.

S.I. Wiselius

Meiogyne Miq.

Ann. Mus. Bot. Lugd.-Bat. 2: 12 (1865).

ANNONACEAE

$x = 9$; *M. stenopetala* (F. v. Mueller) v. Heusden: $n = 18$

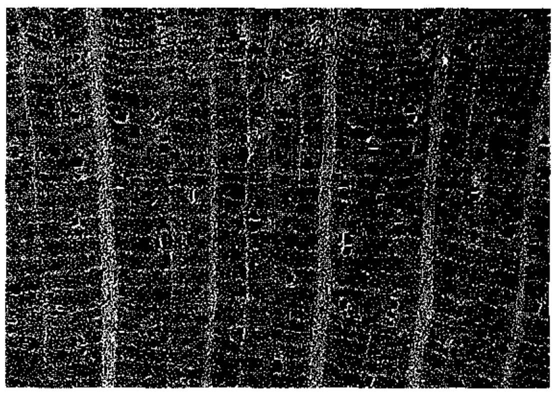
Vernacular names Mempisang (trade name). Brunei: karai. Malaysia: antoi (Peninsular), karai (Sabah), pisang-pisang (Peninsular, Sabah). Philippines: pugan. Vietnam: b[as] th[uw], thi[eer]u nh[uj]y.

Origin and geographic distribution *Meiogyne* comprises about 9 species occurring from India to Indo-China, Thailand, Peninsular Malaysia, Sumatra, Java, Borneo, the Philippines, the Lesser Sunda Islands, New Guinea, the Guam and Marianas Islands, Vanuatu, New Caledonia, Fiji and eastern Australia. Five species occur within the Malesian region.

Uses The wood of *Meiogyne* can be used like other *Annonaceae* timber for general construction (beams, joists, rafters, door and window frames), household utensils, furniture, boxes and crates. It is also suitable for the production of veneer and plywood, and is used as firewood.

Production and international trade 'Mempisang' is a general trade name comprising most of the genera of *Annonaceae*, and *Meiogyne* probably comprises only a very minor proportion of the wood traded under this name. In 1992 the export of mempisang wood from Sabah amounted to 25 000 m^3 of sawn timber and 42 500 m^3 of logs with a total value of about US$ 7.2 million. Small amounts of mempisang are imported into Japan, mainly from Sabah and Sarawak. The majority of *Meiogyne* wood is probably used locally.

Properties *Meiogyne* yields a medium-weight



Meiogyne sp.
transverse surface (×20)

hardwood with a density of about 750 kg/m^3 at 15% moisture content. Heartwood yellow-brown, not clearly differentiated from the sapwood; grain straight; texture rather coarse to moderately fine and uneven; wood with silver grain. Growth rings usually indistinct, occasionally indicated by a layer of denser fibres; vessels moderately small to medium-sized, solitary or sometimes in radial multiples of 2–4 or small clusters, open; parenchyma abundant, apotracheal in regular, narrow bands (scalariform); rays moderately small to medium-sized; ripple marks absent.
The wood is fairly strong, but only slightly durable. The wood should be treated with antistain chemicals immediately after sawing.
See also the table on microscopic wood anatomy.

Botany Evergreen shrubs or small to medium-sized trees up to 30 m tall; bole straight, up to 50 cm in diameter, without buttresses but sometimes slightly fluted; bark surface hoop-marked, smooth, grey to grey-brown or dark brown, inner bark fibrous, brown; crown dense, with spreading branches. Leaves arranged spirally, simple, entire, papery to leathery, exstipulate. Flowers in a 1–4(–8)-flowered, axillary or sometimes terminal fascicle, bisexual; sepals 3, valvate, free or sometimes connate; petals 6, valvate, free, more or less equal, cream to yellow or yellow-green becoming purplish, in 2 whorls, those of the inner whorl grooved or warty at base inside; stamens many, arranged spirally, inner ones elongated at the top; carpels 1–15, free, each with 3–16 ovules in 1–2 rows, stigma obconical to irregularly shaped. Fruit apocarpous, each monocarp sessile or short-stalked, subglobose to ellipsoid. Seed more or less kidney-shaped, with ruminate endosperm. Seedling with epigeal germination.
Early growth is reported to be slow.
Recently, the genera *Ancana*, *Chieniodendron*, *Guamia*, *Oncodostigma* and *Polaulax* were merged with *Meiogyne* to form a single genus.

Ecology *Meiogyne* is found in primary or secondary, lowland to lower montane rain forest, up to 1450 m altitude.

Silviculture *Meiogyne* can be propagated by seed. Regeneration in natural forest is poor.

Genetic resources and breeding As logging of *Meiogyne* is insignificant, there seems to be no risk of genetic erosion.

Prospects Very little is known about the ecology, wood properties and silviculture of *Meiogyne*. There is hardly any scope for increased use.

Literature 70, 162, 163, 707, 837, 861, 883, 1017, 1038, 1126, 1127, 1134, 1221.

Selection of species

Meiogyne monosperma (Hook. f. & Thomson) v. Heusden

Synonyms *Desmos conchyliata* (Ridley) Merr., *Desmos purpurata* (Ridley) Merr., *Oncodostigma monosperma* (Hook. f. & Thomson) J. Sinclair.

Vernacular names Thailand: yai-pluak.

Distribution Peninsular Thailand, Peninsular Malaysia and Borneo (Sarawak).

Meiogyne virgata (Blume) Miq.

Synonyms *Meiogyne monogyna* (Merr.) Tien Ban, *Meiogyne montana* (Blume) Backer, *Meiogyne subsessilis* (Ast) J. Sinclair.

Vernacular names Malaysia: medang tanjong (Peninsular). Philippines: pugan. Thailand: san-gyu khao (peninsular). Vietnam: thi[eer]u nh[uj]y nh[awx]n.

Distribution Indo-China, Thailand, Peninsular Malaysia, Singapore, Sumatra, Java, Borneo and the Philippines.

Nguyen Tien Ban

Melanochyla Hook. f.

Fl. Brit. India 2: 38 (1876).
ANACARDIACEAE
x = unknown; $2n$ = unknown

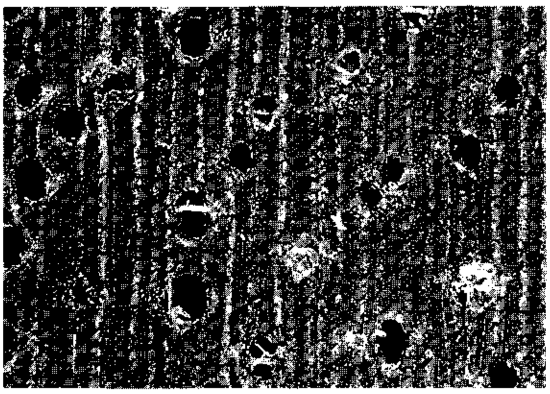
Vernacular names Rengas (trade name). Malaysia: rengas padi, rengas pisang (Peninsular).

Origin and geographic distribution *Melanochyla* comprises about 30 species occurring in peninsular Thailand, Peninsular Malaysia, Sumatra, Borneo and western Java.

Uses Due to the highly irritant sap the wood of *Melanochyla* is seldom harvested, but when seasoned the attractively figured and red heartwood is used occasionally for high-class furniture, decorative work, panelling, flooring, fancy articles, turnery, walking sticks and sliced veneers. It used to be used to build local houses. The sapwood is suitable for concrete shuttering and temporary light construction.

Production and international trade In Malaysia *Melanochyla* wood is traded together with that of *Gluta* under the trade name 'rengas', of which *Melanochyla* constitutes only a very minor proportion.

Properties *Melanochyla* yields a medium-weight hardwood with a density of the sapwood of



Melanochyla caesia
transverse surface (×20)

550–810 kg/m³ at 15% moisture content. Heartwood dark brown to red with almost black streaks, moderately sharply differentiated from the up to 15 cm wide sapwood, which is pale yellow-brown with a pink or green tinge, sometimes with black specks of exuding sap; grain interlocked and sometimes wavy; texture slightly coarse; wood with zig-zag figure on longitudinal faces due to vessel lines with surrounding parenchyma. Growth rings indistinct; vessels medium-sized to moderately large, mostly solitary but also in radial multiples of 2–3, tyloses sometimes abundant; parenchyma moderately abundant, paratracheal vasicentric and confluent, hardly visible even with a hand lens due to lack of contrast; rays moderately fine, only visible with a hand lens; ripple marks absent; radial canals present in most species.

The wood is soft to moderately hard. It is easy to work and finishes cleanly. It is very probably non-durable and the heartwood is resistant to preservative treatment due to the presence of tyloses.

See also the table on microscopic wood anatomy.

Botany Evergreen, usually dioecious, small to medium-sized trees up to 30(–39) m tall; bole up to 100 cm in diameter, with buttresses up to 2(–3) m high or in swampy areas with abundant stilt roots; bark surface smooth to cracking, reddish-brown to grey-brown, inner bark granular, reddish-brown to pinkish, often with droplets of black sap. Leaves arranged spirally, simple, entire, usually papillose below, exstipulate. Flowers in a terminal and/or axillary panicle or rarely a fascicle, usually unisexual, (4–)5-merous; hypanthium cup-shaped, slightly accrescent and persistent in fruit; calyx lobed; petals imbricate, villous or woolly inside; stamens with filaments hairy and free or fused with the petals below; disk intrastaminal, rim-like; ovary superior, sometimes partly or completely concealed in the hypanthium and appearing semi-inferior or inferior, 1-locular with a single ovule, style with 3 stigmas. Fruit a hairy drupe, with black resin. Seedling with hypogeal germination; cotyledons not emergent, succulent; hypocotyl not elongated; all leaves arranged spirally.

Pollination is by insects.

Melanochyla is the only genus of the *Anacardiaceae* in Malesia with a hypanthium, and belongs to the tribe *Semecarpeae*.

Ecology *Melanochyla* is mainly found scattered in primary or occasionally secondary, lowland or rarely lower montane, evergreen rain forest, up to 1000(–1800) m altitude. It often occurs in swampy locations, on peaty or sandy soils, occasionally on limestone.

Silviculture In a 50-ha plot in lowland forest in Peninsular Malaysia 6 species of *Melanochyla* were recorded, and there were 140 stems with a diameter over 10 cm; 33 of these were *M. angustifolia*.

Harvesting is seriously hindered by the highly irritant sap.

Genetic resources and breeding As *Melanochyla* is hardly ever exploited, the only threat results from the destruction of the habitat.

Prospects The aggressive and irritant sap discourages the exploitation of *Melanochyla*. Therefore, increased use is highly unlikely.

Literature 162, 163, 209, 267, 275, 341, 438, 553, 721, 740, 1048, 1221, 1222.

Selection of species

Melanochyla angustifolia Hook. f.

Vernacular names Malaysia: kayu paroh-paroh, poko kain pari pari, rapa bukit (Peninsular).

Distribution Peninsular Malaysia and Borneo.

Melanochyla auriculata Hook. f.

Vernacular names Indonesia: rengas lanyuh (Dayak, Kalimantan), rengas lisang (Kalimantan). Malaysia: kerbau jalang, mempayan, rengas lanjut (Peninsular).

Distribution Peninsular Malaysia, Singapore and Borneo (Sabah, Kalimantan).

Melanochyla borneensis (Ridley) Ding Hou

Synonyms *Nothopegia borneensis* Ridley.
Distribution Borneo (Sarawak).

Melanochyla bracteata King

Vernacular names Indonesia: silungham bosi (Batak, Sumatra). Malaysia: rengas alus (Peninsular).
Distribution Peninsular Malaysia, Singapore, Sumatra and Borneo (Sarawak, Kalimantan).

Melanochyla bullata Ding Hou

Vernacular names Indonesia: rengas berlukup (Kalimantan).
Distribution Borneo.

Melanochyla caesia (Blume) Ding Hou

Synonyms *Melanochyla kunstleri* King, *Melanochyla maingayi* Hook. f., *Melanochyla tomentosa* Hook. f. var. *glabrescens* Koord. & Valeton.
Vernacular names Indonesia: rengas manuk (Sundanese).
Distribution Peninsular Malaysia, Singapore, Sumatra, West Java and Borneo.

Melanochyla elmeri Merr.

Vernacular names Brunei: rengas hitam.
Distribution Borneo.

Melanochyla fulvinervis (Blume) Ding Hou

Synonyms *Melanochyla rugosa* King, *Semecarpus fulvinervis* Blume.
Vernacular names Indonesia: rengas bulu (Kalimantan).
Distribution Peninsular Malaysia and Borneo.

Melanochyla montana Kochummen

Distribution Borneo (Sabah, Sarawak).

Melanochyla tomentosa Hook. f.

Synonyms *Melanochyla densiflora* King.
Vernacular names Malaysia: kayu lau (Sarawak), rengas api, selemah (Peninsular).
Distribution Peninsular Malaysia, Sumatra (Aceh) and Borneo.

K.M. Kochummen

Melicope J.R. Forster & J.G. Forster

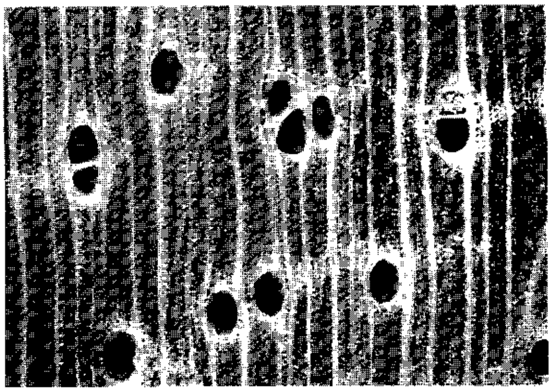
Charact. gen. pl.: 55 (1775).
RUTACEAE
$x = 18$; *M. bonwickii*, *M. confusa*: $2n = 36$

Vernacular names Euodia (En, trade name). Indonesia: sampang. Malaysia: pauh-pauh, pepauh (Peninsular), serang (Sabah, Sarawak). Burma (Myanmar): thipyu. Cambodia: beysamlek, svaisnor. Thailand: phia krating. Vietnam: ba ch[aj]c, ba g[aj]c.

Origin and geographic distribution *Melicope* comprises about 230 species occurring from Madagascar to Sri Lanka, India, Burma (Myanmar), Indo-China, southern China, Thailand, throughout Malesia, east to Hawaii and Samoa, south to Australia and New Zealand. Some 30 species are found within Malesia.

Uses The wood of *Melicope* is used for mouldings, interior trim, plain furniture, cabinet work, dowels, clog soles, weatherboards, wall panelling, pattern making, fruit cases, shingles, match splints and artifacts. It also produces good-quality veneer.
Several species contain alkaloids and are applied medicinally. The bark of *M. bonwickii* is reported to prevent leech bites. In the Philippines the bark of *M. confusa* is used for treating an enlargement of the spleen. The resin from the trunk of *M. latifolia* has been used as a varnish and adhesive. Leaves of the latter species have been applied as soap, and for treating fever and cramps. In Taiwan roots of *M. lunu-ankenda* are used against colds and rheumatism, and in Peninsular Malaysia leaves and flowers are applied to treat menstrual disorders and fever. Its leaves are eaten as a condiment or used to flavour food. The fruits of some species have been applied as a spice or condiment.

Production and international trade Small amounts of *Melicope* logs are exported from Papua New Guinea to Japan. In Papua New Guinea *Melicope* timber was ranked in the MEP (Minimum Export Price) group 5, fetching a minimum export price of US\$ 40/m^3 for round logs in 1992. In Papua New Guinea a distinction is sometimes made between 'light euodia' (wood of *M. elleryana*) and 'heavy euodia' (wood of *M. bonwickii*). In 1996 Papua New Guinea exported about 1550 m^3 of light euodia and about 2350 m^3 of heavy euodia logs at an average free-on-board (FOB) price of US\$ 101/m^3 and US\$ 99/m^3, respectively. Elsewhere, utilization is on a local scale only. Occasionally, *Melicope* timber may be found in mixed



Melicope bonwickii
transverse surface (×20)

consignments of lightweight or medium-weight hardwood.

Properties *Melicope* yields a lightweight, occasionally a medium-weight hardwood with a density of 230–610 kg/m^3 at 12% moisture content. Heartwood almost white or pale yellow-white to pale yellow-brown, occasionally with an orange tinge, not clearly differentiated from the sapwood; grain straight or shallowly interlocked; texture moderately fine and even; wood lustrous, with unpleasant or aromatic odour when fresh. Growth rings distinct to indistinct to the naked eye, boundaries indicated by marginal parenchyma; vessels moderately small to medium-sized, solitary and in radial multiples of 2–3, some tendency for tangetial arrangement evident, sometimes with yellow or brownish-yellow deposits; parenchyma abundant, paratracheal aliform to confluent forming more continuous layers towards the outer side of the growth ring, with marginal or seemingly marginal bands; rays moderately fine; ripple marks absent.

Shrinkage upon air drying is low to high. The wood seasons moderately fast without degrade. It is soft, occasionally to moderately hard, and very weak. It is easy to work, non-durable and fairly permeable to preservatives when pressure-treated. The sapwood is susceptible to *Lyctus* and blue stain. The energy value of the sapwood of *M. latifolia* is 19 665 kJ/kg.

Several species contain alkaloids, coumarins and essential oils.

See also the tables on microscopic wood anatomy and wood properties.

Botany Evergreen or deciduous shrubs or small to medium-sized or rarely large trees up to 40 m tall; bole straight or slightly twisted, cylindrical to slightly angular, branchless for up to 15 m, up to 60 cm in diameter, sometimes with buttresses up to 1.5(–5) m high; bark surface smooth to deeply fissured and slightly peeling, whitish to grey or pale brown to greenish-brown, inner bark white to pale brown or orange-brown to fleshy red, with slightly watery exudate; crown usually spreading. Leaves opposite or whorled, 3-foliolate or 1-foliolate, aromatic; leaflets with pellucid dots. Inflorescence axillary or on branches, paniculate. Flowers bisexual or unisexual and then trees dioecious, 4-merous; sepals fused at base; petals white; stamens 4 or 8; disk present; ovary superior, 4-carpellate, carpels fused completely or only at base, ovules (1–)2 per cell, styles united. Fruit with 1–4 follicles to a 4-locular capsule, with shiny, black seeds remaining attached in the fruit. Seedling with epigeal germination; cotyledons emergent; hypocotyl elongated; all leaves opposite, early leaves toothed, later ones entire.

Most species seem to flower almost throughout the year. *M. lunu-ankenda* is reported fruiting in Java in June, August, September and November. The shiny seeds are likely to be eaten and dispersed by birds. Dispersal by bats is also stated.

Recently, all except about 6 species of *Euodia* were transferred to *Melicope*. Unfortunately, not all necessary new combinations are available yet. A full revision of *Melicope* is in progress at the time of writing. The most important differences between the two genera are the dull and roughened seeds that are discharged upon dehiscence of *Euodia* fruit versus the shiny and smooth seeds remaining attached in the dehisced fruit of *Melicope*.

Ecology Timber-yielding *Melicope* species occur scattered in primary or secondary rain forest, occasionally also in semi-deciduous or deciduous forest, from the lowlands up to 1600(–2200) m altitude. Some species are also found along forest edges or in more open locations. Several species, notably *M. accendens*, *M. incana* and *M. lunu-ankenda* are recorded from swamp forest, the first also from kerangas.

Silviculture *Melicope* can be propagated by seed. For *M. lunu-ankenda*, there are about 267 000 dry seeds/kg. Fresh seed of *M. glabra* had a germination rate of only about 5% in about 4–5 months. *M. glabra* has pioneer characteristics. *Melicope* species coppice and grow rapidly and may therefore be recommended for plantations. They are not resistant to fire.

Genetic resources and breeding Although the wood is lightweight, some *Melicope* species are locally exploited heavily for firewood and may become endangered.

Prospects The wood of *Melicope* may continue to be of some importance for purposes where whitish and lightweight wood is required. *Melicope* may have potential for plantation establishment due to their ease of handling, coppicing capability and fast growth.

Literature 40, 70, 124, 163, 209, 221, 260, 267, 277, 300, 346, 348, 376, 405, 414, 436, 464, 526, 553, 595, 672, 724, 772, 829, 831, 861, 883, 933, 934, 947, 974, 1038, 1048, 1167, 1221, 1232.

Selection of species

Melicope accendens (Blume) T.G. Hartley

Synonyms *Euodia accendens* Blume, *Euodia macrophylla* Blume, *Euodia nervosa* Koord. & Valeton.

Vernacular names Indonesia: tempayang (Javanese).

Distribution From the Andaman Islands, Indo-China and Thailand towards Peninsular Malaysia, Java and Borneo.

Melicope bonwickii (F. v. Mueller) T.G. Hartley

Synonyms *Euodia bonwickii* F. v. Mueller, *Euodia speciosa* Rchb. f. & Zoll. ex Teijsm. & Binnend., *Euodia villamilii* Merr.

Vernacular names Indonesia: abal (Madura), awal (Javanese). Philippines: kamal (Tagalog).

Distribution Java, Borneo, the Philippines, Sulawesi, the Moluccas, New Guinea, Australia and Vanuatu.

Melicope confusa (Merr.) Liu

Synonyms *Euodia confusa* Merr.

Vernacular names Philippines: mangkau (Filipino).

Distribution Borneo, the Philippines, Sulawesi and the Moluccas.

Melicope elleryana (F. v. Mueller) T.G. Hartley

Synonyms *Euodia elleryana* F. v. Mueller.

Distribution New Guinea and Australia.

Melicope glabra (Blume) T.G. Hartley

Synonyms *Euodia glabra* (Blume) Blume, *Euodia kingii* Engl., *Euodia krukovii* Merr.

Vernacular names Indonesia: empah (Kutai, East Kalimantan), empatung (Dayak Benuag, East Kalimantan). Malaysia: leban pelandok, pauh betina, tenggek burong (Peninsular).

Distribution Peninsular Malaysia, Singapore, Sumatra, Java and Borneo (Kalimantan, possibly also Sabah).

Melicope incana T.G. Hartley

Synonyms *Euodia alba* Hook. f.

Distribution Sumatra, Borneo and northern Sulawesi.

Melicope latifolia (DC.) T.G. Hartley

Synonyms *Euodia latifolia* DC.

Vernacular names Indonesia: empag (Bali), sauyu (Ternate). Malaysia: ambong-ambong, leban pelandok jantan, serapoh jantan (Peninsular).

Distribution Peninsular Malaysia, Java, Borneo (Sabah), the Philippines, New Guinea and east to Samoa and Vanuatu.

Melicope lunu-ankenda (Gaertn.) T.G. Hartley

Synonyms *Euodia aromatica* Blume, *Euodia lunu-ankenda* (Gaertn.) Merr., *Euodia roxburghiana* (Cham.) Benth.

Vernacular names Indonesia: sempayang (Javanese). Malaysia: pauh-pauh paya, tapak itek, tenggek burong (Peninsular). Thailand: saam ngaam (central, south-eastern), uam (peninsular).

Distribution From Sri Lanka, India and the Himalayas to Indo-China, southern China, Thailand, Peninsular Malaysia, Java, Borneo, south-western Philippines and Sulawesi.

Ha Van Tue (general part),
E. Boer (general part),
M.S.M. Sosef (general part, selection of species)

Meliosma Blume

Catalogus: 10 (1823).
SABIACEAE

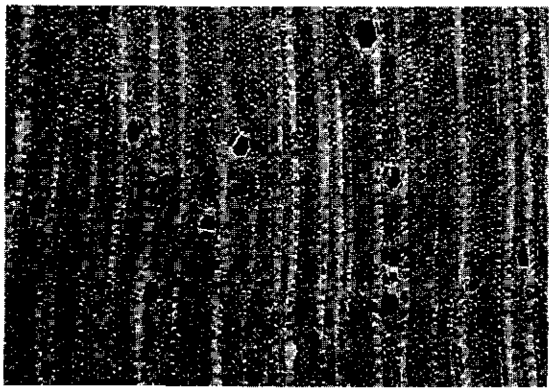
$x = 8$; *M. simplicifolia* (Roxb.) Walp., *M. pinnata* and several non-Malesian species: $n = 16$, *M. simplicifolia* subsp. *pungens* (Walp.) v. Beusekom: $2n = 32 + (0\text{–}3)B$

Origin and geographic distribution *Meliosma* comprises some 20 to 25 species occurring in Central and South America and in Sri Lanka, India, Burma (Myanmar), Indo-China, China, Japan, Thailand and throughout the Malesian region to New Britain. In South-East Asia 15 species are found, 8 of which occur in Malesia.

Uses The wood of *Meliosma* has traditionally been used for boards in house building.
M. sumatrana and *M. pinnata* have been suggested as useful for reforestation purposes. *M. pinnata* has been used for underplanting in forest plantations to control weed development. The fruits of *M. sumatrana* are edible. In Mindanao the pounded bark and leaves are used medicinally to cure wounds, to soothe itchy skin or, charred and put in water, against tympanites. Some species are planted in gardens as ornamental trees.

Production and international trade Utilization of the wood of *Meliosma* is on a local scale only.

Properties *Meliosma* yields a lightweight to medium-weight hardwood with a density of 280–675 kg/m^3 at 15% moisture content. Heartwood pale grey-brown or red-brown with a purple hue, not clearly differentiated from the whitish, pale pink or brown sapwood; darker coloured silver grain present on radial surface and darker markings on tangential surface (rays); wood occasionally with a slight aromatic odour. Growth rings indistinct, when visible indicated by parenchyma bands or slight colour differences between earlywood and latewood; vessels moderately small to medium-sized, solitary and in radial multiples of 2–3, less frequent in clusters of more than 3, white powdery deposits or thin-walled tyloses occasionally present; parenchyma apotracheal in marginal or seemingly marginal bands, paratracheal vasicentric and occasionally aliform connecting a few rays or 2–several vessels near the marginal bands; rays medium-sized to moderately broad, visible to the naked eye and conspicuous on radial surface; ripple marks absent.
Shrinkage of the wood upon seasoning is probably high and checking occurs rather frequently. The wood is very soft to moderately hard and fairly weak. It is non-durable and readily attacked by blue stain.
See also the table on microscopic wood anatomy.



Meliosma simplicifolia
transverse surface (×20)

Botany Evergreen or sometimes deciduous shrubs or small to medium-sized or rarely large trees up to 30(–42) m tall; bole sometimes crooked, otherwise cylindrical, up to 100 cm in diameter, sometimes with buttresses up to 2.5 m high, rarely stilt-rooted; bark surface smooth or sometimes shallowly fissured or slightly scaly in old trees, lenticellate, grey to brown, inner bark fibrous, streaked, pale brown to pinkish or red-brown, turning red, brown-red or brown upon exposure, with watery exudate. Leaves arranged spirally, simple or imparipinnate with opposite or subopposite leaflets and 1 or 3 apical ones, exstipulate, leaves or leaflets entire or toothed. Flowers in a terminal or sometimes axillary, many-flowered panicle; sepals (3–)5; petals 5, the outer 3 more or less unequal, mostly suborbicular and convex, the inner 2 equal, much smaller, opposite the fertile stamens, entire to bifid; disk usually present; stamens 5, 2 fertile; ovary superior, 2(–3)-locular with (1–)2 ovules in each cell, style short. Fruit a small drupe with 1(–2) seeds, endocarp splitting in 2 halves. Seedling with epigeal germination; cotyledons emergent, leafy; hypocotyl elongated; all leaves arranged spirally.
M. pinnata is very variable and has been divided into 9 subspecies.

Ecology *Meliosma* species are found in primary and secondary lowland and montane forest, from sea-level up to 3300 m altitude. They prefer perhumid to humid, tropical to subtropical conditions and have been reported from a wide range of soils including sand, volcanic loam and those on limestone and andesite. Individual species have been found in a wide range of ecological conditions: near streams or on ridges, in both dipterocarp forest and kerangas.

Silviculture *Meliosma* may be raised from seed. About 75% of seed of *M. sumatrana* germinated in 36–51 days after sowing.

Genetic resources and breeding The very limited utilization of *Meliosma* for timber will probably not affect its genetic variation.

Prospects It is not expected that the use of *Meliosma* timber will increase.

Literature 163, 172, 179, 181, 198, 260, 267, 341, 343, 436, 543, 829, 831, 974, 1038, 1116, 1221, 1274.

Selection of species

Meliosma lanceolata Blume

Synonyms *Meliosma levis* King, *Meliosma nervosa* Koord. & Valeton, *Meliosma polyptera* Miq.

Vernacular names Indonesia: kabung kabung (Batak, Sumatra), ki suren leuweung, ki tiwu (Sundanese). Malaysia: medang siri (Peninsular). Thailand: soi mole (peninsular).

Distribution The Nicobar Islands, Burma (Myanmar), peninsular Thailand, Peninsular Malaysia, Singapore, Sumatra, West Java and Borneo.

Meliosma pinnata (Roxb.) Maxim.

Synonyms *Meliosma arnottiana* (Wight) Walp., *Meliosma ferruginea* Blume, *Meliosma ridleyi* King.

Vernacular names Indonesia: gempong (Javanese), ki tiwu lalaki (Sundanese), sekapong (Takengon, Sumatra). Philippines: agosos (Tagalog), arokong (Igorot), mungapong (Bikol). Burma (Myanmar): pet-kanon. Thailand: mayom hin, phayom dong (northern). Vietnam: ch[af]nh ch[af]nh, n[aa]y tr[aw]n, ph[oor]i b[of].

Distribution From Sri Lanka and India to Burma (Myanmar), China and Japan, Thailand, and throughout the Malesian region, east to New Britain.

Meliosma rufopilosa Hend.

Vernacular names Malaysia: sengkuang (Peninsular).

Distribution Peninsular Malaysia and Borneo (Sabah, Sarawak).

Meliosma sumatrana (Jack) Walp.

Synonyms *Meliosma cuspidata* Blume, *Meliosma nitida* Blume, *Meliosma philippinensis* Merr. & L.M. Perry.

Vernacular names Indonesia: ki tiwu (Sundanese), si paturut (Karo, Sumatra), tambalilin (Dayak, Kalimantan). Malaysia: bulu manuk (Iban, Sarawak), gapas-gapas (Dusun, Sabah), mengading besar (Peninsular). Philippines: bentinguasay (Zamboanga), kadabudabo (Manobo), sumagasa (Bagobo). Vietnam: da t[oo]ng, ph[awr]ng tia.

Distribution Peninsular Malaysia, the Anambas Islands, Sumatra, western Java, Borneo, Sulawesi and the Philippines (Mindanao, Palawan).

E. Boer (general part),
M.S.M. Sosef (general part, selection of species)

Memecylon L.

Sp. pl. 1: 349 (1753); Gen. pl., ed. 5: 481 (1754).
MELASTOMATACEAE
x = unknown; *M. edule*: $n = 7$, $2n = 24$, *M. caeruleum*: $2n = 24$

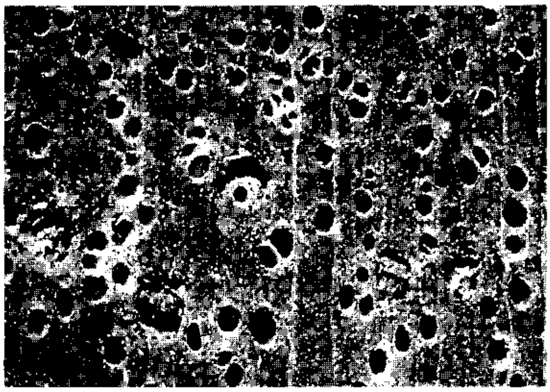
Vernacular names Brunei: gelam-gelam. Malaysia: nipis kulit (general), bangas, delek (Peninsular). Thailand: phlong.

Origin and geographic distribution *Memecylon* comprises about 300 species distributed in the Old World tropics, from tropical Africa to the whole of the Malesian region, northern Australia and the Pacific. Within Malesia some 80 species are found: 28 in Peninsular Malaysia, 18 in Sumatra, 12 in Java, 27 in Borneo, 4 in Sulawesi and 5 in the Moluccas. No up-to-date figures are available for the Philippines and New Guinea; each has some 20–30 species.

Uses The wood of *Memecylon* has been applied for local house building (e.g. poles, beams and rafters), temporary construction, ship and boat building, furniture, paddles, tool handles, rice pestles, anchors, household utensils and walking sticks. It also yields a good-quality charcoal and fuelwood.
The leaves of *M. caeruleum* are edible. The fruits of all species are edible with a sweet to sour taste, but the pericarp is generally thin. In India and Thailand a yellow dye has been obtained from leaves of *M. edule*, whereas a decoction of the leaves has been applied against gonorrhoea. The bark of the same species has been used for poulticing bruises. A decoction of the root of *M. dichotomum* has been used as a lotion for rheumatism and given internally after childbirth. Its leaves, pounded with cumin seeds and onions, have been used to poultice the head for vertigo, whereas the fruits stupefy fish.

Production and international trade There is no information on trade of the wood of *Memecylon*; utilization is probably on a local scale only.

Properties *Memecylon* yields a heavy hardwood with a density of 770–1150 kg/m^3 at 15% moisture content. Heartwood yellow-brown or brown to dark brown with a purplish tinge, not sharply demarcated from the sapwood; grain in-



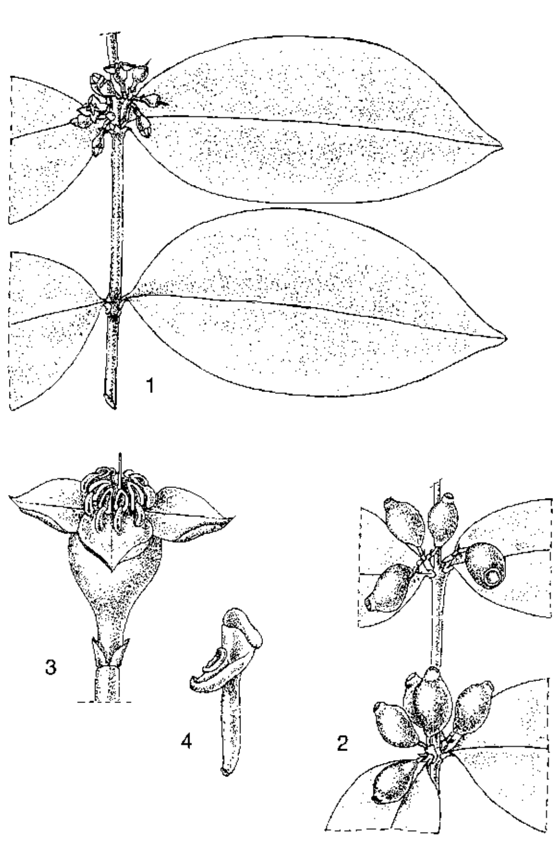
Memecylon sp.
transverse surface (×20)

terlocked and sometimes irregular; texture fine or moderately fine and uneven due to the islands of included phloem. Growth rings indistinct, occasionally distinct; vessels moderately small to medium-sized, solitary, in radial multiples of 2–3, or in clusters of 2–3, in oblique or tangential arrangement, open or some filled with dark-coloured solid deposits; parenchyma moderately abundant, paratracheal vasicentric, aliform and infrequently confluent, linking up several vessels, microscopically diffuse and diffuse-in-aggregates parenchyma is visible; rays of two distinct sizes, very fine to medium-sized, the broader ones visible to the naked eye; ripple marks absent; islands of included phloem scattered, in transverse section 2–3 times the area of a vessel.

Shrinkage upon seasoning is low to very high. Boards 13 mm and 38 mm thick take respectively 3.5–4 months and 5–6 months to air dry with slight bowing, twisting or end-checking and with moderate insect attack during drying. The wood is hard to very hard and strong. It is easy to work and saw, but saw teeth are rapidly blunted. Planing is difficult, especially the radial surface which has a tendency to pick up. The wood is durable under cover, but not durable when exposed to the weather or in contact with the ground. An absorption of 128–226 kg/m^3 was determined when treated in the open tank method with a mixture of 50% creosote and 50% fuel oil, the heartwood being almost impermeable and the sapwood very permeable in this test. The sapwood is very susceptible to Bostrychid borers but the heartwood is only slightly susceptible.

See also the tables on microscopic wood anatomy and wood properties.

Botany Shrubs or small to medium-sized trees, up to 25(–30) m tall; bole sometimes twisted, up to 100(–200) cm in diameter, often fluted, infrequently with buttresses; bark extremely thin, the surface very shallowly closely fissured or cracked, sometimes smooth and slightly scaly, grey or greyish-brown, inner bark thin, yellow or pinkish to orange or brown; branches terete or flattened, grooved, angled or winged. Leaves opposite, simple, entire, glabrous, with 1 main vein and straight or looping intramarginal veins, exstipulate. Flowers in an axillary or occasionally terminal cyme, sometimes paniculate or reduced to glomerules or umbels, 4-merous; calyx cup- to funnel-shaped with a truncate to shortly lobed margin; petals reflexed at anthesis and caducous after fertilization, white, pink, blue or purple; stamens 8, equal, anthers curved like a walking stick to crescent-shaped, opening with a vertical slit; ovary inferior and united with the calyx tube, unilocular with 2–20 ovules, style 1. Fruit a 1(–2)-seeded berry, ripening red, purplish or black, crowned by the persistent calyx, smooth or with 8



Memecylon edule Roxb. – 1, flowering twig; 2, fruiting twig; 3, flower; 4, stamen.

vertical grooves. Seedling with epigeal germination; cotyledons emergent and leafy; hypocotyl elongated; all leaves opposite.

M. edule develops according to Rauh's architectural tree model, determined by a monopodial trunk which grows rhythmically and so develops tiers of branches. The flowering-to-fruiting period of *Memecylon* sp. in a lowland dipterocarp forest in Peninsular Malaysia is about 13 weeks. The fruits are readily eaten and dispersed by birds, making it sometimes difficult to collect specimens with ripe fruits.

Memecylon belongs to the tribe *Memecyleae* within the subfamily *Memecyloideae*. The fairly common species *M. oligoneurum* Blume has recently been transferred to the genus *Lijndenia*; its correct name is *L. laurina* Zoll. & Moritzi.

Ecology *Memecylon* species are comparatively common, sometimes occurring gregariously in the lower part of the canopy of primary lowland to montane forest, up to 1800 m altitude. They are also found in freshwater and peat-swamp forest and kerangas. Some, e.g. *M. edule*, prefer more open forest or localities near the seashore.

Silviculture *Memecylon* can be propagated by seed. In germination trials in Peninsular Malaysia fruits of *M. cantleyi* Ridley had a germination of about 35% in 36–56 days, whereas 8 seeds of *M. intermedium* all germinated in 23–49 days.

Genetic resources and breeding *M. edule* is recorded in a germplasm collection in Malaysia at the Rimba Ilmu of the University of Malaya. As most *Memecylon* species are rather rare with a restricted geographic distribution, the destruction of their natural habitat is probably a much greater threat than their utilization for timber.

Prospects Although *Memecylon* timber is of fairly good quality, its utilization is restricted due to the often poor form of the trees and their scarcity.

Literature 70, 79, 140, 141, 151, 163, 209, 238, 267, 387, 436, 438, 464, 677, 678, 696, 750, 766, 785, 800, 810, 831, 861, 889, 933, 974, 988, 1038, 1151, 1169, 1221, 1242, 1250.

Selection of species

Memecylon acuminatum J.J. Smith

Distribution Peninsular Malaysia and Singapore.

Memecylon amplexicaule Roxb.

Synonyms *Memecylon microstomum* C.B. Clarke.

Vernacular names Malaysia: delek tembaga, pantat ulat (Peninsular).

Distribution Peninsular Thailand, Peninsular Malaysia and Singapore.

Memecylon caeruleum Jack

Synonyms *Memecylon caeruleum* Jack var. *floribundum* (Blume) Kurz, *Memecylon cordatum* Wallich, *Memecylon floribundum* Blume.

Vernacular names Malaysia: api-api hutan, delek-delek jambu, delek jambu putih (Peninsular). Burma (Myanmar): thabye-on. Thailand: phlong khee khwai, phlong khee tai (south-western), phlong khee nok (northern).

Distribution Burma (Myanmar), Indo-China, Thailand, Peninsular Malaysia, Singapore, Sumatra, Java, the Anambas Islands and New Guinea.

Memecylon campanulatum C.B. Clarke

Synonyms *Memecylon cephalantum* Ridley, *Memecylon multiflorum* Bakh. f.

Vernacular names Indonesia: liuh fatuh (Simeuluë), temberas nasi (Palembang, Sumatra).

Distribution Peninsular Malaysia, Sumatra and Borneo.

Memecylon dichotomum (C.B. Clarke) King

Synonyms *Memecylon curtisii* Burkill & Hend., *Memecylon eugeniiflora* Ridley, *Memecylon gracilipes* Ridley.

Vernacular names Malaysia: bangas putih, delek ayer, delima burong (Peninsular).

Distribution Peninsular Thailand and Peninsular Malaysia.

Memecylon edule Roxb.

Synonyms *Memecylon globiferum* Wallich.

Vernacular names Malaysia: delek air, delek bangas, kuku baning (Peninsular). Burma (Myanmar): me-byaung. Laos: 'muat ê, 'sa long[1] khong. Thailand: miat (north-eastern), phlong dam (south-western), phlong mueat (central).

Distribution Widespread from India and Sri Lanka to Burma (Myanmar), Indo-China, Thailand, Peninsular Malaysia, Singapore, Sumatra, Java and Borneo.

Memecylon excelsum Blume

Synonyms *Memecylon elmeri* Merr., *Memecylon heteropleurum* Blume, *Memecylon subtrinervium* Miq.

Vernacular names Indonesia: liuh alafai, liuh falah (Simeuluë), liuh payo (Siberut). Malaysia: jambu baning, kuku baning (Peninsular).

Distribution The Nicobar Islands, Peninsular Malaysia, Sumatra, Java and Borneo (Sabah, Sarawak).

Memecylon floridum Ridley

Distribution Peninsular Malaysia, Singapore and Borneo (Brunei, Sarawak).

Memecylon garcinioides Blume

Synonyms *Memecylon eurhynchum* Miq., *Memecylon heyneanum* Benth.

Vernacular names Indonesia: ki kawat (Sundanese), temberas talang, timbras kemuning (Sumatra). Malaysia: bangas merah, jenitan, sial menahun (Peninsular).

Distribution Peninsular Thailand, Peninsular Malaysia, Sumatra, Java and Borneo.

Memecylon intermedium Blume

Vernacular names Indonesia: ketam (Sumatra), ki jangkar, ki kajeru (Sundanese).

Distribution Peninsular Malaysia, Sumatra, Java and Borneo (Sabah, Sarawak).

Memecylon lilacinum Zoll. & Moritzi

Synonyms *Memecylon laevigatum* Blume, *Memecylon myrsinoides* Blume, *Memecylon pseudonigrescens* Blume.

Vernacular names Indonesia: pea-pea (Sulawesi), temenges (Sumatra). Malaysia: delik, tengading (Peninsular). Thailand: kamcham, phlong bai iat, phlong kaem on (peninsular).

Distribution Burma (Myanmar), Indo-China, Thailand, Peninsular Malaysia, Singapore, Sumatra, Java, Borneo, the Philippines, Sulawesi and the Lesser Sunda Islands (Lombok).

Memecylon minutiflorum Miq.

Vernacular names Indonesia: kalet bunga tanjung (Sumatra). Malaysia: bangas merah, pokok liyok, sedanwai hitam (Peninsular).

Distribution Peninsular Thailand, Peninsular Malaysia, Singapore, Sumatra and Borneo (Sabah, Sarawak).

Memecylon oleifolium Blume

Synonyms *Memecylon ambiguum* Blume, *Memecylon horsfieldii* Miq.

Vernacular names Indonesia: geah anda (Sumatra), pundah (Sumba). Malaysia: delek puteh (Peninsular). Burma (Myanmar): taungzon-inpet. Thailand: phlong khao (peninsular).

Distribution Burma (Myanmar), Thailand, Peninsular Malaysia, Singapore, Sumatra, Java, Borneo and the Lesser Sunda Islands (Sumba).

Memecylon paniculatum Jack

Synonyms *Memecylon caloneuron* Miq., *Memecylon costatum* Miq., *Memecylon venosum* Merr.

Vernacular names Indonesia: kayu tulang (Sumatra), ki jambe (Sundanese), liuk (Tapah, Simeuluë). Malaysia: api-api bukit, kayu kapas. Philippines: gikayan (Lanao, Manobo), pasagit (Tagalog).

Distribution Thailand, Peninsular Malaysia, Singapore, Sumatra, Java, Borneo, the Philippines, Sulawesi and the Moluccas.

Memecylon pubescens (C.B. Clarke) King

Synonyms *Memecylon grande* Retz. var. *pubescens* C.B. Clarke.

Distribution Peninsular Thailand, Peninsular Malaysia, Singapore and Borneo (Sarawak, Kalimantan).

Memecylon schraderbergense Mansf.

Distribution Papua New Guinea.

Memecylon schumannianum Mansf.

Distribution Papua New Guinea.

Noorma Wati Haron

Merrillia Swingle

Phil. Journ. Sc., Bot. 13: 337 (1919).

RUTACEAE

x = unknown; $2n$ = unknown

Vernacular names Malay lemon (En). Indonesia: kemuning hutan (Sumatra). Malaysia: kemuning gajah, kemuning limau, keteng(g)ah (Peninsular). Thailand: ka-ting-ka, kaeo khe khwai (peninsular).

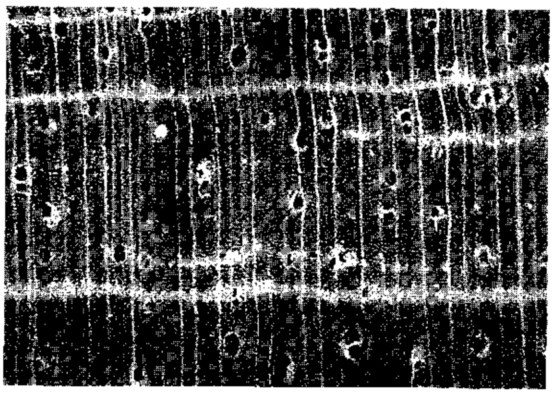
Origin and geographic distribution *Merrillia* is a monotypic genus occurring in southern Burma (Myanmar), peninsular Thailand, Peninsular Malaysia, Sumatra and Borneo (Sabah). The only species is *M. caloxylon* (Ridley) Swingle (synonym: *Murraya caloxylon* Ridley). In Peninsular Malaysia and Singapore it is occasionally planted in villages for its timber.

Uses The wood of *Merrillia* is used for kris handles and sheaths, walking-sticks, and other small fancy articles like pipes, amulets and rings. It has also been applied for making furniture and boxes. An infusion of the wood is applied medicinally for stomach-ache, whereas powdered wood is rubbed on the skin against aches and pains.

Production and international trade The wood of *M. caloxylon* is used rarely and on a local scale only, but it fetches high prices and is sold by the piece.

Properties *M. caloxylon* yields a heavy hardwood with a density of 890–930 kg/m^3 at 15% moisture content. Heartwood red-brown with black streaks, clearly differentiated from the up to 5 cm wide, white to golden-yellow sapwood; grain straight or irregular; texture very fine and even. Growth rings visible to the naked eye, boundaries indicated by marginal parenchyma bands; vessels moderately small, solitary or in radial multiples of 2–3 or in small clusters, open or containing yellow gum-like and chalky white deposits; parenchyma abundant, paratracheal scanty, apotracheal in marginal or seemingly marginal bands, and diffuse but difficult to see even with a hand lens; rays very fine, visible only with a hand lens on transverse surface; ripple marks absent.

The wood is very strong and difficult to work. It is non-durable when in contact with the ground where it is serviceable for less than 1 year. However, the wood is durable under cover, which is more important as it is seldom applied in contact with the ground.



Merrillia caloxylon
transverse surface (×20)

The leaves and fruits contain alkaloids. The fruit juice yields the cytotoxic flavone eupatorin.

See also the table on microscopic wood anatomy.

Botany An evergreen, small to medium-sized, unarmed tree up to 20(–30) m tall; bole short, ridged, up to 50 cm in diameter, without buttresses; bark surface finely, somewhat reticulately fissured, brownish or greyish-yellow, inner bark fibrous, pale brownish; crown rather bushy. Leaves alternate, imparipinnate; leaflets 5–13, nearly opposite, entire, larger towards the apex, lowest ones stipule-like; rachis narrowly winged; stipules absent. Flowers axillary, 1 or 2 together, bisexual, slightly zygomorphic, 5-merous; calyx cup-like, small; petals free but forming a long tube, greenish-white; stamens 10, free, unequal; ovary superior, on a gynophore, 5(–6)-carpellate, carpels fused, each with 8–10 ovules, style slender, stigma capitate. Fruit a large lemon-shaped berry, yellow when ripe; pericarp thick, resinous. Seed lens-shaped, densely scaly; endosperm absent. Seedling with epigeal germination; cotyledons emergent, fleshy; hypocotyl elongated; first 2 leaves opposite, simple, subsequent ones alternate and with 5 or more, often alternate leaflets; leaflets minutely toothed.

In Peninsular Malaysia planted trees showed a mean annual diameter increment of 0.6–0.9 cm. Trees flower and fruit almost throughout the year, and often flowers and fruits are found simultaneously on the same tree.

Merrillia belongs to the subfamily *Aurantioideae* and is closely related to *Murraya*, especially to the section *Murraya*; this is also supported by chemotaxonomic data. The genera differ in the size and shape of their flowers and fruits.

Ecology *M. caloxylon* is found scattered in evergreen, primary or secondary rain forest, up to 400 m altitude. It occurs on stream banks, hills and ridges and is able to grow on various kinds of well-drained soils.

Silviculture *M. caloxylon* can be propagated by seed. In a germination experiment in Peninsular Malaysia about 75% of the seeds germinated in 23–73 days.

Genetic resources and breeding *M. caloxylon* is rare and is mentioned in the IUCN list of non-endemic threatened plants of Peninsular Malaysia for 1991. Except for a few individuals in botanic gardens, and its occurrence in small villages, there are no reports of active ex situ conservation.

Prospects The use of the attractive and valuable wood of *M. caloxylon* will probably remain at about the same low level. Its growth rate is probably too low to make it a promising plantation species.

Literature 5, 133, 163, 209, 267, 354, 472, 588, 829, 831, 832, 861, 864, 1048, 1082, 1221.

H.C. Ong

Metadina Bakh. f.

Taxon 19: 472 (1970).

RUBIACEAE

x = unknown; $2n$ = unknown

Vernacular names Indonesia: kayu kunyit, ki anggrit (Java), nangi kuning (Sumatra). Malaysia: berombong, meraga (Peninsular), mengkeniab (Sabah). Philippines: Zschokke adina (general). Thailand: khamin (northern), khem chang, lang khao (peninsular). Vietnam: v[af]ng v[es].

Origin and geographic distribution *Metadina* is a monotypic genus. The species *M. trichotoma* (Zoll. & Moritzi) Bakh. f. (synonyms: *Adina polycephala* Benth., *Adina zschokkei* Elmer, *Nauclea trichotoma* Zoll. & Moritzi) occurs in India, Burma (Myanmar), Cambodia, Vietnam, Thailand, Peninsular Malaysia, Sumatra, Java, Borneo and the Philippines.

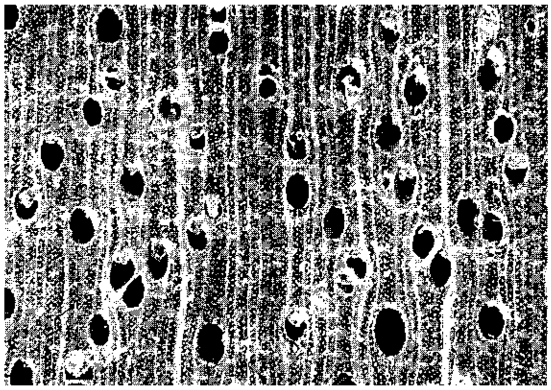
Uses The wood of *M. trichotoma* is used for house building (e.g. for planks), flooring, fence posts, joinery, turnery, tool handles and agricultural implements.

The bark is used as a tonic in local medicine in Indonesia and Thailand.

Production and international trade The timber of *M. trichotoma* is used only locally and supplies are too limited to be of importance.

Properties *M. trichotoma* yields a heavy hardwood with a density of 860–940 kg/m^3 air dry. Heartwood yellow, yellow-brown or orange-red, sharply or not sharply demarcated from the paler, 3–6 cm wide sapwood; grain straight, occasionally interlocked; texture fine and even. Growth rings indistinct, sometimes suggested by a narrow layer without parenchyma succeeded by a layer with more numerous vessels; vessels moderately small to medium-sized, almost exclusively solitary, but with occasional radial multiples of 2–3, open; parenchyma abundant, apotracheal diffuse and diffuse-in-aggregates, hardly visible with a hand lens; rays extremely fine to moderately fine; ripple marks absent.

The wood is hard and easy to work. It is very durable and remains serviceable as freshwater piles for 5–15 years, for 8–10 years as poles in the ground, for 15 years for boats and for 60–100 years for construction under cover.



Metadina trichotoma
transverse surface (×20)

See also the table on microscopic wood anatomy.

Botany A medium-sized to fairly large tree up to 40 m tall; bole straight, sometimes slightly fluted, up to 50 cm in diameter; bark surface smooth to finely fissured and flaky, greyish-brown, inner bark pink to red. Terminal vegetative bud pyramidal to conical. Leaves opposite, simple, entire, elliptical to obovate, acuminate; stipules overlapping, caducous. Flowers in numerous stalked heads borne terminally on 1–3 flowering axes which are each branched like a compound thyrse, 5-merous; interfloral bracteoles present; calyx with a short tube and persistent elliptical-oblong lobes; corolla hypocrateriform to narrowly funnel-shaped, with valvate lobes (but subimbricate at apex); stamens inserted in the upper part of the corolla tube; ovary inferior, 2-locular with 4–12 ovules in each cell, style exserted, stigma globose to clavate, smooth. Fruits in a head-like infructescence, free, splitting into 4 parts, with persistent central axis and calyx. Seed trigonal, slightly bilaterally compressed, not winged. Seedling with epigeal germination; cotyledons leafy; hypocotyl elongated.

Metadina is related to *Adina* and a group of 4 small 'satellite' genera (including *Adinauclea*, *Haldina* and *Pertusadina*) in the tribe *Naucleeae*. It is recognizable particularly by the pyramidal or conical terminal vegetative bud and the numerous flowering heads on a branched axis.

Ecology *M. trichotoma* occurs in primary forest, particularly in hilly and mountainous locations, up to 1300 m altitude. In most regions it is uncommon, and locally even rare (e.g. in Java).

Genetic resources and breeding *M. trichotoma* has a large area of distribution and does not seem to be endangered. However, it needs protection in regions where it is rare, such as Java.

Prospects The wood of *M. trichotoma* is used only locally and increased use for sawn timber is not very likely, as timber of large dimensions is rare. As the wood is hard and durable, however, research on its silviculture and propagation seems justified.

Literature 162, 163, 267, 436, 861, 943, 1165, 1221, 1242.

Isa Ipor

Mezzettia Becc.

Nuovo Giorn. Bot. Ital. 3: 187 (1871).

ANNONACEAE

$x = 7$; *M. parviflora*: $2n = 14$

Vernacular names Mempisang (trade name). Brunei: karai, kepayang babi. Malaysia: karai (Sabah), kepayang babi (Sarawak).

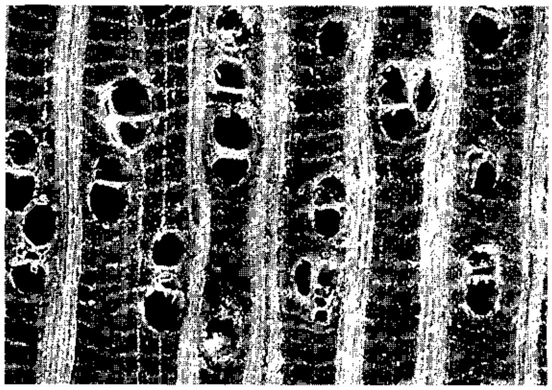
Origin and geographic distribution *Mezzettia* comprises 4 species and occurs in the Andaman Islands, peninsular Thailand, Peninsular Malaysia, Sumatra, Borneo and the Moluccas. All 4 are present within Malesia.

Uses The wood of *Mezzettia* is used for light construction, interior finish, planking, packing cases, matchboxes and splints, and crates. It also produces a good-quality sliced as well as rotary veneer and plywood, and is used as fuelwood.

The fibrous bark is occasionally used for making rope.

Production and international trade 'Mempisang' is a general trade name comprising most of the genera of *Annonaceae*, and *Mezzettia* probably comprises a fair proportion of the wood traded under this name. In 1992 the export of mempisang wood from Sabah amounted to 25 000 m^3 of sawn timber and 42 500 m^3 of logs with a total value of about US$ 7.2 million. Small amounts of mempisang are imported by Japan, mainly from Sabah and Sarawak.

Properties *Mezzettia* yields a lightweight to medium-weight hardwood with a density of 420–755 kg/m^3 at 15% moisture content. Heartwood yellow-brown, sometimes moderately sharply differentiated from the paler sapwood; grain straight; texture rather coarse and uneven; rays appear as orange-brown-coloured streaks. Growth rings usually indistinct, when distinct boundaries indicated by denser tissue; vessels medium-sized to moderately large, solitary and in radial multiples of 2–6, open; parenchyma abundant, apotracheal in regular, narrow bands (scalariform), and paratracheal scanty or vasicentric but indistinct; rays of 2 sizes, very fine few, and moderately broad to very broad; ripple marks absent.

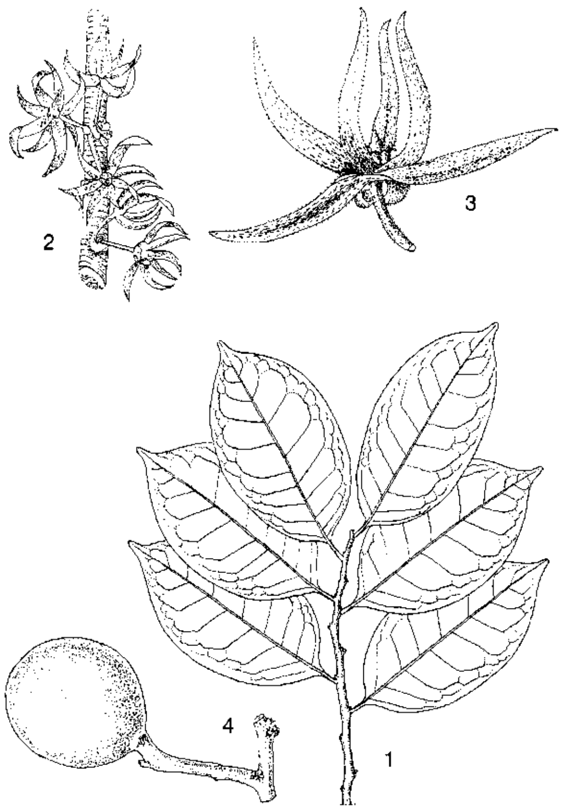


Mezzettia parviflora
transverse surface (×20)

Shrinkage upon air drying is high and the wood air dries very rapidly: 13 and 38 mm thick boards of *M. parviflora* take respectively 1.5 and 2 months to air dry. There is moderate risk of cupping, insect attack and stain and a slight risk of splitting during seasoning. The wood is moderately soft but fairly strong. It is easy to work. The wood is non-durable and susceptible to sap-stain, but apparently fairly resistant to insect attack when dry. Wood of *M. parviflora* absorbs copper-chrome-arsenic (CCA) preservatives readily when pressure treated, with an absorption of 430 kg/m^3. Extracts of wood from *Mezzettia* spp. have insecticidal properties: when the dry-wood termite *Cryptotermes cynocephalus* was exposed to filter paper treated with wood extracts, mortality was 55–75% after 8 weeks.

See also the tables on microscopic wood anatomy and wood properties.

Botany Evergreen, small to large trees up to 45 m tall; bole straight, cylindrical, branchless for up to 25 m, up to 80(–110) cm in diameter, sometimes fluted or with small buttresses up to 60 cm high; bark surface rough with irregular cracks, sometimes dippled, flaking off, grey to brown, inner bark fibrous, orange-brown, with a dark line between inner and outer bark. Leaves distichous, simple, entire, leathery, dull or glaucous below, exstipulate. Flowers in an axillary fascicle or umbel, bisexual; sepals 3, valvate, free or connate



Mezzetia parviflora Becc. - 1, sterile twig; 2, inflorescence; 3, flower; 4, fruit.

up to halfway; petals 6, in 2 whorls, valvate, the inner ones smaller than the outer, yellowish-green; stamens 9–21, in 2–3 whorls, connective dilated over the locules; carpel 1, with 2 superimposed ovules, tapering into the stigma. Fruit apocarpous, the single monocarp sessile or on a short stipe, globose to ellipsoid or obovoid, with a woody wall and (1–)2 seeds. Seed smooth, flattened on one side, with a hard testa. Seedling with epigeal germination; cotyledons not emergent; hypocotyl elongated; all leaves distichous; shoots plagiotropic.

Mezzettia retains its monopodial architecture even when mature. In Peninsular Malaysia *M. parviflora* is observed flowering and fruiting in mast fruiting years. The seeds are probably eaten and dispersed by monkeys.

Mezzettia can be readily distinguished from other *Annonaceae* genera by its single carpel with 2 ovules, but its relationship with other genera within this family remains uncertain.

Ecology *Mezzettia* species grow under perhumid conditions in evergreen, primary, lowland rain forest, up to 500(–1100) m altitude. They are usually found in dipterocarp forest or swamp forest on level land as well as on hills, often on peaty or podzolic, sandy soils. *M. parviflora* also occurs in kerangas.

Silviculture *Mezzettia* can be propagated by seed. Seeds of *M. parviflora* sown with or without adhering pulp show 15–20% germination in 2.5–4.5 months.

Genetic resources and breeding There are no records of *Mezzettia* in germplasm banks. As *Mezzettia* is not rare the risk of genetic erosion is probably low.

Prospects The good wood properties of *Mezzettia* for the production of veneer and plywood may hold some potential for the future.

Literature 14, 40, 151, 162, 163, 267, 387, 436, 445, 468, 543, 678, 707, 761, 829, 831, 861, 863, 1017, 1038, 1098, 1119, 1126, 1134, 1214, 1221, 1242.

Selection of species

Mezzettia havilandii (Boerl.) Ridley

Synonyms *Mezzettia parviflora* Becc. var. *havilandii* Boerl.

Vernacular names Indonesia: hakai rawang, tetapa itam (Sumatra).

Distribution Sumatra and Borneo.

Mezzettia macrocarpa v.d. Heijden & Kessler

Distribution Borneo (Brunei, Sabah, Sarawak).

Mezzettia parviflora Becc.

Synonyms *Mezzettia curtisii* King, *Mezzettia herveyana* Oliv., *Mezzettia leptopoda* (Hook. f. & Thomson) Oliv.

Vernacular names Indonesia: bayut batu (Fatuk, Sumatra), empanyit selapatan (Dayak, Kalimantan), foki-foki (Ternate). Malaysia: bongkoi (Sabah), kepayang burong (Malay, Sarawak). Thailand: hua tao (peninsular).

Distribution The southern Andaman Islands, peninsular Thailand, Peninsular Malaysia, Sumatra, Borneo and the Moluccas.

Mezzettia umbellata Becc.

Synonyms *Mezzettia pauciflora* Ridley.

Vernacular names Indonesia: sariwaka (Kalimantan).

Distribution Borneo; possibly also in Peninsular Malaysia.

E. Boer (general part),
M.S.M. Sosef (general part, selection of species)

Michelia L.

Sp. pl. 1: 536 (1753); Gen. pl., ed. 5: 240 (1754).
MAGNOLIACEAE

x = 19; *M.* ×*alba* DC., *M. champaca*, *M. figo* (Lour.) Spreng., *M. montana*, and many other non-Malesian species: $2n$ = 38

Vernacular names Chempaka (trade name). Indonesia: cempaka (trade name). Malaysia: champaka (Peninsular, Sabah). Philippines: champaka (general). Burma (Myanmar): safan, sagah, sagawa. Laos: cham pa. Thailand: champa. Vietnam: gi[ows]i, ng[oj]c lan, su.

Origin and geographic distribution *Michelia* comprises about 30 species and is distributed from Sri Lanka and India towards the Himalayas, Indo-China, China, southern Japan, Taiwan, Thailand, Peninsular Malaysia, Sumatra, Java, Borneo, the Philippines and the Lesser Sunda Islands. Some species are commonly cultivated throughout the tropics. Within Malesia 7 species are native.

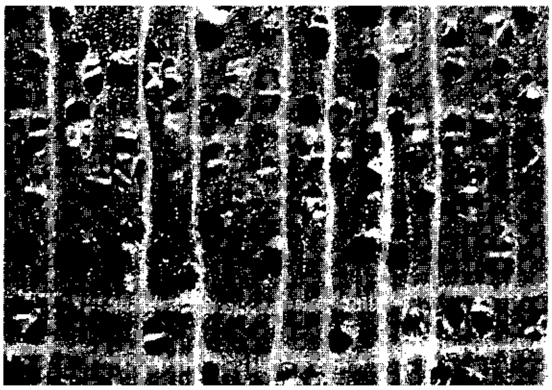
Uses *Michelia* wood is used for general light construction, bridge building, flooring, door panels, vehicle bodies, packing cases and formerly also for battery separators. The nicely figured wood of *M. champaca* is particularly used for furniture and cabinet work, carvings, turnery and pattern making. *Michelia* has also been used for the production of veneer and plywood, sometimes as a substitute for 'American whitewood' (*Liriodendron tulipifera* L.), cement-bonded wood-wool board, and as firewood. The wood may be suitable for the production of hardboard.

In West Java *M. champaca* is used to reforest badly eroded areas, and is suitable as a wayside tree in low-traffic areas. *M. champaca* and *M.* ×*alba* are often cultivated for ornamental purposes, also near temples. Their fragrant flowers yield an essential oil used as a perfume though with a different odour, and in India and Indonesia the flowers are used in religious ceremonies, in Bali e.g. in the 'Ngaben' ceremony. The seed oil of *M. champaca* shows antibacterial activity. Its leaves are used to feed silkworms. A decoction of the bark and sometimes also of the leaves of *M. champaca* is commonly given after childbirth. The bark is also used as a febrifuge. In Burma (Myanmar) the flowers are used to treat leprosy and the leaves for colic.

Production and international trade 'Chempaka' is a general trade name which apart from *Michelia* wood includes wood of *Elmerrillia* (usually), *Magnolia* and *Manglietia*. Small amounts of chempaka are imported by Japan from Sabah and Sarawak. Supplies are limited and in 1992 only about 900 m³ of chempaka timber with a value of about US$ 87 000 were exported from Sabah. The flowers are marketed locally.

Properties *Michelia* yields a medium-weight or occasionally lightweight hardwood with a density of (310–)460–695 kg/m³ at 15% moisture content. Heartwood olive-brown turning to dark brown with a greenish tinge upon exposure, clearly differentiated from the pale brown, up to 8 cm wide sapwood; grain straight or slightly interlocked; texture fine to moderately fine and even; wood slightly greasy to the touch, sometimes with camphor-like odour. Growth rings distinct, boundaries indicated by marginal parenchyma; vessels moderately small to medium-sized, solitary and in radial multiples of 2–5, usually open; parenchyma sparse, apotracheal in marginal bands; rays very fine to moderately fine, oil cells at the margins of the rays sometimes visible with a hand lens; ripple marks absent.

Shrinkage upon air drying is very low. In Peninsular Malaysia the wood air dries without degrade, but insect attack may be severe during seasoning. It takes about 2 and 4 months, respectively, to air dry boards 13 mm and 38 mm thick. In India it has been recommended to ring girdle *M. champaca* trees about 3 years before felling and conversion to prevent possible warping and checking of the wood. The wood is soft to moderately



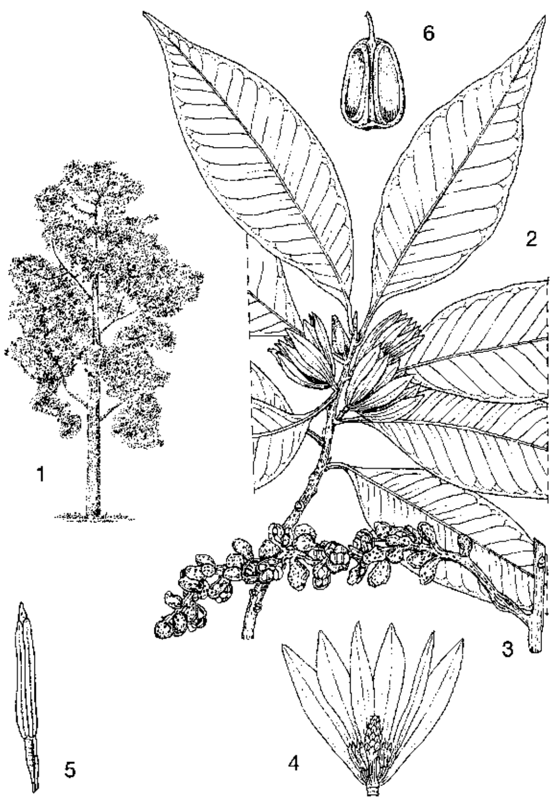
Michelia champaca
transverse surface (×20)

hard and of low to moderate strength. It can be worked easily, but occasional specimens of *M. philippinensis* have hard chalky deposits which dull cutting edges. The wood is non-durable to moderately durable depending on species and provenance. The wood of *M. montana* is reportedly very resistant to fungal attack. The heartwood is resistant to dry-wood termites and refractory to treatment with preservatives. The sapwood is considered to be non-susceptible to *Lyctus*.

The gross energy value of the heartwood of *M. champaca* is about 21 070 kJ/kg. The mean fibre length of *M. champaca* is 1.560–1.590 mm and of *M. montana* 1.710 mm.

See also the tables on microscopic wood anatomy and wood properties.

Botany Evergreen or semi-deciduous, small to large trees up to 50 m tall; bole straight, cylindrical, up to 200 cm in diameter, without buttresses; bark surface smooth, grey to greyish-white, inner bark fibrous, yellow to brown; crown conical to cylindrical. Leaves arranged spirally, simple, entire; stipules adnate to or free from the petiole. Flowers on short, axillary brachyblast, solitary or rarely in pairs, large; tepals 6–21, in 3–6 usually subequal whorls, white to yellow; stamens many, anthers with a short to prominently elongated connective; gynoecium stipitate, with few–many, spirally arranged, free or connate carpels containing 2–many ovules. Fruiting carpels dehiscing along the dorsal suture when free or fused and forming a fleshy or woody syncarp. Seed hanging from its funicle. Seedling with epigeal germination; cotyledons emergent, leafy; hypocotyl elongated; all leaves arranged spirally.



Michelia champaca L. – 1, tree habit; 2, flowering twig; 3, infructescence; 4, sectioned flower; 5, stamen; 6, seed.

Growth form is according to Roux's architectural tree model, characterized by a continuously growing monopodial orthotropic trunk with plagiotropic branches. Vesicular-arbuscular mycorrhizae have been observed on *M. champaca* roots in India. In Java the mean annual increment of 10–27-year-old *M. champaca* trees is 1.0–1.8 m in height and 1.5–2.0 cm in diameter, the corresponding figures for almost 10-year-old *M. montana* trees in East Java are 1.3 m and 2.9 cm respectively. *M. ×alba*, *M. champaca*, *M. koordersiana* and *M. montana* flower and fruit throughout the year, *M. philippinensis* in January and February, *M. salicifolia* in March and July, and *M. scortechinii* in April–May. The flowers are protogynous and pollinated by beetles which feed on the stigmas, pollen, nectar and secretion of the petals.

Michelia belongs to the tribe *Michelieae* and is closely related to *Elmerrillia* which differs in having a sessile gynoecium. *M. ×alba* has probably arisen by hybridization between *M. champaca* and *M. montana*. It only rarely produces fruit and is unknown in the wild.

Ecology *Michelia* is found scattered in primary lowland to montane rain forest, up to 2100 m altitude. The absolute maximum temperature for *M. champaca* is 35–40°C, the absolute minimum temperature 3–10°C.

Silviculture *Michelia* can be propagated by seed. For ornamental purposes it is also propagated by various vegetative techniques. *M. champaca* has 10 000–29 500 dry seeds/kg and *M. montana* about 1900 dry fruitlets/kg. Seeds should be dried in the shade; they lose their viability very fast, often within 2 weeks. Seed viability can be maintained by moist storage at 5°C for about 7 months or by storage in pits at 13°C for about 4 months. Seed should be sown in the shade, but shade should be removed after germination. Before sowing, the seeds may be treated with insecticide, as they are susceptible to insect attack. Seedlings of

12–15 months old are usually made into stumps with a diameter of at least 1.5 cm before planting in the field. *M. champaca* requires moist, deep and fertile soils and is a moderate light-demander. In Java it is planted at 3 m × 2.5–3 m but the open canopy makes weed control or planting of cover crops necessary. Although planted *M. montana* grows very fast, the stem is crooked. *M. champaca* can attain an annual increment of 20–25 m^3/ha during the first 10 years. A rotation of 50 years is recommended to produce sawn timber. *M. champaca* is susceptible to fire; it coppices well. Moreover, it is intolerant of air pollution when planted as a roadside tree.

Genetic resources and breeding In Arunachal Pradesh, India a germplasm bank with 33 clones and 2 seed orchards with 25 clones each of *M. champaca* have been established.

Prospects The favourable wood properties and fairly fast growth as observed in a few trials suggest that *M. champaca* is promising for increased use. Although it is commonly cultivated, more information needs to be obtained on its silvicultural aspects through research.

Literature 9, 40, 70, 99, 101, 103, 104, 129, 150, 161, 163, 170, 193, 198, 209, 218, 222, 235, 258, 259, 260, 261, 267, 306, 341, 387, 402, 405, 406, 427, 436, 464, 480, 706, 758, 822, 829, 850, 861, 882, 908, 920, 933, 934, 974, 1038, 1052, 1089, 1095, 1098, 1169, 1177, 1198, 1199, 1221, 1242.

Selection of species

Michelia ×alba DC.

Synonyms *Michelia longifolia* Blume.

Vernacular names White chempaka (En). Indonesia: cempaka putih (general), campaka bodas (Sundanese), kantil (Javanese). Malaysia: chempaka gading, chempaka puteh (Peninsular). Philippines: champakang puti (Filipino). Laos: cham pi. Thailand: champee (general). Vietnam: ng[oj]c lan tr[aws]ng.

Distribution Commonly cultivated in tropical and subtropical regions, probably throughout Malesia.

Michelia champaca L.

Synonyms *Michelia pilifera* Bakh. f., *Michelia velutina* auct. non DC.

Vernacular names Orange chempaka (En). Indonesia: cempaka kuning (general), capaka (Halmahera), cempaka (Javanese). Malaysia: champaka (Sabah), chempaka, chempaka merah (Peninsular). Philippines: champaca (general). Burma (Myanmar): mawk-sam-lung. Laos: cham pa. Thailand: champa (general), champa khao, champa pa (peninsular). Vietnam: ng[oj]c lan.

Distribution From India and Burma (Myanmar) to Indo-China, Thailand, Peninsular Malaysia, Sumatra, Java and the Lesser Sunda Islands; possibly native only to India, now commonly cultivated throughout the tropics.

Michelia koordersiana Noot.

Vernacular names Indonesia: medang bamban, medang kemit (Sumatra).

Distribution Peninsular Malaysia and Sumatra.

Michelia montana Blume

Synonyms *Michelia ecicatrisata* Miq.

Vernacular names Mountain chempaka (En). Indonesia: cempaka hutan (Sumatra), cempaka jahe (Indonesian, Java), manglid (Sundanese). Malaysia: cempaka hutan (Sabah).

Distribution Peninsular Malaysia, Sumatra, Java, Borneo and Bali.

Michelia philippinensis (P. Parm.) Dandy

Synonyms *Magnolia philippinensis* P. Parm., *Michelia cumingii* Merr. & Rolfe.

Vernacular names Philippines: adagan (Iloko), sandit (Tagalog).

Distribution The Philippines.

Michelia salicifolia Agostini

Synonyms *Michelia sumatrae* Dandy.

Distribution Sumatra.

Michelia scortechinii (King) Dandy

Synonyms *Manglietia scortechinii* King, *Paramichelia scortechinii* (King) Dandy.

Distribution Peninsular Malaysia and Sumatra.

U.A. Dasuki

Microcos L.

Sp. pl. 1: 514 (1753); Gen. pl., ed. 5: 230 (1754).

TILIACEAE

x = unknown; $2n$ = unknown

Vernacular names Malaysia: chenderai (general), bunsi (Iban, Sarawak), damak-damak (Peninsular). Burma (Myanmar): myat-ya. Thailand: lai, yap.

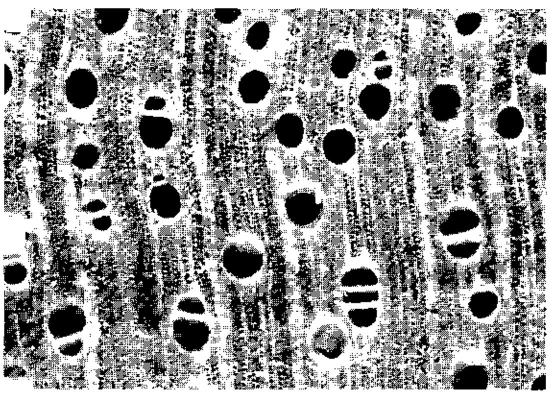
Origin and geographic distribution *Microcos* comprises about 40 species occurring in tropical Africa, Sri Lanka, India, Burma (Myanmar), Indo-China, southern China, Hainan, Thailand and throughout the Malesian archipelago (not yet reported from Sulawesi and the Lesser Sunda Islands). Within Malesia some 35 species are found with 2 centres of diversity, one in western Malesia (Peninsular Malaysia, Sumatra and Borneo) and one in eastern Malesia (New Guinea).

Uses The wood of *Microcos* is used for general construction under cover (e.g. rafters) and also for small objects where strength and elasticity are required like tool handles, agricultural implements, sporting goods, billiard cues and vehicle bodies. The wood may be suitable for pulping and has been used for fuel.

Rope can be manufactured from the fibrous bark. The fruits of most species are reported as edible. The resin from the bark is traditionally used as a fuel. The pulped bark is used in Papua New Guinea to stupefy fish.

Production and international trade Utilization of the wood of *Microcos* is on a local scale only.

Properties *Microcos* yields a lightweight to medium-weight hardwood with a density of 290–840 kg/m^3 at 15% moisture content. Heartwood pale red to pale brown or pale pink-brown, often becoming grey-brown on exposure, not differentiated from the paler sapwood; grain slightly interlocked, sometimes spiral or straight; texture fine to moderately fine and even; wood with slight watered-silk figure on tangential surface. Growth rings distinct, marked by bands of dense wood with relatively few or no vessels; vessels moderately small to medium-sized, solitary and in radial multiples of 2–4(–more), also in clusters, solitary vessels usually oval, deposits scanty; parenchyma abundant, predominantly apotracheal diffuse and diffuse-in-aggregates, visible with a hand lens, also apotracheal in marginal or in seemingly marginal bands and paratracheal scanty; rays very fine to moderately fine, the broader ones visible to the naked eye, conspicuous on radial surface; normal ripple marks absent but fibres and wood parenchyma arranged in horizontal storeys of two different heights producing faint ripple-like marks.



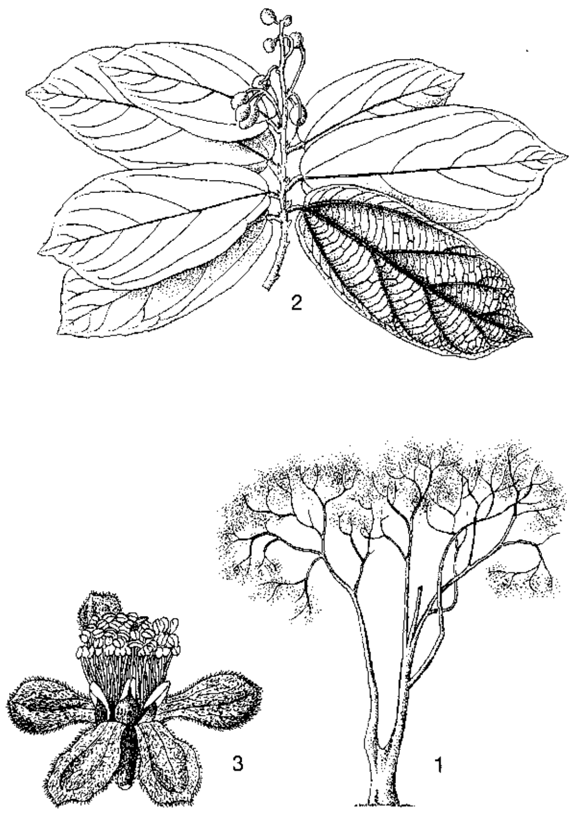
Microcos argentata
transverse surface (×20)

The wood seasons well, but is susceptible to sapstain. It is moderately hard to hard, moderately strong and tough. It works and finishes very well. The wood is non-durable when exposed to the weather or in contact with the ground, probably less durable than *Grewia* timber. The heartwood and sapwood are susceptible to dry-wood termites. The sapwood is susceptible to *Lyctus*.

See also the table on microscopic wood anatomy.

Botany Evergreen or deciduous shrubs or small to medium-sized trees up to 30 m tall; bole usually straight, up to 60(–70) cm in diameter, sometimes fluted at base, sometimes with small buttresses; bark surface smooth to scaly, sometimes lenticellate, green or grey-green or green-brown, inner bark fibrous, red-brown to orange-yellow or even paler and then streaked red. Indumentum of stellate and simple hairs. Leaves alternate, simple, 3- or 5-veined from the base, entire or minutely serrate, sometimes slightly lobed; stipules entire or divided. Inflorescence usually terminal or sometimes axillary in the upper leaf axils, composed of paniculately arranged triads preceded by often 3-fid bracts. Flowers 5-merous; petals absent or up to half as long as the sepals and caducous; stamens many, on a raised torus; ovary superior, (1–)3(–5)-locular with (2–)4–8 ovules in each cell; style subulate. Fruit a fleshy or pulpy drupe, globose to pear-shaped, with 1–4 pyrenes containing 1–2 seeds. Seedling with epigeal germination; cotyledons emergent, leafy; hypocotyl elongated; all leaves alternate or sometimes the first pair subopposite.

In Thailand several species flower and bear fruit for about 3 months in the period between January and September. In Java *M. tomentosa* can be found flowering throughout the year. In Papua New Guinea *M. argentata* flowers in July. In *M. laurifolia* the period from anthesis to fruit-ripening is about 2 months. The fruits are dispersed by animals.



Microcos tomentosa J.E. Smith – 1, tree habit; 2, fruiting twig; 3, flower.

There is disagreement about whether *Microcos* should be united with the genus *Grewia* or kept separate. The main differences between the two are the subulate stigma, the terminal paniculate inflorescence, the involucral bracts and the unlobed fruit of *Microcos* versus the thickened or lobed stigma, the often axillary inflorescence, the absence of involucral bracts and the usually lobed fruit of *Grewia*. *Microcos* has been divided into 2 subgenera: *Microcos* and *Eumeriandra* Burret. The former is confined to continental Asia and western Malesia, the latter to the Moluccas and New Guinea.

Ecology The timber-yielding species of *Microcos* are locally abundant in primary and secondary, deciduous to evergreen, lowland dipterocarp rain forest, but also in thickets and hedges, up to 1000 m altitude. They are found in plains as well as on hill slopes on a range of soils, from clayey to sandy. *M. antidesmifolia* and *M. grandiflora* are also found in freshwater swamps and along river banks. *M. blattifolia* is also found in kerangas, particularly in waterlogged areas.

Silviculture *Microcos* can be raised from seed. Sown fruits of *M. blattifolia* show about 70% germination in 2.5–8.5 months and those of *M. laurifolia* about 65% in 1–2.5 months. *M. paniculata* coppices easily but is not resistant to fire. In the Philippines a brown leaf-spot disease caused by *Phyllosticta microcosi* has been observed causing only slight damage.

Genetic resources and breeding As the timber-yielding *Microcos* species are locally abundant the risk of genetic erosion is low.

Prospects Locally, the utilization of *Microcos* wood for its toughness (e.g. for tool handles) will probably remain important, but the comparatively small tree size and scattered occurrence would deter an increase in its importance as a timber. *M. paniculata* may be suitable for afforestation in the dry zones of the Lesser Sunda Islands.

Literature 61, 70, 161, 164, 188, 209, 218, 267, 438, 464, 576, 595, 694, 772, 780, 829, 830, 831, 861, 887, 934, 955, 974, 1038, 1039, 1164, 1169, 1221, 1222, 1232, 1242.

Selection of species

Microcos antidesmifolia (King) Burret

Synonyms *Grewia antidesmifolia* King.

Vernacular names Malaysia: chenderai (Peninsular).

Distribution Peninsular Malaysia and Borneo (Sarawak).

Microcos argentata Burret

Distribution Papua New Guinea.

Microcos blattifolia (Corner) Rao

Synonyms *Grewia blattifolia* Corner, *Grewia latifolia* Mast., *Microcos latifolia* (Mast.) Burret.

Vernacular names Malaysia: damak-damak (Peninsular).

Distribution Peninsular Malaysia and Borneo (Brunei, Sarawak).

Microcos cinnamomifolia Burret

Synonyms *Grewia cinnamomifolia* (Burret) Stapf ex Ashton.

Distribution Borneo.

Microcos fibrocarpa (Mast.) Burret

Synonyms *Grewia fibrocarpa* Mast., *Microcos reticulata* Ridley.

Vernacular names Malaysia: asam damat (Peninsular), kerudong (Dusun, Sarawak). Thailand: phla khon (general).

Distribution Peninsular Thailand, Peninsular Malaysia and Borneo.

Microcos florida (Miq.) Burret

Synonyms *Grewia florida* Miq.

Distribution Sumatra.

Microcos grandiflora Burret

Distribution Papua New Guinea.

Microcos lanceolata (Miq.) Burret

Synonyms *Grewia miqueliana* Kurz.

Distribution Peninsular Malaysia and Sumatra.

Microcos laurifolia (Hook. ex Mast.) Burret

Synonyms *Grewia florida* Gagnep. non Miq., *Grewia laurifolia* Hook. ex Mast.

Vernacular names Thailand: phla som (peninsular).

Distribution Peninsular Thailand, Peninsular Malaysia and Borneo (Sarawak).

Microcos ledermannii Burret

Distribution New Guinea.

Microcos paniculata L.

Synonyms *Grewia microcos* L., *Grewia ulmifolia* Roxb.

Vernacular names Laos: khom. Thailand: ka phla (peninsular), khom (northern), laai (central). Vietnam: bung lai, m[es].

Distribution Sri Lanka, India, Burma (Myanmar), Indo-China, southern China, Thailand and the Lesser Sunda Islands (Timor).

Microcos stylocarpa (Warb.) Burret

Synonyms *Grewia stylocarpa* Warb., *Microcos havilandii* Ridley.

Vernacular names Brunei: damak damak. Malaysia: damak damak (Sarawak), kerudong (Sungei, Sarawak). Philippines: kamuling (general), namot (Iloko), porong (Mindoro).

Distribution Borneo and the Philippines.

Microcos tomentosa J.E. Smith

Synonyms *Grewia blumei* Hassk., *Grewia cumingiana* Turcz., *Grewia paniculata* Roxb. ex DC.

Vernacular names Indonesia: talok (general), darowak (Sundanese), dluwak (Javanese). Malaysia: chenderai, chenerah, jenerai (Peninsular). Laos: khom som. Thailand: khom kliang (south-eastern), khom som (north-eastern), phla lai (peninsular). Vietnam: c[of] ke.

Distribution Burma (Myanmar), Indo-China, Thailand, Peninsular Malaysia, Sumatra and Java.

E. Boer (general part),
M.S.M. Sosef (general part, selection of species)

Miliusa Lesch. ex A. DC.

Mém. Soc. Phys. Genève 5: 213, t. 3 (1832).

ANNONACEAE

$x = 9$; *M. globosa* (A. DC.) Panigrahi & S.C. Mishra: $2n = 18$

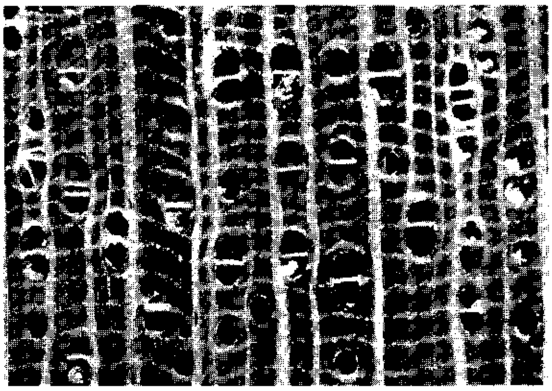
Vernacular names Mempisang (trade name).

Origin and geographic distribution *Miliusa* comprises about 40 species occurring from India and Sri Lanka to Indo-China, southern China, Thailand, Peninsular Malaysia, Borneo, the Philippines, New Guinea and Australia. Most of the species are found in Indo-China; only 8 occur within the Malesian region.

Uses The wood of *Miliusa* is suitable for light construction, furniture and cabinet work, carvings, tool handles, shafts, axles, oars, packing cases and crates. It is also used as firewood.

Production and international trade As the trees are generally small, the wood of *Miliusa* is used on a local scale only.

Properties *Miliusa* yields a medium-weight, rarely heavy, hardwood with a density of 630–890 kg/m^3 at 15% moisture content. The wood anatomy of *Annonaceae* is fairly similar and is given here, as no specific description is available for *Mil-*



Miliusa koolsii
transverse surface (×20)

iusa. Heartwood yellow-brown, not clearly differentiated from the sapwood; grain straight; texture rather coarse to moderately fine and uneven; wood with silver grain. Growth rings usually distinct, indicated by a layer with denser fibres, occasionally indistinct; vessels moderately small to medium-sized, mostly solitary, sometimes with radial multiples of 2–4(–7) or small clusters, open, *Miliusa* occasionally with gum or other deposits; parenchyma abundant, apotracheal in regular, narrow bands (scalariform); rays moderately small to very broad and distinct to the naked eye; ripple marks absent.

The wood of *Miliusa* is strong and only moderately durable to non-durable. In a graveyard test in the Philippines the average service life of test stakes of *M. vidalii* was about 7 months.

See also the table on microscopic wood anatomy.

Botany Evergreen or sometimes deciduous shrubs or small to medium-sized trees up to 20(–32) m tall; bole straight, cylindrical, branchless for up to 15(–25) m, up to 40(–60) cm in diameter, without buttresses, occasionally fluted; bark surface smooth or slightly ridged, sometimes flaky, brown or grey, inner bark fibrous, yellowish. Indumentum of simple hairs. Leaves distichous, simple, entire, exstipulate. Flowers axillary, solitary or in a few-flowered fascicle, bisexual or sometimes unisexual; sepals 3, valvate, free or connate, small; petals 6, valvate, yellow or brown to pink or with purple streaks, in 2 whorls, outer petals similar to the sepals, inner petals longer and somewhat saccate at base, stamens few to many, in several rows, apex short and tongue-shaped or not prolonged; carpels many, free, each with 1–10 ovules in 1–2 rows, stigma globose to obovoid or cylindrical. Fruit apocarpous, each of the 2–30(–40) monocarps stipitate and globose to oblong. Seed with smooth testa. Seedling with epigeal germination; cotyledons emergent, leafy; hypocotyl elongated; leaves arranged spirally at first, distichous above the first branch.

M. horsfieldii is deciduous with the new leaves appearing at the same time or shortly after the flowers. In Java it flowers in October.

Ecology *Miliusa* species occur scattered as understorey trees in primary and secondary rain forest, up to 500 m altitude. Some species are confined to monsoon forest where they may also occur in the canopy layer. *M. horsfieldii* can be quite common in teak forest.

Silviculture *M. horsfieldii* is not resistant to fire.

Genetic resources and breeding Most *Miliusa* species are uncommon and have a narrow area of distribution, rendering them vulnerable to genetic erosion. Apart from some individual trees planted in botanic gardens, there are no records of ex situ conservation of *Miliusa*.

Prospects It is unlikely that the use of *Miliusa* timber will increase in the near future.

Literature 70, 161, 163, 235, 436, 494, 552, 741, 772, 861, 863, 934, 1017, 1126, 1134, 1221, 1232.

Selection of species

Miliusa horsfieldii (Benn.) Baillon ex Pierre

Synonyms *Saccopetalum horsfieldii* Benn.

Vernacular names Indonesia: janglot, kalak kembang (Javanese), kalak (Sundanese).

Distribution Java and northern Australia (Queensland).

Miliusa koolsii (Kosterm.) J. Sinclair

Synonyms *Saccopetalum koolsii* Kosterm.

Distribution New Guinea (Irian Jaya).

Miliusa vidalii J. Sinclair

Synonyms *Saccopetalum longipes* S. Vidal.

Vernacular names Philippines: takulau (general), dangluk, lanutan (Tagalog).

Distribution The Philippines.

P.J.A. Kessler

Mimusops L.

Sp. pl. 1: 349 (1753); Gen. pl., ed. 5: 165 (1754).

SAPOTACEAE

$x = 12$; *M. elengi*: $2n = 24$

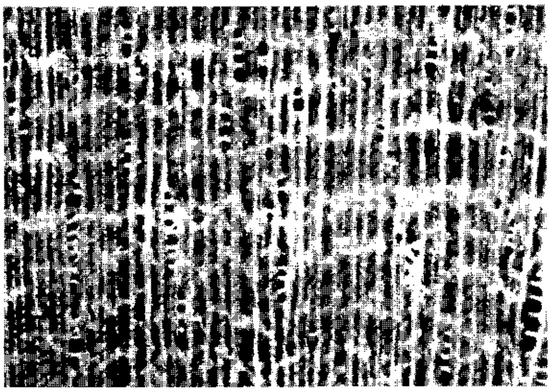
Vernacular names Asian bulletwood (En). Bukal, tanjung (En, Fr). Indonesia: tanjung (general, trade name), karikis (North Sulawesi), tanjung laut (Moluccas). Malaysia: bitis (general, trade name), elengi (general), mengkula (Peninsular), nyatoh batu (Peninsular, Sabah). Philippines: betis (general, trade name), bansalagin (general), kabiki (Tagalog). Burma (Myanmar): kaya. Laos: 'sa koun, phi koun. Thailand: kun (peninsular), kaeo (northern), phikun (central). Vietnam: c[aa]y vi[eef]t, s[eef]n c[as]t.

Origin and geographic distribution *Mimusops* comprises about 40 species, 20 of which occur in Africa, some 15 in Madagascar, 5 in the Mascarenes and Seychelles and 1, *M. elengi* L. (synonyms: *M. parvifolia* R. Br., *M. elengi* var. *parvifolia* (R. Br.) H.J. Lam), in Asia and the Pacific. The latter is probably native to India, Sri Lanka, Burma (Myanmar), Indo-China, Thailand and the Andaman Islands, but is commonly planted throughout Malesia towards the Solomon Islands, New Caledonia, Vanuatu and northern Australia, and many other tropical countries.

Uses The heavy, strong and durable wood of *M. elengi* is suitable for heavy general construction, bridge building, boat and ship building, marine construction, flooring, bearings, doors and framing. It has also been used for poles and piles, foundation sills, railway sleepers, paving blocks, mine timber, furniture and cabinet work, vehicle bodies, turnery, tool handles, wheelwrighting, walking sticks, weaving shuttles, bobbins, toys, sporting goods and musical instruments. A good-quality veneer and plywood can be manufactured from the wood. It also yields a good 'hot' fuelwood.

M. elengi has fragrant flowers and is often planted as an ornamental in gardens and along roads, including coastal sites. The leaves are used medicinally for headache and sore eyes, and are smoked to cure infections of the nose and mouth. A decoction of the bark, sometimes mixed with the flowers, has been used against fever, diarrhoea, inflammation of the gums and gonorrhoea and, mixed with tamarind bark, as a lotion for skin complaints. The young fruits have been employed in a gargle for treating sprue. The pounded seeds are used to cure obstinate constipation. Fresh flowers yield an oil used as perfume and are also strung in garlands or necklaces for decoration, or placed in linen-cupboards. In Java the flowers have been used against diarrhoea. The seeds yield an oil after pressing which has been used for cooking and illumination. The fruits are edible but reported as tasteless and/or astringent. In India the bark has been use for tanning, but the amount of tannin is low.

Production and international trade *M. elengi* wood is regarded as a commercial wood in Indonesia, but no trade figures are available. It is probably traded in mixed consignments of 'bitis' wood, which comprises many other *Sapotaceae* genera, such as *Madhuca*, *Palaquium*, *Payena* and *Pouteria*. *M. elengi* wood is traded locally in the Philippines. In Burma (Myanmar) and Sri Lanka, plantations of *M. elengi* have been established.



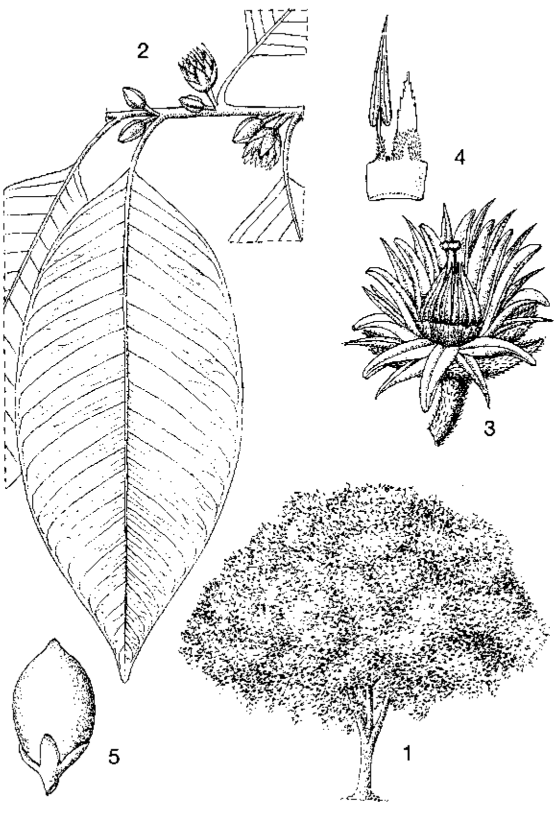
Mimusops elengi
transverse surface (×20)

Properties *M. elengi* yields a heavy hardwood with a density of 780–1120 kg/m^3 at 15% moisture content. Heartwood deep red or dark red-brown, often with darker streaks, distinct, but not sharply demarcated from the paler 5–7 cm wide sapwood; grain straight, wavy or slightly interlocked; texture very fine to fine and even; occasional watered-silk figure on tangential face of sapwood; taste bitter; wood contains saponin and lathers when rubbed with water. Growth rings indistinct, boundary occasionally indicated by zone without parenchyma; vessels very small to medium-sized, in radial multiples of 2–5(–more), sometimes solitary, tyloses abundant and with dark coloured deposits; parenchyma abundant, apotracheal diffuse-in-aggregates to more or less continuous and closely spaced bands, distinct with a hand lens; rays very fine to moderately fine, usually visible only with a hand lens; ripple marks absent.

Shrinkage of the wood is moderate to very high and it takes about 2 months to air dry boards 3 cm thick from 40% to 15% moisture content. It is liable to end-splitting, warping and surface checking if not carefully seasoned. The wood is very hard, very strong and tough. It is generally considered rather difficult to difficult to work, especially in sawing, due to the presence of silica, but is easier to work when still green; it finishes very well using sharp tools. The sawdust is irritating to nose and throat. The wood is very durable, even when exposed to the weather or in contact with the ground. The heartwood is very resistant to impregnation with preservatives. The wood is reportedly resistant to marine borer attack and to dry-wood termites. The sapwood is susceptible to *Lyctus*. The gross energy value of the heartwood is 21 340 kJ/kg, that of the sapwood 21 090 kJ/kg.

See also the tables on microscopic wood anatomy and wood properties.

Botany Evergreen, monoecious, small to medium-sized tree up to 30(–40) m tall; bole often short and divided into several large main branches but sometimes branchless for up to 15(–20) m, up to 100 cm in diameter, buttresses absent or up to 2 m high; bark surface becoming deeply fissured and sometimes peeling off in thin scales, grey, brown or dark red to blackish, inner bark fibrous, pink or reddish, with scanty watery or white sticky latex; crown dense, rounded and spreading, glossy dark green. Leaves alternate or distantly spiral, simple, with wavy, upcurled margins; stipules minute and caducous. Flowers bisexual or functionally male or functionally female, solitary or fasciculate in leaf axils; sepals in 2 whorls of 4; corolla white, fragrant, with a short tube and 8 lobes each divided in three; stamens 8, alternating with 8 staminodes and inserted on the corolla tube; ovary superior, (6–)8-locular with 1 ovule in each cell, style 1. Fruit a 1–2-seeded, ovoid to ellipsoid berry, ripening orange then red. Seedling with epigeal germination; cotyledons emergent, leafy; hypocotyl elongated; all leaves alternate-spiral; taproot strongly developed.



Mimusops elengi L. – 1, tree habit; 2, flowering twig; 3, flower; 4, stamen and staminode; 5, fruit.

Seedlings and trees are considered to grow slowly, although in the arboretum of the Forest Research Insitute Malaysia, Kepong a 21-year-old individual was 34.5 m tall with a clear bole of 18.6 m and a diameter at breast height of 53.4 cm, i.e. a mean annual diameter increment of 2.5 cm. In Java trees flower and fruit throughout the year. The scented flowers produce nectar at the base of the ovary, and infrequent visits of insects and bats have been observed. Still, pollination is most likely by wind. The stigma is receptive before the pollen is released, stimulating cross-pollination. The seed is known to be dispersed by bats, but monkeys, squirrels and wild pigs probably also eat the fruits.

Ecology *M. elengi* is fairly common near the sea, but may also be found in rocky locations and inland forest, up to 600 m altitude. It thrives in areas with perhumid or slightly seasonal rainfall types, is usually found in seasonally dry habitats but can stand waterlogging for up to 2 months. It requires a fertile soil.

Silviculture *M. elengi* can be propagated by seed or cuttings. Seed can be stored for about 9 months and needs 'after-ripening' during the first month of storage. There are about 2000 dry seeds/kg. Seeds have 70–90% germination in 17–82 days. It is best sown directly in containers. The seedlings can be planted out when 20–30 cm tall. The rooting success of cuttings 10–15 cm long and with a diameter of 0.5–1 cm is 70–90%. It is a shade-tolerant species which retains a full crown and reproduces satisfactorily under fairly dense shade.

Genetic resources and breeding *M. elengi* is stored in a germplasm collection in Malaysia, chiefly for its medicinal value. Trees may differ markedly in size depending on the site and origin, which offers potential for initiating selection and possibly breeding activities. In the Philippines *M. elengi* is classified as a vanishing timber tree.

Prospects Because of its superior wood quality, it is worthwhile starting silvicultural trials with *M. elengi*. It has good potential for increased utilization in suitable silvicultural schemes. *M. elengi* is recommended as an ornamental and shade tree in Malaysia.

Literature 71, 80, 162, 163, 209, 218, 235, 267, 300, 343, 375, 405, 406, 436, 464, 487, 513, 526, 536, 568, 571, 572, 632, 757, 780, 796, 828, 829, 831, 832, 861, 877, 889, 934, 974, 988, 1037, 1038, 1040, 1050, 1067, 1086, 1096, 1098, 1104, 1123, 1169, 1174, 1202, 1221.

Noorma Wati Haron

Mitrephora (Blume) Hook. f. & Thomson

Fl. ind. 1: 112 (1855).
ANNONACEAE
$x = 9$; *M. celebica* R. Scheffer: $2n = 18$

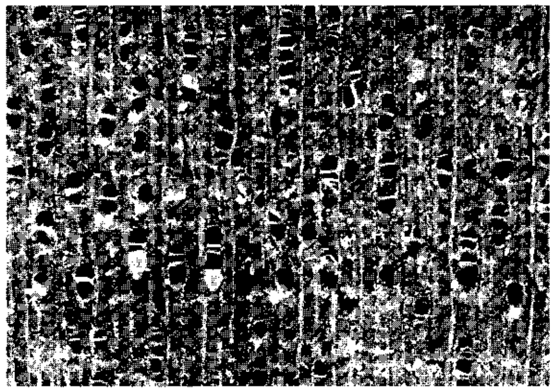
Vernacular names Mempisang (trade name). Malaysia: karai (Sabah), pisang-pisang (Peninsular). Philippines: lanutan (Filipino).

Origin and geographic distribution *Mitrephora* comprises some 40 species occurring from Sri Lanka and India to Indo-China, southern China, Thailand, throughout the Malesian region and in Australia (Queensland). About 25 species are found within Malesia.

Uses The wood of *Mitrephora* is used for interior joinery, poles, tool handles, matchboxes and splints, and packing cases. It is suitable for firewood.
In Java *M. polypyrena* is also cultivated as an ornamental and has been used as cover crop in forest plantations.

Production and international trade 'Mempisang' is a general trade name comprising most of the genera of *Annonaceae*, and *Mitrephora* probably comprises only a very minor proportion of the wood traded under this name. In 1992 the export of mempisang wood from Sabah amounted to 25 000 m^3 of sawn timber and 42 500 m^3 of logs with a total value of about US$ 7.2 million. Small amounts of mempisang are imported by Japan, mainly from Sabah and Sarawak.

Properties *Mitrephora* yields a medium-weight to heavy hardwood with a density of 780–950 kg/m^3 at 15% moisture content. Heartwood pale yellow-brown, not clearly differentiated from the sapwood; grain straight; texture rather coarse to moderately fine and uneven; wood with silver grain. Growth rings usually indistinct; vessels moderately small to medium-sized, solitary and in radial multiples of 2–4, occasionally in small clusters, mostly open and with chalky white deposits; parenchyma abundant, apotracheal in regular, narrow bands (scalariform); rays moderately fine to medium-sized; ripple marks absent.
The wood is fairly strong and non-durable.



Mitrephora maingayi
transverse surface (×20)

See also the table on microscopic wood anatomy.

Botany Shrubs or small trees up to 21 m tall; bole fairly straight, up to 40(–50) cm in diameter, without buttresses; bark surface grey; crown irregular with spreading branches. Leaves distichous, simple, entire, leathery, with nearly parallel veins and fine reticulations, exstipulate. Flowers opposite the leaves, solitary or in a few to many-flowered, extra-axillary fascicle, bisexual; sepals 3, valvate, free or connate; petals 6, valvate, in 2 rows, outer ones longer than inner, white or yellowish-green to purple, inner ones distinctly clawed and united at apex; stamens many, with flat-topped connectives; carpels few to many, free, each with 4–many ovules in 2 rows, stigma oblong to curved. Fruit apocarpous, each monocarp stalked or sessile, globose to ellipsoid, hairy. Seedling with epigeal germination; cotyledons emergent, leafy; hypocotyl elongated; leaves arranged spirally on the orthotropic leader, distichous on the branches.
In an open forest in East Kalimantan the mean annual height increment of seedlings of a *Mitrephora* species, possibly *M. lanotan*, was 42 cm. In cultivation *M. polypyrena* flowers throughout the year.
Mitrephora is botanically poorly known and in need of a thorough taxonomic revision.

Ecology The timber-yielding *Mitrephora* species are found in primary rain forest, up to 600 m altitude.

Silviculture *Mitrephora* can be propagated by seed. In a germination test in Peninsular Malaysia seeds of *M. maingayi* showed about 40% germination in 1–9 months.

Genetic resources and breeding As the timber-yielding *Mitrephora* species occur only in primary forest and generally display a comparatively narrow distribution, genetic erosion through deforestation represents a serious threat.

Prospects Wood properties and silvicultural aspects of *Mitrephora* are poorly known, indicating that present use is very limited. It probably has very little potential in the near future.

Literature 70, 162, 163, 267, 358, 436, 595, 707, 829, 831, 861, 863, 967, 1017, 1038, 1126, 1134, 1221, 1274.

Selection of species

Mitrephora lanotan (Blanco) Merr.

Synonyms *Uvaria lanotan* Blanco.

Vernacular names Philippines: lanutan (Filipino), banitan, dalinas-lalaki (Tagalog).

Distribution The Philippines; possibly also in Borneo (Kalimantan).

Mitrephora maingayi Hook. f. & Thomson

Synonyms *Mitrephora obtusa* Hook. f. & Tomson, *Mitrephora teysmannii* R. Scheffer.

Vernacular names Malaysia: meribut daun besar (Peninsular). Burma (Myanmar): thabu-net.

Distribution Burma (Myanmar) and Peninsular Malaysia.

Mitrephora polypyrena (Blume) Miq.

Synonyms *Mitrephora macrantha* Hassk.

Vernacular names Indonesia: janglot, kalak sapi (Javanese), tapai bunga (West Sumatra).

Distribution Sumatra and Java.

Mitrephora vulpina C.E.C. Fischer

Vernacular names Thailand: sang yu (peninsular).

Distribution Peninsular Thailand and Peninsular Malaysia.

E. Boer (general part),
M.S.M. Sosef (general part, selection of species)

Monocarpia Miq.

Ann. mus. lugd.-bat. 2: 12 (1865).

ANNONACEAE

x = unknown; $2n$ = unknown

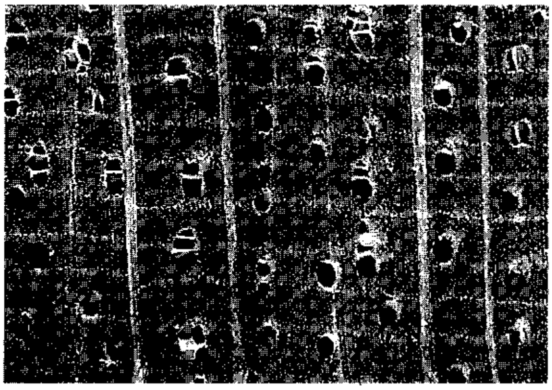
Vernacular names Mempisang (trade name). Malaysia: karai (Sabah), pisang-pisang (Peninsular).

Origin and geographic distribution *Monocarpia* comprises 2 species occurring in Thailand, peninsular Malaysia, Sumatra and Borneo.

Uses The wood of *Monocarpia* is used for general construction under cover (posts, rafters), interior finish, furniture and cabinet work, light-duty parquet and strip flooring, musical instruments, tool handles, toys and novelties, turnery, pattern making, packing cases, matchboxes and splints. It is suitable for the production of veneer and plywood, and can be used for pulp and paper manufacture.

Production and international trade 'Mempisang' is a general trade name comprising most of the genera of *Annonaceae*, and *Monocarpia* probably comprises only a minor proportion of the wood traded under this name; in Peninsular Malaysia, however, it is the commonest big *Annonaceae* tree. In 1992 the export of mempisang wood from Sabah amounted to 25000 m^3 of sawn timber and 42500 m^3 of logs with a total value of about US$ 7.2 million. Small amounts of mempisang are imported by Japan, mainly from Sabah and Sarawak.

Properties *Monocarpia* yields a medium-weight hardwood with a density of 520–615 kg/m^3 at 15% moisture content. Heartwood uniformly yellow turning greenish-yellow on exposure, not clearly differentiated from the up to 6 cm wide sapwood; grain straight; texture very fine and even; wood slightly lustrous, somewhat oily. Growth rings distinct to indistinct, when distinct indicated by a layer of denser fibres; vessels medium-sized, mostly in radial multiples of 2–4(–7) or in small clusters, open; parenchyma abundant, apotracheal in regular, narrow bands (scalariform); rays of 2 distinct sizes, medium-sized to



Monocarpia euneura
transverse surface (×20)

moderately broad and extremely fine to very fine; ripple marks absent.

Shrinkage of *M. euneura* upon air drying is low to moderate. Boards 13 mm and 38 mm thick take about 4 and 5 months, respectively, to air dry. There is a risk of splitting and a slight risk of surface checking in seasoning thick boards. The wood is easy to work with all tools, but the planed surface may not be perfectly smooth. Peeling should be done as soon as possible after felling. End splits in logs are the main problem in the manufacture of rotary veneer. The wood is fairly strong. It is prone to stain and susceptible to termite and marine borer attacks; the sapwood, however, is apparently non-susceptible to *Lyctus*. The sapwood is permeable and the heartwood is moderately resistant to preservative treatment. Even for interior work, the timber should be impregnated to prevent damage by dry-wood termites.

See also the tables on microscopic wood anatomy and wood properties.

Botany Usually medium-sized trees up to 35 m tall, occasionally only small trees; bole straight, fairly cylindrical, up to 60 cm in diameter, buttresses present; bark surface smooth, with distinct patches of white, grey, pale green, brown and black and with eye marks and hoop marks, inner bark fibrous, orange-brown with white stripes, darkening rapidly upon exposure. Leaves distichous, simple, entire, thin leathery, exstipulate. Flowers opposite the leaves, solitary or 2–3 together in a short-stalked extra-axillary cluster, bisexual; sepals 3, valvate, fused up to halfway; petals 6, valvate, in 2 whorls, pale yellowish to orange-green, the inner ones slightly shorter and with a short claw; stamens many, with flat-topped connectives; carpel(s) 1 or 3, each with 6–12(–20) ovules in (1–)2 rows, stigma slightly cup-shaped. Fruit apocarpous, with 1–3 sessile monocarps; monocarp ellipsoid to globose or ovoid, with a woody or fleshy wall, minutely pubescent. Seed semi-orbicular, with a crustaceous to stony wall; endosperm very hard. Seedling with epigeal germination; cotyledons emergent, leafy; hypocotyl elongated; leaves arranged spirally on the orthotropic leader, distichous on the branches.

Monocarpia retains its monopodial architecture throughout its life. In Peninsular Malaysia *M. euneura* has been observed flowering and fruiting during a mast fruiting year; its flowering to fruiting period is 9–14 weeks.

Ecology *Monocarpia* occurs scattered but can be locally common in primary, lowland, evergreen rain forest, up to 1200 m altitude. It occurs on hilly and undulating terrain, in dipterocarp forest, but also in semi-swampy habitats.

Silviculture *Monocarpia* can be propagated by seed. In a germination test in Peninsular Malaysia seeds of *M. euneura* showed about 90% germination in 2.5–8 months; seeds sown with pulp tend to germinate faster than cleaned seeds.

Genetic resources and breeding *M. kalimantanensis* is locally frequent but is a narrow endemic of East Kalimantan that could easily become endangered.

Prospects Due to its limited supply and only moderate wood quality, the use of *Monocarpia* timber is unlikely to increase in the near future.

Literature 162, 267, 317, 387, 436, 536, 553, 677, 678, 707, 725, 800, 829, 831, 1017, 1038, 1098, 1126, 1134, 1214, 1221, 1242.

Selection of species

Monocarpia euneura Miq.

Synonyms *Cyathocalyx maingayi* Hook. f. & Thomson, *Cyathocalyx marginalis* R. Scheffer, *Monocarpia marginalis* (R. Scheffer) J. Sinclair.

Vernacular names Indonesia: cepakok (Lampung, Sumatra). Malaysia: banitan itam, medang tanyong (Peninsular). Thailand: phi-ne mu-do, punae mu-do (peninsular).

Distribution Peninsular Thailand, Peninsular Malaysia, Singapore, Sumatra and Borneo.

Monocarpia kalimantanensis Kessler

Distribution Borneo (Kalimantan).

E. Boer (general part),
M.S.M. Sosef (general part, selection of species)

Morus L.

Sp. pl. 2: 986 (1753); Gen. pl., ed. 5: 424 (1754).
MORACEAE
$x = 14$; *M. alba*: $n = 14, 28$; *M. australis* Poir.: $n = 14$; *M. macroura*: $2n = 28, 56$

Vernacular names Mulberry (En). Mûrier (Fr). Indonesia: murbei (general). Malaysia: bebesaran (general). Philippines: amoras (Filipino). Cambodia: moon. Laos: mon. Thailand: mon. Vietnam: d[aa]u t[awf]m, t[awf]m tang.

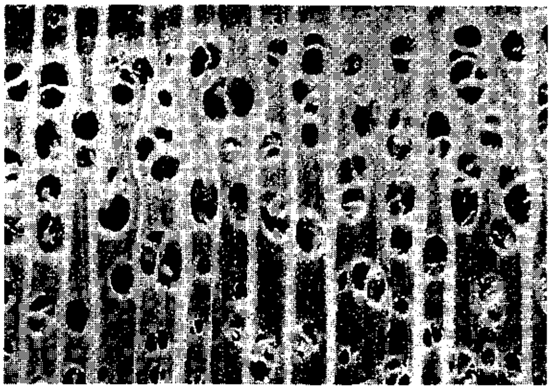
Origin and geographic distribution *Morus* comprises some 12 species occurring in all tropical and temperate regions of the world. Only one species (*M. macroura*) seems to be native in Malesia and several others have been introduced.

Uses The attractive wood of *Morus* is used mainly for furniture and cabinet work, but also for beams, posts, flooring and bridge building. In India the wood of *M. alba* is additionally used for boats, turnery, sporting goods and buggy shafts. Wood of *M. macroura* yields a medium-quality firewood.

M. alba is much better known as the chief mulberry used to rear silkworms and grown for its tasty fruits. In India it is fairly frequently used in agroforestry. It is occasionally planted as a roadside tree, and is highly valued as medicinal plant.

Production and international trade In India *M. alba* has been managed quite extensively in *Dalbergia sissoo* Roxb. ex DC. plantations where it establishes spontaneously. Within Malesia the use of mulberry wood is limited and on a local scale only.

Properties *Morus* yields a medium-weight hardwood with a density of 670–850 kg/m^3 at 15% moisture content. Heartwood yellow or yellowish-brown, darkening to golden or red-brown upon exposure, sharply demarcated from the up to 4 cm wide, white or pale yellow sapwood; grain straight; texture moderately coarse and even in semi-ring-porous material, uneven in ring-porous material; wood lustrous at first, becoming dull with age, with attractive silver grain. Growth rings distinct due to large earlywood vessels, ring-porous; vessels very small (in latewood) to moderately large (in earlywood), solitary and in radial multiples of 2–3, occasional clusters in smaller vessels, tyloses and white deposits present; parenchyma paratracheal vasicentric, and apotracheal in marginal or seemingly marginal bands; rays moderately fine to medium-sized; ripple marks absent. *M. macroura* wood resembles teak (*Tectona grandis* L. f.).



Morus alba
transverse surface (×20)

In seasoning, the wood of *M. alba* has a tendency to warp. Kiln drying of *M. macroura* boards resulted in no degrade at all. The wood is easy to work and machine, finishes smoothly, and quarter-sawn boards present a decorative silver grain figure. The wood is moderately hard to hard, tough and very flexible when steamed. It is fairly durable when exposed to the weather or in contact with the ground and not susceptible to insect or fungal attack.

The energy values of the sapwood and the heartwood of *M. alba* are 19 260 kJ/kg and 20 380 kJ/kg, respectively.

See also the table on microscopic wood anatomy.

Botany Deciduous, monoecious or dioecious shrubs or small to fairly large trees up to 35 m tall; bole up to 150 cm in diameter, without buttresses; bark exuding white or yellowish-white latex. Leaves distichous, simple to 3-lobed, dentate, palmately 3-veined at base; stipules lateral, caducous, coriaceous. Inflorescence axillary, pendulous. Flowers with 4, free, imbricate tepals. Male flowers in a catkin-like raceme; stamens 4; pistillode top-shaped. Female flowers in a long or short spike; tepals becoming succulent in fruit; ovary enclosed, 1(–2)-locular with a single ovule, style 2-partite. Fruit a drupaceous syncarp. Seedling with epigeal germination; cotyledons emergent; hypocotyl elongated; leaves often palmately or pinnately lobed.

In India 20-year-old coppice shoots of *M. alba* showed a mean annual diameter increment of 1.5 cm and a mean annual height increment of 1.0 m; early growth was very fast: 4.5 m in the first two years. In Java *M. macroura* has been observed flowering in June–December. The sporadically collected fruits mostly proved to contain no seeds. Seeds are dispersed by water and by birds, but fruits on long, pendulous spikes may also be dispersed by bats.

The number of species within *Morus* is often greatly overestimated because many cultivated forms which have subsequently been described as species have arisen through hybridization.

Ecology *M. macroura* is found in evergreen rain forest or sometimes on fallow land, often on volcanic soils, at 400–2500 m altitude.

Silviculture *Morus* can be easily propagated by seed, by cuttings and by tissue culture. When fruits are soaked in water for a few days, seeds can be released by gently rubbing the pulpy mass followed by rinsing with water. In India *M. alba* is raised from seeds and seedlings are pricked out when 10–15 cm tall. All but a few terminal leaves are stripped ('striplings') before seedlings are planted during the cold season or at the beginning of the rainy season. Plantations are managed by coppicing, which stimulates vigorous growth. *M. macroura* is also propagated by cuttings. *M. alba* is considered shade-tolerant.

Genetic resources and breeding *M. macroura* is rare and almost extinct in West Java. There are no recent records of its occurrence in Sumatra.

Prospects In view of the apparently good quality of the timber of *M. macroura* and its expected rapid growth, silvicultural trials are desirable.

Literature 70, 73, 238, 261, 364, 399, 406, 436, 458, 595, 751, 861, 874, 974, 1038, 1104, 1169.

Selection of species

Morus alba L.

Synonyms *Morus macrophylla* Moretti, *Morus morettiana* Jacq. ex Burr., *Morus nervosa* Deless. ex Spach.

Vernacular names White mulberry (En). Mûrier blanc (Fr). Indonesia: murbei (general), bebesaran (Sundanese), bebesaran lampung (Javanese). Philippines: amingit, amoras (Filipino). Burma (Myanmar): posa. Thailand: mon (general). Vietnam: d[aa]u, t[awf]m tang.

Distribution Native to India, Burma (Myanmar), Indo-China, China and Japan; widely cultivated in Europe and most Asiatic regions, including Java, and occasionally naturalized.

Morus macroura Miq.

Synonyms *Morus laevigata* (Wallich ex Bureau) Hook. f.

Vernacular names Indonesia: andalas (Sumatra), hole tanduk (Batak, Sumatra), kertau (Sundanese). Burma (Myanmar): taw-posa. Thailand: mon luang.

Distribution India (Sikkim), southern China and Hainan, Burma (Myanmar), Cambodia, Thailand, Sumatra and West Java.

E. Boer (general part),
M.S.M. Sosef (general part, selection of species)

Murraya J. König ex L.

Mant. pl. 2: 544, 563 (1771).
RUTACEAE
x = 9; *M. exotica* L., *M. koenigii*, *M. paniculata*: 2*n* = 18

Vernacular names Andaman satinwood, Burmese boxwood, Chinese myrtle (En). Malaysia: kemuning (trade name). Philippines: kamuning (general). Cambodia: xantroc. Laos: doc ki be. Vietnam: c[uwr]u ly h[uw][ow]ng, cut di, ng[eej]t gu[ees].

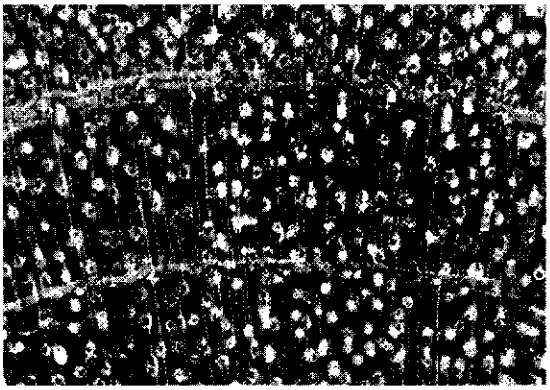
Origin and geographic distribution *Murraya* comprises about 15 species which are distributed from Sri Lanka and India to Indo-China, southern China and Taiwan towards Thailand and throughout the Malesian region to north-eastern Australia and New Caledonia. Four species are present within Malesia, but one, or perhaps two, have been introduced.

Uses The wood, especially the root wood, has a very nice figure and is one of the most highly prized woods for small, decorative objects like kris handles and sheaths, walking sticks, paperweights, inlaying, chessmen and flutes.

M. exotica is planted as an ornamental because of its scented flowers and shiny dark green leaves. Leaves of *M. koenigii* and *M. paniculata* yield an essential oil. Those of *M. koenigii* are an essential ingredient in curries. The leaves, fruits and bark of *M. paniculata* and *M. exotica* are used medicinally against venereal diseases, intestinal worms, and dysentery; the leaves are also reported as an ingredient in an infusion against irregular menstruation and leucorrhoea. The bark and roots have been used in Burma (Myanmar) as a face powder. The pleasantly scented flowers have been used for decoration and in cosmetics. Ripe fruits are eaten raw and have a sweet taste.

Production and international trade The root wood is locally considered the best of all woods for the specialty uses mentioned above. As the supplies are often extremely limited, the wood fetches high prices and is sold by the piece.

Properties *Murraya* yields a heavy hardwood with a density of 1020–1120 kg/m^3 at 15% moisture content. Heartwood greyish-brown or dark yellow with dark olive or black shades, sharply demarcated from the pale yellow or buff-coloured up to 4 cm wide sapwood; grain straight, but curly or wavy at base of trunk; texture very fine and even; wood lustrous. Growth rings visible, indicated by marginal parenchyma; vessels very small to moderately small, solitary and in radial multiples of



Murraya paniculata
transverse surface (×18)

2–4, in occasional clusters, open or with yellow, gum-like deposits, occasionally with tyloses; parenchyma abundant, apotracheal in marginal or seemingly marginal bands, some layers running diagonally between marginal layers producing false growth rings, visible to the naked eye, and scanty paratracheal, visible with a hand lens; rays very fine, visible with a hand lens; ripple marks absent; wood occasionally with pith flecks.

The wood seasons slowly and is inclined to check in the log and to split; it is reported from India to be a very refractory timber to season. The wood is hard to very hard and very strong. It is fairly easy to work and can be cut smoothly, although it is not easy to work with hand tools. The wood is durable to very durable. The heartwood is resistant to dry-wood termites. The sapwood is non-susceptible to *Lyctus*.

The main component of the oil obtained from the leaves is cadimene.

See also the tables on microscopic wood anatomy and wood properties.

Botany Shrubs or small trees up to 15(–20) m tall; bole often forking low, branchless for up to 3 m, up to 40(–60) cm in diameter, fluted at base; bark thin, the surface smooth, whitish to pale greyish, inner bark yellow. Leaves arranged spirally, imparipinnate, 1–4(–12)-jugate, or rarely unifoliolate, exstipulate; leaflets alternating, articulated at base, with pellucid dots. Flowers in an axillary or terminal panicle, cyme or corymb, bisexual, 5-merous; sepals fused at base; petals linear to oblanceolate, imbricate; stamens 10; disk annular to cylindrical; ovary superior, 2–5-carpellate with (1–)2 ovules per locule, style slender. Fruit a glandular berry with 1–2 developed locules. Seed with a membranous coat. Seedling with epigeal germination; cotyledons emergent, fleshy; hypocotyl elongated; first 2 leaves opposite and simple, subsequent leaves alternate and increasingly compound.

A 44-year-old *M. paniculata* tree in the Arboretum of the Forest Research Institute Malaysia, Kepong measured 17 m in height and 44 cm in diameter, while another tree was 15 cm in diameter by the age of 12 years. However, it has also been reported that the rate of growth is rather slow. *M. koenigii* and *M. paniculata* are evergreen. Flowering is induced by chilling the bud initials. *M. paniculata* is a night-flowering tree; in India it flowers from March–May and from July–October. Flowers are protandrous. Anthesis occurs between 20.00 h and 23.00 h while stigmas became receptive approximately 11 hours after the flowers open. It is a strictly cross-pollinated species. Pollination is by wind.

M. exotica has long been regarded as a synonym or just a variety of *M. paniculata*, but it now appears to represent a distinct species.

Ecology *M. paniculata* is found in evergreen, lowland and hill rain forest, usually on rocky soils or limestone, up to 600 m altitude, but it is more often encountered in cultivation.

Silviculture *Murraya* can be propagated by air layering and by seed. Seeds should be sown immediately after harvesting, since they are no longer viable after being stored for 3 weeks. They can be sown in the shade, without pretreatment. *M. paniculata* seeds have a germination rate of about 75% in 13–20 days, *M. exotica* seeds start to germinate after 16 days and 80% of the germinating seeds having appeared 27 days after sowing; total germination is about 90%. In a test in India, however, germination of *M. paniculata* was only 40–45% in 4–7 days.

Genetic resources and breeding As the timber-yielding *Murraya* species are comparatively widespread and frequently cultivated they do not seem to be endangered. Indiscriminate exploitation of the valuable wood, however, may impair the genetic resources.

Prospects Because of the highly valuable wood, trials to determine the suitability of *Murraya* for plantation establishment are justified.

Literature 70, 80, 151, 163, 209, 267, 354, 436, 672, 829, 831, 832, 861, 874, 883, 889, 934, 1022, 1038, 1048, 1081, 1169, 1218, 1221.

Selection of species

Murraya exotica L.

Synonyms *Murraya paniculata* (L.) Jack var. *exotica* (L.) Huang.

Distribution Native to China and possibly also to Taiwan; frequently cultivated throughout the tropics and locally naturalized.

Murraya koenigii (L.) Spreng.

Synonyms *Bergera koenigii* L., *Chalcas koenigii* (L.) Kurz, *Murraya foetidissima* Teijsm. & Binnend.

Vernacular names Curry bush, curry leaf (En). Malaysia: garupillai, karwa pale, kerupulai (Peninsular). Burma (Myanmar): kyaung-thwe. Cambodia: xantroc. Laos: dok kibi, 'khi^2 bê^2. Thailand: samat, som, mo 'noi (central). Vietnam: cari, c[ow]m ngu[ooj]i, ng[eej]t qu[ows]i koenig.

Distribution Native to Sri Lanka, India, Burma (Myanmar), Indo-China, southern China and Hainan; frequently cultivated in the tropics and locally naturalized. In the Malesian region reported from Peninsular Malaysia, Java and Borneo but probably planted throughout.

Murraya paniculata (L.) Jack

Synonyms *Chalcas paniculata* L., *Murraya odorata* Blanco, *Murraya sumatrana* Roxb.

Vernacular names Burmese boxwood, mock orange, orange jasmine (En). Indonesia: kemuning (general), kamuning (Sundanese), kayu gading (North Sulawesi). Malaysia: kemuning (general), kemuning lada (Peninsular). Philippines: kamuning (Filipino), banasi (Iloko), banati (Negrito). Burma (Myanmar): yuzana. Laos: kèo^2. Thailand: kaeo (central), talai kaeo, cha phrik (northern). Vietnam: ng[eej]t qu[ows]i, nh[aa]m h[oo]i.

Distribution From Sri Lanka and India to Burma (Myanmar), Indo-China, southern China and Taiwan towards Thailand and throughout the Malesian region to north-eastern Australia and New Caledonia; also frequently cultivated within this region.

Ha Van Tue

Mussaendopsis Baillon

Adansonia 12: 282 (1879).

RUBIACEAE

x = unknown; $2n$ = unknown.

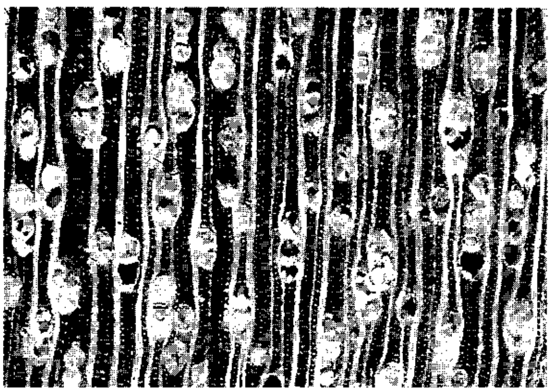
Vernacular names Indonesia: patin (general), rambai tiang (Sumatra), selumar putih (Riau Archipelago). Malaysia: melabira bukit, merlimau, penyabong (Peninsular). Singapore: chan chu kang.

Origin and geographic distribution *Mussaendopsis* comprises only 2 species; the only timber-yielding species is *M. beccariana* Baillon which is distributed in Peninsular Malaysia, Singapore, Sumatra and Borneo. The other species, *M. celebica* Bremek., is endemic to Sulawesi.

Uses The wood of *M. beccariana* is used for construction, e.g. for houses, bridges and scaffolding; it is also suitable for shingles and boats. The buttresses are locally used for paddles.

Production and international trade *M. beccariana* timber is only locally important; it has been reported as one of the more important timbers in the Riau Archipelago.

Properties *M. beccariana* yields a heavy hardwood with a density of 820–1090 kg/m^3 at 15% moisture content. Heartwood orange-yellow with orange streaks, not clearly differentiated from the sapwood; grain straight; texture moderately fine and even. Growth rings not observed; vessels medium-sized to moderately large, solitary and in radial multiples of 2–4, open; parenchyma very sparse, apotracheal diffuse and scanty paratracheal, difficult to see with a hand lens; rays very fine to moderately fine; ripple marks absent.
The wood is hard and fairly strong. It is difficult to saw and durable when exposed to the weather or



Mussaendopsis beccariana
transverse surface (×20)

in contact with the ground. In contact with wet soil it lasts for at least 5 years.
See also the tables on microscopic wood anatomy and wood properties.

Botany A medium-sized to fairly large tree up to 35 m tall; bole often fluted, up to 65(–75) cm in diameter, with buttresses up to 2 m high, sometimes with stilt roots; bark surface smooth, eventually being shed in small rectangular flakes, pale greyish to reddish-brown, inner bark silky fibrous, whitish to yellow, turning brown on exposure; crown open, often irregular, main branches ascending and often twisted. Leaves opposite, simple and entire, coriaceous, petiolate; stipules intrapetiolar, caducous. Flowers in an axillary thyrsoid inflorescence on a long peduncle, (4–)5-merous; calyx often with one lobe conspicuously enlarged and whitish to pale yellow; corolla white, outside densely hairy, tube obsolete or short, lobes contorted; stamens 5, inserted on corolla tube or on the edge of the large disk; ovary inferior, 2-locular with many ovules, style with 2 stigmatic lobes. Fruit a septicidal capsule, many-seeded. Seed oblong, winged. Seedling with epigeal germination.
The shape of the flowers suggests that *M. beccariana* is pollinated by flies.
Mussaendopsis most probably belongs to the tribe *Coptosapelteae*, in which it occupies a rather isolated position.

Ecology *M. beccariana* prefers lowland forest below 500 m altitude, and is often found in swampy, riverine or lakeside vegetation or in freshwater swamp forest. It is also reported from mixed dipterocarp forest on moist clayey sand soils.

Genetic resources and breeding It is difficult to harvest *M. beccariana* and transport the logs, because it is often found in swampy areas difficult to access and the wood is hard and not easy to cut. It will therefore not easily become endangered.

Prospects Although the use of *M. beccariana* timber will remain locally important, it is unlikely to increase since it is difficult to work.

Literature 139, 163, 267, 436, 464, 861, 911, 933, 1221, 1242.

R.R.P. Irwanto

Nauclea L.

Sp. pl., ed. 2: 243 (1762).
RUBIACEAE
x = unknown; *N. orientalis*: $2n = 88$, for 2 African species $2n = 44$

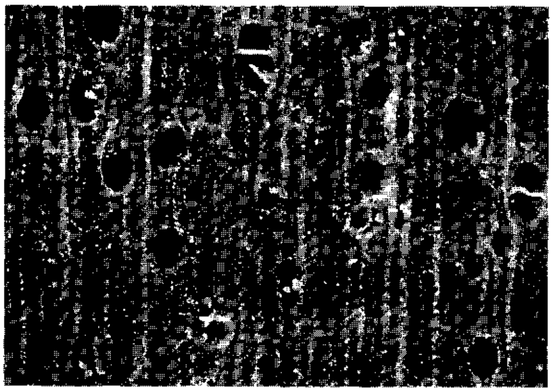
Vernacular names Bangkal (trade name). Malaysia: mengkal (Peninsular).

Origin and geographic distribution *Nauclea* comprises 10 species, 4 of which occur in Africa and Madagascar and 6 in Asia with 1 species extending to northern Australia. All 6 Asian species are found in Malesia; 3 of them have a large area of distribution, of the other 3, one is endemic to Borneo, one to the Philippines and one to New Guinea.

Uses The wood of *Nauclea* is used for light framing, interior joinery, weatherboard, flooring, furniture, cabinet work, mouldings, veneer and plywood, sculptures, implements, shuttering, toys, packing cases and match splints. It is sometimes used for house construction, e.g. *N. orientalis* in Papua New Guinea and the Philippines. In Indo-China the wood is considered suitable for making a good pulp for paper production.
The fruits are edible but not tasty. The leaves are used as a febrifuge in local medicine. Leaves and bark of *N. orientalis* are used medicinally against abdominal pain and wounds. They contain indole alkaloids with anticancer activity. Branches are planted in Indonesia and Malaysia as a live fence, as they root easily. An intensely yellow dye can be obtained from the root-bark. In the Philippines *N. orientalis* and *N. subdita* are planted to stabilize river banks and slopes. Young leaves and fruits of *N. subdita* are edible and the trees are occasionally planted as a hedge.

Production and international trade The supply of *Nauclea* timber is limited and is mainly used locally. When traded, it is often mixed with timber of *Neonauclea*, *Ochreinauclea* and *Pertusadina* and sold as 'bangkal'. In 1987 the amount of bangkal round logs exported from Sabah was 3450 m^3 with a value of US$ 220 000 (US$ 64/m^3), and in 1992 it was 4150 m^3 (only 1% as sawn timber, 99% as logs) with a total value of US$ 320 000 (US$ 76/m^3 for logs). In 1996 Papua New Guinea exported about 1700 m^3 of 'yellow cheesewood' (*N. orientalis*) logs at an average free-on-board (FOB) price of US$ 99/m^3.

Properties *Nauclea* yields a lightweight to medium-weight hardwood with a density of 335–750 kg/m^3 at 15% moisture content. Heartwood rather bright orange or orange-yellow to dark



Nauclea orientalis
transverse surface (×20)

orange or dark yellow, not sharply differentiated from the wide, pale yellow sapwood; grain slightly interlocked, occasionally straight; texture moderately fine to slightly coarse and even; wood with some stripe figure on radial surface, with bitter taste and greasy to the touch. Growth rings indistinct or distinct and boundaries indicated by zones without vessels or parenchyma; vessels moderately small to medium-sized or sometimes moderately large, solitary in varying amounts and in radial multiples of 2–3(–6), open but heartwood vessels with orange-brown gum-like contents; parenchyma fairly abundant, apotracheal diffuse and diffuse-in-aggregates, distinct only with a hand lens; rays very fine to moderately fine, indistinct to the naked eye; ripple marks absent.

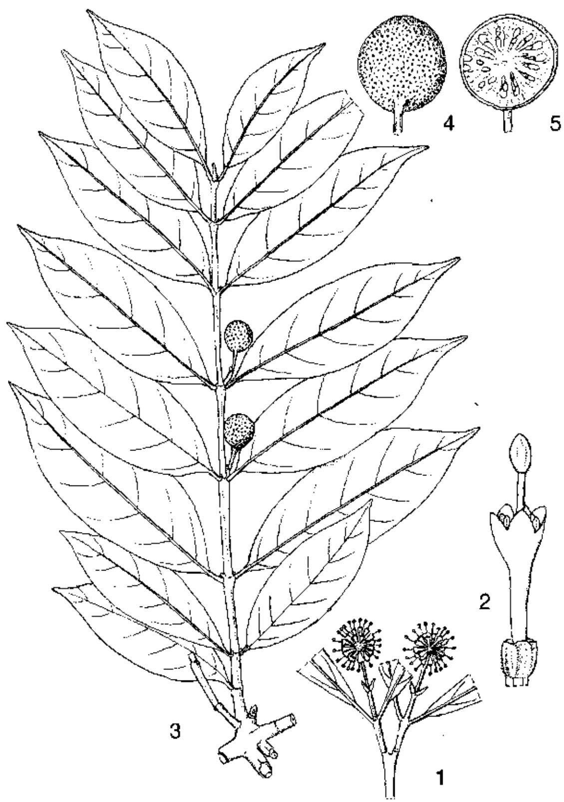
Shrinkage is low and care is needed to prevent warping during seasoning especially in back-sawn material. The wood is moderately hard and moderately weak to moderately strong. It is easy to work and finish and turns excellently. It is rated from durable to non-durable when exposed to the weather or in contact with the ground. The wood is fairly resistant to insect attack, but it is also reported to be susceptible to termites. The sapwood is susceptible to *Lyctus* and to blue stain. Heartwood is moderately resistant to blue stain. The sapwood is permeable to impregnation, the heartwood is usually permeable but may be moderately resistant in some instances.

See also the tables on microscopic wood anatomy and wood properties.

Botany Small to fairly large trees up to 35 m tall; bole usually straight, up to 80(–100) cm in diameter; bark surface smooth to irregularly fissured and cracking, sometimes scaly, greyish-brown to reddish-brown, inner bark yellow turning orange or brown upon exposure. Terminal vegetative bud usually strongly flattened. Leaves opposite, simple, entire, leathery, with short petioles; stipules appressed, usually caducous. Flowers in an axillary and terminal, stalked head with simple peduncles, 4–5-merous; hypanthia mutually connate; calyx lobes triangular to oblong or spatulate, persistent; corolla funnel-shaped with imbricate lobes; stamens inserted in the upper part of the corolla tube; disk indistinct; ovary inferior, 2-locular with many ovules in each cell, style exserted, with spindle-shaped stigma. Fruits connate into an indehiscent, globose syncarp. Seed ovoid to ellipsoid, sometimes slightly bilaterally compressed, not winged. Seedling with epigeal germination; cotyledons emergent, leafy; hypocotyl elongated; all leaves decussate.

The fruits are eaten by wild pigs.

Nauclea belongs to the tribe *Naucleeae* and is most closely related to *Ochreinauclea* and the African



Nauclea parva (Havil.) Merr. – 1, flowering twig; 2, flower; 3, fruiting twig; 4, fruit; 5, longitudinal section of fruit.

genus *Sarcocephalus* which also have a syncarp (or pseudosyncarp). It differs from *Ochreinauclea* in the usually flattened terminal vegetative bud, the appressed stipules, the comparatively shorter calyx lobes, and wingless seeds. *Nauclea* used to be a large genus, but many species have been transferred to other genera such as *Adinauclea*, *Anthocephalus*, *Haldina*, *Ludekia*, *Metadina*, *Neonauclea*, *Ochreinauclea* and *Uncaria*.

Ecology *Nauclea* occurs in lowland and hill forest, sometimes up to 1100 m altitude, often along streams, and also in swampy locations. In the Philippines it is found mainly in secondary forest. In Papua New Guinea it is locally common in fire-induced grassland and secondary vegetation.

Silviculture *Nauclea* may be raised from seed. Seeds of *N. subdita* germinate in 13–59 days. *N. orientalis* may be suitable for soils with a periodically high groundwater table. It is considered a true pioneer and in northern Queensland it is one of the most abundant trees represented in the soil seed bank. The larvae of the beetle *Alcidodes cinchonae* have been found living in the shoots of *N. orientalis*, but they cause little damage.

Genetic resources and breeding Although the supply of the timber of *Nauclea* is limited, it is rather common in many regions and most species are widespread. There is no indication of a threat of genetic erosion.

Prospects *Nauclea* may have potential for the future. The feasibility of using species such as *N. orientalis* (a pioneer species) to establish timber plantations should be studied. Information is needed on its silvicultural characteristics.

Literature 70, 151, 161, 162, 163, 209, 260, 267, 300, 304, 348, 360, 436, 449, 464, 487, 519, 536, 553, 568, 632, 715, 772, 780, 829, 831, 861, 916, 933, 934, 943, 1052, 1198, 1221, 1232.

Selection of species

Nauclea officinalis (Pierre ex Pitard) Merr. & Chun

Synonyms *Nauclea brunnea* Craib, *Sarcocephalus junghuhnii* auct. non Miq., *Sarcocephalus officinalis* Pierre ex Pitard.

Vernacular names Malaysia: mengkal (Peninsular). Laos: 'khmin² tôn². Thailand: khe min, khem nam (peninsular).

Distribution Indo-China, southern China, Thailand, Peninsular Malaysia, Sumatra and Borneo.

Nauclea orientalis (L.) L.

Synonyms *Nauclea coadunata* Roxb. ex J.E. Smith, *Sarcocephalus cordatus* Miq., *Sarcocephalus undulatus* Miq.

Vernacular names Indonesia: gempol (general), kayu mas (Minahassa, North Sulawesi), klepu pasir (Javanese). Papua New Guinea: yellow cheesewood (En). Philippines: bulala, mambog (general). Burma (Myanmar): mau-kadon, prung. Thailand: kan lueang (central), krathum khlong (central, peninsular), tum kham (northern).

Distribution Sri Lanka, Burma (Myanmar), Thailand, throughout Malesia (except for Peninsular Malaysia) and northern Australia.

Nauclea parva (Havil.) Merr.

Synonyms *Sarcocephalus parvus* Havil.

Distribution Borneo.

Nauclea subdita (Korth.) Steud.

Synonyms *Nauclea junghuhnii* (Miq.) Merr., *Nauclea pubescens* (Valeton) Merr., *Sarcocephalus mitragynus* Miq.

Vernacular names Indonesia: bangkal laki-laki, kome banga (Moluccas). Malaysia: gedembah, lempedu jawa, lempedu tanah (Peninsular). Philippines: southern bangkal (general), bulubangkal (Panay Bisaya).

Distribution India and throughout Malesia except for New Guinea.

Wardah

Neesia Blume

Nova Acta Phys.-Med. Acad. Caes. Leop.-Carol. Nat. Cur. 17: 83 (1835).

BOMBACACEAE

x = unknown; $2n$ = unknown

Vernacular names Durian (trade name for wood of several *Bombacaceae* genera). Indonesia: bengang (general), ki bengang (Sundanese), sibengang (Sumatra). Malaysia: ben(g)gang, ha ha (general), apa-apa, punggai (Peninsular), durian monyit (Sabah). Thailand: chang haek.

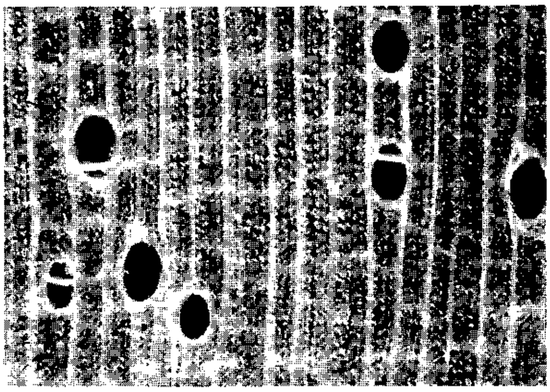
Origin and geographic distribution *Neesia* comprises 8 species and occurs in peninsular Thailand, Peninsular Malaysia, Sumatra, Java and Borneo. Borneo harbours 7 species.

Uses The wood of *Neesia* is suitable for light construction, door and window frames, cheap furniture and fittings, flooring, planking, wooden

shoes, floats, low grade coffins, sliced veneer and plywood.
The fruit wall of *N. altissima* has been used medicinally against gonorrhoea.

Production and international trade The wood of *Neesia* is generally traded in mixed consignments together with that of *Coelostegia*, *Durio*, and sometimes also *Bombax*, as 'durian' wood. *Neesia* wood constitutes only a minor proportion of this trade group. It may also be sold in mixed consignments of 'red meranti'.

Properties *Neesia* yields a lightweight to medium-weight hardwood with a density of 400-710 kg/m^3 at 15% moisture content. Heartwood pale brown to brown with a red tinge, sharply demarcated from the pale yellow to dirty white sapwood; grain straight to slightly interlocked; texture moderately coarse to coarse and even. The wood structure is very similar to other species of 'durian'. Growth rings distinct, occasionally less distinct; vessels moderately large to large, mostly solitary or solitary and in radial multiples of 2–3(–4), tangential pairs and clusters rare; parenchyma apotracheal diffuse or diffuse-in-aggregates, and scanty paratracheal; rays of 2 distinct sizes, very fine and medium-sized, only the broader ones distinct; ripple marks present, but not always distinct.
Shrinkage is low to moderate and wood air dries rapidly and easily without defects. Boards 13 mm and 38 mm thick take 1.5–2 and 3–4 months, respectively, to air dry; kiln drying properties are good. The wood is soft and not very strong. It converts well in all machining processes, although in planing it tends to pick up on quarter-sawn surfaces. In a graveyard test in Peninsular Malaysia the wood has an average service life of 1.5 years.



Neesia sp.
transverse surface (×20)

Both heartwood and sapwood are easily treated with preservatives, showing an absorption of 96 kg/m^3 when soaked in cold creosote and diesel oil mixtures. The wood is not resistant to pinhole borer, longhorn beetle, termite and marine borer attacks. The sapwood is susceptible to *Lyctus*.
See also the tables on microscopic wood anatomy and wood properties.

Botany Evergreen, medium-sized to large (rarely small) trees up to 50 m tall; bole often short, up to 120 cm in diameter, sometimes with short thick buttresses; bark surface smooth to cracking or scaly, grey-brown to dark brown, inner bark fibrous, red-brown. Twigs stout, glabrous or set with stellate hairs or frilled scales. Leaves alternate, crowded at the apices of branches, simple, entire, the tip usually rounded or emarginate, nerves prominent below; petiole prominently kneed; stipules large. Flowers in a cymose inflorescence borne on the branches below the leaves; epicalyx covering the flower bud completely; calyx cup- or saucer-shaped; petals 5; stamens many, united at base only or forming a tube, anthers versatile; ovary superior, 5-locular with 5–12 ovules in each cell, style short, with capitate stigma. Fruit a large, woody, 5-angled muricate-tessellate capsule splitting almost to the base, inside densely covered with golden irritant hairs. Seed smooth, red-brown, with a small orange aril. Seedling with epigeal germination; cotyledons emergent, leafy, fringed with fine hairs; hypocotyl elongated; leaves alternate, conduplicate.
Branching is delayed until after the seedling stage. *N. altissima* trees aged 23 years in the arboretum of the Forest Research Institute Malaysia, Kepong were to 12.5 m tall with a clear bole of up to 3 m and a diameter of up to 17 cm. In Java *N. altissima* flowers from February to July.
Neesia is most closely related to *Coelostegia*, the main diagnostic characters being the epicalyx covering the flower bud and the irritating hairs in the fruit. There is some discussion on species delimitation; some authors recognize only 6 species in *Neesia*.

Ecology *Neesia* is found scattered or locally frequent in evergreen, primary forest, often along streams or in freshwater swamps, up to 1800 m altitude. The species occur on a wide variety of soils including shallow peat soils, damp sandy soils like groundwater podzols and gleyed clay-rich soils.

Silviculture *Neesia* can be propagated by seed. Seeds of *N. kostermansiana* had a germination rate of about 70% in 8–27 days. In a 50 ha plot in lowland forest in Peninsular Malaysia 70 stems of *N. synandra* with a diameter of over 1 cm were present, 10 of which were more than 10 cm in diameter. Rapid conversion of wood after harvest is essential to prevent fungal attack.

Genetic resources and breeding There are no records of ex situ conservation of *Neesia*, but the trees do not seem to be in immediate danger of genetic erosion or extinction, as they are seldom logged, even in concession areas.

Prospects No increase in the use of *Neesia* timber is foreseen.

Literature 46, 61, 70, 151, 162, 163, 193, 198, 238, 260, 267, 387, 436, 526, 536, 677, 678, 741, 749, 829, 831, 832, 861, 1040, 1046, 1188, 1221, 1222, 1242, 1245.

Selection of species

Neesia altissima (Blume) Blume

Synonyms *Neesia ambigua* Becc.

Vernacular names Indonesia: durian hantu (Sumatra).

Distribution Peninsular Malaysia (rare), Singapore, Sumatra, Java and Borneo.

Neesia glabra Becc.

Distribution Sumatra and Borneo (Sarawak).

Neesia kostermansiana Soepadmo

Distribution Peninsular Thailand and Peninsular Malaysia.

Neesia malayana Bakh.

Distribution Peninsular Malaysia, Singapore, Sumatra and Borneo.

Neesia synandra Mast.

Distribution Peninsular Malaysia, Singapore and Borneo.

R.C.K. Chung

Neolitsea (Benth.) Merr.

Philipp. Journ. Sci. 1, Suppl.: 56 (1906).

LAURACEAE

$x = 12$; *N. zeylanica*: $2n = 48 + (0\text{–}5)$B

Vernacular names Medang (trade name). Indonesia: huru (Javanese), makila (Ambon). Burma (Myanmar): kyese.

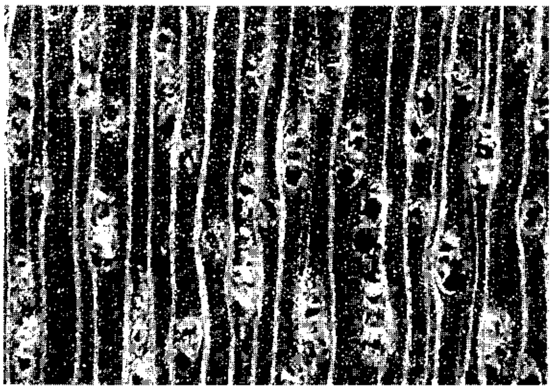
Origin and geographic distribution *Neolitsea* comprises about 80 species occurring from Sri Lanka and India towards Indo-China, China, Japan and Taiwan to Thailand, the whole of the Malesian region to northern Australia. Some 30 species are found within the Malesian region. China can be regarded as the centre of diversity.

Uses The wood of *Neolitsea* has been used for light or temporary construction, house building, agricultural implements and is suitable for handicrafts. In general, 'medang' timber is suitable for interior finish, furniture, boat building, and for veneer and plywood production.

The bark of many species contains alkaloids, and medicinal application of the bark has been reported for several species. The leaves of *N. vidalii* yield a glutinous substance which, when mixed with mortar, adds to the strength of the latter. The leaves of *N. cassiaefolia* are reported to cure scabies and ring worm infections.

Production and international trade The timber of *Neolitsea* is traded together with that of many other *Lauraceae* genera as 'medang', but probably constitutes only a minor portion of the total amount traded. In 1984 the total export of medang from Peninsular Malaysia to Singapore was 1500 m^3 with a value of US$ 62 000. In 1992 the export from Sabah amounted to 52 000 m^3 (of which about 10% was sawn timber) with a total value of US$ 4.3 million. In Papua New Guinea the minimum export price for medang logs was US$ 43/m^3 in 1992. Japan imports medang mainly from Sabah and Sarawak and Papua New Guinea.

Properties *Neolitsea* yields a medium-weight hardwood with a density of 590–740 kg/m^3 at 15% moisture content. Heartwood greyish-brown, sharply demarcated from the paler sapwood; grain



Neolitsea cassia
transverse surface (×20)

interlocked or wavy; texture fine and even; planed surface greasy to the touch; wood with distinct 'fruity' fragrance that may persist for years. Growth rings distinct or indistinct; vessels moderately small to medium-sized, solitary or in radial multiples of 2–4, tyloses abundant; parenchyma sparse to moderately abundant, paratracheal vasicentric; rays very fine to moderately fine, inconspicuous on radial surface; ripple marks absent.

Medang wood is of medium strength, hard and generally easy to saw and machine; an anti-stain treatment should be applied directly after sawing. The wood of *Neolitsea* is moderately durable to durable under cover and non-durable in contact with the ground. The heartwood of medang is generally very resistant and the sapwood amenable to preservative treatment, but the sapwood of *N. vidalii* is resistant to impregnation. Most species are attacked by termites and their sapwood is susceptible to *Lyctus*. The heartwood of *N. vidalii* is resistant to dry-wood termites and its sapwood is non-susceptible to *Lyctus*. The gross energy value of *N. vidalii* is about 18 830 kJ/kg.

See also the table on microscopic wood anatomy.

Botany Evergreen, dioecious shrubs or small to medium-sized trees up to 25 m tall; bole usually straight and slender, branchless for up to 18 m, up to 60 cm in diameter, without buttresses; bark surface smooth, greyish, inner bark whitish or pale brown to orange-white or reddish, often fragrant. Leaves arranged spirally to opposite or even in pseudowhorls, often tripliveined, usually with areolate venation, exstipulate; bud scales large, leaving ring-like scars on the twigs. Flowers unisexual, in an axillary cluster or short raceme of 3–7-flowered umbellules with each umbellule enclosed by 4 bracts; tepals 4, with a short tube. Male flowers with 6 stamens in 3 whorls, those of the inner whorl with 2 glands at base, anthers 4-celled, opening by valves. Female flowers with superior ovary, unilocular with 1 ovule, stigma peltate. Fruit a 1-seeded, black or sometimes red berry, seated on a disk-shaped perianth tube, pedicel often slightly thickened. Seedling with hypogeal germination; cotyledons not emergent, peltate; hypocotyl not developed; epicotyl with a few scales; first few leaves arranged spirally.

In Java *N. cassiaefolia* flowers from March to October and bears fruits in October, *N. javanica* flowers in March and April. The seeds are dispersed by birds.

Like most other genera of the *Lauraceae*, *Neolitsea* is in desperate need of a thorough taxonomic revision. Identifications at species level are often very doubtful, rendering the scarce information available even less useful.

Ecology Timber-yielding species of *Neolitsea* are found in evergreen, primary and secondary rain forest, mainly from sea-level up to 1200 (–1700) m altitude. *N. javanica* is found in montane forest at 1500–2400 m. *N. cassia* occurs along sandy and rocky coasts.

Silviculture *Neolitsea* can be propagated by seed. Seeds of *N. brassii* germinate in 30–170 days.

Genetic resources and breeding Because of the scarcity of botanical knowledge, it is difficult to assess the risk of genetic erosion or the degree of threat of the presently recognized *Neolitsea* species. For species with a limited geographical distribution, however, the threat may be appreciable.

Prospects Utilization of *Neolitsea* is very limited and its wood qualities are still poorly known. In the near future its use is unlikely to transcend local level.

Literature 41, 70, 162, 163, 209, 300, 304, 406, 436, 462, 534, 594, 605, 614, 695, 740, 755, 772, 785, 861, 934, 1038, 1094, 1221.

Selection of species

Neolitsea amboinensis Merr.

Vernacular names Indonesia: ai laun seron, makila daun kecil (Ambon, Moluccas).

Distribution The Moluccas.

Neolitsea brassii Allen

Distribution Papua New Guinea and northern Australia.

Neolitsea cassia (L.) Kosterm.

Synonyms *Litsea zeylanica* Nees, *Neolitsea zeylanica* (Nees) Merr.

Vernacular names Shore laurel (En). Malaysia: medang pasir, tejur, tejur pasir (Peninsular). Philippines: Ceylon bohian (Cebu Bisaya). Thailand: ian (peninsular).

Distribution From Sri Lanka and India to Burma (Myanmar), Indo-China, Thailand, Peninsular Malaysia, Borneo, the Philippines and northern Australia.

Neolitsea cassiaefolia (Blume) Merr.

Synonyms *Litsea acerina* Blume, *Litsea cassiaefolia* Blume.

Vernacular names Indonesia: huru merang, ki bodas (Sundanese), wuru lemah (Javanese).

Distribution Java.

Neolitsea javanica (Blume) Backer

Synonyms *Litsea javanica* Blume.

Vernacular names Indonesia: huru gambir, huru hiris (Sundanese), wuru teja (Javanese).

Distribution Java.

Neolitsea novoguinensis (Teschner) Merr.

Synonyms *Tetradenia novoguinensis* Teschner.

Distribution Papua New Guinea.

Neolitsea vidalii Merr.

Vernacular names Philippines: puso-puso (Filipino).

Distribution The Philippines.

S. Suhandono

Neonauclea Merr.

Journ. Wash. Acad. Sci. 5: 538 (1915).

RUBIACEAE

x = unknown; $2n$ = unknown

Vernacular names Bangkal (trade name). Indonesia: cangcaratan (Sundanese). Malaysia: lenggaung (Sarawak), mengkal (Peninsular). Papua New Guinea: yellow hardwood (En). Philippines: kalamansanai (general), hambabalud (Cebu Bisaya, Samar-Leyte Bisaya).

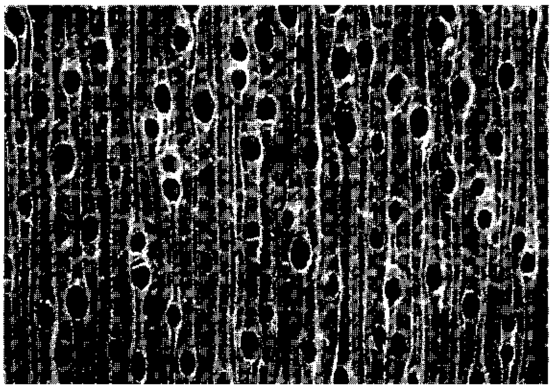
Origin and geographic distribution *Neonauclea* is a fairly large genus of 65 species distributed in India, Burma (Myanmar), Indo-China, southern China, Thailand, throughout the Malesian region, the Solomon Islands, Melanesia and Micronesia, and northern Australia. No less than 61 species occur in Malesia. New Guinea is richest, with about 20 species, followed by the Philippines (14), Borneo (12), Sulawesi and the Moluccas (each 10).

Uses The wood of *Neonauclea* is fairly commonly used for general construction, bridge building (also for heavy construction), window-sills, flooring, boat building, joinery, furniture and cabinet work, posts, poles, piles, crossarms, inlaying, turnery, implements and packaging. It is also used for the production of core veneer, pulp and paper, and for charcoal.

A few species have been used as ground cover in forest plantations, e.g. in *Pinus merkusii* Jungh. & de Vriese plantations. The leaves and fruits are used in local medicine against urinary complaints.

Production and international trade *Neonauclea* is traded in South-East Asia as 'bangkal', which also includes *Nauclea*, *Ochreinauclea* and *Pertusadina* timber. The amount of bangkal round logs exported from Sabah in 1987 was 3450 m^3 with a value of US\$ 220 000 (US\$ 64/m^3), and in 1992 it was 4150 m^3 (only 1% as sawn timber, 99% as logs) with a total value of US\$ 320 000 (US\$ 76/m^3 for logs). In the Philippines, *Neonauclea* timber is obtainable in limited or small quantities; the bulk of it is attributed to *N. calycina*. Small amounts of *Neonauclea* logs are exported, mainly from Papua New Guinea, where in 1987 they amounted to 0.7% of the total round logs exported. In 1996 Papua New Guinea exported a fair volume of about 15 060 m^3 of 'yellow hardwood' logs at an average free-on-board (FOB) price of US\$ 92/m^3.

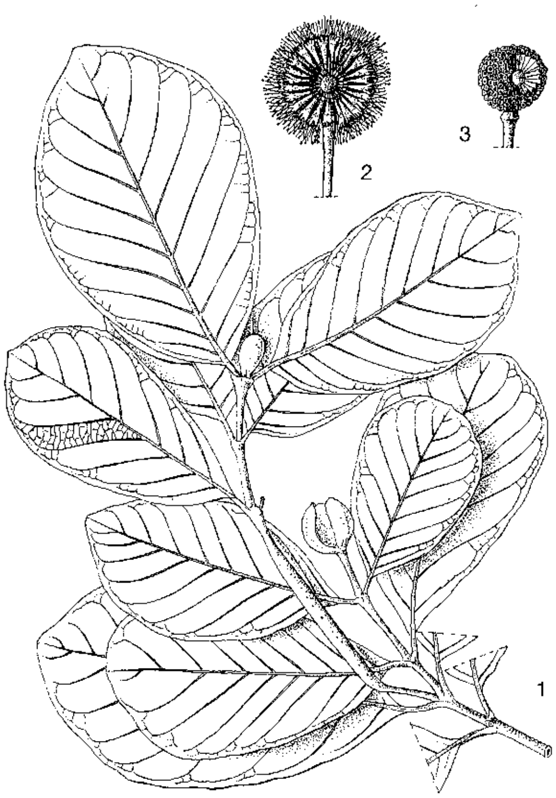
Properties *Neonauclea* yields a medium-weight to heavy hardwood with a density of (430–)560–980 kg/m^3 at 15% moisture content. Heartwood pale to bright orange or dark yellow to pink becoming paler on exposure, only distinguishable from the paler sapwood when fresh; grain interlocked, occasionally straight; texture moderately fine and even; occasionally with some figure due to growth rings or pink streaks; wood lustrous. Growth rings indistinct, sometimes marked by narrow zones of denser wood; vessels moderately small to medium-sized, mostly solitary but with very occasional radial multiples of 2(–3), sometimes with whitish, yellow or yellow-brown deposits, tyloses sparse; parenchyma moderately abundant to abundant, paratracheal vasicentric,



Neonauclea acuminata
transverse surface (×20)

inconspicuous, and apotracheal diffuse and diffuse-in-aggregates; rays extremely fine to moderately fine, only visible with a hand lens; ripple marks absent.
Shrinkage upon seasoning is low, occasionally reported high; back-sawn stock is subject to checking and severe warping, quarter-sawn stock dries satisfactorily. It takes about 11 days to kiln dry boards 25 mm thick from 65% to 15% moisture content. The wood is hard and strong. It is fairly easy to work and finishes well, quarter-sawn material tends to pick up and chip upon machining. The wood is moderately durable to durable when exposed to the weather or in contact with the ground, very durable under cover. The sapwood is permeable but the heartwood is resistant to pressure impregnation; a retention of 410 kg/m^3 for sapwood and 185 kg/m^3 for heartwood of *N. hagenii* has been reported when pressure treated. The wood is moderately resistant to termite attack. The sapwood is non-susceptible to *Lyctus*.
The average fibre length of *N. hagenii* is 1.63 mm, the sulphate pulp yield is 41%. Mechanical properties in the table on wood properties probably refer to *N. hagenii*, which has been often misidentified as *N. maluensis* (Valeton) S. Moore.
See also the tables on microscopic wood anatomy and wood properties.

Botany Deciduous shrubs or small to fairly large trees, up to 40(–45) m tall; bole straight, branchless for up to 20(–25) m, up to 80(–150) cm in diameter, buttresses absent or present and up to 2 m high; bark surface smooth to scaly, flaky or fissured, sometimes pustular, often greyish-brown but sometimes dark brown to greyish-black, inner bark usually fibrous, creamy, yellow, yellowish-brown, pink to reddish-brown; crown comparatively narrow, dense. Terminal vegetative bud usually strongly flattened. Leaves opposite, simple, entire, usually with a short petiole; stipules usually strongly appressed, caducous or persistent. Flowers in a terminal, stalked, spherical head, 1–3(–7) together, young head covered by large bracts, interfloral bracteoles present or absent, 5-merous; hypanthia mutually free; calyx with short tube and lobes, apical portion deciduous, partly persistent; corolla hypocrateriform to narrowly infundibular with imbricate lobes, white or cream; stamens inserted in the upper part of the corolla tube; ovary inferior, 2-locular with many ovules per cell, style exserted, with globose to obovoid stigma. Fruits in a head-like infructescence, free, splitting in 4 parts, with persistent central axis. Seed ellipsoid, slightly bilaterally compressed, with short wings at both ends. Seedling with epigeal germination; cotyledons leafy.
In Java *N. lanceolata* flowers in both the rainy and dry seasons, and ripe fruits are found at the beginning of the dry season. *N. excelsa* flowers mainly in April–June, but sporadically throughout the year and its ripe fruits are found in January–March. In several species the internodes of the ultimate branches are swollen and the hollow chambers are inhabited by ants (myrmedomes).
Within the tribe *Naucleeae*, *Neonauclea* is most closely related to *Ludekia* and 3 other small genera. The large bracts covering the young flowering heads, the calyx lobes with a distinct apical portion and the fruiting heads with free fruitlets are particularly characteristic. Material with young flowering heads and with mature corollas together with a vegetative bud is required to be able to identify the species with certainty; fruiting material is difficult or impossible to identify.



Neonauclea ventricosa Ridsd. – 1, twig with young flowering head and myrmedome; 2, flowering head; 3, fruiting head.

Ecology *Neonauclea* species occur in lowland forest, hill forest and lower montane forest up to 1800 m altitude. Some are common secondary species (e.g. *N. bartlingii*, *N. calycina*), but others are usually confined to the canopy or more frequently the sub-canopy layer of primary forest; most species occur on well-drained soils. In Papua New Guinea *Neonauclea* is sometimes associated with *Araucaria*, *Cryptocarya* and *Endiandra* species. A few *Neonauclea* species are frequently found on limestone (e.g. *N. excelsioides*).

Silviculture *Neonauclea* can be propagated by seed or by cuttings. Seeds should be separated from the fruits. Seeds of *N. excelsa* may be stored for about 2 months; they are extremely small, with about 37 million seeds/kg. They should be sown in the shade and have about 35% germination. Large cuttings of *N. excelsa* have been planted in forest plantations as a ground cover with easily decomposing leaves. In West Java natural regeneration of *N. lanceolata* is fairly abundant in both open and shaded locations in lower montane forest, but growth is very slow, being only 25 cm in height in the first 5 years and on average 1 m after 11 years. It is very sensitive to competition from herbs and small shrubs. Seedlings of *N. excelsa* mainly develop in the open or under slight shade and subsequent growth is good under moist conditions, as in the vicinity of streams. In 5 years they may attain 2–3 m in height. *Neonauclea* is usually considered to be intolerant of shade. In one locality in Papua New Guinea the estimated net volume of merchantable timber amounted to 1.1 m^3/ha, being 6% of the total. In the highlands of West Java, *N. excelsa* has been so severely damaged by animals when planted in monoculture that its planting is discouraged.

Genetic resources and breeding Some *Neonauclea* species are gregarious and not seriously threatened, but others are much less common or occur only locally and may easily become endangered. Locally, stands of certain species have already been considerably depleted by logging and habitat destruction, e.g. in the Philippines where the timber has been in great demand and where *N. calycina* is now considered a vanishing and endangered timber.

Prospects Many *Neonauclea* species are too small to be of importance as a timber, but some (e.g. *N. acuminata*, *N. brassii*, *N. glabra*, *N. hagenii*, *N. lanceolata*, *N. obversifolia*) reach a large size and are potentially of commercial importance. Since increased utilization of these durable timber species can be expected, e.g. for heavy construction, sleepers, and joinery, trials to assess their silvicultural potential are recommended.

Literature 40, 75, 80, 101, 125, 151, 162, 163, 209, 234, 235, 260, 267, 300, 302, 304, 348, 405, 423, 436, 536, 568, 571, 632, 634, 635, 715, 716, 780, 829, 861, 875, 934, 943, 945, 1052, 1086, 1209, 1221, 1232, 1248.

Selection of species

Neonauclea acuminata Ridsd.

Distribution New Guinea.

Neonauclea artocarpoides Ridsd.

Distribution Borneo (Brunei, Sabah, Kalimantan).

Neonauclea bartlingii (DC.) Merr.

Synonyms *Nauclea cumingiana* S. Vidal, *Neonauclea cordatula* (Merr.) Merr., *Neonauclea vidalii* (Elmer) Merr.

Vernacular names Philippines: tikim (general), lisak (Tagalog), pantauan (Bikol).

Distribution The Philippines.

Neonauclea brassii S. Moore

Distribution New Guinea.

Neonauclea calycina (Bartl. ex DC.) Merr.

Synonyms *Nauclea calycina* Bartl. ex DC., *Nauclea purpurascens* Korth., *Neonauclea peduncularis* (Wallich ex G. Don) Merr.

Vernacular names Hooded bur-flower tree (En). Malaysia: bengkal batu, mengkal batu (Peninsular). Philippines: kalamansanai (general). Thailand: krathum khao, lok khao (peninsular), lin kwang (north-eastern).

Distribution Burma (Myanmar), Indo-China, peninsular Thailand, Peninsular Malaysia, Sumatra, Java, Borneo, the Philippines, Sulawesi and the Lesser Sunda Islands.

Neonauclea celebica (Havil.) Merr.

Synonyms *Nauclea celebica* Havil.

Vernacular names Indonesia: masela, maumar, pepoipoyen (Sulawesi).

Distribution Sulawesi; possibly also in the Sula Islands.

Neonauclea clemensii Merr. & L.M. Perry

Distribution Papua New Guinea.

Neonauclea excelsa (Blume) Merr.

Synonyms *Nauclea excelsa* Blume, *Nauclea mollis* Blume, *Nauclea obtusa* Blume.

Vernacular names Indonesia: ki saat (Sundanese), klepu ketek (Javanese).

Distribution The Andaman Islands, Sumatra, Java, Borneo, Sulawesi and the Lesser Sunda Islands.

Neonauclea excelsioides Ridsd.

Distribution Borneo (Sabah, Kalimantan).

Neonauclea formicaria (Elmer) Merr.

Synonyms *Nauclea formicaria* Elmer.

Vernacular names Philippines: hambabalud (Bisaya).

Distribution The Philippines (Viscayas, Mindanao).

Neonauclea forsteri (Seem. ex Havil.) Merr.

Synonyms *Nauclea forsteri* Seem. ex Havil., *Neonauclea cardiophylla* Merr. & L.M. Perry, *Neonauclea vitiensis* Gillespie.

Distribution New Guinea, the Bismarck Archipelago, the Solomon Islands, Vanuatu, Fiji, Tonga, Samoa and the Society Islands.

Neonauclea gigantea (Valeton) Merr.

Synonyms *Neonauclea cyrtopodioides* (Wernh.) Merr.

Distribution Borneo (Sarawak, Sabah, Kalimantan).

Neonauclea glabra (Roxb.) Bakh. f. & Ridsd.

Synonyms *Neonauclea gordoniana* (F.M. Bailey) Ridsd., *Neonauclea moluccana* (Miq.) Merr., *Neonauclea nitida* (Havil.) Merr.

Vernacular names Indonesia: gogurati, kamayua, laharong (Moluccas). Philippines: balod, uisak-sikat (Tagalog).

Distribution The Philippines, the Moluccas, New Guinea and northern Australia.

Neonauclea hagenii (Lauterb. & K. Schumann) Merr.

Synonyms *Nauclea hagenii* Lauterb. & K. Schumann, *Neonauclea dahlii* (Valeton) Merr. & L.M. Perry, *Neonauclea papuana* (Valeton) Merr. & L.M. Perry.

Distribution The Moluccas (Seram), the Aru Islands, New Guinea and New Britain.

Neonauclea intercontinentalis Bakh. f. & Ridsd.

Distribution Sulawesi and the Moluccas (Sula Islands).

Neonauclea lanceolata (Blume) Merr.

Synonyms *Nauclea lanceolata* Blume, *Neonauclea gracilis* (S. Vidal) Merr., *Neonauclea philippinensis* (Havil.) Merr., *Neonauclea schlechteri* (Valeton) Merr. & L.M. Perry.

Vernacular names Indonesia: ki anggrit (Sundanese), klepu pasir (Javanese). Philippines: tiroron (Bikol).

Distribution Peninsular Malaysia (rare), Sumatra, Java, Borneo (Sabah), the Philippines, Sulawesi, the Lesser Sunda Islands, the Moluccas and New Guinea.

Neonauclea longipedunculata Merr.

Distribution Borneo (Sabah).

Neonauclea media (Havil.) Merr.

Synonyms *Nauclea media* Havil.

Vernacular names Philippines: uisak (Tagalog).

Distribution The Philippines (northern part).

Neonauclea obversifolia (Valeton) Merr. & L.M. Perry

Synonyms *Nauclea obversifolia* Valeton.

Distribution New Guinea and New Britain.

Neonauclea pallida (Reinw. ex Havil.) Bakh. f.

Synonyms *Nauclea pallida* Reinw. ex Havil.

Vernacular names Indonesia: cangcaratan caj, sengeh caah, tengeh caah (Sundanese).

Distribution Peninsular Thailand, Peninsular Malaysia, Sumatra and Java.

Neonauclea parviflora (Koord. & Valeton) Ridsd.

Synonyms *Nauclea purpurascens* Korth. var. *parviflora* Koord. & Valeton.

Distribution Eastern Java, the Lesser Sunda Islands and the Moluccas.

Neonauclea puberula (Merr.) Merr.

Synonyms *Nauclea puberula* Merr.

Vernacular names Philippines: bagodilau (Tagalog).

Distribution The Philippines (central part).

Neonauclea reticulata (Havil.) Merr.

Synonyms *Nauclea reticulata* Havil.

Vernacular names Philippines: malauisak (Tagalog).

Distribution The Philippines (Luzon).

Neonauclea solomonensis Ridsd.

Distribution The Bismarck Archipelago, the Solomon Islands and Vanuatu.

Neonauclea superba (S. Moore) S. Moore

Synonyms *Nauclea grashoffii* Valeton ex K. Heyne.

Vernacular names Indonesia: hangli (Sumatra).

Distribution Sumatra.

Neonauclea ventricosa Ridsd.

Distribution Sulawesi.

S. Aggarwal

Neoscortechinia Pax

Engl. & Prantl, Nat. Pflanzenfam. 1: 213 (1897).
EUPHORBIACEAE
x = unknown; $2n$ = unknown

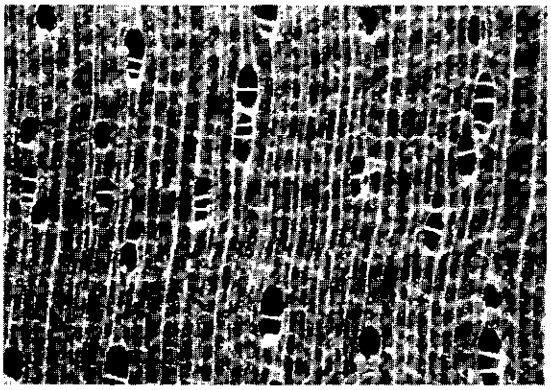
Vernacular names Neoscortechinia (En). Malaysia: agar agar (Sabah). Philippines: magong.

Origin and geographic distribution *Neoscortechinia* comprises 6 species occurring in southern Burma (Myanmar), the Nicobar Islands, Peninsular Malaysia, Sumatra, West Java, Borneo, the Philippines, Sulawesi, New Guinea and the Solomon Islands. All species are present in Malesia.

Uses The wood of *Neoscortechinia* is used for general, light or temporary construction, interior trim, mouldings, flooring, joinery, window-sills, window and door frames, boat building, turnery, packing cases and, when treated, for garden furniture. It is also applied for the manufacture of blockboard, particle board and core veneer, and for the production of pulp and paper. The wood of *N. kingii* is considered a good firewood.

Production and international trade The wood of *Neoscortechinia* is rarely used in western Malesia, but in Papua New Guinea and the Solomon Islands *N. forbesii* is regarded as a commercial timber. In 1996 Papua New Guinea exported only 38 m^3 of *Neoscortechinia* logs at an average free-on-board (FOB) price of US$ 101/m^3.

Properties *Neoscortechinia* yields a medium-weight to heavy hardwood with a density of 470–900 kg/m^3 at 15% moisture content. Heartwood straw-coloured to pale yellow-brown, darkening on exposure, not clearly differentiated from the sapwood; grain straight, interlocked or wavy; texture moderately fine and even; wood somewhat lustrous. Growth rings sometimes indicated by a narrow layer of dark-coloured wood; vessels moderately small to medium-sized, mostly in radial multiples of 2–3(–5), tyloses rare; parenchyma abundant, apotracheal in narrow bands often grading to diffuse-in-aggregates, distinct with a hand lens; rays moderately fine, just visible to the naked eye on transverse surface; ripple marks absent.



Neoscortechinia kingii
transverse surface (×20)

Shrinkage upon seasoning is low to moderate. Both air and kiln drying from the green condition is rapid; 25 mm thick boards take 3 days to kiln dry, 50 mm thick ones about 10 days. Back-sawn stock is liable to end-splitting and surface checking, the latter closing up again by the end of kiln drying. The wood is moderately hard and moderately strong. Sawing and working properties are average to good, it machines well and turns, bores and finishes to a good surface. The wood is moderately durable, the sapwood is permeable, the heartwood moderately permeable to impregnation. Sapwood and heartwood are liable to blue stain and susceptible to termites. The sapwood is non-susceptible to *Lyctus*.

The mean fibre length of *N. kingii* from Sumatra is 1.115 mm.

See also the tables on microscopic wood anatomy and wood properties.

Botany Evergreen, dioecious, small to fairly large trees up to 36 m tall; bole often irregular, branchless for up to 24 m, up to 100 cm in diameter, often fluted or channelled and/or with short to steep buttresses at base; bark surface smooth to rugulose, later dippled, red-brown, inner bark fibrous and granular, red to pink. Indumentum of simple and stellately bundled hairs. Leaves arranged spirally, simple, subentire to dentate, usually with 2 glands at base above; stipules caducous. Inflorescence axillary to terminal, thyrsoid, branching racemosely 2–3 times; cymules 1–7-flowered, scorpioid. Flowers unisexual, yellow, fragrant; sepals 4–5(–6); petals absent; disk absent. Male flower with 5–9 stamens; pistillode present. Female flower with a superior, 2-locular ovary with 1 ovule in each cell, style absent, stigma 2(–3)-lobed. Fruit a thin-walled capsule dehiscing with 4 valves, with 1(–2) seeds, central column and sepals persistent. Seed black, covered by a thin, red aril. Seedling with epigeal germination; cotyledons emergent, fleshy; hypocotyl elongated; first 2 leaves opposite, subsequent ones arranged spirally.

Diameter increment is reported to be low. In Peninsular Malaysia *N. kingii* flowers in September–December whereas its fruits ripen in about 13 weeks. Most other *Neoscortechinia* species seem to flower and fruit almost throughout the year. Orang utans have been observed to eat the fruits of *N. nicobarica*.

Neoscortechinia and the genus *Cheilosa* together form the tribe *Cheiloseae* within the subfamily *Acalyphoideae*. *Neoscortechinia* differs from *Cheilosa* in e.g. having fewer locules and seeds, no style and thinner-walled fruits. In western Malesia *N. forbesii* has often been confused with *N. philippinensis*.

Ecology *Neoscortechinia* occurs scattered, but *N. forbesii* is often gregarious, mainly in primary evergreen rain forest, up to 1500 m altitude. It occurs in a wide variety of habitats including dipterocarp forest, freshwater swamp forest, peat-swamp forest, riverine forest and mangrove forest.

Silviculture *Neoscortechinia* can be propagated by seed. Seeds of *N. kingii* still embedded in their aril have about 50% germination in 11–42 days.

Genetic resources and breeding Logging of *Neoscortechinia* is very limited. Only *N. forbesii*, which is logged more regularly and has a narrow geographic distribution, seems to risk genetic erosion.

Prospects It is unlikely that the use of *Neoscortechinia* timber will increase.

Literature 28, 32, 34, 70, 162, 163, 267, 300, 346, 436, 464, 536, 543, 553, 745, 800, 829, 831, 861, 974, 1154, 1195, 1221, 1222, 1232.

Selection of species

Neoscortechinia forbesii Hook. f. ex S. Moore

Vernacular names Indonesia: kir (Asmat, Irian Jaya), mansambree (Biak, Irian Jaya), wolok (Mooi, Irian Jaya).

Distribution New Guinea and the Solomon Islands.

Neoscortechinia kingii (Hook. f.) Pax & K. Hoffm.

Synonyms *Scortechinia kingii* Hook. f.

Vernacular names Indonesia: baniran (Kalimantan), meresik, mersikulit (Sumatra). Malaysia: bantas (Sarawak), jintek-jintek, tembatu (Peninsular).

Distribution Peninsular Malaysia, Singapore, Sumatra and Borneo.

Neoscortechinia nicobarica (Hook. f.) Pax & K. Hoffm.

Synonyms *Neoscortechinia arborea* (Elmer) Pax & K. Hoffm., *Neoscortechinia paniculata* (Ridley) Burkill, *Scortechinia nicobarica* Hook. f.

Vernacular names Indonesia: bantana (Sumatra), batin-batin (Tapah, Simeuluë), menteng monyet (Sundanese). Malaysia: perupoh jantan, salah (Peninsular). Philippines: magong (Samar-Leyte Bisaya).

Distribution The Nicobar Islands, Peninsular Malaysia, Sumatra, West Java, Borneo, the Philippines (Palawan) and Sulawesi.

Neoscortechinia philippinensis (Merr.) v. Welzen

Synonyms *Neoscortechinia arborea* (Elmer) Pax & K. Hoffm. var. *parvifolia* (Merr.) Pax & K. Hoffm., *Neoscortechinia coriacea* Merr., *Neoscortechinia parvifolia* (Merr.) Merr.

Vernacular names Indonesia: kayu lobang (Sumatra), medang berembang (Belitung), telapak kira (Bangka). Malaysia: agar-agar (Sabah), beki (Peninsular). Philippines: magong-liitan (Tagalog).

Distribution Southern Burma (Myanmar), Peninsular Malaysia, Sumatra, Borneo and the Philippines.

Neoscortechinia sumatrensis S. Moore

Vernacular names Malaysia: pudoh (Sabah).

Distribution Peninsular Malaysia, Sumatra and Borneo (Brunei, Sabah, Sarawak).

Rudjiman

Nephelium L.

Mant. pl. 1: 18 (1767).
SAPINDACEAE
$x = 11$; *N. lappaceum*: $2n = 22$

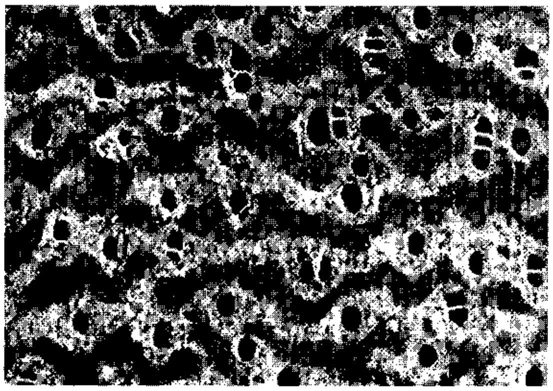
Vernacular names Rambutan (En, trade name). Brunei: buah hitam, buah satu inchi. Malaysia: meritam (Sabah), sibu (Sarawak). Thailand: ngoh (central). Vietnam: ch[oo]m ch[oo]m.

Origin and geographic distribution *Nephelium* comprises 22 species which occur from India (Assam), peninsular Burma (Myanmar), Indo-China, southern China, Hainan and Thailand to Peninsular Malaysia (10 species), Sumatra (8), western Java (3), Borneo (8), the Philippines (4) and Sulawesi (1).

Uses The wood of *Nephelium* is used for general construction (e.g. planking, beams) and furniture. It has also been applied for tool handles because of its toughness, and as firewood.
The sarcotesta of the fruits of many species – including the well-known, cultivated rambutan (*N. lappaceum*) – is edible, but the sarcotesta of some species is too small or too acid to be edible. The seeds contain an oil formerly used for illumination and a fat used formerly for soap and candles. The boiled or roasted seeds have been used in a beverage. The seeds of some *Nephelium* species are said to be poisonous. The fruit rind and occasionally the roots are used for medicinal purposes. An inferior black dye has been prepared from the shoots and the leaves.

Production and international trade As many *Nephelium* species yield edible fruits and trees are generally fairly small and too crooked to produce sawn timber, trees are seldom cut.

Properties *Nephelium* yields a medium-weight to heavy hardwood with a density of 615–1110 kg/m³ at 15% moisture content. Heartwood brown or pale purple-red or pale greyish-brown, sometimes distinct from the narrow sapwood; grain slightly interlocked to interlocked; texture moderately fine and even; pale zig-zag markings caused by parenchyma present on longitudinal surfaces. Growth rings indistinct or marked by marginal parenchyma; vessels moderately small to medium-sized, solitary or in radial multiples of 2–4, with occasional pale-coloured yellow-brown deposits; parenchyma moderately abundant to abundant, paratracheal aliform and confluent, and apotracheal in narrow marginal or seemingly marginal bands, visible to the naked eye; rays extremely fine to very fine, only visible with a hand lens; ripple marks absent.



Nephelium ramboutan-ake
transverse surface (×18)

The wood of *N. lappaceum* is liable to splitting during seasoning. It is moderately hard to very hard, strong and tough. The wood is easy to work and can be finished well. It is durable under cover and generally resistant to insect attacks, but susceptible to fungal attack.
The average fibre length of wood of *N. lappaceum* is 1.07 mm.
See also the table on microscopic wood anatomy.

Botany Evergreen, dioecious or sometimes monoecious, small to fairly large trees up to 35(–44) m tall, rarely shrubs; bole usually fairly slender and straight or rather crooked, up to 90(–140) cm in diameter, occasionally fluted, sometimes with buttresses up to 2(–4) m high; bark surface smooth to slightly flaking or sometimes dippled, often lenticellate, inner bark brown to orange or red. Leaves arranged spirally, paripinnate, 1-foliolate or 1–5(–18)-jugate, exstipulate; leaflets alternate or occasionally opposite, often glaucous and with domatia below. Flowers in an axillary or terminal, thyrsoid inflorescence, unisexual (sometimes at least functionally so); sepals (4–)5(–6), free to connate in the lower half; petals 5(–6), sometimes 1–4 reduced or all absent, shorter than the calyx, clawed and with a bilobed scale inside; disk entire. Male flowers with 4–10 stamens. Female flowers with a superior, (1–)2(–4)-locular, warty ovary with 1 ovule in each cell, style 1. Fruit a 1(–3)-lobed, partly to irregularly dehiscing capsule, generally with a warty to spiny wall. Seed almost entirely covered by a sarcotesta. Seedling with hypogeal germination; cotyledons not emergent; hypocotyl not elongated; first pair of leaves opposite, paripinnate, subsequent ones with increasing numbers of leaflets. Seedlings of *N. juglandifolium* and *N. ramboutan-ake* differ in being semi-hypogeal and in having tardily emergent cotyledons.

Ectomycorrhizae have been observed in *Nephelium*. Growth is in distinct flushes. Tree architecture is according to Scaronne's model, characterized by an indeterminate trunk bearing tiers of orthotropic branches which branch sympodially as a result of terminal flowering. *N. lappaceum* flowers 5–6 years after sowing. Flowering is initiated by a distinct dry spell and is reported to be annually. However, observations in Peninsular Malaysia show that most *Nephelium* species flower only once every 4 years. Apparently they need a definite, but not excessive, dry season for good flowering and heavy fruit set. Flowers are pollinated by insects, mainly bees. Most species are effectively dioecious since little or no viable pollen is produced in flowers appearing to be bisexual. The fruits take about 3 months to mature. They are eaten and dispersed by primates.

Identification without fruits is almost impossible. *N. cuspidatum* is highly variable with 6 varieties. *N. lappaceum* is subdivided into 3 varieties.

Ecology Timber-yielding species of *Nephelium* are generally found as middle storey trees in evergreen, lowland or sometimes montane, primary or sometimes secondary rain forest on hills and ridges, up to 600(–1950) m altitude. The habitat varies between species, but most are found in well-drained locations on sandy to loamy or clayey soils or on limestone, although several occur on river banks and in swamps. *N. daedaleum* has been reported from kerangas, and *N. lappaceum* from peat soils. *N. papillatum* is typical of montane forest.

Silviculture *Nephelium* is usually propagated by seed, but in commercial fruit production of *N. lappaceum* vegetative propagation (budding) is used. The seed of *Nephelium* should be sown immediately after collection. When stored, the seed should be kept in polyethylene bags at 20°C in sawdust moistened with juice from the fruits, as the juice inhibits germination. In this way, seed can be stored for up to 4 weeks. Germination trials in Malaysia included the following species: *N. costatum*, *N. cuspidatum*, *N. hamulatum*, *N. juglandifolium*, *N. lappaceum*, *N. maingayi*, *N. ramboutan-ake* and *N. uncinatum*. In general germination was good and rapid, being 85–100% in (7–)13–52(–58) days after sowing, and no important differences were found between seed sown with or without adhering pulp. The germination rate of seed of *N. uncinatum*, however, was only about 40%, regardless of whether the seed was sown with or without pulp. It may be necessary to inoculate the planting stock with ectomycorrhizae before planting out. In a 50-ha plot in natural forest at Pasoh (Peninsular Malaysia), a total of 280 *Nephelium* trees with a diameter over 10 cm were present.

Genetic resources and breeding Several of the minor fruit trees of *Nephelium* are of interest for cultivation and breeding. *N. lappaceum* is especially promising for breeding. Germplasm collections in South-East Asia are now being enriched with these minor species.

Prospects Timber production is not very important within *Nephelium* and is unlikely to increase in the near future. Some species, notably *N. ramboutan-ake*, may become important as fruit trees.

Literature 151, 158, 163, 191, 209, 238, 267, 341, 436, 438, 543, 595, 632, 690, 694, 825, 829, 831, 861, 934, 974, 981, 987, 1038, 1048, 1164, 1219, 1221, 1242, 1259.

Selection of species

Nephelium costatum Hiern

Vernacular names Malaysia: rambutan pasak (Peninsular).

Distribution Peninsular Malaysia.

Nephelium cuspidatum Blume

Synonyms *Nephelium eriopetalum* Miq., *Nephelium ophiodes* Radlk., *Nephelium robustum* Radlk.

Vernacular names Giant rambutan (En). Indonesia: rambutan kabung, ranggung, sangga lutung. Malaysia: buah kebuau (Iban, Sarawak), lotong, rambutan kabong (Peninsular). Philippines: panungaian (Tagalog). Singapore: sanggul lotong.

Distribution Peninsular Burma (Myanmar), Cambodia, Vietnam, Thailand, Peninsular Malaysia, Singapore, Sumatra, West Java (rare), Borneo and the Philippines (Palawan).

Nephelium daedaleum Radlk.

Vernacular names Malaysia: kalas (Iban, Sarawak).

Distribution Borneo (Sabah, Sarawak).

Nephelium hamulatum Radlk.

Synonyms *Nephelium herveyi* Ridley.

Vernacular names Malaysia: gumpal benang, rambutan pachat, sanggul lotong jantan (Peninsular).

Distribution Peninsular Malaysia.

Nephelium juglandifolium Blume

Synonyms *Nephelium altissimum* Teijsm. & Binnend., *Nephelium tuberculatum* Radlk.

Vernacular names Indonesia: lungsir, lengsar (Java), sorogol (Sundanese).

Distribution Peninsular Malaysia, Sumatra and West Java.

Nephelium lappaceum L.

Synonyms *Nephelium chryseum* Blume, *Nephelium obovatum* Ridley, *Nephelium sufferrugineum* Radlk.

Vernacular names Litchi chevelu (Fr). Rambutan (En). Indonesia: rambutan (general), chorogol (Sundanese), kakapas (Sumatra). Malaysia: rambutan (general), buah abong (Kenyah, Sarawak), rangalau (Dusan Ranau, Sabah). Philippines: rambutan (general). Cambodia: saaw maaw, ser mon. Thailand: ngoh (central), ngoh paa (peninsular). Vietnam: ch[oo]m ch[oo]m, vai thi[ee][uf].

Distribution Southern China (Yunnan), Hainan, Indo-China, Thailand, Peninsular Malaysia, Singapore, Sumatra, Java, Borneo, the Philippines and Sulawesi; cultivated throughout humid tropical Asia (from Sri Lanka to New Guinea) and in small numbers in tropical America, Africa and Australia.

Nephelium laurinum Blume

Synonyms *Nephelium caudifolium* Ridley, *Nephelium rubescens* Hiern.

Distribution Peninsular Malaysia, Sumatra, Borneo (Kalimantan, rare) and doubtfully reported from West Java.

Nephelium maingayi Hiern

Synonyms *Nephelium glabrum* auct. non Noroña.

Vernacular names Indonesia: buah unjing, penjaih, ridan (Sumatra). Malaysia: buah raydun, redan tumu (Peninsular), buah sungkit (Kedayan, Sabah).

Distribution Peninsular Malaysia, Sumatra and Borneo.

Nephelium meduseum Leenh.

Distribution Borneo (Brunei, Sarawak, Kalimantan).

Nephelium melliferum Gagnep.

Synonyms *Nephelium parviflorum* Gagnep.

Vernacular names Vietnam: boc, bor lo, c[aa]y truong v[as]i.

Distribution Peninsular Burma (Myanmar), Vietnam, Thailand and Peninsular Malaysia.

Nephelium papillatum Leenh.

Distribution Borneo (Sabah).

Nephelium ramboutan-ake (Labill.) Leenh.

Synonyms *Nephelium intermedium* Radlk. p.p., *Nephelium mutabile* Blume.

Vernacular names Indonesia: kapulasan, pulasan (Sundanese). Malaysia: buah mua (Iban, Sarawak), meritam (Sabah, Sarawak), pulasan (Peninsular). Philippines: bulala (Filipino), karayo (Tagalog), malapution (Samar-Leyte Bisaya). Singapore: pulasan. Burma (Myanmar): kyetmauk.

Distribution India (Assam), Burma (Myanmar), Peninsular Malaysia, Singapore, Sumatra, Java (doubtful), Borneo and the Philippines; also planted locally and possibly indigenous in the Moluccas.

Nephelium reticulatum Radlk.

Vernacular names Malaysia: buah sibo kakuran, buah stagok (Sarawak).

Distribution Borneo.

Nephelium subfalcatum Radlk.

Distribution Peninsular Malaysia, Sumatra and Borneo (Brunei, Sabah, Sarawak).

Nephelium uncinatum Radlk. ex Leenh.

Vernacular names Indonesia: lomon, namun (Kalimantan). Malaysia: mentaokod (Peninsular).

Distribution Peninsular Malaysia, Sumatra and Borneo.

T. Uji

Neuburgia Blume

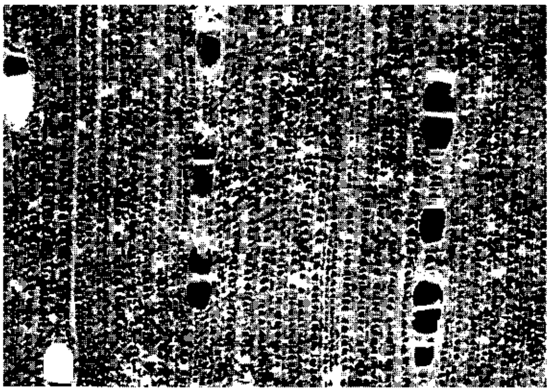
Mus. Bot. Lugd.-Bat. 1: 156 (1850).

LOGANIACEAE

x = unknown; $2n$ = unknown

Vernacular names Neuburgia (trade name).

Origin and geographic distribution *Neuburgia* comprises 10–12 species occurring in the Philippines, Sulawesi, the Moluccas, New Guinea, the Carolina Islands, the Solomon Islands, Vanuatu, New Caledonia and Fiji. Within the Malesian region 7 species are found.



Neuburgia corynocarpa
transverse surface (×20)

Uses The wood of *Neuburgia* is used for indoor construction, mouldings, interior finish, fruit cases and light framing. In Papua New Guinea the wood was formerly used to make bowls and plates. In the Solomon Islands the macerated bark is applied against skin diseases.

Production and international trade Small amounts of *Neuburgia* timber are imported in Japan in mixed consignments from Papua New Guinea. In 1996 Papua New Guinea exported about 1400 m^3 of *Neuburgia* logs at an average free-on-board (FOB) price of US$ 99/m^3.

Properties *Neuburgia* yields a lightweight to medium-weight hardwood with a density of 355–565 kg/m^3 at 15% moisture content. Heartwood grey-white or greenish grey-yellow, occasionally with streaks, not clearly demarcated from the paler sapwood; grain usually straight, sometimes interlocked; texture moderately fine to coarse. Growth rings indistinct; vessels almost all in radial multiples of 2–4, rarely in clusters; parenchyma rather scarce, apotracheal diffuse and diffuse-in-aggregates of 4–5 cells; rays fine; ripple marks absent.

Shrinkage of the wood upon seasoning is moderate to high. The wood is moderately soft and not strong. It is non-durable and the sapwood is susceptible to *Lyctus*.

See also the tables on microscopic wood anatomy and wood properties.

Botany Evergreen shrubs or small to fairly large trees up to 40 m tall; bole usually straight, branchless for up to 20 m, up to 100 cm in diameter, sometimes with buttresses; bark surface smooth to fissured or flaky, brown or straw-coloured to white, inner bark fibrous, straw-coloured to grey-white or white. Lateral twigs usually coalescent with the main twig for about 1 cm. Leaves opposite, simple, entire; stipules interpetiolar. Flowers in a terminal, thyrsoid inflorescence, sessile, 5-merous; calyx lobed; corolla rotate to salver-shaped, white, with a ring of hairs in the mouth, the lobes valvate in bud; stamens inserted in the upper half of the corolla tube, included, anthers hastate; ovary superior, 2-celled with many ovules, style 1, stigma ellipsoid to club-shaped. Fruit drupaceous with 1(–2) spindle-shaped seeds. Seedling with epigeal germination; hypocotyl elongated; internodes sometimes with longitudinal and undulate wings.

Tree form is according to Stone's architectural tree model, characterized by continuous growth of the orthotropic trunk, which produces orthotropic branches; branches develop sympodially below terminal inflorescences. Trees flower almost throughout the year. Fruits have been observed in January to April and in July to September. The scented flowers probably attract insects. In Fiji the fruits are eaten by pigeons, but otherwise they appear to be dispersed by water.

N. corynocarpa is polymorphic and has been divided into 2 varieties: var. *corynocarpa* and var. *sarcantha* (Gilg & Bened.) Conn (synonym: *N. sarcantha* (Gilg & Bened.) Leenh.).

Ecology *Neuburgia* is found in primary or sometimes old secondary forest. It occurs as an understorey or rarely a canopy tree in well-drained as well as in swamp forests and in temporarily flooded habitats. In Papua New Guinea *Neuburgia* is relatively common in montane forest, often in association with *Calophyllum*, *Castanopsis* or *Nothofagus*. *N. corynocarpa* does not tolerate salt-water conditions and occurs up to 2000 m altitude, whereas *N. celebica* is found in both salt- and freshwater habitats and up to 400 m altitude.

Silviculture *Neuburgia* can be raised from seed. Sown fruits of *N. corynocarpa* germinate after about 6 weeks, but only after the exocarp and mesocarp have been removed.

Genetic resources and breeding Both timber-yielding *Neuburgia* species have a relatively wide geographical distribution and seem not to be endangered.

Prospects It is unlikely that the use of *Neuburgia* wood for sawn timber will increase.

Literature 40, 125, 200, 300, 341, 348, 402, 403, 693, 781, 1232.

Selection of species

Neuburgia celebica (Koord.) Leenh.

Synonyms *Couthovia calophylla* Gilg & Bened., *Couthovia celebica* Koord., *Couthovia toua* Kaneh.

Vernacular names Indonesia: achera, dongkina putih, rondo rondo (Sulawesi). Philippines: bali-bali (Cebu Bisaya), pagi-pagi (Manobo), tanalak (Bagobo).

Distribution The Philippines, Palau Island, Sulawesi, the Moluccas and southern New Guinea.

Neuburgia corynocarpa (A. Gray) Leenh.

Synonyms *Couthovia corynocarpa* A. Gray, *Couthovia novobritannica* Kaneh. & Hatus., *Couthovia seemannii* A. Gray.

Vernacular names Indonesia: aifim (Numfoor, Irian Jaya), metan (Aru Islands), rantiepi (Japen Island).

Distribution The Moluccas (Obi), the Kai and Aru Islands, New Guinea, the Bismarck Archipelago, the Solomon Islands and Fiji.

E. Boer (general part),
M.S.M. Sosef (general part, selection of species)

Norrisia Gardner

Hook. Journ. Bot. Kew Gard. Misc. 1: 326 (1849).

LOGANIACEAE

x = unknown; $2n$ = unknown

Vernacular names Malaysia: kelat (Peninsular), menaseh (Sarawak).

Origin and geographic distribution *Norrisia* comprises 2 species confined to the western Malesian region. They occur in Peninsular Malaysia, Sumatra, Borneo and the Philippines.

Uses The wood of *Norrisia* is used for construction under cover and flooring. Tool handles and oars are made from the buttresses. In Sarawak the Iban value the wood for boat building.

Production and international trade *Norrisia* wood is not economically important and is used only locally.

Properties *Norrisia* yields a lightweight hardwood with a density of 380–490 kg/m^3 at 15% moisture content. Heartwood pale yellow, the included phloem sometimes visible as white streaks on the radial surfaces, not clearly differentiated from the sapwood; grain straight; texture slightly coarse and uneven due to the radial groups of vessels and islands of included phloem. Growth rings not observed; vessels moderately small to medium-sized, almost exclusively in radial multiples of 2–5(–14), with very long radial multiples in *N. malaccensis*; parenchyma scarce, not visible, even with a hand lens; rays extremely fine; ripple marks absent; included phloem occurring as numerous, small, round to oval islands, diffusely scattered.

Norrisia maior
transverse surface (×20)

The wood is soft to moderately hard, moderately strong and non-durable.

See also the table on microscopic wood anatomy.

Botany Evergreen, medium-sized to large trees, up to 50 m tall; bole usually angular and sometimes poorly shaped, up to 100 cm in diameter, with buttresses up to 5 m high; bark surface smooth to cracking or finely fissured, grey or grey-brown, inner bark yellowish-brown or pale yellowish-brown with a pink tinge. Leaves opposite, simple, entire, connected by small stipules. Inflorescences terminal and axillary, thyrsoid to dichasially branched, many-flowered, rusty tomentose. Flowers 5-merous, subsessile; calyx with a short tube; corolla salver-shaped, cream to yellowish, tomentose outside, the lobes valvate in bud; stamens inserted on the tube in between the corolla lobes and far exserted; ovary superior, 2-locular with many ovules, stigma slightly bilobed. Fruit a 2-valved, tomentose capsule with few to many, small, spindle-shaped seeds.

Flowers and fruits have been observed almost throughout the year. Pollination is probably by insects. The tiny seeds are likely to be dispersed by wind.

The two species are very similar and some confusion has occurred in literature, making it sometimes impossible to attribute certain features to either one of them.

Ecology *Norrisia* occurs scattered or locally gregarious in primary and secondary lowland rain forest, up to about 900 m altitude. It is often found along rivers, in swamp forest or periodically inundated locations, but also in well-drained habitats like mixed dipterocarp forest, on both clayey and sandy soils. *N. malaccensis* has been reported forming pure stands in old secondary forest.

Genetic resources and breeding There are no records of ex situ conservation of *Norrisia*.

Prospects Research on wood characteristics and propagation of *Norrisia* is a prerequisite for a potential increase in the use of the wood. No such increase is foreseen in the near future.

Literature 61, 163, 198, 267, 341, 436, 693, 781, 861, 974, 1040, 1048, 1221, 1250.

Selection of species

Norrisia maior Soler.

Synonyms *Norrisia malaccensis* Gardner var. *maior* (Soler.) Ridley.

Vernacular names Indonesia: bengkaras, merkaras (Kubu, Sumatra). Malaysia: empaling (Iban, Sarawak), serapak paya (Peninsular), simpapait (Putatan Dusun, Sabah).

Distribution Peninsular Malaysia, Bangka, the Riau Archipelago, Sumatra and Borneo.

Norrisia malaccensis Gardner

Synonyms *Antonia griffithii* Wight, *Norrisia philippensis* Elmer.

Vernacular names Indonesia: balang, barehbareh (Sumatra). Malaysia: kayu karkaras, serapoh bukit (Peninsular). Philippines: yangi (Manobo).

Distribution Peninsular Malaysia, Sumatra, Borneo (Sabah) and the Philippines.

Isa Ipor

Nothaphoebe Blume

Mus. Bot. Lugd.-Bat., 21e stuk: 328 (1851).

LAURACEAE

x = probably 12 as in many other *Lauraceae* genera; $2n$ = unknown

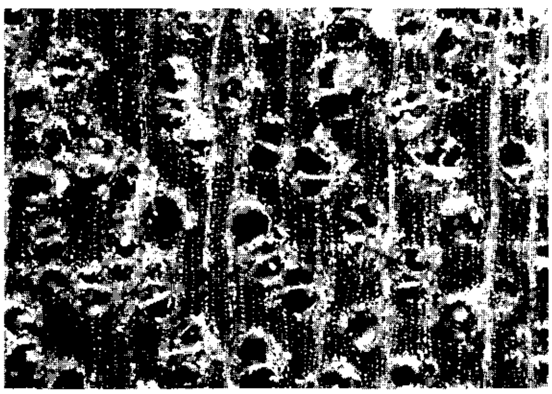
Vernacular names Medang (trade name). Burma (Myanmar): kyese.

Origin and geographic distribution *Nothaphoebe* comprises about 25 species occurring in Burma (Myanmar), Indo-China, Thailand and throughout the Malesian region. Six species are found in Peninsular Malaysia, probably about 10 in Borneo, 3 in the Philippines, only 2 in Java and probably 2 in New Guinea.

Uses The wood of *Nothaphoebe* has been used for house building (the heavier species for medium heavy construction under cover), interior finish, furniture, carving and sculpture, pattern making, and for the production of veneer and plywood.

Production and international trade The wood of *Nothaphoebe* is traded together with that of many other *Lauraceae* genera as 'medang'. It probably constitutes only a minor portion of the total amount of medang traded. In 1984 the total export of medang from Peninsular Malaysia to Singapore was 1500 m^3 with a value of US$ 62 000. In 1992 the export of medang from Sabah amounted to 52 000 m^3 (of which about 10% was sawn timber) with a total value of US$ 4.3 million. In Papua New Guinea the minimum price for medang logs was US$ 43/m^3 in 1992. Japan imports logs of medang mainly from Sabah, Sarawak and Papua New Guinea.

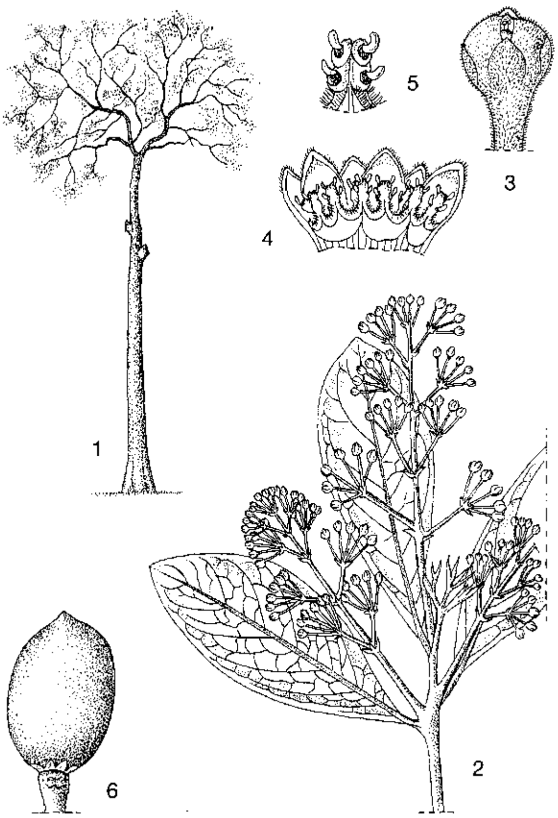
Properties *Nothaphoebe* yields a lightweight to medium-weight hardwood with a density of 390–750 kg/m^3 at 15% moisture content; for *N. macrocarpa* a density of up to 960 kg/m^3 at 15% moisture content is reported. Heartwood pale olive-brown, darkening on exposure, moderately sharply differentiated from the pale yellow-green or grey-green, up to 4 cm wide sapwood; grain interlocked, sometimes straight; texture moderately fine and even; wood rather lustrous; planed surfaces slightly greasy to the touch; wood with faint pungent odour. Growth rings indistinct; vessels



Nothaphoebe malabonga
transverse surface (×20)

medium-sized, solitary and in radial multiples of 2–4, sometimes in diagonal arrangement, tyloses present; parenchyma scanty, paratracheal vasicentric, occasionally slightly aliform; rays moderately fine; ripple marks absent.
Shrinkage of the wood upon seasoning is low. Seasoning is easy; air drying of 2.5 cm thick boards of *N. umbelliflora* to 16% moisture content takes about 80 days. The wood is soft and moderately strong. It works very easily. The wood is durable for interior work, but non-durable when exposed to the weather or in contact with the ground. Heartwood of *N. malabonga* is resistant to impregnation, but that of *N. umbelliflora* is moderately well treatable. The sapwood is easily treated with preservatives.
The bark of most species contains the poisonous alkaloid laurotetanine.
See also the tables on microscopic wood anatomy and wood properties.

Botany Evergreen, small to medium-sized trees up to 30(–36) m tall; bole often straight and cylindrical, branchless for up to 21 m, up to 70(–90) cm in diameter, without or with small buttresses, coarse pneumatophores and tall buttresses are present in *N. coriacea*; bark surface smooth to cracked or flaky, lenticellate, grey-brown, brown or pinkish-brown, inner bark granular, brownish, fawn or pink to red, sometimes pinkish-yellow with white flecks. Leaves generally alternate, rarely subopposite or opposite, simple, entire, usually aromatic when crushed, exstipulate. Flowers in an axillary or subterminal panicle, bisexual, 3-merous; tepals 6, with a short tube, the outer whorl much smaller than the inner; stamens 9, those of the inner whorl with 2 glands each, anthers 4-celled, opening by valves, sessile; ovary superior, 1-locular with a single ovule, stigma peltate. Fruit a 1-seeded, black berry, seated on a persistent but hardly enlarged perianth cup. Seedling with hypogeal germination; cotyledons not emergent, peltate; hypocotyl not developed; epicotyl with a few scales; first few leaves arranged spirally.



Nothaphoebe macrocarpa (Blume) Kosterm. – 1, tree habit; 2, flowering twig; 3, flower bud; 4, opened flower; 5, stamen; 6, fruit.

The seeds are dispersed by birds.
Nothaphoebe has formerly been regarded as congeneric with *Persea*, but is now thought to be distinct because of its small outer perianth lobes and sessile anthers. *Nothaphoebe* is also closely related to *Alseodaphne* but differs in the normal, not fleshy and thickened, fruit pedicel. Like many other genera in the *Lauraceae* the genus is in desperate need of a thorough taxonomic revision. Identifications at species level are often doubtful.

Ecology Timber-yielding *Nothaphoebe* species occur in primary, evergreen lowland to lower montane rain forest, up to 1200 m altitude. They are found in flat to hilly locations and are sometimes riverine. *N. coriacea* is found in swamp, especially peat-swamp forest. *N. foetida* prefers sandy loams, whereas *N. helophila* is found in peat-swamp forest.

Silviculture *Nothaphoebe* can be raised from seed. Fruits of *N. umbelliflora* germinated for about 60% in 2–3.5 months and the seeds for about 55% in 2–3.5 months after sowing, indicating that cleaning of the seed does not influence germination.

Genetic resources and breeding Species with a narrow geographical distribution may be at risk of genetic erosion by habitat destruction. However, the assessment of this threat is difficult, since species identification is often doubtful.

Prospects Although a number of species (e.g. *N. malabonga*, *N. umbelliflora*) have fairly often been used as 'medang' it is unlikely that their future use will increase.

Literature 41, 70, 162, 163, 267, 436, 543, 595, 603, 604, 605, 607, 614, 626, 756, 785, 829, 831, 861, 933, 934, 1038, 1076, 1169, 1221, 1232, 1242.

Selection of species

Nothaphoebe coriacea (Kosterm.) Kosterm.

Synonyms *Alseodaphne coriacea* Kosterm.

Distribution Peninsular Malaysia, Singapore, Sumatra and Borneo (Kalimantan).

Nothaphoebe elata (Kosterm.) Kosterm.

Synonyms *Alseodaphne elata* Kosterm.

Vernacular names Indonesia: sbei (Manikiong, Irian Jaya).

Distribution New Guinea (Irian Jaya).

Nothaphoebe foetida (Kosterm.) Kosterm.

Synonyms *Alseodaphne foetida* Kosterm.

Distribution Borneo (Kalimantan); possibly also in Sumatra.

Nothaphoebe helophila (Kosterm.) Kosterm.

Synonyms *Alseodaphne helophila* Kosterm.

Vernacular names Indonesia: medang paya (Sumatra).

Distribution Sumatra.

Nothaphoebe kingiana Gamble

Distribution Peninsular Malaysia.

Nothaphoebe macrocarpa (Blume) Kosterm.

Synonyms *Alseodaphne macrocarpa* (Blume) Kosterm., *Alseodaphne spathulata* (Blume) Boerl., *Nothaphoebe spathulata* (Miq.) Meissner.

Vernacular names Indonesia: bang gunong (Madura), ki lahung (Sundanese), pajar gunung (Javanese).

Distribution Java.

Nothaphoebe magnifica (Kosterm.) Kosterm.

Synonyms *Alseodaphne magnifica* Kosterm.

Distribution Sumatra.

Nothaphoebe malabonga (Blanco) Merr.

Synonyms *Alseodaphne malabonga* (Blanco) Kosterm.

Vernacular names Philippines: malabunga (Filipino), kabulo (Tagalog), malaya (Bikol).

Distribution The Philippines.

Nothaphoebe pachyphylla Kosterm.

Distribution Borneo (East Kalimantan).

Nothaphoebe panduriformis (Hook. f.) Gamble

Synonyms *Alseodaphne panduriformis* Hook. f.

Vernacular names Malaysia: medang ayer, medang hitam, medang lebar daun (Peninsular).

Distribution Peninsular Malaysia and Borneo.

Nothaphoebe umbelliflora (Blume) Blume

Synonyms *Alseodaphne umbelliflora* (Blume) Hook. f., *Nothaphoebe archboldiana* Allen, *Nothaphoebe novoguineensis* Kaneh. & Hatus., *Persea umbelliflora* (Blume) Kosterm.

Vernacular names Indonesia: ki kawat, madang kapas (Sundanese), medang lasa (general). Malaysia: medang merah, medang lenggadai, telur belangkas hutan (Peninsular). Laos: yang b[oo]ng. Thailand: thang bai cho (peninsular).

Distribution Indo-China, Thailand, Peninsular Malaysia, Singapore, Sumatra, Java, Borneo and New Guinea.

E. Boer (general part),
M.S.M. Sosef (general part, selection of species)

Nyssa L.

Sp. pl. 2: 1058 (1753); Gen. pl., ed. 5: 478 (1754).
CORNACEAE

$x = 11$; *N. javanica* and all North American species: $2n = 44$

Vernacular names Kirung (trade name). Indonesia: hirung, kapi dengkung (Sundanese), wuru gading (Javanese). Malaysia: terang bulu (Kelabit, Sarawak). Laos: 'theun. Thailand: khai pla, mueat khon khao (north-eastern), khang khok, khueng khak (northern). Vietnam: t[uwx] Java.

Origin and geographic distribution *Nyssa* comprises 8 species, 4 of which occur in North and Central America, 3 in China and 1 widespread from north-eastern India and the Himalayas to Indo-China, southern China, Thailand, Peninsular Malaysia, Sumatra, Java and Borneo. The latter is *N. javanica* (Blume) Wangerin (synonyms: *N. arborea* (Blume) Koord., *N. bifida* Craib, *N. sessiliflora* Hook. f. & Thomson).

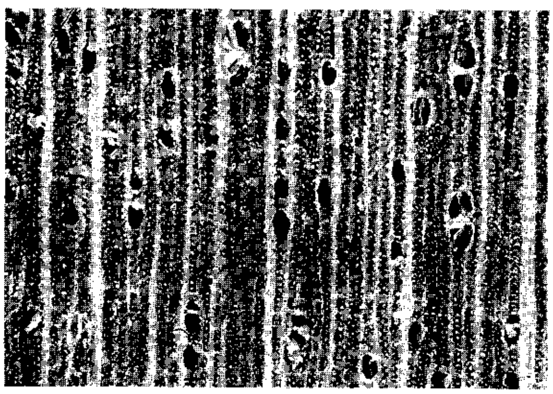
Uses The wood of *Nyssa* is used for house building under cover, interior finish, furniture, packing cases and tea boxes, and for the production of veneer and plywood. It is suitable for the production of wood-wool board.

The juicy aril of the fruit is edible, tasting like that of *Baccaurea racemosa* (Reinw. ex Blume) Müll. Arg.; in Thailand it is cooked in syrup before consumption.

Production and international trade As supplies of *Nyssa* timber are generally limited, it is used on a local scale only.

Properties *N. javanica* yields a medium-weight hardwood with a density of 500–720 kg/m^3 at 15% moisture content. Heartwood pale yellow-brown to pale grey-brown, not clearly differentiated from the sapwood; grain straight to slightly interlocked; texture moderately fine and even; wood sometimes lustrous. Growth rings indistinct to distinct, boundaries indicated by denser tissues or occasionally by more parenchyma; vessels moderately small to medium-sized, solitary and in radial multiples of 2–4, tyloses and white deposits rare; parenchyma moderately abundant, scanty paratracheal, or apotracheal diffuse and diffuse-in-aggregates, hard to discern even with a hand lens; rays very fine to moderately fine, conspicuous on radial surface; ripple marks absent.

Shrinkage and checking upon seasoning is low. The wood is moderately soft to moderately hard and fairly strong. It is easy to saw and can be worked to a bright smooth surface. It can be turned well and requires little hand finishing. It is non-durable to slightly durable under exposed conditions and is somewhat liable to stain.



Nyssa javanica
transverse surface (×20)

The gross energy value of the heartwood is about 19 575 kJ/kg. All *Nyssa* species accumulate cobalt and nickel in their leaves.

See also the tables on microscopic wood anatomy and wood properties.

Botany An evergreen or semi-deciduous, androdioecious, medium-sized to large tree up to 50 m tall; bole cylindrical, branchless for up to 25 m, up to 100 cm in diameter, sometimes with very small buttresses; bark surface smooth to flaky, lenticellate, grey or pale brown, inner bark fibrous or laminated, dull yellow or pale brown, staining dark blue upon exposure. Leaves arranged spirally, crowded, simple, entire, exstipulate. Flowers in an axillary, stalked head, male or bisexual; calyx with a smooth or 4–5-toothed rim; petals 4–5; disk cushion-shaped. Male flowers in a 20–40-flowered head or short raceme; stamens 8–10, in 2 whorls. Bisexual flowers in a 2–10-flowered head; at least stamens of inner whorl sterile; ovary inferior, 1-locular with a single ovule, style with 2 diverging branches. Fruit a drupe, crowned by the persistent calyx and disk. Seed with scanty, oily endosperm. Seedling with epigeal germination; cotyledons emergent, leafy; hypocotyl elongated; all leaves arranged spirally.

In natural forest the average height increment during the first 4 years is 2–3 m. Within Malesia *N. javanica* flowers mostly during the rainy season in January–June and fruits in July–December. The fruits are frequently deformed into worm-shaped galls.

Nyssa has often been accommodated in the family *Nyssaceae*, but it has recently been strongly advocated to incorporate the *Nyssaceae* into the *Cornaceae*.

Ecology *N. javanica* occurs scattered but may be locally common. It is found in primary, lowland to lower montane rain forest, at (100–)600–1600 m altitude. It occurs on slopes and ridge tops, in both perhumid and periodically dry regions.

Silviculture *N. javanica* can be propagated by seed; there are about 2650 dry seeds/kg. Seeds should be left for 1 week to improve the germination rate, which then is about 55%. They should be sown in the shade. Natural regeneration under *N. javanica* trees can be very dense and occasionally attains 300 seedlings/m^2. Over larger areas regeneration is patchy due to the heavy seeds which are not dispersed far. Natural regeneration does not occur in dense shade. In Java considerable damage by a root borer, probably the moth *Phassus damor*, has been observed.

Genetic resources and breeding *N. javanica* is rare but does not seem to be endangered as it has a comparatively wide area of distribution and is seldom cut.

Prospects *N. javanica* may hold some promise in agroforestry systems as it can produce both timber and tasty fruits.

Literature 70, 101, 130, 148, 159, 161, 163, 198, 260, 267, 341, 343, 405, 436, 509, 634, 861, 889, 933, 947, 1038, 1039, 1048, 1182, 1221.

P.C. Yii

Ochreinauclea Ridsd. & Bakh. f.

Blumea 24: 331 (1978).

RUBIACEAE

x = unknown; $2n$ = unknown

Vernacular names Bangkal (trade name). Malaysia: jengkai, lenggaung (Sabah), mengkal (Peninsular).

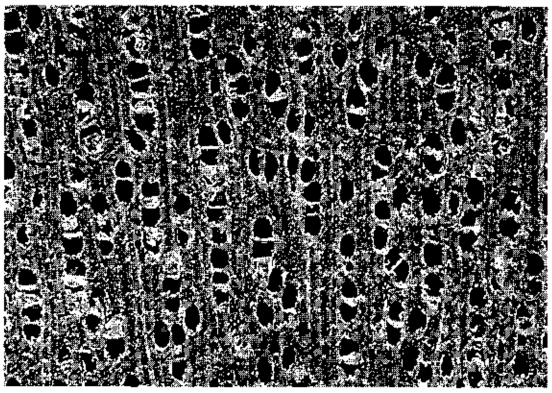
Origin and geographic distribution *Ochreinauclea* comprises 2 species, one of which is confined to India; the other species, *Ochreinauclea maingayi* (Hook. f.) Ridsd. (synonyms: *Nauclea maingayi* Hook. f., *Sarcocephalus maingayi* (Hook. f.) Havil.), occurs in peninsular Thailand, Peninsular Malaysia, Sumatra and Borneo.

Uses The wood of *O. maingayi* can be used for similar purposes as that of *Nauclea* and *Neonauclea*: for house and bridge building, furniture and cabinet work, flooring, boats, inlaying, turnery and implements.

The sweetish fruits are edible.

Production and international trade *Ochreinauclea* timber is traded together with that of *Nauclea*, *Neonauclea* and *Pertusadina* under the trade name 'bangkal', but it probably accounts for only a minor portion of the total amount of bangkal traded.

Properties *O. maingayi* yields a medium-weight hardwood with a density of 540–795 kg/m^3 at 15% moisture content. Heartwood pale brown or yellow-brown with a pink tinge, not clearly demarcated from the pale yellow sapwood; grain shallowly interlocked; texture moderately fine. Growth rings mostly indistinct, sometimes present, when present boundaries indicated by a zone with fewer vessels; vessels medium-sized, in radial multiples of 2–4, sometimes over 4, in definite radial alignment, solitary in the earlywood, open; parenchyma moderately abundant, very occasionally paratracheal vasicentric, and apotracheal diffuse and diffuse-in-aggregates, visible with a hand lens; rays very fine to moderately fine; ripple marks absent.



Ochreinauclea maingayi
transverse surface (×20)

The wood is strong but not durable and is susceptible to blue stain.

See also the table on microscopic wood anatomy.

Botany A medium-sized tree up to 25 m tall; bole up to 65(–100) cm in diameter; bark surface smooth to lenticellate, greyish-brown, inner bark yellow turning purplish on exposure. Terminal vegetative bud conical to pyramidal. Leaves opposite (sometimes ternate), simple, entire, elliptical to obovate, petiolate; stipules embracing the terminal bud, persistent. Inflorescence terminal, composed of solitary heads on unbranched axes. Flowers 5-merous; hypanthia mutually connate at apices; calyx with a short tube and oblong to trigonal lobes, persistent; corolla hypocrateriform with imbricate lobes; stamens inserted in the upper part of the corolla tube; ovary inferior, 2-locular with many ovules, style exserted, with spindle-shaped stigma. Fruits partially cohering into a pseudosyncarp, slowly breaking apart into the semi-free actual fruits. Seed ellipsoid, bilaterally compressed, shortly winged at each end. Seedling with epigeal germination; cotyledons leafy.

Ochreinauclea belongs to the tribe *Naucleeae* and is most closely related to *Nauclea* and the African genus *Sarcocephalus* which both have a syncarp. It differs from *Nauclea* in the conical to pyramidal terminal vegetative bud, the overlapping stipules, the comparatively longer calyx lobes, and the winged seeds.

Ecology *O. maingayi* occurs in lowland forest including riverine and swamp forest.

Silviculture *O. maingayi* can be raised from seed; in a trial seeds germinated in 12–50 days after sowing, with few seeds taking up to 5 months.

Genetic resources and breeding *O. maingayi* is locally common (e.g. in Peninsular Malaysia) and does not seem to be immediately endangered.

Prospects Since very little information is available on *O. maingayi*, more research is needed to determine its prospects.

Literature 163, 209, 267, 553, 829, 831, 943, 1221, 1242.

E. Boer & R.H.M.J. Lemmens

Ochroma Sw.

Prodr.: 97 (1788).

BOMBACACEAE

x = unknown; *O. pyramidale*: $2n$ = 72, 78, 88, 90

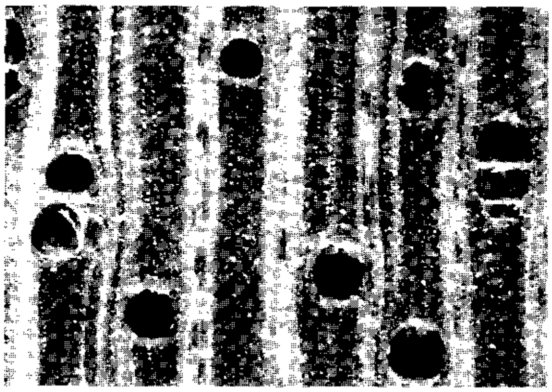
Vernacular names Balsa (trade name).

Origin and geographic distribution *Ochroma* is a monotypic genus occurring in tropical Central and South America from southern Mexico to Bolivia. The only species is *O. pyramidale* (Cav. ex Lamk) Urban (synonyms: *O. bicolor* Rowlee, *O. grandiflora* Rowlee, *O. lagopus* Sw.) which is planted in many tropical countries; in the Malesian region in the Philippines, Malaysia, Java and Papua New Guinea where it has locally become naturalized.

Uses The extremely lightweight wood of *Ochroma* is used for buoys, life-jackets and life-belts, surf boards, aircraft construction, toys, model making, entomology mounting boards, core stock in sandwich construction, surgical splints, packaging of fragile articles and as insulation for heat, vibration, sound and formerly also for electricity. The heavier wood of *Ochroma* is suitable for matches, popsicle sticks, toothpicks, etc. and for the production of pulp and paper.
The kapok from the fruits is suitable for filling pillows and mattresses. Ropes have been made from the fibrous bark. The tree is sometimes planted as an ornamental or to provide shade expediently.

Production and international trade Ecuador is the main exporting country of *Ochroma* wood supplying 80–90% of the volume traded on the world market.

Properties *Ochroma* is an extremely lightweight hardwood with a density of (40–)90–310 kg/m³ at 12% moisture content, but with a very large difference between the outer most wood and that from the centre, the new wood being on average 2.2 times heavier than the old wood as determined for wood samples from Costa Rica. Most of the commercial stock is sapwood. Heartwood white to grey-white, sometimes with a pinkish tinge near the heart in older trees, not clearly demarcated from sapwood; grain straight; texture coarse and even; wood with silky lustre. Growth rings indistinct; vessels moderately small to moderately large, solitary and in radial multiples of 2–3, rarely more than 4, open, vessels lines conspicuous appearing as coarse brown scratches; parenchyma paratracheal mostly vasicentric, and apotracheal diffuse-in-aggregates, indistinct; rays medium-sized to moderately broad, conspicuous on all surfaces producing a silver grain on the radial surface; ripple marks absent.

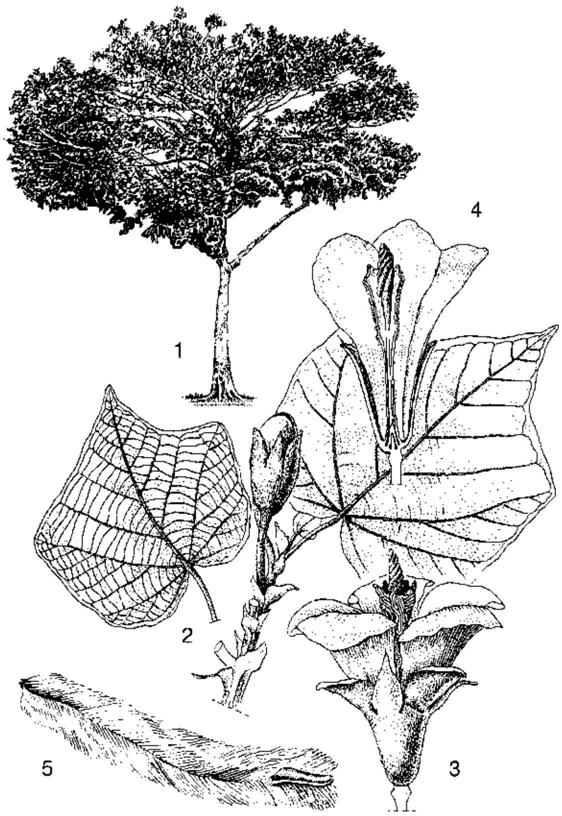


Ochroma pyramidale
transverse surface (×20)

Shrinkage upon seasoning is low to moderate, the wood seasons easily and rapidly (air drying from green to 15% moisture content takes 1–3 weeks) with very little degrade, but is highly prone to blue stain. It should be converted rapidly after felling to prevent extensive splitting and staining. Kiln drying is preferable to air drying, to minimize splitting and warping; kiln schedule H is recommended. The wood is very soft and very weak but with a good strength to weight ratio. The wood from old trees tends to be brittle. The wood is very easy to work with hand and machine tools, but sharp tools are essential to prevent crumbling. It has good insulating properties and high buoyancy. The wood is non-durable and prone to attack by *Anobium*, *Lyctus*, termites and longhorn beetles. Both sapwood and heartwood are permeable to impregnation, the retention of preservative by the pressure heating method is about 560 kg/m³ for sapwood and about 334 kg/m³ for heartwood.
The fibres are very long and yield a high-quality

chemical pulp with a recovery ratio of 45–50%, whereas the raw pulp can be easily bleached.
See also the tables on microscopic wood anatomy and wood properties.

Botany Deciduous or evergreen, medium-sized or rarely large trees up to 30(–50) m tall; bole straight, usually short, cylindrical, up to 100 (–180) cm in diameter, with short buttresses in older trees; bark surface smooth, grey-white mottled. Leaves arranged spirally, simple, angular-lobate, palmately veined; stipules present. Flowers axillary, solitary; calyx tubular, with 5 unequal lobes; petals 5, whitish; stamens united into a briefly 5-lobed staminal column bearing sessile wavy anthers from the middle to the apex; ovary superior, 5-locular with many ovules in each cell, style club-shaped, stigma spiralled. Fruit an oblong, ribbed, 5-valved dehiscent capsule, densely lanate inside.
Growth of *O. pyramidale* trees can be extremely rapid and is according to Koriba's architectural



Ochroma pyramidale (Cav. ex Lamk) Urban – 1, tree habit; 2, flowering twig; 3, flower; 4, longitudinal section of flower; 5, dehisced fruit.

tree model, characterized by orthotropic axes which branch to produce initially equivalent modules. Subsequently one of these modules becomes dominant, constituting one unit of the sympodial trunk. In Peninsular Malaysia growth is too slow to produce the very low-density wood which is sought after for many of its uses. In trials in Indonesia the mean annual increment was 2.0–6.6 cm in diameter and 1.2–3.3 m in height. In Papua New Guinea trees with a diameter of about 20 cm displayed a mean annual diameter increment of 1.7–4.3 cm. In South America mean annual diameter increment is even up to 10 cm and after 10–12 years, when growth stabilizes, trees are generally 20–25 m tall and about 100 cm in diameter. After 12–15 years growth slows down and the trees deteriorate rapidly. Only under specific circumstances may trees reach 50 m in height. In Java and Peninsular Malaysia *O. pyramidale* flowers throughout the year and is pollinated by bats. Trees start producing viable seed after (2–)3–4 years and dispersal is by wind.
O. pyramidale is highly variable, which is probably why the genus was formerly thought to comprise at least 11 species.

Ecology *O. pyramidale* is a typical pioneer, colonizing clearings. It grows gregariously with a preference for alluvial flats, on rich, well-drained or volcanic soils up to 1000 m altitude. In natural conditions it prevails under an annual precipitation of 1250–3000 mm and a mean annual temperature of 22–27°C; it can tolerate a dry season of up to 4 months, but only if the relative humidity does not normally drop below 75%.

Silviculture *O. pyramidale* can be propagated by seed. The very fine seeds (112 000–150 000 dry seeds/kg) should be collected from standing trees and can be stored for several years in jute bags or in closed receptacles. In Papua New Guinea seed is collected in June–August. Seeds can be sown directly in the field or in the nursery. Freshly collected seed has only 10% germination. Seeds contain an impervious testa which must be ruptured by heat (boiling water, fire) before they will germinate. Under natural conditions forest clearance exposes the soil to the sun and this triggers germination of *Ochroma* seeds. In the nursery seeds are sown in lines 3–4 cm apart under slight shade and in sterilized soil to prevent damping-off. Pretreated seeds show 65–75% germination in 6–28 days and seedlings are pricked out and transferred to containers. When they are 3–4 months old and 20–25 cm tall, they can be planted out in the field at 4–5 m × 4–5 m, possibly in a taungya system with a spacing of 2 m × 3 m. In Papua New Guinea a higher initial density of 2268 trees/ha (about 2.1 m × 2.1 m) is applied. As the roots of young plants are extremely sensitive to damage, bare-rooted plants cannot be used and direct seeding is preferred using seed holes at 3 m × 3 m. The soil should be deep, well-aerated and fertile, to allow for rapid growth; slightly inferior sites retard growth and will produce wood with a higher density (over 160 kg/m^3), which is not of commercial interest as only the extremely lightweight wood is in demand. Thinning is comparatively heavy and aims at creating enough growing space for the trees to allow for rapid growth. For Papua New Guinea a reduction of the initial 2268 trees/ha to 99 trees/ha before clear felling at the age of five is advocated. A rotation of 8 years is applied in Indonesia with a reduction in stems from 900–1225 to 90–170 per ha, depending on the site. Great care should be taken to avoid damage to the remaining trees, as they heal very poorly or not at all. A mean annual volume increment of 17–30 m^3/ha can generally be expected, although 69 m^3/ha and 90 m^3/ha has been achieved in Indonesia in 8- and 6-year-old plantations, respectively and 50 m^3/ha is commonly accepted as realistic. Rotations do not generally exceed 7–8 years, as the rapid growth slows down appreciably after 7–12 years. At this age heartwood development starts with a much higher density and a darker colour rendering it less suitable for the special purposes. After harvest, residues can be burnt, which gives rise to abundant natural regeneration. *Zeuzera coffeae*, a wood borer, has been observed in a 1.5-year-old plantation in Java seriously damaging the majority of trees which had to be clear felled to avoid attack of other trees.

Genetic resources and breeding Differences in wood density in *Ochroma* may be a starting point for further selection and breeding.

Prospects *O. pyramidale* has lost some importance due to the increased use of synthetic materials, but it will probably remain the best material for some special applications, e.g. model making. Increased use for such special applications and for pulpwood is possible.

Literature 99, 130, 176, 193, 219, 300, 304, 308, 327, 334, 381, 402, 403, 405, 425, 427, 436, 464, 475, 526, 536, 658, 697, 719, 861, 933, 954, 1155, 1157, 1172, 1177, 1207, 1220, 1225, 1226, 1235, 1248.

S.I. Wiselius

Oncosperma Blume

Bull. Sci. Phys. Nat. Néerl. 1: 64 (1838).

PALMAE

$x = 16$; *O. tigillarium*: $2n = 32$

Vernacular names Bayas, nibong (En). Indonesia: bayas, nibung (general). Malaysia: bayas, nibong (general). Philippines: anibong (Filipino). Thailand: lao cha on (peninsular). Vietnam: nhum.

Origin and geographic distribution *Oncosperma* comprises 5 species, 1 is endemic to Sri Lanka, 2 others in the Philippines, the remaining 2 are more widespread, occurring in Indo-China, southern Thailand and throughout the Malesian region except for the Lesser Sunda Islands.

Uses The trunk of *O. tigillarium* is in demand for salt-water piling in the construction of off-shore fish traps. The entire trunk is used for house supports, posts and footbridges. The split trunk is applied in flooring, decorative panelling, fencing, furniture, platforms, tools and weapons (bows, arrowheads and spear shafts) and as rafters, but also for slats in thatching work and gutters.

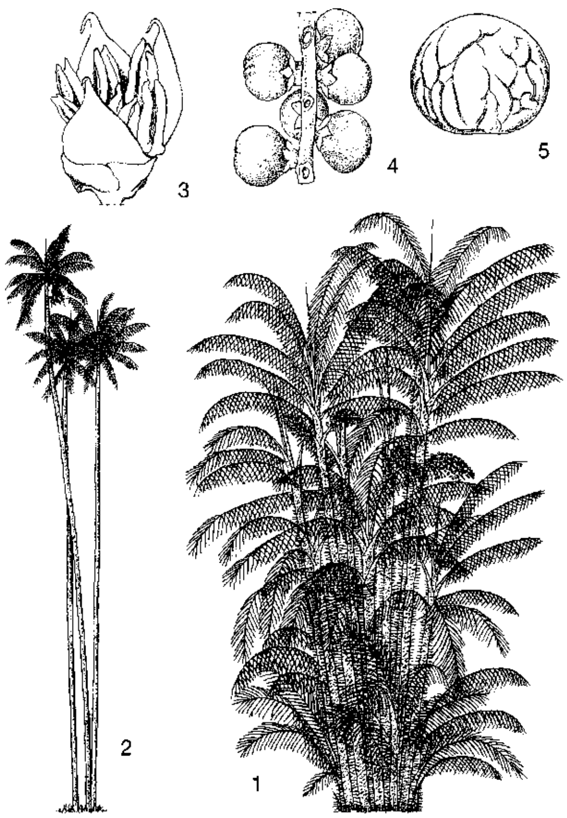
O. horridum and *O. tigillarium* are occasionally planted in parks and large gardens as ornamentals. The spines are used for blowpipe darts. The large inflorescence sheaths are used as containers or, in Siberut Island (Indonesia), as back panels on rattan baskets. While the palm cabbage (apex) of *O. tigillarium* is excellent to eat, both raw and boiled, that of *O. horridum* is supposed to induce headache and is therefore not consumed. The leaves are used for basketry, roofing, and in some places in ceremonies. Flowers are used to flavour rice; the fruits to make preserves and as a substitute for betel nut (*Areca catechu* L.). In Peninsular Malaysia boiled roots of *O. horridum* are applied medicinally to reduce fever.

Production and international trade The use of the trunk of *O. tigillarium* for piling is of great importance locally, because a substitute of comparable quality is hard to find. In coastal areas annual consumption may easily run into several tens of thousands of stems and supplies are becoming scarce. The export of *Oncosperma* from Bengkalis (Sumatra) to Malaysia was banned as long ago as 1934, but considerable imports to Singapore from Sumatra were reported in 1962.

Properties The basic density at 1 m height is 1040 kg/m^3 at the periphery and 680 kg/m^3 in the centre, the comparable figures at 14 m height being 610 kg/m^3 and 140 kg/m^3, respectively. The cortex is dark brown to deep black with interlock-

ing fibres, in the outer 2–3 cm vascular bundles dense, about 50/cm^2 at 1 m height and about 75/cm^2 at 8 m height; in the centre vascular bundles about 20/cm^2 at 1 m height and 25/cm^2 at 8 m height; the outer side of the vascular bundle shows rows of stegmata in boxlike indentions. Ground parenchyma cells elongated, often with perfectly round starch grains.
Shrinkage in the lower stem increases from 3% in the core to 5–7% in the stem periphery. Its resistance to salt- and brackish water and to marine borers is often mentioned, but 15–18 months after placing test sticks of *O. tigillarium* in salt-water, they were already badly damaged by *Martesia striata* and *Lyrodus pedicellatus*.
See also the table on wood properties.

Botany Armed, monoecious, pleonanthic, clustered, medium-sized palms up to 25(–30) m tall; pole straight, slender, up to 20(–25) m long, up to 20(–25) cm in diameter, ringed with leaf scars and often with robust, flat spines; bark finely corrugated, grey. Leaves pinnate, large; sheath forming a well-defined crown-shaft; petiole densely armed; leaflets many, acute or acuminate. Inflorescence below the leaves, solitary, branching to 2 orders near the base, to 1 order higher up the trunk; prophylls and peduncular bracts similar, caducous; rachillae bearing spirally arranged triads of 1 female and 2 male flowers, or distally solitary or paired male flowers. Flowers unisexual, with 3 sepals and 3 petals. Male flower asymmetrical; petals much longer than the sepals, acute or acuminate; stamens 6–9, filaments free or connate only at base. Female flower globose; petals similar to the sepals; ovary superior, 1-locular with a single ovule, stigmas 3. Fruit a globose, dark purple or blue-black drupe, with excentric stigma remains. Seed attached by a lateral, elongated hilum; endosperm ruminate. Seedling with adjacent-ligular germination; eophyll bifid.



Oncosperma tigillarium (Jack) Ridley – 1, habit; 2, habit; 3, male flower; 4, fruits; 5, seed.

O. tigillarium develops according to Tomlinson's architectural model, characterized by the repeated development of equivalent orthotropic modules in the form of basal branches, growth of the modules is usually continuous, sometimes rhythmic. In Sumatra *O. tigillarium* usually flowers in June–August and fruits in November–December. Seeds are dispersed by bats, large birds and monkeys. The latter also like to eat the flowers.
Oncosperma belongs to the subtribe *Oncospermatinae* of the tribe *Areceae* within the subfamily *Arecoideae*.

Ecology *Oncosperma* is found in lowland rain forest, up to 1000 m altitude. *O. tigillarium* is generally found growing gregariously or even in pure stands in the upper mangrove fringe, just above the spring-tide level. *O. tigillarium* forest appears to be a stage in the succession where accretion of land occurs, and grows in peaty soils of less than 0.5 m deep. But it also occurs occasionally on hills in humid regions, up to 150 m altitude. *O. horridum* is reported from well-drained soils in lowland forest and on steep hillsides, generally not in profusion and only rarely on inundated land. It has a preference for soils with low fertility and may locally form an important component of the main canopy layer.

Silviculture *Oncosperma* can be propagated by seed and by basal suckers. Cleaned seeds should be sown as soon as possible after collection as they remain viable for only 2–3 weeks. Fresh seeds of *O. tigillarium* show about 60% germination in 1–6 months after sowing. Seeds should be sown in shaded beds, the humidity being kept high; watering twice a day is necessary. Seedlings of at least one year old may be planted in the open; care should be taken not to harm the taproot while planting. A spacing of 3 m × 3 m is recommended for establishing pure plantations and 10 m × 3 m for enrichment planting of secondary forest. Harvesting from pure stands creates problems, even when 1–2 stems per clump are left, as the opening of stands allows the invasion of aggressive ferns, creepers and secondary forest trees. This problem may be overcome by selective harvesting and at the same time favouring the growth of young palms, as they do not grow satisfactorily under a closed canopy. *O. tigillarium* generally stand on the mounds formed by their own roots; reproduction is to some extent by seed, the seedlings mostly occurring well up on the mounds, clear of flood water, but the principal method of regeneration, once a colony has been established, is by means of root suckers. The palms should not be harvested before flowering as the wood is then still soft and spongy. After felling, the remaining stand is cleared and burned to make extraction easier without being hindered by the spines on the stems. Burning, however, seriously curtails natural regeneration. A normal composition of an *O. tigillarium* forest is about 250 stools/ha with about 800 poles with a diameter of 15–20 cm, which can be harvested directly and about 800 poles of 10–15 cm harvestable in 10 years and another 800 measuring 5–10 cm harvestable in 20 years. Annual production in well-managed stands is estimated at about 60 stems/ha with an average pole length of 17 m and an annual wood production of about 20 m^3/ha. In Siberut Island no seedlings of *O. horridum* were observed beneath mature clump canopies, suggesting they need more light for establishment or that they cannot stand the heavy litter fall. Sites where *Oncosperma* grows are also in demand for shifting cultivation, and thus its cultivation has to compete with food cropping.

Genetic resources and breeding As young *Oncosperma* is unable to compete with secondary growth, exploited stands are generally rapidly transformed into secondary dryland forest. Because of the comparatively high demand for poles, most *Oncosperma* species are threatened, except *O. horridum*.

Prospects Unless proper conservation measurements are taken, depletion of *O. tigillarium* stands will continue and supplies will rapidly diminish. More research is needed on how to establish and maintain *Oncosperma* plantations.

Literature 2, 70, 80, 85, 99, 150, 151, 163, 236, 295, 307, 364, 402, 424, 436, 451, 452, 499, 500, 566, 645, 720, 785, 871, 974, 997, 1038, 1059, 1100, 1102, 1110, 1173, 1176, 1201, 1210, 1213, 1263.

Selection of species

Oncosperma gracilipes Becc.
Vernacular names Philippines: anibong-liitan (Filipino).
Distribution The Philippines.

Oncosperma horridum (Griffith) R. Scheffer
Vernacular names Bayas (En). Indonesia: bayas (general), ari ribbuk (Siberut), pinang bayeh (Minangkabau, Sumatra). Malaysia: bayas (general), debung (Bidayuh, Sarawak), nyivung (Penan, Sarawak). Philippines: anibong-gubat (Filipino), tanaian (Bagobo). Thailand: krarian khao, lao cha on khao, thu rian (peninsular).
Distribution Peninsular Thailand, Peninsular Malaysia, Sumatra, Borneo and the Philippines.

Oncosperma platyphyllum Becc.
Vernacular names Philippines: anibong-laparan (Filipino).
Distribution The Philippines (Negros).

Oncosperma tigillarium (Jack) Ridley
Synonyms *Oncosperma filamentosum* Blume.
Vernacular names Nibong (En). Indonesia: nibung (general), erang (Sundanese), gendiwong (Javanese). Malaysia: nibong (general), anau (Sarawak), nibong pa saloi (Iban, Sarawak). Philippines: anibong (Filipino), anibung (Tagbanua). Burma (Myanmar): kazaung. Cambodia: ta-aon. Thailand: cha on, lao cha on, nibong (peninsular).
Distribution Indo-China, Thailand and throughout the Malesian region except for the Lesser Sunda Islands.

J.W. Hildebrand

Ormosia Jackson

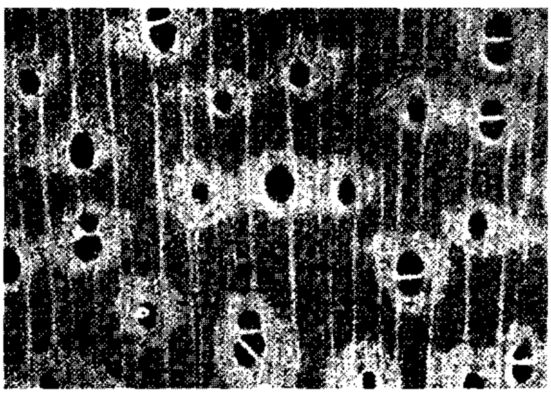
Trans. Linn. Soc., London 10: 360 (1811).
LEGUMINOSAE
$x = 8$; $2n = 16$ for several American species
Vernacular names Indonesia: kupang (general). Malaysia: saga hutan (Peninsular, Sabah). Philippines: bahai (general). Vietnam: r[af]ng r[af]ng.

Origin and geographic distribution *Ormosia* includes about 100 species occuring in eastern South America, eastern Asia and north-eastern Australia. Approximately 12 species are found throughout the Malesian region except for eastern Java and the Lesser Sunda Islands. In Indo-China about 20 species have been found, in Thailand 8.

Uses The wood of *Ormosia* is sometimes used in local house construction (planks, beams, rafters), temporary or light construction, furniture, shingles and agricultural implements. Tests in Indonesia showed that the wood of *O. sumatrana* is suitable for the production of plywood. It is occasionally used as firewood.
The attractively coloured and shiny seeds are used for necklaces. The roots have been used in local medicine against stomach-ache. Trees are sometimes planted as ornamentals.

Production and international trade The wood of *Ormosia* is used on a local scale only.

Properties *Ormosia* yields a medium-weight hardwood with a density of 480–830 kg/m^3 at 15% moisture content. Heartwood grey-brown or reddish-yellow with paler streaks, sharply differentiated (*O. sumatrana*) or not (*O. calavensis*) from the up to 5 cm wide, pale yellow-brown sapwood; grain straight, slightly interlocked or wavy; texture moderately fine to rather coarse and uneven. Growth rings when present indicated by marginal parenchyma and a zone with relatively few vessels; vessels medium-sized to moderately large, solitary and in radial multiples of 2–3, tendency to oblique or tangential arrangement, open but sometimes with reddish gum-like deposits; parenchyma abundant, paratracheal vasicentric, aliform and confluent, visible to the naked eye, and apotracheal in marginal or seemingly marginal bands; rays very fine to moderately broad, visible to the naked eye; ripple marks indistinct, rays in slanting, occasionally horizontal storeys.
The wood seasons well with little or no degrade but is sometimes prone to blue stain. It is hard to very hard and strong. The wood is fairly easy to work and takes a beautiful polish. It is non-durable to moderately durable when exposed to the weather or in contact with the ground. The sapwood is susceptible to *Lyctus*.
See also the table on microscopic wood anatomy.



Ormosia calavensis
transverse surface (×18)

Botany Small to medium-sized trees up to 30 m tall; bole branchless for up to 15 m and up to 70(–100) cm in diameter, with buttresses; bark surface smooth but lenticellate and becoming rough in older trees, greyish to dark brown, inner bark granular, mottled or streaked, yellowish, orange to pinkish-brown; crown often open and spreading. Twigs often with tiny stiff prickles. Leaves alternate, imparipinnate, with (1–)3–7(–9) pairs of opposite leaflets; stipules small. Flowers in a terminal or axillary panicle, papilionaceous, 5-merous; calyx deeply cleft and golden velvety; petals free, clawed, white to pink or purple, standard broader than wings and keel; stamens 10, free or fused at very base; ovary superior, subsessile, unilocular with 2–6 ovules, style long and curved. Fruit an oblong to rounded, leathery to woody, dehiscent pod, 1–3-seeded. Seed hard, shiny, usually red with a black spot at base, without endosperm, cotyledons thick. Seedling with semi-hypogeal germination; hypocotyl elongated; first 2 leaves opposite, subsequent ones alternate.
Dichotomously branched root nodules have been observed in *O. sumatrana*. American *Ormosia* species are known to form ecto-mycorrhizae.
Ormosia belongs to the tribe *Sophoreae* of the subfamily *Papilionoideae* and is related to *Pericopsis*, which differs in its alternate leaflets, flowers with conspicuous disk and auriculate wings and keel, and its indehiscent, flat, narrowly winged fruit.

Ecology *Ormosia* species usually occur in lowland, primary or secondary rain forest, rarely in lower montane forest, up to 1000(–1800) m altitude, also on river banks, in seasonal swamps and along the seashore. Several species occur in monsoon forest on poor, acid soils.

Silviculture *Ormosia* can be propagated by seed or by cuttings. Seeds of *O. sumatrana* have a germination rate of about 50% in 20–51 days and in a very small trial with *O. venosa* Baker all seeds germinated in 1–2 months. In Indonesia mechanical scarification of seed of *O. monosperma*

(Sw.) Urban is recommended. When sown under shade the germination rate is 40%, germination starts after 17 days and 80% of the germinating seeds have appeared after 29 days. Eight *Ormosia* species originating from Surinam have been planted in trials in Java, but plants died soon after planting in the field. In general, *Ormosia* is considered to be light-demanding.

Genetic resources and breeding Many South-East Asian *Ormosia* species are uncommon or even rare. Large-scale indiscriminate logging of lowland forest will seriously endanger individual *Ormosia* species.

Prospects It is unlikely that the importance of *Ormosia* timber will increase because the trees occur too scattered to be of any interest in selective cutting systems.

Literature 42, 70, 80, 163, 174, 198, 209, 235, 267, 304, 343, 427, 436, 464, 573, 829, 831, 843, 861, 883, 934, 1163, 1221, 1232, 1242.

Selection of species

Ormosia bancana (Miq.) Merr.

Synonyms *Ormosia parvifolia* Baker.

Vernacular names Indonesia: saga, saga dengkol (Bangka). Malaysia: saga laut (Sabah).

Distribution Peninsular Malaysia, Singapore, Sumatra and Borneo.

Ormosia calavensis Azoala ex Blanco

Vernacular names Philippines: bahai (Filipino).

Distribution Central Java, Borneo, the Philippines, Sulawesi, the Moluccas, New Guinea and Micronesia.

Ormosia macrodisca Baker

Synonyms *Ormosia basilanensis* Merr., *Ormosia clementis* Merr., *Ormosia grandifolia* Merr.

Vernacular names Philippines: Basilan bahai, bahai-laparan (Filipino), gayai (Bagbo).

Distribution Thailand, Peninsular Malaysia, Singapore, Sumatra, western Java, Borneo, the Philippines and Sulawesi.

Ormosia polita Prain

Synonyms *Ormosia nitida* Prain.

Distribution Peninsular Malaysia.

Ormosia sumatrana (Miq.) Prain

Synonyms *Ormosia microsperma* Baker.

Vernacular names Indonesia: kupang (general), bai (Sumatra), simau fatuh (Simeuluë). Malaysia: sepit-sepit (Peninsular).

Distribution Laos, Vietnam, Thailand, Peninsular Malaysia, Singapore, Sumatra, western and central Java and Borneo.

Nguyen Ba

Orophea Blume

Bijdr. fl. Ned. Ind. 1: 18 (1825).

ANNONACEAE

$x = 9$; *O. corymbosa*: $2n = 18$

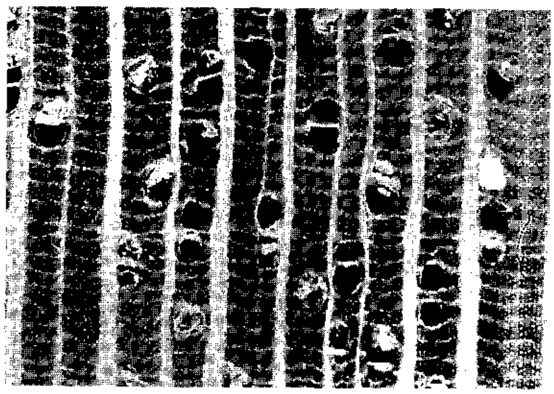
Vernacular names Mempisang (trade name). Indonesia: kalak (Javanese). Malaysia: karai (Sabah), pisang-pisang (Peninsular). Philippines: amunat.

Origin and geographic distribution *Orophea* comprises about 40 species occurring from Sri Lanka and southern India to the Nicobar and Andaman Islands, southern Burma (Myanmar), Indo-China, Hainan, Thailand, and throughout the Malesian region except for New Guinea. Within Malesia 29 species are found.

Uses The wood of *Orophea* can be used for interior finish and packing cases, and has been used in Java for bows because of its elasticity.

Production and international trade 'Mempisang' is a general trade name comprising most of the genera of *Annonaceae*, but it seems unlikely that *Orophea* is included in consignments of mempisang wood. Its use is probably only local.

Properties *Orophea* yields a medium-weight hardwood with a density of 550–810 kg/m^3 at 15% moisture content. The wood anatomy of *Annonaceae* is fairly similar and is given here, as no spe-



Orophea cumingiana S. Vidal transverse surface (×20)

cific description of *Orophea* is available. Heartwood yellow-brown, not clearly differentiated from the sapwood; grain straight; texture rather coarse to moderately fine and uneven; wood with silver grain. Growth rings usually distinct, indicated by a layer of denser fibres; vessels moderately small to medium-sized, mostly solitary or sometimes with radial multiples of 2–4, occasionally in small clusters, open; parenchyma abundant, apotracheal in regular, narrow bands (scalariform); rays with a tendency to 2 distinct sizes, moderately small or medium-sized to very broad; ripple marks absent.
The wood is fairly strong and non-durable.
See also the table on microscopic wood anatomy.

Botany Small or rarely medium-sized trees up to 15(–25) m tall; bole generally straight and cylindrical, up to 30 cm in diameter, without buttresses; bark surface dark grey. Leaves alternate, simple, entire, exstipulate. Flowers in a few- to many-flowered cyme or fascicle in or above the leaf axil, bisexual, small; sepals 3, valvate, free or connate; petals 6, valvate, in 2 rows, creamy-white to yellow or greenish-yellow, the outer similar to the sepals but twice as long, the inner clawed, diamond-shaped and bent over the stamens and carpels, generally with nectaries inside; stamens 3–12, connective not enlarged; carpels 3–12, each with (1–)2–10 ovules, stigma broadly ellipsoid to globose, sometimes hooked. Fruit apocarpous, with 1–6(–8) monocarps; monocarp sessile or short-stalked, globose to beaded, with crustaceous to papyraceous wall and 1–8 seeds in 1 row. Seed globose to lenticular, with crustaceous to papyraceous wall; endosperm very hard.
Probably all species are evergreen. In Java *O. corymbosa* has been observed with flowers throughout the year.
Orophea is closely related to *Mezzettiopsis* but the latter differs in e.g. the more numerous stamens and carpels, and the spoon-shaped petals that do not bend over the stamens and carpels. *O. corymbosa* has often been considered to be a synonym of *O. hexandra* Blume, but it recently turned out that the two are distinct. *O. palawanensis* Elmer has been reported as possibly being used for timber in Sabah, but it has been found to be synonymous with *Mezzettiopsis creaghii* Ridley.

Ecology *O. corymbosa* occurs in primary, evergreen rain forest up to 1500 m altitude, on basalt and basic soil types. *O. cuneiformis* is often found along rivers, up to 300 m altitude, on basic soils.

Genetic resources and breeding Although many *Orophea* species are rare and narrow endemics, the two timber-yielding species are comparatively common and widespread and not in immediate danger. There are no records of ex situ conservation of these species.

Prospects Due to the small size of the timber-yielding *Orophea* species, it seems unlikely that their importance as timber will increase in the near future.

Literature 70, 163, 436, 548, 551, 595, 861, 863, 974, 1017, 1126, 1134, 1221.

Selection of species

Orophea corymbosa (Blume) Miq.

Synonyms *Orophea enterocarpoidea* S. Vidal.
Vernacular names Indonesia: janglot (Madurese), kalak lombok (Javanese), ki teguh (Sundanese). Philippines: makitarin (Tagalog).
Distribution Sumatra, Java, Borneo and the Philippines.

Orophea cuneiformis King

Distribution Burma (Myanmar), Thailand and Peninsular Malaysia.

E. Boer (general part),
M.S.M. Sosef (general part, selection of species)

Osbornia F. v. Mueller

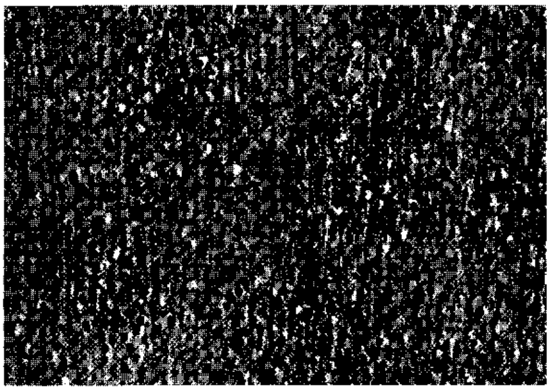
Fragm. 3: 30 (1862).
MYRTACEAE
x = unknown; $2n$ = unknown

Vernacular names Philippines: dulok-dulok (Panay Bisaya), monotbonot (Samar-Leyte Bisaya), taualis (Tagalog).

Origin and geographic distribution *Osbornia* is a monotypic genus. Its only species is *O. octodonta* F. v. Mueller with a disjunct distribution. It occurs in Borneo (Sabah), the Philippines, Sulawesi, the Lesser Sunda Islands (Bali, Sumbawa), and in southern Papua New Guinea and north-eastern Australia.

Uses The trunk of *O. octodonta* is usually used in the round because of its small size and the hardness of the wood. The wood has a reputation of good durability and strength and is used for railway ties, house posts and fences.
In the Philippines the bark is sometimes used for caulking boats.

Production and international trade *Osbornia* timber has no importance on the international



Osbornia octodonta
transverse surface (×18)

market and is used only very locally.

Properties *O. octodonta* yields a heavy hardwood with a density of 955–1050 kg/m^3 at 15% moisture content. Heartwood reddish-brown, not clearly differentiated from the 1–2 cm wide sapwood; grain interlocked or spiral; texture very fine and even. Growth rings indistinct; vessels very small to small, indistinct to the naked eye, exclusively solitary; parenchyma apotracheal diffuse and diffuse-in-aggregates with some scanty paratracheal, visible with a hand lens; rays very fine, barely visible to indistinct with a hand lens.

The wood is susceptible to checking in the log. It is very hard and strong. The wood is difficult to work, but sharp tools give a good finish. It is very durable, even when in contact with the ground.

The main components of the essential oil extracted from the leaves are the monoterpenes α-pinene (35%), 1,8-cineole (24%) and α-terpineol (11%).

See also the table on microscopic wood anatomy.

Botany An evergreen shrub or small tree up to 7 m tall; bole short and often crooked, up to 30 cm in diameter but usually much less; bark surface very shaggy, spongy flaking and soft, grey to reddish-brown. Leaves decussate, simple, rather small, obovate, entire, rounded or slightly emarginate at apex, aromatic, with pellucid dots below, exstipulate. Flowers axillary or pseudo-terminal, solitary or in a 2–3-flowered cyme, sessile, white; calyx campanulate, 8-lobed, densely silvery hairy; petals absent; stamens numerous, inserted on the mouth of the calyx cup; ovary inferior, 1-locular with many ovules, style simple. Fruit a globose, leathery berry, included within the calyx tube, 1(–2)-seeded. Seedling with epigeal germination; cotyledons hemispherical, much exceeding the short hypocotyl.

O. octodonta has an irregular habit, often with several slender stems and a dense, rounded crown. The branches grow rhythmically and frequently show sympodial development as a result of the abortion of the terminal bud or, in older plants, the development of pseudoterminal inflorescences. Frequently, there are 2 buds in an axil, with the lower becoming reproductive and the upper remaining vegetative. It is likely that the aromatic flowers are pollinated by insects. The indehiscent fruits float in water.

Osbornia is considered to take a more or less isolated position within the *Myrtaceae*. It is usually included in the subfamily *Leptospermoideae* because of the non-fleshy fruit; this classification is supported by anatomical characteristics of its wood and flowers and morphological characteristics of its pollen.

Ecology *O. octodonta* occurs along the inner border of mangrove swamps on more exposed sites (but never within the dense mangrove community) and along tidal streams. It is locally common (e.g. in the Philippines) but is usually not abundant.

Silviculture *Osbornia* can be propagated by seed.

Genetic resources and breeding There is no reason to consider *O. octodonta* as endangered or liable to genetic erosion as it is widespread and its timber is not sought after.

Prospects The trunk of the tree is too small and too irregular to render *O. octodonta* a promising timber-producing species.

Literature 149, 150, 469, 780, 861, 880, 934, 1101, 1136.

H. Purnobasuki & B. Irawan

Osmelia Thwaites

Enum. pl. zeyl.: 20 (1858).

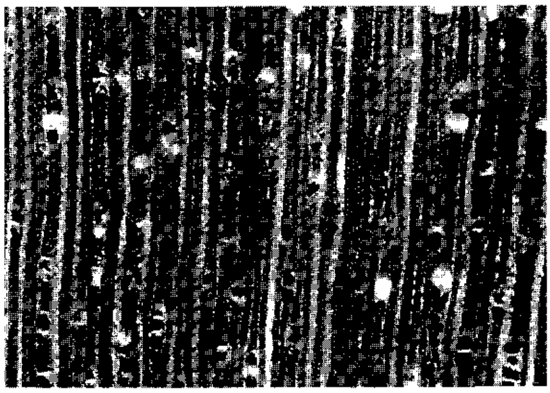
FLACOURTIACEAE

x = unknown; $2n$ = unknown

Vernacular names Malaysia: rambai burong (Peninsular).

Origin and geographic distribution *Osmelia* comprises 4 species, one of which is endemic to Sri Lanka, the other three occur in peninsular Thailand, Peninsular Malaysia, Sumatra, Borneo, the Philippines, Sulawesi, the Moluccas and New Guinea.

Uses The wood of *Osmelia* is used for house building, mainly for (rough) posts, and for the manufacture of chairs.



Osmelia philippina
transverse surface (×20)

Production and international trade Utilization of the wood of *Osmelia* is only local.

Properties *Osmelia* yields a medium-weight hardwood with a density of 650–740 kg/m^3 at 15% moisture content. Heartwood pale yellow, not clearly differentiated from the sapwood; texture fine and even. Growth rings indistinct; vessels small to medium-sized, indistinct to the naked eye, solitary and in radial multiples of 2–5, oval to markedly angular, open; parenchyma absent or very sparse paratracheal; rays fine to moderately fine, numerous, with a slight tendency to 2 distinct widths; ripple marks absent.
The wood of *Osmelia* is fairly strong and durable. It is resistant to dry-wood termites. The sapwood is non-susceptible to *Lyctus*.
See also the table on microscopic wood anatomy.

Botany Dioecious shrubs or small to medium-sized trees up to 24 m tall; bole up to 60 cm in diameter, sometimes with small buttresses up to 0.6 m high; bark surface smooth to papery flaky, yellowish-grey to pale yellowish-buff. Leaves arranged spirally, simple, entire, 3-veined at base; stipules minute, early caducous. Flowers small, in an axillary or terminal, simple or often panicled, spike-like raceme, subtended by a prominent bract and 2 bracteoles; calyx 4(–5)-lobed, tube very short; petals absent. Male flowers with 8(–10) stamens, half of them inserted in between 2 staminodes. Female flowers with a superior, 1-locular, hairy ovary with 3 few-ovuled placentas, styles 3, short. Fruit a 3-valved capsule with 1–3(–4) seeds. Seed with a red or yellow, fleshy aril and membranous testa. Seedling with epigeal germination; cotyledons emergent, leafy; hypocotyl elongated; all leaves arranged spirally.
The distinction between *O. maingayi* and *O. philippina* is weak and the two may eventually prove to represent a single species. Specimens are frequently mistakenly identified as *Baccaurea* (*Euphorbiaceae*).

Ecology *Osmelia* species are found scattered in primary and secondary, lowland rain forest, up to 600 m altitude. *O. philippina* occurs on moist but well-drained, fertile, clayey soils in mixed dipterocarp forest and on river banks.

Silviculture *Osmelia* can be propagated by seed. A germination rate of 75% in 13–71 days after sowing is reported for seed of *O. maingayi*, sown while still embedded in its aril.

Genetic resources and breeding There is no information on *Osmelia* germplasm collections being maintained.

Prospects The lack of information on wood properties and wood quality of *Osmelia* indicates its very low importance for timber production. It is not expected that this will change in the near future.

Literature 61, 68, 162, 163, 198, 213, 267, 341, 436, 829, 831, 861, 1028, 1038, 1221, 1222.

Selection of species

Osmelia grandistipulata v. Slooten

Vernacular names Indonesia: anang, awa sare-sare, tulian balah (Simeuluë).

Distribution Sumatra, Simeuluë and the Lingga Archipelago.

Osmelia maingayi King

Vernacular names Malaysia: akar laka, berunai ayer (Peninsular), mata kanan (Sabah).

Distribution Peninsular Thailand, Peninsular Malaysia, Singapore, Sumatra and Borneo (Sabah).

Osmelia philippina (Turcz.) Benth.

Synonyms *Osmelia borneensis* Merr., *Osmelia celebica* Koord., *Osmelia conferta* Benth.

Vernacular names Indonesia: ancerina (Kalimantan), kayu si basaon (Sumatra), kayu watu (North Sulawesi). Philippines: malakamanga, oonog (Tagalog), malatayotes (Samar-Leyte Bisaya).

Distribution Peninsular Malaysia, Singapore, Sumatra, Borneo, the Philippines, Sulawesi, the Moluccas (the Aru Islands) and New Guinea.

T.H. Wardini (general part, selection of species),
J. Ilic (wood anatomy)

Pajanelia DC.

Bibl. Univ. Genève ser. 2, 17: 130, repr. p. 14 (1838).

BIGNONIACEAE

$x = 20$; *P. longifolia*: $2n = 40$

Vernacular names Dagger tree (En). Indonesia: abeueng laut (Meulaboh, Aceh), kayu semua (Natuna Islands). Malaysia: beka, bekak gunong, kayu bonglai (Peninsular). Burma (Myanmar): kyaung-dauk, kyaung-sha-letto. Thailand: i-pong, pong (peninsular).

Origin and geographic distribution *Pajanelia* is a monotypic genus occurring from southern India and Sri Lanka through Burma (Myanmar), the Andaman Islands and Thailand towards Peninsular Malaysia, Singapore, northern Sumatra and the Natuna Islands. It was erroneously reported from the Philippines. The single species is *P. longifolia* (Willd.) K. Schumann (synonyms: *P. multijuga* (Wallich) DC., *P. rheedii* Wight).

Uses The wood of *P. longifolia* has been used in the Andaman Islands for house building, planking and canoes. In the Natuna Island the timber is esteemed for boat building.

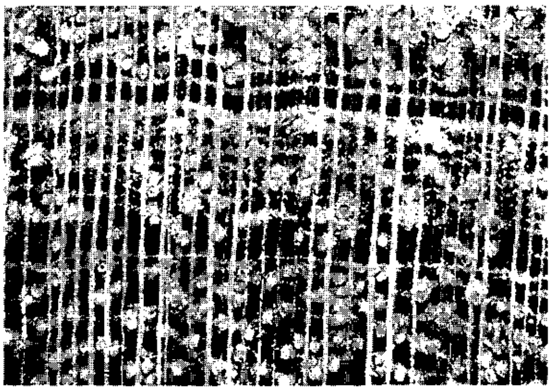
In parts of Malaysia it is commonly planted as stakes for hedges along rice fields, and, similar to *Oroxylum indicum* (L.) Kurz, a hot decoction of the leaves is used externally against stomach disorders. In the Natuna Islands a decoction of the leaves is used against fever.

Production and international trade The wood of *P. longifolia* is only used locally on a small scale.

Properties *P. longifolia* yields a lightweight hardwood with a density of 345–375 kg/m^3 at 15% moisture content. Heartwood pale grey-brown with a speckled appearance, not clearly demarcated from the sapwood; grain shallowly interlocked; texture rather coarse and even. Growth rings indistinct; vessels medium-sized to moderately large, mostly solitary with occasional radial multiples of 2–3, in tangential arrangement, tyloses occasionally present; parenchyma moderately abundant, paratracheal vasicentric and confluent, occurring as broad sheaths to the vessels, distinct with a hand lens; rays moderately fine, just visible to the naked eye; ripple marks absent.

The wood is soft and non-durable.

See also the table on microscopic wood anatomy.



Pajanelia longifolia
transverse surface (×20)

Botany An evergreen or briefly deciduous, small to medium-sized, glabrous, sparingly branched tree up to 30(–36) m tall; bole up to 115 cm in diameter, without buttresses; bark surface shallowly fissured and lenticellate, grey, inner bark soft, light green. Twigs massive, with large leaf scars; innovations resinous. Leaves opposite, crowded at the end of twigs, exstipulate, pinnate; rachis and petiole sharply keeled above; leaflets opposite or alternate, with a very asymmetrical base and large glands along the midrib below. Flowers in a terminal thyrse up to 1 m long, large, 5-merous, pale yellowish, with a soapy odour; calyx closed in bud, with 5 irregular lobes; corolla zygomorphous, with a broad, dull greenish-red tube, with 5 crisped lobes, pubescent except at base; stamens 4 and a 5th rudimentary one, inserted about halfway up the corolla tube; disk annular; ovary superior, 2-locular with many ovules, style 1. Fruit a large dagger-shaped capsule with a septum, the valves broadly winged, leathery. Seeds in several rows, hyaline-winged. Seedling with epigeal germination; hypocotyl elongated; first leaves opposite and simple, subsequent ones pinnate.

Saplings are monopodial and unbranched until they reach a height of 4.5–9 m. Growth is rapid, but exact figures are lacking. Flowering has been observed from January to April and in August, fruiting in March to April and in August. Pollination of the nocturnal flowers seems to be by nectarivorous bats, as pollen has been identified in guano samples in Peninsular Malaysia. The seeds seem adapted to wind dispersal but the numerous seedlings observed in coconut stands along the shore suggest they are also dispersed by water.

Ecology *Pajanelia* is found locally common in primary but more often in secondary lowland to montane rain forest, but has also been encountered in monsoon forest, coconut stands near the sea and more open country. It occurs scattered along rivers and along the edges of coastal forest, up to 500(–700) m altitude.

Silviculture *Pajanelia* can be propagated by seed, but is rarely planted, e.g. in Aceh, Sumatra.

Genetic resources and breeding The fairly wide geographical distribution of *P. longifolia* and its locally common occurrence indicate that there is no risk of genetic erosion. It is, however, now extinct in Singapore.

Prospects The reportedly rapid growth of *P. longifolia* and its pioneer-like characteristics make it worthwhile to be tested in plantation trials. Although resembling teak to some degree, the wood is much lighter in weight and less durable.

Literature 163, 209, 267, 341, 527, 829, 1038, 1039, 1053, 1221, 1242.

S.H. Widodo

Parartocarpus Baillon

Adansonia 11: 294 (1875).

MORACEAE

x = unknown; $2n$ = unknown

Vernacular names Parartocarpus (En). Malaysia: terap (general), ara berteh (Peninsular), minggi, pinggi (Sarawak). Philippines: malanangka (Filipino).

Origin and geographic distribution *Parartocarpus* comprises 3–5 species occuring in peninsular Thailand, throughout the Malesian region (except for the Lesser Sunda Islands), and the Solomon Islands.

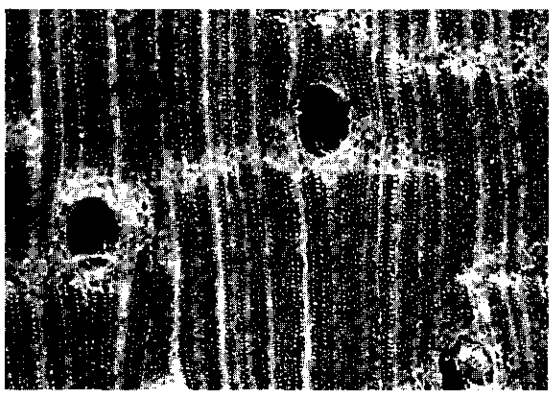
Uses The wood of *Parartocarpus* is used for light construction, light flooring, furniture, door and window frames, and also for blockboard, particle board and plywood. Furthermore, it is suitable for shuttering, crates and pallets, panelling, boat building, vehicle bodies, non-striking tool handles, sporting goods, musical instruments, turnery, toys and pattern making.

The fruits are edible, but the seeds are reputedly poisonous. The latex of the bark has been used as arrow poison and, mixed with various foodstuffs, as rat poison. Pounded bark has been applied to stupefy fish. In Papua New Guinea dried pounded seeds of *P. venenosus* mixed with lime have been used to treat sores.

Production and international trade In general, *Parartocarpus* wood is used only locally, or traded in mixed consignments of lightweight hardwood. Occasionally it is exported as 'terap', a trade group that also includes timber of the lightweight species of *Artocarpus* and of *Antiaris*, but *Parartocarpus* probably constitutes only a very minor proportion. Very small amounts are exported from Sabah, Sarawak and Papua New Guinea to Japan. In 1992 the export of terap from Sabah amounted to almost 9000 m^3, mainly as logs, with a total value of US$ 630 000. In 1996 Papua New Guinea exported a volume of about 3495 m^3 of *Parartocarpus* logs at an average free-on-board (FOB) price of US$ 102/m^3.

Properties *Parartocarpus* yields a lightweight to medium-weight hardwood with a density of 310–670 kg/m^3 at 15% moisture content. Heartwood yellowish-white to grey-white, not clearly differentiated from the white sapwood; grain fairly straight; texture coarse and even. Growth rings indistinct; vessels moderately large, solitary, in short radial multiples occasionally with clusters, mostly open but with occasional tyloses; parenchyma sparse, paratracheal vasicentric, aliform and confluent; rays moderately fine to moderately broad; ripple marks absent; latex tubes in rays, sometimes visible as brown spots on tangential faces.

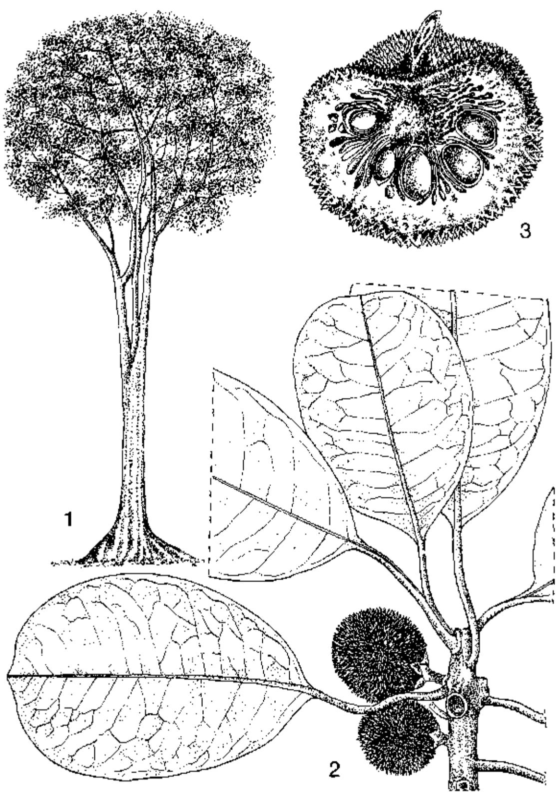
Shrinkage upon seasoning is moderate to high. During air drying slight cupping, bowing, twisting, end checking, surface checking and insect attack are likely to occur. Boards 13 mm and 38 mm thick take respectively 3.5 and 5 months to air dry. The wood is rather soft, fairly easy to saw and peel but should be treated immediately upon felling and after sawing to prevent blue stain. It can be planed to a smooth and moderately lustrous surface. The wood is non-durable when exposed to the weather or in contact with the ground; all sticks in a graveyard test in Malaysia were destroyed within a year. Both sapwood and heartwood are amenable to preservative treat-



Parartocarpus venenosus transverse surface (×20)

ment. Using the pressure treatment the retention in the sapwood and heartwood is respectively 600 kg/m^3 and 500 kg/m^3. The wood is not resistant to termites and marine borers. The sapwood is susceptible to pinhole borers and *Lyctus*.
See also the tables on microscopic wood anatomy and wood properties.

Botany Evergreen, monoecious, medium-sized to large trees up to 45 m tall; bole usually straight, cylindrical or fluted, branchless for up to 16 m, up to 90 cm in diameter, occasionally with short buttresses; bark surface smooth or dippled to slightly scaly, prominently lenticellate, greyish-white, often tinged brownish or yellowish, with faint hoop marks, inner bark fibrous, orange with cream or white mottles, with copious white latex. Leaves arranged spirally, simple, entire; stipules caducous, leaving an intrapetiolar scar. Inflorescence an axillary, capitate and globose syncarp, with a basal involucre of 3–4(–8) bracts, solitary or paired, unisexual or rarely bisexual; stamens and ovaries sunken in numerous cavities; receptacle armed with numerous, spinous, conical, obtuse or truncate processes; perianth absent. Male head with 1–3 stamens in each cavity; pistillode absent. Female head with 1-locular ovaries containing a single ovule, stigma lanceolate or fimbriate. Fruit a syncarp formed by enlargement of the female head. Seedling with epigeal germination; cotyledons emergent, fleshy; hypocotyl elongated; leaves conduplicate, first 2 opposite, subsequent ones arranged spirally.
A single 40-year-old *P. bracteatus* tree in the Arboretum of the Forest Research Institute Malaysia, Kepong displayed a mean annual increment of 2.2 cm in diameter and 0.7 m in height. Trees flower when they are about 12 m tall. In Java *P. venenosus* has been observed in flower throughout the year.
Parartocarpus may be easily confused with *Artocarpus* because of the similarity of the syncarps. *Parartocarpus* differs in having a usually well-developed involucre below the inflorescence and no perianth.
P. venenosus has been divided into 4 subspecies, but some authors suggest that there are 3 distinct species within this complex.



Parartocarpus venenosus (Zoll. & Moritzi) Becc. – 1, tree habit; 2, fruiting twig; 3, fruit in longitudinal section.

Ecology *Parartocarpus* occurs scattered in lowland to submontane or rarely montane, primary, evergreen rain forest, up to 1800 m altitude. *P. venenosus* is a characteristic element of peat-swamp, freshwater and tidal forest but like *P. bracteatus*, also occurs on heavy clay or even sandy soils in well-drained locations. *P. microcarpus* is found in montane kerangas and on sandy peat soils.

Silviculture *Parartocarpus* can be propagated by fruitlets. Fruitlets picked off the tree have a germination rate of about 75% in 27–120 days, but when collected from the ground it is only about 15% in 33–136 days. In peat-swamp forest in Singapore and Johore (Peninsular Malaysia) the density of large *P. venenosus* trees is 2–4/ha.

Genetic resources and breeding The most vulnerable timber-producing *Parartocarpus* is probably *P. microcarpus*, being endemic to Sabah and Sarawak and having a narrow ecological amplitude.

Prospects It is unlikely that *Parartocarpus* timber will be increasingly used in the near future.

Literature 40, 70, 151, 162, 163, 207, 218, 304, 348, 387, 436, 491, 536, 553, 677, 678, 740, 741, 829, 831, 832, 933, 974, 1038, 1087, 1098, 1164, 1221, 1242, 1248.

Selection of species

Parartocarpus bracteatus (King) Becc.

Synonyms *Artocarpus bracteata* King.

Vernacular names Malaysia: ara berteh bukit (Peninsular).

Distribution Peninsular Malaysia, Singapore, Sumatra and Borneo.

Parartocarpus microcarpus Corner

Vernacular names Malaysia: kateh (Iban, Sarawak).

Distribution Borneo (Sabah, Sarawak).

Parartocarpus venenosus (Zoll. & Moritzi) Becc.

Synonyms *Gymnartocarpus venenosa* (Zoll. & Moritzi) Boerl., *Parartocarpus triandra* (J.J. Smith) J.J. Smith, *Parartocarpus woodii* (Merr.) Merr.

Vernacular names Indonesia: bulu ongko (Javanese), pejatai (West Kalimantan), purut (Sundanese). Malaysia: ara berteh paya (Peninsular). Philippines: malanangka (Filipino), buratu (Ibanag), pangi (Iloko). Thailand: le khaem, phaya rak lueang (peninsular).

Distribution Peninsular Thailand, throughout the Malesian region (except for the Lesser Sunda Islands), and the Solomon Islands.

E. Boer (general part),
M.S.M. Sosef (general part, selection of species)

Parastemon A. DC.

Ann. Sci. Nat. Bot., sér. 2, 18: 208 (1842).
CHRYSOBALANACEAE
x = unknown; $2n$ = unknown

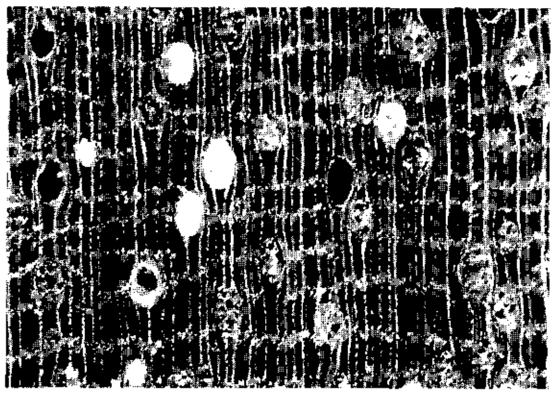
Vernacular names Malas (trade name). Pink beam (En). Brunei: mandailas, sempalawan. Indonesia: galam tambaga, meriawak (Sumatra), ilas (Kalimantan). Malaysia: ngilas (general), kelat puteh (Peninsular), mendailas (Sabah), tampaluan (Sarawak).

Origin and geographic distribution *Parastemon* comprises 3 species occurring in the Nicobar Islands, peninsular Thailand, Peninsular Malaysia, Sumatra, Borneo, the Moluccas, New Guinea and the Admiralty Islands.

Uses The wood of *Parastemon* is used for medium or heavy construction under cover, generally in the form of logs due to difficulty of sawing, for heavy-duty flooring, fence posts, laboratory benches, bridges, ship and boat building, salt-water piling, railway sleepers, sporting goods and agricultural implements. It yields a good-quality charcoal and in Sarawak it has a good reputation as firewood.

Production and international trade The wood of *Parastemon* is rarely traded internationally, and mainly used on a local scale. In 1996 Papua New Guinea exported only 74 m^3 of *Parastemon* logs at an average free-on-board (FOB) price of US$ 99/m^3.

Properties *Parastemon* yields a heavy hardwood with a density of 915–1245 kg/m^3 at 15% moisture content. Heartwood purple-brown turning pale brown on exposure, occasionally with black streaks, not clearly differentiated from the pale purple-brown sapwood which turns greyish-yellow to pale red-brown on exposure; grain straight or slightly interlocked; texture moderately fine to moderately coarse, even; wood with some watered-silk figure on tangential surface and some ribbon figure on radial surface. Growth rings indistinct, sometimes visible by fewer vessels and less parenchyma; vessels variable in size from very small to moderately large, almost exclusively solitary, sometimes in oblique arrangement; parenchyma abundant, apotracheal in narrow bands, distinct to the naked eye; rays very fine and only visible with a hand lens; ripple marks absent; intercellular canals of traumatic origin occasionally present.
Shrinkage upon seasoning is moderate; degrade is not serious except for a tendency to check, split and warp. Boards of 13 mm and 38 mm thick can be air dried in 2 months and 4 months, respectively. The wood is very hard with a rather low weight/strength ratio. It is very difficult to saw, as



Parastemon urophyllus
transverse surface (×20)

it contains a considerable amount of silica, but planing does not excessively dull the blades. The wood splits easily which is advantageous for its use as fuelwood. The timber is non-durable when exposed to the weather or in contact with the ground, but in a graveyard test a service life of 2–5 years has been recorded, which classifies it as moderately durable. It is considered fairly resistant to marine borers. The sapwood is occasionally attacked by pinhole and shothole borers. It is non-susceptible to *Lyctus*.
See also the tables on microscopic wood anatomy and wood properties.

Botany Evergreen, medium-sized to fairly large trees up to 40 m tall; bole cylindrical, branchless for up to 20(–25) m, up to 70 cm in diameter, often with small buttresses; bark surface becoming slightly cracked and fissured, purplish-brown to greyish, inner bark fibrous, reddish. Twigs waxy-resinous when young. Leaves arranged spirally, simple, entire, glabrous, with 2 small glands at base of blade, cuspidate at apex; stipules caducous. Inflorescence an axillary or rarely terminal, simple or sparsely branched raceme. Flowers slightly zygomorphic, with a saucer-shaped or shallowly cup-shaped receptacle; sepals 5, subequal; petals 5, not exceeding the sepals; stamens 5, often only 2 fertile, inserted on margin of disk; ovary inserted at base of receptacle, unilocular with 2 ovules, style basal. Fruit a small drupe with thin hard endocarp and 2 large lateral plates which break away on germination. Seedling with epigeal germination; cotyledons emergent, fleshy; cataphylls absent; first 2 leaves opposite, subsequent ones alternate.
In Thailand fruits are ripe in December.

Ecology *P. urophyllus* is common along seashores and in primary but more often secondary forest, characteristic in peat-swamp forest or freshwater swamp forest along rivers, but also in kerangas and more open scrub forest, in *Dacrydium* forest, generally on poor soils, up to 700 m altitude. *P. versteeghii* is found in beach forest and secondary forest, on well-drained soils. *P. grandifructus* grows in lowland forest including swamp forest and kerangas, up to 150 m altitude.

Silviculture *Parastemon* can be propagated by seed. Sown fruits of *P. urophyllus* show about 90% germination in 13–59 days.

Genetic resources and breeding As the wood of timber-yielding *Parastemon* species is rarely used they are probably not in danger of genetic erosion.

Prospects *Parastemon* will probably not become commercially important because of its limited supply and extreme difficulties in working the wood, but it will continue to be used locally, especially for firewood and charcoal.

Literature 151, 163, 198, 209, 260, 261, 267, 300, 341, 348, 387, 436, 464, 526, 536, 677, 678, 829, 831, 861, 905, 933, 1039, 1040, 1048, 1221, 1232, 1242.

Selection of species

Parastemon grandifructus Prance

Vernacular names Malaysia: kayu ajung (Dusun, Sabah), praus (Dayak, Sarawak).

Distribution Borneo (Sabah, Sarawak).

Parastemon urophyllus (Wallich ex A. DC.) A. DC.

Synonyms *Parastemon spicatus* Ridley.

Vernacular names Brunei: tempalawan. Malaysia: mengilas (Bidayuh, Sarawak).

Distribution The Nicobar Islands, peninsular Thailand, Peninsular Malaysia, Sumatra and Borneo.

Parastemon versteeghii Merr. & L.M. Perry

Vernacular names Indonesia: mangu (Tobelo, Moluccas), sinoree (Biak, Irian Jaya), sosopi (Yapen Island, Irian Jaya).

Distribution The Moluccas, New Guinea and the Admiralty Islands.

G.T. Prance

Parinari Aubl.

Hist. pl. Guiane 1: 514, t. 204–206 (1775).
CHRYSOBALANACEAE
x = unknown; $2n$ = unknown

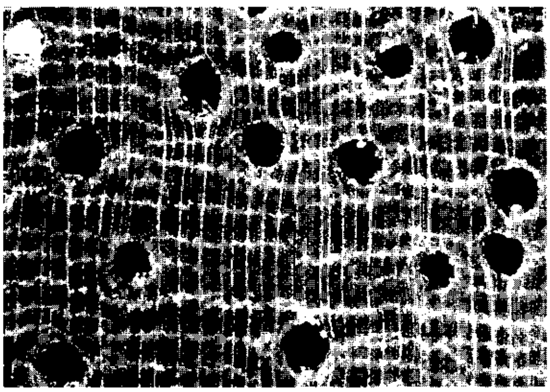
Vernacular names Merbatu (trade name). Parinari, sea beam (En). Brunei: baritu. Indonesia: kolaka (general). Malaysia: bangkawang (Sabah), nyalin, obah ngilas (Sarawak). Philippines: baritadiang (general). Burma (Myanmar): tauk-kade. Thailand: maphok.

Origin and geographic distribution *Parinari* comprises 39 species: 18 in the Neotropics, 6 in tropical Africa and 15 in tropical Asia from Indo-China and Thailand, throughout the Malesian region (13 species) towards northern Australia, Fiji and Samoa.

Uses The wood of *Parinari* is used for medium and heavy construction under cover, posts, beams, parquet flooring, panelling and packaging for heavy articles. When treated it can be used for wharf decking, transmission posts and railway sleepers, dunnage, salt-water piling and other marine constructions. It provides a good fuelwood and excellent charcoal.
The fruits of several species are edible but apparently little used. The oil obtained from the seeds is used as lacquer and to coat paper umbrellas.

Production and international trade *Parinari* wood is probably traded in mixed consignments of medium-heavy hardwood, or together with that of the genera *Atuna* and *Maranthes* as 'merbatu'. Supplies are generally limited, but fairly large amounts of *P. papuana* are exported from the Solomon Islands to Japan: 6.1% of the total log export from the Solomon Islands to Japan in 1987.

Properties *Parinari* yields a medium-weight to heavy hardwood with a density of 630–1010 kg/m^3 at 15% moisture content. Heartwood red-brown, sometimes with a yellow tinge and not clearly demarcated from the paler sapwood, sapwood up to 7 cm wide in *P. papuana*; grain straight to slightly interlocked; texture moderately coarse but even; wood sometimes slightly streaked, that of *P. papuana* slightly oily to the touch. Growth rings indistinct, occasionally visible as darker coloured bands of fibres with fewer vessels and less parenchyma; vessels medium-sized to very large, exclusively solitary, often in oblique arrangement, tyloses very rare; parenchyma moderately abundant (e.g. *P. oblongifolia*) to abundant (e.g. *P. costata*), apotracheal in narrow, more or less continuous bands, visible to the naked eye; rays very fine, only visible with a hand lens; ripple marks absent.



Parinari papuana
transverse surface (×20)

Shrinkage upon seasoning is moderate to high. Boards of *P. costata* 13 mm and 38 mm thick take respectively 1.5 and 3.5 months to air dry without serious degrade, but with some end-checking and risk of stain. It takes about 3 days to kiln dry 25 mm thick boards of *P. papuana* from green to 12% moisture content, and surface and end-checking are unavoidable. The wood is very abrasive and difficult to saw and work with hand and machine tools, has a rapidly blunting effect due to silica inclusions, and tends to pick up in planing. It splits easily, which is an advantage for its use for firewood. The wood is only moderately durable when exposed to the weather or in contact with the ground and it is easily attacked by termites. It is easy to treat: *P. oblongifolia* absorbs about 345 kg/m^3 of a 50/50 mixture of creosote and diesel oil. The sapwood is occasionally attacked by pinhole borers or termites but is rarely susceptible to *Lyctus*.
See also the tables on microscopic wood anatomy and wood properties.

Botany Evergreen, small to large or very large trees up to 50(–60) m tall; bole straight, cylindrical, branchless for up to 25 m, up to 110 cm in diameter, buttresses small and steep or absent; bark surface smooth, characteristically lenticellate, becoming cracked or patchy, with adherent scales, grey to pale brown, inner bark characteristically hard and gritty, pink or orange to red-brown. Leaves arranged spirally, simple, entire, usually hairy below; petiole usually with 2 circular glands above; stipules present, caducous. Inflorescence a much-branched cyme or cymose panicle; bracteoles enclosing small groups of flowers. Flowers bisexual, actinomorphic, with a cup-shaped tomentose receptacle and 5 sepals; petals 5, white; stamens (6–)7–9(–10), inserted unilaterally on the margin of the disk; ovary inferior, inserted on the upper half of the receptacle tube, 2-locular with a single ovule in each cell, style arising from the base of the ovary. Fruit a fleshy drupe with hard endocarp, opening by a pair of basal plugs or stoppers to allow the seedling to escape. Seedling with hypogeal germination; cotyledons not emergent; hypocotyl not developed; epicotyl scaly, all leaves arranged spirally.
In West Java *P. sumatrana* flowers in June and July. The fruits are known to be dispersed by bats, elephants, primates, squirrels, fruit pigeons, pigs, cassowaries and fish.
The family *Chrysobalanaceae* is sometimes re-

garded as a subfamily of the *Rosaceae*. The Malesian species of *Parinari* are very uniform in flowers and inflorescences and are mainly identified by means of leaf characteristics. The name *Parinarium* is an erroneous orthographic variant of *Parinari*.

Ecology Most *Parinari* species occur in primary or occasionally secondary, evergreen, semi-evergreen or more rarely mixed deciduous to dry deciduous forest in the lowlands or on hills and ridges, often along rivers and streams, sometimes ascending into montane areas, up to 1400(–2000) m altitude. They occur scattered but may be locally common and usually prefer well-drained habitats. Few species are found in kerangas and swamp forest.

Silviculture *Parinari* can be propagated by seed, the stone being the unit of sowing; there are about 165 stones in 1 kg. Stones of *P. oblongifolia* have about 70%, but germination does not start until 9 months after sowing, and the last seeds germinate after more than 3 years. Trees are shade-tolerant and under natural conditions seedlings establish in small numbers and grow up in primary forest.

Genetic resources and breeding Apart from trees incidentally cultivated in botanical gardens, there are no records of ex situ conservation of *Parinari* spp.

Prospects As *Parinari* timber is very difficult to saw, its use will probably remain limited to marine constructions and firewood.

Literature 40, 70, 162, 163, 198, 209, 238, 260, 261, 267, 341, 387, 405, 436, 464, 536, 616, 677, 678, 705, 741, 829, 831, 861, 903, 905, 963, 1038, 1048, 1221, 1239, 1242.

Selection of species

Parinari argenteo-sericea Kosterm.

Distribution Borneo (Sabah).

Parinari canarioides Kosterm.

Distribution Sumatra, Borneo, the Philippines (Palawan) and North Sulawesi.

Parinari costata (Korth.) Blume

Synonyms *Parinari bicolor* Merr., *Parinari polyneurum* Miq., *Parinari rubiginosa* Ridley.

Vernacular names Indonesia: mengkudur (East Kalimantan), sukupal, tayas (Sumatra). Malaysia: bugan (Iban, Sabah), merbatu pipit, sekepal kemalau (Peninsular).

Distribution There are 3 subspecies whose distributional ranges largely overlap: Burma (Myanmar), Peninsular Malaysia, Sumatra, Borneo and the Philippines.

Parinari elmeri Merr.

Distribution Peninsular Malaysia, Borneo and the Philippines (Mindanao).

Parinari oblongifolia Hook. f.

Synonyms *Ferolia oblongifolia* (Hook. f.) O. Kuntze, *Parinari gigantea* Kosterm., *Parinari borneense* Merr.

Vernacular names Indonesia: mankudar, mengkudu (Kalimantan). Malaysia: bedara hutan, mempelan babi, mentelur kemalau (Peninsular).

Distribution Peninsular Malaysia, Sumatra and Borneo (Sabah, Kalimantan).

Parinari papuana C.T. White

Synonyms *Parinari salomonense* C.T. White.

Vernacular names Solomon Island parinari (En). Indonesia: ogelet (Mooi, Irian Jaya).

Distribution Divided into 3 subspecies, 2 in New Guinea and the third in the Solomon Islands.

Parinari rigida Kosterm.

Synonyms *Parinari ashtonii* Kosterm.

Distribution Peninsular Malaysia, Sumatra and Borneo (Sarawak, East Kalimantan).

Parinari sumatrana (Jack) Benth.

Synonyms *Ferolia sumatrana* (Jack) O. Kuntze, *Lepidocarpa ovalis* (Korth.) Blume ex Miq.

Vernacular names Indonesia: kanjere badak (Java).

Distribution Sumatra and West Java.

C. Phengklai

Parkia R. Br.

Denham & Clapp., Narr. Travels Africa, Bot. App.: 289 (1826).

LEGUMINOSAE

$x = 12, 13$; *P. speciosa*: $2n = 24, 26$

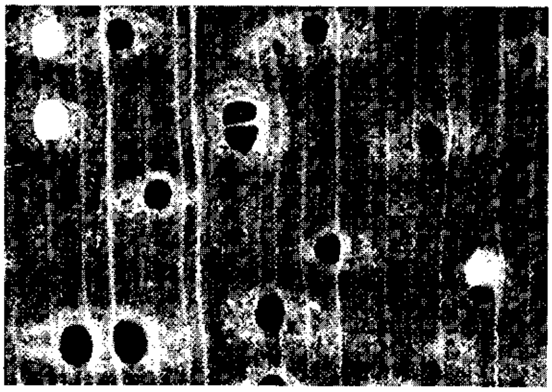
Vernacular names Petai (trade name). Thailand: sato.

Origin and geographic distribution *Parkia* is a pantropical genus with about 35 species, most of them being found in tropical America, especially in the Amazon basin. In Asia *Parkia* occurs from north-eastern India and Bangladesh east through Burma (Myanmar), Indo-China and Thailand to the whole of the Malesian region, with more isolated species in Micronesia and Fiji. About 5 species occur within Malesia. Peninsular Malaysia, Sumatra and Borneo are richest, each with 4 species. *P. timoriana* has the largest area of distribution, occurring from India to New Guinea.

Uses The wood of *Parkia* is used locally for temporary light construction, carpentry, furniture and cabinet making, moulding, interior finish, cladding, concrete shuttering, boxes, crates, matches, clogs, disposable chopsticks, fish-net floats and paper. General utility purpose plywood has been manufactured from the wood. In Peninsular Malaysia *P. singularis* wood is a popular firewood.
This species is sometimes used as a shade tree, e.g. for coffee plantations and in nurseries. The seeds are commonly used as a vegetable; they have a garlic flavour. Young leaves and the receptacle of the inflorescence are occasionally eaten. The seeds are used in local medicine against hepatalgia, oedema, nephritis, colic, cholera, diabetes and as anthelmintic, and also applied externally to wounds and ulcers. Powdered bark of *P. sumatrana* has been reported to be used against leeches in Indo-China, and the bark of *P. timoriana* against scabies, boils and abscesses.

Production and international trade *Parkia* timber generally does not reach the market because it is considered of poor quality and supplies are limited.

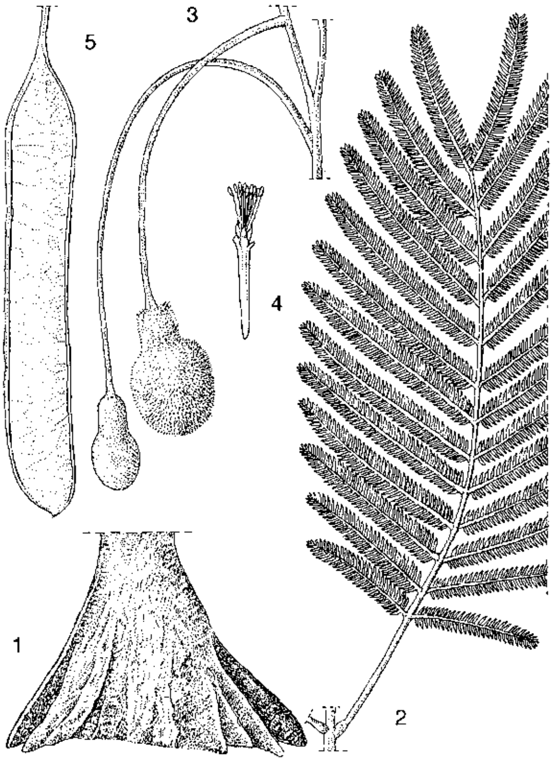
Properties *Parkia* yields a usually lightweight, occasionally medium-weight hardwood with a density of 350–810 kg/m^3 at 15% moisture content. Heartwood white, yellow-white or pale yellowish-brown, in older trees with paler and darker streaks, not clearly differentiated from the rather wide paler coloured sapwood (25 cm wide sapwood once recorded for *P. timoriana*), very occasionally darker coloured core present; grain straight or slightly interlocked; texture moderately coarse and uneven; wood with unpleasant garlic or bean-like odour when fresh. Growth rings indistinct or visible due to colour differences, narrow layers of marginal parenchyma only visible with a hand lens; vessels medium-sized to very large, mostly solitary, also in radial multiples of 2–3, sometimes more than 4, occasionally with red gum-like deposits; parenchyma abundant, paratracheal aliform and confluent, and apotracheal in marginal or seemingly marginal bands and diffuse, the latter type rare; rays very fine to medium-sized, visible to the naked eye; ripple marks absent, but rays irregularly storied; occasionally with pith flecks.



Parkia timoriana
transverse surface (×18)

Shrinkage upon seasoning is low; degrade during seasoning is mainly due to insect attack and blue stain, whereas end-checks have been observed in *P. speciosa*. It takes respectively 3–4 months and 4.5–5 months to air dry boards 13 mm and 38 mm thick. The wood is soft to moderately hard in *P. singularis* and weak. The wood is relatively easy to work, saw and machine, both when green and when air-dry; it can be planed well and gives a smooth finish, but boring and turning give a rough finish. The production of rotary veneer is satisfactory, but the production of good-quality plywood is doubtful. The wood is non-durable with a service life of about one year for *P. speciosa* wood, but preservative treatment applying the standard open-tank method with creosote is very easy, and an absorption of 320 kg/m^3 has been obtained in *P. speciosa*. A dry salt retention of 12.3 kg/m^3 of copper-chrome-arsenic solution was obtained in treating *P. speciosa* wood by the vacuum-pressure method. The wood is not resistant to any kind of insect or wood-borer attack nor to wood-staining fungi. The sapwood is susceptible to *Lyctus*.
See also the tables on microscopic wood anatomy and wood properties.

Botany Deciduous, medium-sized to large trees up to 50 m tall; bole up to 100(–250) cm in diameter, buttresses small to large (up to 4 m high and spreading up to 2 m) or absent; bark surface smooth to rough, fissured or flaky, pale greyish to reddish-brown, inner bark fibrous, hard, usually pinkish or reddish to deep red-brown, sometimes streaked or mottled, with a strong smell of beans. Leaves alternate or opposite, bipinnate with up to 30(–42) pairs of pinnae; leaflets opposite, sessile;



Parkia timoriana (DC.) Merr. – 1, base of trunk; 2, leaf; 3, flowering heads; 4, flower; 5, fruit.

petiole and rachis usually with extrafloral nectaries; stipules small, caducous. Flowers in a long-stalked, pendulous, pyriform to clavate, dense head, sterile flowers at base of inflorescence, male ones in middle portion and bisexual ones at apex, 5-merous; calyx long-tubular or funnel-shaped with imbricate lobes; corolla longer than calyx; stamens 10, connate below, shortly exserted; ovary superior, short-stiped, style exserted. Fruit a leathery or woody, stalked, linear to strap-shaped or oblong pod, usually indehiscent, many-seeded, usually several pods together in a pendent infructescence with swollen receptacle. Seeds in 1 row, ellipsoid, with a pleurogram. Seedling with epigeal germination; cotyledons fleshy, peltate; epicotyl with a scale leaf and subsequently bipinnate leaves.

P. speciosa and *P. timoriana* show a synchronized annual cycle of flowering, fruiting and leaf fall; the trees are without leaves for 2–3 weeks each year. They start flowering when 10–15 m tall, but vegetatively propagated *P. speciosa* starts flowering and fruiting a few years after planting. The flowering heads are usually pollinated by bats, but are also visited by insects and birds. They produce a foetid odour and a copious nocturnal supply of nectar. Hornbills, monkeys, squirrels, deer, elephants and wild pigs feed on the fruits and probably disperse the seeds. In Java *P. timoriana* flowers in April–July and usually many fruits are found in June–August. A 24-year-old *P. timoriana* tree in the arboretum of the Forest Research Institute Malaysia, Kepong had attained only 13.8 m in height and 9.2 cm in diameter.

Parkia is classified in the tribe *Parkieae* of the subfamily *Mimosoideae*, together with *Pentaclethra*, which is confined to tropical Africa and America.

P. timoriana is often cited as *P. javanica* (Lamk) Merr., especially in Malaysian literature. Although the latter name is older and would therefore have priority, it has been superseded because the correct identity of the species concerned cannot be recovered. The status of *P. intermedia* Hassk. is uncertain, but it is probably a hybrid between *P. speciosa* and *P. timoriana*; it is found almost exclusively in Java. *P. sherfeseei* Merr. from the Philippines (Mindanao) is possibly conspecific with *P. sumatrana*.

Ecology *Parkia* occurs scattered in lowland rain forest and sometimes also in tall secondary forest, on sandy, loamy and podzolic soils, also in waterlogged locations, in freshwater swamp forest and on river banks, up to 1000(–1400) m altitude. *P. sumatrana* and *P. timoriana* also occur in dry evergreen forest, often along streams.

Silviculture *Parkia* can be propagated by seed and by vegetative means. Seeds of *P. timoriana* can be hand-picked from underneath mother trees from the hard, indehiscent pods that should be opened with a chopping knife. *P. timoriana* has 1000–1400 dry seeds/kg. Seedlings of *P. speciosa* are collected by farmers from the wild and planted in their home garden or fields. About 90% of the soft seeds of *P. speciosa* germinate in 3–15 days; the germination rate of the hard seeds of *P. timoriana* is about 55% in 8–103 days. Mechanical scarification is recommended for the latter. In a test in Thailand, 3-year-old seed had a germination rate of only 8.5% whereas nicked seed had a germination rate of 90.5% in only 4–8 days. A pretreatment with concentrated sulphuric acid for 15 minutes gave a germination of 95%. *P. speciosa* can be propagated by stem cuttings and budding, but *P. timoriana* cannot be propagated vegetatively. Seedlings of *P. timoriana* can be stumped with 10–20 cm shoot and 20–40 cm root length, and survival after planting is 100%. In Java growth during the first 5 years was fast, but then slowed down. For optimal growth ample space and light are necessary. Mixed plantations with *Lagerstroemia speciosa* (L.) Pers. and *Artocarpus heterophyllus* Lamk planted in alternating rows at 3 m × 1 m spacing were successful with a production of 65 m³/ha clear bole volume at the age of 15.5 years. The mean diameter of *P. timoriana* at this age is 15.6–20.4 cm and its height is 14.5–16.1 m. Some unidentified borers have been found tunnelling in the stem of living trees. In Malaysia it is recommended to treat timber of *Parkia* with anti-stain chemicals immediately after sawing. In a survey of almost 700 ha of primary forest in Peninsular Malaysia, an average of 0.22 trees/ha of *P. singularis* and *P. speciosa* with a diameter of over 40 cm was found, but usually these species are much less common.

Genetic resources and breeding Within Malesia no seed or germplasm collections of *Parkia* are known to exist and no breeding programmes are being carried out. Most species have a fairly wide area of distribution and are also cultivated, suggesting that it is unlikely that they are threatened. *P. versteeghii*, however, seems to be rare.

Prospects There is little scope for increased utilization of the timber of *Parkia* as it is non-durable and of poor quality. Only the quality and durability of the timber of *P. singularis* is slightly better, but its scattered occurrence makes exploitation difficult.

Literature 16, 70, 151, 162, 163, 198, 209, 235, 260, 267, 302, 304, 316, 341, 343, 348, 387, 405, 436, 448, 464, 488, 577, 632, 633, 677, 678, 679, 740, 741, 770, 780, 825, 829, 831, 832, 862, 882, 933, 934, 955, 972, 980, 987, 1015, 1039, 1053, 1163, 1198, 1218, 1221, 1226.

Selection of species

Parkia singularis Miq.

Vernacular names Indonesia: petai papan (general), empamai (Dayeeb Barito, Kalimantan), parira hayu (Batak Toba, Sumatra). Malaysia: belungai, petai meranti (Peninsular).

Distribution Peninsular Malaysia, Sumatra and Borneo.

Parkia speciosa Hassk.

Synonyms *Parkia harbesonii* Elmer.

Vernacular names Indonesia: petai (general), pete (Javanese), peuteuy (Sundanese). Malaysia: petai (general), nyiring (Peninsular), patag (Murut, Sabah). Philippines: u'pang (Palawan). Thailand: sator (general), sator dan, sator kow (peninsular).

Distribution Southern Thailand, Peninsular Malaysia, Sumatra, Borneo and the Philippines (Palawan); frequently cultivated in western Java, and occasionally elsewhere.

Parkia sumatrana Miq.

Synonyms *Parkia dongnaiensis* Pierre, *Parkia macrocarpa* Miq., *Parkia streptocarpa* Hance.

Vernacular names Brunei: kupang amas, petai belalong. Indonesia: soga (Muna, Sulawesi). Malaysia: buah putai, kedaung (Iban, Sarawak), petai nering (Peninsular). Burma (Myanmar): mai-ka-tor (Shan), thit lein. Cambodia: royôông (Kampot), ta sek (Kompong Speu). Laos: 'hua 'lôn² (Savannakhet), 'sôm² po:y¹ 'luang (Louang Prabang). Thailand: i-thao (south-eastern), luk ding (central). Vietnam: th[us]i (Biên Hoa).

Distribution Southern Burma (Myanmar), Indo-China, Thailand, Peninsular Malaysia, Sumatra, Borneo and Sulawesi.

Parkia timoriana (DC.) Merr.

Synonyms *Parkia biglobosa* auct. non (Jacq.) R. Br., *Parkia javanica* auct., *Parkia roxburghii* G. Don.

Vernacular names Indonesia: alai (Sumatra), kedawung (Javanese), peundeuy (Sundanese). Malaysia: kedaung (Sarawak), kupang (Sabah), petai kerayong (Peninsular). Philippines: kupang (Filipino), amarang (Palawan). Burma (Myanmar): mai-karien (Shan). Thailand: kariang, riang (peninsular).

Distribution India, Bangladesh, Burma (Myanmar), Thailand and throughout the Malesian region (except Papua New Guinea).

Parkia versteeghii Merr. & L.M. Perry

Distribution New Guinea and the Solomon Islands.

F.M. Setyowati

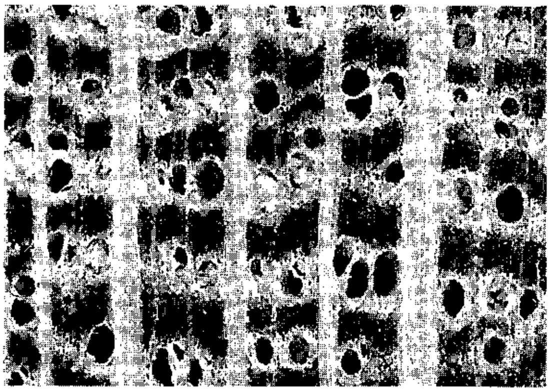
Pellacalyx Korth.

Tijdschr. Natuurl. Gesch. Physiol. 3: 20 (1836).

RHIZOPHORACEAE

x = unknown; $2n$ = unknown

Vernacular names Indonesia: kayu bulu (Sumatra). Malaysia: membuloh (general), merbuloh, sawar bubu (Sarawak). Thailand: kan phlu.



Pellacalyx saccardianus
transverse surface (×20)

Origin and geographic distribution *Pellacalyx* comprises 7 or 8 species and is distributed in Burma (Myanmar), southern China, Thailand, and western Malesia (Peninsular Malaysia, Singapore, Sumatra, Borneo, the Philippines and northern Sulawesi). Six species occur in Malesia, most of which have restricted areas of distribution.

Uses The wood of *Pellacalyx* is occasionally used for rafters and other construction purposes under cover and for fuel.

Production and international trade *Pellacalyx* trees are usually too small to be important for their timber. The wood is only used locally.

Properties *Pellacalyx* yields a medium-weight hardwood with a density of 470–640 kg/m^3 at 15% moisture content. Heartwood yellow-brown to pale brown with a pink hue, not differentiated from the sapwood; grain straight or interlocked; texture slightly to moderately coarse and uneven due to the presence of broad rays; wood with conspicuous silver grain on radial surfaces. Growth rings indistinct; vessels moderately small to moderately large, solitary or in tangential multiples of 2–3, tangential arrangement conspicuous, clusters common, tyloses not abundant; parenchyma abundant, paratracheal aliform and confluent; rays moderately broad to extremely broad; ripple marks absent.
The wood is moderately hard to hard. The wood is durable under cover, but susceptible to powder-post beetle attack.
See also the table on microscopic wood anatomy.

Botany Small to fairly large trees up to 35(–45) m tall, sometimes shrubs; bole usually straight, up to 40(–65) cm in diameter, usually becoming deeply fluted at base, sometimes with small or large buttresses up to 5 m high; bark surface initially smooth but becoming polygonally fissured, often rugose, grey to brown or reddish-brown, inner bark pale brown to reddish-brown; twigs hollow. Leaves decussate, simple, entire to slightly serrate; stipules flat and not overlapping. Flowers bisexual, fascicled or on branched glomerules, (1–)2–8 together, (3–)4–5(–6)-merous; calyx tube hairy inside; petals inserted on the margin of the calyx tube, toothed to fringed at the apex, densely hairy outside; stamens twice as many as petals, connate at base or free, unequal; ovary inferior, 9–10(–12)-locular with 8–25 ovules per cell, style columnar, stigma obscurely 8–10-lobed. Fruit a subglobose, few to many-seeded berry, with persistent calyx lobes. Seed tiny, black. Seedling with epigeal germination; cotyledons leafy; hypocotyl well-developed.
The trees show monopodial growth and have a lanceolate to conical crown, often with stiffly horizontal branches and drooping leaves. In swampy locations *P. axillaris* develops looped pneumatophores.

Ecology *Pellacalyx* trees occur in lowland evergreen rain forest, including secondary forest, up to 1300 m altitude, often along streams and in damp locations, but also on ridges.

Silviculture *Pellacalyx* can be propagated by seed. In a germination test in Malaysia seed with pulp of *P. saccardianus* had a germination rate of 55% in 1–3 months.

Genetic resources and breeding Many *Pellacalyx* species occur only very locally and scattered in the forest. Since they are not commonly logged for their timber, there seems to be no particular danger of genetic erosion.

Prospects The commercial importance of *Pellacalyx* timber is unlikely to increase, as the trees seldom reach exploitable size.

Literature 46, 61, 151, 163, 209, 267, 341, 543, 831, 861, 934, 1039, 1048, 1221, 1242.

Selection of species

Pellacalyx axillaris Korth.

Synonyms *Craterianthus fimbripetalus* Valeton ex K. Heyne.

Vernacular names Indonesia: kayu bulu, merah bulu (Sumatra), kayu merah kuku (Bangka). Malaysia: danguh, merbuloh (Sarawak), membuloh bulu (Peninsular). Philippines: pamaluian (Bagobo).

Distribution Peninsular Malaysia, Singapore, Sumatra, Borneo and the Philippines (Mindanao).

Pellacalyx lobbii (Hook. f.) Schimp.
Synonyms *Plaesiantha lobbii* Hook. f.
Vernacular names Indonesia: baniran, paserujan gunugo (Dayak, Kalimantan), kayu bulu (Sumatra). Malaysia: paserujan gunugo, rasu (Dayak Iban, Sarawak).
Distribution Sumatra and Borneo.

Pellacalyx pustulatus Merr.
Vernacular names Philippines: magatalo (Magindanao), mamatog (Tagalog), sinagaw (Subanun).
Distribution The Philippines and northern Sulawesi.

Pellacalyx saccardianus Scort.
Vernacular names Malaysia: huka hurgu, kayu johor, membuloh rimba (Peninsular). Thailand: ai kraek bai lek (peninsular).
Distribution Peninsular Thailand, Peninsular Malaysia and Singapore.

Pellacalyx symphiodiscus Stapf
Distribution Borneo.

Ding Hou

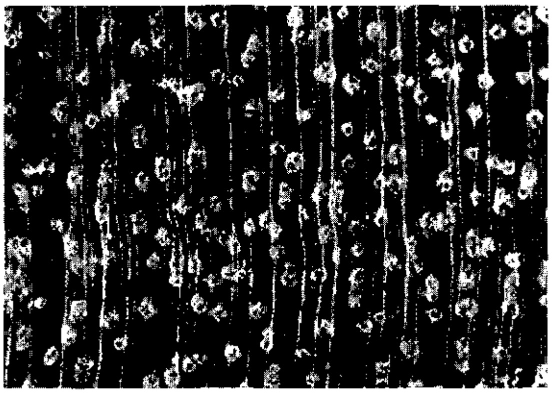
Pemphis J.R. Forster & J.G. Forster

Charact. gen. pl., ed. 1: 34 (1775).
LYTHRACEAE
$x = 16$; *P. acidula*: $2n = 32$

Vernacular names Indonesia: cantigi (Sundanese), mentigi (Ambon), sentigi (Javanese). Malaysia: mentigi (general). Philippines: bantigi (Filipino), kabantigi (Tagalog), ligad (Tagbanua). Thailand: thian le (peninsular).

Origin and geographic distribution *Pemphis* is a monotypic genus occurring along the shores of East Africa and Madagascar to Sri Lanka, India, Burma (Myanmar), Indo-China, China, the Ryukyu Islands, Taiwan, Thailand, throughout the Malesian region, northern Australia and the Pacific east to Fiji, Tonga and Pitcairn Island. The only species is *P. acidula* J.R. Forster & J.G. Forster.

Uses The very hard wood of *Pemphis* is used for house posts, fence posts, tool handles, walking-sticks, kris handles and sheaths, novelties, domestic implements, turnery, anchors, boat nails and pestles. It is also used for firewood.
It is occasionally planted as an ornamental. The acid leaves can be eaten raw.



Pemphis acidula
transverse surface (×18)

Production and international trade Because of the small size and poor form of the bole of *Pemphis* as well as its limited supply, the use made of the wood is limited and on a local scale only.

Properties *P. acidula* yields a very heavy hardwood with a density of 1100–1210 kg/m^3 at 15% moisture content. Heartwood reddish-brown to dark reddish-brown, turning dark brown with age, clearly differentiated from the pale, about 1 cm wide sapwood; grain interlocked; texture very fine; wood lustrous. Growth rings indistinct to fairly distinct, wood diffuse-porous to semi-ring-porous; vessels very small to moderately small, solitary and in radial multiples of 2–3 or in clusters, with a tendency to ring-porous arrangement, generally with reddish-yellow deposits; parenchyma paratracheal vasicentric to aliform; rays extremely fine to very fine, paler than surrounding tissue; ripple marks absent.
Shrinkage upon air seasoning is very low but is very high when oven dried. The wood seasons well with little checking and warping. It is very hard and very strong. It is very difficult to work but with care it takes a high finish. The wood is very durable when exposed to the weather or in contact with the ground. The heartwood is very resistant to dry-wood termites. The sapwood is non-susceptible to *Lyctus*.
See also the tables on microscopic wood anatomy and wood properties.

Botany An evergreen shrub or small tree up to 10 m tall; bole often short and crooked, up to 20(–40) cm in diameter; bark surface becoming deeply fissured with age and flaking into long strips, light grey to dark grey-brown, inner bark laminated, light reddish. Twigs angular, densely hairy. Leaves decussate, simple, entire, fleshy, subsessile, silky-haired; stipules absent. Flowers axillary, solitary or in pairs, 6-merous, heterostylous; calyx bell-shaped or tubular; petals inserted near the mouth of the calyx tube, white, clawed; stamens 12 or rarely 18, in 2 dimorphic series; ovary superior, 1-locular with many ovules, style 1. Fruit a capsule, enclosed in the calyx tube, the upper half falling as a lid. Seed with thick marginal wings.

Growth form corresponds to Attims' architectural tree model, characterized by axes with continuous growth, differentiated into a monopodial trunk and equivalent branches. Flowers show heterodistyly, with anthers and styles in 2 length classes, whereas heterotristyly with 3 length classes is the usual situation within *Lythraceae*. However, the sets of stamens and anthers of *Pemphis* do occupy 3 different levels. Flowers are generally self-incompatible.

P. madagascariensis (Baker) Koehne has been transferred to a separate genus: *Koehneria*.

Ecology *P. acidula* is found on sandy and rocky shores and exposed mangrove vegetations. It is uncommon but may be locally gregarious.

Silviculture *P. acidula* can be propagated by seed.

Genetic resources and breeding In the Philippines *P. acidula* is threatened by the harvest of living plants, sometimes together with the rocky substrate, to be exported to Taiwan where it is used in rock gardens.

Prospects Increased use of *P. acidula* timber is unlikely but it will remain of interest for specialty uses.

Literature 69, 70, 163, 209, 342, 372, 382, 436, 699, 734, 934, 1048, 1101, 1115, 1221.

H. Purnobasuki & B. Irawan

Perrottetia Kunth

Humb., Bonpl. & Kunth, Nov. gen. pl. 7: fol. ed. 57, qu. ed. 73 (1824).

CELASTRACEAE

x = unknown; $2n$ = unknown

Vernacular names Indonesia: kayu musang (Sumatra), kemalon (Javanese), ki hurang (Sundanese). Malaysia: kayu tungas (Peninsular), maesa (Sarawak). Philippines: balakbakan (Bukidnon), bubayug (Igorot), tigaundako (Cebu Bisaya).

Origin and geographic distribution *Perrottetia* comprises about 15 species. There is 1 endemic species in central China, 1 in Taiwan, 1 in northern Australia (Queensland), 1 in most of the Malesian region and the Solomon Islands, and 1 in the Solomon Islands and Hawaii. The remaining ones are found in Central America. The only Malesian species is *P. alpestris* (Blume) Loes. which occurs throughout the Malesian region (except for the Lesser Sunda Islands), and in the Solomon Islands.

Uses The decorative wood of *P. alpestris* is suitable for turnery, carving, engraving, and other small objects such as trinket boxes.

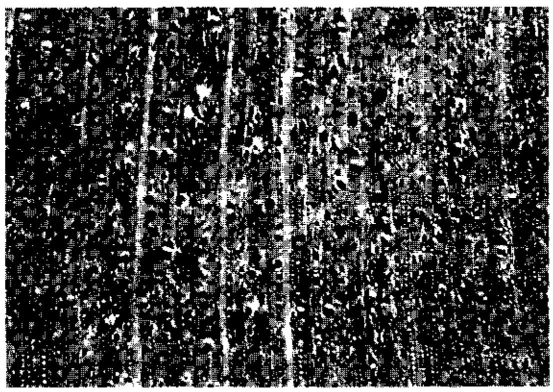
Production and international trade The wood of *P. alpestris* is used rarely and on a local scale only.

Properties Heartwood pale brown with a pinkish tinge, not clearly demarcated from the sapwood; grain straight to wavy; texture fine and even; wood lustrous. Growth rings indistinct; vessels moderately small, solitary and in radial multiples of 2–4(–6), open; parenchyma absent; rays of 2 sizes, moderately fine to moderately broad; ripple marks absent.

The wood of *P. alpestris* is non-durable.

See also the table on microscopic wood anatomy.

Botany An evergreen, small to medium-sized tree up to 15(–24) m tall. Leaves alternate, simple, glandulose-serrulate or crenulate; stipules small, caducous. Inflorescence axillary, cymose, composed of small, divaricate thyrses. Flowers bisexual, rarely unisexual, 4–5-merous; calyx lobes valvate; petals similar in shape to the calyx lobes, white or pale green; disk shallowly cupular; stamens inserted on the margin of the disk; ovary superior, half-sunken in the disk, 2-locular with 2 ovules in each cell, style short, stigma with 2 short



Perrottetia alpestris
transverse surface (×20)

lobes. Fruit a 3–4-seeded, globose to subglobose, reddish-black berry. Seed covered with a thin aril; testa thick, rugulose to tuberculate.

In Java *P. alpestris* flowers throughout the year.

P. alpestris has been subdivided into 3 subspecies: subsp. *alpestris* is found in Peninsular Malaysia, Sumatra and Java, subsp. *philippinensis* (S. Vidal) Ding Hou (synonym: *Perrottetia philippinensis* (S. Vidal) Loes.) in Borneo, the Philippines and Sulawesi, and subsp. *moluccana* (Blume) Ding Hou (synonyms: *Perrottetia arborescens* (F. v. Mueller) Loes., *Perrottetia grandifolia* Ridley, *Perrottetia moluccana* (Blume) Loes.) in the Moluccas, New Guinea and the Solomon Islands.

Ecology *P. alpestris* is fairly common and occurs in primary and secondary, hill and montane forest or alpine thickets, at 500–3300 m altitude, under perhumid conditions.

Genetic resources and breeding The wide geographical distribution of *P. alpestris*, its fairly wide altitudinal range and its restricted use almost exclude the risk of genetic erosion.

Prospects The wood of *P. alpestris* is hardly used for timber and it is unlikely that this situation will change in the near future.

Literature 61, 70, 163, 198, 341, 497, 974, 1048, 1221.

K.M. Kochummen (general part),
J. Ilic (wood anatomy)

Persea Miller

Gard. Dict., abr. ed.: 4 (1754).

LAURACEAE

$x = 12$; *P. americana*: $2n = 24, 36, 48$, *P. philippinensis*: $2n = 24$

Vernacular names Medang (trade name). Machilus (En). Burma (Myanmar): kyese (general), seiknangyi.

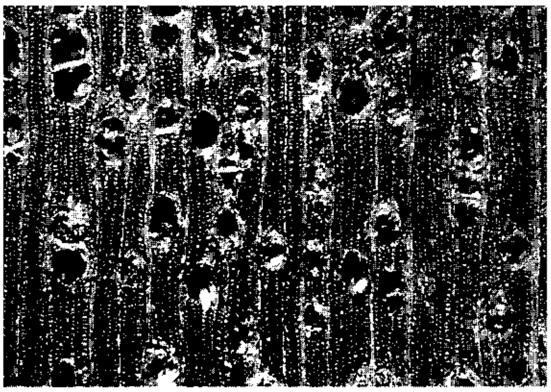
Origin and geographic distribution *Persea* is a large genus comprising about 150 species. About 80 species are found in the Neotropics, only one species is found in the Canary Islands, and the rest occur in the Asiatic tropics and subtropics from Sri Lanka and India to the Himalayas, Burma (Myanmar), Indo-China, China, Japan and south to Thailand and the whole of the Malesian region except for New Guinea. Most Asiatic species are found on the Asian mainland; only about 20 occur in the Malesian region.

Uses Wood of *Persea* has been used for house building (especially for house posts), light construction, furniture, cabinet making, agricultural implements, carving, sculptures, musical instruments, paddles, small articles like pen and brush holders, and novelties. It also yields a good-quality veneer and plywood, and has been used for the production of charcoal and as firewood. In India the aromatic wood of e.g. *P. odoratissima* (Nees) Kosterm. has been used for tea chests.

The bark and leaves contain a volatile oil with a faint smell of anise. Avocado (*P. americana* Miller) is well-known for its edible fruits; its wood is seldom used.

Production and international trade *Persea* timber is traded together with that of many other *Lauraceae* genera as 'medang'. It probably constitutes only a very small portion of the total amount traded. In 1984 the total export of medang from Peninsular Malaysia to Singapore was about 1500 m^3 with a value of US$ 62 000. In 1992 the export from Sabah amounted to 52 000 m^3 (of which about 10% was sawn timber) with a total value of US$ 4.3 million. Japan imports medang mainly from Sabah and Sarawak.

Properties *Persea* yields a medium-weight hardwood with a density of 530–830 kg/m^3 at 15% moisture content. Heartwood pale red-brown, pink-yellow or dark olive-buff, moderately sharply differentiated from the about 3 cm wide sapwood which is pale yellow or straw-coloured with a slight green tinge; grain straight or interlocked; texture fine to moderately fine; wood lustrous; with cedary odour when freshly sawn; planed surface greasy to the touch. Growth rings distinct to indistinct to the naked eye, generally fairly conspicuous with a hand lens from denser wood with relatively few vessels; vessels moderately small to medium-sized, solitary and in radial multiples



Persea macrantha (Nees) Kosterm.
transverse surface (×20)

of 2–3(–7), occasionally in clusters; parenchyma sparse, paratracheal vasicentric with a tendency to aliform, indistinct with a hand lens; rays extremely fine to moderately fine; occasional oil cells in parenchyma and in rays hardly visible, even with a hand lens; ripple marks absent.

The wood seasons very well. It is moderately hard and moderately strong. It works very easily and turns and carves well. The durability is variable, from very durable when exposed to the weather and moderately durable in contact with the ground for *P. philippinensis*, to moderately durable under cover for *P. excelsa*. The sapwood of 'medang' timber is generally amenable to preservative treatment and the heartwood is not; in *P. philippinensis* the heartwood is very resistant and the sapwood moderately resistant to preservative treatment.

A charcoal yield of about 32% can be obtained (based on oven-dry weight). The bark of several species contains alkaloids.

See also the tables on microscopic wood anatomy and wood properties.

Botany Evergreen, small to medium-sized trees up to 30(–40) m tall; bole usually fairly straight, branchless for up to 20(–25) m, up to 80(–90) cm in diameter, sometimes with small buttresses; bark surface smooth to cracking or shallowly fissured, lenticellate, grey or grey-brown to yellowish-brown, inner bark pinkish to pale orange. Leaves arranged spirally, simple, entire, venation minutely areolate, usually aromatic when crushed, exstipulate. Flowers bisexual, in an axillary or terminal panicle, 3-merous; tepals 6, with a shallow tube; fertile stamens 9, in 3 whorls, those of the inner whorl with glandular filaments, anthers 4-celled, opening by valves; ovary superior, unilocular with a single ovule, stigma peltate. Fruit a 1-seeded, green or black berry seated on the persistent and indurated perianth with spreading or reflexed lobes, sometimes the perianth deciduous. Seedling with hypogeal germination; cotyledons not emergent, peltate; hypocotyl not developed; epicotyl with a few scales, all leaves arranged spirally.

In Java *P. declinata* flowers in June, *P. rimosa* in May–November and fruits of the latter are ripe in July–November. The seeds are dispersed by birds, but in *P. americana* dispersal may also take place by bats. *P. americana* develops according to Rauh's architectural model, characterized by a monopodial trunk which grows rhythmically and so develops tiers of branches. In other *Persea* species, however, branches are developed by syllepsis, hence the branch tier tends to be more diffuse. Vesicular-arbuscular mycorrhizae have been observed in *P. americana*.

Persea is botanically still not well understood and the Asiatic species are in desperate need of a full taxonomic revision. The distinction between *Persea*, *Alseodaphne*, *Nothaphoebe* and *Phoebe* is only slight. Most authors include the genus *Machilus* in *Persea*.

Ecology Timber-yielding *Persea* species occur in primary, evergreen lowland to lower montane forest, up to 1500 m altitude.

Silviculture *Persea* may be propagated by seed; the only seedweight known is that of *P. rimosa*: 2600 dry seeds/kg. The seeds are recalcitrant and cannot tolerate drying out. *P. americana* is also propagated vegetatively by budding and grafting.

Genetic resources and breeding A possible decrease of genetic variation of timber-yielding *Persea* species is linked with the destruction of their habitat.

Prospects Since the supply is limited, it is not very likely that the use of *Persea* timber as part of the 'medang' timber trade group will increase.

Literature 70, 101, 163, 193, 238, 267, 374, 405, 417, 436, 438, 464, 595, 605, 613, 614, 620, 627, 785, 861, 934, 974, 1123, 1124, 1164, 1221.

Selection of species

Persea declinata (Blume) Kosterm.

Synonyms *Phoebe declinata* (Blume) Nees, *Phoebe incerta* Blume, *Phoebe sumatrana* Miq.

Vernacular names Indonesia: huru leu-ur, huru manok (Sundanese), kayu helah (Sumatra). Malaysia: medang inai, medang tanah, medang telur (Peninsular).

Distribution Peninsular Malaysia, Singapore, Sumatra, Java and Borneo.

Persea excelsa (Blume) Kosterm.

Synonyms *Alseodaphne excelsa* (Blume) Blume, *Ocotea excelsa* Blume, *Phoebe excelsa* (Blume) Nees.

Vernacular names Indonesia: huru leu-ur, ki jeruk (Sundanese), wuru janggel (Javanese).

Distribution Thailand, Peninsular Malaysia, Java and Bali.

Persea philippinensis (Merr.) Merr.

Synonyms *Machilus philippinensis* Merr.

Vernacular names Philippines: kulilisiau (Filipino).

Distribution The Philippines.

Persea rimosa (Blume) Zoll. ex Meissner

Synonyms *Machilus rimosa* (Blume) Blume.

Vernacular names Indonesia: huru gambir, huru puspa (Sundanese), wuru janggel (Javanese).

Distribution India (Assam), Thailand, Peninsular Malaysia, Sumatra, Java, Borneo, the Philippines, Sulawesi and the Moluccas.

H. Sutarno

Pertusadina Ridsd.

Blumea 24: 353 (1978).

RUBIACEAE

x = unknown; $2n$ = unknown

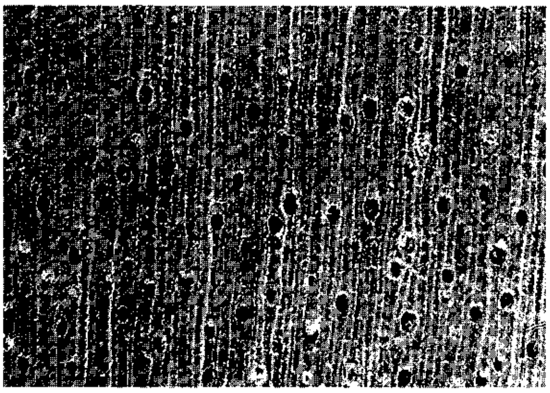
Vernacular names Bangkal (trade name). Indonesia: berumbung. Malaysia: meraga (Peninsular). Philippines: adina (Filipino).

Origin and geographic distribution *Pertusadina* is a small genus of 4 species, one of which occurs in southern China, and the other 3 in peninsular Thailand, Peninsular Malaysia, Sumatra, Borneo, the Philippines, the Moluccas and New Guinea; in all these regions only 1 species is found, except for Peninsular Malaysia where 2 species occur.

Uses The wood of *Pertusadina* is rarely used because it is difficult to get timber from well-formed boles. However, the quality is recorded as excellent and the wood is very suitable for fence posts, corbels and tool handles; it is also applied for bridges and salt-water piling. In the Philippines it is considered excellent for flooring, furniture and turnery.

Production and international trade Supplies of *Pertusadina* timber are limited because the trees usually occur scattered, and because of the poor bole form it is difficult to obtain large-sized timber. It is traded as 'bangkal' together with *Nauclea*, *Neonauclea* and *Ochreinauclea* timber.

Properties *Pertusadina* yields a medium-weight hardwood with a density of 790–860 kg/m^3 at 15% moisture content. Heartwood yellow-brown with an olive tinge or yellow-pink to red-brown, not sharply differentiated from the paler sapwood; grain straight to wavy, occasionally interlocked; texture fine and even. Growth rings indistinct, sometimes suggested by a narrow layer without parenchyma succeeded by a layer with more numerous vessels; vessels moderately small



Pertusadina eurhyncha
transverse surface (×20)

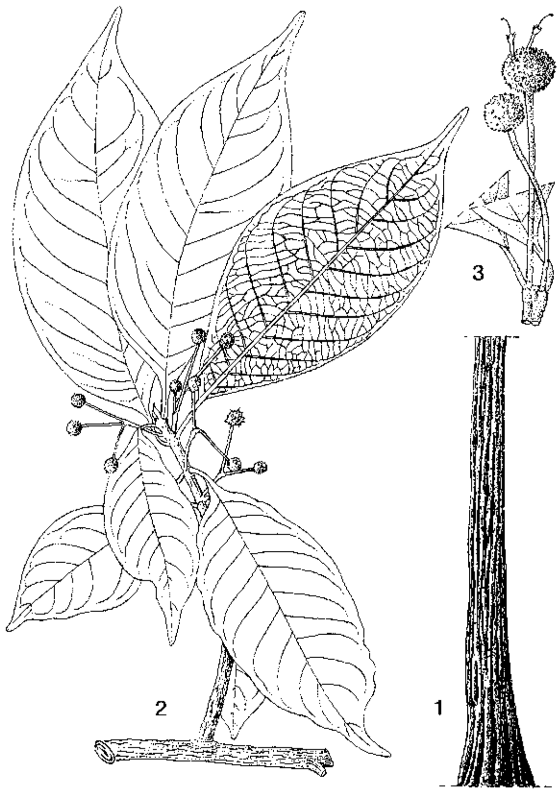
to medium-sized, almost exclusively solitary, but with occasional radial multiples of 2–3, open; parenchyma abundant, apotracheal diffuse and diffuse-in-aggregates, hardly visible with a hand lens; rays extremely fine to moderately fine, not distinct to the naked eye; ripple marks absent.

The wood needs care during seasoning to prevent checking. It is hard and strong. Wood of *P. multifolia* is difficult to work and to finish. The wood is durable. Its resistance to marine borers is variable.

See also the table on microscopic wood anatomy.

Botany Medium-sized to large trees up to 45 m tall; bole branchless for up to 20 m and up to 150(–200) cm in diameter, often fluted or becoming latticed in old trees; bark surface finely fissured to slightly scaly, greyish-brown, inner bark pale yellow. Terminal vegetative bud conical. Leaves opposite, simple, entire, elliptical to obovate, shortly petiolate; stipules embracing the terminal bud, deciduous. Inflorescence usually lateral at branches, composed of 1–3 stalked heads. Flowers with interfloral bracteoles, 5-merous; calyx with a short tube and persistent deltoid to elliptical-oblong lobes; corolla hypocrateriform to narrowly funnel-shaped, with valvate lobes (but subimbricate at apex); stamens inserted in the upper part of the corolla tube; ovary inferior, 2-locular with 4–10 ovules in each cell, style exserted, with a globose to obovoid stigma. Fruits in a head-like infructescence, free, splitting in 4 parts, with a persistent central axis. Seed ovoid to trigonal, slightly bilaterally compressed, narrowly winged. Seedling with epigeal germination; cotyledons leafy.

Older trees of *P. eurhyncha* show a peculiar stem formation: the bole has a large number of openings where the cambium is locally not functional,



Pertusadina eurhyncha (Miq.) Ridsd. – 1, bole; 2, flowering branch; 3, inflorescences.

giving a lattice-like effect similar to that presented by strangling figs (*Ficus* spp.). Eventually the bole may become a hollow cylinder of lattice work. This process often starts when the trees have reached a diameter of 30–40 cm. In Peninsular Malaysia *P. eurhyncha* flowers in April–August and in October, whereas ripe fruits are found in July–August.

Pertusadina is related to *Adina* and a group of 4 small 'satellite' genera (including *Adinauclea*, *Haldina* and *Metadina*) in the tribe *Naucleeae*. It is particularly characterized by the conical terminal vegetative bud and the few, laterally positioned flower heads.

Ecology *Pertusadina* species occur in lowland and hill forest, up to 400 m altitude. The trees usually occur scattered, but sometimes gregarious (e.g. *P. eurhyncha* locally in Peninsular Malaysia and Sumatra). *P. eurhyncha* is reported to be able to grow on poor sandy soils and is at least locally common in secondary forest.

Silviculture Large dimensions of *P. eurhyncha* are not commercially exploitable due to the tendency for the stem to become hollow. Its natural regeneration in Peninsular Malaysia is sparse.

Genetic resources and breeding Although *Pertusadina* trees are recorded as locally common, there is so little information that their status of genetic erosion or endangerment cannot be determined. *P. malaccensis* is rare.

Prospects Because of the excellent quality and durability of the wood it seems justified to investigate its potential for social forestry. The peculiar bole structure of older trees of *P. eurhyncha* restricts its commercial trade.

Literature 163, 209, 267, 354, 360, 436, 487, 513, 553, 716, 934, 943, 1221.

Selection of species

Pertusadina eurhyncha (Miq.) Ridsd.

Synonyms *Adina minutiflora* Valeton, *Adina rubescens* Hemsley, *Uncaria eurhyncha* Miq.

Vernacular names Indonesia: barumbung (Minangkabau, Sumatra), gerunggung (Sumatra), kayu lobang (Belitung). Malaysia: berombong, meraga, peropong (Peninsular).

Distribution Peninsular Malaysia, Sumatra, Belitung and Borneo.

Pertusadina malaccensis Ridsd.

Distribution Peninsular Thailand (Surat Thani) and Peninsular Malaysia (rare).

Pertusadina multifolia (Havil.) Ridsd.

Synonyms *Adina garciae* Elmer, *Adina multifolia* Havil., *Metadina multifolia* (Havil.) Ridsd.

Vernacular names Indonesia: badeng, kayu gatal (general), baluin (Karoon). Philippines: adina (Filipino), dunpilan (Cebu Bisaya), kulilisiau (Tagalog).

Distribution The Philippines, the Moluccas and New Guinea.

E. Boer (general part),
R.H.M.J. Lemmens (general part, selection of species)

Petersianthus Merr.

Phil. Journ. Sci., Bot. 11: 200 (1916).
LECYTHIDACEAE
x = unknown; $2n$ = unknown

Vernacular names Philippine rosewood (En, trade name). Philippines: toog (Filipino), kapullan

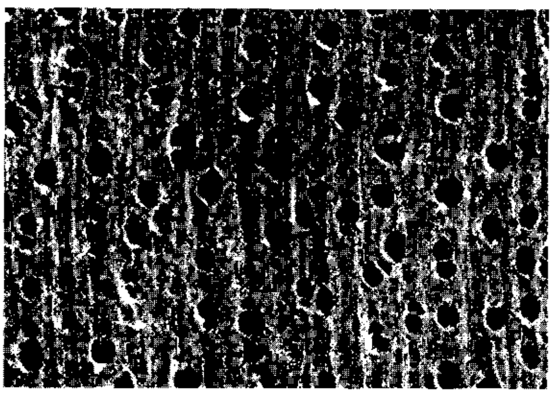
(Cebu Bisaya), magtalisai (Samar-Leyte Bisaya).

Origin and geographic distribution *Petersianthus* comprises only 2 species. One occurs in tropical West Africa. The second species, *P. quadrialatus* (Merr.) Merr. (synonym: *Combretodendron quadrialatum* (Merr.) Knuth), is endemic to the Philippines.

Uses The wood of *P. quadrialatus* is mainly used for the production of face veneer and fancy plywood, and for the production of pulp and paper. It is also suitable for general construction (beams, joists), panelling, bridge building, mine timber, pallets and the production of charcoal. It is potentially useful for poles and piles, and vehicle bodies. The seeds are reported edible and taste like groundnut. The leaves have been used medicinally against rash.

Production and international trade Utilization of *P. quadrialatus* wood gained much importance after the proper method of handling was developed in the 1970s. Fairly large supplies were available, especially in Mindanao, Samar and Leyte, but these have diminished rapidly. Small amounts may have reached the international market, but there are no statistics available on the local consumption nor on export.

Properties *P. quadrialatus* yields a medium-weight hardwood with a density of 615–720 kg/m^3 at 15% moisture content. Heartwood pale red turning reddish-brown with pale streaks upon exposure, sharply demarcated from the pale and fairly wide sapwood; grain interlocked; texture moderately fine to moderately coarse. Growth rings indistinct, when visible indicated by somewhat denser latewood; vessels moderately small to moderately large, predominantly solitary and in radial multiples of 2–3, tyloses rare, occasional chalky white deposits; parenchyma paratracheal vasicentric to aliform and confluent, apotracheal in narrow bands spanning up to 10 rays, sometimes appearing as irregular bands, variable in width and occurrence, visible only with a hand lens; rays very fine to moderately broad, indistinct to the naked eye; ripple marks absent.



Petersianthus quadrialatus
transverse surface (×18)

Shrinkage is rather high and the wood is rather difficult to season, as it is likely to warp and split. It is hard, moderately strong and tough, moderately hard to work, but can be finished satisfactorily. The wood is durable for interior use and slightly durable when exposed to the weather or in contact with the ground; in a graveyard test in the Philippines it lasted for about 17 months. The heartwood is amenable to preservative treatment. The heartwood is susceptible to dry-wood termites and the sapwood is susceptible to *Lyctus*.

The average fibre length is 2.4 mm.

See also the tables on microscopic wood anatomy and wood properties.

Botany A deciduous, medium-sized to fairly large tree up to 40 m tall; bole straight, cylindrical, branchless for up to 20(–30) m, up to 100(–250) cm in diameter, occasionally with buttresses up to 2 m high; bark surface flaky to deeply fissured, dark brown to greyish-red, inner bark tough and fibrous, pinkish; slash with a strong foetid smell. Leaves arranged spirally, simple, obscurely toothed, abruptly acuminate; stipules early caducous. Flowers in axillary and terminal panicles forming a corymb; calyx 4-lobed, the tube 4-angled or 4-winged; petals 4, free, white; stamens numerous, forming a small tube at base; disk present; ovary inferior, 4-locular with many ovules in 2 rows in each cell, style 1, slender. Fruit a 1–4-seeded capsule, indehiscent, almost circular in outline, with 4 large, papery wings, the seed-bearing portion very narrow. Seedling with epigeal germination; cotyledons emergent, leafy; hypocotyl elongated; first pair of leaves opposite, subsequent ones arranged spirally.

Early development in the nursery is rapid and height increment in the first 4 months averages 31 cm. Height increment in a 2-year-old plantation was 0.7–2.9 m and diameter increment 0.6–3.8 cm. Flowering is erratic and apparently triggered by sudden fluctuations in temperature. However, flowering is usually observed between July and February. The fruits take about 1 month to mature and mature fruits are generally present between March and May. Trees remain leafless during flowering and fruiting and buds appear after seedfall. Seed is dispersed by wind or animals.

The strange disjunct distribution of *Petersianthus* remains unexplained. The generic name *Combretodendron* is sometimes encountered in literature. It is not validly published and has been replaced by *Petersianthus*.

Ecology *P. quadrialatus* is fairly common and grows scattered though locally common in primary rain forest at low to medium altitudes, on well-drained soils near river banks or on hill sides.

Silviculture *P. quadrialatus* can easily be propagated by seed. Seed loses its viability very rapidly and hence it should be sown immediately after collection. After storing for 13 days the germination rate is about 60%. From the Philippines it is reported that when establishing plantations the young plants must be ring weeded. A mortality of about 11% was recorded for non-weeded control plots. Natural regeneration is very scarce. It has been suggested that various animals (e.g. insects, rodents, birds) feed on the seed up in the tree so that very few seeds reach the forest floor. Seedlings are found as far as 200 m from mother trees, especially between buttresses or in soil that has accumulated in depressions. Seedlings establish easiest on bare soil, e.g. along roads. *P. quadrialatus* coppices easily, at least when young. Until the 1970s the tree was left unexploited and could be seen towering in logged-over forest.

Genetic resources and breeding The high demand in the last 20 years has led to stands of *P. quadrialatus* being depleted drastically. So it has become vulnerable to genetic erosion and is considered a vanishing timber. Plantation establishment, however, may still secure its genetic potential to a large extent.

Prospects If plantations of *P. quadrialatus* can be established successfully, its utilization will probably increase.

Literature 87, 154, 228, 234, 235, 464, 489, 530, 575, 665, 666, 702, 780, 784, 785, 803, 804, 894, 934, 955, 959, 960, 974, 1086, 1171.

D.S. Alonzo

Phoebe Nees

Syst. laur.: 98 (1836).
LAURACEAE
$x = 12$; *P. lanceolata*: $n = 12$

Vernacular names Medang (trade name). Burma (Myanmar): kyese. Thailand: satit. Vietnam: kh[as]o, re tr[aws]ng, s[uj].

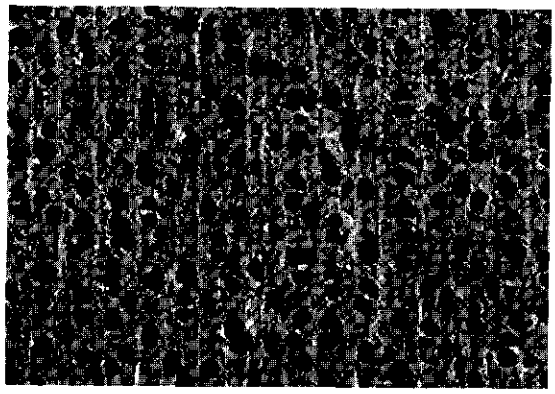
Origin and geographic distribution *Phoebe* comprises about 50 species which occur in India, Burma (Myanmar), Indo-China, China, Japan, Taiwan and south to Thailand and throughout the Malesian region. About 20 species occur in the latter area.

Uses Wood of *Phoebe* species is used for house building (ceilings, solid doors, door frames, cladding), furniture and cabinet work, carriages, agricultural implements, mine props, musical instruments, casings, carving, sculpture and novelties. It has also been used as firewood. In general, 'medang' is suitable for the production of veneer and plywood.

P. longepetiolata has been reported to be planted for construction timber in Bukittinggi, West Sumatra. The cultivation of *P. grandis* as an ornamental has been suggested. Its bark and leaves have been used in traditional medicine to treat gum ulcers.

Production and international trade The timber of *Phoebe* is traded together with that of many other *Lauraceae* genera as 'medang'. It probably constitutes only a minor portion of the total amount traded. In 1984 the total export of medang from Peninsular Malaysia to Singapore was 1500 m^3 with a value of US\$ 62 000. In 1992 exports from Sabah amounted to 52 000 m^3 (of which about 10% was sawn timber) with a total value of US\$ 4.3 million. In Papua New Guinea the minimum export price for medang logs was US\$ 43/m^3 in 1992. Japan imports medang mainly from Sabah, Sarawak and Papua New Guinea.

Properties *Phoebe* yields a medium-weight hardwood with a density of 480–750 kg/m^3 at 15% moisture content. Heartwood pale olive-brown, darkening upon exposure, not sharply demarcated from the paler sapwood; grain slightly interlocked



Phoebe sterculioides
transverse surface (×18)

or straight; texture moderately fine and even; wood lustrous; greasy to the touch. Growth rings distinct or indistinct, when distinct marked by differences in density and colour; vessels moderately small to medium-sized, solitary or in radial multiples of 2–5, occasionally arranged diagonally, tyloses often abundant; parenchyma sparse, scanty paratracheal and vasicentric, inconspicuous even with a hand lens; rays extremely fine to moderately fine; ripple marks absent; oil cells in parenchyma and occasionally in rays; numerous pith flecks in *P. grandis*.

The wood seasons very well. It is comparatively hard and moderately strong and very easy to work. The wood is durable under cover, but non-durable when exposed to the weather or in contact with the ground. The sapwood is susceptible to *Lyctus*.

See also the table on microscopic wood anatomy.

Botany Evergreen shrubs or small to medium-sized trees up to 25(–30) m tall; bole usually straight and cylindrical, branchless for up to 15 m, up to 75 cm in diameter, sometimes fluted at base or with short buttresses up to 2 m high; bark surface smooth to scaly, sometimes lenticellate, sometimes papery, grey-brown to grey-fawn, inner bark yellow to dark brown, often aromatic. Leaves arranged spirally, often crowded near the end of twigs, simple, entire, usually aromatic when crushed, exstipulate. Flowers in an axillary or subterminal panicle, bisexual, 3-merous; tepals 6, with a short tube, the outer ones shorter than the inner ones, persistent; stamens 6 or 9, those of the inner whorls with 2 glands at base, anthers 4-celled, opening by valves; ovary superior, unilocular with a single ovule, stigma obtuse. Fruit a 1-seeded, black or sometimes red berry, the indurated and enlarged perianth clasping the base of the fruit. Seedling with hypogeal germination; cotyledons not emergent, peltate; hypocotyl not developed; epicotyl with a few scales; all leaves arranged spirally.

Trees display monopodial or sympodial branching. The annual diameter increment of *P. lanceolata* observed in an Indian wood sample is 1.3–1.7 cm, which is rapid. In Java *P. elliptica* has been observed flowering from April to June, and *P. grandis* in April, July and September to January. The seeds are dispersed mainly by birds but probably also by squirrels and monkeys.

Like many other *Lauraceae* genera, *Phoebe* is in desperate need of a thorough taxonomic revision, as the status of many species is unclear. This generally renders information at species level unreliable. *Phoebe* is closely related to *Cinnamomum*, *Persea* and the American genus *Ocotea*. All *Phoebe* species originally described from the American tropics have now been transferred to these genera.

Ecology Timber-producing species of *Phoebe* are found in evergreen, lowland to montane forest up to 1500(–2000) m altitude. *P. lanceolata* is a riverine species, also occurring in teak forest in Java. *P. grandis* also occurs in more open country and along forest edges.

Silviculture *Phoebe* can be propagated by seed. Seed of *P. elliptica* had a germination rate of about 75% in 18–83 days and fruits about 65% in 46–70 days. Natural regeneration is not very abundant, even though fruits are found in abundance in the fruiting season. In India *P. lanceolata* is considered shade-tolerant.

Genetic resources and breeding The conservation of genetic resources of *Phoebe* is directly linked to the conservation of its habitat. Some species appear to be rare and narrowly endemic, but clear statements on their genetic conservation are hindered by the unclear taxonomic situation.

Prospects Some *Phoebe* species, e.g. *P. sterculioides*, yield valued timber, but an increase in use is hampered by limited supplies.

Literature 41, 70, 101, 162, 163, 209, 267, 302, 304, 436, 438, 553, 595, 605, 614, 623, 627, 673, 756, 785, 829, 831, 833, 861, 883, 934, 938, 1038, 1104, 1169, 1221, 1242.

Selection of species

Phoebe clemensii Allen

Distribution Papua New Guinea.

Phoebe elliptica Blume

Synonyms *Phoebe macrophylla* (Blume) Blume.

Vernacular names Indonesia: huru dapung, huru huya, huru leksa (Sundanese).

Distribution Peninsular Malaysia and western Java.

Phoebe grandis (Nees) Merr.

Synonyms *Phoebe cuneata* (Blume) Blume, *Phoebe kunstleri* Gamble, *Phoebe multiflora* Blume, *Phoebe opaca* Blume.

Vernacular names Sun laurel (En). Indonesia: huru taleus (Sundanese), marsihung (Kalimantan), medang pungut (Sumatra). Malaysia: medang keserai, medang ketanah (Peninsular), medang silau (Sabah). Laos: 'tha dong. Thailand: mun khao, thang bon (peninsular).

Distribution Indo-China, Thailand, Peninsular Malaysia, Singapore, Sumatra, Java and Borneo.

Phoebe lanceolata (Wallich ex Nees) Nees

Synonyms *Phoebe ligustrina* Nees.

Vernacular names Indonesia: tales, wuru (Javanese). Burma (Myanmar): saneng, seiknan. Thailand: lae buk, sirai khang khok (peninsular), pee tong (northern). Vietnam: re tr[aws]ng m[ux]i m[as]c.

Distribution India, Indo-China, southern China, Thailand, Peninsular Malaysia and Java.

Phoebe longepetiolata Kosterm.

Vernacular names Indonesia: kulee (Sumatra).

Distribution Sumatra.

Phoebe sterculioides (Elmer) Merr.

Synonyms *Persea sterculioides* Elmer.

Vernacular names Philippines: kaburo (Filipino), batikuling (Tagalog), hindang (Samar-Leyte Bisaya).

Distribution The Philippines.

Phoebe tenuifolia Kosterm.

Vernacular names Indonesia: aripungu (Sulawesi).

Distribution The southern Philippines and Sulawesi.

Nguyen Kim Dao

Pholidocarpus Blume

in Schult. & Schult. f., Syst. Veg. 7(2): 1308 (1830).

PALMAE

x = unknown; $2n$ = unknown

Vernacular names Malaysia: kepau.

Origin and geographic distribution *Pholidocarpus* comprises about 6 species occurring in southern Thailand, Peninsular Malaysia, Sumatra, Borneo, Sulawesi and the Moluccas.

Uses The trunk of *Pholidocarpus* is used for poles and posts in local house building, and in Peninsular Malaysia for piling of wharves.
Several species have been cultivated for ornamental purposes. Sago of poor quality is occasionally harvested from *P. ihur*. The leaves may be used for thatch. The palm cabbage (apex) of some species is reputed to be edible.

Production and international trade The trunks of *Pholidocarpus* are used comparatively rarely and on a local scale only.

Properties The peripheral wood of *Pholidocarpus* is very hard and durable.

Botany Armed, pleonanthic, solitary, often large palms up to 35(–45) m tall; pole straight, slender, up to 30 cm in diameter, inconspicuously but densely ringed with leaf scars. Leaves costapalmate; sheath disintegrating into a conspicuous mass of fibres; petiole armed with robust spines; blade split into 3–4-fold elements, these further divided into single-fold segments. Inflorescence borne between the leaves, solitary, branched to 4 orders; peduncle robust. Flowers bisexual, solitary or in clusters of 2–3 on low tubercles, golden-yellow; calyx shallowly 3-lobed; petals 3, valvate, united at base; stamens 6, filaments united into a tube; ovary superior, 3-carpellate with a single ovule in each cell, carpels united distally into a slender style, stigma punctate. Fruit a large drupe, developing from 1 carpel, globose, smooth or with low corky warts. Seed with homogeneous endosperm, intrusion of seed-coat lateral. Seedling with remote-tubular germination; eophyll entire, lanceolate, plicate.
Flowers of *P. macrocarpus* are open only for about a day, after which they fall; they have a strong sweet-sour smell.
Pholidocarpus is closely related to *Livistona*, differing only in the usually corky-warted and large fruits, leaves that are divided into compound segments and subtle differences in the flowers. It belongs to the subtribe *Livistoninae* of the tribe *Corypheae* within the subfamily *Coryphoideae*.

Ecology *Pholidocarpus* is found fairly commonly in primary lowland rain forest, especially in freshwater and peat-swamp forest and along streams, rarely away from waterlogged soils.

Silviculture *Pholidocarpus* can be propagated by seed.

Genetic resources and breeding Except for some specimens of *P. kingianus* and *P. macrocarpus* being cultivated in botanic gardens, there are no records of ex situ conservation of *Pholidocarpus*.

Prospects It is unlikely that there will be any commercial prospects for *Pholidocarpus*, except perhaps as an ornamental.

Literature 70, 98, 163, 289, 290, 436, 499, 563, 1110, 1176, 1210.

Selection of species

Pholidocarpus ihur (Giseke) Blume

Vernacular names Indonesia: ibul (Buru), ihur (Ambon), woka utan (Moluccas).

Distribution Sulawesi and the Moluccas.

Pholidocarpus kingianus (Becc.) Ridley

Synonyms *Livistona kingiana* Becc.

Vernacular names Indonesia: serdang (Sumatra). Malaysia: kepau, serdang (Peninsular).

Distribution Peninsular Malaysia and Sumatra.

Pholidocarpus macrocarpus Becc.

Vernacular names Malaysia: kepau, serdang (Peninsular).

Distribution Peninsular Malaysia.

Pholidocarpus majadum Becc.

Vernacular names Indonesia: liran (Dayak, Kalimantan). Malaysia: anau, jawong, saong (Sarawak).

Distribution Borneo.

Pholidocarpus mucronata Becc.

Distribution Sumatra.

L.G. Saw

Pigafetta (Blume) Becc.

Malesia 1: 89 (1877).

PALMAE

$x = 14$; $2n = 28$

Vernacular names Pigafetta palm (En).

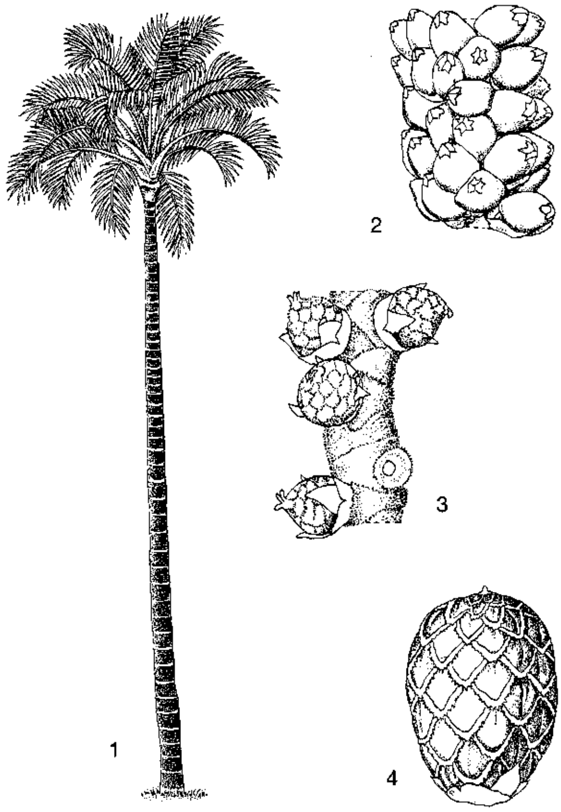
Origin and geographic distribution *Pigafetta* probably comprises 2 species occurring in Sulawesi, the Moluccas and the western half of New Guinea. Both are occasionally planted in South-East Asia and rarely elsewhere.

Uses The smooth shiny trunk of *P. elata* is used as supports for traditional houses and rice barns in Tana Toraja, Sulawesi, as rats cannot climb up it. When the soft core is removed the trunks are also used as relatively cheap conduits in rice fields; split poles can serve as boards for flooring. *Pigafetta* is planted as an ornamental. Boiled young leaves can be scraped and subsequently split to produce sewing-thread. The seeds are eaten by the local people in Tana Toraja.

Production and international trade The trunk of *Pigafetta* is used on a local scale only.

Properties Peripheral wood of *Pigafetta* is very hard and durable but apt to split.

Botany Armed, dioecious, pleonanthic, solitary, large palms up to 50 m tall; pole straight, slender, green or greenish-brown with conspicuous grey rings, often with abundant adventitious roots at base. Leaves pinnate, distinctly curved; sheath splitting, distally armed; leaflets many, single-fold, acuminate. Inflorescences borne between the leaves, solitary, branched to 2 orders. Male flowers in pairs; calyx very shallowly 3-lobed; corolla exceeding the calyx, tubular at base, with 3 valvate lobes; stamens 6, borne at the mouth of the corolla tube, filaments connate. Female flowers solitary; corolla divided almost to the base; ovary superior, incompletely 3-locular with 1 ovule in each cell, stigmas 3, reflexed. Fruit a small, ovoid, 1-seeded, drupe covered with scales. Seed with homogeneous endosperm with shallow depressions, attached basally. Seedling with adjacent-ligular germination; eophyll bifid, with very narrow



Pigafetta elata (Blume) H. Wendl. – 1, habit; 2, part of male inflorescence; 3, part of female inflorescence; 4, fruit.

leaflets; two scale leaves are produced before the true laminate leaves appear.
Growth of *P. elata* is fast; 3-year-old palms raised from seed attained 7 m in height, 15-year-old ones are 20 m or more. In Sulawesi it flowers in September and October. In Bogor (Indonesia) 12-year-old trees planted from seed attained 15 m in height and had fruited 15 times.
Pigafetta is the only genus within the subtribe *Pigafettinae* of the tribe *Calameae* within the subfamily *Calamoideae*. Its relationships within the tribe are uncertain. Very recently it was suggested that the genus probably comprises 2 species, not 1. They differ most strikingly in the colour and form of the petioles and rachises, *P. elata* having dark coloured and densely spiny ones, *P. filaris* showing pale, white powdered and sparsely spiny ones.

Ecology *Pigafetta* grows as a pioneer in secondary habitats in well-drained, hilly or montane areas, at 300–1500 m altitude. It may be abundant along forest edges and grows on old landslides, old lava flows, ridge tops and river banks; it also tends to colonize abandoned cultivated fields.

Silviculture *P. elata* can be propagated by seed, which should be sown as soon as possible after harvest as it loses viability extremely quickly, possibly within a few days. The seed is comparatively small and germinates between 10 days and 1 year. Seedlings require constant moisture, high light intensities and protection from wind.

Genetic resources and breeding Since 1973 the Botanical Garden at Bogor (Indonesia) has distributed *P. elata* seed all over the world. An important stand of trees has been conserved in the Sibolangit Botanic Garden (North Sumatra), but the stand probably no longer exists. *Pigafetta* is sought after by collectors because of its large stature, fast growth and rather isolated botanical position.

Prospects The local use of *Pigafetta* wood for construction will probably remain important. Both species have potential as an ornamental.

Literature 70, 229, 230, 284, 286, 288, 325, 436, 499, 502, 506, 731, 798, 983, 1041, 1059, 1110, 1176.

Selection of species

Pigafetta elata (Blume) H. Wendl.

Vernacular names Indonesia: wanga (North Sulawesi).

Distribution Sulawesi.

Pigafetta filaris (Giseke) Becc.

Synonyms *Pigafetta filifera* Merr., *Pigafetta papuana* Becc.

Vernacular names Indonesia: sagu laki-laki (Buru), lapai abal (Ambon).

Distribution The Moluccas and New Guinea (Irian Jaya).

I. Samsoedin

Pimelodendron Hassk.

Verslagen Meded. Afd. Natuurk. Kon. Akad. Wetensch. 4: 140 (1856).

EUPHORBIACEAE

x = unknown; $2n$ = unknown

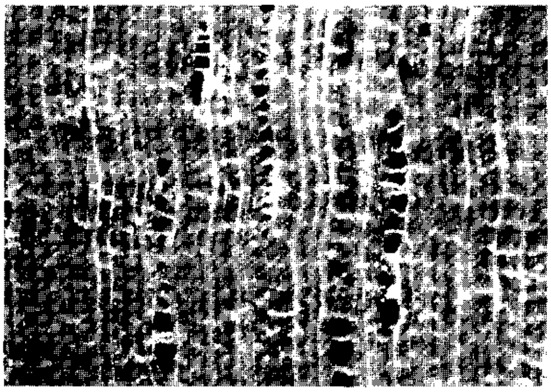
Vernacular names Memina (trade name). Pimelodendron (En). Malaysia: perah ikan (Peninsular).

Origin and geographic distribution *Pimelodendron* comprises 6–8 species occurring in peninsular Thailand, Peninsular Malaysia, Sumatra, Borneo, Sulawesi, the Moluccas, New Guinea, the Solomon Islands and northern Australia. Four species are present within Malesia.

Uses The wood of *Pimelodendron* is used for general light or temporary construction, rafters, interior trim, lining, shelving, joinery, utility furniture, mouldings, tool handles and veneer. It is suitable for the production of fibreboard and pulp for writing paper. In Japan it is used as a substitute for 'ramin' (*Gonystylus* spp.).
Seeds of *P. amboinicum* and *P. griffithianum* are edible and taste like hazel nuts. The squeezed bark of *P. amboinicum* has been applied medicinally as a gentle purgative for adults; the sap from the leaves has been applied as a purgative for infants. The bark yields a latex suitable for varnishing; in the Solomon Islands the latex is applied as a glue for wooden articles.

Production and international trade The wood of *Pimelodendron* is seldom used in western Malesia, but in Papua New Guinea it is a commercial timber. In 1996 Papua New Guinea exported 3070 m^3 of *Pimelodendron* logs at an average free-on-board (FOB) price of US$ 100/m^3.

Properties *Pimelodendron* yields a lightweight to medium-weight hardwood with a density of 420–770 kg/m^3 at 15% moisture content. Heartwood cream, pale yellow-brown or grey-white, not clearly differentiated from the sapwood; grain straight; texture moderately fine and even. Growth rings absent; vessels medium-sized, in ra-



Pimelodendron amboinicum
transverse surface (×20)

dial multiples of 2–6, open; parenchyma abundant, apotracheal in narrow bands, grading to diffuse-in-aggregates and diffuse, distinct with a hand lens; rays very fine to moderately fine, visible on transverse surface with a hand lens; ripple marks absent.
Shrinkage upon seasoning is moderate. The wood is moderately soft and only moderately strong. Sawing is moderately easy with a relatively smooth finish; machining properties are fair when the stock is green, but rated as poor when air dry. The wood is non-durable and pressure permeability is high; a retention of 507–535 kg/m³ for sapwood and 460–469 kg/m³ for heartwood is recorded for *P. amboinicum*. The wood is highly susceptible to blue stain. The sapwood is susceptible to *Lyctus*.
The mean fibre length of *P. amboinicum* from Indonesia is 1.328 mm.
See also the tables on microscopic wood anatomy and wood properties.

Botany Evergreen, dioecious, small to medium-sized trees up to 30(–40) m tall; bole branchless for up to 15 m, up to 80 cm in diameter, often fluted at base; bark surface smooth or sometimes dippled or pustular and finely fissured, with small lenticels, grey-brown to reddish-brown, inner bark granular, corky, pink with orange-brown flecks, exuding thick, white latex becoming yellow; crown dense. Leaves arranged spirally, crowded at twig ends, simple, wavy to crenate; petiole kneed; stipules obsolete. Flowers unisexual, in an axillary raceme; petals absent; disk absent. Male flower with a calyx composed of 2 connate sepals; stamens 10–16; pistillode absent. Female flower with a shortly 2–3-lobed calyx; ovary superior, 2–10-locular with 1 ovule in each cell, stigma ses-

Pimelodendron amboinicum Hassk. – 1, male flowering twig; 2, fruits.

sile, cushion-like. Fruit a large drupe, dehiscing tardily or not al all, with 1–several seeds. Seed almost half enclosed in a sarcotesta. Seedling with epigeal germination; cotyledons not emergent; hypocotyl elongated; first 2 leaves opposite, subsequent ones produced in flushes, each flush with 1–2 scale leaves followed by pseudowhorls of 1–3 leaves.

Ecology *Pimelodendron* is scattered in primary lowland to submontane, evergreen rain forest, up to 1800 m altitude. It occurs on well-drained sites as well as in freshwater swamp forest and peat-swamp forest, where it may be locally dominant, and in the mangrove fringe. *Pimelodendron* species grow on clayey to sandy soils and occasionally on coral limestone. *P. amboinicum* is often found on sites where natural disturbance has occurred.

Silviculture *Pimelodendron* can be propagated by seed. Seeds of *P. griffithianum* still embedded in their sarcotesta have 50–85% germinating in 7–31 days. In another germination experiment seed without sarcotesta of *P. amboinicum* was sown under shade and started germinating 8 days after sowing; the germination rate was 95% and 80% of the germinating seeds had appeared 17 days after sowing. A 50 ha plot in Peninsular Malaysia was found to contain 29 *Pimelodendron* trees with a diameter of over 30 cm.

Genetic resources and breeding The risk of genetic erosion is probably not very high, as *Pimelodendron* species have a fairly wide geographic distribution and logging is not very intensive.

Prospects As *Pimelodendron* wood is somewhat similar to ramin, its use may well increase in the near future, as trees with a diameter of 50–70 cm are sometimes common in lowland forest.

Literature 28, 29, 32, 34, 36, 40, 80, 125, 163, 267, 300, 346, 348, 436, 464, 482, 553, 745, 749, 829, 831, 861, 1195, 1221, 1232, 1242, 1248.

Selection of species

Pimelodendron amboinicum Hassk.

Synonyms *Daphniphyllum conglutinosum* Hemsl., *Pimelodendron papuanum* Warb.

Vernacular names Indonesia: mamina, pamum (Ambon), pokopokor (Halmahera).

Distribution Sulawesi, the Moluccas, New Guinea, the Solomon Islands and northern Australia (Cape York Peninsula).

Pimelodendron griffithianum (Müll. Arg.) Benth.

Synonyms *Pimelodendron acuminatum* Merr., *Pimelodendron borneense* Warb., *Pimelodendron papaveroides* J.J. Smith.

Vernacular names Indonesia: lempanai (West Kalimantan), murung (Kutai, East Kalimantan). Malaysia: perah ikan (Peninsular).

Distribution Peninsular Thailand, Peninsular Malaysia, Sumatra and Borneo.

Pimelodendron macrocarpum J.J. Smith

Distribution Peninsular Malaysia, Sumatra and Borneo.

K.M. Kochummen

Pinanga Blume

Bull. Sci. Phys. Nat. Néerlande 1: 65 (1838).
PALMAE
$x = 14, 16$; *P. coronata*, *P. disticha* (Roxb.) Blume ex H. Wendl.: $2n = 28$, *P. patula*: $2n = 32$

Vernacular names Indonesia: pinang (general). Malaysia: pinang (general), legong (for larger species). Philippines: abiki (general), dasigan (Iloko), salansigang (Manobo). Thailand: maak. Vietnam: cau b[uj]i r[uwf]ng.

Origin and geographic distribution *Pinanga* comprises about 120 species ranging from the Himalayas and southern China to Indo-China, Thailand and the entire Malesian region. The greatest diversity is found in the per-humid areas of western Malesia.

Uses The slender poles of *Pinanga* have been used as walking-sticks, spear shafts and, especially those of *P. punicea*, also as rafters and for walls. Several species with attractively mottled leaves are becoming popular ornamentals. The palm cabbage (apex) of young plants is edible. The leaves are used as thatch. Young leaves of *P. punicea* have been used to obtain threads to weave rough textile. The kernel of several species is used for chewing, as a substitute for betel nut (*Areca catechu* L.). The endosperm has been used as a dye in the batik industry. *Pinanga* is also applied for erosion control.

Production and international trade *Pinanga* wood is used rarely and on a local scale only, as stems are usually too small.

Properties Cortex narrow with numerous fibrous strands and occasional small vascular bundles; central cylinder with peripheral vascular bundles somewhat congested; central vascular bundles each with a well-developed fibrous phloem sheath, xylem sheathed by parenchyma only, phloem undivided, metaxylem with a single wide vessel; ground parenchyma cells somewhat transversely expanded but not lacunose; scattered fibrous strands frequent.
The wood is very strong.

Botany Unarmed, monoecious, pleonanthic, solitary or diffusely to densely clustered, very small to medium-sized palms up to 8(–12) m tall; pole straight, slender, up to 15 cm in diameter, with conspicuous leaf scars, occasionally stilt-rooted. Leaves simple or pinnate; sheath forming a well-defined crown-shaft; petiole present or absent; leaflets 1- to several-fold, acute or lobed. Inflorescence usually borne below the leaves, protogynous, spicate or branched to 1 order; peduncular bract absent. Flowers unisexual, in spirally arranged or distichous triads or in 4 or 6 vertical rows. Male flower asymmetrical; calyx cupular with 3 often unequal lobes; petals 3, briefly joined at base, much exceeding the calyx; stamens usually 12–30, rarely 6, filaments short. Female flower globose, symmetrical, much smaller than the male one; sepals free or connate at base, imbricate, membranous; petals free, imbricate; ovary superior, 1-locular with a single ovule, stigma usually convolute, sessile or on a short style. Fruit a globose to spindle-shaped, smooth drupe. Seed usually with ruminate endosperm and basal hilum. Seedling with adjacent-ligular germination; eophyll usually bifid.

When the inflorescences of *P. patula* heat up, its flowers produce a musty odour and are pollinated by beetles. Seed dispersal is probably by birds.

Little is known of the botany of *Pinanga*. It is in need of a taxonomic revision; the last review was in 1886. It belongs to the subtribe *Arecinae* of the tribe *Areceae* within the subfamily *Arecoideae*.

Ecology *Pinanga* is found in the understorey of primary lowland to montane rain forest, up to 2800 m altitude. Many species are found on sandstone soils, a few on limestone and ultrabasic soils. Several *Pinanga* species may grow sympatrically, especially in Borneo.

Silviculture *Pinanga* can be propagated by seed; propagation from suckers of *P. coronata* is difficult. Seeds of *Pinanga* remain viable for only 2–3 weeks and generally germinate within a few weeks after sowing. Seed of *P. coronata* soaked for 7 days germinates in about 13 days when kept in a polythene bag at a temperature of 35°C.

Genetic resources and breeding None of the timber-yielding *Pinanga* species is rare.

Prospects *Pinanga* does not have any important commercial prospects.

Literature 70, 150, 163, 229, 236, 324, 430, 436, 499, 500, 785, 931, 940, 1059, 1100, 1110, 1176, 1210.

Selection of species

Pinanga coronata (Blume ex Mart.) Blume

Synonyms *Pinanga kuhlii* Blume, *Pinanga noxa* Blume.

Distribution Sumatra, Java and Sulawesi.

Pinanga insignis Becc.

Vernacular names Philippines: banga, tibanglan (Tagalog), sarauag (Manobo, Panay Bisaya).

Distribution The Philippines.

Pinanga malaiana (Mart.) R. Scheffer

Vernacular names Indonesia: kelandau (Belitung), pinang kera, pinang keru (Sumatra). Malaysia: legong, pinang boreng hijau, pinang dampong (Peninsular).

Distribution Peninsular Malaysia, Sumatra and Belitung.

Pinanga patula Blume

Vernacular names Indonesia: bebiong, pinang bancang (Palembang), pinang kelandau (Kalimantan).

Distribution Peninsular Malaysia, Sumatra and Borneo.

Pinanga punicea Merr.

Synonyms *Pinanga ternatensis* R. Scheffer.

Distribution Sulawesi, the Moluccas and New Guinea.

L.G. Saw

Pistacia L.

Sp. pl. 2: 1025 (1753); Gen. pl., ed. 5: 452 (1754).

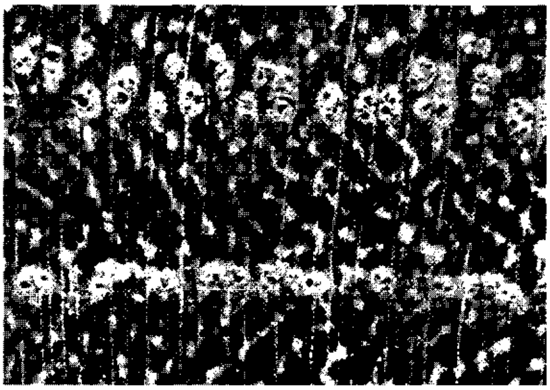
ANACARDIACEAE

x = unknown; *P. chinensis*: $2n = 24$

Vernacular names Chinese pistache (En). Philippines: sanguilo (Filipino), agiao (Iloko), sanido (Igorot).

Origin and geographic distribution *Pistacia* comprises about 9 species distributed disjunctly in North and Central America, the Canary Islands, the Mediterranean region, and western, southern and eastern Asia. Of the 2 species found in the Malesian region, one is endemic to Peninsular Malaysia, the other, *P. chinensis* Bunge (synonyms: *P. formosana* Matsum., *P. philippinensis* Merr. & Rolfe), is the only one yielding timber and is found in China, Taiwan and the Philippines (Luzon). It is locally naturalized in the United States (Texas).

Uses The wood of *P. chinensis* is favoured locally for carving, walking sticks, jewellery boxes, tobacco pipes, paper weights and other novelties. It is an excellent wood for sport-rifle stocks and pistol grips. It has occasionally been used



Pistacia chinensis
transverse surface (×18)

for temporary construction.
P. chinensis is well known as a landscape and shade tree, especially in the United States, and is valued for its leaf colour in autumn.

Production and international trade The wood of *P. chinensis* is used very locally; supplies are limited.

Properties *P. chinensis* yields a heavy hardwood with a density of about 990 kg/m^3 at 15% moisture content. Heartwood olive-brown with narrow dark brown concentric bands, sharply differentiated from the sapwood which is buff-coloured often with a yellowish-green tinge; grain interlocked; texture very fine and uneven. Growth rings distinct, delimited by concentric rows of relatively large vessels; vessels in the earlywood medium-sized, solitary and in multiples of 2–3, arranged in concentric rings, in the latewood extremely small to moderately small in oblique chains of 2–8 or in clusters, completely occluded by tyloses; parenchyma indistinct; rays medium-sized; radial canals present.
The wood seasons well, checks little but warps considerably in back-sawn stock. It is very hard, strong and tough, but is easy to work for a hard wood. The wood is very durable, the sapwood is susceptible to *Lyctus* and the heartwood is very resistant to dry-wood termites.
See also the table on microscopic wood anatomy.

Botany A deciduous, dioecious, small to medium-sized tree up to 26 m tall; bole usually straight, short, up to 100 cm in diameter, sometimes with small buttresses; bark surface scaly, pale green to pale brown. Leaves arranged spirally, imparipinnate or the terminal leaflet sometimes absent, with (3–)5–6(–10) pairs of opposite, sessile or subsessile, entire leaflets, exstipulate. Inflorescence axillary or terminal, racemose in male trees, paniculate in female trees. Flowers unisexual, small; perianth segments 2–5, free; disk absent. Male flower with 3–5 stamens, filaments very short; pistillode minute. Female flower with a superior, 1-locular ovary with a single ovule, style short, stigmas 3. Fruit a drupe with a bony stone. Seed with testa free from the endocarp.
In the Philippines *P. chinensis* flowers from March–April, occasionally in July; ripe fruits have been observed in May–July, occasionally in September. The small fruits are eaten by birds which thus disperse the seeds.

Ecology In the Philippines *P. chinensis* is found scattered on slopes with an open vegetation and in rocky areas, at elevations of 650–1350 m.

Silviculture *P. chinensis* can be propagated by seed, but for ornamental purposes it is often propagated vegetatively. Stratification of seed at 0–5°C greatly improves germination. In the United States it shows a high resistance to various pests.

Genetic resources and breeding In the Philippines unregulated exploitation of *P. chinensis* for wood carving has greatly depleted its natural genetic resources.

Prospects The local importance of *P. chinensis* for carving and novelties will probably diminish, as it is becoming rare. It may gain importance as an ornamental in South-East Asia.

Literature 235, 267, 341, 714, 780, 847, 934, 1005.

S.H. Widodo

Pittosporum Banks ex Gaertn.

Fruct. sem. pl. 1: 286, t. 59 (1788).
PITTOSPORACEAE
$x = 12$; *P. tobira* (Thunb.) Aiton: $n = 12$

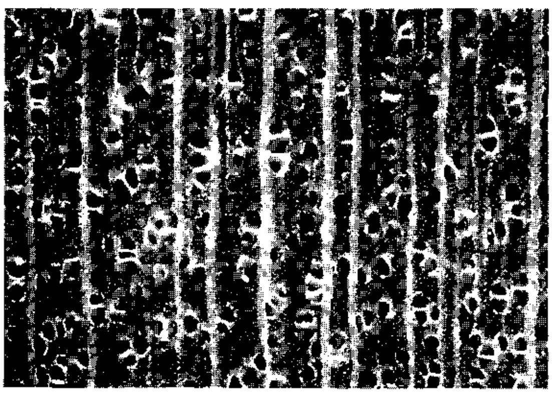
Vernacular names White hollywood (En). Malaysia: belalang puak (Peninsular). Vietnam: khuy [as]o.

Origin and geographic distribution *Pittosporum* comprises about 100 species occurring in the Old World tropics and the Pacific. They are found from tropical Africa and Madagascar to India, Sri Lanka, Burma (Myanmar), Indo-China, north to Korea and Japan, south to Thailand, throughout the Malesian region, Australia, New Zealand, and east to Fiji, Tonga and Hawaii. Thirteen species are found within Malesia, most of them in East Malesia. Australia is regarded as the centre of diversity for the genus.

Uses The wood of *Pittosporum* is used for poles, joists and flooring in house building, and small articles like bobbins, spindles, shuttles, fans, tennis rackets, toothpicks, lollipop sticks, novelties and fashion accessories, sometimes for rafters or as firewood, and as pulp for making paper. It may be suitable for small turnery articles. The wood of several Australian species is used as a substitute for boxwood (*Buxus* spp.) and used for e.g. rulers, carving, inlay work and marquetry.
Several species, including *P. ferrugineum*, have been grown as an ornamental. Some species might be useful for reforesting bare land and in firebreaks. In Indonesia the pounded leaves and fruits of *P. ferrugineum* have been used as a fish poison. In Peninsular Malaysia poultices made from the leaves and roots of this species have been applied to treat malaria. The fruits of *P. pentandrum* are used medicinally in the Philippines; they contain 'mamalis oil'. Leaves of that species are used for fodder and aromatic baths.

Production and international trade *Pittosporum* wood is used on a local scale only. It has some importance for local industries.

Properties *Pittosporum* yields a medium-weight hardwood with a density of 600–865 kg/m^3 at 15% moisture content. Heartwood cream to almost white, not differentiated from the sapwood; grain straight; texture very fine and even; wood with a good sheen. Growth rings not visible on transverse surface, but visible when thin sections are observed due to difference in density; vessels very small to moderately small, solitary and in radial multiples of 2–5, occasionally in clusters, sometimes arranged obliquely, open; parenchyma very sparse, scanty paratracheal, indistinct even with a hand lens; rays moderately fine; ripple marks absent.



Pittosporum ferrugineum
transverse surface (×20)

The wood seasons well under cover with low shrinkage and with little degrade. The wood is moderately hard, is easy to work and takes a high finish. It is non-durable but seldom affected by wood borers including *Lyctus*.
Mamalis oil consists of dihydroterpene.
See also the table on microscopic wood anatomy.

Botany Small to medium-sized, aromatic trees or shrubs, sometimes epiphytic, up to 15(–30) m tall; bole often sinuous, short, up to 30(–40) cm in diameter, without buttresses; bark surface smooth, grey-brown to purple-brown, with yellow-brown horizontal lenticels, inner bark yellowish. Leaves arranged spirally, often crowded in pseudo-whorls, simple, entire, exstipulate. Flowers in a terminal or axillary, few- to many-flowered fascicle, a thyrse, or in a short raceme, rarely solitary or cauliflorous, 5-merous; sepals free to connate; petals free or connate below, white or pale yellow; stamens sometimes coherent with the corolla tube; disk absent; ovary superior, 1-locular with 2(–6) placentas and many ovules, style 1 with 2–5 stigmatic lobes. Fruit a globose capsule, dehiscing lengthwise into 2(–5) valves. Seed reddish or blackish, embedded in a resinous, sticky fluid. Seedling with epigeal germination; cotyledons emergent, leafy; all leaves arranged spirally.
Growth is reported to be optimal on poor soils, but a single tree of *P. ferrugineum* in the Arboretum of Forest Research Institute Malaysia, Kepong of 15 years measured only 6 m in height and 4 cm in diameter. Growth is in intermittent flushes, each flush unit consisting of 2 scale leaves and several normal leaves. The terminal bud is protected by scale leaves. Growth form is according to Scarrone's architectural tree model, characterized by a well-developed monopodial trunk with tiers of orthotropic, sympodial branches. In Java flowers of *P. ferrugineum* have been observed throughout the year, those of *P. ramiflorum* in October and November. The orange to red colour of the fruit valves and the contrasting, sticky black seeds suggest that the seed is dispersed by birds.

Ecology *P. ferrugineum* is fairly common on exposed, sandy or rocky sea coasts, rarely on limestone, up to 2000 m altitude, in New Guinea up to 2800 m. *P. ramiflorum* is an understorey rain forest tree, mainly occurring on banks of rivers or streams, occasionally in mossy oak forest, at (0–)1000–3200 m altitude.

Silviculture *Pittosporum* may be raised from seed, although the essential oil-yielding *P. pentandrum* is also propagated by cuttings and air layering. Seed of *P. ferrugineum* can be stored for up to two months and there are about 125 000 dry seeds/kg. Seeds should be sown in the shade and show 65–80% germination in 43–108 days.

Genetic resources and breeding The risk of genetic erosion is low, as some species are cultivated and others have a fairly wide geographical distribution.

Prospects Increased use of *Pittosporum* wood is unlikely. Its suitability for reforesting bare land should be investigated further.

Literature 61, 70, 72, 93, 130, 163, 204, 227, 267, 341, 397, 405, 436, 464, 829, 831, 832, 861, 974, 994, 1038, 1048, 1160, 1221.

Selection of species

Pittosporum ferrugineum Aiton

Synonyms *Pittosporum nativitatis* Baker, *Pittosporum rufescens* Turcz., *Pittosporum versteeghii* Merr. & L.M. Perry.

Vernacular names Brunei: ara bukit (Malay). Indonesia: giramong (Moluccas), huru honje (Sundanese), kacombrangan (Javanese). Malaysia: akar belalang puak, medang pasir (Peninsular), saipang (Dusun Ranau, Sabah). Philippines: mamalis-pula (Filipino). Thailand: khela, sum ton (peninsular). Vietnam: c[aa]y khuy [as]o.

Distribution From the Nicobar Islands and peninsular Thailand to the entire Malesian region (in the Philippines only known from Palawan) towards the Solomon Islands, northern and eastern Australia, and the Caroline Islands; cultivated as an ornamental in Sri Lanka, Kenya and Florida (United States).

Pittosporum pentandrum (Blanco) Merr.

Synonyms *Pittosporum brachysepalum* Turcz., *Pittosporum fernandezii* Fernandez-Villar, *Pittosporum pseudostipitatum* Merr.

Vernacular names Philippines: mamelis (Filipino), oplai (Iloko), pangangto-an (Cebu).

Distribution Taiwan, the Philippines and North Sulawesi.

Pittosporum ramiflorum (Zoll. & Moritzi) Zoll. ex Miq.

Synonyms *Pittosporum clementis* Merr., *Pittosporum comptum* K. Schumann & Lauterb.

Vernacular names Indonesia: karangkangbanti, mawuring (Tombulu, Sulawesi), wuru, wuru combrangan (Javanese). Philippines: duong (Bagobo), kolinus-hamolaon (Cebu Bisaya), riin (Lanao).

Distribution Java, Borneo (Sabah), the southern Philippines, Sulawesi, the Lesser Sunda Islands (Sumbawa), the Moluccas, New Guinea and the Solomon Islands.

S.I. Wiselius (general part),
M.S.M. Sosef (selection of species)

Planchonia Blume

Van Houtte, Fl. Serres 7: 24 (1851).
LECYTHIDACEAE
x = unknown; *P. valida*: $n = 13$

Vernacular names Planchonia (En, trade name). Indonesia: putat (trade name). Malaysia: putat (general). Philippines: lamog (Filipino).

Origin and geographic distribution *Planchonia* comprises 8 species and occurs in the Andaman Islands, throughout Malesia (except the Moluccas), the Solomon Islands and northern Australia. Seven species are present within Malesia.

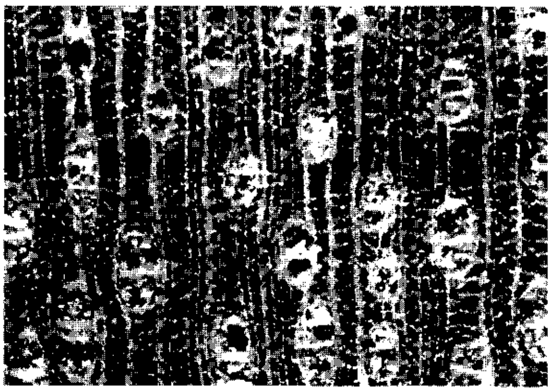
Uses The hard and heavy wood is used for house building (posts, beams, joists, rafters), interior work (flooring, cladding, panelling), pallets, thresholds, vehicle shafts and tool handles. The timber is popular for temporary construction in logging operations such as bridge bearers, rail cribwork and log-launching skids, since it is one of the few sufficiently long strong timbers found in riverine flats where timber is rafted. It is unclear whether it has actually been applied or is just recommended for boat framing, furniture and cabinet work, and bentwood work. The wood yields a good firewood. *P. valida* has been recommended for replacing teak in regions too wet for it (but not near stagnant water or in marshes).

The young leaves and shoots of *P. grandis* and *P. valida* are eaten as a salad with rice or steamed, e.g. with fish. In the Solomon Islands a decoction of the macerated bark of *P. papuana* has been used medicinally against headache and ulcers.

Production and international trade Exports of *Planchonia* from Sabah in 1992 were 900 m^3 of sawn timber and 6000 m^3 of round logs with a total value of US$ 525 000. In 1996 Papua New Guinea exported about 8120 m^3 of *Planchonia* logs at an average free-on-board (FOB) price of US$ 101/m^3.

Properties *Planchonia* yields a medium-weight to heavy hardwood with a density of 610–1010 kg/m³ at 15% moisture content. Heartwood brown, dark brown or dark red-brown, occasionally with darker streaks, distinctly demarcated from the pale, partially yellow, up to 8 cm wide sapwood, which turns grey with age; grain moderately or deeply interlocked; texture moderately fine to moderately coarse; wood sometimes lustrous. Growth rings usually indistinct, when distinct delimited by relatively dense tissue; vessels moderately small to medium-sized, solitary or in radial multiples of 2–4(–6), multiples over 4 common, tyloses abundant; parenchyma moderately abundant, paratracheal scanty and apotracheal diffuse and diffuse-in-aggregates to narrow, regular or wavy bands; rays very fine to medium-sized, aggregate rays occasionally observed; ripple marks absent.

Shrinkage upon seasoning is moderate to high. The wood warps considerably and is difficult to season. Some species are subject to honeycombing when seasoned in large dimensions (*P. spectabilis*). The wood is moderately strong to strong, tough and hard to very hard. It is fairly easy to difficult to work, depending on density, and picking up of grain may occur when planing radial surfaces. When care is taken, it can be finished to a smooth surface. The wood is moderately durable to durable even in contact with the ground, e.g. a service life of just over 4 years has been reported for *P. spectabilis*. The abundance of tyloses makes heartwood highly resistant to preservative treatment under pressure. A retention of 4.2 kg/m³ has been determined when treating *P. valida* for 5 days with a 5% BFCA solution (a mixture of boron, fluorine, chromium and arsenic compounds) by the cold soaking method. The sapwood is non-susceptible to *Lyctus*. The heartwood of *P. spectabilis* is resistant to dry-wood termites.



Planchonia papuana
transverse surface (×20)

The average fibre length of wood of *P. valida* is 2.116 mm.

See also the tables on microscopic wood anatomy and wood properties.

Botany Deciduous, small to large trees up to 50 m tall; bole usually straight and regular, branchless for up to 20 m, up to 150(–200) cm in diameter, if present, buttresses are large and up to 4 m high; bark surface vertically fissured, flaking off in small scales, greyish-brown to dark brown, inner bark fibrous, pink to reddish-orange, sometimes with watery pink exudate. Leaves arranged spirally, crowded towards the end of twigs, simple, entire to crenulate or denticulate, glabrous, decurrent at base; petiole narrowly winged; rudimentary stipules present in *P. valida* only. Flowers in a terminal or rarely axillary raceme or spike, sometimes solitary, actinomorphic or zygomorphic, large, with large bracts and bracteoles; sepals 4, connate at base into a turbinate or campanulate tube; petals 4, free but connate to the filament tube at base; stamens numerous, multiseriate; disk annular; ovary inferior, 3–4-locular with numerous axially arranged ovules in each cell, style slender. Fruit a few to many-seeded, 1–4-locular berry, barrel-shaped, fibrous, crowned by the persistent calyx. Seed with a round, coiled radicle and leafy, folded cotyledons. Seedling with epigeal germination; cotyledons emergent, serrate; hypocotyl elongated; scale leaves absent.

P. andamanica King, endemic to the Andaman Islands and very similar to *P. valida*, is leafless from December to February; the old leaves turn bright red. New leaves develop together with the inflorescences in February–March and fruits mature in April and May. In Peninsular Malaysia *P. grandis* is known to have mast fruiting years. Flowers of *Planchonia* open during the night and are mainly pollinated by bats. Parrots have been reported to feed on the fruits.

Ecology Timber-yielding *Planchonia* species are found scattered but locally common in primary, evergreen to semi-deciduous (monsoon) rain forest. They often occur in humid locations, near water or on alluvial flats, but also on slopes and along ravines, up to 650(–1000) m altitude. *P. valida* is locally common on swampy alluvial soils. *P. papuana* is also found along margins of freshwater swamp forest and in secondary forest at the inner edge of the mangrove.

Silviculture *Planchonia* can be propagated by seed. Fresh seeds of *P. grandis* had a germination rate of about 90% in 14–49 days. *P. valida* is probably not very sensitive to fire. In Papua New Guinea *P. papuana* made up about 6.5% of the total timber volume of trees over 50 cm in diameter of the Brown River Timber Area in the Central Province, thus ranking third in importance. It has also been stated that *Planchonia* trees are often not exploited as they have high buttresses, their wood is hard and the logs are sinkers.

Genetic resources and breeding Apart from occasionally cultivated specimens in botanical gardens, there are no records of ex situ conservation of *Planchonia* species. Several are rare and may easily become endangered by destruction of their habitat.

Prospects Since information on silvicultural aspects is meagre, it is difficult to indicate the potential use of *Planchonia* for e.g. enrichment planting. The suitability of the wood for bentwork needs further attention.

Literature 4, 40, 57, 70, 125, 161, 162, 163, 198, 260, 300, 302, 304, 340, 348, 436, 464, 526, 528, 553, 632, 746, 780, 829, 831, 862, 933, 934, 1007, 1052, 1221, 1232.

Selection of species

Planchonia grandis Ridley

Vernacular names Indonesia: jonger, telikai (Kalimantan), putat talang (Sumatra). Malaysia: putat nasi (Peninsular).

Distribution Peninsular Malaysia, Singapore, Sumatra and Borneo (Kalimantan).

Planchonia papuana Knuth

Vernacular names Indonesia: imaa, inara, makakai (Aru Islands).

Distribution The Aru Islands, New Guinea and the Solomon Islands.

Planchonia spectabilis Merr.

Vernacular names Philippines: lamog (Filipino), abobo (Bikol), apalang (Tagalog).

Distribution The Philippines.

Planchonia timorensis Blume

Synonyms *Gustavia alata* Spanoghe, *Gustavia globosa* Spanoghe, *Planchonia tetraptera* Miers.

Vernacular names Indonesia: bentenu (Sumbawa), lengkak (Sumba), kai ua-bouco (East Timor).

Distribution The Lesser Sunda Islands (Sumbawa, Komodo, Sumba and Timor).

Planchonia valida (Blume) Blume

Synonyms *Gustavia valida* (Blume) DC., *Planchonia alata* (Blume) Zippel, *Planchonia sundaica* Miq.

Vernacular names Indonesia: putat (general), putat kebo (Javanese), telisai (Dayak Tunjung, Kalimantan). Malaysia: putat, putat paya (general), kasui (Murut, Sabah).

Distribution Peninsular Malaysia, Sumatra, Borneo, Java, Sulawesi and the Lesser Sunda Islands.

S. Susiarti

Platea Blume

Bijdr. fl. Ned. Ind. 13: 646 (1826).

ICACINACEAE

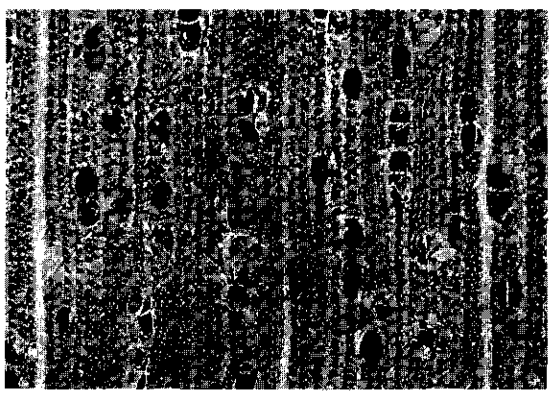
x = unknown; $2n$ = unknown

Origin and geographic distribution *Platea* comprises 5 species, one of which is endemic to Hainan, the other 4 occur from north-eastern India (Sikkim and Assam) through Indo-China, Thailand, and the whole of the Malesian region.

Uses The wood of *Platea* is used locally for construction under cover.

Production and international trade The wood of *Platea* is used rarely and on a local scale only.

Properties *Platea* yields a lightweight hardwood. The heartwood of *P. excelsa* has a density of 295–530 kg/m³ and the sapwood of different species has a density of 350–550 kg/m³ at 15%



Platea excelsa
transverse surface (×20)

moisture content. Heartwood pale yellow to white or straw-coloured, not demarcated from the often sap-stained sapwood; grain straight; wood lustrous and with a smell of cumarine. Growth rings indistinct; vessels moderately small to medium-sized, solitary and in radial multiples of 2–4, often with a tendency for radial alignment producing appearance of long radial multiples, open; parenchyma sparse to moderately abundant, paratracheal scanty and apotracheal diffuse to diffuse-in-aggregates; rays of 2 distinct sizes, medium-sized and fine; ripple marks absent.

The wood is not strong and non-durable. The gross energy value of the sapwood of *P. latifolia* is 19 550 kJ/kg.

See also the table on microscopic wood anatomy.

Botany Dioecious, small to large trees up to 45 m tall; bole columnar, fluted at base, up to 60(–100) cm in diameter, sometimes with short buttresses rarely up to 1.5 m high, sometimes with stilt roots; bark surface shallowly longitudinally fissured, lenticellate, grey to brown, inner bark soft, orange-brown. Leaves more or less distichous, simple, entire, at least initially covered with stellate hairs or silvery scales below, exstipulate. Inflorescence axillary. Male flowers sessile, in interrupted, glomerulose spikes often arranged in panicles. Female flowers in few-flowered cymes. Flowers (4–)5-merous; petals inflexed at apex, connate at base, absent in female flowers; stamens inserted on the corolla tube; ovary superior, 1-locular with 2 apical ovules, stigma sessile. Fruit a 1-seeded drupe. Seedling with epigeal germination; cotyledons emergent, leafy; hypocotyl elongated; all leaves arranged spirally.

Trees flower and fruit almost throughout the year. Within *P. excelsa* 5 varieties have been distinguished on the basis of leaf shape, venation and drupe size. Some of these are geographically restricted.

Ecology *P. excelsa* occurs scattered in primary or rarely secondary, lowland and montane forest, up to 2000(–2200) m altitude. It is found on fertile volcanic soils, but also in peat-swamp forest, temporarily inundated locations and river banks. *P. latifolia* occurs in primary and secondary lowland and montane forest, usually on predominantly wet or even swampy locations, up to 1750 m altitude.

Silviculture Pyrenes of *P. latifolia* collected from the ground show about 75% germination in 23–61 days. Fruits show about 70% germination in 46–92 days, which is fairly slow when compared to the germination of pyrenes.

Genetic resources and breeding As *Platea* trees are seldom harvested for timber and species have a comparatively wide ecological amplitude, the risk of genetic erosion is low.

Prospects The lack of information on wood properties indicates that the use of *Platea* timber is limited. It is unlikely that this situation will change in the near future.

Literature 198, 341, 436, 543, 829, 831, 861, 947, 974, 1026, 1221, 1232.

Selection of species

Platea excelsa Blume

Synonyms *Platea microphylla* Sleumer, *Platea parviflora* Koord. & Valeton, *Platea philippinensis* Merr.

Vernacular names Indonesia: balunan (Batak, Sumatra), gempel (Javanese), mandalaksa (Sundanese). Philippines: kalisan, kaliso (Bagobo), pagpago (Bontok).

Distribution Throughout the Malesian region east towards the Bismarck Archipelago (New Britain).

Platea latifolia Blume

Synonyms *Platea fuliginea* Elmer, *Platea ledermannii* Sleumer, *Platea myristicea* (R. Br. ex Hook. f.) Hallier f.

Vernacular names Indonesia: kaci pako (Batak, Sumatra), ki kadanca (Sundanese), wuru (Javanese). Malaysia: kadondong, kadondong herong (Peninsular). Thailand: man mu.

Distribution North-eastern India (Sikkim and Assam), Burma (Myanmar), Indo-China, southern China, Thailand, Peninsular Malaysia, Singapore, Sumatra, Java, Borneo, the Philippines, Sulawesi, New Guinea and the Bismarck Archipelago (New Britain).

E. Boer (general part),
M.S.M. Sosef (general part, selection of species),
J. Ilic (wood anatomy)

Platymitra Boerl.

Cat. pl. phan. 1: 33 (1899).
ANNONACEAE
$x = 9$; *P. macrocarpa*: $2n = 18$

Vernacular names Mempisang (trade name). Malaysia: pisang pisang (Peninsular). Philippines: bolon.

Origin and geographic distribution *Platymitra* comprises 2 species occurring in Thailand, Peninsular Malaysia, Sumatra, Java and the Philippines.

Uses The wood of *Platymitra* is used for general construction under cover, ship and boat building, furniture, sporting goods, agricultural implements, tool handles, oars, packing cases, matchboxes and splints. *P. arborea* is regarded as a possible substitute for hard maple (*Acer* spp.) wood of the temperate zone.

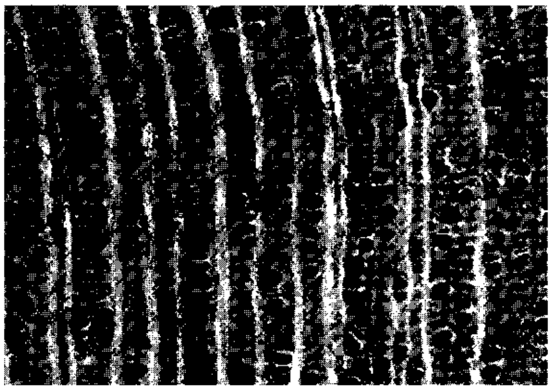
Extracts of *P. arborea* show a high antimicrobial activity. Its boiled fruits are used locally in the Philippines to cure fever, and a decoction is a good remedy in amenorrhoea. The edible fruits are also used to treat tuberculosis and leprosy. Moreover, *P. arborea* is used as an ornamental in the Philippines.

Production and international trade 'Mempisang' is a general trade name comprising most of the genera of *Annonaceae*, and *Platymitra* probably comprises only a minor proportion of the wood traded under this name.

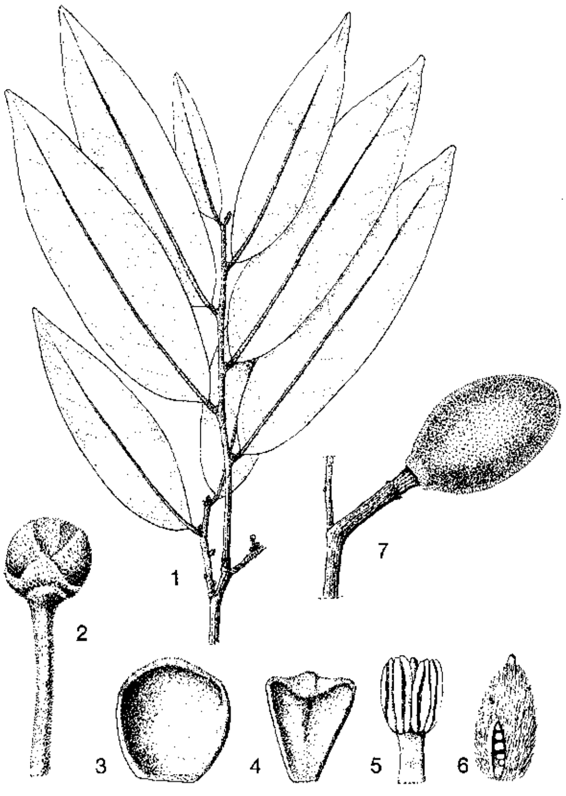
Properties *Platymitra* yields a medium-weight to heavy hardwood with a density of 610–890 kg/m^3 at 15% moisture content. Heartwood yellow-white to yellowish-brown with a slight green tinge, not clearly differentiated from the paler sapwood; grain straight; texture moderately fine. Growth rings indistinct, when visible boundaries indicated by denser fibres; vessels moderately small to medium-sized, mostly in radial multiples of 2–3, open; parenchyma abundant, apotracheal in regular, narrow bands (scalariform); rays of 2 sizes, medium-sized and moderately broad; ripple marks absent.

The wood seasons well and is hard, strong and tough. The wood is easy to work and non-durable. It is not resistant to dry-wood termites and fungal attack. The sapwood is susceptible to *Lyctus*.

See also the tables on microscopic wood anatomy and wood properties.



Platymitra arborea
transverse surface (×18)



Platymitra arborea (Blanco) Kessler – 1, flowering twig; 2, flower bud; 3, outer petal; 4, inner petal; 5, stamen; 6, opened carpel; 7, fruit.

Botany Medium-sized to fairly large trees up to 40 m tall; bole straight, cylindrical, up to 80(–150) cm in diameter, occasionally with buttresses up to 1.5 m high; bark surface smooth, irregularly finely cracking, densely hoop-marked, dark brown to dark green, inner bark light brown to reddish-brown. Leaves alternate, simple, entire, exstipulate. Flowers in a few- to many-flowered fascicle in the axil of fallen leaves, bisexual, small, usually only 1 per inflorescence developing into the fruiting stage; sepals 3, united in a 3-lobed cup, valvate; petals 6, in 2 whorls, valvate, pale orange to yellow or pale greenish, inner ones narrowed towards the base and cohering above the stamens and carpels; stamens 20–35, imbricate, connective not enlarged; carpels 1–3, each with 6–15 ovules, stigma sessile, slightly bilobed. Fruit apocarpous,

with 1–2 monocarps, each monocarp sessile or on a short stipe, globose, ovoid or cylindrical, glabrous, with a woody wall, with 3–12 seeds in (1–)2 rows. Seed semi-orbicular to semi-lenticular, with a woody or glass-like testa; endosperm very hard.
In Java *P. macrocarpa* flowers from May to November.

Ecology *Platymitra* is found scattered in primary, lowland rain forest. *P. arborea* occurs up to 300 m altitude. *P. macrocarpa* is confined to limestone hills up to 500 m altitude.

Genetic resources and breeding *P. arborea* is a rare endemic and is vulnerable to genetic erosion by destruction of its habitat.

Prospects As both *Platymitra* species are rare and have rather specific ecological requirements, their supply is extremely limited. Therefore, they will hardly be used in the near future.

Literature 70, 151, 235, 267, 438, 549, 707, *861*, *863*, *933*, *934*, *955*, *1017*, *1038*, *1098*, *1126*, 1134, 1221, 1242, 1268.

Selection of species

Platymitra arborea (Blanco) Kessler

Synonyms *Alphonsea arborea* (Blanco) Merr., *Alphonsea philippinensis* Merr.

Vernacular names Philippines: bolon (general), lanutan (Tagalog), sapiro (Bisaya).

Distribution The Philippines.

Platymitra macrocarpa Boerl.

Synonyms *Platymitra siamensis* Craib.

Vernacular names Indonesia: kalak kembang (Javanese), ki laja, ki sigeung (Sundanese). Malaysia: mangitan (Peninsular). Thailand: ham chang, hua chang (south-eastern, south-western).

Distribution Thailand, Peninsular Malaysia, Sumatra and West Java.

E. Boer (general part),
M.S.M. Sosef (general part, selection of species)

Pleiogynium Engl.

A. DC. & C. DC., Monogr. phan. 4: 255 (1883).
ANACARDIACEAE
x = unknown; $2n$ = unknown

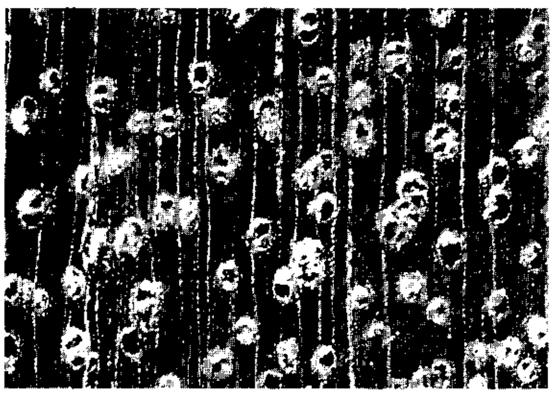
Vernacular names Burdekin plum (En). Indonesia: injo wato (Sumba), lumba (Flores), woigiek (Mooi, Irian Jaya). Papua New Guinea: tulip plum (En, trade name).

Origin and geographic distribution *Pleiogynium* comprises 2 species; one is endemic to Fiji, the other, *P. timorense* (DC.) Leenh. (synonyms: *P. cerasiferum* (F. v. Mueller) R. Parker, *P. papuanum* C.T. White, *P. solandri* (Benth.) Engl.) occurs in Borneo (Sabah, rare), the Philippines (Luzon, rare), South-East Sulawesi (rare), the Lesser Sunda Islands, the Moluccas, New Guinea, the Solomon Islands, north-eastern Australia, the Tonga Islands and Fiji. It is planted in the Cook Islands and Hawaii.

Uses The wood of *P. timorense* is used for cabinet work, general construction (posts and beams), tool handles, veneer and specialty items, and locally for canoes.
The thin, fleshy layer of the fruit is reported to be edible when ripe.

Production and international trade The wood of *P. timorense* is used mainly on a local scale. In 1996 Papua New Guinea exported 257 m^3 of 'tulip plum' logs at an average free-on-board (FOB) price of US\$ 100/m^3.

Properties *P. timorense* yields a medium-weight to heavy hardwood with a density of 630–950 kg/m^3 at 12% moisture content. Heartwood dark red-brown with dark bands, sapwood pale pink to pink-brown, up to 7 cm wide; grain straight to mostly interlocked. Growth rings usually indistinct; vessels moderately small to moderately large, solitary and in radial multiples of 2–4, with tyloses and filled with dark-coloured extraneous deposits; parenchyma sparse, paratracheal vasicentric and sometimes apotracheal in irregularly spaced bands; rays narrower than the vessels, pinkish-yellow in colour; radial canals present.
The wood is strong, hard and slightly difficult to



Pleiogynium timorense
transverse surface (×20)

work due to the interlocked grain. It is moderately durable to durable when exposed to the weather or in contact with the ground. The heartwood is highly resistant to preservative treatment under pressure. The sapwood is susceptible to *Lyctus*.
See also the tables on microscopic wood anatomy and wood properties.

Botany An often dioecious, medium-sized to fairly large or occasionally large tree up to 35(-48) m tall; bole branchless for up to 25 m, up to 90 cm in diameter, sometimes with buttresses up to 2.5 m high; bark surface fissured, flaky, dark grey or grey-brown, inner bark with white streaks, exuding small amounts of sticky, white sap. Leaves arranged spirally, imparipinnate or rarely paripinnate, (2-)3-6-jugate, exstipulate; leaflets opposite or subopposite, entire, with hairy domatia below. Flowers unisexual, in an axillary paniculate inflorescence or sometimes female flowers in a racemose or spiciform inflorescence, (4-)5(-6)-merous; calyx lobed; petals imbricate. Male flower with stamens twice the number of petals, inserted below the margin of the crenate disk; pistillode present. Female flower with annular, cushion-shaped, radially furrowed disk; ovary superior, (5-)8-12-locular with a single ovule in each cell, styles 5-12, divergent. Fruit a red to dark purple, glabrous, 5-12-seeded drupe with woody endocarp. Seed with testa free from endocarp.
Flowering and fruiting has been observed in March-December, in Papua New Guinea only in May and June; pollination is by insects.
Pleiogynium belongs to the tribe *Spondieae*. Whether the endemic Fijian species is truly distinct from *P. timorense* remains to be studied.

Ecology *P. timorense* occurs scattered in primary, lowland rain forest, up to 600(-1000) m altitude. In Australia it also occurs in open forest, littoral forest, and seasonally dry, semi-evergreen vine forest and thickets.

Genetic resources and breeding *P. timorense* has been found only once in Sulawesi, Luzon and Sabah, and its present occurrence in these areas is doubtful.

Prospects The quality of *P. timorense* timber is good, but as supplies are scarce, its use will probably remain only local.

Literature 125, 300, 304, 340, 341, 348, 464, 632, 659, 861, 1035, 1048, 1132, 1205.

Ding Hou

Pleurostylia Wight & Arn.

Prodr. fl. Ind. orient. 1: 157 (1834).
CELASTRACEAE
x = unknown; $2n$ = unknown

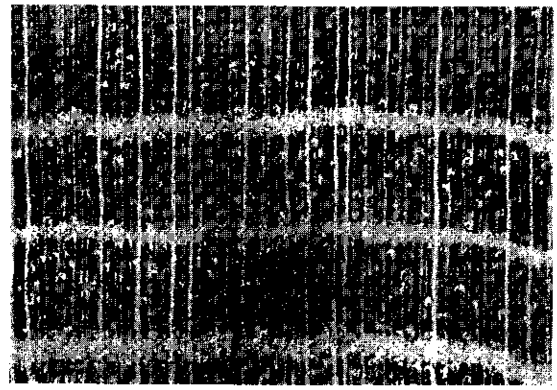
Vernacular names Panaka (En, trade name), Wight saffranwood (En). Thailand: mu khwai khao (peninsular), ta kai (eastern), yot daeng (south-western). Vietnam: ca lau.

Origin and geographic distribution *Pleurostylia* comprises 7 species occurring in tropical and subtropical Africa, Madagascar, the Mascarenes, and from Sri Lanka and India to Indo-China, China (Hainan), Thailand, the Malesian region, Australia and New Caledonia. The only Malesian species is *P. opposita* (Wallich) Alston (synonyms: *Elaeodendron mindanaense* Merr., *Pleurostylia heynei* Wight & Arn., *Pleurostylia wightii* Wight & Arn.) which occurs in Mozambique and from Sri Lanka and India to Indo-China, China (Hainan), Thailand, Peninsular Malaysia, the Philippines, New Guinea, north-eastern Australia and New Caledonia.

Uses The attractive wood of *P. opposita* is used for small decorative articles (carving, handles, combs), mosaic flooring, but also for rafters and tool handles. Its use for furniture has been recommended.

Production and international trade The use of the wood of *P. opposita* is probably only local.

Properties *P. opposita* yields a medium-weight hardwood with a density of 770-870 kg/m^3 when air dry. Heartwood pale yellow-brick-red or reddish-brown with darker lines, not clearly differentiated from the sapwood; grain straight; texture fine; wood lustrous. Growth rings distinct to sometimes indistinct, when distinct demarcated by



Pleurostylia capensis (Turcz.) Loes.
transverse surface (×20)

darker tissue lacking parenchyma; vessels small, mostly solitary, rarely in radial multiples of 2–3, open, vessels not visible to the naked eye; parenchyma in wide apotracheal bands, conspicuous; rays narrow, visible to the naked eye; ripple marks absent.
The wood is moderately hard to hard.
The tree contains a poisonous alkaloid.
See also the table on microscopic wood anatomy.

Botany A shrub or small tree up to 15(–20) m tall; bole branchless for up to 5 m, up to 35 cm in diameter; bark surface deeply fissured, peeling in narrow strips, dark brown to pale brown or grey, inner bark red-brown to pink. Leaves decussate, simple, entire, stipulate or exstipulate. Inflorescence axillary or rarely on the internodes between leaves, cymose, 1–few-flowered, shortly peduncled. Flowers bisexual, 5-merous; calyx lobes imbricate; petals imbricate, greenish; disk cup-shaped; stamens attached just outside the disk; ovary superior, 2-locular or 1-locular by abortion, with 2(–8) ovules in each cell, style short, stigma capitate. Fruit a 1(–2)-seeded nut, with a prominent, persistent, lateral style; endocarp crustaceous. Seed without aril.
Pollination is probably by insects.

Ecology *P. opposita* is found scattered in primary or secondary light rain forest or seasonally dry forest or even thickets, up to 650 m altitude.

Genetic resources and breeding There is hardly any risk of genetic erosion due to the wide geographical distribution and the limited use of *P. opposita*.

Prospects The attractive wood of *P. opposita* deserves more attention in South-East Asia. More information is needed about its wood properties.

Literature 103, 340, 341, 371, 974, 1038, 1098, 1221.

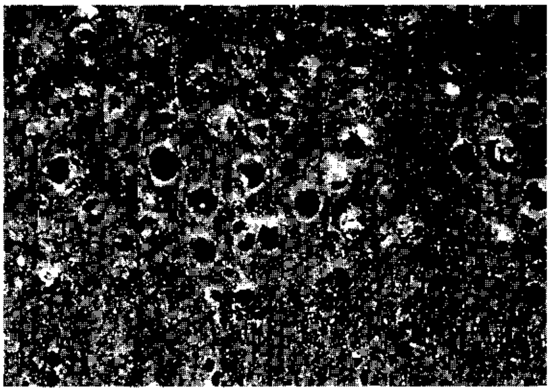
Ding Hou

Ploiarium Korth.

Temminck, Verh. Natuurl. Gesch. Overz. Bez., Bot., Kruidk. 3: 135 (1840).
BONNETIACEAE
x = unknown; $2n$ = unknown

Origin and geographic distribution *Ploiarium* comprises 3 species and occurs in Cambodia, Thailand, Peninsular Malaysia, Sumatra, Borneo, the Moluccas (Gebe Island) and New Guinea (Irian Jaya).

Uses The wood of *Ploiarium* is mainly used for house building as posts and rafters, for fence posts, pepper posts and implements. It is suitable for temporary piling and, when treated, for marine work. It yields a good firewood.



Ploiarium alternifolium
transverse surface (×20)

The root is one of many ingredients in a decoction administered after childbirth. The raw leaves are eaten as a salad and have a pleasant, sharp taste. The leaves have also been used as a hair wash, whereas a decoction has been applied to treat stomach-ache.

Production and international trade The wood of *Ploiarium* is used on a local scale only; supplies are locally abundant.

Properties *Ploiarium* yields a heavy hardwood with a density of 945–1100 kg/m³ at 15% moisture content. Heartwood bright orange-red of a distinctive, characteristic shade when freshly cut, darkening to deep red-brown upon exposure, not sharply differentiated from the yellowish, narrow sapwood; grain moderately straight, irregular to interlocked; texture slightly coarse but even. Growth rings not evident, boundaries indicated by zones without vessels; vessels moderately small to moderately large, exclusively solitary, tyloses present and solid, gum-like deposits abundant; parenchyma apotracheal diffuse to diffuse-in-aggregates, paratracheal scanty and sometimes vasicentric, difficult to see with a hand lens; rays moderately fine to medium-sized, visible with a hand lens; ripple marks absent.
The wood is liable to split upon seasoning. It is hard to very hard and very strong. The wood is fairly durable, and about 80 kg/m³ of a mixture of 50% creosote and 50% diesel oil can be absorbed by using the open tank method.
See also the table on microscopic wood anatomy.

Botany Evergreen shrubs or small to medium-sized trees up to 20(-30) m tall; bole usually straight, up to 15 cm in diameter, developing stilt roots in swampy locations; bark surface narrowly and deeply fissured, brown to greyish-brown, inner bark fibrous, yellow. Leaves arranged spirally, clustered at the end of twigs, simple, entire, sessile or subsessile; young leaves inrolled. Flowers axillary among the upper leaves, solitary, with 2 bracts and 2 bracteoles, bisexual, 5-merous; sepals unequal, deciduous; petals free; stamens many, in 5 bundles and alternating with 5 glands; ovary superior, 5-locular with many ovules in each cell, styles 5, free. Fruit a thinly woody capsule dehiscing from the base upwards leaving the central column crowned with the persistent styles. Seed small, slender, elongate.

Growth is generally slow. The annual diameter increment in a forest dominated by *P. alternifolium* in Peninsular Malaysia varied between 0.2 cm and 0.5 cm. *P. alternifolium* develops according to Aubréville's architectural model, the so-called 'Terminalia branching', characterized by a monopodial trunk with rhythmic growth, bearing tiers of branches; branches are modular and plagiotropic by apposition. Flowering is lateral and modules grow indefinitely. Ants may build nests around the twigs and promote the growth of epiphytes. *P. alternifolium* flowers fairly frequently, in Peninsular Malaysia in mast fruiting years.

Several authors have placed *Ploiarium* in the families *Theaceae* or *Guttiferae*. There is growing evidence that the family *Bonnetiaceae* is distinct enough to be kept separate. *P. sessile* (R. Scheffer) Hallier f. is a rare species of the Moluccas and Irian Jaya growing to 40 m tall and 30 cm in diameter.

Ecology *P. alternifolium* occurs in secondary forest and thickets, up to 700(-1300) m altitude. It is locally very common and often gregarious and may occur as a dominant species or even in pure stands. It prefers dry, acid, sandy soils like podzols but is also frequently observed in shallow freshwater swamps, rocky river beds, or rarely in brackish peat-swamps. In freshwater swamps on old mining land it has been found associated with *Alstonia spathulata* Blume, *Cratoxylum arborescens* (Vahl) Blume and *Melaleuca leucadendra* (L.) L. *P. pulcherrimum* is a primary forest species occurring on similar soils.

Silviculture *Ploiarium* can be propagated by seed. Viability of seed of *P. alternifolium* does not decrease for the first 8 weeks in storage. Seeds germinate unsatisfactorily when sown immediately after collection, but germination increases dramatically after the seed has been kept in the dark for two weeks or more. In stands on old mining land dominated by *P. alternifolium* its natural regeneration is often not successful. It builds up the soil and changes the water table, making a site suitable for high forest trees. It tolerates frequent cutting, as is often done for poles and firewood, by producing abundant root suckers. *P. pulcherrimum* regenerates fairly easily on podsols and in shallow swamps.

Genetic resources and breeding *P. alternifolium* varies greatly in height in the various habitats, being up to 30 m tall in peat-swamps or less than 0.3 m in rocky river beds. As *P. alternifolium* is favoured by cutting, there is no danger of genetic erosion; the conservation of *P. pulcherrimum*, however, depends on the protection of its habitat, which is primary forest. The rare *P. sessile* is probably a threatened species.

Prospects Slow growth of *P. alternifolium* hampers the development of silvicultural management of the secondary stands in which it is found. Its wide ecological range and its positive effects on the vegetation may render this species suitable for reforestation purposes. Its local importance for supplying wood from secondary vegetation, especially for posts, will probably remain.

Literature 88, 92, 151, 162, 163, 198, 209, 267, 402, 436, 486, 579, 802, 861, 902, 1039, 1140, 1218, 1221, 1232, 1242, 1249.

Selection of species

Ploiarium alternifolium (Vahl) Melchior

Synonyms *Archytaea alternifolia* (Vahl) Szyszyl., *Archytaea vahlii* Choisy, *Ploiarium elegans* Korth.

Vernacular names Cicada tree (En). Indonesia: beriang (Sumatra), bunyok (Bangka), malaka udang (south-western Kalimantan). Malaysia: reriang, riang-riang (Peninsular), sauma (Sarawak), saruna (Sabah). Thailand: chamuang kwang, muang kwang, som kwang (peninsular).

Distribution Cambodia, peninsular Thailand, Peninsular Malaysia, Sumatra and Borneo.

Ploiarium pulcherrimum (Becc.) Melchior

Synonyms *Archytaea pulcherrima* Becc.

Distribution Borneo (Sarawak) and Sumatra.

H.C. Ong

Polyalthia Blume

Fl. Javae Anonac.: 68 (1830).
ANNONACEAE
$x = 9$; *P. affinis* Teijsm. & Binnend.: $2n = 16$, *P. glauca*, *P. lateriflora*, *P. longifolia*, *P. micrantha* (Hassk.) Boerl., *P. rumphii*: $2n = 18$, *P. littoralis* (Blume) Boerl.: $2n = 36$

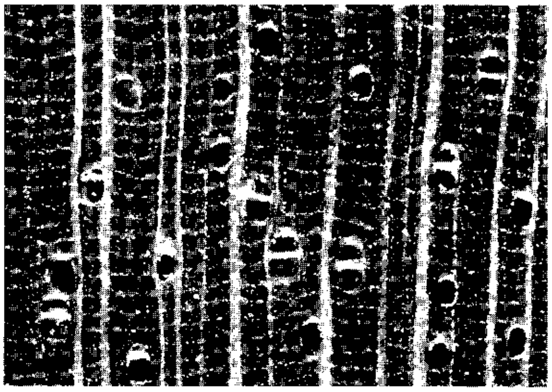
Vernacular names Mempisang, polyalthia (trade names). Brunei: karai. Indonesia: tepis (general). Malaysia: karai (Sarawak), pisang-pisang (Peninsular, Sabah). Philippines: lanutan (Filipino). Vietnam: nh[oj]c, n[os]c, qu[aaf]n d[aaf]u.

Origin and geographic distribution *Polyalthia* comprises about 150 species and is distributed in the Asian tropics from India to Indo-China, China, Taiwan, Thailand, throughout the Malesian region, Australia, the Solomon Islands and Fiji. The largest number of species is found in South-East Asia, especially in Malesia.

Uses The generally tough and flexible wood of *Polyalthia* is used for temporary construction, house building, furniture, interior trim, mouldings, light framing, decorative wall panelling, masts, oars, wooden shoes, tool handles, sporting goods, novelties, toys, match splints, packing cases and boxes. It is also suitable for the production of veneer and plywood and is used as firewood (especially *P. glauca*). The wood of several species including that of *P. cauliflora* is often decoratively figured.

The fibrous bark of several species, but notably of *P. sumatrana* and *P. hypoleuca*, is used to make rope. A poultice of crushed leaves of *P. cauliflora* is used locally in Indonesia to treat skin diseases. *P. longifolia* is planted in Peninsular Malaysia as an ornamental; an extract of its leaves shows antibacterial and antifungal activities; its seeds yield an oil and in India its bark is used as a febrifuge.

Production and international trade 'Mempisang' is a general trade name comprising most of the genera of *Annonaceae*, and *Polyalthia* comprises an important part of the timber traded under this name. In 1992 the export of mempisang wood from Sabah amounted to 25 000 m^3 of sawn timber and 42 500 m^3 of logs with a total value of about US$ 7.2 million. Most of the small amounts of mempisang imported by Japan comes from Sabah, Sarawak and Papua New Guinea. In 1996 Papua New Guinea exported 1845 m^3 of *Polyalthia* logs at an average free-on-board (FOB) price of US$ 103/m^3.



Polyalthia hypoleuca
transverse surface (×20)

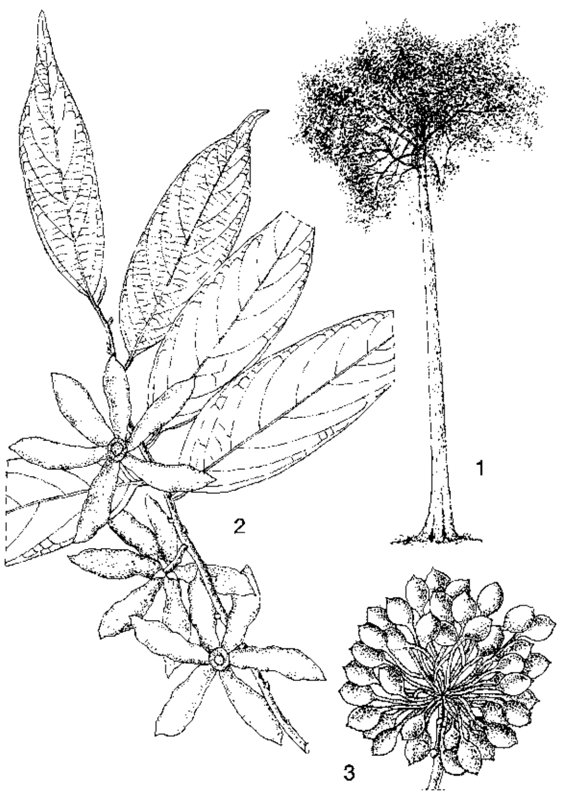
Properties *Polyalthia* yields a medium-weight hardwood with a density of (555–)645–900 kg/m^3 at 15% moisture content; wood of *P. glauca* and *P. oblongifolia* are lightweight to medium-weight with a density of 390–730 kg/m^3 at 15% moisture content. Heartwood yellow to yellowish-brown with a pink or green tinge, not clearly differentiated from the pale yellow sapwood; grain straight; texture moderately coarse to fine and even; wood with silver grain; occasionally dark, hard core present. Growth rings rather distinct, sometimes indistinct, boundaries indicated by denser tissue; vessels moderately small to medium-sized, mostly in radial multiples of 2–4, rarely in clusters, occasional white deposits present; parenchyma abundant, apotracheal in regular, narrow bands (scalariform); rays moderately broad or rarely fine, distinct; ripple marks absent.

Shrinkage of the wood during seasoning is very low to moderate. The wood is moderately soft to hard and fairly weak to strong and tough with a wide variation between species. The wood is non-durable and needs chemical treatment to prevent stain immediately after sawing. In a graveyard test in the Philippines the average service life of test stakes (probably of *P. rumphii*) was about 21 months. The wood of *P. flava* is resistant to dry-wood termites and the sapwood is non-susceptible to *Lyctus*. The sapwood of most other species is susceptible to *Lyctus*. The wood is fairly resistant to pressure preservative treatment.

Leaves of *P. cauliflora* and other species contain alkaloids.

See also the tables on microscopic wood anatomy and wood properties.

Botany Evergreen or briefly deciduous, small to medium-sized or occasionally large trees up to



Polyalthia rumphii (Blume) Merr. – 1, tree habit; 2, flowering twig; 3, infructescence.

40(–50) m tall; bole straight, cylindrical, up to 60(–90) cm in diameter, occasionally fluted at base or with small buttresses, sometimes with pneumatophores (*P. glauca*); bark surface smooth to cracking or scaly to papery flaky, sometimes with hoop marks and/or lenticels, light grey to yellowish-white or brown, inner bark fibrous, pale yellow or yellow-brown with red spots or entirely pinkish. Leaves alternate, simple, entire, often narrowly elliptical, exstipulate. Flowers axillary or leaf-opposed, sometimes cauliflorous, solitary or in fascicles, bisexual; sepals 3, valvate or imbricate, free or connate; petals 6, valvate or imbricate, in 2 rows, subequal, often large and red, orange, yellow, greenish or white; stamens many, with flat-topped or convex connective; carpels few to many, free, each with 1–5 ovules in 1 row, style often absent. Fruit apocarpous, with 1–50(–80) monocarps, each monocarp sessile or stalked, oblong or ovoid to transversely broadly elliptical. Seed with a papery to woody wall; endosperm ruminate. Seedling with epigeal or hypogeal germination; cotyledons emergent and leafy or not emergent; hypocotyl may or may not be elongated; leaves arranged spirally on the orthotropic leader, distichous on the branches.

Early growth is reputed to be slow, becoming more rapid afterwards. A 19-year-old *P. sclerophylla* Hook. f. & Thomson tree in the Arboretum of the Forest Research Institute Malaysia, Kepong was 14 m tall and 13 cm in diameter. Growth is rhythmic with suspension of the terminal bud of the vertical shoot, followed by plagiotropic branch growth, after which the vertical shoot resumes growth. *Polyalthia* develops according to Roux's architectural tree model, characterized by a monopodial orthotropic trunk with plagiotropic branches inserted continuously and with distichous leaf arrangement, flowering not influencing the architecture. Flowering can occur twice a year and flowers appear just before the new leaves. *P. flava* flowers from February to April. In Peninsular Malaysia the flowering-to-fruiting period of *P. jenkensii* is about 19 weeks. In general, *Annonaceae* fruits are eaten and dispersed by birds, mainly pigeons; fruits of *P. longifolia* are eaten and dispersed by bats.

Many of the individual *Polyalthia* species are rather poorly known botanically and in need of a thorough taxonomic revision. *Polyalthia* species reported for Africa and Madagascar probably all belong to *Greenwayodendron*, rendering *Polyalthia* in the present sense purely Asian.

Ecology *Polyalthia* species occur scattered as understorey or main canopy trees in primary or secondary, lowland to lower montane rain forest, up to 1200(–1800) m altitude. They are found in evergreen and monsoon forest, both on well-drained hills and poorly drained level sites. Individual *Polyalthia* species may occur as common elements of peat-swamp forest, occasionally also in kerangas.

Silviculture *Polyalthia* can be propagated by seed. Germination experiments in Peninsular Malaysia, however, showed that germination is unpredictable. The best results were obtained for *P. cinnamomea*, the seeds of which were sown with pulp and had about 95% germination in 1–2 months. Seeds of several other species showed 10–35% germination in 1–10 months. Sowing of fruits of *P. sumatrana* yielded a very low germination. *P. cauliflora* and *P. cinnamomea* are highly vulnerable in the nursery, as the cotyledons and epicotyl are easily trapped in the testa and then rot. Sufficient watering and manual removal of the testa may resolve the problem. In natural forest the regeneration of *Polyalthia* is generally profuse.

Genetic resources and breeding Some *Polyalthia* species have a rather narrow geographical distribution and face the risk of genetic erosion by deforestation.

Prospects *Polyalthia* is considered to be rather fast-growing and may be promising in timber plantations. However, only little silvicultural information is available and it seems justifiable to increase the research on propagation and planting, and on growth and yield.

Literature 40, 70, 125, 151, 162, 163, 209, 238, 267, 300, 304, 348, 358, 402, 436, 438, 464, 468, 496, 507, 526, 547, 632, 672, 673, 707, 800, 825, 827, 829, 831, 832, 836, 837, 861, 863, 883, 934, 955, 957, 974, 1017, 1038, 1098, 1123, 1126, 1134, 1221, 1242.

Selection of species

Polyalthia cauliflora Hook. f. & Thomson

Synonyms *Polyalthia beccarii* King, *Polyalthia desmantha* (Hook. f. & Thomson) Ridley, *Unona wrayi* Hemsley.

Vernacular names Malaysia: jambul burong chichit, larak merah, mengala hutan (Peninsular). Thailand: champa khom (peninsular).

Distribution Peninsular Thailand, Peninsular Malaysia, Singapore, Sumatra and Borneo.

Polyalthia cinnamomea Hook. f. & Thomson

Synonyms *Polyalthia velutinosa* Ridley.

Vernacular names Malaysia: pokok segaoh, segumpal hitam (Peninsular).

Distribution Peninsular Thailand and Peninsular Malaysia.

Polyalthia discolor Diels

Distribution New Guinea.

Polyalthia flava Merr.

Vernacular names Philippines: lanutan dilau (Filipino), yellow lanutan (En).

Distribution The Philippines.

Polyalthia glauca (Hassk.) F. v. Mueller

Synonyms *Guatteria glauca* (Hassk.) Miq., *Polyalthia merrittii* (Merr.) Merr., *Polyalthia parkinsonii* Hutch.

Vernacular names Indonesia: banitan putih (Indonesian), ki tinjang (Sundanese), saselo (Morotai). Malaysia: lulusan sowong (Sabah), manitan (Peninsular). Philippines: dogan (Filipino).

Distribution The Andaman Islands, peninsular Thailand and throughout Malesia except for the Lesser Sunda Islands.

Polyalthia hypoleuca Hook. f. & Thomson

Vernacular names Indonesia: tepis (general), banitan (Sumatra), usai (Bangka). Malaysia: akar larak hutan, melilin (Peninsular), selaut (Iban, Sabah).

Distribution Peninsular Malaysia, Sumatra and Borneo.

Polyalthia jenkensii (Hook. f. & Thomson) Hook. f. & Thomson

Synonyms *Polyalthia agusanensis* (Elmer) Merr., *Polyalthia andamanica* Kurz, *Polyalthia havilandii* Boerl.

Vernacular names Burma (Myanmar): thanlung. Thailand: dang nga khao (peninsular). Vietnam: nh[oj]c [aas]n d[ooj].

Distribution India (Assam), Burma (Myanmar), Indo-China, southern China, Thailand, Peninsular Malaysia, Sumatra, Borneo and the Philippines.

Polyalthia lateriflora (Blume) King

Synonyms *Guatteria lateriflora* Blume, *Monoon lateriflorum* (Blume) Miq.

Vernacular names Indonesia: janglot (Madurese), kalak (Sundanese), kalak ucet (Javanese). Thailand: kluai mu sang, nian khao (peninsular), kra dang nga pa (northern).

Distribution Thailand, Peninsular Malaysia, Singapore, Sumatra and Java.

Polyalthia longifolia (Sonn.) Thwaites

Synonyms *Guatteria longifolia* (Sonn.) Wallich, *Unona longifolia* (Sonn.) Dun.

Vernacular names Cemetery tree (En).

Distribution Native to Sri Lanka and India; planted for ornamental purposes in Peninsular Malaysia and Java, and possibly elsewhere.

Polyalthia motleyana (Hook. f.) Airy Shaw

Synonyms *Oxymitra motleyana* Hook. f., *Polyalthia oblonga* King.

Distribution Thailand, Peninsular Malaysia, and Borneo.

Polyalthia oblongifolia Burck
Distribution New Guinea.

Polyalthia ovalifolia Rogstad
Vernacular names Brunei: dilleh. Indonesia: ribui (Kalimantan). Malaysia: dillah, selaut telor (Sarawak).
Distribution Borneo (Brunei, Kalimantan, Sarawak).

Polyalthia rumphii (Blume) Merr.
Synonyms *Polyalthia canangioides* (Rchb. f. & Zoll.) Boerl., *Polyalthia kunstleri* King, *Polyalthia scortechinii* King.
Vernacular names Indonesia: pamelesian (Sulawesi). Malaysia: merpadi (Peninsular). Philippines: Rumphius' lanutan (En). Thailand: sang yu (peninsular).
Distribution Peninsular Thailand, Peninsular Malaysia, Singapore, Sumatra, Java, Borneo, the Philippines, Sulawesi and the Moluccas.

Polyalthia sumatrana (Miq.) Kurz
Synonyms *Monoon sumatranum* (Miq.) Miq.
Vernacular names Brunei: delasai (Iban). Indonesia: antoi sembago, banetan putih (Palembang, Sumatra), binhut (Banjar, East Kalimantan). Malaysia: dilasai (Iban, Sarawak), kalamanjat (Tidong, Sabah), melilin (Peninsular).
Distribution Peninsular Malaysia, Sumatra and Borneo.

Nguyen Tien Ban

Polyosma Blume

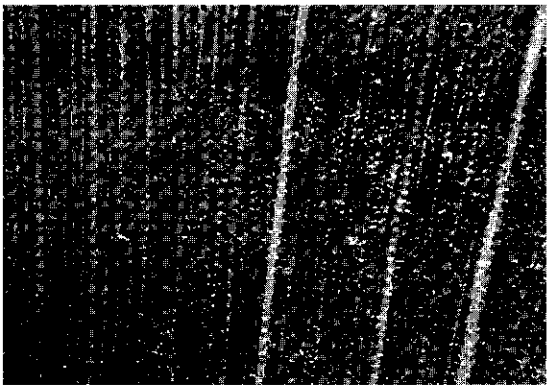
Bijdr. fl. Ned. Ind. 13: 658 (1826).
ESCALLONIACEAE
x = unknown; $2n$ = unknown

Origin and geographic distribution *Polyosma* comprises about 50 species occurring in India, Burma (Myanmar), Indo-China, southern China, Thailand, throughout the Malesian region to New Caledonia and tropical Australia. Some 35 species are found within Malesia.

Uses The wood of *Polyosma* has been used for local house building.
The inner bark has been applied against scurf and the leaf sap for eye diseases.

Production and international trade Utilization of *Polyosma* wood is on a limited and local scale only.

Properties *Polyosma* yields a medium-weight hardwood with a density of 490–715 kg/m^3 at 15% moisture content. Heartwood pale orange-brown or yellow-brown with a grey tinge, not differentiated from the sapwood; grain shallowly interlocked or spiral; texture rather fine and even. Growth rings absent; vessels moderately small, solitary and in radial multiples of 2–several, in radial arrangement; parenchyma moderately abundant, apotracheal diffuse-in-aggregates, visible with a hand lens; rays very fine to medium-sized, the latter visible to the naked eye, with a tendency to 2 distinct types; ripple marks absent.



Polyosma hirsuta C.T. White
transverse surface (×20)

The wood is rather soft to moderately hard and fairly strong. It is non-durable when exposed to the weather or in contact with the ground but it is durable under cover. The sapwood is susceptible to *Lyctus*.
See also the table on microscopic wood anatomy.

Botany Evergreen shrubs or small to medium-sized trees up to 20(–30) m tall; bole straight, up to 70 cm in diameter, sometimes with small buttresses; bark surface smooth or fissured, sometimes lenticellate, whitish to brown or grey-brown, inner bark fibrous, white to yellow or reddish brown to pink. Leaves opposite or subopposite, simple, entire to toothed. Flowers in a terminal raceme, with 3 bracteoles, 4-merous; sepals partly fused, persistent, hairy; petals valvate, linear, hairy on both surfaces; stamens 4, with hairy filaments; disk present; ovary inferior, 1-locular with many ovules, style columnar, persistent. Fruit a 1-seeded drupe. Seedling with epigeal germination; cotyledons emergent, small and linear; hypocotyl elongated; first 2 leaves opposite and serrate.
In Java *P. longipes* is flowering in July and Sep-

tember, whereas *P. integrifolia* flowers from March to October.

Polyosma is botanically poorly known and in need of a thorough taxonomic revision. The wood of many more species than the ones mentioned below is potentially useful, but they are too poorly known. *Polyosma* and the *Escalloniaceae* have sometimes been included in the *Saxifragaceae*. Recent DNA research has shown the latter family to be a highly polyphyletic gathering. Therefore it seems best to maintain the *Saxifragaceae* in a strict sense next to several other small families.

Ecology *Polyosma* species can be encountered from sea-level up to 3750 m altitude (*P. subalpina* Schulze-Menz in Papua New Guinea) but timber-yielding species are generally found in primary or secondary lowland to montane forest, up to 2000 m altitude.

Silviculture *Polyosma* can be raised from seed. Seeds of *P. integrifolia* have a germination rate of about 65% in 6–9 months after a long dormancy period. Sown drupes failed to germinate altogether.

Genetic resources and breeding As the trees are only occasionally cut for timber the risk of genetic erosion depends mainly on the conservation of the habitat of the individual *Polyosma* species involved.

Prospects The scarce information on the wood properties of *Polyosma* indicates that the utilization of the wood is limited. It is unlikely that this situation will change in the near future.

Literature 70, 163, 267, 300, 343, 436, 438, 543, 595, 829, 831, 861, 930, 990, 1221, 1232.

Selection of species

Polyosma integrifolia Blume

Synonyms *Polyosma grandis* Ridley, *Polyosma mutabilis* Blume, *Polyosma wallichii* Benn.

Vernacular names Indonesia: beleber (Javanese), ki jebug, lunglum (Sundanese).

Distribution From India and Burma (Myanmar) to Indo-China, Hainan, Thailand, Peninsular Malaysia, Singapore, Sumatra, Java, Borneo and New Guinea.

Polyosma kingiana Schlechter

Synonyms *Polyosma flavovirens* Ridley.

Distribution Peninsular Malaysia, Singapore and Borneo.

Polyosma laetevirens Griffith ex King

Vernacular names Malaysia: pokok tambal, pokok tampol (Peninsular).

Distribution Peninsular Malaysia.

Polyosma longipes Koord. & Valeton

Vernacular names Indonesia: ki jombang (Sundanese).

Distribution Java.

Polyosma oligantha Reeder

Distribution New Guinea (Irian Jaya).

Polyosma ridleyi King

Distribution Peninsular Malaysia, Singapore and Borneo.

Polyosma scortechinii King

Distribution Peninsular Malaysia.

E. Boer (general part),
M.S.M. Sosef (general part, selection of species)

Polyscias J.R. Forster & J.G. Forster

Charact. gen. pl.: 63, t. 32 (1776).
ARALIACEAE

$x = 12$; *P. fruticosa* (L.) Harms, *P. scutellaria* (Burm. f.) Fosberg: $2n = 24$, *P. guilfoylei* (Cogn. & Marché) L.H. Bailey: $2n = 24, 36$

Vernacular names Malapapaya (trade name). Indonesia: kambowa (Sulawesi), ki langit (Sundanese), pata tulan (Ambon). Philippines: bias-bias (Tagalog), bungliu (Tagalog), panalatangen (Pangasinan).

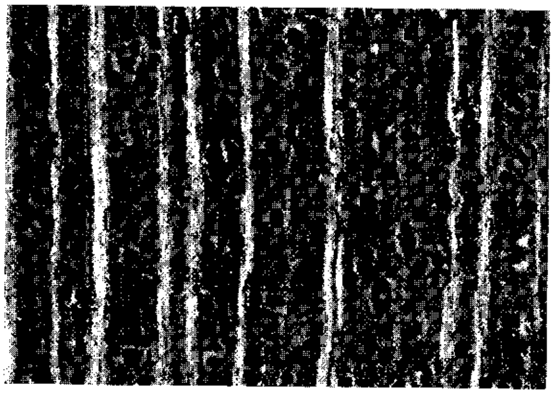
Origin and geographic distribution *Polyscias* comprises about 100 species occurring throughout the Old World tropics, including Australia and the islands in the Pacific. Within the Malesian region 23 species are found, most of which occur in New Guinea. The genus was originally absent from Peninsular Malaysia and Sumatra, but several species have been introduced there. The principal Malesian species yielding timber is *P. nodosa* (Blume) Seem. (synonym: *Eupteron nodosa* (Blume) Miq.) which occurs in Java, the Lesser Sunda Islands, Sulawesi, the Philippines, the Moluccas, New Guinea and the Bismarck Archipelago.

Uses In Malesia the wood of *Polyscias* is apparently only used commercially in the Philippines, where it is regarded as one of the best woods for small objects like boxes, matches, pencil slats,

popsicle sticks, toothpicks, chopsticks and ice-cream spoons. It has also been used for wooden shoes, fence posts and handles for rice-knives. Large diameter logs are suitable for veneer and plywood production.
In Mindanao the leaves of *P. nodosa* have been used medicinally against purpuric fever and as a contraceptive. Pounded leaves, mixed with ash have also been applied as a fish poison. Several non-timber *Polyscias* species are used as ornamentals, and the leaves are sometimes applied medicinally, or serve as a vegetable or cosmetic.

Production and international trade As the supply of *Polyscias* wood is very limited, it is only used on a local scale.

Properties *P. nodosa* yields a lightweight hardwood with a density of 300–515 kg/m^3 at 15% moisture content. Heartwood pale to pinkish buff, not clearly differentiated from the sapwood; grain straight; texture fine and even. Growth rings generally indistinct, occasionally visible to the naked eye, marked by darker and denser woody tissue; vessels moderately small to medium-sized, solitary and in radial multiples of 2–3, in oblique or tangential pairs, or in occasional clusters; parenchyma scanty paratracheal to vasicentric, mostly indistinct; rays moderately broad, distinct to the naked eye on all surfaces; ripple marks absent.
Shrinkage of the wood is high, it seasons well and warping and checking is negligible. The wood is weak and soft. It is easy to work and fairly durable for interior work, but very perishable when exposed to the weather or in contact with the ground, having an average service life of less than one year in graveyard tests. The wood is susceptible to dry-wood termites. The sapwood is susceptible to *Lyctus*.



Polyscias nodosa
transverse surface (×18)

The leaves contain a poisonous saponinaceous substance.
See also the tables on microscopic wood anatomy and wood properties.

Botany A small to medium-sized tree up to 25(–30) m tall; bole branchless for up to 15(–18) m, up to 60 cm in diameter, without buttresses; bark surface with vertical lines, pale grey to brown, inner bark very brittle, white with yellow rays; crown sparsely branched, branches slender and rather flexuous, crowned with large leaves. Leaves arranged spirally, crowded at the end of branches, imparipinnate, multijugate, exstipulate, large; petiole with a short basal sheath; rachis articulated; leaflets sessile, slightly crenate. Inflorescence a large terminal panicle, sometimes with several axillary branches below. Flowers small, in capitula which are borne racemosely along the secondary inflorescence branches; pedicel articulated below the ovary; calyx a minute persistent rim only; petals 5, valvate, yellow; disk present; ovary inferior, 5-locular with a single ovule in each cell, styles 5, spreading and reflexed in fruit. Fruit a subglobose yellowish-red drupe.
In secondary forest in the Philippines the average annual diameter increment of *P. nodosa* for the diameter class 5–10 cm is estimated at 1.7 cm. Trees flower throughout the year.
Polyscias is divided into several sections. *P. nodosa* belongs to the section *Eupteron* (Miq.) Philipson which is characterized by the imparipinnate or bipinnate leaves, the flowers in umbellules or capitula and the divergent style arms.

Ecology *P. nodosa* is found scattered in primary or more often in secondary evergreen or deciduous forest, sometimes in dipterocarp forest or in thickets, up to 1000 m altitude. It occurs on permanently moist or periodically dry soils; also found on chalk.

Silviculture Propagation of *P. nodosa* from seed is possible. The fruits contain small seeds and should be picked from the trees. In the Philippines a spacing of 1 m × 1 m proved satisfactory for the production of wood for matchsticks, pencil slats and other small articles. A spacing of 3 m × 3 m is recommended for the production of timber for rotary-cut veneer. The fungus *Fusarium solani* was found to attack stored seeds.

Genetic resources and breeding There is no record of ex situ conservation of *P. nodosa*. As it is often found in secondary vegetation there seems to be no danger of genetic erosion.

Prospects *P. nodosa* seems to have good prospects as a fast producer of a comparatively soft wood, but its silvicultural characteristics need further investigation in order to be able to benefit fully from this resource.

Literature 10, 70, 235, 272, 341, 403, 436, 595, 780, 861, 891, 934, 974, 1198, 1208.

E. Boer & M.S.M. Sosef

Porterandia Ridley

Bull. Misc. Inform. (Kew Bull.) 1939: 593 (1940).
RUBIACEAE
x = unknown; $2n$ = unknown

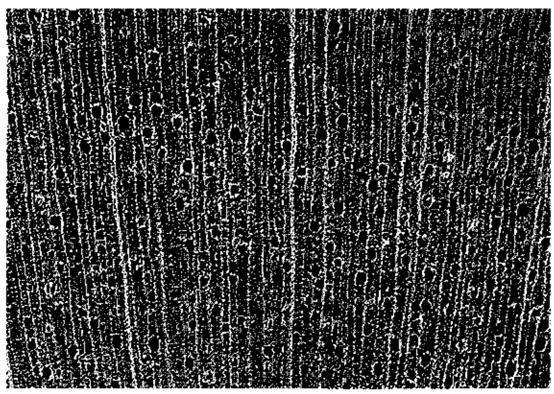
Vernacular names Malaysia: simpoh gajah, tinjau belukar (Peninsular).

Origin and geographic distribution *Porterandia* comprises about 10 species and is distributed in Peninsular Malaysia, Sumatra and Borneo. Only a single species has been reported to be used for its timber: *P. anisophylla* (Jack ex Roxb.) Ridley (synonyms: *P. scortechinii* (King & Gamble) Ridley, *Randia anisophylla* (Jack ex Roxb.) Hook. f.), which occurs in Peninsular Malaysia, Singapore, Sumatra and possibly in Borneo.

Uses The wood of *P. anisophylla* is sometimes used in house building for posts, beams and rafters.
The fruits are reported as edible and sweet, but also as poisonous.

Production and international trade Utilization of the wood of *P. anisophylla* is rare and only local.

Properties *P. anisophylla* yields a medium-weight hardwood with a density of 645–720 kg/m^3 at 15% moisture content. Heartwood pale brown with a pink tinge, not clearly differentiated from the sapwood; grain straight; texture fine and even. Growth rings absent to distinct, boundaries marked by a zone with few vessels followed by a ring of vessels in the earlywood; vessels moderately small, mostly solitary with occasional radial pairs, open or with some solid, gum-like deposits; parenchyma moderately abundant to very abundant, mostly apotracheal diffuse and diffuse-in-aggregates, occasionally paratracheal vasicentric; rays extremely fine to moderately fine; ripple marks absent.
The wood is durable for interior use, probably only moderately durable under exposed conditions.
Saponins have been found in *P. anisophylla*.
See also the table on microscopic wood anatomy.



Porterandia anisophylla
transverse surface (×20)

Botany A small tree up to 12 m tall; bark surface smooth and lenticellate to cracking, grey to dark brown, inner bark pale brown. Leaves opposite, leaves of a pair often unequally sized, simple, entire, obovate, with more than 10 pairs of secondary veins; petioles short; stipules broadly triangular and often with persistent base. Flowers in a terminal, cymose inflorescence, bisexual, 5-merous; calyx cup short-haired; corolla salver-shaped, slightly longer than the calyx, white, hairy outside, lobes contorted in bud; stamens inserted on upper part of corolla tube, filaments very short; ovary inferior, 2-locular to incompletely 4-locular with many ovules, style with long 2-lobed stigma. Fruit a globose to obovoid drupe, short-haired, many-seeded. Seed compressed, ellipsoid to kidney-shaped. Seedling with epigeal germination.
P. anisophylla can be found flowering throughout the year, but in Peninsular Malaysia it has been observed that flowering and fruiting is usually during a mast year. A 41-year-old tree in the arboretum of the Forestry Research Institute Malaysia, Kepong attained a height of 16.2 m and a diameter of 26 cm.

Ecology *P. anisophylla* is locally very common in lowland to lower montane forest up to 1300 m altitude. It is found frequently in secondary forest.

Silviculture *P. anisophylla* may be raised from seed. In a trial about 75% germination was attained in 41–77 days. In Peninsular Malaysia it is considered a shade-tolerant tree.

Genetic resources and breeding *P. anisophylla* is not endangered as it is common, particularly in forest edges, thickets and secondary forest.

Prospects *Porterandia* is seldom used for timber and due to its small dimensions its future utilization will be only very local.

Literature 163, 209, 267, 436, 553, 825, 829, 831, 832, 942, 1221.

E. Boer & R.H.M.J. Lemmens

Potoxylon Kosterm.

Mal. Nat. Journ. 32: 143 (1978).

LAURACEAE

x = probably 12 as in most other *Lauraceae* genera; $2n$ = unknown

Vernacular names Malagangai (trade name). Brunei: legangai (Dusun), tebellian kebuau (Iban). Malaysia: belian kapok, belian kebuau (Iban, Sarawak), belian malagangai (Dayak, Sarawak).

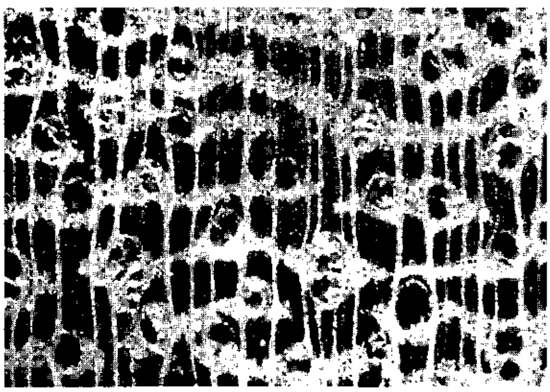
Origin and geographic distribution *Potoxylon* is a monotypic genus endemic to Borneo (all parts). The only species is *P. melagangai* (Sym.) Kosterm. (synonym: *Eusideroxylon melagangai* Sym.).

Uses The wood of *P. melagangai* is used for heavy construction, boat building, posts, paddles, fences, pepper posts and shingles. It is a popular substitute for the more durable 'ulin' (*Eusideroxylon zwageri* Teijsm. & Binnend.) especially in areas where the latter is not readily available.

Production and international trade As the supplies are only limited, *P. melagangai* timber is seldom traded commercially. In areas where it is comparatively common, it may be traded on a local scale, or occasionally exported in mixed consignments with 'ulin'. In Sarawak there is a total ban on the export of both ulin and malagangai.

Properties *P. melagangai* yields a medium-weight to heavy hardwood with a density of 525–920 kg/m³ at 15% moisture content. Heartwood brown with a distinct reddish tinge, sharply differentiated from the yellowish sapwood when freshly cut; grain usually fairly straight; texture moderately fine and even. Growth rings usually indistinct, sometimes indicated by fine lines of parenchyma; vessels medium-sized, solitary and in radial multiples of 2–3, tyloses abundant; parenchyma abundant, paratracheal vasicentric to aliform, occasionally confluent, conspicuous, and apotrachel in marginal or seemingly marginal bands; rays moderately fine; ripple marks absent. Shrinkage is high, but the wood seasons fairly easily. The wood is moderately hard and very strong. It is easy to saw and plane, very durable, slightly less than that of ulin, but reportedly when used as pepper posts lasts for 20–30 years, similar to the service life of ulin posts.

See also the tables on microscopic wood anatomy and wood properties.



Potoxylon melagangai
transverse surface (×20)

Botany An evergreen, small to medium-sized tree up to 25 m tall; bole straight and cylindrical, up to 100 cm in diameter, with small, rounded buttresses up to 2 m high or with a mattress of slender roots at base; bark surface smooth to slightly flaky or fissured, dark reddish-brown to dark grey, inner bark whitish. Young twigs angular. Leaves arranged spirally, simple, entire, exstipulate. Inflorescence axillary, thyrsoid, pseudo-racemose with the lateral cymes short-stalked and 1-flowered. Flowers bisexual, 3-merous; tepals 6, in 2 rows, subequal, with a shallow tube; fertile stamens 9, those of the outer 2 whorls petaloid, those of the inner whorl each with 2 glands at base, anthers 4-locular, opening by valves; ovary superior, unilocular with a single ovule, stigma capitate. Fruit a large, 1-seeded berry, completely enclosed in and adnate to the accrescent perianth tube. Seed with a prominently, irregularly, longitudinally furrowed testa. Seedling with hypogeal germination; cotyledons not emergent, peltate; hypocotyl not developed; epicotyl with a few scales; all leaves arranged spirally.

Flowering is irregular and occurs once every 3–5 year, generally in March, April or May. Fruiting is usually recorded in September. Fruits are apparently dispersed by water, but porcupines and squirrels eat the fruits and may also disperse the seeds.

Potoxylon is very closely related to *Eusideroxylon* and some authors consider them to be congeneric.

Ecology *P. melagangai* is characteristic of primary lowland evergreen forest, mainly mixed dipterocarp forest. It is especially found on sandy-clayey alluvial soils in riverine forest and adjacent hills including limestone hills, up to 300 m altitude. It prefers well-drained but moist soils and usually occurs scattered or is rarely locally abundant.

Silviculture Silvicultural characteristics of *P. melagangai* are probably very similar to those of *Eusideroxylon zwageri*, but it probably grows faster, showing at least 0.5 cm mean annual diameter increment. In its early stage of development it requires shade. *P. melagangai* coppices freely.

Genetic resources and breeding *P. melagangai* is rare and may be locally endangered. The protection by legislation in Sarawak seems adequate.

Prospects Increased use of *P. melagangai* timber is unlikely as it is rare, grows slowly and seldom reaches large dimensions.

Literature 46, 151, 162, 251, 353, 422, 457, 464, 602, 605, 629, 741, 1040, 1050, 1085, 1099, 1222.

S.P. Teo

Prainea King ex Hook. f.

Fl. Brit. India 5: 546 (1888).

MORACEAE

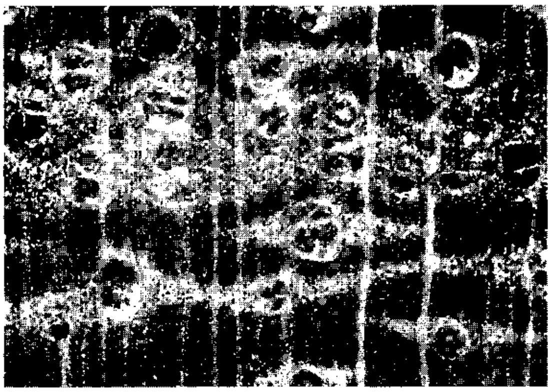
x = unknown; $2n$ = unknown

Origin and geographic distribution *Prainea* comprises 4 species which are found in Peninsular Malaysia, Sumatra, Borneo, the Moluccas and New Guinea.

Uses The hard and heavy wood of *Prainea* is used for posts and beams in house and bridge building.
The fleshy perianth surrounding the fruit is edible.

Production and international trade The wood of *Prainea* is used on a local scale only.

Properties *Prainea* yields a medium-weight to heavy hardwood with a density of 460–745 kg/m^3 for *P. papuana* and 770–930 kg/m^3 for *P. limpato* at 15% moisture content. Heartwood olive-yellow-brown when fresh, darkening upon exposure to dark olive-brown, sharply demarcated from the pale yellow, up to 8 cm wide sapwood; grain shallowly interlocked; texture moderately fine and even; wood with ribbon figure visible as narrow stripes on radial surface due to alternating grain. Growth rings distinct to indistinct, boundary indicated by marginal parenchyma, visible to the naked eye; vessels medium-sized, solitary and in radial multiples of 2(–3), tending to oblique arrangement, tyloses abundant; parenchyma moderately abundant to abundant, apotracheal in marginal or seemingly marginal bands, and paratracheal aliform, tending to confluent connecting 2 to several vessels laterally; rays moderately fine to medium-sized, distinct to the naked eye on transverse surface; ripple marks absent.



Prainea papuana
transverse surface (×20)

Shrinkage upon seasoning is low, with only slight checking and warping. The wood is hard to very hard, strong (*P. limpato*) or moderately strong (*P. papuana*). It is usually difficult to work and to plane. The wood of *P. limpato* is very durable, that of *P. papuana* slightly durable when exposed to the weather or in contact with the ground. The sapwood is considered to be susceptible to *Lyctus*.
See also the table on microscopic wood anatomy.

Botany Dioecious, small to fairly large trees up to 40 m tall; bole up to 90 cm in diameter, buttresses present; bark surface cracking to scaly and peeling off in flakes, grey-brown to red-brown, inner bark orange-yellow, exuding white latex. Leaves alternate and distichous, simple, entire; stipules lateral or interpetiolar. Inflorescence pedunculate, solitary or paired in leaf axils, unisexual, capitate, with globose heads, without an involucre; interfloral bracts many, peltate, clavate or spatulate; perianths free. Male flowers numerous; perianth tubular, bilobed or perforate above; stamen 1; pistillode absent. Female flowers 20–100 per head; perianth tubular, clavate, 2–4-lobed or merely perforate above; ovary superior, 1-locular with a single ovule, style bifid. Fruit 1–20 per head; perianth greatly enlarged and fleshy, subglobose to ellipsoid. Seed large, without endosperm. Seedling with hypogeal germination;

cotyledons not emergent; hypocotyl not elongated; epicotyl with a few scale leaves followed by alternately arranged normal leaves.

Ecology Timber-yielding *Prainea* species are found in lowland, evergreen rain forest, sometimes on the edges of peat-swamps or floodplains, up to 800 m altitude, *P. papuana* occurs up to 1200 m altitude.

Silviculture *Prainea* can be propagated by seed. The germination rate of seeds of *P. limpato* is 75–95% in 13–27 days.

Genetic resources and breeding There are no records of ex situ conservation of *Prainea* species.

Prospects As long as supplies are sufficient the hard and durable timber of *P. limpato* will remain to be used locally in heavy constructional works.

Literature 261, 267, 436, 490, 829, 831, 861, 1221, 1232.

Selection of species

Prainea frutescens Becc.

Synonyms *Artocarpus frutescens* (Becc.) Renner.

Distribution Borneo (Sarawak, Kalimantan).

Prainea limpato (Miq.) Beumée ex K. Heyne

Synonyms *Artocarpus limpato* Miq., *Prainea cuspidata* Becc., *Prainea multinervia* Merr.

Vernacular names Indonesia: limpato (west coast of Sumatra), tampang lemasa (Lampung, Sumatra), tampang reges (Palembang, Sumatra).

Distribution Peninsular Malaysia (rare), Sumatra and Borneo.

Prainea papuana Becc.

Synonyms *Artocarpus papuanus* (Becc.) Renner, *Parartocarpus papuanus* (Becc.) S. Moore, *Prainea microcephala* J.J. Smith.

Vernacular names Indonesia: naka banga (Ternate), raba tigo (northern Halmahera), raskawan (Nufur, southern Halmahera).

Distribution The Moluccas and New Guinea.

E. Boer (general part),
M.S.M. Sosef (general part, selection of species)

Premna L.

Mant. pl. 2: 154, 252 (1771).
VERBENACEAE
$x = 19$; *P. latifolia* Roxb.: $n = 19$

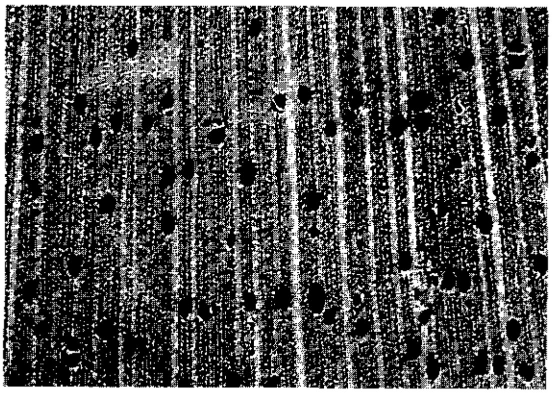
Vernacular names Premna (En).

Origin and geographic distribution *Premna* comprises about 200 species occurring in the tropical and subtropical regions of the Old World. Most species are found in Asia, from Sri Lanka and India to Indo-China, China, Japan, Thailand, throughout the Malesian region, northern Australia and Polynesia. Some species are cultivated in Europe, North and South America, New Zealand and southern Australia.

Uses The wood of *Premna* is used for general construction, house building (mainly as posts), household implements, agricultural implements and paddles; it might be suitable for furniture. In India it is generally used for turning, carving, weaving shuttles and bobbins. The nicely figured root wood has also been used for knife handles.
Several species are well-known for their medicinal properties. The roots of *P. cordifolia* are applied medicinally against shortness of breath, its roots and leaves against fever, and the young sprouts are edible. *P. serratifolia* is occasionally grown as hedge. Its bark is used for binding whereas the boiled leaves are eaten with fish and by women to stimulate milk production. A decoction of the leaves of *P. cumingiana* has been used as a remedy for dropsy and also as a diuretic. The sap obtained from the bark of *P. tomentosa* is used against diarrhoea; a decoction of its roots is applied against stomach-ache; the pounded leaves may be used to treat wounds in animals. In the Philippines a decoction of the roots, leaves, flowers and fruits of *P. odorata* is used as a sudorific and is said to be carminative.

Production and international trade Mainly due to the small size of *Premna* trees, use is on a local scale only.

Properties *Premna* yields a medium-weight to heavy hardwood with a density of 535–860(–960) kg/m^3 at 15% moisture content. Heartwood pale yellow to pale brown, not clearly differentiated from the sapwood; grain straight or interlocked; texture fine and even; wood with slight silver grain. Growth rings distinct, boundaries indicated by marginal parenchyma, sometimes latewood clearly denser than earlywood; vessels moderately small to medium-sized, solitary and in radial multiples of 2–4, open or with tyloses; parenchyma abundant, apotracheal in marginal bands conspic-



Premna serratifolia
transverse surface (×20)

uous to the naked eye, paratracheal vasicentric, with the slightest tendency to aliform; rays very fine to moderately broad, the latter producing the silver grain; ripple marks absent.

The wood is hard and fairly strong to strong. It is moderately durable but susceptible to sap-stain. The heartwood of *P. odorata* is resistant to dry-wood termites. The sapwood is non-susceptible to *Lyctus*.

The gross energy value of the wood of *P. nauseosa* Blanco is 19 740–20 735 kJ/kg.

See also the table on microscopic wood anatomy.

Botany Shrubs (sometimes lianescent) or small to occasionally medium-sized trees up to 20(–30) m tall; bole up to 30(–60) cm in diameter, often fluted, without buttresses; bark surface slightly fissured and flaky, greyish or pinkish, inner bark without exudate. Leaves decussate, simple, with reticulate venation, rather foetid odour when crushed, margin entire to dentate; stipules absent. Flowers in a terminal, cymose, often much-branched inflorescence, small, zygomorphic, bisexual; calyx tubular or somewhat campanulate, often slightly 2-lipped with 2–5 teeth; corolla 2-lipped, with a short tube and 4–5 lobes; stamens 4, of 2 lengths, exerted, inserted on the corolla tube; ovary superior, 4-locular with 1 ovule in each cell, style filiform with 2 small stigmatic lobes. Fruit a small globose to obovoid drupe with a hard 4-celled kernel, seated on the persistent calyx. Seed without endosperm. Seedling with epigeal germination; cotyledons emergent, leafy; hypocotyl elongated; leaves opposite, conduplicate.

In the Philippines a mean annual diameter increment of 0.9 cm has been recorded for *P. cumingiana* and 2.1 cm for *P. odorata*. A mean annual increment of 0.6–1.3 cm was determined from wood samples of *P. tomentosa* originating from India. *P. serratifolia* is deciduous; on Henderson Island (South Pacific) it remained leafless for about 2 months. In Java *P. tomentosa* has been observed with flowers almost all year round. Pollination is by insects.

The taxonomy of many of the Malesian *Premna* species is still poorly understood, and the genus is in need of a thorough revision. *P. nauseosa* is probably identical to *P. dallachyana*, but as the type specimen of the former has been destroyed, this remains uncertain. *Premna* is closely related to *Gmelina* but can be readily distinguished by its short and cylindrical corolla tube.

Ecology Timber-yielding *Premna* species are usually found in open secondary forest or thickets, up to 800 m altitude. They occur in a wide variety of habitats including sandy seashores and peat-swamp forest.

Silviculture *Premna* can be propagated by seed. Sown fruits of *P. serratifolia* showed about 60% germination in 12 days to 5 months. The short and often deeply fluted bole strongly diminishes the value of *Premna* as a timber.

Genetic resources and breeding There are no records of *Premna* in seed or germplasm banks. As the timber-yielding species usually have a wide ecological range it is unlikely that genetic erosion is a major risk.

Prospects The use of *Premna* for timber is unlikely to increase in the near future.

Literature 70, 147, 151, 163, 209, 235, 267, 364, 406, 436, 464, 648, 653, 813, 829, 831, 861, 934, 937, 974, 1038, 1221.

Selection of species

Premna adenosticta Schauer

Vernacular names Philippines: malauin-usa (Filipino), kalanggiauan (Iloko), lanabau (Panay Bisaya).

Distribution The Philippines.

Premna cordifolia Roxb.

Vernacular names Indonesia: baruwas (Batak, Sumatra), baruweh (Aceh & Minangkabau, Sumatra).

Distribution Peninsular Malaysia and Sumatra.

Premna cumingiana Schauer

Synonyms *Premna cardiophylla* Schauer.

Vernacular names Philippines: alagau (Panay

Bisaya), magilik (Tagalog), manaba (Bikol, Bukidnon).

Distribution The Philippines and Sulawesi.

Premna dallachyana Benth.

Synonyms *Premna minor* Domin, *Premna tateana* F.M. Bailey.

Vernacular names Philippines: agrau (Iloko), angsuan (Bikol), mulauin-aso (Tagalog).

Distribution The Philippines, Papua New Guinea and northern Australia (Queensland).

Premna odorata Blanco

Synonyms *Premna curranii* H.J. Lam, *Premna inaequilateralis* E. Beer & H.J. Lam, *Premna vestita* Schauer.

Vernacular names Fragrant premna (En). Philippines: adgau (Panay Bisaya, Bikol), alagau (Tagalog, Iloko), pumuhat (Bisaya).

Distribution From India and Nepal to Burma (Myanmar), Indo-China, China, Japan, Taiwan, Thailand, throughout the Malesian region towards Australia; occasionally planted in e.g. the Philippines, Java, India and Florida.

Premna serratifolia L.

Synonyms *Premna corymbosa* Rottl. & Willd., *Premna integrifolia* L., *Premna obtusifolia* R. Br.

Vernacular names Indonesia: babon (Bali), seungit (Sundanese), singkil alas (Javanese). Malaysia: buas-buas, pokok buru hantu (Peninsular). Philippines: alagau-dagat (Filipino). Burma (Myanmar): taung-tangyi. Thailand: akkhe thawan thale (peninsular), man kai (northern), sam pra nga bai (south-western). Vietnam: c[aa]y c[as]ch, v[oj]ng c[as]ch.

Distribution From East Africa and Madagascar towards India, Indo-China, China, Japan, Taiwan, Burma (Myanmar), Thailand, Peninsular Malaysia, Java, the Philippines, the Moluccas, New Guinea, northern Australia, Melanesia and Polynesia.

Premna tomentosa Willd.

Synonyms *Premna flavida* Miq., *Premna pyramidata* Wallich.

Vernacular names Bastard teak (En). Indonesia: bulang (Sundanese, Javanese), gembulang (Javanese), leban capo (Indonesian, Palembang). Malaysia: bebuas, sarang burong, tembaroh (Peninsular). Burma (Myanmar): kyunbo, kyunnalin, nathabyu. Thailand: po fan, sak ke kai, sak khe khwai (northern).

Distribution From India and Nepal to Burma (Myanmar), Indo-China, Thailand, Peninsular Malaysia, Sumatra, Java and the Lesser Sunda Islands (Timor).

Rusea Go

Protium Burm. f.

Fl. indica: 88 (1768).

BURSERACEAE

x = unknown; *P. serratum* (Colebr.) Engl.: $n = 11$

Vernacular names Kedondong (trade name). Indonesia: ketos. Papua New Guinea: protium (En).

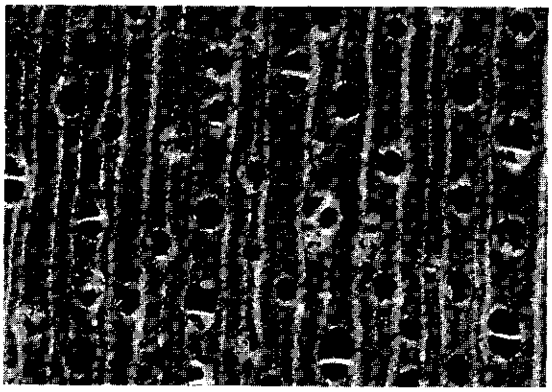
Origin and geographic distribution *Protium* comprises about 85 species, most of which are found in tropical America, furthermore in Madagascar, the Mascarenes, and from India to Indo-China, Thailand, Java, the Philippines (Palawan), the Lesser Sunda Islands and Papua New Guinea. There are 3 species within the Malesian region and only 1 in continental Asia.

Uses The wood of *Protium* is used for posts, pulley-blocks, tool handles and wooden hammers. It yields a good-quality charcoal. The wood of the continental Asian species *P. serratum* is much esteemed and used for furniture.

The young leaves and fruits are edible. The leaves, young twigs and the rind of fruits are used as a flavouring in cooking. A decoction of the leaves has been used medicinally in Java against stomach-ache and coughs. The rind of the fruit contains an aromatic essential oil used as a substitute for e.g. turpentine. *P. javanicum* has been used as a cover crop in teak (*Tectona grandis* L. f.) plantations. *P. macgregorii* is also planted as a shade tree in Papua New Guinea.

Production and international trade *Protium* timber is traded together with that of many other *Burseraceae* genera as 'kedondong', but comprises only a very small proportion of the total amount traded. In 1996 Papua New Guinea exported only 67 m^3 of *Protium* logs at an average free-on-board (FOB) price of US$ 104/m^3.

Properties *Protium* yields a medium-weight to heavy hardwood with a density of 750–1060 kg/m^3 at 15% moisture content. Heartwood reddish-brown to dark brown, not clearly differentiated from the sapwood; grain interlocked; texture very fine to moderately fine and even; wood with ray flecks on longitudinal surface. Growth rings indistinct, tending to semi-ring porous; vessels moderately small; solitary or in radial multiples of 2–3,



Protium macgregorii
transverse surface (×20)

tyloses abundant (*P. javanicum*) or sparse (*P. connarifolium*); parenchyma sparse to absent, scanty paratracheal to vasicentric barely evident with a hand lens; rays very fine to moderately fine, inconspicuous; ripple marks absent.
The wood is hard to very hard but only of moderate strength. Some species are difficult to saw due to the high silica content. Splitting is difficult due to grain irregularities. It should be treated with anti-stain chemicals immediately after sawing. The wood is moderately durable. The sapwood is susceptible to *Lyctus*.
The gross energy value is about 20 360 kJ/kg for sapwood and 21 840 kJ/kg for heartwood of *P. javanicum*.
See also the table on microscopic wood anatomy.

Botany Monoecious, small to medium-sized trees up to 30 m tall; bole often short and crooked, up to 115 cm in diameter, spurred; bark surface peeling off in large thin scales and slightly pustular, light-grey to brown, inner bark reddish or pink turning red-brown upon exposure, with sticky exudate. Twigs sometimes spiny. Leaves arranged spirally, imparipinnate, exstipulate; leaflets 1–11, opposite, entire, often mucronulate. Flowers in an axillary or sometimes pseudoterminal inflorescence, generally unisexual, 4–5-merous; sepals connate, forming a saucer-shaped receptacle; petals with inflexed tips; disk intrastaminal, annular. Male flower with stamens free, twice as many as the petals; pistil only slightly reduced. Female flower with a superior, 4–5-locular ovary with 2 ovules in each cell, stigma sessile, lobed; stamens only slightly reduced, occasionally even fertile. Fruit a globose to ovoid drupe with 1–5 1-seeded pyrenes; pericarp fleshy; calyx persistent. Seedling with epigeal germination; cotyledons emergent, lobed; hypocotyl elongated; first pair of leaves opposite, simple, subsequent ones arranged spirally and compound, leaflets serrate.
The mean annual increment of 7.5-year-old *P. javanicum* trees planted at 2 m × 1 m on moderately fertile soil in East Java was 1.0 cm in diameter and 1.1 m in height. *Protium* species are reputed to flower and fruit almost throughout the year, though flowers seem to be most abundant in the dry season and fruits in the wet season. Fruits are eaten by monkeys.
Protium resembles *Scutinanthe* but the latter differs in its cup-shaped receptacle, 3-locular ovary and 1-seeded fruit. The Asiatic species of *Protium* are grouped into the section *Protium*.

Ecology *Protium* is found in evergreen or semi-deciduous, lowland, primary or secondary forests, up to 800(–1100) m altitude. *P. javanicum* prefers a periodically dry climate and is often associated with teak. It is also found in more open land, along the inner border of tidal forest and sometimes on the beach. *P. macgregorii* may also be found in swamps.

Silviculture *Protium* can be propagated by seed. Care should be taken to collect mature seeds only. The only available seed count is for *P. javanicum* which has about 19 500 dry seeds/kg. Seeds of *P. javanicum* gave about 70% germination and germination started 3–4 weeks after sowing; they should not be sown deeper than 2.5 cm. Seeds stored for 4.5 months are no longer viable. Seedlings of *P. javanicum* can be made successfully into stumps before being planted. *P. javanicum* has been extensively tested in Java to be planted as cover crop in teak plantations at 1 m × 1 m. On poor soils it performed unsatisfactorily, on fertile soils, however, it did fairly well when enough light was available, but wood production was minimal due to the bad stem form. When planted in pure stands at 1 m × 2 m on moderately fertile soils the first thinning was necessary 7 years after planting but the formation of low and heavy branches again proved to be a disadvantage. Pruning, however, is very well tolerated but the abundance of spines on the branches makes this operation difficult. *P. javanicum* also coppices easily; it is not resistant to fire.

Genetic resources and breeding As *Protium* species have a narrow geographical distribution, destruction of the habitat may increase the risk of genetic erosion.

Prospects Plantation experiments as conducted in Java indicate that *P. javanicum* can not be recommended for forestry plantations due to its poor stem form and very modest growth rate even on fertile soils.

Literature 70, 80, 161, 260, 308, 330, 341, 405, 408, 409, 423, 436, 442, 488, 680, 740, 780, 861, 934, 947, 1080.

Selection of species

Protium connarifolium (Perkins) Merr.

Synonyms *Canarium connarifolium* Perkins, *Protium philippinensis* Elmer.

Vernacular names Philippines: marangub (Tagbanua).

Distribution The Philippines (Palawan).

Protium javanicum Burm. f.

Synonyms *Amyris protium* L., *Protium zollingeri* Engl.

Vernacular names Indonesia: bernang (Javanese), tanggulun (Sundanese), trenggulon (Javanese and Bali).

Distribution Java and the Lesser Sunda Islands.

Protium macgregorii (F.M. Bailey) Leenh.

Synonyms *Dracontomelum papuanum* Lauterb., *Protium schlechteri* (Lauterb.) Leenh., *Santiria schlechteri* Lauterb.

Distribution Papua New Guinea including the d'Entrecasteaux Islands.

S. Aggarwal

Prunus L.

Sp. pl. 1: 473 (1753); Gen. pl., ed. 5: 212 (1754).

ROSACEAE

$x = 8$; $2n$ = unknown for Malesian species

Vernacular names Tenangau (trade name). Indonesia: kawoyang (Sundanese). Malaysia: pepijat (general), kelanus (Sabah), medang kelanus (Peninsular). Philippines: lago (Filipino), amugan (Tagalog). Thailand: nang-phaya-sua-khrong. Vietnam: d[af]o, m[ow].

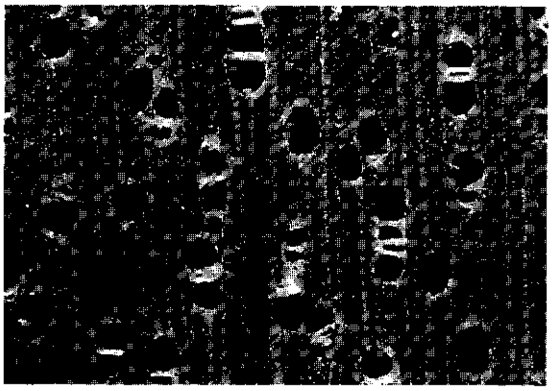
Origin and geographic distribution *Prunus* comprises over 200 species occurring all over the world. Within Malesia about 35 species are present apart from a few exotic species, which are cultivated. The native species are distributed as follows: Peninsular Malaysia 8 species, Sumatra 8, Java 4, Borneo 12, the Philippines 10, Sulawesi 5, the Lesser Sunda Islands 3, the Moluccas 6, and New Guinea 14.

Uses The wood of *Prunus* is used for general construction, house building (poles, rafters), furniture, cabinet work, mouldings, interior finish, and also for firewood. In Vietnam wood of *P. arborea* is used for plywood manufacture.

A number of extra-Malesian *Prunus* species have been introduced into South-East Asia and are cultivated for their edible fruits. The most important ones are *P. mume* Siebold & Zucc. (Japanese apricot) and *P. persica* (L.) Batsch (peach, nectarine). *P. arborea* is reputed to be used in Bali for reforestation. *P. grisea* is planted as an ornamental in the Philippines; its bark yields a dark greenish-brown dye. In New Guinea the bark of several species is used to make belts. In East Kalimantan the bark of *P. arborea* and *P. beccarii* (Ridley) Kalkman is used for partitions in temporary shelters. The bark of *P. marsupialis* yields a dark greenish-brown dye, whereas that of several other species has been used for rice-bins, as a vermicide for buffaloes and as a fish poison, and is probably the source of local medicines to treat headache and skin eruptions. A decoction of the leaves of *P. arborea* has been used by women as a stimulant when working. Leaves of *P. dolichobotrys* are reputed to be used to flavour soup or cooked vegetables.

Production and international trade *Prunus* wood is mainly used on a local scale. In 1996 Papua New Guinea exported about 1035 m^3 of *Prunus* logs at an average free-on-board (FOB) price of US$ 103/m^3.

Properties *Prunus* yields a lightweight to medium-weight hardwood with a density of (345–)410–770(–830) kg/m^3 at 15% moisture content.



Prunus gazelle-peninsulae transverse surface (×20)

Heartwood pink-brown to red-brown, not sharply demarcated from the paler sapwood; grain wavy to deeply interlocked, sometimes straight; texture moderately fine to moderately coarse and even; wood lustrous. Growth rings indistinct or occasionally distinct; vessels moderately small to moderately large, solitary and in radial multiples of 2–3(–4), sometimes dark gum-like deposits present; parenchyma rather sparse, paratracheal scanty to vasicentric, and apotracheal diffuse; rays very fine or medium-sized, the latter visible to the naked eye; ripple marks absent; traumatic axial canals occasionally present.

Shrinkage upon air drying is moderate to high, but the wood seasons well with little degrade. It is moderately soft to hard, moderately strong and fairly tough. It is reasonably easy to work. The wood is moderately durable to non-durable. The sapwood is susceptible to *Lyctus* and the heartwood is susceptible to dry-wood termites.

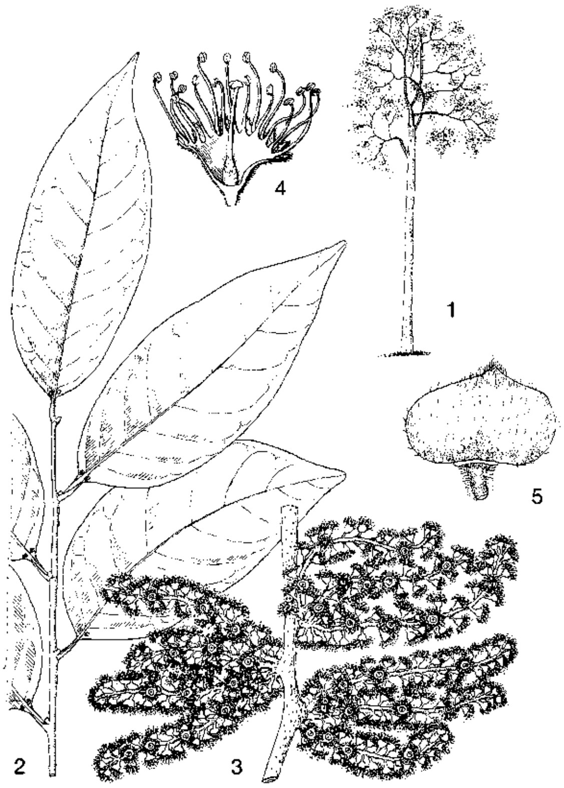
The bark contains cyanogenetic glucosides.

See also the tables on microscopic wood anatomy and wood properties.

Botany Evergreen or rarely deciduous (e.g. *P. polystachya*), small to fairly large trees up to 35(–40) m tall, rarely shrubs; bole crooked or straight and cylindrical, branchless for up to 15 m, up to 100 cm in diameter, occasionally with small buttresses or spurs; bark surface smooth or sometimes shallowly fissured, often lenticellate, sometimes flaking, dark brown to greyish-brown, inner bark usually fibrous, pink or red-brown to straw, smelling of almonds or cyanide. Leaves arranged spirally, simple, entire or incised, with glands along the margin and/or on the lower side or on the petiole; stipules free or connate, caducous. Inflorescence axillary or ramiflorous, a simple or sometimes branched raceme, solitary or in bundles. Flowers usually bisexual; hypanthium cup-, bell-, or funnel-shaped, circumscissile and persistent in fruit; sepals and petals comprising 5–14 segments, often subequal in size and similar in colour (within Malesia) or petals white or pink; stamens many; ovary superior, 1-locular with 2 ovules, style 1, apical. Fruit a drupe with hard endocarp. Seed with thin testa. In Malesia seedling with hypogeal germination; cotyledons not emergent; hypocotyl not elongated; epicotyl pubescent; first 2 leaves opposite, subsequent ones arranged spirally.

Pollination is by insects and seeds are dispersed by animals.

Within Malesia only species of the subgenus *Laurocerasus* (Tourn. ex Duhamel) Rehder are native.



Prunus arborea (Blume) Kalkman – 1, tree habit; 2, sterile twig; 3, inflorescence; 4, sectioned flower; 5, fruit.

The formerly distinguished genus *Pygeum* has been included in this subgenus.

Ecology *Prunus* species are found in primary and secondary, lowland to montane forest, sometimes even in alpine scrub, up to 3700 m altitude. Individual species occur in evergreen to deciduous forest types, and on soils on a wide variety of parent materials, including volcanic sand, ultrabasic rocks and limestone. They are regularly reported from river banks.

Silviculture *Prunus* can be propagated by seed. Sown fruits of *P. arborea* have a germination rate of about 70% in 5–24 weeks and for *P. polystachya* the rate is about 60% in 24–47 days. Sown seeds of *P. grisea* have a germination rate of about 90%; in a plantation trial in the Philippines they had only 2% survival. Trees are not resistant to fire.

Genetic resources and breeding Collection, conservation and research is still needed for many *Prunus* species to determine their suitability for plantations. As they are seldom cut for timber they do not seem directly endangered.

Prospects The use of *Prunus* timber is unlikely to increase in the near future.

Literature 101, 124, 150, 163, 198, 209, 238, 260, 261, 267, 341, 343, 348, 436, 464, 514, 568, 595, 632, 825, 829, 831, 861, 933, 934, 955, 974, 1038, 1039, 1147, 1164, 1221, 1232, 1242, 1255, 1268.

Selection of species

Prunus arborea (Blume) Kalkman

Synonyms *Pygeum arboreum* (Blume) Blume, *Pygeum parviflorum* Teijsm. & Binnend., *Pygeum stipulaceum* King.

Vernacular names Currant laurel (En). Indonesia: kawoyang (Sundanese), moyang (Javanese). Malaysia: merubik (Sarawak). Philippines: kabung (Manobo). Thailand: taeng chang (northern). Vietnam: d[oo] ca, xoan d[af]o.

Distribution From north-eastern India to Burma (Myanmar), Indo-China, southern China, Thailand, and throughout the Malesian region.

Prunus clementis (Merr.) Kalkman

Synonyms *Pygeum apoense* Elmer, *Pygeum clementis* Merr.

Vernacular names Philippines: bakad (Bagobo), dalisai (Tagalog).

Distribution The Philippines (Mindanao) and Sulawesi.

Prunus dolichobotrys (K. Schumann & Lauterb.) Kalkman

Synonyms *Pygeum dolichobotrys* K. Schumann & Lauterb.

Distribution New Guinea and the Bismarck Archipelago.

Prunus gazelle-peninsulae (Kaneh. & Hatus.) Kalkman

Synonyms *Pygeum gazelle-peninsulae* Kaneh. & Hatus., *Pygeum platyphyllum* K. Schumann.

Distribution The Moluccas (Seram), New Guinea and the Bismarck Archipelago.

Prunus grisea (Blume) Kalkman

Synonyms *Pygeum latifolium* Miq., *Pygeum melanocarpum* Merr. & L.M. Perry, *Pygeum vulgare* (Koehne) Merr.

Vernacular names Philippines: amatogan (Filipino), amongyang (Tagalog). Thailand: nut ton (peninsular).

Distribution Southern Burma (Myanmar), Vietnam, Thailand, and throughout the Malesian region; possibly also in Taiwan.

Prunus javanica (Teijsm. & Binnend.) Miq.

Synonyms *Prunus forbesii* Koehne, *Prunus junghuhniana* Miq., *Prunus martabanica* Kurz.

Vernacular names Indonesia: jengkot, salamanjing (Sundanese). Philippines: Palawan cherry (En). Vietnam: vang n[uw][ow]ng (Baria).

Distribution Burma (Myanmar), the Andaman Islands, Vietnam, Thailand, Peninsular Malaysia, Sumatra, Java, Borneo, the Philippines (Palawan), Sulawesi, the Lesser Sunda Islands (Bali, dubious), the Moluccas and New Guinea (Irian Jaya).

Prunus malayana Kalkman

Distribution Peninsular Malaysia (Pahang).

Prunus marsupialis Kalkman

Synonyms *Pygeum glandulosum* Merr., *Pygeum pubescens* Merr.

Vernacular names Philippines: apoakan-amok (Samar-Leyte Bisaya).

Distribution The Philippines and possibly also in Taiwan.

Prunus polystachya (Hook. f.) Kalkman

Synonyms *Pygeum myriandrum* Merr., *Pygeum polystachyum* Hook. f.

Vernacular names Bat's laurel (En). Malaysia: medang kelawar (Peninsular).

Distribution Peninsular Malaysia, Singapore and Sumatra; possibly also in Borneo (Brunei).

Prunus schlechteri (Koehne) Kalkman

Synonyms *Pygeum forbesii* Koehne, *Pygeum schlechteri* Koehne, *Pygeum tetradenium* Koehne.

Vernacular names Indonesia: sissemohi (Manikion, Irian Jaya).

Distribution New Guinea, the Bismarck Archipelago and the Solomon Islands.

Prunus turneriana (F.M. Bailey) Kalkman

Synonyms *Prunus glomerata* (Koehne) Kalkman, *Pygeum glomeratum* Koehne, *Pygeum turnerianum* F.M. Bailey.

Distribution The Moluccas (Bacan), Papua New Guinea, the Bismarck Archipelago and Australia (Queensland).

Prunus wallaceana Kalkman

Vernacular names Indonesia: kemoyang (Sumbawa).

Distribution Sulawesi, the Lesser Sunda Islands and the Moluccas.

H.C. Ong

Pteleocarpa Oliv.

Trans. Linn. Soc., London 28: 515 (1873).

BORAGINACEAE

x = unknown; $2n$ = unknown

Vernacular names Indonesia: dangku (general), kihulat talong (Lampung, Sumatra), madang sugi-sugi (Minangkabau, Sumatra). Malaysia: kaki bayan, singah, tembusu tikus (Peninsular).

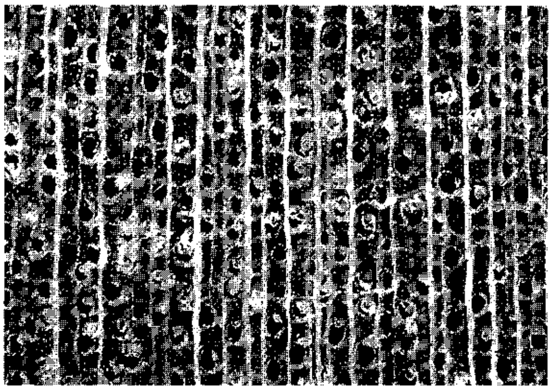
Origin and geographic distribution *Pteleocarpa* is a monotypic genus occurring in southern Thailand, Peninsular Malaysia, Singapore, Sumatra, Bangka and Borneo. The only species is *P. lamponga* (Miq.) Bakh. ex K. Heyne (synonyms: *P. longistyla* Becc., *P. malaccensis* Oliv.).

Uses The wood of *P. lamponga* has been used for house building and interior construction.

The trees are also planted as ornamentals and for shade. The ripe seeds are boiled and eaten as a flavouring.

Production and international trade Production of *P. lamponga* timber is probably very small and only local.

Properties *P. lamponga* yields a medium-weight hardwood with a density of 740–840 kg/m^3 at 15% moisture content. Heartwood pale brown with a pinkish tinge, not clearly differentiated from the sapwood; grain straight; texture rather fine and even. Growth rings absent; vessels moderately small, exclusively solitary, open; parenchyma moderately sparse, paratracheal vasicentric, aliform with short wings sometimes confluent, apotracheal diffuse sometimes not visible; rays moderately fine, visible to the naked eye; ripple marks absent.



Pteleocarpa lamponga
transverse surface (×20)

Shrinkage upon seasoning is moderate to high. The wood is fairly hard, fairly strong and rather durable under cover.

See also the table on microscopic wood anatomy.

Botany A medium-sized tree up to 37 m tall; bole straight, cylindrical, up to 60 cm in diameter; crown bushy, open; bark surface smooth to shallowly fissured, yellowish to greenish-grey, inner bark laminate, pale brown to pale orange. Leaves alternate, simple, obovate, entire, exstipulate. Flowers in a many-flowered, terminal, paniculoid inflorescence, 5-merous; calyx imbricate; corolla yellow or rarely red, with a short tube; stamens with sagittate anthers; ovary superior, 2-locular with 1 upright and 1 pendulous ovule in each cell, style 1, divided to the base. Fruit a 1-seeded samara, suborbicular, with a wide, radially veined wing. Seedling with epigeal germination; cotyledons narrow, ovate, leafy; hypocotyl.elongated; all leaves arranged spirally.

Leaves wither yellow before shedding. The winged fruits are wind-dispersed.

Pteleocarpa is sometimes placed in the small family *Ehretiaceae*, which has been split off from the *Boraginaceae*, but it is actually unclear to which family this genus belongs. If it does prove necessary to create a new family to accommodate it, that family's taxonomic position will probably remain uncertain.

Ecology *Pteleocarpa* occurs scattered but may be locally common in well-drained, primary or secondary, lowland and hill forest, up to 800 m altitude. Habitat types include mixed dipterocarp and kerangas forest.

Silviculture *Pteleocarpa* can be propagated by seed. Seeds of *P. lamponga* have about 55% germination in 3–7 weeks, whereas 80% of sown fruits germinated in 4–12 weeks. Fruits should be covered with about 2 cm of soil. When seedlings are transferred to polythene bags they prove to be susceptible to nematodes (*Meloidogyne* spp.) causing swollen stems, knotty roots and finally dying of roots, and to secondary virus infections. To control this pest a nematicide should be applied 2–3 weeks before planting.

Genetic resources and breeding As *Pteleo-*

carpa is only occasionally harvested there is hardly any risk of genetic erosion.

Prospects It is unlikely that the use of *Pteleocarpa* wood will increase. However, *P. lamponga* has potential as an ornamental and a shade tree. Therefore, more information is needed on its husbandry.

Literature 8, 163, 198, 267, 436, 553, 829, 831, 861, 946, 1048, 1159, 1221.

Cheksum Tawan

Pternandra Jack

Malayan Misc. 2(7): 60 (1822).

MELASTOMATACEAE

x = unknown; $2n$ = unknown

Vernacular names Merubi (trade name). Cursed shade (En). Malaysia: sial menahun (Peninsular), sireh-sireh (Sarawak).

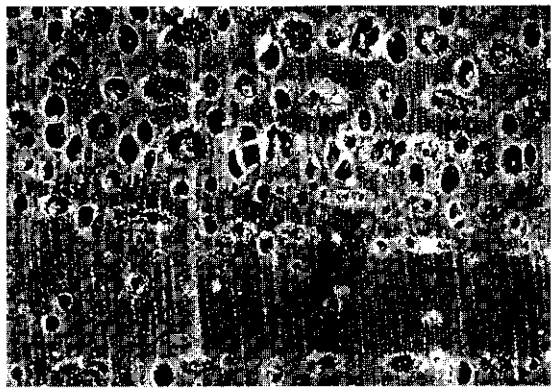
Origin and geographic distribution *Pternandra* comprises 15 species; New Guinea may harbour several still undescribed ones. The genus is distributed from Hainan, Cambodia and Thailand to the whole of the Malesian region and northern Australia.

Uses The use of the wood of *Pternandra* is restricted due to the belief that cutting the trees or using the wood brings about bad luck. When used, it is generally for house building (under cover) and poles. It has also been used as fuelwood.

The pounded fruits of *P. coerulescens* have been used for poulticing orchitis or hydrocele. In Sarawak an extract is drunk to induce vomiting. In Peninsular Malaysia a decoction of the roots of the same species has been administered after childbirth. A decoction of the pounded leaves of *P. echinata* mixed with those of *Pericampylus glaucus* (Lamk) Merr. has been used to treat coughs and asthma.

Production and international trade No trade of *Pternandra* wood has been reported. Local use is very limited due to the superstition surrounding it.

Properties *Pternandra* yields a lightweight to medium-weight hardwood with a density of 465–760 kg/m^3 at 15% moisture content. Heartwood yellow, yellow-brown or pale brown often with an olive tinge, not sharply differentiated from the sapwood; grain interlocked; texture coarse and uneven due to the islands of included phloem; frequently with beautiful watered-silk figure. Growth rings indistinct to distinct; vessels moderately small to medium-sized, mostly solitary, sometimes in radial or infrequently in oblique or tangential multiples of 2–3; parenchyma sparse, paratracheal scanty, apotracheal surrounding included phloem; rays very fine to medium-sized, visible with a hand lens; ripple marks absent; included phloem conspicuous, islands larger and much more distinct than vessels, diffusely arranged and sometimes in tangential zones.



Pternandra coerulescens
transverse surface (×20)

The wood is moderately hard and moderately strong. It is reportedly moderately durable to non-durable.

See also the table on microscopic wood anatomy.

Botany Evergreen, small to medium-sized, trees up to 25(–30) m tall, less frequently shrubs; bole usually straight, up to 90 cm in diameter, buttresses present in larger individuals; bark surface finely to shallowly fissured, sometimes peeling off, dark grey to brown or yellow-brown, inner bark thin, fibrous, whitish or pale brown to orange or brown-red. Twigs terete, 4-angled or 4-winged. Leaves opposite, simple, entire, 3–5-veined from the base, exstipulate. Flowers in few- to many-flowered, axillary or terminal cymes, sometimes umbellate or reduced to glomerules, 4-merous; calyx tube campanulate, set with spines, scales or setose appendages; petals free; stamens 8, equal, anthers axe- or wedge-shaped and opening by a longitudinal slit; ovary inferior and united with the calyx tube, 4-locular with many ovules, style 1. Fruit a many-seeded berry, often truncate and with a crater-like depression at the top, ornamented like the calyx.

In East Kalimantan a mean annual increment of 0.3 cm over 4 years has been observed in young *P. coerulescens* trees. Young leaves are often dark blue or purplish. Flowering is seasonal and fairly frequent. The flowering-to-fruiting period of *Pternandra* sp. in Peninsular Malaysia is about 17 weeks. Seed dispersal is by birds eating the colourful fruits.

The genera *Ewyckia* and *Kibessia* have been merged with *Pternandra*.

Ecology *Pternandra* species are common elements of primary and secondary lowland forest, and also occur in forest edges and thickets, up to 1300 m altitude. They have also been found in swamp forest and along rivers. In East Kalimantan *P. azurea* has been observed as dominant in old secondary forest together with *Macaranga gigantea* (Rchb. f. & Zoll.) Müll. Arg. and *M. pruinosa* (Miq.) Müll. Arg.

Silviculture Silviculturally, *Pternandra* species are often considered as weeds which are difficult to eradicate. They coppice freely. *P. coerulescens* has pioneer characteristics.

Genetic resources and breeding There is a low risk of genetic erosion, since most *Pternandra* species have a fairly wide geographical distribution and trees are seldom cut for their wood.

Prospects The generally fairly small size of *Pternandra* trees makes it unlikely that the wood will gain importance.

Literature 70, 79, 151, 163, 209, 267, 340, 436, 531, 569, 767, 800, 820, 861, 950, 1038, 1151, 1221, 1242.

Selection of species

Pternandra azurea (Blume) Burkill

Synonyms *Kibessia azurea* (Blume) DC., *Kibessia cordata* Korth., *Pternandra acuminatissima* (Merr.) Nayar.

Vernacular names Indonesia: ipis kulit, ki buruy, ki jambe (Sundanese). Malaysia: polok (Iban, Sarawak), siri siri, siren siren (Sabah).

Distribution The Lingga Archipelago, Sumatra, Java and Borneo.

Pternandra coerulescens Jack

Synonyms *Ewyckia medinilliformis* Naudin, *Pternandra capitellata* Jack, *Pternandra latifolia* (Blume) Triana.

Vernacular names Brunei: sari sari. Indonesia: memeteng (Sumatra), mereiie (Arfak, Irian Jaya). Malaysia: lidah katak, sial menaun (Peninsular), ubah merkatak (Sarawak). Thailand: me chang, phlong kaem on (peninsular).

Distribution Hainan, Thailand, Peninsular Malaysia, Singapore, Sumatra, Borneo, Sulawesi, the Moluccas, New Guinea and northern Australia.

Pternandra echinata Jack

Synonyms *Kibessia acuminata* Dcne, *Kibessia angustifolia* Blume, *Kibessia echinata* (Jack) Cogn.

Vernacular names Malaysia: kayu kaki kura, lemak ketam, sial menaun (Peninsular). Thailand: kan phlu, tho paa (peninsular).

Distribution Thailand, Peninsular Malaysia, Singapore, the Riau Archipelago and Borneo.

Pternandra galeata (Korth.) Ridley

Synonyms *Kibessia elmeri* Merr., *Kibessia galeata* (Korth.) Cogn. ex DC., *Pternandra forbesii* Baker f.

Vernacular names Malaysia: lagis hutan betina, lagis pukuan hutan, lidah batak (Peninsular).

Distribution Peninsular Malaysia, Sumatra, Borneo and New Guinea.

Pternandra tuberculata (Korth.) Nayar

Synonyms *Kibessia tuberculata* (Korth.) Hook. f. ex C.B. Clarke, *Pternandra korthalsiana* (Miq.) Triana, *Pternandra paniculata* Benth. ex Ridley.

Vernacular names Malaysia: mempoyan, mengkoyan hutan, nipis kulit (Peninsular).

Distribution Peninsular Malaysia, Singapore, Sumatra, Borneo (Sabah) and New Guinea.

E. Boer (general part),
M.S.M. Sosef (general part, selection of species)

Pterospermum Schreb.

Gen. pl. 2: 461 (1791).

STERCULIACEAE

$x = 19$; *P. acerifolium* and several non-Malesian species: $2n = 38$

Vernacular names Bayur (trade name). Malaysia: bayor, litak (Sabah). Philippines: bayok (general). Vietnam: l[of]ng mang.

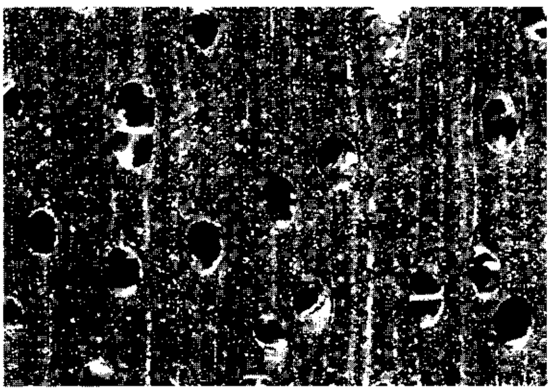
Origin and geographic distribution *Pterospermum* comprises about 40 species occurring in India, Burma (Myanmar), Indo-China, southern China, Thailand and throughout Malesia except for New Guinea. About 15 species are found in Malesia; the Philippines and Peninsular Malaysia are richest with about 9 and 6 species, respectively. Thailand is also rich in species (about 10).

Uses The wood of *Pterospermum* is used for joinery, flooring, furniture, cladding, striking tool handles, implements and plywood; it is also used in ship and bridge building. It is suitable for construction under cover, e.g. for boards, beams, joists and rafters. The wood is suitable for matches and for the production of wood-wool board. The pulp is suitable for making paper.

The bark is sometimes used to obtain a yellow dye. Leaves and bark, which are rich in tannin, are occasionally applied in traditional medicine, e.g. as a poultice against itch and to treat wounds, and internally against dysentery. The bark is locally used for toughening fishing nets.

Production and international trade In Peninsular Malaysia *Pterospermum* trees are too scattered and the form of the bole is often too poor to be of importance. In Borneo, particularly in Sabah, *Pterospermum* is locally abundant. In 1987 the export of round logs from Sabah was 17 000 m^3 with a value of US$ 1.05 million (US$ 62/m^3), and in 1992 it was 24 000 m^3 (6% as sawn timber and 94% as logs) with a total value of US$ 1.7 million (US$ 151/m^3 for sawn timber and US$ 68/m^3 for logs). Japan imports this timber in comparatively small amounts from Sabah and Sarawak.

Properties *Pterospermum* yields a lightweight to medium-weight hardwood with a density of 300–780 kg/m^3 at 15% moisture content. Heartwood pale brown to pale red-brown with a purplish tinge, not clearly demarcated from the paler sapwood; grain straight or shallowly interlocked; texture moderately fine to slightly coarse, even. Growth rings distinct to indistinct, boundaries irregular and fairly ill-defined; vessels moderately small to moderately large, solitary and in radial multiples of 2–3(–4), occasionally in clusters, open, sometimes with tyloses or pale brown deposits; parenchyma abundant, paratracheal vasicentric, apotracheal diffuse and diffuse-in-aggregates, both types rather indistinct with a hand lens; rays very fine; ripple marks present due to storeying of lower rays and axial parenchyma, rather inconspicuous; axial traumatic canals observed in *P. javanicum*.



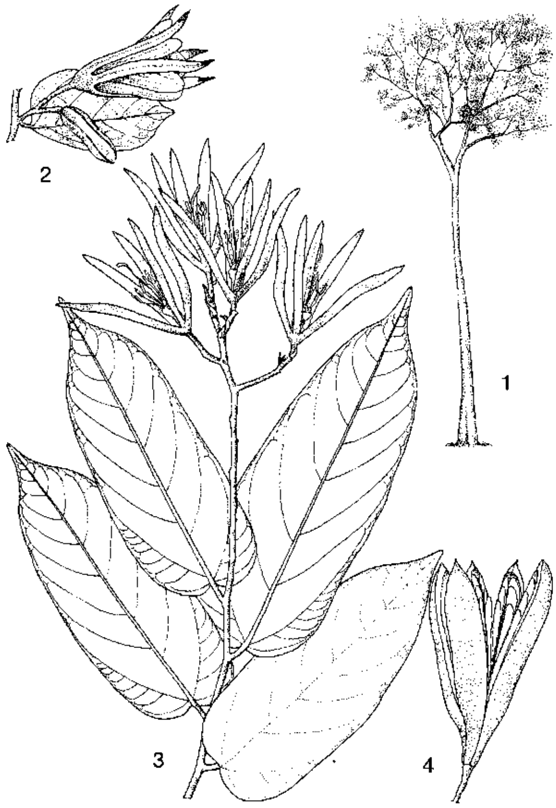
Pterospermum javanicum
transverse surface (×20)

Shrinkage of the wood upon seasoning is moderate and the only risk of degrade is stain, therefore stock should be treated with anti-stain chemicals immediately after sawing. The wood air dries fairly rapidly; air drying of 13 mm, 25 mm and 38 mm thick boards of *P. javanicum* takes 1.5 months, 2 months and 3.5 months, respectively. Kiln drying of 25 mm thick boards from green to 10% moisture content takes 5 days with a drying temperature of 54°C to 83°C and a relative humidity of 84% to 30%. The wood is soft to moderately hard, moderately strong and tough. It is easy to work and gives a smooth finish; the machining properties of *P. celebicum* are rated lowest and those of *P. diversifolium* highest. The wood is durable for interior use and reputedly for use under water. The sapwood is susceptible to moderately resistant to *Lyctus*. The resistance of the wood to termites is variable. The wood of *P. javanicum* is resistant to wood-rotting fungi. The wood is moderately easy to easy to treat with preservatives.

The gross energy value of the wood of *P. diversifolium* is 19 530–20 350 kJ/kg, that of the heartwood of *P. javanicum* is 20 350 kJ/kg.

See also the tables on microscopic wood anatomy and wood properties.

Botany Medium-sized to large trees up to 45 m tall; bole short or crooked but sometimes fairly straight and branchless for up to 30 m, often fluted, up to 100(–120) cm in diameter, buttresses usually present, short to stout (up to 2 m high), rounded; bark surface smooth, distantly scaly or shallowly fissured, lenticellate, pale brown to grey or sometimes dark brown, inner bark fibrous, red or red-brown with white streaks; crown usually becoming somewhat flattened, coppery. Leaves alternate, simple, often unequal at base (often peltate in young trees), entire, wavy or toothed, densely hairy below; stipules present. Flowers solitary or up to 3 together in leaf axils or pseudoterminal, generally large and showy, bisexual, 5-merous, white or yellow; calyx appearing tubular with cohering or free sepals; petals strap-shaped; short androgynophore present; stamens in 5 bundles of 3, staminodes 5; ovary superior, 5-locular with many ovules in each cell, style slender. Fruit an oblong, woody, many-seeded capsule. Seed flattened, winged on one side. Seedling with



Pterospermum javanicum Jungh. – 1, tree habit; 2, inflorescence in leaf axil; 3, flowering twig with petals fallen; 4, dehisced fruit.

epigeal germination; cotyledons emergent, leafy; hypocotyl elongated; leaves conduplicate, all arranged spirally.

The leaves of saplings are different from those of mature trees; they are often peltate and lobed or toothed. Growth is rapid, as observed in trials in Java. The mean height and mean diameter of *P. javanicum* trees are 11.9–12.5 m and 11.4–11.8 cm when 5.5 years old and 18.1 m and 24.3 cm when 13 years old. In another trial 17-year-old trees even measured 24 m in height and 40 cm in diameter. The trees flower every year or sometimes even twice a year. In Java *P. javanicum* flowers in June–July and bears ripe fruits in October–December. In Thailand *P. diversifolium* flowers in February–April and fruits in March–May.

P. javanicum var. *montanum* Koord. & Valeton has been described from Java. No complete taxonomical revision exists. It seems probable that the number of species will be considerably reduced when specimens and species from different regions are compared.

Ecology *Pterospermum* occurs scattered in primary forest or locally abundantly in secondary forest and especially on river banks, often on alluvial soils, up to 1400 m altitude.

Silviculture *Pterospermum* can be propagated by seed. *P. diversifolium* has about 19 500 dry seeds without wings per kg, for *P. javanicum* the range is wide, being 7000–54 000 dry seeds/kg. Seeds can be stored for a maximum of two weeks, hence they should be transported in the form of fruits. Seeds of *P. javanicum* gave 45–100% germination in 4–20 days. They should be sown in the shade and at the final spacing in nursery beds, as the young seedlings cannot withstand being pricked out. Direct sowing or planting of wildlings has been done, in the latter case development of the seedlings is fairly slow. When seedlings are planted in the field at 3 m × 1 m or 3 m × 2 m, the canopy closes after three years and the first thinning is necessary after five years. Early thinning is important to prevent the formation of too slender stems which tend to bend. The yield in these trials was 51–64 m^3/ha when 8 years old and 98 m^3/ha when 13 years old, irrespective of the stem wood volume of thinnings. Trees generally coppice well and resprout after fire. *Pterospermum* trees are fast-growing and light-demanding and regeneration in natural forest is restricted to gaps and forest fringes. *P. lanceaefolium* Roxb. originating from Vietnam has been planted in Java and measured 13.0 m in height and 21.5 cm in diameter at the age of 24 years.

Genetic resources and breeding Several *Pterospermum* species are at least locally common, and they do not seem endangered. However, other species are now considered as rather narrow endemics, especially in the Philippines, and this calls for caution, at least as long as a thorough taxonomical revision is wanting. The major drawback for its use for timber is the often poor form of the bole. *P. javanicum* var. *montanum*, however, has a superior bole form and could be of interest for future breeding activities.

Prospects *Pterospermum* seems to have good prospects for enrichment planting in selective logging systems and for plantations, as it regenerates usually well in disturbed forest and grows fast. Moreover, the wood is of fair quality, but breeding for a better bole form seems essential.

Literature 40, 61, 70, 101, 130, 151, 163, 198, 209, 235, 259, 260, 267, 376, 387, 405, 406, 427, 436, 464, 488, 633, 678, 740, 741, 757, 758, 780,

783, 829, 831, 861, 888, 933, 934, 947, 1177, 1199, 1221, 1239, 1242.

Selection of species

Pterospermum acerifolium (L.) Willd.
Vernacular names Burma (Myanmar): taung-petwun. Thailand: kanan pling (south-western), tong tao (northern).
Distribution India, Burma (Myanmar), Thailand and Peninsular Malaysia.

Pterospermum celebicum Miq.
Synonyms *Pterospermum niveum* S. Vidal.
Vernacular names Indonesia: lawanan, puyaan, wayu (Sulawesi). Philippines: bayok-bayokan (Filipino).
Distribution The Philippines, Sulawesi and the Moluccas.

Pterospermum diversifolium Blume
Synonyms *Pterospermum acerifolium* auct. non (L.) Willd.
Vernacular names Indonesia: balang (Javanese), balangkoras (Batak, Sumatra), cerlang (Sundanese). Malaysia: bayur jantan (Peninsular). Philippines: bayok (general). Thailand: champa thet, sa la pang (central), yu (peninsular). Vietnam: l[of]ng mang x[er], mang l[as] l[os]n.
Distribution India, Vietnam, Thailand, Peninsular Malaysia, Sumatra, Java and the Philippines.

Pterospermum elongatum Korth.
Distribution Sumatra, Borneo and the Philippines.

Pterospermum javanicum Jungh.
Synonyms *Pterospermum blumeanum* Korth.
Vernacular names Indonesia: bayur (general), wadang (Java). Malaysia: bayur, letop-letop, melerang (Peninsular). Burma (Myanmar): nwa-labyin.
Distribution Burma (Myanmar), Peninsular Malaysia, Sumatra, Java, Borneo, the Lesser Sunda Islands and the Moluccas.

Pterospermum obliquum Blanco
Vernacular names Philippines: kulatingan (Filipino).
Distribution The Philippines.

Pterospermum subpeltatum Merr.
Synonyms *Pterospermum stapfianum* Ridley.
Vernacular names Philippines: kantingan (Mangyan).
Distribution Borneo, Sulawesi and the Philippines (Mindanao).

E. Boer (general part),
R.H.M.J. Lemmens (general part, selection of species)

Pterygota Schott & Endl.

Melet. Bot.: 32 (1832).
STERCULIACEAE
x = unknown; *P. alata*: $2n = 40$, *P. macrocarpa* K. Schumann: $2n = 36$

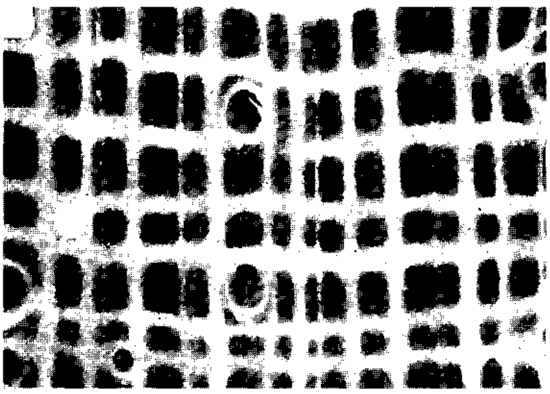
Vernacular names Mabin, pterygota (trade name). Malaysia: kasah (Peninsular), melebu (Iban, Sarawak). Papua New Guinea: white tulip oak (En).

Origin and geographic distribution *Pterygota* comprises about 20 species occurring throughout the tropics. In Asia they are found from Bangladesh (Chittagong) to Indo-China, Thailand, throughout the Malesian region (except for Sumatra), the Solomon Islands and northern Australia.

Uses When treated, the wood of *Pterygota* is suitable for general construction, bridge and wharf superstructure, railway sleepers and poles. It is used for flooring, interior finish, furniture and cabinet work, joinery, mouldings, panelling, cladding, lining, steps, hand rails, tool handles, pattern work, packing boxes, pallets, carvings, shoe heels, toys and novelties and turnery. It is often applied as face veneer and for concrete shuttering. It is also suitable for manufacture of cement-bonded wood-wool board and may be suitable for producing short fibre pulp.

Production and international trade Supplies of *Pterygota* are generally limited and the wood is mainly used locally, but small amounts are imported into Japan from Papua New Guinea and the Solomon Islands. In 1996 the export from Papua New Guinea amounted to 7800 m^3 of round logs at an average free-on-board (FOB) price of US$ 98/m^3.

Properties *Pterygota* yields a medium-weight to heavy hardwood with a density of 460–980 kg/m^3 at 15% moisture content. Heartwood pale yellow-white to pale brown, not clearly differentiated from the pale yellow to straw sapwood; grain



Pterygota alata
transverse surface (×20)

straight or shallowly interlocked; texture medium to coarse and uneven; wood with silver grain and characteristic ray pattern on radial surface; fresh wood with offensive smell. Growth rings indistinct, occasionally indicated by zones with fewer, or wavier parenchyma bands; vessels moderately large, solitary and in radial multiples of 2–4 (–more), occasionally in clusters, tyloses rare, but gummy deposits occasionally present; parenchyma moderately abundant to abundant, scanty paratracheal, vasicentric, or apotracheal in broad, continuous or interrupted bands; rays medium-sized to moderately broad with occasional very wide rays; fine ripple marks present due to storied arrangement of parenchyma cells.

Shrinkage of the wood when seasoned is moderate to high. During preliminary air drying short surface checks usually develop, which extend during kiln drying. It takes about 5 days to kiln dry boards 25 mm thick from the green condition. Quarter-sawn boards develop some end checks whereas back-sawn boards may show severe surface checking. The wood is soft to moderately hard and may be slightly heavier and harder in the periphery of the stem. It is moderately strong, tough and very shock resistant. The wood is fairly easy to saw, plane and finish, but has a tendency to tear when quarter-sawing boards with interlocked grain. A sticky substance is released when sawing green stock, so the saw blades have to be cleaned frequently. Stock may be sliced, but peeling *P. horsfieldii* may not be satisfactory due to the presence of harder and softer zones. The wood is moderately durable. The sapwood of *P. horsfieldii* is susceptible to *Lyctus*. The sapwood and heartwood are permeable when treated with preservatives under pressure. Logs are very susceptible to blue stain, termites and pinhole borer attack unless rapidly removed from the forest and treated with appropriate prophylactic preservatives.

See also the tables on microscopic wood anatomy and wood properties.

Botany Deciduous, monoecious, medium-sized to large trees up to 50 m tall; bole cylindrical to tapering, up to 120 cm in diameter and branchless for up to 36 m, with thin, small to tall buttresses; bark surface smooth to shallowly fissured, mauve-grey, inner bark pale brown; crown dense, dark. Twigs slender, prominently wrinkled. Leaves arranged spirally, simple, entire, palmately veined; stipules subulate, caducous; petiole kneed. Flowers in a short, terminal or subterminal panicle or raceme, unisexual; sepals 5, almost free; petals absent. Male flower with 8–10 or 20–25 sessile anthers placed on a staminal tube and a rudimentary ovary. Female flower with staminodes; ovary superior, with 3–5 partly fused carpels each with many ovules, styles short. Fruit a stalked, globose, woody, many-seeded follicle, splitting on one side. Seed with a large wing on one side. Seedling with epigeal germination; cotyledons emergent, leafy; hypocotyl elongated; leaves alternate-spiral from the outset (occasionally the first 2 opposite in extra-Malesian species).

In trials in West and East Java with *P. alata* at 19–31 years of age, the mean annual increment was 0.9–1.9 cm in diameter and 0.8–1.1 m in height. Branches are produced in pseudowhorls and their tips curve upwards in a *Terminalia*-like fashion. In Peninsular Malaysia *P. horsfieldii* has been observed to flower and fruit in mast fruiting years. In Thailand *P. alata* flowers and fruits in December–March. The winged seeds are dispersed by wind.

Ecology *Pterygota* is found scattered or rarely gregarious in primary, lowland rain forest, up to 1000 m altitude, in areas with a short but pronounced dry period. It occurs on fertile soils and apparently tolerates periodic droughts. *P. alata* prefers flat alluvial soils and periodically inundated localities. In Papua New Guinea *P. horsfieldii* is locally common in monsoon forest.

Silviculture *Pterygota* can be propagated by seed. For *P. alata* there are about 1250 seeds without wings per kg. Seeds should be sown in the shade and those of *P. alata* have 80–85% germination in 7–203 days. In a trial in West Java *P. alata* regenerated naturally with an average of 19 seedlings/m^2.

Genetic resources and breeding *Pterygota* is widespread but rare and occurs only locally, so is at serious risk of genetic erosion from habitat destruction.

Prospects The wood of *Pterygota* is of reasonable quality and may have potential for face veneer and as pulp for paper.

Literature 40, 61, 80, 125, 209, 267, 300, 304, 348, 360, 378, 455, 464, 487, 536, 600, 678, 758, 829, 831, 888, 933, 1023, 1038, 1145, 1169, 1221, 1242.

Selection of species

Pterygota alata (Roxb.) R. Br.

Synonyms *Sterculia alata* Roxb.

Vernacular names Malaysia: kangsar, menuang (Peninsular). Burma (Myanmar): sin-kadet, taung-letkok. Laos: po dêng. Thailand: huaka (peninsular), mabin (northern), tongching (south-western).

Distribution From Bangladesh (Chittagong) to Burma (Myanmar), Indo-China, Thailand and Peninsular Malaysia.

Pterygota horsfieldii (R. Br.) Kosterm.

Synonyms *Pterygota forbesii* F. v. Mueller, *Pterygota thwaitesii* (Mast.) Alston, *Pterygota trinervia* K. Schumann.

Vernacular names Malaysia: melebu (Iban, Sarawak). Papua New Guinea: impa (general).

Distribution Throughout the Malesian region except for Sumatra, and in northern Australia.

C. Phengklai

Ptychopyxis Miq.

Fl. Ind. Bat., Suppl. 1 (Prodr. Fl. Sum.): 402 (1861).

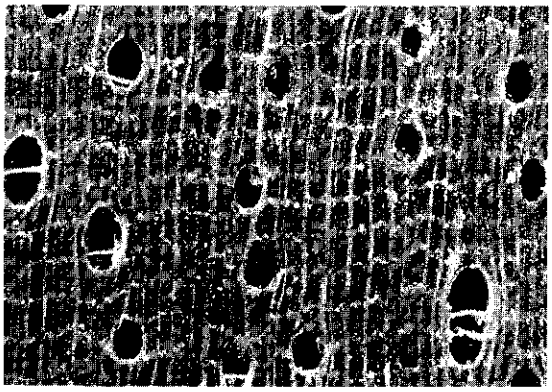
EUPHORBIACEAE

x = unknown; $2n$ = unknown

Vernacular names Malaysia: mendaroh (Peninsular).

Origin and geographic distribution *Ptychopyxis* comprises about 15 species occurring in Sri Lanka, Vietnam, Thailand, Peninsular Malaysia, Sumatra, Java, Borneo, the Philippines and Papua New Guinea. All except one occur within Malesia.

Uses The wood of *Ptychopyxis* is used in pole form in native house building, e.g. as rafters and small posts. It provides a good quality firewood be-



Ptychopyxis nervosa Airy Shaw
transverse surface (×20)

cause even the green wood burns readily.
The sarcotesta around the seeds of most Bornean species is edible.

Production and international trade *Ptychopyxis* wood cannot be obtained in large quantities nor in large sizes as the boles are often crooked, and is therefore of local use only.

Properties *Ptychopyxis* yields a medium-weight hardwood with a density of 625–675 kg/m^3 at 15% moisture content. Heartwood brown with a purple-grey tinge, not clearly differentiated from the sapwood; grain straight; texture moderately fine and even. Growth rings absent; vessels medium-sized, solitary and in radial multiples of 2–4; parenchyma abundant, apotracheal in narrow bands; rays very fine, visible with a hand lens on transverse surface, relatively conspicuous on radial surface; ripple marks absent.
The wood is moderately hard and fairly strong. Durability is not well-known, but is probably moderate.
See also the table on microscopic wood anatomy.

Botany Evergreen, dioecious, small to medium-sized or rarely fairly large trees up to 30(–40) m tall; bole often crooked, up to 50(–70) cm in diameter, buttresses often present, sometimes branching, up to 2 m high; bark surface smooth to finely fissured or occasionally hoop-marked, grey to brown, occasionally mottled, inner bark brownish to yellowish. Leaves arranged spirally, crowded at the twig tips, simple, entire, with conspicuous scalariform tertiary venation; petiole strongly kneed at both ends; stipules caducous. Flowers in an axillary or terminal raceme or panicle; petals absent. Male flower in fascicles; calyx 3–5-lobed; disk absent; stamens many, intermixed with small glands; pistillode absent. Female flower

solitary; calyx 4–6-lobed; disk small, annular; ovary superior, 2–3-locular with 1 ovule in each cell, styles connate at base, hairy. Fruit a large, tardily dehiscing, slightly woody capsule, furry, smooth or folded or set with spines or glands. Seed with a pulpy sarcotesta. Seedling with epigeal germination; cotyledons not emergent; hypocotyl elongated; first pair of leaves opposite, subsequent ones arranged spirally, produced in flushes, each flush preceded by a scale leaf.
Trees have been observed flowering from March to September, fruiting from March to December.

Ecology *Ptychopyxis* species are rare but may be locally abundant and are generally found in primary, evergreen, dipterocarp forest, up to 600(–1600) m altitude. They occasionally occur in swampy locations or in old secondary forest. They grow on a wide range of soils including clayey soils, sandstone, loam, basalt and sand, and sometimes also on limestone (*P. arborea* usually) or ultrabasic soils (*P. kingii* sometimes).

Silviculture *Ptychopyxis* can be propagated by seed. Seeds of *P. caput-medusae* still embedded in their sarcotesta have 55–75% germination in 19–110 days, those of *P. costata* about 45% in 9–74 days.

Genetic resources and breeding No information is known to exist on the presence of *Ptychopyxis* in seed banks, germplasm collections and botanical gardens. Some endemic species are vulnerable as they mainly occur in primary forest.

Prospects It is unlikely that *Ptychopyxis* will gain importance as a timber, since its boles are often crooked.

Literature 19, 26, 28, 32, 33, 34, 70, 162, 163, 267, 436, 543, 829, 831, 861, 1195, 1221, 1232, 1242.

Selection of species

Ptychopyxis arborea (Merr.) Airy Shaw

Synonyms *Mallotus arboreus* Merr.

Vernacular names Indonesia: lebui (Bassap Dayak, Kalimantan), marjilawat (East Kalimantan). Malaysia: luagan lagan, tarip (Kedayan, Sabah).

Distribution Borneo.

Ptychopyxis bacciformis Croizat

Synonyms *Ptychopyxis poilanei* Croizat.

Vernacular names Malaysia: bantas (Malay, Sarawak).

Distribution Vietnam and Borneo.

Ptychopyxis caput-medusae (Hook. f.) Ridley

Synonyms *Mallotus caput-medusae* Hook. f.

Vernacular names Malaysia: medang jerenas, rambai hutan (Peninsular).

Distribution Peninsular Malaysia and Singapore.

Ptychopyxis chrysantha (K. Schumann) Airy Shaw

Synonyms *Clarorivinia chrysantha* (K. Schumann) Pax & K. Hoffm., *Clarorivinia grandifolia* Pax & K. Hoffm., *Mallotus chrysanthus* K. Schumann.

Distribution Papua New Guinea.

Ptychopyxis costata Miq.

Vernacular names Indonesia: keresak bulu, keresak lingeh, resak lingeh (Sumatra). Malaysia: balong ayam batu, kaliah toah (Peninsular), bantas (Sarawak).

Distribution Peninsular Malaysia, Singapore, Sumatra and Borneo (Sarawak).

Ptychopyxis glochidiifolia Airy Shaw

Vernacular names Indonesia: kayu api (East Kalimantan).

Distribution Borneo (Brunei, Kalimantan, Sarawak); possibly also in Papua New Guinea.

Ptychopyxis grandis Airy Shaw

Vernacular names Malaysia: bantas, bedulang (Iban, Sarawak), bertulang (Sarawak).

Distribution Borneo (Sarawak).

Ptychopyxis javanica (J.J. Smith) Croizat

Synonyms *Podadenia javanica* J.J. Smith, *Ptychopyxis angustifolia* Gage.

Vernacular names Indonesia: rambutan monyet (Sundanese). Malaysia: kamanyan (Kedayan, Sabah).

Distribution Peninsular Thailand, Peninsular Malaysia, Borneo (Sabah, possibly also in Kalimantan) and West Java.

Ptychopyxis kingii Ridley

Synonyms *Mallotus arboreus* Merr. var. *platyphyllus* Merr.

Distribution Peninsular Malaysia, Sumatra and Borneo (Sabah, Sarawak).

P.C. van Welzen

Pyrenaria Blume

Bijdr. fl. Ned. Ind. 17: 1119 (1827).
THEACEAE
x = unknown; $2n$ = unknown

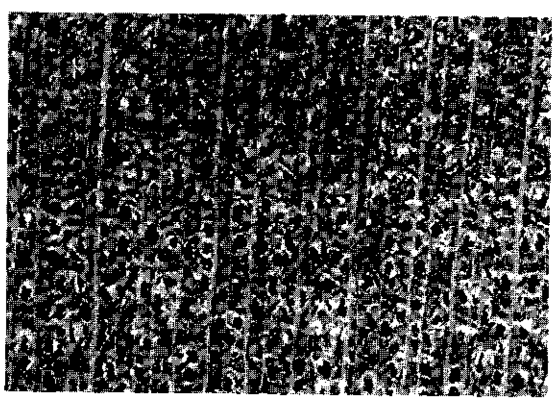
Vernacular names Bat's apple (En). Malaysia: kelat jambu arang, medang gelugur, samak jantan (Peninsular).

Origin and geographic distribution *Pyrenaria* comprises about 30 species occurring from eastern India to Burma (Myanmar), Indo-China, southern China, the Ryukyu Islands, Taiwan, Thailand and the western Malesian region. Southern China appears to be richest in species. In Malesia 8 species are found, 7 of which occur in Peninsular Malaysia, 4 in Sumatra, 1 in Java, 2 in Borneo and possibly 1 in the Philippines. Timber use has been reported for a single species, *P. acuminata* Planch., found in Peninsular Malaysia, Singapore and the Riau Archipelago.

Uses The wood of *Pyrenaria* has been used in local house building for posts and rafters and as poles for fencing.
The root has been applied as a medicine for sores on legs.

Production and international trade Utilization of the wood of *Pyrenaria* is very limited and on a local scale only.

Properties *P. acuminata* yields a medium-weight hardwood with a density of about 600 kg/m^3 at 15% moisture content. Wood pale reddish-brown and soft. The following description is based on 3 extra-Malesian *Pyrenaria* species. Wood pale brown with pink tinge; grain straight to wavy; texture very fine and even. Growth rings indistinct to distinct, distinct rings marked by vesselless zones producing faint but attractive longitudinal streaks; vessels very small to small grading in size across the growth ring, solitary and in short radial multiples; parenchyma apotracheal diffuse to diffuse-in-aggregates, and scanty paratracheal, only visible in vesselless zones; rays fine to moderately broad tending to be of 2 distinct widths; ripple marks absent.
See also the table on microscopic wood anatomy.



Pyrenaria camelliiflora Kurz
transverse surface (×20)

Botany Evergreen, small trees up to 12 m tall; bark surface smooth, becoming cracked in patches with age, grey to brown-black, inner bark fibrous, red; crown dense with stout branches. Young twigs hispid, older ones sericeous. Leaves arranged spirally, simple, serrate, lower surface velvety, exstipulate. Flowers axillary, solitary or sometimes in a fascicle of 2–3, with 3 bracts and 3 bracteoles; sepals 5–6, subequal; petals 5, shortly fused at base; stamens many, in 5–6 rows and adnate to the corolla; ovary superior, 5–6-locular with 2–3(–7) ovules in each cell, styles 3–5, fused. Fruit an indehiscent berry. Seedling with epigeal germination; cotyledons emergent, leafy; hypocotyl elongated; all leaves arranged spirally.
The shoot system is monomorphic with all shoots upright or dimorphic with orthotropic leaders and plagiotropic branching. *P. acuminata* bears flowers and fruits throughout the year. It is possibly night-flowering.
Pyrenaria has been united with the genus *Tutcheria* which formerly incorporated many Chinese species.

Ecology *P. acuminata* is versatile. It is found in dense forest, on the crests of ridges, in swamp forest or along streams. It usually occurs below 100 m altitude but may ascend up to 1300 m.

Silviculture *Pyrenaria* can be raised from seed. Seed of *P. acuminata* achieved a germination rate of about 80% in 24–74 days, but in another test seed failed to germinate. A seed count is available for *P. serrata* Blume which has about 3200 dry seeds/kg. In nursery conditions germination of the species proved good and more or less simultaneous.

Genetic resources and breeding As *P. acuminata* is hardly ever cut for its wood and is an ecologically verstile species, it does not seem endangered.

Prospects No description of the wood of *P. acuminata* and no information on wood properties is available, indicating that the wood is only very rarely used. This situation is unlikely to change in the near future.

Literature 163, 209, 238, 405, 436, 539, 541, 829, 831, 939, 1221.

E. Boer (general part),
M.S.M. Sosef (general part),
J. Ilic (wood anatomy)

Radermachera Zoll. & Moritzi

Zoll., Syst. Verz. 3: 53 (1855).
BIGNONIACEAE
x = probably 20 as in most *Bignoniaceae*; $2n$ = unknown

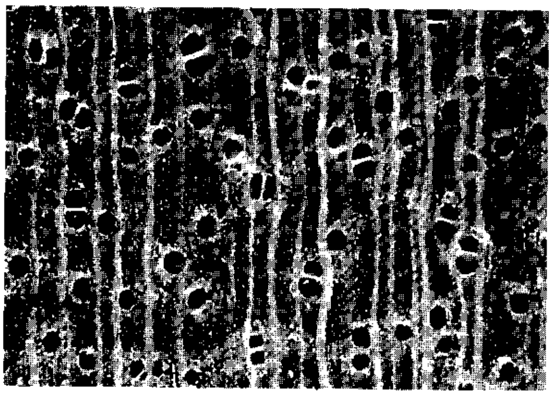
Vernacular names Philippines: banai-banai.

Origin and geographic distribution *Radermachera* comprises about 17 species occurring in India, Indo-China, southern China, Taiwan, the Ryukyu Islands, Thailand, and almost throughout the Malesian region (but only in the western Moluccas (Sulu Islands) and not in New Guinea).

Uses The wood of *Radermachera* is used solely for purposes under cover like house building, furniture, cabinets, sculpture and carving, and is suitable for matchboxes and matches. The reported use for bridges seems doubtful. The wood has also been applied as fuelwood and in India for charcoal production.
R. gigantea seems suitable for reforestation and erosion control.

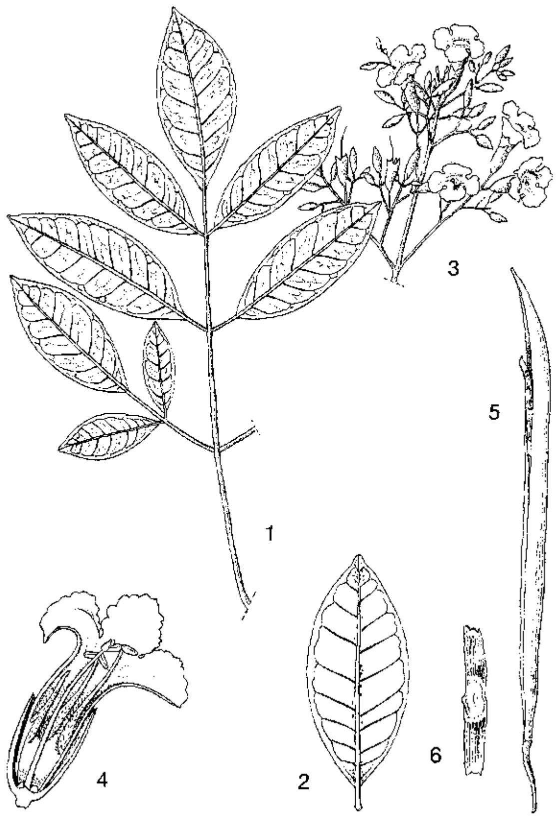
Production and international trade In the Philippines *Radermachera* wood is traded in mixed consignments and supplies are limited. Elsewhere, use is on a local scale only.

Properties *Radermachera* yields a lightweight to medium-weight hardwood with a density of 440–750 kg/m^3 at 15% moisture content. Heartwood pale reddish-yellow to pale reddish-brown turning cinnamon-buff upon exposure, not clearly differentiated from the sapwood; grain slightly interlocked; texture moderately fine; wood with silver grain, lustrous. Growth rings distinct, boundaries indicated by denser tissue and often a line of marginal parenchyma; vessels small to moderately small, solitary or in radial or occasionally tangential multiples of 2–4, open; parenchyma paratracheal aliform and confluent; rays very fine; ripple marks absent.
Shrinkage is low and the wood seasons with little defects. It is easy to work and is non-durable when exposed to the weather or in contact with the ground, durable under cover.
See also the table on microscopic wood anatomy.



Radermachera pinnata
transverse surface (×20)

Botany Evergreen, small to large trees up to 40 m tall; bole straight, usually short, branchless for up to 12 m, up to 80 cm in diameter, fluted to prominently buttressed at base; bark surface deeply fissured and slightly scaly, grey, inner bark laminated, soft, whitish to pale yellow; innovations resinous. Leaves opposite, 1–3-pinnate, exstipulate; leaflets opposite, entire, with scattered



Radermachera pinnata (Blanco) Seem. – 1, leaf; 2, lower side leaflet; 3, inflorescence; 4, sectioned flower; 5, fruit; 6, seed.

or clustered glands below. Flowers in a terminal thyrse (rarely rami- or cauliflorous); calyx closed in bud, truncate or irregelarly 2–5-lobed; corolla 5-lobed, slightly 2-lipped; stamens 5, the 5th often rudimentary, inserted in the corolla tube, not exserted; ovary superior, 2-locular with many ovules, stigma 2-lipped. Fruit a long linear capsule with thin valves, a terete corky septum and many small hyaline-winged seeds. Seedling with epigeal germination; cotyledons emergent, reniform and emarginate; hypocotyl elongated; first few leaves simple, subsequent ones increasingly compound.

Flowering is throughout the year in some species, but concentrated in January to April and July to October. Pollination of the narrowly tubular orange flowers of some species is probably by birds, whereas hawk-moths seem the most likely pollinators of the species with wider white and nocturnal flowers. Fruits develop within a month.

R. pinnata has been subdivided into two subspecies: subsp. *pinnata* from the Philippines, Sulawesi and the Moluccas and subsp. *acuminata* (v. Steenis) v. Steenis from Thailand, Sumatra, Borneo and the south-western Philippines.

Ecology *Radermachera* is found in lowland to submontane primary or more often secondary forest or open forest or thickets, up to 1600 m altitude. They are not rare (pioneer species occur in disturbed locations) or may be locally common, and occur in both perhumid and seasonal areas, often along streams. *R. pinnata* is associated with ultramafic and limestone soils in Sabah and Sarawak. In Timor *R. gigantea* occurs in evergreen forest on soils with a high groundwater table.

Silviculture *Radermachera* can be propagated by seed or by branch cuttings. One kg of dry winged seeds of *R. gigantea* contains 590 000–780 000 seeds. Seeds of *R. glandulosa* gave about 12% germination in 28–70 days, those of *R. gigantea* about 25%. As seeds cannot be stored without a serious decline in viability, they should be sown immediately after collection. Immersing seeds in water at 60°C and allowing them to cool for 24 hours enhances germination. It is recommended to sow seeds under shade. The beetle *Cionus radermacherae* has been observed in Indonesia puncturing shoots of *Radermachera*.

Genetic resources and breeding As the timber-yielding *Radermachera* species are widespread and occur in both primary and secondary habitats, they are not threathened.

Prospects The silvicultural characteristics of *Radermachera*, as yet ill-known, merit further attention for possible plantation establishment and erosion control.

Literature 130, 163, 198, 209, 260, 341, 343, 405, 436, 519, 772, 829, 831, 861, 934, 1048, 1144, 1221, 1274.

Selection of species

Radermachera gigantea (Blume) Miq.

Synonyms *Radermachera borneensis* v. Steenis, *Radermachera elmeri* Merr., *Stereospermum hypostictum* Miq.

Vernacular names Indonesia: kedali (Javanese), ki padali (Sundanese), raja matan (Batak Karo, Sumatra). Philippines: agtap (Tagbanua), barangau-analabaga (Iloko), sayo (Igorot).

Distribution India (Assam), Burma (Myanmar), Sumatra, Java, Borneo (Kalimantan), the Philippines and the Lesser Sunda Islands.

Radermachera glandulosa (Blume) Miq.

Synonyms *Bignonia porteriana* Wallich ex DC., *Radermachera stricta* Zoll. & Moritzi ex Zoll., *Stereospermum glandulosum* (Blume) Miq.

Vernacular names Hill fox-glove tree (En). Indonesia: ambal (Javanese), ki pahit (Sundanese), tuwi gadang (Minangkabau, Sumatra). Malaysia: lempoyang (Peninsular). Thailand: hu wua, pheka phu (peninsular).

Distribution From India (Assam) to Indo-China, southern China, Thailand, Peninsular Malaysia, Sumatra and Java.

Radermachera pinnata (Blanco) Seem.

Synonyms *Radermachera acuminata* Merr., *Radermachera lobbii* (Teijsm. & Binnend.) Miq., *Radermachera whitfordii* Merr.

Vernacular names Lowland fox-glove tree (En). Indonesia: binutan (Kapuas Dayak, Kalimantan), kayu singamba (Batak, Sumatra), ririh (Muna, Sulawesi). Malaysia: bunga pawang, jangkal, setenggek burong (Peninsular). Philippines: banai-banai (Filipino), kalapuing (Tagalog), pata del monto (Pangasinan). Thailand: pheka phru (peninsular).

Distribution Peninsular Thailand, Peninsular Malaysia, Sumatra, Java, Borneo, the Philippines, Sulawesi and the western Moluccas.

D. Sasmitamihardja

Rapanea Aublet

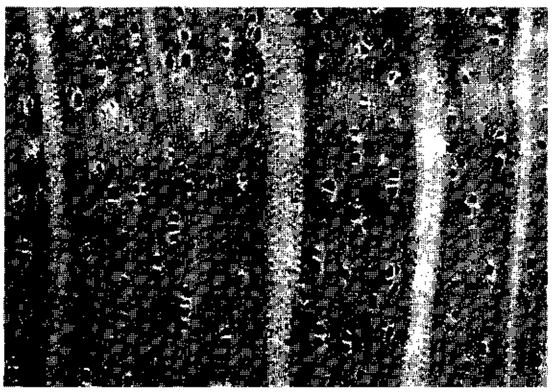
Pl. Guiane Franç. 1: 121, t. 46 (1775).
MYRSINACEAE
$x = 12$; $2n = 24$, 46 or 48 for several non-Malesian species

Origin and geographic distribution *Rapanea* is a large genus comprising about 175 species occurring in tropical and subtropical or warm temperate regions. The largest number of species is found in tropical South America. Within the Malesian region about 30 species are present, the majority of which are endemic to New Guinea.

Uses The wood of *Rapanea* is used for furniture and cabinet work and may be suitable for tool handles.
R. hasseltii may be suitable for reforestation purposes.

Production and international trade Utilization of the wood of *Rapanea* is probably very limited and on a local scale only. In Halmahera (the Moluccas) the wood of *R. cordata* seems to be in demand for cabinet work.

Properties *Rapanea* yields a medium-weight to heavy hardwood with a density of 660–960 kg/m^3 at 15% moisture content. Heartwood pale brown with a pinkish hue, not sharply demarcated from the somewhat paler sapwood; grain mostly straight; texture fine but uneven due to large rays. Growth rings absent; vessels very small to small, solitary and in radial multiples of 2–4(–6), sometimes showing radial alignment, clusters present, vessels open; parenchyma sparse, scanty paratracheal to vasicentric, sometimes difficult to see with a hand lens; rays very broad, 'oak-lik', often containing 'breakdown' areas in cross section appearing as yellow to orange dots; ripple marks absent.



Rapanea papuana (Hemsl.) Mez
transverse surface (×20)

The wood is slightly durable and strong to very strong.
See also the table on microscopic wood anatomy.

Botany Evergreen or deciduous, glabrous shrubs, small or uncommonly medium-sized trees up to 20(–30) m tall; bole crooked to straight and cylindrical, up to 35(–60) cm in diameter, sometimes pachycaul, without buttresses; bark surface smooth with longitudinal fissures, lenticellate, dark grey to almost black, inner bark red to red-brown. Leaves arranged spirally, simple, entire or rarely denticulate, punctate, exstipulate. Flowers in an axillary, racemose-umbelliform fascicle, unisexual or bisexual, 4–5(–6)-merous, glandular; sepals free or connate at base; petals connate at base, imbricate; stamens inserted on the corolla, anthers sessile; ovary superior, 1-locular with few ovules, style 1. Fruit a dry to slightly fleshy, 1-seeded drupe or berry. Seedling with epigeal germination; cotyledons emergent; hypocotyl elongated.
In Java *R. hasseltii* flowers throughout the year. The fruits are probably dispersed by birds.
The genus *Rapanea* used to be included in *Myrsine* but at present there is general agreement about its distinctiveness. The main difference between the two genera is the filament tube being completely fused with the corolla in *Rapanea* (hence the anthers appear sessile) versus partly fused in *Myrsine*.

Ecology Most Malesian *Rapanea* species are found in primary or secondary montane rain forest, in moss forest or in alpine habitats, in Java up to 3000 m altitude, in New Guinea up to 4000 m. Some species are also found on limestone or ultrabasic soils. *R. involucrata* occurs in montane forest, sometimes dominated by *Libocedrus* and *Podocarpus* or *Phyllocladus*, to subalpine scrub vegetation or grassland borders at (2050–)2350–4000 m altitude. Some are, however, found in the lowland (e.g. *R. cordata*) or even in brackish habitats along the coast (e.g. *R. porteriana* Wallich ex A. DC.). In Timor *R. hasseltii* is characteristic of the *Ehretion* vegetation type.

Silviculture *R. hasseltii* has been recommended for reforestation at 1000–1500 m altitude in Timor. It is not resistant to fire.

Genetic resources and breeding Preservation of montane forest is important for the conservation of *Rapanea*, as the geographical distribution of many species is very local. New Guinea harbours many endemic species.

Prospects The quality of the wood is poorly known, indicating that its utilization is very restricted. Increased utilization is unlikely as trees are generally small and occur in montane habitats which are not easily accessible.

Literature 70, 238, 300, 345, 438, 595, 772, 861, 1029, 1034, 1060, 1062, 1180, 1221.

Selection of species

Rapanea cordata (R. Scheffer) Mez

Synonyms *Myrsine cordata* R. Scheffer.

Distribution The Moluccas (Halmahera) and New Guinea (Irian Jaya: Gebeh Island).

Rapanea hasseltii (Blume ex R. Scheffer) Mez

Synonyms *Myrsine hasseltii* Blume ex R. Scheffer, *Myrsine tenuifolia* Koord. & Valeton.

Vernacular names Indonesia: ki harupat (Sundanese), kukuran (Javanese), sawu alas kene (Madurese).

Distribution Java and the Lesser Sunda Islands (Timor).

Rapanea involucrata Mez

Distribution New Guinea.

E. Boer (general part),
M.S.M. Sosef (general part, selection of species),
J. Ilic (wood anatomy)

Reinwardtiodendron Koord.

Versl. Minahasa: 389 (1898).

MELIACEAE

x = unknown; $2n$ = unknown

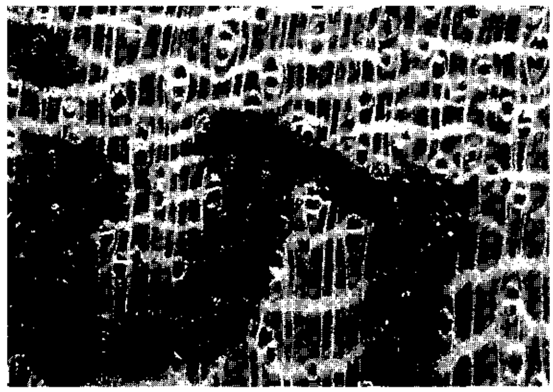
Origin and geographic distribution *Reinwardtiodendron* comprises 6 or possibly 7 species. One of these is restricted to the western Ghats (India), whereas the others occur in Indo-China, Hainan and scattered through the Malesian archipelago.

Uses The wood of *Reinwardtiodendron* is used for high-grade furniture, panels, and door and window frames. It has been suggested that the strong aromatic smell of the wood should make it valuable for fancy boxes, linen chests, and other decorative articles.

The sarcotesta is edible.

Production and international trade Actual utilization of *Reinwardtiodendron* wood is reported only for *R. celebicum* in the Philippines, where it has been used on a local scale.

Properties *Reinwardtiodendron* yields a medium-weight to heavy hardwood with a density of 710–930 kg/m^3 at 15% moisture content. Heartwood pale yellow to pinkish-yellow, distinct but not sharply demarcated from the buff-coloured sapwood; grain slightly interlocked and wavy; texture fine and even; wood with a delicate watered-silk appearance on the longitudinal faces; wood with a pronounced aromatic odour. Growth rings mostly indistinct, sometimes delimited by marginal parenchyma; vessels very small to small, solitary and in radial pairs, with chalky white deposits; parenchyma paratracheal vasicentric to aliform and confluent, and apotracheal in narrow wavy to broken bands and in marginal or seemingly marginal narrow to wide bands; rays very narrow; ripple marks absent.



Reinwardtiodendron celebicum transverse surface (×20)

The wood seasons well. It is very strong and hard. It is slightly difficult to work on account of its hardness. The wood is moderately durable to durable in contact with the ground or when exposed to the weather. The heartwood is very resistant to dry-wood termites. The sapwood is non-susceptible to *Lyctus*.

See also the table on microscopic wood anatomy.

Botany Small to medium-sized trees up to 30 m tall; bole branchless for up to 18 m, up to 70 cm in diameter, strongly fluted or with buttresses up to 4 m high; bark surface smooth with scaly patches, sometimes conspicuously knobbly, fawn-coloured to pale brown or yellowish, inner bark white to yellow or reddish-brown. Leaves arranged spirally, pinnate to unifoliolate, exstipulate; leaflets alternate to subopposite, entire, the most apical one often larger and appearing to be terminal; domatia often present. Flowers in an axillary spike or basally branched panicle of spikes, bisexual, yellow, 5-merous; calyx deeply lobed; petals united with the staminal tube at base; staminal tube globose to ovoid with an undulate to toothed margin and 10 anthers in 2 whorls carrying apical appendages; disk absent; ovary superior, 5-locular with 1 ovule in each cell, style very short. Fruit a 1–5-seeded berry. Seed with sarcotesta.

In Java *R. humile* flowers from December to April, but in the Philippines mainly between April and August. The flowers are insect-pollinated. In the Philippines *R. humile* fruits in September–December. In the Lesser Sunda Islands (Indonesia) *R. kostermansii* fruits between June and November. The fruits are eaten by primates and seed is thus dispersed.

Ecology *Reinwardtiodendron* species are found scattered in primary lowland and hill rain forest, up to 800(–1000) m altitude.

Silviculture *Reinwardtiodendron* can be propagated by seed.

Genetic resources and breeding Both *R. celebicum* and *R. humile* are rare, at least in the Philippines.

Prospects Since very little is known about the timber of *Reinwardtiodendron* it is unlikely that interest will increase in the near future. Its possible application for fancy boxes and decorative articles should be investigated further.

Literature 70, 163, 235, 341, 464, 619, 729, 780, 861, 878, 909, 934, 974, 1164, 1221, 1232.

Selection of species

Reinwardtiodendron celebicum Koord.

Synonyms *Aglaia reinwardtiana* Kosterm., *Reinwardtiodendron merrillii* Perkins.

Vernacular names Indonesia: langsot (Sulawesi), sakogwa, tam (Irian Jaya). Philippines: malakamanga (general), balibisan (Manobo), bianti (Tagalog).

Distribution Eastern Borneo, the Philippines, northern Sulawesi, the Moluccas and New Guinea (Irian Jaya).

Reinwardtiodendron cinereum (Hiern) Mabb.

Synonyms *Aglaia pseudolansium* Kosterm., *Lansium cinereum* Hiern.

Distribution Peninsular Malaysia, Sumatra and Borneo (Sabah).

Reinwardtiodendron humile (Hassk.) Mabb.

Synonyms *Aglaia dubia* (Merr.) Kosterm., *Lansium dubium* Merr., *Lansium humile* Hassk.

Vernacular names Indonesia: tembangan, tipis kulit (Java). Philippines: lansones-bundok (Filipino), aragnan, malakanasi (Bikol).

Distribution Hainan, Indo-China, Peninsular Malaysia, Sumatra, Java, Borneo, the Philippines and South-East Sulawesi.

Reinwardtiodendron kostermansii (Prijanto) Mabb.

Synonyms *Aglaia kostermansii* (Prijanto) Kosterm., *Lansium kostermansii* Prijanto.

Vernacular names Indonesia: garu (Flores), kayu narab (Sumbawa).

Distribution The Lesser Sunda Islands (Flores, Sumbawa).

T. Uji

Rhodamnia Jack

Malayan Misc. 2(7): 48 (1822).

MYRTACEAE

x = unknown; $2n$ = unknown

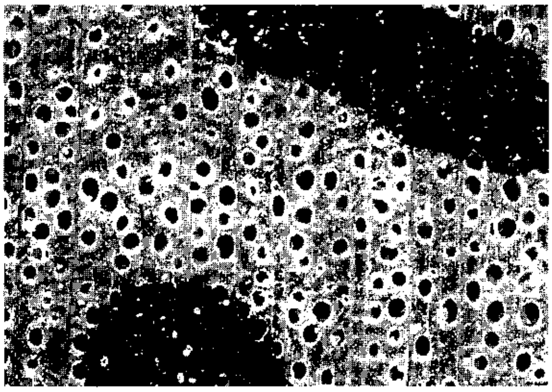
Vernacular names Brown malletwood, iron malletwood, silver malletwood (En). Malaysia: mempoyan (Peninsular).

Origin and geographic distribution *Rhodamnia* comprises 29 species which are distributed in southern Burma (Myanmar), Indo-China, southern China, Thailand, throughout the Malesian region (except for the Philippines), the Solomon Islands, New Caledonia and northern and eastern Australia. Australia and New Guinea are richest in species, with 13 and 10 species, respectively.

Uses The hard and durable wood of *Rhodamnia* is used in the construction of local houses, particularly for posts, and for implements. It is also used to make charcoal of good quality.

The bark of *R. cinerea* was used in Indonesia to prepare a black dye and for tanning fishing nets. The ripe fruits are edible. The branches of *R. cinerea* are considered excellent for the cultivation of epiphytic orchids. In Malaysia the leaves and roots are used in local medicine, particularly after childbirth; in Indo-China a decoction of the fruit is applied to ulcers and bleeding gums.

Production and international trade *Rhodamnia* wood is used on a very local scale only.



Rhodamnia argentea Benth.
transverse surface (×20)

Properties *Rhodamnia* yields a heavy hardwood with a density of (770–)940–1120 kg/m^3 at 15% moisture content. Heartwood pink to red-brown or sometimes grey-brown with a purple-red tinge, sometimes with darker flecks, not clearly differentiated from the sapwood; grain straight or occasionally interlocked; texture fine and even. Growth rings indistinct to distinct and marked by darker tissue; vessels moderately small to medium-sized, almost exclusively solitary, rarely in radial or oblique pairs, sometimes in oblique arrangement, tyloses infrequent, chalky white and reddish deposits sometimes present; parenchyma moderately abundant, paratracheal aliform and confluent, apotracheal in narrow to moderately broad bands, and diffuse, barely visible to the naked eye; rays of two distinct sizes, very fine and moderately broad, visible with a hand lens; ripple marks absent.
The wood is hard, strong and tough. It works reasonably well and turns well. It is moderately durable to very durable when exposed to the weather or in contact with the ground. The sapwood is non-susceptible to *Lyctus*.
See also the table on microscopic wood anatomy.

Botany Shrubs to medium-sized trees, up to 25(–32) m tall; bole up to 50(–65) cm in diameter, large trees sometimes have buttresses; bark surface narrowly fissured, scaly or flaky, greyish-brown to reddish-brown; branches usually opposite. Leaves opposite, simple, entire, 3-veined, pubescent below, exstipulate. Flowers in an axillary cluster or a 3–9-flowered dichasium, usually pedicellate, bisexual, 4(–5)-merous; calyx with persistent lobes; petals free, spreading, white or pale pink; stamens numerous, free; ovary inferior, unilocular with 2(–3) parietal placentas and many ovules, style filiform, stigma peltate. Fruit a globose drupe, 2–30-seeded. Seed reniform, enclosed by a horny or stony endocarp, embryo linear and curved, with small cotyledons. Seedling with epigeal germination; cotyledons resembling the leaves but smaller.
In natural forest *R. cinerea* develops very slowly in the first 2–3 years. The trees may flower gregariously 4–5 times a year. They flower already when still a small shrub. The sweet-scented flowers are pollinated by large numbers of bees, whereas the fruits are eaten by squirrels, monkeys, bats and birds, which disperse the seeds.
Rhodamnia is placed in the tribe *Myrteae* together with related genera such as *Rhodomyrtus*, *Decaspermum* and *Myrtus*. It is characterized by the 3-veined leaves (sometimes also found in *Rhodomyrtus*) and the unilocular ovary with 2(–3) parietal placentas..

Ecology *Rhodamnia* species usually occur in secondary lowland and lower montane forest, up to 1400(–2400) m altitude, and more rarely in primary forest. Locally, they may be very common, e.g. *R. cinerea* in Peninsular Malaysia which grows in various habitats but with a preference for open places in the forest.

Silviculture *Rhodamnia* may be propagated by seed. *R. cinerea* has about 15000 air-dry fruits/kg. In a trial in Peninsular Malaysia seed of *R. cinerea* showed only about 20% germination in 3 weeks to 5 months. In mountain forest of Java *R. cinerea* displayed a good natural regeneration; most seedlings were found in gaps or under a light canopy.

Genetic resources and breeding *Rhodamnia* trees are only logged for their timber very locally and on a small scale. There seems to be no particular danger of genetic erosion. *R. cinerea* is planted in several botanical gardens in the region.

Prospects As *Rhodamnia* trees seldom reach a large size, their use as a timber is not expected to increase. Its utilization for special purposes will continue to be of local importance.

Literature 101, 163, 209, 260, 267, 394, 395, 405, 436, 464, 469, 634, 829, 831, 861, 988, 998, 1037, 1221, 1232, 1242.

Selection of species

Rhodamnia cinerea Jack

Synonyms *Rhodamnia trinervia* auct. non (J.E. Smith) Blume.

Vernacular names Indonesia: andong (Javanese), ki beusi (Sundanese), merampuyan (Bangka). Malaysia: mempoyan bukit, menkoyan pinang (Peninsular). Burma (Myanmar): taungkamyaing. Thailand: khee tai, phae, ya waeng (peninsular).

Distribution Southern Burma (Myanmar), southern Thailand, Peninsular Malaysia, Sumatra, Belitung, Bangka, Java and Borneo; possibly also in the Moluccas.

Rhodamnia latifolia (Benth.) Miq.

Synonyms *Rhodamnia lamprophylla* Diels, *Rhodamnia polyantha* Diels.

Distribution The Moluccas, New Guinea and New Britain.

Rhodamnia moluccana Burret

Distribution Eastern Java, the Lesser Sunda Islands, Sulawesi, the Moluccas and New Guinea.

Rhodamnia pachyloba A.J. Scott

Distribution The Moluccas and Irian Jaya.

Noorma Wati Haron

Rhodoleia Champion ex Hook.

Curtis' Bot. Mag., ser. III, 6: t. 4509 (1850).

HAMAMELIDACEAE

$x = 12$; *R. championi*: $2n = 24$

Vernacular names Indonesia: kasiebranah (Sumatra), sialagundi (Tapanuli). Malaysia: kerlik, keruntum (Peninsular). Vietnam: l[oo]t.

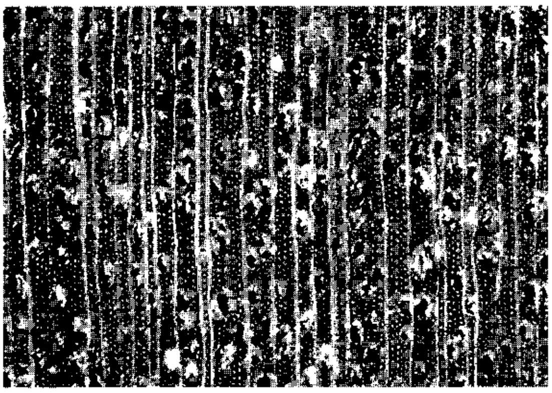
Origin and geographic distribution *Rhodoleia* is probably monotypic and is distributed from Upper Burma (Myanmar) to southern China, Hainan and Vietnam, and in Peninsular Malaysia and Sumatra. The only species is *R. championi* Hook. (synonyms: *R. ovalifolia* Ridley, *R. subcordata* Exell, *R. teysmannii* Miq.). In recent years 3 new species have been described from China but these may well prove to be synonymous with the former one.

Uses The wood of *R. championi* is used for interior finish.

R. championi has been planted in Peninsular Malaysia, mountainous parts of West Java and probably also in China for ornamental purposes. In Sumatra it has been planted as a fire-break.

Production and international trade Utilization of the wood of *R. championi* is very limited and on a local scale only.

Properties *R. championi* yields a medium-weight hardwood with a density of 645–860 kg/m^3 at 15% moisture content. Heartwood red-brown, not sharply differentiated from the paler sapwood; grain interlocked; texture fine and even; wood with narrow stripe figure on radial surface due to alternating grain; wood lustrous, fragrant when fresh. Growth rings usually not distinct, occasionally indicated by a narrow layer of denser tissue; vessels very small to moderately small, mostly solitary with few radial pairs, angular, open; parenchyma absent; rays fine, not always visible to the naked eye due to lack of contrast in colour; ripple marks absent.



Rhodoleia championi
transverse surface (×20)

The wood seasons moderately fast with slight surface and end checking. The wood is strong and can be fairly easily sawn. It takes a very smooth finish and an excellent polish. It is durable for interior use, but non-durable when exposed to the weather or in contact with the ground.

See also the table on microscopic wood anatomy.

Botany Evergreen, small to medium-sized trees up to 25(–33) m tall; bole up to 45(–100) cm in diameter; bark surface smooth, with large lenticels and scaly patches, inner bark firm, pink-buff, spotted brown inwards. Leaf buds rounded, scaly. Leaves arranged spirally, simple, entire, with long petioles, leathery, bluish-grey to whitish below; stipules generally present only in the transition zone between bud scales and foliage leaves. Flowers connate, 5–10 together in a large, nodding, peduncled head with an involucre of 12–20 bracts and resembling a single flower, bisexual; sepals connate; petals only well developed and rayed along the outer margin of the head, red; stamens 7–11; disk absent; ovary semi-inferior, (1–)2-locular with many ovules in each cell, styles 2, long and slender. Fruit a 4-valved, woody capsule,

basally connate. Seed 10–20 per cell of which 0–1 is fertile.
Vegetative growth is flush-wise. In Java flowers have been observed throughout the year, but in Hong Kong flowering seems restricted to February and March. Birds, such as sun-birds, and various kinds of insects (bumble bees, flies, wasps) have been observed to visit the flowers. The flowers produce nectar, starting at daybreak, and have sticky pollen. The fruit takes about 6 months to mature.
Rhodoleia is the only genus of the subfamily *Rhodoleioideae*. It used to be thought that it lacked stipules, until it was discovered that these are restricted to certain parts of the plant (see above). *R. championi* is highly polymorphic and was formerly divided into at least 7 distinct species.

Ecology *R. championi* occurs in primary forest or rarely in secondary vegetation, at (350–)1400–2500 m altitude.

Silviculture *R. championi* can be raised from seed. There are about 440 000 dry seeds per kg. Seeds of *R. championi* germinate in 10–24 days. Wildlings have been used for reforestation, but mortality was fairly high.

Genetic resources and breeding The risk of genetic erosion is low, as *R. championi* is hardly harvested for its timber and is planted as an ornamental.

Prospects In the future its use as an ornamental may become more important than as a timber.

Literature 70, 163, 267, 279, 314, 341, 343, 379, 405, 709, 790, 829, 831, 861, 1221, 1242.

E. Boer & M.S.M. Sosef

Rhopaloblaste R. Scheffer

Ann. Jard. Bot. Buitenzorg 1: 137 (1876).
PALMAE
$x = 16$; *R. ceramica*: $n = 16$

Origin and geographic distribution *Rhopaloblaste* comprises 6 species occurring in the Nicobar Islands, southern Peninsular Malaysia (Johor), Singapore, and in the Moluccas, New Guinea and the Solomon Islands.

Uses The scraped poles of *Rhopaloblaste* can be made into spear handles and good-quality walking sticks. In Papua New Guinea they are traditionally used for roofs.
R. singaporensis is occasionally grown as an ornamental. *R. ceramica* and *R. augusta* (Kurz) H.E. Moore have also sporadically been grown as an ornamental.

Production and international trade Utilization of the wood of *Rhopaloblaste* is limited and on a local scale only.

Properties The wood of *Rhopaloblaste* is black.

Botany Unarmed, monoecious, pleonanthic, single-stemmed or multi-stemmed, small to medium-sized palms up to 20 m tall (outside Malesia to 30 m); pole straight, slender, up to 30 cm in diameter, often swollen at base. Leaves pinnate; sheaths forming a tubular crown-shaft; leaflets linear and acute or sometimes bifid apically, with a pulvinus at base, only the midrib elevated above. Inflorescence borne below the leaves, branching divaricate-spreading to 3 orders; prophyl tubular and enclosing the similar peduncular bract; rachis bearing horizontally-oriented pairs of male flowers towards the apex and triads of a female flower and 2 lateral male ones towards the base. Flowers with 3 sepals and 3 petals, all free, in bud the outer sepal largely enfolding the remainder of the perianth. Male flowers more or less symmetrical, with 6–9 stamens which are free to very briefly connate at base. Female flowers with a unilocular ovary and a single ovule, stigmas 3. Fruit a drupe, smooth, orange-yellow to red at maturity. Seed with an operculum covering the embryo. Seedling with adjacent-ligular germination; first two leaves consisting of bladeless sheaths, followed by a pinnate eophyll or first leaf.
In Papua New Guinea young fruits of *R. dyscrita* have been observed in January and May. The fruits are eaten by white cockatoos.
Rhopaloblaste is an arecoid palm genus and presently also includes *Ptychoraphis*.

Ecology *Rhopaloblaste* species are found in lowland rain forest, mainly as elements of the understorey.

Silviculture *Rhopaloblaste* can be propagated by seed which remains viable for only 2–3 weeks.

Genetic resources and breeding *R. singaporensis* is planted e.g. in the Arboretum of the Forest Research Institute Malaysia, Kepong and in the Singapore Botanic Garden.

Prospects It is unlikely that the wood of *Rhopaloblaste* will be increasingly used.

Literature 163, 167, 236, 436, 564, 797, 807, 1110.

Selection of species

Rhopaloblaste ceramica (Miq.) Burrett
Synonyms *Rhopaloblaste hexandra* R. Scheffer.
Distribution The Moluccas (Bacan, Seram).

Rhopaloblaste dyscrita H.E. Moore
Synonyms *Rhopaloblaste micrantha* Burrett.
Distribution Papua New Guinea.

Rhopaloblaste singaporensis (Becc.) Hook. f.
Synonyms *Ptychoraphis longiflora* Ridley, *Ptychoraphis singaporensis* (Becc.) Becc.
Vernacular names Malaysia: kerinting, rinting (Peninsular).
Distribution Peninsular Malaysia and Singapore.

E. Boer (general part),
M.S.M. Sosef (general part, selection of species)

Ryparosa Blume

Bijdr. fl. Ned. Ind. 12: 600 (1826).
FLACOURTIACEAE
x = unknown; $2n$ = unknown

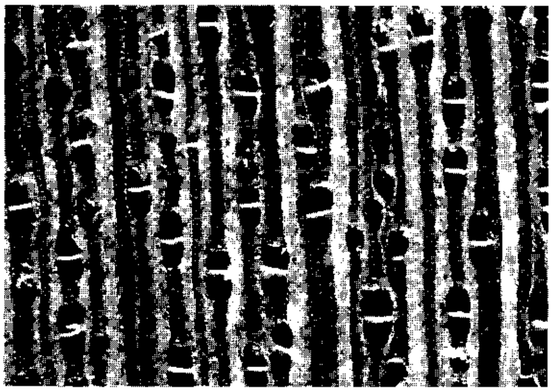
Vernacular names Malaysia: pehapan ruai (Iban, Sarawak).

Origin and geographic distribution *Ryparosa* comprises about 18 species occurring in southern Burma (Myanmar), the Andaman and Nicobar Islands, Thailand, Peninsular Malaysia, Sumatra, Java, Borneo, the Philippines, the Lesser Sunda Islands and New Guinea. Malesia harbours 16 species.

Uses The wood of *Ryparosa* has been applied in local house building (poles, beams) and bridge building.
The fruits of several species are sour but edible.

Production and international trade The wood of *Ryparosa* is probably used only locally. Small amounts may enter the market in mixed consignments of medium-weight hardwood.

Properties *Ryparosa* yields a medium-weight to heavy hardwood with a density of 460–920 kg/m^3 at 15% moisture content. Heartwood pale yellow to yellow-brown, not clearly differentiated from the sapwood; grain straight or interlocked, sometimes deeply interlocked; texture fine to moderately fine, even. Growth rings usually lacking, occasionally visible as tangential arrangement of vessels, or as differences in fibre density; vessels



Ryparosa javanica
transverse surface (×20)

medium-sized, solitary and in radial groups of 2–4, mostly open; wood parenchyma sparse, scanty paratracheal, barely visible with a hand lens; rays medium-sized, conspicuous to the naked eye; ripple marks absent.
The wood is moderately hard to hard. It is moderately durable to durable. The sapwood is susceptible to *Lyctus*.
See also the table on microscopic wood anatomy.

Botany Dioecious, small to medium-sized trees up to 25(–35) m tall; bole usually straight, up to 60 cm in diameter, rarely with buttresses up to 1.5 m high; bark surface smooth, becoming slightly scaly, brown to grey, inner bark granular, yellowish with reddish spots, smelling strongly of cyanide. Leaves arranged spirally to subopposite, simple, entire, often with T-shaped hairs, exstipulate; petiole usually thickened and kneed at both ends. Flowers unisexual, small, in an axillary, elongated, spike-like raceme, or on tubercles on the stem, raceme solitary or 2–3 together; calyx 3–4-lobed; petals 4–5, with a hairy appendage at base inside. Male flowers with (4–)5 stamens, filaments usually connate. Female flowers with ovary superior, densely haired, unilocular with few ovules, styles 2–3, stigma sessile or nearly so. Fruit a globose or angular, leathery berry, with seeds embedded in a little pulp. Seedling with epigeal germination; cotyledons not emergent; hypocotyl elongated; first pair of leaves opposite or subopposite, subsequent ones arranged spirally.
In Java flowering of *R. javanica* has been observed from April to December. *R. hullettii* flowers in October–May and bears fruits from December to July. Ripe fruits are probably dispersed by animals.

Ecology Timber-producing *Ryparosa* species occur scattered in primary or rarely secondary lowland or less frequently lower montane rain forest, up to 1200(–1500) m altitude. They have been reported from mixed dipterocarp forest, kerangas and peat-swamp forest.

Silviculture *Ryparosa* can be propagated by seed. The seedlings develop poorly in the nursery, however, as the testa becomes hard when dry, trapping the epicotyl inside. Subsequently, the seedling starts to rot from the top and dies. *R. kunstleri* proved very susceptible to this in the nursery, and watering the seedlings twice a day could not prevent a high mortality. The only way to save such seedlings is to remove the testa by hand as soon as the epicotyl is seen to be trapped. Seed of *R. kunstleri* germinates for about 75% in 25–29 days, but seed in pulp gives less than 10% germination. *R. acuminata* Merr. has 40–50% germination in 14–25 days and *R. scortechinii* King about 50% in 26–42 days. Sowing fruits of the latter resulted in a germination percentage of about 40%.

Genetic resources and breeding There are no records of *Ryparosa* in seed or germplasm collections. Some of the endemic species may be vulnerable to genetic erosion by destruction of the habitat.

Prospects Since supplies are limited it is unlikely that the use of *Ryparosa* timber will increase.

Literature 61, 70, 162, 163, 180, 198, 267, 340, 341, 436, 809, 827, 829, 831, 861, 1028, 1038, 1135, 1221, 1232.

Selection of species

Ryparosa fasciculata King

Synonyms *Ryparia fasciculata* (King) Ridley.

Vernacular names Malaysia: mesekang puteh, tajam belat, tukol (Peninsular).

Distribution Peninsular Malaysia.

Ryparosa hirsuta J.J. Smith

Vernacular names Malaysia: poh-poh (Sarawak).

Distribution Borneo.

Ryparosa hullettii King

Synonyms *Ryparosa borneensis* v. Slooten, *Ryparosa oligophlebia* Merr.

Vernacular names Brunei: chandarai, chandari. Indonesia: kepayang bangai, sumpit-sumpit (South Kalimantan). Malaysia: pitoling, sireh-sireh, tampasak busong (Sabah).

Distribution Peninsular Malaysia, Singapore and Borneo.

Ryparosa javanica (Blume) Kurz ex Koord. & Valeton

Synonyms *Ryparosa kurzii* King, *Ryparosa longipedunculata* Boerl., *Ryparosa wrayi* King.

Vernacular names Indonesia: cingkuang (Sumatra), ki mengati, ki sijung (Sundanese). Thailand: ai bao, dang khao, phong kraak (peninsular).

Distribution The Andaman and Nicobar Islands, southern Burma (Myanmar), peninsular Thailand, Peninsular Malaysia, Sumatra, Borneo, Java, the Lesser Sunda Islands, New Guinea and Queensland (Australia).

Ryparosa kunstleri King

Synonyms *Xanthophyllum hebecarpum* Chod.

Vernacular names Indonesia: kalet akar mambu, kepayang rimbu, kubang-kubang (Sumatra). Malaysia: kelat, tembasah (Peninsular).

Distribution Peninsular Malaysia and Sumatra.

Ryparosa multinervosa v. Slooten

Vernacular names Indonesia: elul sawali, sikasa ilir, taramayang silai (Simeuluë).

Distribution Sumatra (Simeuluë).

R.E. Nasution

Sageraea Dalzell

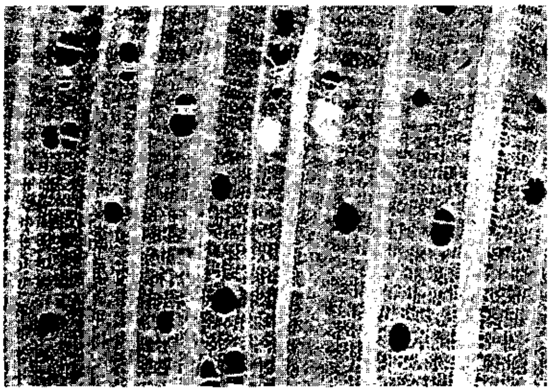
Hook. Journ. Bot. Kew Gard. Misc. 3: 207 (1851).
ANNONACEAE
x = unknown; $2n$ = unknown

Vernacular names Mempisang (trade name). Andaman bow wood (En). Chooi (Indian trade name). Malaysia: pisang pisang (Peninsular), karai (Sabah). Vietnam: sang mai.

Origin and geographic distribution *Sageraea* comprises 9 species occurring in India, Sri Lanka, The Andaman Islands, Burma (Myanmar), Indo-China, Thailand, Peninsular Malaysia, Sumatra, Borneo, the Philippines and North Sulawesi.

Uses The hard and very flexible wood of *Sageraea* is especially useful for bows, boat building (e.g. ribs), striking tool handles, billiard cues, golf clubs, fishing rods and turnery. It has also been used for power transmission poles and bent-wood camping furniture.

Production and international trade The use



Sageraea lanceolata
transverse surface (×20)

and trade of *Sageraea* wood is on a local scale only.

Properties *Sageraea* yields a medium-weight to heavy hardwood with a density of 560–900 kg/m^3 at 15% moisture content, *S. elliptica* has a density of 810–860 kg/m^3. Heartwood yellowish-white, sometimes with a pinkish tinge, not clearly differentiated from the sapwood; grain straight; texture fine and uneven; wood with silver grain and lustrous. Growth rings mostly distinct, indicated by a narrow layer of denser tissue and closer spacing of fine parenchyma strands; vessels moderately small to medium-sized, solitary, in radial multiples of 2–4, sometimes in small clusters, open with occasional chalky white deposits; parenchyma abundant, apotracheal in regular, narrow bands (scalariform); rays medium-sized to very broad, fine rays few; ripple marks absent.
The wood seasons fairly well but needs care to prevent stain. It is hard, fairly strong and tough. It is rather difficult to fairly easy to work, turns very well but picking up of the grain may occur in planing. It is suitable for steam bending. It is slightly to moderately durable.
The mean fibre length is about 1.22 mm.
See also the table on microscopic wood anatomy.

Botany Evergreen, small to medium-sized trees up to 30 m tall; bole straight, without buttresses, sometimes fluted at base; bark surface grey or brownish-grey. Twigs slightly angled. Leaves alternate, simple, entire, leathery, exstipulate. Inflorescence axillary or ramiflorous, rarely cauliflorous. Flowers in a 1–several-flowered fascicle on a woody tubercle or rarely subsessile in a leaf axil, small, bisexual or unisexual; sepals 3, imbricate, free or connate; petals 6, in 2 whorls, imbricate, white, warty, outer ones longer; stamens 7–40, connective squarely truncate above; carpels 1–7(–10), free, each with 6–12 ovules in 2 rows, style absent or very short, stigma capitate. Fruit apocarpous, with 1–6 monocarps, each monocarp sessile, globose to broadly ellipsoid, 2–12-seeded, with a thin, crustaceous to woody wall. Seed semi-ellipsoid to semi-orbicular; testa papyraceous to crustaceous.
Sageraea belongs to the tribe *Uvarieae* and is most closely related to the genera *Phoenicanthus* and *Stelechocarpus*.

Ecology *S. elliptica* and *S. lanceolata* are fairly common in primary or secondary lowland rain forest, up to 600 m altitude. The former has been reported from rocky sides of rivers.

Genetic resources and breeding Being fairly common and little-used *Sageraea* does not face a serious risk of genetic erosion.

Prospects Because of its hard and elastic wood *Sageraea* may have future potential for specialty purposes.

Literature 163, 192, 218, 267, 464, 468, 861, 1017, 1038, 1098, 1126, 1128, 1134, 1221.

Selection of species

Sageraea elliptica (A. DC.) Hook. f. & Thomson

Synonyms *Bocagea elliptica* (A. DC.) Hook. f. & Thomson, *Sageraea hookeri* Pierre.

Vernacular names Thailand: kamok khao, laa mok (south-eastern).

Distribution Burma (Myanmar), Indo-China, Thailand and Peninsular Malaysia.

Sageraea lanceolata Miq.

Synonyms *Sageraea glabra* Merr.

Vernacular names Malaysia: melilin (Peninsular). Philippines: manalau (Tagalog).

Distribution Peninsular Malaysia, Sumatra, Borneo, the Philippines and North Sulawesi.

E. Boer (general part),
M.S.M. Sosef (general part, selection of species)

Sandoricum Cav.

Diss. 7: 359 (1789).
MELIACEAE
x = unknown; *S. koetjape*: $2n$ = 16, 22, 28, 32, 44

Vernacular names Sentul (trade name). Katon (En). Brunei: kalampu, kelampu. Indonesia:

kecapi. Malaysia: kecapi, sentol (general), kelampu (Sabah, Sarawak), langsat kera (Sarawak). Philippines: santol, santor. Burma (Myanmar): thitto. Cambodia: kompeng reach. Laos: tong[2]. Thailand: kra thon. Vietnam: s[aa][us]-dau, su, xoan dau.

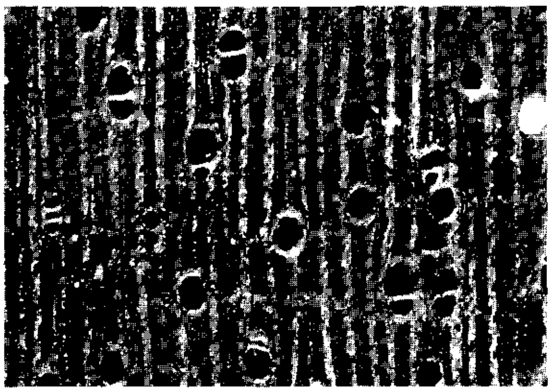
Origin and geographic distribution *Sandoricum* comprises 5 species, four of which are restricted to western Malesia. The fifth, *S. koetjape*, is commonly cultivated mainly for its fruit and frequently naturalized from India, Burma (Myanmar) and Indo-China to Thailand, the whole of the Malesian region, and tropical Australia and even in the New World tropics. Timber plantations of *S. koetjape* have been established in Burma (Myanmar).

Uses The wood of *Sandoricum* is used for house construction, furniture, cabinet work, joinery, interior construction, shop fitting, panelling, planking and decking of boats, scantlings, carving, butchers' chopping blocks, packing cases, household implements, agricultural implements and sandals. The wood is also used for the production of veneer and plywood, blockboard, and for pulp and paper. It yields a good-quality charcoal, and is used as firewood in Indonesia.

S. koetjape is a well-known fruit tree, the fruits being eaten fresh or processed into jam and chutney. The fruits of the other *Sandoricum* species are edible but less palatable. *S. koetjape* is also an excellent shade tree with ornamental value, is planted as an avenue tree, and is suitable for use in shelter-belts. Its pounded leaves are sudorific when applied to the skin and are used to make a decoction against diarrhoea and fever. The powdered bark is an effective treatment for ringworm, shows anti-cancer activity, and has been used for tanning fishing nets. The roots are employed as an anti-diarrhetic, anti-spasmodic, carminative, stomachic and are prescribed as a general tonic after childbirth. Limonoids isolated from the seeds showed insecticidal activity. Fruits of *S. borneense* have been used as fish bait in Sarawak.

Production and international trade The annual production of *Sandoricum* wood in Thailand at the end of the 1970s was estimated at 12 000 m^3; part of this was exported to Great Britain. In Europe the timber has been applied for furniture and interior finishing. In Malaysia, and probably also elsewhere, the timber is traded in mixed consignments of medium-weight hardwood.

Properties *Sandoricum* yields a lightweight to medium-weight hardwood with a density of 290–590 kg/m^3 at 15% moisture content. Heartwood pale red, yellowish-red or yellow-brown with a pink tinge, indistinct or distinguishable from the pale white or pinkish sapwood; grain straight or slightly wavy; texture moderately fine to slightly coarse and even; wood occasionally with fiddleback figure, with characteristic faint odour, especially when fresh. Growth rings mostly indistinct, when distinct sometimes marked by a narrow marginal parenchyma band; vessels small to medium-sized, solitary and in radial multiples of 2–3, gum-like deposits sometimes present; parenchyma moderately abundant, paratracheal vasicentric, aliform to confluent, sometimes apotracheal diffuse, occasionally in narrow marginal bands; rays moderately fine, barely visible to the naked eye; ripple marks absent; axial traumatic canals occasionally present.



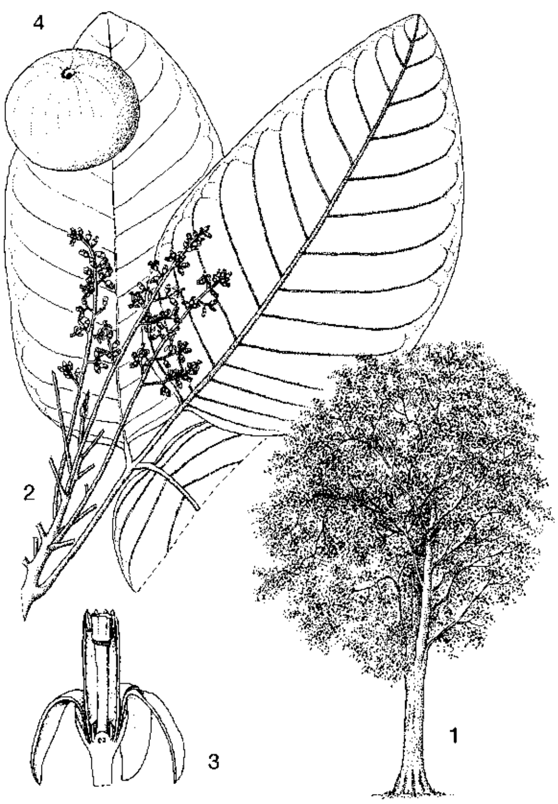
Sandoricum koetjape
transverse surface (×20)

Shrinkage upon seasoning is low to high; the wood seasons well and is not subject to checking and splitting, although material from Sarawak was difficult to dry due to uneven shrinkage with a tendency to collapse. The wood is moderately soft to moderately hard, fairly weak to moderately strong. It is easy to saw and and can be planed and finished with good results, occasionally a little furry, and takes a high polish. The wood is non-durable when exposed to the weather or in contact with the ground, fairly durable under cover. The heartwood is resistant but sapwood amenable to preservative treatment. The wood is susceptible to marine borer attack and moderately resistant to insect attack. The sapwood is susceptible to *Lyctus*.

The stem of *S. koetjape* yields anti-cancer compounds (triterpenes), and anti-feedant compounds (limonoids) have been extracted from its seed. The gross energy value of the sapwood is 19 780 kJ/kg.

The mean fibre length of wood of *S. koetjape* is 1.65 mm.
See also the table on microscopic wood anatomy.

Botany Semi-deciduous, small to large trees, up to 45(–50) m tall; bole sometimes straight, but often crooked or fluted, branchless for up to 18(–21) m, up to 75(–100) cm in diameter, usually with buttresses up to 3 m high; bark surface smooth or sometimes flaky or fissured, lenticellate, greyish to pale pinkish-brown, inner bark pale brown or red-brown to pink, exuding a milky latex; crown rather compact. Leaves arranged spirally, 3-foliolate, exstipulate; leaflets entire. Flowers in an axillary thyrse, bisexual, 4–5-merous; calyx truncate to shallowly lobed; petals free; staminal tube cylindrical, carrying 10 anthers; disk tubular; ovary superior, 4–5-locular with 2 ovules in each cell, style-head lobed. Fruit a 1–5-locular drupe; pyrenes 1(–2)-seeded. Seed without aril. Seedling with epigeal germination; cotyledons emergent; hypocotyl elongated; first pair of leaves opposite, 3-foliolate, subsequent pairs alternate.



Sandoricum koetjape (Burm. f.) Merr. – 1, tree habit; 2, flowering twig; 3, sectioned flower; 4, fruit.

Seedling growth is fast and flowering starts after 5–7 years, whereas clonally propagated trees may flower already after 3–4 years. Trees are semi-deciduous after a prolonged dry spell, rarely becoming completely leafless. New leaves develop rapidly and flowers appear shortly after the development of new shoots. *S. koetjape* trees flower annually and in Peninsular Malaysia the flowering period is so reliable in its timing that it was formerly the signal for the planting of rice. Pollination is by insects. Fruit maturation takes about 5 months, but other reports mention only 2–3 months. In the Philippines ripe fruits are present from June to October, and in Thailand from May to July. It has been suggested that bats disperse *S. koetjape* seed. *S. koetjape* is known to form vesicular-arbuscular mycorrhizae.

S. koetjape is highly variable and was formerly divided into 2 or 3 species, often associated with the 'red sentol' and 'yellow sentol' based on the colour of the old leaves. As there appeared to be no correlation with other characters, the distinction could not be upheld.

Ecology *Sandoricum* occurs scattered in primary or sometimes secondary rain forest, up to 1200 m altitude. *S. koetjape* has been reported from lowland dipterocarp forest but also from kerangas on podzolic soils in both perhumid and seasonal climates. *S. beccarianum* is locally co-dominant in peat-swamp forest.

Silviculture *Sandoricum* can be propagated by seed, but *S. koetjape* is also propagated by vegetative means like budding, grafting, inarching and marcotting. Seed, however, can not be stored for any length of time. *S. koetjape* seed with or without the adhering pulp have 90–95% germination in 16–31 days. The density of *S. koetjape* trees of over 40 cm diameter in natural forest in Peninsular Malaysia is 2.0 per 100 ha.

Genetic resources and breeding Various cultivars of the fruit tree *S. koetjape* exist, including tetraploid ones. Important tree collections are held in the Philippines, Malaysia and Thailand.

Prospects Little is known on the silviculture of *Sandoricum* and, as the wood quality is only moderate, it is not very likely that its wood will be increasingly used for sawn timber.

Literature 57, 151, 163, 209, 218, 238, 260, 267, 278, 341, 436, 464, 521, 536, 729, 780, 825, 829, 831, 861, 867, 878, 900, 908, 933, 934, 947, 977, 1038, 1040, 1052, 1065, 1098, 1123, 1164, 1169, 1213, 1221, 1232, 1239, 1242.

Selection of species

Sandoricum beccarianum Baillon

Synonyms *Sandoricum emarginatum* Hiern.

Vernacular names Indonesia: kecapi kera, sentul kera, sentul kerok (Sumatra). Malaysia: gapas-gapas, kapas-kapas (Sabah), kelampu apau (Sarawak).

Distribution Thailand, Peninsular Malaysia, Sumatra and Borneo.

Sandoricum borneense Miq.

Vernacular names Malaysia: apoh (Kaya, Sarawak), apok (Kenyah, Sarawak).

Distribution Borneo.

Sandoricum koetjape (Burm. f.) Merr.

Synonyms *Sandoricum indicum* Cav., *Sandoricum maingayi* Hiern, *Sandoricum nervosum* Blume, *Sandoricum vidalii* Merr.

Vernacular names Kechapi, santol, sentol (En). Brunei: kelampu. Indonesia: kecapi, ketuat, sentul (general). Malaysia: kecapi, sentol (general), kelampu (Sabah, Sarawak). Philippines: malasantol, santol (general). Burma (Myanmar): thitto. Cambodia: kompeng reach. Laos: tong[2]. Thailand: katon (general), kra thon (central), sa thon (peninsular). Vietnam: s[aa][us]-dan, s[aa][us]-dau.

Distribution Commonly planted and naturalized in the Asiatic tropics, probably native only to the Malesian region. It is also cultivated in the Mascarenes, the New World tropics and under glass in Europe.

Salma Idris

Sapium P. Browne

Civ. nat. hist. Jamaica II: 338 (1756).

EUPHORBIACEAE

$x = 11$; *S. baccatum*: $n = 22$, *S. insigne* (Royle) Benth.: $n = 22$ (+ 0–3B), *S. sebiferum*: $n = 44$

Vernacular names Ludai (trade name). Malaysia: gurah (Peninsular, Sarawak).

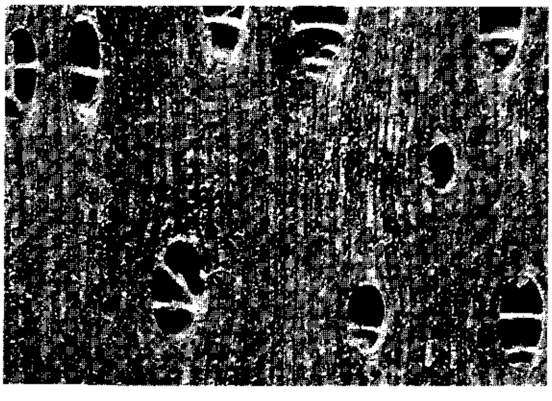
Origin and geographic distribution *Sapium* is a pantropical genus and comprises about 100 species, most of which occur in South America, and the rest in Africa and Asia. Some 6 species are present within Malesia and 1 other (*S. sebiferum*) has been introduced into the region.

Uses The soft and non-durable wood of *Sapium* is suitable for temporary construction, boxes and crates, small tool handles, and as core veneer in the production of plywood. It is also suitable for making particle board. When mixed with other species, the pulp is suitable for the production of writing paper. The wood of *S. sebiferum* yields a good quality fuel.

The mealy but very sweet fruits of *S. baccatum* are edible. These fruits and those of *S. discolor* are used in Peninsular Malaysia for baiting traps set for mousedeer. In Taiwan logs of *S. discolor* are an important medium for shiitake mushroom cultivation. *S. sebiferum* is well-known because its seedcoat yields tallow that can also be used to manufacture soap, and the seed is a rich source of 'stillinga oil' used as an illuminant and which may be used as a substitute for tung or linseed oil. The leaves of *S. sebiferum* have been used to dye silk black. The male flowers are important for the production of honey and pollen. The trees are planted as ornamentals and are considered useful in India for stabilizing the banks of streams and rivers. In China they are also interplanted with tea. In Texas, United States, the white seeds are used in decorative flower arrangements. A disadvantage is that *S. sebiferum* can be an aggressive weed, which is easily spread by birds and difficult to eradicate as it sprouts profusely from stumps and is highly resistant to herbicides.

Production and international trade The wood of *Sapium* is seldom used but may reach the market only in mixed consignments of lightweight hardwood.

Properties *Sapium* yields a lightweight hardwood with a density of 285–470 kg/m^3 at 15% moisture content. Heartwood pale yellow-brown, not clearly differentiated from the sapwood; grain straight to deeply interlocked, occasionally wavy; texture moderately coarse and even; longitudinal



Sapium insigne (Royle) Benth. transverse surface (×20) faces dotted with numerous latex traces. Growth rings sometimes distinct, indicated by darker and denser tissue; vessels medium-sized to moderately large, solitary and in radial multiples of 2–4, conspicuously open; parenchyma moderately abundant, apotracheal in narrow bands to diffuse-in-aggregates, usually visible to the naked eye; rays very fine or moderately fine, visible with a hand lens; ripple marks absent; latex traces may be mistaken for radial latex canals.

Shrinkage upon air drying is low. Air drying is fairly rapid, 13 mm thick boards take about 2 months and 38 mm thick boards about 3 months. Major degrade during seasoning can be caused by moderately severe insect attack and stain, whereas bowing during seasoning is only slight. The wood is soft and weak. *S. baccatum* is easy to saw and plane, giving a smooth surface; *S. luzonicum* is reportedly very difficult to saw, as the tough fibres clog and pinch the saw and crystals easily dull the saw blade. The wood is non-durable under exposed conditions, but it is extremely easy to impregnate both heartwood and sapwood. In an experiment using different open tank methods and a 50/50 mixture of creosote and diesel, cold soaking gave an absorption of 73 kg/m^3, whereas hot soaking at different temperatures yielded figures between 115 and 354 kg/m^3. The sapwood is susceptible to *Lyctus*.

The gross energy value of the wood is 17 300–17 900 kJ/kg. The latex is irritant and blisters the skin.

See also the tables on microscopic wood anatomy and wood properties.

Botany Deciduous, monoecious, small to medium-sized trees up to 30(–39) m tall; bole columnar to sinuous, up to 60(–95) cm in diameter, sometimes fluted at base, sometimes with steep buttresses; bark surface smooth to finely cracked, greyish, in *S. baccatum* becoming coarsely fissured and dark brown with age, inner bark finely fibrous, often yellowish-brown, with or without white latex. Leaves arranged spirally, simple, entire to serrate; petiole with 2 glands at apex, red; stipules minute. Flowers in an axillary or terminal simple spike or raceme of spikes, male or female ones in different inflorescences or with a few female flowers at base of the otherwise male spike; calyx small, 2–3-lobed; petals absent; disk absent. Male flowers fascicled; stamens 2–3, free or shortly connate; pistillode absent. Female flowers solitary; ovary superior, 2–3-locular with 1 ovule in each cell, styles basally connate, stigmas entire. Fruit a small, woody or leathery capsule dehiscing into 4–6 parts often leaving the central column. Seed black, with a thin, fleshy sarcotesta. Seedling with epigeal germination; cotyledons emergent; hypocotyl elongated; first pair of leaves opposite, subsequent ones arranged spirally.

Sapling growth of *S. discolor* is intermittent; at the end of the season the leading shoot dies back and one or two of the variably whorled twigs take its place, thus leading to a seemingly dichotomous branching pattern. This tree shape is according to Koriba's architectural model. In India a mean annual diameter increment of 0.8–1.7 cm has been recorded for *S. sebiferum*; early growth may be very rapid, plants attained 12 cm in diameter and 4.8 m in height after only 3 years and 9 months. In Peninsular Malaysia a mean annual diameter increment of 1.2–1.6 cm has been recorded for *S. baccatum*. An annual production of 22–26 m^3/ha in a 4-year rotation has been recorded for firewood plantations in Texas, United States. In Peninsular Malaysia *S. baccatum* flowered in April–May though not in all years of observation, but fruits never developed. It produced new leaves in February–April and sometimes also in July–September. *S. discolor* renews its leaves after a pronounced dry spell. Birds and mammals eat the sarcotesta of the seeds and thus disperse them.

The generic boundaries between *Sapium* and related genera (e.g. *Excoecaria*) are not very clear, and various taxonomic publications treat some of the species mentioned here in various other genera. The delimitation followed here represents a conservative view.

Ecology *Sapium* species are scattered in well-drained primary and secondary, evergreen to deciduous rain forest, up to 800(–1800) m altitude.

Silviculture *Sapium* can be propagated by seed or by cuttings. For *S. sebiferum* 8300–8500 seeds/kg and 1–3 seeds/fruit have been reported. Seeds of *S. baccatum* have only about 5% germination in 54–95 days. Seeds stored in sealed containers remain viable for at least two years. Germination of *S. baccatum* is inhibited by dense shade; the seeds remain viable in the soil for at least 6 months. *S. sebiferum* is frost-hardy in India, coppices well, produces root suckers and is not grazed by cattle.

Genetic resources and breeding Thanks to their extensive area of distribution, none of the *Sapium* species except *S. luzonicum* seems in danger of genetic erosion; the latter has been depleted in the Philippines by deforestation.

Prospects *Sapium* may be increasingly planted to serve various purposes, including firewood, but its use as sawn timber is likely to decrease. The aggressive nature of *S. sebiferum* discourages its use.

Literature 26, 28, 33, 34, 40, 44, 64, 70, 163, 209, 235, 267, 387, 402, 436, 454, 632, 636, 641, 677, 678, 770, 785, 818, 829, 831, 934, 955, 974, 1038, 1104, 1169, 1195, 1221, 1239, 1242.

Selection of species

Sapium baccatum Roxb.

Synonyms *Excoecaria baccata* (Roxb.) Müll. Arg., *Sapium populifolium* Wallich ex Wight, *Stillingia baccata* (Roxb.) Baillon.

Vernacular names Mousedeer's rubber tree (En). Indonesia: banai (Simeuluë), budi, ludai (Sumatra). Malaysia: ludai pelandok, memaya (Peninsular). Thailand: pho bai (peninsular), salee nok (northern).

Distribution From the eastern Himalayas and northern India to Indo-China, southern China, Burma (Myanmar), Thailand, Peninsular Malaysia, Sumatra and Borneo (Kalimantan).

Sapium discolor (Champ. ex Benth.) Müll. Arg.

Synonyms *Excoecaria discolor* (Champ. ex Benth.) Müll. Arg., *Stillingia discolor* Champ. ex Benth.

Vernacular names Mousedeer's delight (En). Malaysia: ludai pelandok, memaya (Peninsular). Laos: i liền, lap lê, lap 'louang. Thailand: som, yuea chong (peninsular), takhian thao (south-eastern).

Distribution Indo-China, China, Japan, Taiwan, Thailand, Peninsular Malaysia, Singapore, Sumatra, Borneo and the Philippines.

Sapium luzonicum (S. Vidal) Merr.

Synonyms *Sapium lateriflorum* Merr., *Sapium merrillianum* Pax & K. Hoffm., *Urandra elliptica* Merr.

Vernacular names Philippines: balakat-gubat (Tagalog), magalmod (Tagbanua), maraotong (Iloko).

Distribution The Philippines.

Sapium sebiferum (L.) Roxb.

Synonyms *Excoecaria sebifera* (L.) Müll. Arg., *Stillingia sebifera* (L.) Mitch., *Triadica sebifera* (L.) Small.

Vernacular names Chinese vegetable tallow tree, soap tree, tallow tree (En). Arbre à suif (Fr).

Distribution Probably native to China only, but widely cultivated and locally naturalized throughout the tropics, notably in Pakistan, and also in Texas (United States).

Purwaningsih

Saraca L.

Mant. pl. 1: 98 (1767).

LEGUMINOSAE

$x = 12$; *S. declinata, S. indica, S. thaipingensis*: $2n = 24$

Vernacular names Saraca (En). Indonesia: kembang dedes, soka (general). Malaysia: babai (Iban, Sarawak), gapis, golak (Peninsular). Thailand: sok. Vietnam: v[af]ng anh.

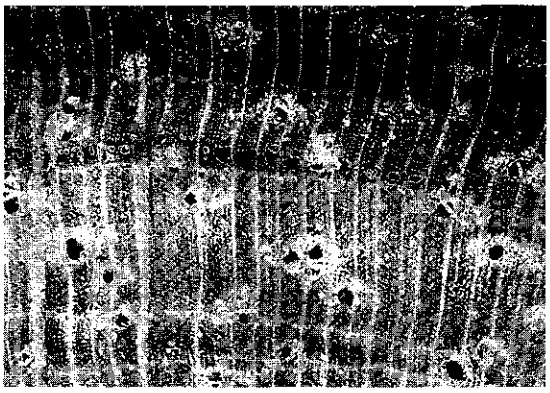
Origin and geographic distribution *Saraca* comprises 10 or 11 species distributed in India, Sri Lanka, Burma (Myanmar), Indo-China, China, Thailand, Peninsular Malaysia, Sumatra, Java, Borneo, Sulawesi, the Lesser Sunda Islands and the Moluccas; it is commonly planted within this region and has been introduced into the Philippines and Papua New Guinea. Within Malesia 7 species occur, and 1 species has been introduced.

Uses The wood of *Saraca* is used for light construction, packing cases, pallets, and small objects. The decorative root wood is used for bush-knife handles.

The timber-yielding species are commonly planted as ornamentals; they have scented, yellow to red or pink flowers. The leaves and flowers of *S. indica* are eaten locally in Thailand. In India the bark of *S. indica* is used in traditional medicine.

Production and international trade The wood of *Saraca* is used seldom and only locally.

Properties *Saraca* yields a medium-weight hardwood with a density of 470–730 kg/m³ at 15% moisture content. Heartwood dark grey-brown with darker streaks, sharply differentiated from the up to 10 cm wide sapwood, which is yellow-white with a pink tinge; grain shallowly interlocked; texture rather coarse and uneven due to the moderately large vessels and associated parenchyma; planed surface slightly lustrous. Growth rings distinct with a hand lens, boundaries indicated by a narrow layer of marginal parenchyma; vessels medium-sized to moderately large, solitary and in radial multiples of 2–3, occasionally filled with white chalky deposits; parenchyma abundant, apotracheal in narrow mar-



Saraca declinata
transverse surface (×20)

ginal or seemingly marginal bands, and paratracheal aliform, both types conspicuous; rays very fine, distinct on longitudinal surface; ripple marks absent.
Shrinkage upon seasoning is high. During seasoning, the sapwood is prone to stain and there is a slight risk of cupping. Boards of *S. thaipingensis* 13 mm and 38 mm thick take about 2 and 3–4 months respectively to air dry. The wood is moderately hard and moderately strong. It is fairly easy to saw and can be planed to a smooth surface, although some picking up may occur on radial surfaces. The wood is non-durable, the sapwood is susceptible to *Lyctus*. Absorption of a mixture of 50% creosote and 50% fuel-oil is 115–165 kg/m^3 for *S. thaipingensis*; the heartwood in these samples is difficult to impregnate, the sapwood absorbs preservatives well.
The aqueous extract of *S. indica* bark has shown considerable inhibitory activity to the AIDS virus (HIV type 1).
See also the tables on microscopic wood anatomy and wood properties.

Botany Evergreen shrubs or small to medium-sized trees up to 20(–29) m tall; bole often poorly shaped, short, up to 40(–60) cm in diameter, without buttresses but with many fine roots stretching out from the butt; bark smooth, sometimes lenticellate, dark brown. Leaves arranged spirally, paripinnate, 1–7-jugate; leaflets opposite, entire; stipules connate, usually caducous. Flowers densely packed in an axillary or terminal, corymb or panicle, sometimes on the branches, bisexual or male; bracteoles often colourful; pedicel articulate; calyx tubular, with 4(–6) lobes, petaloid; petals absent; disk absent; stamens (3–)4–8(–10), filaments free or fused into a short tube at base; ovary superior, on a short stalk, excentric, 1-locular with (2–)6–8(–12) ovules, style filiform. Fruit a flattened, 2-valved, coriaceous to woody, dehiscing pod, 1–8-seeded; valves twisting or coiling upon drying. Seed compressed, exarillate. Seedling with semi-hypogeal germination; cotyledons emergent, fleshy; hypocotyl elongated; epicotyl with scale leaves arranged spirally, followed by pinnate leaves.
S. thaipingensis develops according to Troll's architectural tree model, characterized by all axes being plagiotropic and built up by continuous superposition of branches thus forming a sympodial stem. New leaves are drooping and pale and appear fairly frequently after short periods of dry weather. Trees generally flower twice a year after dry weather, in Peninsular Malaysia around March and August. The distinctly coloured central eye-spot, formed by the hypanthium, develops as the flowers age. Each inflorescence contains a variable percentage of bisexual and functionally male flowers, but the male ones frequently preponderate and only few fruits per inflorescence develop. Monkeys and squirrels eat the unripe seeds in the pods. In Peninsular Malaysia the hollow internodes of young plants of *S. thaipingensis* are inhabited by ants, mainly by two *Cladomyrma* species; in older trees, a *Crematogaster* sp. has been found.
Saraca belongs to the subfamily *Caesalpinioideae*. In Malesian literature *S. declinata* has often been confused with *S. thaipingensis*.

Ecology *Saraca* trees are found in primary and secondary, evergreen rain forest, up to 900(–1100) m altitude. They are particularly abundant along small streams where they may form characteristic 'tunnels'; such streams are known as 'Saraca streams'. They grow in perhumid and seasonal conditions, sometimes in swamp forest, but also on well-drained locations like hill slopes, and on a wide variety of soils including those on limestone.

Silviculture *Saraca* can be propagated by seed or by vegetative propagation. The seeds of *S. thaipingensis* have about 90% germination in 1–2.5 months. Marcotting was successful on an experimental scale in the Philippines; branches up to 3 cm in diameter all rooted in 4–5 months. The roots had attained 5–8 cm 12–29 days later and plants could be potted.

Genetic resources and breeding Timber-yielding *Saraca* species planted for ornamental purposes do not seem in danger of genetic erosion. Several others are narrow endemics and may easily become endangered.

Prospects The ornamental *Saraca* species are hardly planted for timber. It is unlikely that this situation will change in the near future.

Literature 151, 157, 163, 183, 198, 209, 238, 267, 341, 343, 387, 402, 643, 677, 740, 741, 759, 829, 831, 861, 974, 1038, 1039, 1163, 1221, 1242, 1273.

Selection of species

Saraca declinata (Jack) Miq.

Synonyms *Saraca macroptera* Miq., *Saraca palembanica* Miq., *Saraca triandra* auct. non (Roxb.) Baker.

Vernacular names Red saraca (En). Indonesia: kahuruan (Sundanese). Malaysia: bakis (Dusun, Sarawak). Cambodia: chiey sbay (Koh Kong), kam' ângtèah' (Kandal), sim a thong (Kampot). Laos: kham ma², kham pha ma², sa ma². Thailand: sok khao (peninsular), som sok (eastern, south-eastern). Vietnam: c[aa]y th[oo].

Distribution Burma (Myanmar), Indo-China, Thailand, Peninsular Malaysia, Sumatra, East Java, Borneo and the Lesser Sunda Islands (Flores); also cultivated in the Philippines and Papua New Guinea.

Saraca indica L.

Synonyms *Saraca bijuga* Prain, *Saraca kunstleri* Prain, *Saraca minor* (Zoll. & Moritzi) Miq.

Vernacular names Malayan saraca (En). Indonesia: soko (Javanese). Laos: 'si 'soup. Thailand: chum saeng nam (peninsular), sok (central), som suk (northern). Vietnam: v[af]ng anh [aas]n.

Distribution Indo-China, Thailand, Peninsular Malaysia, Sumatra and Java; often planted for ornamental purposes.

Saraca thaipingensis Prain

Synonyms *Saraca declinata* auct. non (Jack) Miq., *Saraca cauliflora* Baker.

Vernacular names Narrow-leaved saraca, yellow saraca (En). Malaysia: talan (Peninsular). Thailand: asok lueang, asok yai (peninsular), sok lueang (Bangkok).

Distribution Southern Burma (Myanmar), Thailand, Peninsular Malaysia and Java (mainly West and Central); also cultivated elsewhere, e.g. in the Philippines and Papua New Guinea.

W.J.J.O. de Wilde

Sarcosperma Hook. f.

Benth. & Hook. f., Gen. pl. 2: 655 (1876).
SAPOTACEAE
$x = 12$; *S. arboreum* Hook. f.: $n = 12$

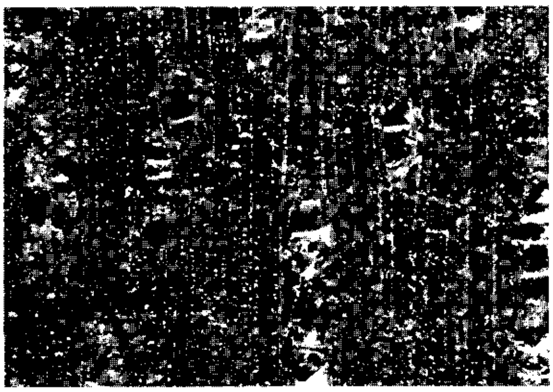
Vernacular names Indonesia: kuriaba (Ternate), nyatuh rabung (Minangkabau, Sumatra), perawas sambungan (Karo, Sumatra). Malaysia: maharaja kayu. Philippines: pamaluian apo (Filipino).

Origin and geographic distribution *Sarcosperma* comprises about 8 species occurring from India to Indo-China, southern China, Thailand and most of the Malesian region but only locally. Two species are found in Malesia but only one yields timber: *S. paniculatum* (King) Stapf & King (synonyms: *Apoia macrocarpa* (Elmer) Merr., *Discocalyx macrocarpa* Elmer, *S. breviracemosum* H.J. Lam). The latter is found in Peninsular Malaysia, northern Sumatra, Borneo, the Philippines (Mindanao), Sulawesi, the Lesser Sunda Islands (Flores), the Moluccas and New Guinea.

Uses The wood of *S. paniculatum* has been used for beams and boards in local house building. Potential uses are similar to those of 'nyatoh' (*Sapotaceae* genera), e.g. fine furniture, panelling and decorative veneer.

Production and international trade *S. paniculatum* wood is used on a local scale only and supplies are very limited. The timber may be encountered sporadically in mixed consignments of 'nyatoh', together with that of other *Sapotaceae* genera.

Properties *S. paniculatum* yields a lightweight to medium-weight hardwood with a density of 430–550 kg/m³ at 15% moisture content. Heartwood brown, sapwood pale brown. Growth rings



Sarcosperma paniculatum
transverse surface (×20)

indistinct; vessels medium-sized, almost exclusively in radial multiples of 2–4(–7), open with occasional tyloses; parenchyma abundant, apotracheal diffuse-in-aggregates to continuous, closely spaced bands.
The wood is rather soft, moderately strong and non-durable.
See also the table on microscopic wood anatomy.

Botany An evergreen, small to fairly large tree up to 35(–40) m tall; bole columnar but sometimes angular or slightly sinuous, branchless for up to 17 m, up to 80 cm in diameter, with steep buttresses up to 2.5 m high; bark surface closely vertically cracked or shallowly fissured, sometimes with small scales, reddish-brown, inner bark fibrous, pale yellow, exuding white latex; crown spreading. Leaves opposite to subopposite, simple, entire, with glandular pits below; stipules small, caducous; apex of petiole with auricles. Inflorescence axillary, a panicle of racemes. Flowers solitary or fascicled along the rachis, small, 5-merous; sepals imbricate; corolla with a short tube and spreading lobes; stamens alternating with the staminodes, inserted at the top of the corolla tube; ovary superior, 1–2-locular with a single ovule in each cell, style short and stout. Fruit a 1(–2)-seeded, fleshy drupe, ripening red or purplish-black. Seed pale brown; endosperm absent. Seedling with hypogeal germination; cotyledons not emergent; hypocotyl not elongated; first few leaves scale-like, subsequent ones alternate-spiral and conduplicate.
The shoot system shows an orthotropic leader bearing plagiotropic branches. Flowering and fruiting seems to be irregular.
Some authors considered *Sarcosperma* to represent a distinct family, *Sarcosperma(ta)ceae*. Based on morphological, palynological, cytological and phytochemical studies it has now been accommodated in the tribe *Sideroxyleae* within the family *Sapotaceae*.

Ecology *S. paniculatum* occurs scattered in primary and secondary rain forest, rarely in forest edges, among bamboos or in thickets, up to 1200 m altitude.

Silviculture *S. paniculatum* may be raised from seeds, which show 60–75% germination in 1–4 months.

Genetic resources and breeding There are no records of *Sarcosperma* in seed or germplasm banks. *S. paniculatum* is widespread but rare.

Prospects The lack of information on wood properties of *S. paniculatum* indicates its rare occurrence and sporadic use as timber. Increased use of the timber is not to be expected.

Literature 71, 163, 267, 341, 343, 436, 649, 650, 654, 655, 656, 829, 831, 861, 877, 974, 1221, 1222, 1232.

Noorsiha Ayop

Sarcotheca Blume

Mus. bot. 1: 241 (1850).
OXALIDACEAE
x = unknown; $2n$ = unknown

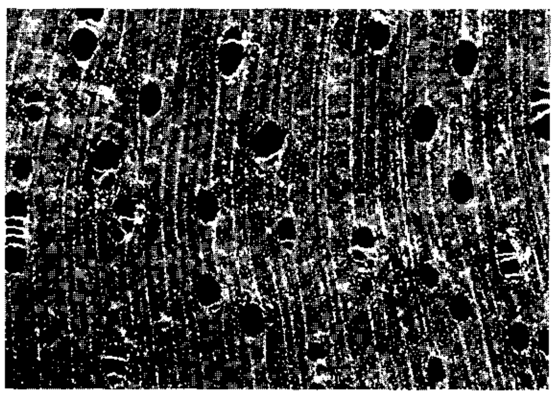
Vernacular names Brunei: tebarus. Indonesia: pupoi (Sumatra). Malaysia: belimbing pipit, pupoi, setundok (Peninsular).

Origin and geographic distribution *Sarcotheca* comprises 11 species occurring in Peninsular Malaysia, Sumatra, Borneo and Sulawesi.

Uses The wood of *Sarcotheca* is used for roofing and interior work.
The sour fruits are eaten in curries and cooked with vegetables and sweets, and are said to be a remedy against cough.

Production and international trade *Sarcotheca* wood is used rarely and on a local scale only.

Properties *Sarcotheca* yields a medium-weight hardwood with a density of 650–840 kg/m^3 at 15% moisture content. Heartwood pale straw-coloured or brownish, not clearly differentiated from the sapwood; grain straight; texture rather fine and even. Growth rings sometimes distinct, boundaries indicated by narrow zones of denser tissue and usually a narrow layer of apparently marginal parenchyma; vessels very small to medium-sized, solitary and in radial multiples of 2–8, all vessel sizes found in the multiples, open and



Sarcotheca diversifolia
transverse surface (×20)

with tyloses; parenchyma sparse, mainly apotracheal, with apparently narrow marginal bands (septate fibres with crystals), just visible to the naked eye, and diffuse, and paratracheal vasicentric, the latter type indistinct even with a hand lens; rays very fine; ripple marks absent.
The wood is moderately hard, fairly strong and easy to work. It is slightly to moderately durable.
See also the table on microscopic wood anatomy.

Botany Shrubs or small to medium-sized or fairly large trees up to 42 m tall; bole up to 100 cm in diameter, deeply fluted, sometimes with buttresses up to 2(–4) m high; bark surface smooth to scaly or dippled, reddish to reddish-brown, inner bark fibrous, yellow-brown to light red or pink. Leaves alternate, 1- or 3-foliolate, exstipulate; leaflets entire; petiole jointed, its apex and the petiolules swollen and wrinkled. Inflorescence axillary or terminal, solitary or few together, composed of cymes arranged along a simple or sparsely branched rachis. Flowers heterodistylous, 5-merous; sepals unequal, connate at base; petals contorted, free at base but adhering above the claw and falling jointly; stamens 10, connate at base, longer and shorter ones alternating; ovary superior, 5-locular with 2 ovules in each cell, styles free. Fruit a fleshy, red or black, 5-lobed berry, with persistent sepals. Seed flat, without aril; testa reddish. Seedling with epigeal germination; cotyledons emergent, leafy; hypocotyl elongated; first 2 leaves opposite, subsequent ones alternate. In *S. griffithii* the first few leaves are 1-foliolate, later ones 3-foliolate.
Growth is in flushes; the stem of saplings zigzags between the nodes. Young leaves are deep violet. Pollination is by insects (e.g. *Xylocopa* bees) and cross-pollination is favoured by the heterodistylous flowers; flowers are long- or short-styled. Flowering and fruiting are almost throughout the year, but *S. celebica* flowers from January to April. In *S. celebica* pollination only succeeded when pollen of short-styled trees was brought on stigmas of long-styled ones; seed set was comparatively poor. The flowering-to-fruiting period of *S. griffithii* in Peninsular Malaysia is about 16 weeks. The fruits are eaten by bats, birds and monkeys which thus disperse the seeds.
The woody genera presently included in the *Oxalidaceae* used to be in the families *Averrhoaceae* and *Lepidobotryaceae* which were even assigned to different orders. More recent investigations, however, retain a broader concept of the *Oxalidaceae*. In the field *Sarcotheca* can be confused with *Rourea*, but the latter has free carpels, seeds with an aril, and dry, 1-celled and 1-seeded fruits.

Ecology *Sarcotheca* is found scattered in primary or secondary, lowland rain forest, up to 900 m altitude.

Silviculture *Sarcotheca* can be propagated by seed. Seeds of *S. griffithii* show about 45% germination in 10–25 days. In a 50-ha plot in lowland forest in Peninsular Malaysia, there were 209 specimens of *S. griffithii* and 179 of *S. monophylla* with stems over 1 cm in diameter, of which 47 and 31 stems respectively measured over 30 cm in diameter.

Genetic resources and breeding As *Sarcotheca* is not commercially exploited the risk of genetic erosion is low.

Prospects It is unlikely that *Sarcotheca* timber will be used increasingly in the near future.

Literature 163, 198, 267, 341, 436, 458, 464, 553, 646, 800, 829, 831, 861, 1048, 1158, 1164, 1221, 1242.

Selection of species

Sarcotheca celebica Veldkamp

Vernacular names Indonesia: kongilu, ngilungilu (Sulawesi).

Distribution Sulawesi.

Sarcotheca diversifolia (Miq.) Hallier f.

Synonyms *Connaropsis grandiflora* Ridley, *Sarcotheca acuminata* (Pearson) Hallier f., *Sarcotheca subtriplinervis* Hallier f.

Vernacular names Brunei: kerapa-kerapa, perapan macas, tebarus. Indonesia: belimbing hutan (Indonesian, Kalimantan). Malaysia: belimbing bulat (general), buah piang (Sarawak), tabarus (Sabah).

Distribution North Sumatra and Borneo.

Sarcotheca griffithii (Planch. ex Hook. f.) Hallier f.

Synonyms *Connaropsis griffithii* Planch. ex Hook. f., *Dapania griffithii* (Planch. ex Hook. f.) Knuth.

Vernacular names Indonesia: asam pupoi, belimbing hutan (Lampung, Sumatra), jintek-jintek (North Sumatra). Malaysia: pupoi (Peninsular).

Distribution Peninsular Malaysia and Sumatra.

Sarcotheca monophylla (Planch. ex Hook. f.) Hallier f.

Synonyms *Connaropsis monophylla* Planch. ex Hook. f., *Dapania monophylla* (Planch. ex Hook. f.) Knuth.

Vernacular names Malaysia: belimbing akar, belimbing burong, belimbing pipit (Peninsular).

Distribution Peninsular Malaysia.

R.C.K. Chung

Schima Reinw. ex Blume

Catalogus: 80 (1823).

THEACEAE

x = unknown; *S. wallichii*: $2n = 36$

Vernacular names Mang tan, simartolu (trade names). Needle wood, schima (Am, En). Brunei: kelinchi padi. Indonesia: puspa (trade name), madang gatal (Kalimantan), seru (Sumatra, Java). Malaysia: medang gatal (trade name), gatal-gatal (Sabah), samak (Peninsular). Papua New Guinea: schima (En). Burma (Myanmar): laukya. Laos: boun nak, 'khai[1] sou[2], 'mi. Thailand: bunnak (south-eastern), champa dong (north-eastern), thalo (northern). Vietnam: v[oos]i thu[oos]c.

Origin and geographic distribution *Schima* is a wide-ranging monotypic genus occurring from north-eastern India through Indo-China, southern China, the Ryukyu Islands and the Bonin Islands to Thailand, Peninsular Malaysia, Sumatra, Java, Borneo and the Philippines (Palawan). The only species, *S. wallichii* (DC.) Korth. (synonyms: *S. bancana* Miq., *S. crenata* Korth., *S. noronhae* Reinw. ex Blume), is fairly widely grown in South-East Asia and locally naturalized.

Uses The wood of *S. wallichii* is used for medium-heavy construction under cover (columns, beams), flooring, interior fitting, panelling, door and window frames, joinery, utility furniture, ship and boat building (ribs, decks), vehicle bodies, agricultural implements, pallets, boxes and crates, poles, toys, turnery and, when treated, for railway sleepers. It has been used for bridge building in mountain areas and young trees have been applied as rafters. A good quality plywood can be manufactured from the wood and it is suitable for the production of wood-wool boards. It also yields good firewood.

S. wallichii is useful for reforestation, also in relation to water conservation in catchment areas, and has been planted along roads. In Indonesia it has been used as a cover crop in plantations of *Pinus merkusii* Jungh. & de Vriese and *Agathis dammara* (Lambert) Rich. In India it has been used as a shade tree in coffee plantations. The astringent corollas are used to treat uterine disorders and hysteria, and also as an ointment to treat smallpox. In Indonesia the crude drug is called 'buah cangkok', in Peninsular Malaysia 'changkoh'. The bark contains an alkaloid used for fish poison. In Nepal its leaves are used for fodder.

Production and international trade 'Samak' is the trade name for timber of the genera *Schima*, *Adinandra* and *Gordonia*, all belonging to the *Theaceae*, but use is mainly on a local scale. Small amounts of *Schima* timber are exported from Sabah and Sarawak to Japan. In 1996 Papua New Guinea exported about 1655 m^3 of 'schima' logs at an average free-on-board (FOB) price of US$ 99/m^3. There is an industrial forest plantation of *S. wallichii* in South Sumatra.

Properties *S. wallichii* yields a medium-weight to heavy hardwood with a density of 450–920 kg/m^3 at 15% moisture content. Heartwood pink-brown, red-brown or grey-brown, sometimes dark red-brown, not clearly differentiated from the pale grey sapwood; grain straight or interlocked, frequently irregular; texture moderately fine or fine and even. Growth rings distinct to indistinct, when distinct demarcated by layers of darker coloured tissue without vessels; vessels moderately small to medium-sized, oval rather than angular as in most *Theaceae*, mostly solitary, but overlapping ends of a vertical series frequently appear as diagonal pairs, tyloses rare; parenchyma moderately abundant, apotracheal diffuse and diffuse-in-aggregates, visible with a hand lens; rays very fine to moderately fine; ripple marks absent.

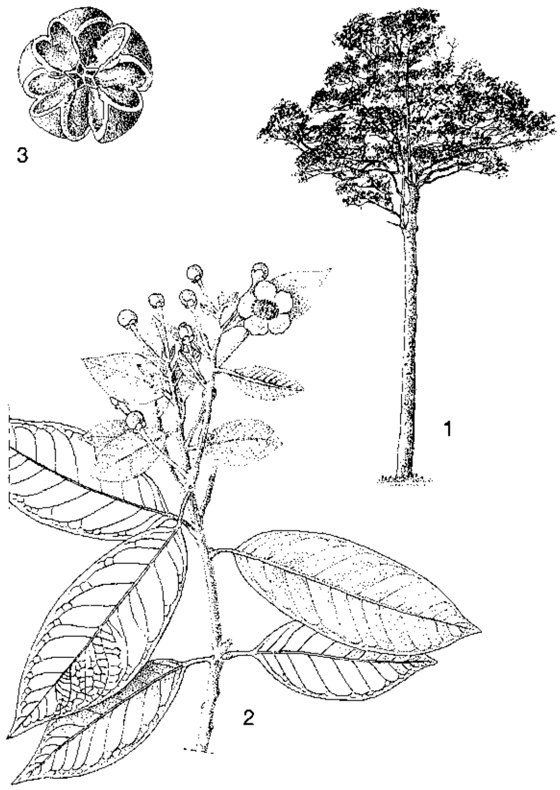
Schima wallichii
transverse surface (×20)

Shrinkage is moderate to very high and the timber seasons fairly rapidly; 13 mm and 38 mm thick boards were observed to take about 2.5 months and 3 months, respectively to air dry in Malaysia. Figures from Indonesia indicate slower air drying, e.g. 7 months for 30 mm thick boards, with slight to severe risk of cupping, bowing, twisting or splitting. The wood is moderately hard and fairly strong. It is easy to work with hand and machine tools and polishes satisfactorily. The wood is durable under cover; in graveyard tests in Peninsular Malaysia it was destroyed in 3.5–4 years, which classifies it as moderately durable. Preservative treatment is easy to difficult, absorption in *S. wallichii* subsp. *noronhae* (Reinw. ex Blume) Bloembergen var. *noronhae* is 69–161 kg/m^3 with mixtures of creosote and residue oil. The wood is relatively resistant to dry-wood termites.

The energy value of the sapwood is about 19 980 kJ/kg. The leaves of *S. wallichii* contain tannin, but too little to be used for tanning. The bark contains fine fibres which may cause skin irritation. Seed of *S. wallichii* from India contains 19% oil.

See also the tables on microscopic wood anatomy and wood properties.

Botany An evergreen, medium-sized to large tree up to 47 m tall; bole cylindrical, branchless for up to 25 m, up to 125(–250) cm in diameter, rarely with up to 1.8 m high steep buttresses; bark surface ruggedly cracked into small thick angular pieces, red-brown to dark grey, inner bark with irritating fibres, bright red. Leaves arranged spirally, simple, entire to coarsely toothed, exstipulate. Flowers solitary in axils at the apices of twigs, with 2 bracteoles, 5-merous; sepals subequal, persistent in fruit; petals connate at base; stamens many, adnate to the corolla base, anthers versatile; ovary superior, 5-locular with 2–6 ovules in each cell, style simple. Fruit a woody, subglobose capsule. Seed winged all around. Seedling with epigeal germination; cotyledons emergent, leafy; hypocotyl elongated; all leaves arranged spirally, involute to almost conduplicate. Growth is according to Rauh's architectural tree model, characterized by a monopodial trunk with rhythmic growth and tiers of branches that are themselves morphogenetically identical with the trunk, flowers having no effect on the growth of the shoot system. Early growth is comparatively slow, accelerating later. A 28-year-old plantation of *S. wallichii* subsp. *noronhae* var. *noronhae* in West Java had an average diameter of 24 cm and an average height of 22 m. Trees may flower and



Schima wallichii (DC.) Korth. – 1, tree habit; 2, flowering twig; 3, dehisced fruit.

fruit already after four years. Flowering and fruiting occurs throughout the year, but flowers are usually most abundant around the seasonal changes. In India trees bear flowers in April–June whereas the first fruits are observed from the end of May to July. The seeds are shed in January to March of the next year. In Indonesia fruiting is reported to be most abundant in August to November. Seeds are dispersed by wind.

S. wallichii is highly variable and was formerly thought to comprise many distinct species. At present it is subdivided into 9 subspecies mainly differing in leaf characteristics; some of these are further split up into varieties. The correctness of these subdivisions is sometimes questioned.

Ecology *S. wallichii* is a common tree that can grow in a wide range of climates, habitats and soils. It is found in perhumid to seasonal climates. It often occurs gregariously in primary lowland to montane forest, up to 2400(–3900) m altitude, but is particularly common in disturbed and secondary forests, scrub and grassland and even in areas inundated by brackish water. It usually prefers well-drained soils, but has been observed in swamps and along rivers, and is not choosy about soil texture and fertility.

Silviculture *S. wallichii* can be raised from seed; the use of cuttings has not been successful. The woody capsules should be collected before dehiscing and seeds can be extracted after drying when the capsules open. There are 196 000–267 000 dry seeds/kg. Dried fruits or seeds can be stored for up to three months, although one record from Nepal shows that they can be stored for a long time without problems. It has been stated that the seed needs 'after-ripening' of about 2 weeks. Germination rates vary considerably: seeds of *S. wallichii* gave about 90% germination in 10–12 days, but in another seedlot the germination rate was only 15% in 23–85 days. In general, germination attains 25–55%. Wildlings have been collected from natural regeneration in plantations. Seeds are sown under shade and only lightly covered with soil. Seedling mortality in the nursery is usually about 50%. After 2–3 months seedlings are 5–8 cm tall and can be transplanted from the seedbed to containers; at 6–8 months, when they are about 20 cm tall, they can be planted out in the field, although stumps may be made of older seedlings. Survival of planted-out seedlings is almost 100%. In Peninsular Malaysia they are planted at 1.8 m × 1.2 m or 3.6 m × 1.8 m spacing resulting in almost double diameter increment in the wider spacing. Silviculturally, *S. wallichii* is also variable and different subspecies have quite different characteristics, e.g. pioneer characteristics and capacity of natural pruning. It is usually considered a moderate light demander and regenerates abundantly where sufficient light is admitted for the development of the seedlings, but it is also stated to be a shade-bearing species which hardly regenerates even in small gaps (*S. wallichii* subsp. *noronhae* var. *noronhae* from the mountains of Java). For Peninsular Malaysia it is stated that its strong forking and persistent branching, even when densely planted, is a serious drawback; this probably refers to the naturally occurring *S. wallichii* subsp. *oblata* (Roxb.) Bloembergen. It is stated that the trees of subsp. *noronhae* var. *noronhae* and subsp. *bancana* (Miq.) Bloembergen have a long clear bole and that natural pruning is good. *S. wallichii* coppices easily and is fairly resistant to fire from the age of five and then reproduces by coppice shoots. The borer *Trachylophus approximator* has been observed tunnelling in stem bases in Java, enhancing secondary diseases and pests.

Genetic resources and breeding The variability in wood characteristics and silvicultural behaviour between subspecies of *S. wallichii* is striking and offers scope for future selection and breeding. Meanwhile, some subspecies have a very small area of distribution and their use may impair their genetic conservation.

Prospects *S. wallichii* has good potential for plantations in South-East Asia due to its ease of handling in the nursery, its easy establishment and satisfactory growth rate.

Literature 40, 57, 70, 75, 80, 101, 118, 130, 161, 162, 163, 198, 209, 240, 259, 260, 267, 308, 328, 387, 388, 405, 436, 479, 518, 526, 536, 546, 632, 634, 635, 677, 678, 701, 757, 829, 831, 922, 933, 947, 1039, 1104, 1169, 1177, 1199, 1221, 1234, 1239, 1242.

E. Boer & M.S.M. Sosef

Schizomeria D. Don

Edinburgh New Philos. Journ. 9: 94 (1830).

CUNONIACEAE

x = unknown; $2n$ = unknown

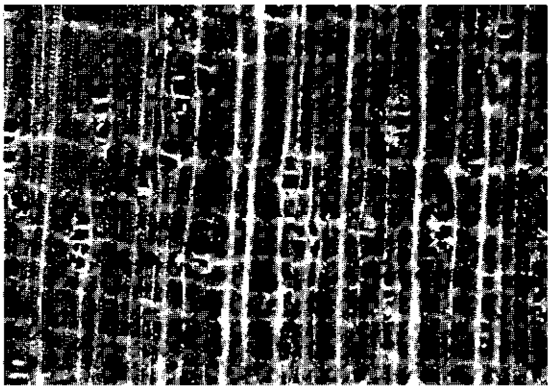
Vernacular names Crab apple, pink birch (En, trade name), schizomeria (En).

Origin and geographic distribution *Schizomeria* comprises about 18 species and is distributed from the Moluccas and New Guinea to the Solomon Islands and eastern Australia.

Uses The wood of *Schizomeria* is mainly used for furniture and cabinet work, interior finish such as door and window frames, mouldings and the production of plywood. Other reported uses include general construction, joinery, lining, wall panelling, shelving, turnery, light flooring, boat decking, poles, brushware, wire casks, vats and musical instruments. The wood is also suitable for packing cases and the production of blockboard. It is sometimes used as a substitute for 'coachwood' (*Ceratopetalum*) but its physical properties are inferior.

The bark of *S. serrata* has been used to tan fishing nets. The fruits are edible but because of their sharply acid flavour they are best used in pies, jams, and to relieve thirst.

Production and international trade In 1987 Japan imported about 1200 *Schizomeria* logs from Papua New Guinea and about 150 logs from the Solomon Islands. In 1996 Papua New Guinea exported about 5800 m^3 of *Schizomeria* logs at an average free-on-board (FOB) price of US$ 100/m^3. In



Schizomeria serrata
transverse surface (×20)

Australia the wood is traded domestically.

Properties *Schizomeria* yields a medium-weight hardwood with a density of 500–740 kg/m³ at 15% moisture content. Heartwood pale brown, red-brown or dark red, sometimes with a purple-grey tinge, not clearly demarcated from the pinkish sapwood; grain straight or shallowly to moderately interlocked; texture fine and even; wood lustrous; heartwood with wavy streaks on longitudinal surface. Growth rings indistinct, boundaries sometimes indicated by denser bands of fibres (*S. serrata*); vessels moderately small to medium-sized, solitary and in radial multiples of 4–6(–10), chalky white deposits present, tyloses present sometimes rare; parenchyma apotracheal in regular or irregular narrow bands; rays moderately fine; ripple marks absent.

Shrinkage is low to moderate. Boards of 25 mm thick can be kiln dried from green to 12% moisture content in 2–3 days without serious degrade, only occasional twist in back-sawn boards. Generally, stock should be weighted down and closely stickered. The wood is moderately soft to moderately hard and is moderately easy to convert, machine tools produce a good surface. The peeling properties are fairly good, but for commercial work the logs should be pre-heated. The wood is moderately strong but brittle. It is non-durable; the sapwood is susceptible to *Lyctus* and pinhole borer attack. The sapwood is permeable, the heartwood resistant to impregnation.

The mean fibre length is 1.24–1.66 mm.

See also the tables on microscopic wood anatomy and wood properties.

Botany Small to medium-sized or rarely fairly large trees up to 25(–40) m tall; bole straight, cylindrical, up to 60(–120) cm in diameter, sometimes with small or steep, narrow buttresses; bark surface smooth to wrinkled, becoming deeply fissured in older trees, sometimes pustular, grey to brown, inner bark fibrous, with light red exudate. Leaves opposite, simple, serrate or crenate; stipules enclosing the terminal bud, small. Flowers in a terminal or axillary, many-flowered cyme or panicle; calyx 4–5(–6)-lobed; petals 4–5(–6), toothed or lobed, white or cream-coloured; stamens 8–10(–12), inserted outside a 8–10(–12)-lobed disk; ovary superior, 2–3-locular with usually 4 ovules in each cell, styles divergent. Fruit an indehiscent, 2–3-seeded drupe with enlarged persistent calyx lobes. Seedling with narrowly elliptical, emergent cotyledons; the leaves become serrate at approximately the tenth leaf stage.

In natural forest in the Solomon Islands *S. serrata* trees of about 50 cm in diameter can achieve a mean annual diameter increment of up to 0.4 cm.

Schizomeria is in need of a taxonomic revision as the botanical information is scanty and the status of several species seems doubtful; many of the New Guinean species are probably only local forms of *S. serrata*.

Ecology *Schizomeria* is found in primary, evergreen or deciduous, subtropical to warm temperate or even cool temperate rain forest. The species may also occur as understory trees in wet sclerophyll forest, often in association with 'coachwood' (*Ceratopetalum*). *Schizomeria* occurs on well-drained soils, also on exposed ridges, up to 1300(–2800) m altitude.

Silviculture Generally, natural regeneration of *Schizomeria* is prolific.

Genetic resources and breeding Although their use for timber is limited, many *Schizomeria* species are narrow endemics and thus vulnerable to genetic erosion.

Prospects No change in the use of *Schizomeria* as a timber is anticipated, although the genus is said to have potential for ornamental purposes.

Literature 40, 121, 125, 128, 215, 269, 270, 300, 304, 348, 356, 436, 463, 464, 470, 536, 745, 762, 861, 881, 991, 1209, 1218, 1232.

Selection of species

Schizomeria clemensiae L.M. Perry

Distribution Papua New Guinea.

Schizomeria gorumensis Schlechter

Distribution New Guinea.

Schizomeria ilicina (Ridley) Schlechter
Synonyms *Cremnobates ilicina* Ridley.
Distribution New Guinea.

Schizomeria katastega Mattf.
Distribution Papua New Guinea.

Schizomeria orthophlebia L.M. Perry
Distribution New Guinea (Irian Jaya).

Schizomeria parvifolia L.M. Perry
Distribution Papua New Guinea.

Schizomeria serrata (Hochr.) Hochr.
Synonyms *Schizomeria brassii* Mattf., *Schizomeria floribunda* Schlechter.
Vernacular names Indonesia: obat rede (Moluccas), ukir (Ambon).
Distribution The Moluccas, New Guinea and the Solomon Islands.

Schizomeria versteeghii L.M. Perry
Distribution New Guinea (Irian Jaya).

W.C. Dickison

Schoutenia Korth.

Ned. Kruidk. Arch. 1: 312 (1848).
TILIACEAE
x = unknown; $2n$ = unknown

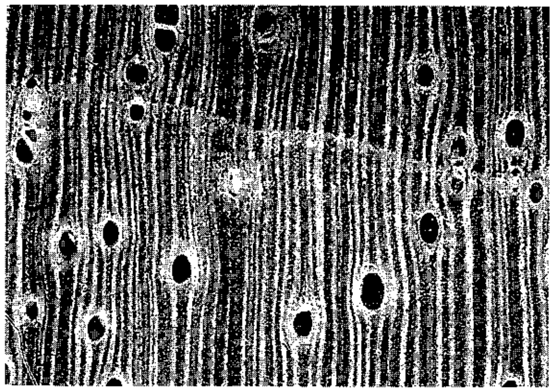
Vernacular names Indonesia: walikukun (general). Malaysia: bayur bukit (Peninsular).

Origin and geographic distribution *Schoutenia* comprises 9 species occurring in Burma (Myanmar), Indo-China, Thailand, Peninsular Malaysia, Sumatra, Java, Borneo and the Lesser Sunda Islands.

Uses The hard, heavy and flexible wood of *Schoutenia* is used for house building, tool handles, agricultural implements, spokes and wheels, poles of vehicles, sporting goods and pegs for boat construction. In Java the wood is used as a substitute for that of *Lagerstroemia speciosa* (L.) Pers. The wood is also used to produce charcoal.
The bark yields rough rope for binding.

Production and international trade *Schoutenia* wood is highly valued locally and traded on a local scale, but no exact figures are available. In Indonesia it is classified as a commercial timber.

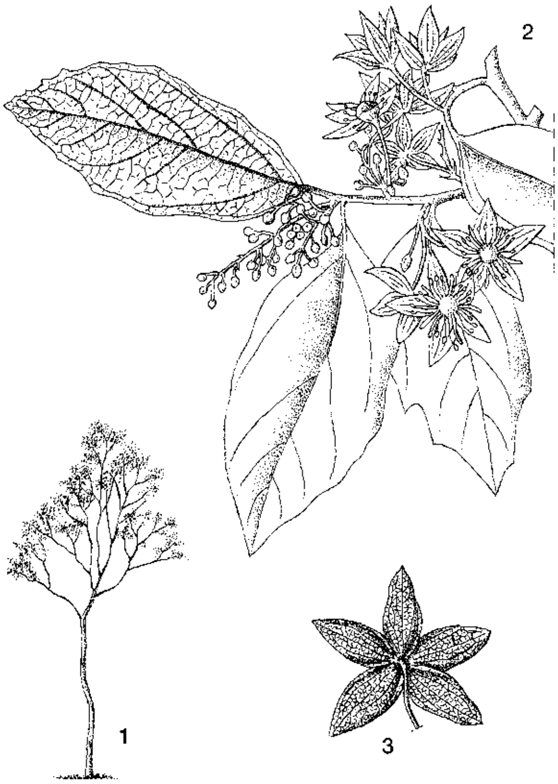
Properties *Schoutenia* yields a heavy hardwood with a density of 770–1080 kg/m^3 at 15% moisture content. Heartwood purple-grey-brown to dark purple-brown, not clearly differentiated from the sapwood; grain straight or interlocked; texture moderately fine and even. Growth rings indistinct or indicated by darker tissue, sometimes also indicated by marginal parenchyma bands; vessels moderately small to medium-sized, solitary and in radial multiples of 2–4, solitary vessels predominating in some areas, the multiples in others, open; parenchyma abundant, apotracheal diffuse and diffuse-in-aggregates rarely grading into narrow bands, sometimes in marginal or seemingly marginal bands, and scanty paratracheal to vasicentric visible; rays extremely fine to moderately fine, visible with a hand lens; ripple marks present, distinct in *S. ovata* but reportedly absent for *S. accrescens*.



Schoutenia ovata
transverse surface (×20)

The wood is very hard, very strong and extremely tough. Although hard, it is easy to work. It is moderately durable to very durable, even in contact with the ground or when exposed to the weather.
The gross energy value of the sapwood of *S. ovata* is about 20 070 kJ/kg and of the heartwood about 20 310 kJ/kg.
See also the tables on microscopic wood anatomy and wood properties.

Botany Evergreen or deciduous, small to medium-sized trees up to 35 m tall, rarely shrubs; bole usually fairly short, up to 60(–80) cm in diameter, sometimes prominently fluted or with buttresses up to 1.7 m high; bark surface closely fissured and flaky, dark reddish-brown to greyish-brown, inner bark fibrous, yellowish to reddish or pinkish. Indumentum of stellate hairs or scales. Leaves alternate, distichous, simple, margin entire to sinuate, base usually unequal, 3-veined; stipules caducous or persistent. Flowers in a few-flowered, panicu-



Schoutenia ovata Korth. – 1, tree habit; 2, flowering twig; 3, fruiting calyx.

late or racemose, axillary or terminal inflorescence, bisexual; pedicel jointed; calyx membranous, usually campanulate, (4–)5(–6)-lobed, conspicuously veined, white to yellow; petals usually absent (5 in *S. ovata*); disk usually present, narrowly annular; stamens 15–many, usually in 5 bundles, persistent; ovary superior, (3–)5-locular with 2 basal ovules in each cell, densely stellate pilose, style 1 with 5 stigmas. Fruit a globular, usually 1-seeded capsule with a strongly enlarged, parachute-shaped, papery calyx and persistent style. Seedling with epigeal germination; cotyledons emergent, bilobed; hypocotyl elongated; first 2 leaves opposite or the first few alternate-spiral, subsequent ones alternate-distichous.

Tree growth is according to Troll's architectural model, characterized by all axes being plagiotropic, the proximal parts becoming erect and forming the main axis. Mean annual diameter and height increment of *S. ovata* in an 8-year-old plantation were 1.4 cm and 1.5 m, respectively; in a mixed plantation with *Dalbergia latifolia* Roxb. of 11 years old they were respectively 0.8 cm and 0.8 m. *S. accrescens* flowers gregariously in March on the bare branches or with the new leaves, whereas fruits are found in April–May. In Java *S. ovata* flowers in March–June(–November) and ripe fruits can be found in (April–)May–September (–December). In Thailand flowers and fruits are found in September–December. Seed is dispersed by wind or water.

S. accrescens is very variable and can be divided into 2–3 subspecies.

Ecology *Schoutenia* species are locally common and sometimes occur gregariously in moist locations in primary rain forest, up to 900(–1100) m altitude. *S. ovata* is found in slightly seasonal climates.

Silviculture *Schoutenia* may be propagated by seed and by vegetative means. Fruits of *S. ovata* should be collected from the ground to avoid the inclusion of immature seed. There are about 42 500 dry seeds/kg. After-ripening of the seed is very important and germination is optimal after 3–5 months of storage when collected seeds are exposed daily to sunlight, or after 17 months of storage in airtight containers. Seeds should be sown in full sunlight and show about 30% germination in 7–21 days. Fresh fruits of *S. accrescens* without a calyx have 2–50% germination in 8–36 days. Fresh fruits of *S. kunstleri* have about 80% germination in 9–14 days. *S. ovata* seed over 3 mm in diameter had a significantly higher germination percentage and all the seedlings survived, whereas seedlings from smaller seed all died. Therefore, the small seeds should be discarded. Seedlings of *S. ovata* can be stumped to leave 20 cm shoot and 20 cm root and a diameter of 0.5–2.5 cm and may attain 90–100% survival. Stem cuttings have also been successful (70–95% survival), whereas the survival for root cuttings was slightly more variable but still 35–90%. *S. ovata* suckers easily; cut or injured roots produce root suckers profusely. On infertile soils *S. ovata* grows very poorly, whereas on fertile soils it is generally more economic to grow other species. It should not be planted on marshy soils or where the water table is periodically high. *S. ovata* has often been used as underplanting in teak (*Tectona grandis* L. f.) plantations where it grows well. It has occasionally been mixed with *Dalbergia latifolia*, but the trees bend or die back because of insufficient light. A pure stand was planted at 2 m × 3 m, but this spacing was considered too wide as it took 6 years for the canopy to close. Natural pruning was generally poor, but pruning to improve stem form was successful. The clear bole wood produced in 8 years was 38 m^3/ha. *S. ovata* is also fairly resistant to fire. The walikukun borer (*Agrilus kalshoveni*) has been a serious pest of *S. ovata*, locally affecting over 50% of the wild population in East Java in the 1920s. Apparently only individuals that are at least periodically in full sunlight are affected and attacked trees no longer sucker. Many trees died as a result of this pest, but it has not been reported since this single outbreak. A 50-hectare plot in natural lowland forest in Peninsular Malaysia was found to contain 473 *Schoutenia* trees of over 1 cm in diameter of which 17 trees were over 30 cm in diameter.

Genetic resources and breeding Some of the *Schoutenia* species are endemic and may be vulnerable to genetic erosion by deforestation.

Prospects Plantations of *S. ovata* did not compare favourably with other timber species and are therefore no longer established. The very tough wood from natural forest sources will probably remain locally important.

Literature 61, 70, 80, 101, 130, 161, 163, 164, 209, 259, 260, 267, 308, 309, 376, 402, 405, 436, 438, 464, 488, 516, 517, 526, 632, 633, 749, 790, 829, 831, 861, 887, 947, 956, 1038, 1039, 1161, 1169, 1199, 1221, 1222, 1242.

Selection of species

Schoutenia accrescens (Masters) Curtis

Synonyms *Schoutenia mastersii* King.

Vernacular names Indonesia: merawai, pasak (Lingga Archipelago). Malaysia: bayur, bayur bukit (Peninsular). Thailand: meng khruan (peninsular).

Distribution Peninsular Thailand, Peninsular Malaysia, the Lingga Archipelago and western Borneo.

Schoutenia buurmanii Koord. & Valeton

Synonyms *Actinophora buurmanii* (Koord. & Valeton) K. Heyne.

Vernacular names Indonesia: durenan, sinduk (Javanese), ki terong (Sundanese).

Distribution Central Java.

Schoutenia kunstleri King

Vernacular names Malaysia: chenderai ayer, chenrai ayer (Peninsular). Thailand: ngon kai (peninsular).

Distribution Peninsular Thailand and Peninsular Malaysia.

Schoutenia ovata Korth.

Synonyms *Actinophora fragrans* Wallich ex R. Br., *Actinophora hypoleuca* (Pierre) O. Kuntze, *Schoutenia hypoleuca* Pierre.

Vernacular names East Indian meat-wood (En). Indonesia: harikukun (Sundanese), kokon (Madurese). Cambodia: ach-sat, popel thugé. Laos: kên[1] thao[1]. Thailand: daeng nieo (central), daeng saeng (eastern), daeng samae (northern).

Distribution Indo-China, Thailand, Java and the Lesser Sunda Islands.

R.C.K. Chung

Scolopia Schreb.

Gen. pl. 1: 335 (1789).

FLACOURTIACEAE

x = unknown; *S. crenata* (Wight) Clos.: $2n = 22$

Vernacular names Indonesia: rukem (general). Malaysia: rukam (general).

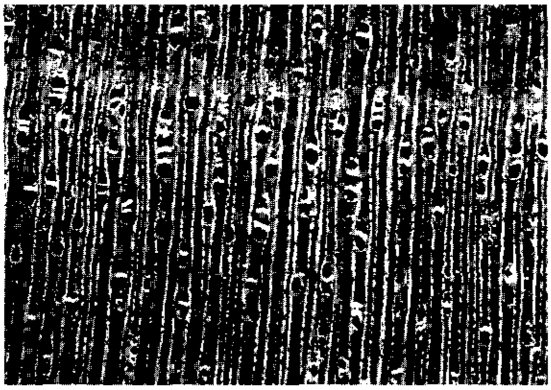
Origin and geographic distribution *Scolopia* comprises 38 species occurring in tropical and subtropical Africa, Madagascar, the Comores, the Mascarenes, Sri Lanka, India, Burma (Myanmar), Indo-China, southern China, Taiwan and Thailand towards the Malesian region (7 species, but not yet reported from the Moluccas and in the Lesser Sunda Islands only in Flores) and east to New Ireland and northern Australia.

Uses The wood of *Scolopia* has been used locally for house building (mainly posts) and fencing.
The fruit of *S. spinosa* is said to be edible.

Production and international trade The wood of *Scolopia* is used on a local scale only. Southern African and Madagascan representatives are used commercially.

Properties *Scolopia* yields a heavy hardwood with a density of 910–940 kg/m^3 at 15% moisture content. Heartwood pale or bright brown, sometimes with a pinkish tinge; grain mostly straight; texture fine. Growth rings indistinct; vessels small, solitary and in radial multiples of 2–4(–7) or more, open; parenchyma absent; rays fine and numerous; ripple marks absent.
The wood is very strong and moderately durable when exposed to the weather or in contact with the ground.
See also the table on microscopic wood anatomy.

Botany Evergreen shrubs or small to medium-



Scolopia spinosa
transverse surface (×20)

sized trees up to 15(–27) m tall; bole often set with spines, sometimes only in young trees, up to 40 cm in diameter; bark surface smooth, brown or reddish-brown, becoming grey. Leaves arranged spirally, simple, entire to crenate, with 2 distinct glands at the base of the blade or apex of the petiole; stipules minute, caducous. Flowers in an axillary, simple raceme, bisexual, small; receptacle flat; sepals 4–6, connate at base; petals resembling the sepals; stamens many; extrastaminal disk glandular or absent; ovary superior, 1-locular with 2–4(–5) few-ovuled placentae, style rather long and persistent. Fruit a fleshy berry with persistent sepals, petals, stamens and style. Seed with a hard testa.
The timber-yielding *Scolopia* species have been observed in flower nearly all year round. Fruit development probably takes at least several months. The fleshy fruits are probably dispersed by animals.

Ecology *S. macrophylla* prefers coastal swamp forest or sometimes other wet locations more inland on both sandy and clayey soils in perhumid conditions. It is locally common and may even occur gregariously, up to 150(–900) m altitude. *S. spinosa* is found in evergreen and deciduous, primary or secondary forest, often on calcareous soils, up to 1200 m altitude.

Genetic resources and breeding Both timber-yielding *Scolopia* species are fairly widespread, and because of their limited use do not seem to be threatened.

Prospects *Scolopia* timber is hardly used at present, and since any assessment of its wood quality is lacking an increase in use is very unlikely.

Literature 61, 70, 162, 163, 180, 198, 209, 267, 340, 341, 343, 436, 464, 809, 861, 1027, 1028, 1135, 1221.

Selection of species

Scolopia macrophylla (Wight & Arn.) Clos

Synonyms *Scolopia maritima* (Miq.) Warb., *Scolopia rhinanthera* (Benn.) Clos.

Vernacular names Mangrove thorn, marsh rukam (En). Indonesia: marong (Java), rukem betina, rukem laut (Sumatra). Malaysia: pokok rukam gajah, pokok rukam hutan (Peninsular), rukam laka (Sabah). Cambodia: trakhop prek (Kampot). Vietnam: c[aa]y gai b[oo]m (Dinh Tuong).

Distribution Indo-China, Thailand, Peninsular Malaysia, Singapore, Sumatra, Java and Borneo.

Scolopia spinosa (Roxb.) Warb.

Synonyms *Scolopia fragrans* Elmer, *Scolopia roxburghii* (Benn.) Clos.

Vernacular names Indonesia: ki kemanden (Sundanese), rukem karang (Javanese), rukem putih (Palembang, Sumatra). Malaysia: piring, rotiom andu, rukam hutan bini (Sabah).

Distribution The Nicobar Islands, Burma (Myanmar), Indo-China, Thailand, Peninsular Malaysia, Sumatra, Java, Borneo and the Philippines (Palawan).

Isa Ipor

Scorodocarpus Becc.

Nuovo Giorn. Bot. Ital. 9: 274 (1877).
OLACACEAE
x = unknown; $2n$ = unknown

Vernacular names Kulim (trade name). Bawang hutan (Am, En). Brunei: bawang hutan. Indonesia: kayu bawang (Sumatra, Kalimantan), kayu bawang utan (Kalimantan), selaru (Kalimantan). Malaysia: bawang hutan (Sabah, Sarawak), sagan berauh, ungsunah (Sarawak). Thailand: krathiam ton, kuleng, kulim (peninsular).

Origin and geographic distribution *Scorodocarpus* is a monotypic genus occurring in peninsular Thailand, Peninsular Malaysia, Sumatra and Borneo. The only species is *S. borneensis* (Baillon) Becc. (synonym: *Ximenia borneensis* Baillon).

Uses The wood of *Scorodocarpus* is used for medium to heavy construction under cover (beams, joists, posts, door and window frames, flooring, rafters), bridge building, salt-water piling (with bark on), boat keels, mine props, transmission posts, agricultural implements and sleepers in temporary railway lines.

In Sarawak the young leaves are eaten as a vegetable. The fruit is edible and is sometimes used as a substitute for garlic. The fruits and also an infusion of the bark are sometimes used as an antidote for 'antiaris' (*Antiaris toxicaria* Lesch.) poisoning. An extract from the fruits shows antimicrobial activity.

Production and international trade Because of the limited supplies and local occurrence, *Scorodocarpus* wood is harvested and traded mainly locally, and only when no alternatives are available. It is occasionally found in mixed consignments of medium-weight hardwood.

Properties *S. borneensis* yields a medium-weight to heavy hardwood with a density of 645–1080 kg/m^3 at 15% moisture content. Heartwood reddish-brown to dark purplish-brown towards the centre, clearly demarcated from the up to 5 cm wide, white or pale yellow sapwood; grain shallowly or deeply interlocked, sometimes straight, wavy or irregular; texture moderately fine to moderately coarse and even; wood with silver fleck (vessel lines) on longitudinal surfaces and with strong odour of garlic when fresh and a peppery smell when dry. Growth rings indistinct; vessels moderately small to medium-sized, solitary but more often in radial multiples of 2–3(–6), tyloses mostly well-developed, occasionally with white deposits; parenchyma moderately abundant, apotracheal diffuse and diffuse-in-aggregates; rays very fine to moderately fine, visible with a hand lens; ripple marks absent.

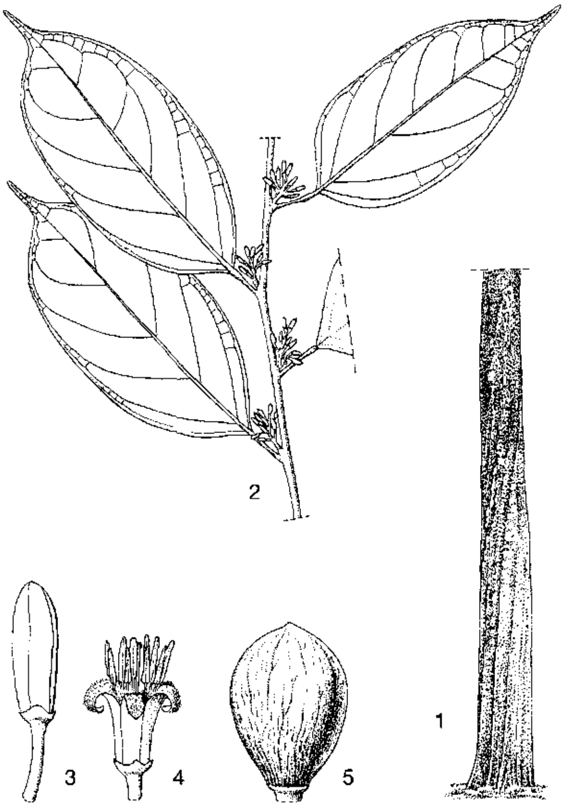
Scorodocarpus borneensis
transverse surface (×20)

Shrinkage upon air seasoning is low to high, especially tangentially, and the wood seasons fairly rapidly with moderate splitting and slight end-checks as the main source of degrade. Boards 13 mm and 38 mm thick take about 2 and 4 months, respectively, to air dry. It takes about 8 days at a temperature of 55–70°C and an initial relative humidity of 85% to kiln dry 25 mm thick boards to 14% moisture content. The wood is moderately hard to hard and very strong, but the core is often defective. The wood is moderately easy to saw and the finish after planing depends on the degree of interlocked grain present in the material. Turning properties are variable; boring, mortising and sanding gives good results but shaping is fairly poor. Due to its hardness it is difficult to peel. Nailing properties are rated as very poor. The wood is moderately durable to durable; the average service life of test stakes in a graveyard test in Peninsular Malaysia was about 4 years. The absorption of a mixture of creosote and diesel oil when using the open tank method is about 110 kg/m^3. The wood is susceptible to pinhole borers and longhorn beetles, moderately resistant to fungal attack and susceptible to dry-wood termites. The sapwood is non-susceptible to *Lyctus*.

The average fibre length is 2.151 mm. The volatile, antimicrobial compound from the fruits has been identified as methyl-methylthiomethyl-disulfide.

See also the tables on microscopic wood anatomy and wood properties.

Botany An evergreen, medium-sized to large tree up to 40(–60) m tall, all parts smelling of garlic; bole columnar, branchless for up to 25 m, up to 80(–150) cm in diameter, often piped, occasionally with small buttresses; bark surface shallowly fissured and flaking into thin rectangles, grey-brown to dark red-brown, inner bark fibrous, purplish-red, inwards with orange flecks. Leaves arranged spirally, simple, entire, exstipulate; petiole swollen distally. Flowers in an axillary, short raceme, 4–5-merous; calyx cup-shaped, margin wavy to toothed; petals reflexed, white, hairy inside; stamens 8 or 10, inserted in pairs about halfway on the petal; ovary superior, imperfectly 3–4-locular with a single ovule in each cell, stigma minutely lobed. Fruit a thinly fleshy, subglobular, 1-seeded, green drupe; endocarp woody with vertical strands. Seedling with hypogeal germination; cotyledons not emergent; hypocotyl not developed; epicotyl with a few scale leaves followed by normal, spirally arranged leaves.



Scorodocarpus borneensis (Baillon) Becc. – 1, bole; 2, flowering twig; 3, flower bud; 4, flower; 5, fruit.

Sapling leaves are alternate-distichous on the branches but arranged spirally on the orthotropic leader. Growth is slow and trees in a large sample in natural forest in Peninsular Malaysia showed an average annual diameter increment of 0.2–0.3 cm. In plantation trials in Peninsular Malaysia the largest trees of 30–33 years old measured 18–29 cm in diameter and 18–21 m in height. In Peninsular Malaysia flowering is in January–July and fruiting more or less throughout the year; in Borneo fruiting is usually in June–September.

Ecology *S. borneensis* occurs scattered but may be locally common or even gregarious in primary rain forest, up to 600(–900) m altitude.

Silviculture *S. borneensis* can be propagated by seed or by wildlings. Before storage seeds should be sun-dried for about 10 days. There are about 27 000 dry pyrenes/kg and they show about 70% germination in 11–32 months, fruits have about 40% germination in 9–16 months. Stumps may coppice easily. For optimal growth it requires well-drained soils. The mean timber volume of *S. borneensis* found in a survey of 20 000 ha of the Semangus forest, Sumatra is about 0.5 m^3/ha.

Genetic resources and breeding There are no records of *S. borneensis* in germplasm collections or seed banks. As it has a wide geographical distribution it is not at risk of genetic erosion.

Prospects It is unlikely that the use of the timber of *S. borneensis* will increase in the near future. It has no potential for reforestation.

Literature 3, 50, 112, 151, 162, 163, 193, 198, 218, 259, 261, 267, 341, 354, 436, 464, 536, 553, 571, 677, 678, 740, 741, 757, 829, 831, 832, 861, 933, 1023, 1038, 1040, 1048, 1052, 1221, 1242.

L.S.L. Chua

Scutinanthe Thwaites

Hooker's Journ. Bot. Kew Gard. Misc. 8: 266 (1856).

BURSERACEAE

x = unknown; $2n$ = unknown

Vernacular names Kedondong (trade name). Indonesia: merdondong. Malaysia: seladah, upi (Sarawak).

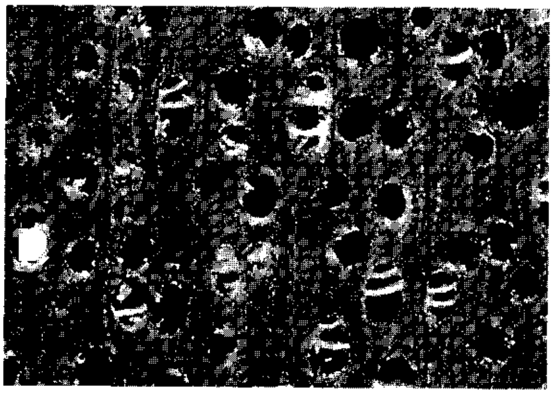
Origin and geographic distribution *Scutinanthe* comprises 2 species and is found in Sri Lanka, southern Burma (Myanmar), Peninsular Malaysia, Sumatra, Borneo, South-East Sulawesi and New Guinea (Irian Jaya). Both species occur within Malesia.

Uses In general, 'kedondong' is used for general light construction under cover, utility furniture, planking, cladding, shuttering, light duty flooring, pallets and boxes. It is suitable for the production of veneer and plywood and the production of particle board.

The fruit is edible.

Production and international trade *Scutinanthe* timber is traded together with that of many other *Burseraceae* genera as 'kedondong', but comprises only a very small part of the total amount traded, and is used mainly on a local scale.

Properties *Scutinanthe* yields a medium-weight hardwood with a density of 470–780 kg/m^3 at 15% moisture content. Heartwood deep red-brown resembling 'dark red meranti' (*Shorea*), on radial surface moderately sharply demarcated from the paler up to 5 cm wide sapwood; grain interlocked; texture moderately fine and even; longitudinal surface with speckles caused by the darker-coloured rays; wood with distinctive lustre.



Scutinanthe brunnea
transverse surface (×20)

Growth rings absent; vessels medium-sized, solitary or in radial multiples of 2–4, with occasional clusters, tyloses sparse; parenchyma very sparse to absent, sometimes scanty paratracheal just visible with a hand lens; rays very fine to moderately fine; ripple marks absent; radial canals not observed.
The wood is soft to only moderately hard. It contains some silica but this will probably not affect the ease of sawing. It should be treated with anti-stain chemicals immediately after sawing. The sapwood is susceptible to *Lyctus*.
See also the table on microscopic wood anatomy.

Botany Evergreen, dioecious, small to medium-sized trees up to 35 m tall; bole up to 90 cm in diameter, occasionally with buttresses up to 1(–3) m high; bark surface smooth or occasionally scaly, often hoop-marked, with powdery lenticels, light red, reddish-fawn or pinkish-grey, inner bark raspberry-red, with cream to colourless exudate. Leaves arranged spirally, imparipinnate, exstipulate; leaflets (2–)9–15, opposite, entire. Flowers in an axillary panicle, unisexual, 5-merous, densely pubescent, with a cup-shaped receptacle; sepals and petals free. Male flower with 10 stamens, filaments confluent at base; disk almost entirely adnate to the receptacle. Female flower with a superior, (2–)3-locular ovary with 2 ovules in each cell, style short, stigma lobed. Fruit an ellipsoid to ovoid, yellow drupe with 1(–2) 1-seeded pyrenes and persistent calyx; pericarp fleshy. Seedling with epigeal germination; cotyledons emergent, leafy, entire; hypocotyl elongated; all leaves arranged spirally, simple at first.
In Peninsular Malaysia *S. brunnea* mainly flowers in August and fruits in September; in Sumatra it fruits in January–February.

Scutinanthe resembles *Protium* but the latter differs in its saucer-shaped receptacle, its 4–5-locular ovary and the 1–5-seeded fruit.

Ecology *S. brunnea* is found scattered in primary, evergreen, non-inundated rain forest, up to 900(–1200) m altitude. *S. brevisepala* occurs in primary, lowland rain forest, up to 650 m altitude.

Silviculture *Scutinanthe* can be propagated by seed. Stones of *S. brunnea* sown still embedded in the pulp gave about 95% germination in 7–20 days.

Genetic resources and breeding *S. brevisepala* is a rare species.

Prospects It is unlikely that *Scutinanthe* will gain importance as a timber.

Literature 15, 162, 267, 341, 436, 464, 681, 682, 740, 826, 829, 831, 861, 1048, 1221, 1242.

Selection of species

Scutinanthe brevisepala Leenh.

Synonyms *Dacryodes papuana* Husson.

Vernacular names Indonesia: kobili (Sulawesi), marjelai (Sumatra).

Distribution Southern Burma (Myanmar), central Sumatra, South-East Sulawesi and New Guinea (Irian Jaya).

Scutinanthe brunnea Thwaites

Synonyms *Canarium brunneum* (Thwaites) Bedd.

Vernacular names Brunei: nyatoh. Indonesia: luwing (Kubu). Malaysia: kayam pengali, kedondong sengkuang, tayam belat (Peninsular).

Distribution Sri Lanka, Peninsular Malaysia, Sumatra and Borneo.

S. Sunarti

Scyphiphora Gaertn. f.

Suppl. carp. (Fruct. sem. pl. 3): 91, t. 196, fig. 2 (1806).

RUBIACEAE

$x = 11$; *S. hydrophyllacea*: $n = 11$

Vernacular names Indonesia: duduk, perepat lanang (Sumatra), duduk rayap (Java). Malaysia: chengam (Peninsular). Philippines: nilad (Filipino), arinaya (Iloko), nilar (Tagalog). Thailand: che ngam (central), se ngam, se-ham (peninsular).

Origin and geographic distribution *Scyphiphora* is a monotypic genus. Its only species, *S. hy-*

drophyllacea Gaertn. f., is distributed in Sri Lanka, India, Burma (Myanmar), Indo-China, southern China, the Andaman Islands, Thailand, throughout the Malesian region, the Solomon Islands, northern Australia, New Caledonia and the Palau Islands.

Uses The wood of *Scyphiphora* is used for small objects such as fence posts, tool handles and rice spoons.

In the Riau Archipelago a decoction of the leaves is used in local medicine for treating stomach-ache.

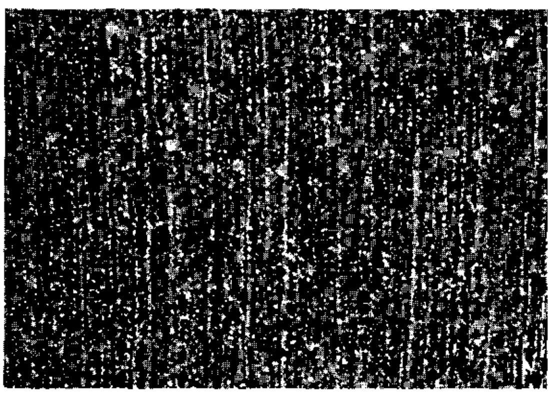
Production and international trade The wood of *Scyphiphora* is probably used on a local scale only.

Properties *S. hydrophyllacea* yields a heavy hardwood with a density of 800–910 kg/m^3 at 15% moisture content. Heartwood dark brown, not clearly differentiated from the sapwood; grain straight; texture very fine and even. Growth rings lacking; vessels extremely small to very small, predominantly solitary with very occasional radial pairs or small clusters, open or with white or yellow deposits; parenchyma moderately abundant, apotracheal diffuse tending to diffuse-in-aggregates, occasionally scanty paratracheal, hardly visible with a hand lens; rays very fine to moderately fine; ripple marks absent.

The wood is hard and strong. It is probably moderately durable when exposed to the weather or in contact with the ground, and durable under cover. The sapwood is rarely susceptible to *Lyctus*.

See also the table on microscopic wood anatomy.

Botany An evergreen shrub or small tree up to 6 m tall; bole up to 10(–20) cm in diameter, sometimes with small stilt roots; bark surface cracking to slightly scaly or fissured, dark brown to dark grey. Twigs and petioles bright red when young; buds resinous. Leaves opposite, simple, entire, obovate, leathery, blunt at apex, margin recurved, petiolate; stipules forming a low cup-like rim with hairy edge. Flowers in an axillary, cymose inflorescence, nearly sessile, 4-merous; calyx tube with obscure teeth; corolla tube hairy inside, white, with contorted, later recurved lobes; stamens inserted in the mouth of the corolla tube, with short filaments; disk annular; ovary inferior, 2-locular, each cell with 1 ascending and 1 descending ovule, style slender, exserted, stigma 2-lobed. Fruit drupe-like, ellipsoid, with 6–10 longitudinal ridges, green turning yellowish, up to 4-seeded. Seed with thin testa, embryo straight, endosperm present. Seedling with hypogeal germination which is aberrant among *Rubiaceae*.



Scyphiphora hydrophyllacea
transverse surface (×20)

Tree development is according to Attims's architectural model, characterized by a monopodial trunk and branches, both showing continuous growth. Growth is seemingly intermittent but irregular. In southern Thailand the trees flower in May–June, with few flowers throughout the year and the fruits ripen one month after flowering. In the Philippines flowering has been observed from January–May, whereas fruits are present in January–June. The flowers are protandrous, with the stigma lobes diverging after the anthers have shrivelled. They are insect-pollinated. Thanks to the spongy layers of the inner fruit wall the fruits float in water.

Scyphiphora is usually included in the tribe *Gardenieae* and is apparently related to *Diplospora*. Sterile trees can be mistaken for *Lumnitzera* (*Combretaceae*) or *Ceriops* (*Rhizophoraceae*), but the former has alternate leaves and the latter a lenticellate bark, more pointed leaf buds and more numerous secondary veins in the leaf. *S. hydrophyllacea* is the only member of *Rubiaceae* occurring in mangrove vegetation.

The name of the capital of the Philippines, Manila, was probably derived from the vernacular name of this tree, 'ma' meaning 'the place of' and thus 'Manila' meaning 'the place where nilar grows'.

Ecology *S. hydrophyllacea* is an uncommon, though locally abundant constituent of mangrove vegetation and more exposed coastal sites including beaches, on muddy or sandy soils. The trunks are sometimes submerged during high tide. It is usually associated with *Rhizophora*, *Ceriops*, *Bruguiera*, *Lumnitzera* and *Xylocarpus* species.

Silviculture Considered undesirable and sometimes referred to as a pest, *S. hydrophyllacea* is seriously hindering natural regeneration of preferred species in the mangrove forest.

Genetic resources and breeding *S. hydrophyllacea* is widespread and locally abundant (e.g. in the Philippines) and does not seem liable to genetic erosion. However, in several areas it is rare (e.g. in Java) and such populations may easily become endangered.

Prospects *S. hydrophyllacea* is too small to be of future importance as a timber.

Literature 70, 163, 209, 235, 267, 436, 464, 845, 861, 912, 1003, 1101, 1221, 1233.

N.O. Aguilar

Securinega Comm. ex A.L. Juss.

Gen. pl.: 388 (1789).

EUPHORBIACEAE

$x = 13$; *S. virosa* (Roxb. ex Willd.) Baillon: $2n = 26$

Vernacular names Philippines: anislag (Filipino), katamangan (Manobo), malagau (Butuan).

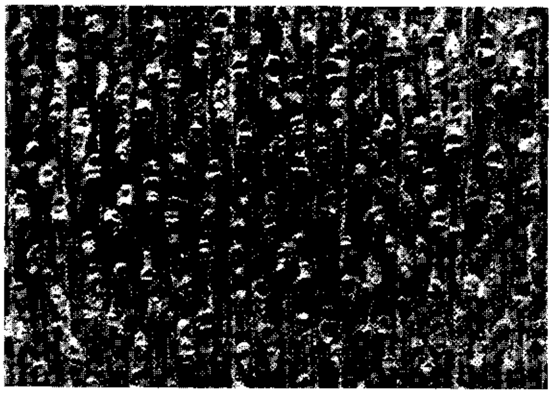
Origin and geographic distribution *Securinega* comprises some 20–25 species occurring in tropical and subtropical regions of the world. Four species are found within Malesia but only one, *S. flexuosa* (Müll. Arg.) Müll. Arg. (synonyms: *S. acuminatissima* (C.B. Rob.) C.B. Rob., *S. keyensis* Warb., *S. samoana* Croizat), is used as a timber. It occurs in the Philippines, the Sula Islands, the Kai Islands, New Guinea (Irian Jaya), the Solomon Islands, New Caledonia, Fiji, Samoa and Vanuatu.

Uses In the Philippines the wood of *S. flexuosa* is locally highly valued for house and fence posts, and additionally used for joists, rafters and tool handles. It also yields a good fuelwood.

In the Solomon Islands, where it is important for house posts, it is regarded as a potential multipurpose and community forest tree and may be important in future reforestation programmes. Pollen and nectar (honey) can be obtained from the flowers. The leaves are used for staining. The bark is applied medicinally in a fever-reducing drink.

Production and international trade Supplies are very limited and the wood of *S. flexuosa* is used on a local scale only.

Properties *S. flexuosa* yields a heavy hardwood with a density of 810–935 kg/m^3 at 15% moisture content. Heartwood pale yellowish-brown, hardly distinguishable from the up to 3 cm wide pale sapwood; grain straight; texture moderately fine; wood fairly lustrous; wood with a bitter taste. Growth rings indistinct, occasionally colour differences indicate growth ring boundaries; vessels very small to medium-sized, mostly in radial multiples of 2–4(–6), in radial arrangement, most vessels blocked by tyloses; parenchyma absent; rays moderately broad, tending to 2 distinct widths; ripple marks absent.



Securinega flexuosa
transverse surface (×18)

The wood is hard and strong but somewhat brittle. It finishes well, is durable and not susceptible to fungal or dry-wood termite attack. The sapwood is non-susceptible to *Lyctus*.

See also the table on microscopic wood anatomy.

Botany A deciduous, dioecious shrub or small or rarely medium-sized tree up to 10(–30) m tall; bole often irregular, branchless for up to 6 m, up to 30(–50) cm in diameter, sometimes with indistinct buttresses; bark surface smooth, becoming fissured and scaly with age, peeling in small, thin strips, lenticellate, pale grey to pale brown. Leaves arranged spirally but distichous on twigs, simple, entire, with short petioles; stipules small. Flowers in an axillary fascicle, unisexual, small, whitish or greenish-yellow; sepals 5; petals absent. Male flowers with 3–5 stamens; disk composed of 5 glands; pistillode present. Female flowers with an annular, crenate disk; ovary superior, 3-locular with 2 ovules in each cell, styles short, connate at base, stigmas deeply 2-lobed or double 2-lobed. Fruit drupaceous, many in clusters, fleshy, red turning black when ripe. Seed angled.

Growth is reputed to be fast. In the Philippines flowering has been observed in January and in May–June, fruiting in January and May. In the Pacific it flowers and fruits several times a year and has been recorded to bloom in January, April, July and September. The fruits are taken and dispersed by birds.

There is some dispute about whether the genus *Securinega* should include *Flueggea*. When two distinct genera are recognized, the Malesian species refer to the latter genus.

Ecology *S. flexuosa* has been found in primary forest at low altitudes and in dense shrub savanna. It is often a pioneer growing in river floodplains, fallowed fields and abandoned coconut plantations. It grows well on nutrient-poor soils.

Silviculture *S. flexuosa* is a light-demanding tree.

Genetic resources and breeding In the Philippines the highly esteemed wood of *S. flexuosa* has been sought after and, therefore, the risk of genetic erosion is high.

Prospects The timber of *S. flexuosa* will probably not gain commercial interest, but local importance for house construction and firewood may increase. Moreover, its rapid growth, outstanding form and heavy wood combined with non-wood uses make it a promising tree for farmers to plant, especially on infertile soils.

Literature 32, 33, 36, 184, 185, 235, 934, 974, 1195, 1202.

P.C. van Welzen

Semecarpus L.

Suppl. pl.: 25 (1782).

ANACARDIACEAE

$x = 15$; *S. anacardium* L. f.: $2n = 60$

Vernacular names Rengas (trade name, actually mainly used for *Gluta* and *Melanochyla* species). Papua New Guinea: semecarpus (En). Philippines: ligas.

Origin and geographic distribution *Semecarpus* comprises some 75 species occurring in India, Sri Lanka, Burma (Myanmar), Indo-China, Taiwan, Thailand, throughout the Malesian region, northern Australia and the Pacific islands east to Fiji. Within Malesia 43 species have been recorded.

Uses The wood of *Semecarpus* is used for temporary construction, mouldings, interior finish, and boxes and crates.

S. cuneiformis is planted as an ornamental in the Philippines. *S. heterophyllus* has been found suitable for soil protection at 500–1000 m altitude. Many species contain abundant poisonous resin which may cause serious inflammation and blistering of the skin. Both the fleshy hypocarp below the actual fruit and the seed kernel are edible. The fleshy exocarp and mesocarp of the fruit, however, contain a dark sap which is as aggressive as the resin. This sap is locally mixed with lime-water or alum and used as a permanent marking ink and as a varnish.

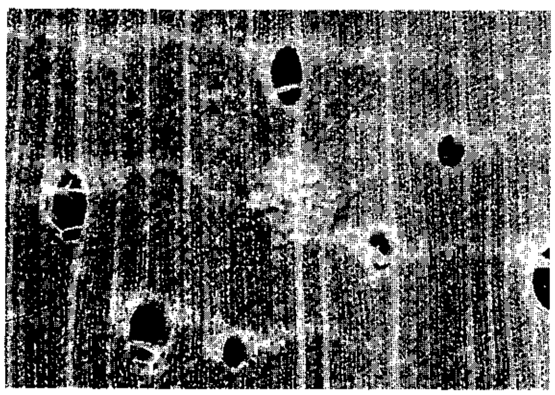
Production and international trade In Indonesia *Semecarpus* wood may make up a minor portion of 'rengas' timber, which consists mainly of *Gluta* spp. In 1996 Papua New Guinea exported about 490 m^3 of *Semecarpus* logs at an average free-on-board (FOB) price of US$ 99/m^3.

Properties *Semecarpus* yields a lightweight hardwood with a density of 380–510 at 12% moisture content. Heartwood pale pink or pale brown, turning yellowish or brownish when dry, with pinkish or yellowish streaks, not clearly demarcated from the pale sapwood which darkens upon drying; grain straight or moderately wavy; texture moderately fine to moderately coarse; wood moderately lustrous. Growth rings absent; vessels moderately small to moderately large, solitary and in radial multiples of 2–4(–5), sometimes in clusters, open; parenchyma paratracheal vasicentric, aliform to confluent; rays moderately fine; ripple marks absent.

The wood is moderately soft and weak, and is non-durable. The heartwood is very susceptible to dry-wood termites and fungi. The sapwood is susceptible to *Lyctus*.

See also the table on microscopic wood anatomy.

Botany Dioecious or polygamous, small to fairly large trees up to 40 m tall, rarely shrubs; bole usually short, up to 60(–100) cm in diameter, occasionally with small buttresses up to 1 m high; bark surface smooth to finely, shallowly fissured,



Semecarpus magnificus K. Schumann transverse surface (×20)

grey to dark brown or orange or red, inner bark exuding irritating creamy resin that darkens on exposure. Leaves arranged spirally or sometimes subverticillate, simple, entire, often papillose below, exstipulate. Inflorescence axillary or terminal, rarely cauliflorous, paniculate or rarely racemose. Flowers unisexual or rarely bisexual, small, female ones usually larger than male ones, (4–)5-merous; calyx lobed; petals usually imbricate; disk intrastaminal; ovary superior, 1-locular with a single ovule, styles 3. Fruit an often laterally compressed drupe, seated on a distinct, fleshy hypocarp; exocarp and mesocarp fleshy. Seed with testa free from the endocarp. Seedling with hypogeal germination; cotyledons not emergent; hypocotyl not elongated; first pair of leaves opposite, subsequent ones arranged spirally.
A myrmecophilous habit with hollow twigs has been reported for several species. Flowering is reported to be gregarious.

Ecology *Semecarpus* grows scattered in primary or less often secondary rain forest, up to 2000 m altitude. Individual species are occasionally found in periodically inundated regions, peat-swamp forest, monsoon forest, teak forest, on limestone hills or on ultrabasic soils.

Silviculture Great precautions should be taken when harvesting the trees, because the highly irritant resin has led to the death of sawyers who became covered with sawdust.

Genetic resources and breeding Apart from occasional trees in botanical gardens, there are no records of ex situ conservation of *Semecarpus* species.

Prospects The use of *Semecarpus* wood is unlikely to increase due to its relatively poor quality and toxic sap.

Literature 96, 150, 163, 209, 235, 238, 340, 341, 343, 348, 436, 464, 632, 934, 974, 1048, 1221, 1232, 1268.

Selection of species

Semecarpus australiensis Engl.

Synonyms *Semecarpus congestiflora* K. Schumann & Lauterb.

Distribution The Aru Islands, New Guinea, northern Australia and New Caledonia.

Semecarpus brachystachyus Merr. & L.M. Perry

Vernacular names Indonesia: sij (Manikiong, Irian Jaya).

Distribution New Guinea and the Solomon Islands.

Semecarpus bracteatus Laut.

Synonyms *Semecarpus archboldianus* Merr. & L.M. Perry.

Vernacular names Indonesia: bengeng (Hattam, Irian Jaya), owu (Mooi, Irian Jaya), rigi (Nemo, Irian Jaya).

Distribution New Guinea.

Semecarpus cassuvium Roxb.

Vernacular names Indonesia: kayu saku (Ambon), lewer (Banda), rotta (Sumba).

Distribution Sulawesi (rare), the Lesser Sunda Islands (Sumba), the Moluccas and New Guinea.

Semecarpus cuneiformis Blanco

Synonyms *Semecarpus obtusifolia* Merr., *Semecarpus perrottetii* Marchand, *Semecarpus philippinensis* Engl.

Vernacular names Philippines: ligas (Filipino), hanagas (Bisaya), kamiring (Ibanag, Iloko).

Distribution Taiwan, the Philippines, Borneo (Brunei, Kalimantan, Sabah), Sulawesi and the Lesser Sunda Islands (Sumbawa).

Semecarpus forstenii Blume

Synonyms *Semecarpus decipiens* Merr. & L.M. Perry, *Semecarpus laxiflora* K. Schumann & Lauterb., *Semecarpus scabrida* Blume.

Vernacular names Indonesia: gier (Kebar), laulasi (Ternate), sijkwa (Manikiong, Irian Jaya). Philippines: kamiring (Ibanag, Iloko).

Distribution Borneo (Kalimantan, Sabah), the Philippines, Sulawesi, the Moluccas, New Guinea and the Solomon Islands.

Semecarpus heterophyllus Blume

Synonyms *Semecarpus glabrescens* Heine.

Vernacular names Indonesia: ingas (Javanese), lungas delok (Sumatra), rengas gunung (Sundanese).

Distribution Peninsular Malaysia (Karimon Island), Sumatra, Java, Borneo (Kalimantan, Sabah), South Sulawesi and the Lesser Sunda Islands (Flores).

Semecarpus longifolius Blume

Synonyms *Semecarpus euphlebia* Merr., *Semecarpus gigantifolia* S. Vidal, *Semecarpus lanceolata* Merr.

Vernacular names Indonesia: ampaela (Sulawesi). Philippines: manalu (Filipino), anagasbabae (Tagalog), libas (Bikol).

Distribution Taiwan, the Philippines, Sulawesi, East Java, the Lesser Sunda Islands (Timor) and the Moluccas.

Semecarpus lucens King

Distribution Peninsular Malaysia and Sumatra.

Semecarpus papuanus Lauterb.

Vernacular names Indonesia: ko-u (Mooi, Irian Jaya).

Distribution New Guinea.

Semecarpus paucinervius Merr.

Synonyms *Semecarpus obtusata* Elmer.

Vernacular names Philippines: ligas-ilanan (Filipino), hanagas (Bisaya).

Distribution The Philippines (Palawan) and Borneo (Sabah).

Ding Hou

Senna Mill.

Gard. dict. abr. ed. 4, vol. 3 (1754).

LEGUMINOSAE

$x = 11, 12, 13, 14$; *S. siamea*: $n = 14, 18, 2n = 28$

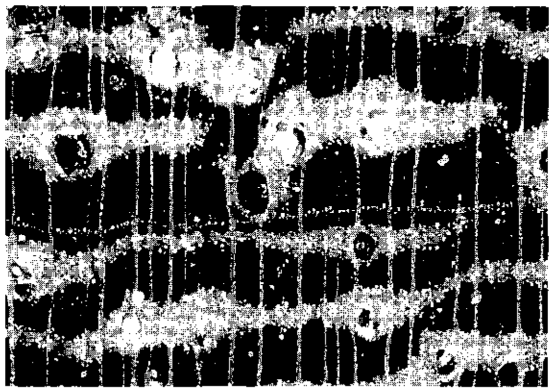
Vernacular names Senna (En). Malaysia: bebusok. Cambodia: ângkanh'. Laos: 'khi[2] 'lek. Thailand: khilek (general). Vietnam: mu[oof]ng.

Origin and geographic distribution *Senna* comprises about 270 species and has a pantropical distribution; a few species extend to temperate regions. Tropical Asia is not very rich in *Senna* species in comparison with tropical America, Africa and Australia. Only about 7 species occur naturally in tropical Asia, and only about 5 in the Malesian region. Only *S. siamea* has importance as a timber. Approximately 10 species have been introduced in Malesia and have become naturalized or even weedy; another 8 are planted as ornamentals and are only rarely found as escapes.

Uses The heartwood of *S. siamea*, which is often nicely figured, is used for joinery, inlaying, handles, sticks and other decorative uses. The wood has also been used for posts, poles, bridges, pit props, beams, and yields a good-quality firewood and charcoal. In Indonesia the wood of *S. timoriensis* has been reported to be favoured for axe handles, whereas in Indo-China it is used for boxes and joinery. Several *Senna* species, including *S. siamea*, are well-known ornamental or roadside trees. Some of the introduced ornamental species grow to medium-sized trees (e.g. *S. multijuga* (L.C. Richard) Irwin & Barneby), and may provide larger sizes of timber when cut. *S. siamea* is also much used for auxiliary purposes in agriculture and forestry, e.g. as a shade tree, for wind-breaks and for the production of firewood. Its bark has been used to tan leather, but the amount of tannin is comparatively low. The roots are used in local medicine; they act as a vermifuge and prevent convulsions in children. *S. timoriensis* is suitable for mixed afforestation for soil protection purposes; it is also planted as a roadside tree. Its fruits have anthelmintic properties and the bark is used against scabies. In Thailand and Indo-China the flowers, young fruits and young leaves of both *S. siamea* and *S. timoriensis* are eaten after soaking 2–3 times in hot water to remove toxins, but they taste bitter. *S. siamea* also yields fodder but the flowers and pods and to a lesser extent the leaves are highly toxic to non-ruminants such as pigs and poultry. Several species are valued as medicinal plants (e.g. *S. alata* (L.) Roxb. and *S. occidentalis* (L.) Link).

Production and international trade *Senna* timber is not traded in large amounts on the international market, but the heartwood is particularly in demand locally as it is decorative and durable.

Properties *Senna* yields a medium-weight to heavy hardwood with a density of 600–1010 kg/m^3 at 15% moisture content. Heartwood black-brown with paler streaks, sharply demarcated from the up to 6 cm wide pale sapwood; grain interlocked, occasionally straight; texture slightly coarse but even. Growth rings indistinct or occasionally



Senna siamea
transverse surface (×20)

distinct, boundary indicated by relatively little parenchyma; vessels medium-sized to moderately large, solitary, occasionally in radial multiples of 2–3, blocked with extraneous dark brown deposits, with occasional white or pinkish chalky deposits; parenchyma abundant, paratracheal confluent and apotracheal in broad more or less continuous concentric layers, narrower near growth ring boundaries and often interrupted, conspicuous; rays very fine, barely visible with a hand lens; ripple marks absent.

Shrinkage of the wood during seasoning is moderate to high but it seasons with little degrade. It is hard to very hard and strong. The wood is difficult to work, with a tendency to pick up in planing, but it takes a high polish. The sawdust of *S. siamea* may cause some irritation to eyes, nose and throat. The wood is durable with a service life of 9.5 years in a graveyard test in Peninsular Malaysia and probably resistant to termite attacks. The sapwood is susceptible to *Lyctus* and is permeable to pressure impregnation. The energy value of the wood is 22 400 kJ/kg.

See also the tables on microscopic wood anatomy and wood properties.

Botany Herbs, shrubs or small to medium-sized trees up to 20(–30) m tall; bole usually short, up to 50 cm in diameter; bark surface smooth, greyish; crown usually dense and rounded at first, later becoming irregular and spreading with drooping branches. Leaves alternate, paripinnate with up to 24(–40) pairs of leaflets; stipules small, usually caducous. Flowers in a 1–many-flowered, axillary raceme often becoming corymbose-paniculate toward the end of branchlets, 5-merous; sepals imbricate, obtuse at apex; petals subequal to heteromorphic, yellow; stamens 10, accrescent toward the abaxial side of the flower, filaments straight and not more than twice as long as anthers; ovary superior, linear and curved. Fruit a stipitate, often strap-shaped, terete to compressed, usually dehiscent pod, usually with septae between the numerous seeds. Seed with distinct areole. Seedling with epigeal germination; cotyledons emergent, semi-fleshy.

Trees of *S. siamea* develop according to Scarrone's architectural tree model, characterized by an indeterminate trunk bearing tiers of orthotropic branches which branch sympodially as a result of terminal flowering. *S. siamea* is known to form ecto-mycorrhizae, but it does not fix nitrogen through *Rhizobium* symbiosis. *S. siamea* and *S. timoriensis* are reported to flower throughout the year and *S. siamea* starts flowering and fruiting at the age of 2–3 years. Early development of both species is rapid and 2-year-old plants of *S. timoriensis* have an average height of 6–7 m. Mean annual increment of the latter 8 years after planting is 1.4 cm in diameter and 1.7–1.8 m in height. For a 10-year-old *S. siamea* plantation, these values are 1–2.5 cm and 1.2–3 m, respectively.

Senna siamea (Lamk) Irwin & Barneby – 1, tree habit; 2, flowering twig; 3, flower; 4, fruits.

Until the beginning of the 1980s *Cassia* was considered to be a very large genus of over 500 species, but then the genus was split into 3 genera: *Cassia* sensu stricto, *Senna* and *Chamaecrista*. *Cassia* now has only about 30 species, whereas *Senna* and *Chamaecrista* comprise about equal numbers of species.

Ecology *S. siamea* is locally common along roadsides, in waste places and along river banks; it occurs in different types of lowland forest. *S. timoriensis* is often found on limestone hills, in open forest, up to 1100 m altitude. It is a common inhabitant of deciduous dipterocarp forest in areas with a monsoon climate, and is a pioneer species.

Silviculture *Senna* can be propagated by seed.

Propagation by stem- and root cuttings has not been successful. The number of dry seeds per kg is 35000–41000 for *S. siamea*, and 52500–71000 for *S. timoriensis*. Seed can be stored for up to three years. Fresh seeds can be sown directly, but older seed needs a pretreatment to enhance a more rapid and uniform germination. For *S. siamea*, treatment with concentrated sulphuric acid for 10–30 minutes or with boiling water is recommended; using the first method about 90% of the seed germinates within 6 days, whereas germination of the untreated seeds is about 75% in 4–29 days. Germination of untreated seeds of *S. timoriensis* is about 25% in 6–103 days. Allowing the seed of both species to ripen for longer resulted in a slight increase in germination. Seed should be sown in full light, as the slightest shade reduces germination quite considerably. Direct seeding is often applied, for instance for the establishment of fuelwood plantations in Vietnam. Seedlings are often made into stumps before planting; for *S. siamea* a shoot of 10 cm long with a root of 30 cm long and a maximum diameter of 1 cm is recommended. Plantations should be weeded for the first two years, as *S. siamea* is susceptible to weed competition. In Indonesia planting trials of both *Senna* species have been conducted at a spacing of 3 m × 1 m. *S. siamea* developed low and heavy branches and forks, but under a closed canopy natural pruning was fairly good. Dense planting, however, leads to too slender stems after three years, which tend to bend over; timely thinning is of great importance. *S. timoriensis* is a very short-lived tree with a very fast early development, stagnating after 3.5 years and starting to die at the age of 8 years. *S. siamea* produced a clear bole volume of 77 m^3/ha after 15.5 years, whereas a mean annual increment of wood of 20–35 m^3/ha was determined in a 10-year-old plantation. *S. siamea* grows fast even on comparatively infertile soils in Indonesia. It tolerates inundation for a few weeks, and drought. It is, however, not suitable for shallow soils. For the production of fuelwood and charcoal, plantations are generally pollarded or regenerated by coppicing, leaving 2–3 shoots/stump after one year. It has been reported that the sapwood should be removed as soon as possible after felling, probably to prevent insect attack of the valuable heartwood. In Indonesia the fungus *Ganoderma lucidum* is locally a serious disease of *S. siamea*, causing wood rot on young plants. In Vietnam the butterfly *Catopsilia crocale* is a serious pest, its larvae feeding on the foliage of *S. siamea*. Plants of *S. siamea* are not susceptible to termite attack.

Genetic resources and breeding There are no records of ex situ conservation of *S. siamea* and *S. timoriensis* but both are rather common in several areas and, moreover, planted extensively. Therefore, they are not endangered or liable to genetic erosion.

Prospects *S. siamea* seems particularly worth trialling as a timber plantation tree. It grows comparatively fast and may provide timber of fair quality, although it may take a considerable time for larger sizes of heartwood to develop. Moreover, it is a rather attractive tree, with the potential of combining use as an ornamental with use as a timber tree.

Literature 40, 70, 130, 163, 209, 218, 255, 260, 261, 267, 308, 333, 343, 402, 405, 436, 471, 488, 536, 633, 697, 736, 817, 829, 831, 861, 889, 933, 934, 1163, 1177, 1198, 1199, 1221, 1242.

Selection of species

Senna siamea (Lamk) Irwin & Barneby

Synonyms *Cassia siamea* Lamk.

Vernacular names Kassod tree, Thai copper pod (En). Indonesia: johar (Sumatra, Java). Malaysia: johor, juah, petai belalang (Peninsular). Philippines: Thailand shower (En). Cambodia: ângkanh'. Laos: 'khi² 'lek. Thailand: khi lek ban (northern), khi lek yai (central), phak chili (northern). Vietnam: mu[oof]ng.

Distribution *S. siamea* is native to India, Burma (Myanmar), Indo-China, Thailand, perhaps also Peninsular Malaysia and Sumatra, but is planted throughout the tropics.

Senna timoriensis (DC.) Irwin & Barneby

Synonyms *Cassia timoriensis* DC.

Vernacular names Indonesia: haringhin (Sundanese), kayu pelen (Timor), turen (Javanese). Malaysia: bebatai, bereksa, sinteng hutan (Peninsular). Philippines: malamalunggai (Filipino). Cambodia: ângkanh', kânthum thet. Laos: 'khi² 'lek mot, 'khi² 'lek pa¹. Thailand: khi lek daeng (northern), khi lek luat (central), khi lek pa (peninsular). Vietnam: mu[oof]ng d[owr], mu[oof]ng t[is]a.

Distribution Sri Lanka, Burma (Myanmar), Indo-China, Thailand, and throughout the Malesian region to northern Australia.

E. Boer (general part),
R.H.M.J. Lemmens (general part, selection of species)

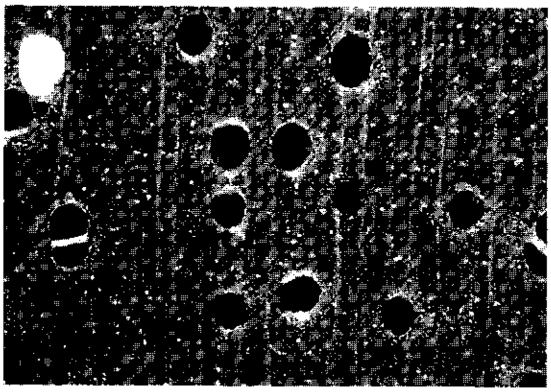
Serianthes Benth.

Lond. Journ. Bot. 3: 225 (1844).
LEGUMINOSAE
$x = 13$; *S. kanehirae* Fosberg: $2n = 26$
Vernacular names Serianthes (En).
Origin and geographic distribution *Serianthes* comprises about 18 species which occur from peninsular Thailand to the entire Malesian region, Micronesia, Melanesia and Polynesia. Four species are present within Malesia.

Uses The wood of *Serianthes* is used for light construction, light flooring, interior finish, mouldings, matches and matchboxes, shingles, cladding, weatherboards, fruit cases and pattern making; locally also for the manufacture of canoes. It is suitable for the production of veneer and plywood, as well as for pulp and paper.

Production and international trade Wood of *S. minahassae* is sometimes traded together with that of *Paraserianthes falcataria* (L.) I.C. Nielsen as 'white albizia'. It probably constitutes a minor proportion of the white albizia exported from Papua New Guinea, which amounted to 2100 m^3 in 1996. *S. myriadena* (Bertero ex Guill.) Planch. is a fairly important timber from Fiji and known as 'vaivai-ni-veikau'.

Properties *Serianthes* yields a lightweight to medium-weight hardwood with a density at 15% moisture content of 280–500 kg/m^3 for *S. minahassae* and 550–690 kg/m^3 for *S. grandiflora*. Heartwood yellow-brown, pink-brown or dark pink-brown, sometimes greenish, clearly demarcated from the pale yellow-white sapwood; grain straight; texture coarse. Growth rings indistinct; vessels moderately large to very large, solitary and in radial multiples of up to 4, rarely in clusters, open; paratracheal parenchyma vasicentric, apotracheal diffuse, rarely in irregularly spaced bands; rays narrower than the vessels; ripple marks absent.



Serianthes minahassae
transverse surface (×20)

The wood is moderately soft to moderately hard and weak to moderately strong, depending on density. It is non-durable. The sapwood is susceptible to *Lyctus*.
See also the table on microscopic wood anatomy.

Botany Unarmed shrubs or small to large trees up to 45 m tall: bole usually straight, branchless for up to 18(–24) m, up to 100(–125) cm in diameter, sometimes with buttresses up to 2.7 m high; bark surface smooth to slightly fissured, often lenticellate, pale grey or yellowish-grey to brown or red-brown, inner bark straw-coloured to pinkish-straw, pale purplish or creamy-orange; crown open and spreading. Leaves arranged spirally, bipinnate; rachis and pinnae usually with extrafloral nectaries; leaflets many, alternate except for the opposite terminal pair, sessile; stipules linear, caducous. Inflorescence composed of spikes, racemes, or 1–4-flowered glomerules aggregated into racemes, panicles or umbels; floral bracts large. Flowers bisexual, 5-merous; calyx and corolla connate, valvate, calyx circumscissile at base, corolla tube united with staminal tube below; stamens many, long-exserted; ovary 1(–2), superior, 1-locular with few to many ovules, style filiform. Fruit a woody, straight or curved, flat, not or tardily dehiscent pod with the seeds transverse and usually in an isolated chamber in the pod. Seed flattened, with pleurogram and hard testa, without aril. Seedling with epigeal germination; cotyledons emergent; hypocotyl elongated; all leaves bipinnate, first 2 opposite, subsequent ones arranged spirally.
In trials in West Java the mean annual increment of 7–8-year-old *S. minahassae* trees was 0.9–1.3 m in height and 1.2–1.6 cm in diameter. In Sulawesi *S. minahassae* flowers in December and fruits have been observed in February, May and June; in the Moluccas it flowers in January. *S. hooglandii* flowers in north-eastern New Guinea in October–March, and fruits in July–September, whereas in south-eastern New Guinea it flowers in January–July and fruits from April–September. The pods of *S. grandiflora* are dispersed by seawater.
Serianthes belongs to the subfamily *Mimosoideae* and is subdivided into 2 subgenera: subgenus *Minahassae* I.C. Nielsen and subgenus *Serianthes*. It is closely allied to *Paraserianthes* which differs mainly in the opposite leaflets. *S. minahassae* is subdivided into 3 subspecies.

Ecology *Serianthes* species possess pioneer characterisitcs and are found scattered in primary or secondary rain forest, up to 800(–1200) m altitude. They occur in well-drained habitats like hill slopes on rocky, sandy, clayey, volcanic or limestone soils, as well as in poorly drained sites on peaty soils. *S. grandiflora* is mostly found along the seashore and on sandy areas behind the mangrove. *S. hooglandii* also occurs in open savanna.

Silviculture *Serianthes* can be propagated by seed. The only germination trial reported is for *S. grandiflora*, in which about 15% of the seeds germinated in 8–20 days. In West Java a plantation trial with *S. minahassae* in an area with a seasonal climate failed.

Genetic resources and breeding Thanks to its pioneer characteristics, *Serianthes* is only slightly vulnerable to genetic erosion through deforestation.

Prospects *S. minahassae* has been proposed to be included in silvicultural trials, but so far the only trials were those conducted in West Java in the 1940s. Because of their pioneer habit *Serianthes* species may easily be established in plantations for timber, e.g. for the production of plywood.

Literature 40, 198, 238, 300, 304, 341, 351, 405, 427, 436, 464, 524, 536, 543, 829, 831, 842, 861, 974, 1039, 1163, 1212, 1221.

Selection of species

Serianthes grandiflora Benth.

Synonyms *Serianthes dilmyi* Fosberg.

Vernacular names Philippines: honok (Cebu Bisaya).

Distribution Peninsular Thailand, Peninsular Malaysia, Singapore, Sumatra, Java, Borneo (Sabah), the Philippines, Sulawesi, the Moluccas, New Guinea (Irian Jaya) and the Bismarck Archipelago (Manus Island).

Serianthes hooglandii (Fosberg) Kanis

Synonyms *Serianthes kanehirae* Fosberg var. *hooglandii* Fosberg.

Distribution Papua New Guinea, the D'Entrecasteaux Islands and the Solomon Islands.

Serianthes minahassae (Koord.) Merr. & L.M. Perry

Synonyms *Albizia melanesica* Fosberg, *Albizia minahassae* Koord., *Serianthes ledermannii* Harms.

Vernacular names Indonesia: bowoi, rayango, terengkuse (Sulawesi).

Distribution Sulawesi, the Lesser Sunda Islands (Sumbawa), the Moluccas, New Guinea and the Solomon Islands.

Serianthes robinsonii Fosberg

Distribution The Moluccas (Ambon, Seram).

J.P. Rojo

Siphonodon Griffith

Calcutta Journ. Nat. Hist. 4: 246, t. 14 (1844).

CELASTRACEAE

x = unknown; $2n$ = unknown

Vernacular names Indonesia: danoklot kepu (Javanese), indohe hapute (Muna, Sulawesi), ki singuguh kayu (Sundanese). Malaysia: kalantaid (Sabah). Papua New Guinea: ivru wood (En). Philippines: malagsak (Filipino). Burma (Myanmar): myauk-okshit. Thailand: ma duk (general), yai pluak (peninsular). Vietnam: sang d[as], x[uw]ng da.

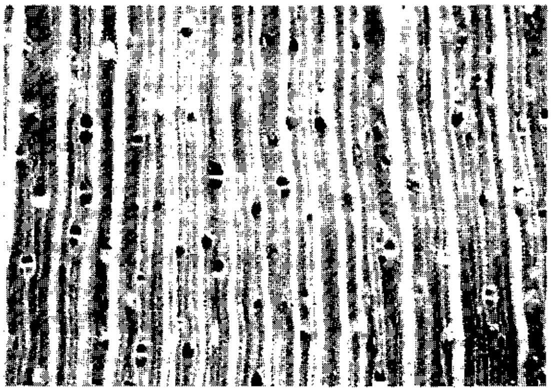
Origin and geographic distribution *Siphonodon* comprises about 7 species occurring in India, Burma (Myanmar), Vietnam, Thailand, throughout the Malesian region, and Australia. Two species are found within Malesia of which only 1, *S. celastrineus* Griffith (synonyms: *S. pyriformis* Merr., *Xanthophyllum subglobosum* Elmer), yields timber. It is widespread from India to the whole of the Malesian region.

Uses The wood of *S. celastrineus* is used for construction (posts), turnery, interior finish and utensils, but is also suitable for carving, engraving, drawing instruments and rulers. It is also used as firewood.

The fruits of *S. celastrineus* are edible.

Production and international trade The wood of *S. celastrineus* is probably used only locally.

Properties *Siphonodon* yields a medium-weight hardwood with a density of 735–780 kg/m^3 at 15% moisture content. Heartwood cream or pale brown to yellowish-brown, not clearly demarcated from the straw-coloured sapwood; grain straight or slightly interlocked; texture fine and even. Growth rings indistinct; vessels small, not visible to the naked eye, solitary and in radial multiples of 2–3, open, occasional white deposits present; parenchyma indistinct; rays moderately broad, distinct to the naked eye.



Siphonodon celastrineus transverse surface (×20)

The wood is fairly strong, hard and moderately durable when exposed to the weather or in contact with the ground. It splits easily.
See also the table on microscopic wood anatomy.

Botany A medium-sized to fairly large, glabrous tree up to 40 m tall; bole fairly straight, up to 90 cm in diameter, usually with small buttresses up to 2 m high or sometimes spurred; bark surface smooth to shallowly cracked, sometimes flaky or peeling off in small scales, grey to grey-brown, inner bark hard, mottled white with pale yellow. Leaves arranged spirally, simple, shallowly crenate; stipules minute, caducous. Flowers in an axillary, cymose inflorescence, sometimes solitary, 5-merous; calyx lobes imbricate; petals imbricate, cream-white; stamens curved inward, filaments flat, united at base; disk circular; ovary superior, half sunken in disk, 10-locular, each locule divided into 2–4 superposed, 1-ovulate cells, style rising from a cavity at the apex of the ovary. Fruit drupaceous, hard or fleshy, with 1-seeded stones. Seed flat, with membranous testa. Seedling with epigeal germination; cotyledons emergent, leafy; hypocotyl elongated; all leaves arranged spirally.
During the first 5 years growth is reputed to be slow, becoming fairly rapid in subsequent years. In Borneo *S. celastrineus* flowers from March–November.
Siphonodon is a rather aberrant genus within the family *Celastraceae*, and has even been proposed to constitute a family of its own.

Ecology *S. celastrineus* occurs scattered in primary rain forest up to 1300(–1600) m altitude. In the Moluccas it has been observed as a dominant tree associated with e.g. *Vitex cofassus* Reinw. ex Blume, *Pangium edule* Reinw., and *Intsia*, *Pometia*, *Ficus* and *Nauclea* species.

Silviculture *S. celastrineus* can be propagated by seed. Natural regeneration in natural forest is poor, but will be greatly enhanced by opening of the canopy. It is resistant to fire.

Genetic resources and breeding Although *S. celastrineus* is rare, it has a very wide geographical distribution and as the wood is not extensively used, the risk of genetic erosion is low. There are no records of *Siphonodon* in seed or germplasm banks, but trees are occasionally cultivated in botanical gardens.

Prospects The limited use of *Siphonodon* timber is unlikely to change in the near future.

Literature 61, 174, 198, 238, 274, 340, 341, 348, 371, 436, 861, 883, 974, 1038, 1048, 1221, 1232.

Nguyen Tien Ban

Sloanea L.

Sp. pl. 1: 512 (1753); Gen. pl., ed. 5: 228 (1754).
ELAEOCARPACEAE
x = unknown; $2n$ = unknown

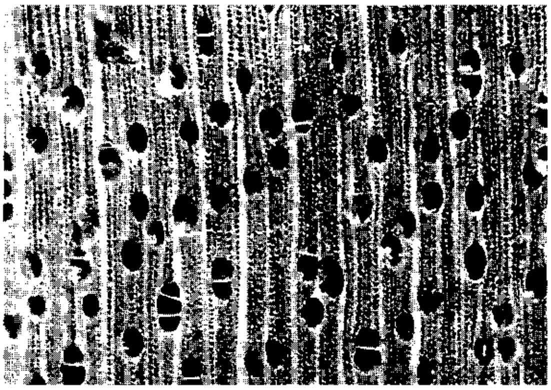
Vernacular names Sloanea (trade name). Carabeen (En). Philippines: sala (Filipino).

Origin and geographic distribution *Sloanea* comprises about 90 species occurring in tropical America, Madagascar and from India and Nepal to Indo-China, southern China, Taiwan, Thailand, throughout the Malesian region (except for the Lesser Sunda Islands), the Solomon Islands, Australia and New Caledonia. Within Malesia 22 species are present, the majority of them in New Guinea.

Uses The wood of *Sloanea* is used for general construction under cover, interior trim, flooring, furniture and cabinet work, joinery, mouldings, packing boxes, turnery, brush-backs, toys and match splints. It is also suitable for the production of veneer and plywood.

Production and international trade Supplies of *Sloanea* wood are limited and its use is mainly on a local scale, but exports from Papua New Guinea seem to be increasing. In 1996 about 9600 m^3 of 'sloanea' logs were exported from Papua New Guinea at an average free-on-board (FOB) price of US\$ 99/m^3, mainly to Japan.

Properties *Sloanea* yields a lightweight to medium-weight hardwood with a density of (325–)400–800 kg/m^3 at 15% moisture content. Heartwood cream to brown, sometimes with an olive tinge, not clearly differentiated from the



Sloanea forbesii
transverse surface (×20)

up to 13 cm wide, pale brown sapwood; grain usually straight; texture moderately fine to moderately coarse and even; wood sometimes moderately lustrous and with slight silver grain on quarter-sawn surface. Growth rings absent in *S. javanica*, distinct in *S. sigun*, boundaries indicated by narrow layers with denser fibres and fewer vessels; vessels medium-sized to large, solitary and in radial multiples of 2–3(–5), occasionally in clusters, open, rarely with tyloses; parenchyma sparse, scanty paratracheal, indistinct even with a hand lens, rarely apotracheal in narrow marginal or seemingly marginal bands; rays of 2 distinct sizes, moderately fine to medium-sized and extremely fine to very fine; ripple marks absent; traumatic axial gum ducts containing solid deposits observed at growth ring boundaries of *S. sigun*; pith flecks present in some material of *S. sigun*.

Care is required when seasoning to prevent surface checking and blue stain. The wood is moderately hard and weak to moderately strong. It is easy to saw and relatively easy to work with hand and machine tools. It is non-durable. The sapwood is susceptible to *Lyctus*. The wood is moderately resistant to pressure treatment. In *S. insularis* a retention of 535 kg/m^3 of sapwood and 79 kg/m^3 of heartwood has been determined.

See also the tables on microscopic wood anatomy and wood properties.

Botany Evergreen or deciduous, small to large trees up to 40(–45) m tall; bole straight, sometimes crooked, up to 70(–120) cm in diameter, often knobbly, often fluted or with large buttresses up to 3 m high, branchless for up to 17 m; bark surface smooth to cracked or scaly, lenticellate, grey or grey-brown, inner bark fibrous or granular, dark yellow to red-brown or pink. Leaves arranged spirally or rarely opposite, simple but sometimes pinnate in saplings, entire but dentate in saplings; petiole kneed; stipules often caducous. Inflorescence axillary or terminal, racemose or fasciculate or flowers solitary. Flowers 4–5-merous; sepals and petals similar or distinct or petals occasionally absent; petals free to completely fused into a tube; disk entire; stamens many, inserted on the disk, anthers dehiscing by 2 apical slits; ovary superior, (2–)3–5(–7)-locular with many ovules, hairy, style simple. Fruit a woody, smooth or spiny, dehiscing capsule. Seeds 1–5 per valve, with a red or orange aril or enveloped in the sarcotesta. Seedling with epigeal germination; cotyledons emergent, fleshy; hypocotyl elongated; first 2 leaves opposite, subsequent ones arranged spirally.

In West Java *S. javanica* flowers in October–December and fruits are mature in March. Seeds of *Sloanea* are dispersed by birds.

Sloanea is occasionally regarded as a member of the tribe *Sloaneeae* within the family *Tiliaceae*.

Ecology *Sloanea* occurs scattered in primary or secondary rain forest, up to 2000(–2800) m altitude. *S. sigun* may become dominant. In New Guinea several *Sloanea* species prefer oak forest.

Silviculture *Sloanea* can be propagated by seed provided the aril is removed. Seeds without aril of *S. malayana* show 40–65% germination in 11–28 days.

Genetic resources and breeding Most *Sloanea* species occurring in New Guinea are endemic and are likely to be vulnerable to genetic erosion by destruction of their habitat.

Prospects *Sloanea* trees may hold potential for increased use for veneer and plywood manufacture although supplies are limited.

Literature 40, 70, 101, 125, 163, 201, 238, 260, 267, 300, 302, 303, 304, 346, 348, 360, 373, 403, 436, 464, 487, 553, 827, 829, 831, 861, 974, 1038, 1039, 1221, 1232, 1248.

Selection of species

Sloanea aberrans (Brandis) A.C. Smith

Synonyms *Echinocarpus papuanus* Schlechter, *Elaeocarpus aberrans* Brandis, *Sloanea papuana* (Schlechter) A.C. Smith.

Distribution New Guinea.

Sloanea forbesii F. v. Mueller

Synonyms *Echinocarpus forbesii* (F. v. Mueller) Schlechter.

Distribution New Guinea and the Bismarck Archipelago.

Sloanea insularis A.C. Smith

Distribution The Bismarck Archipelago and the Solomon Islands; possibly also elsewhere in Papua New Guinea.

Sloanea javanica (Miq.) Szyszyl. ex K. Schumann

Vernacular names Indonesia: sarang (Indonesian, East Kalimantan). Philippines: Java sala (Filipino).

Distribution Peninsular Malaysia (very rare), Singapore, Sumatra, Java, Borneo, the Philippines and Sulawesi.

Sloanea ledermannii A.C. Smith

Distribution Papua New Guinea.

Sloanea malayana Coode

Distribution Peninsular Malaysia.

Sloanea nymanii K. Schumann

Synonyms *Anoniodes glabra* Schlechter, *Anoniodes nymanii* (K. Schumann) Schlechter, *Sloanea glabra* (Schlechter) A.C. Smith.

Distribution New Guinea.

Sloanea paradisearum F. v. Mueller

Synonyms *Echinocarpus brassii* O.C. Schmidt, *Sloanea brassii* (O.C. Schmidt) A.C. Smith, *Sloanea myriandra* A.C. Smith.

Distribution New Guinea.

Sloanea pulchra (Schlechter) A.C. Smith

Synonyms *Sloanea clemensiae* A.C. Smith, *Sloanea aculeata* A.C. Smith p.p.

Distribution New Guinea.

Sloanea pullei A.C. Smith

Distribution New Guinea.

Sloanea pulleniana Coode

Distribution New Guinea.

Sloanea sigun (Blume) K. Schumann

Synonyms *Echinocarpus sigun* Blume.

Vernacular names Indonesia: ki somang (Sundanese), landakan (Javanese), si bala kayu (Batak Karo, Sumatra). Thailand: ko rian (peninsular), ngoh pa (south-eastern), sati ton (north-eastern).

Distribution India (Assam), Thailand, Peninsular Malaysia, Sumatra, Java and Borneo.

Sloanea sogerensis Baker f.

Synonyms *Sloanea oxyacantha* A.C. Smith.

Distribution The Moluccas, New Guinea and the Bismarck Archipelago.

Sloanea tieghemii (F. v. Mueller) A.C. Smith

Synonyms *Sloanea archboldiana* A.C. Smith, *Sloanea arfakensis* (Kaneh. & Hatus.) Merr., *Sloanea perbella* A.C. Smith.

Distribution New Guinea.

S.I. Wiselius (general part),
M.S.M. Sosef (selection of species)

Sonneratia L. f.

Suppl. pl.: 38 (1782).

SONNERATIACEAE

$x = 11, 12$; *S. alba*, *S. caseolaris*: $n = 11, 12$, *S. lanceolata*: $n = 12$, *S. ovata*: $n = 11$

Vernacular names Perepat (trade name). Brunei: pedada. Indonesia: perepat laut (general). Malaysia: pedada (general). Papua New Guinea: red-brown mangrove (En). Philippines: pagatpat, pedada. Thailand: lam phaen.

Origin and geographic distribution *Sonneratia* comprises 6 species which occur along the shores of tropical East Africa, islands in the Indian Ocean, tropical Asia, northern Australia, Micronesia, Melanesia and New Caledonia. It is found throughout Malesia, where 5 species occur, 4 of which are widespread.

Uses The wood of *Sonneratia* is used locally for interior house building, ship building, piles of bridges, sleepers, paving blocks, flooring, occasionally for furniture, sporting goods, and produces a good firewood. Sulphate pulp is suitable for making paper.

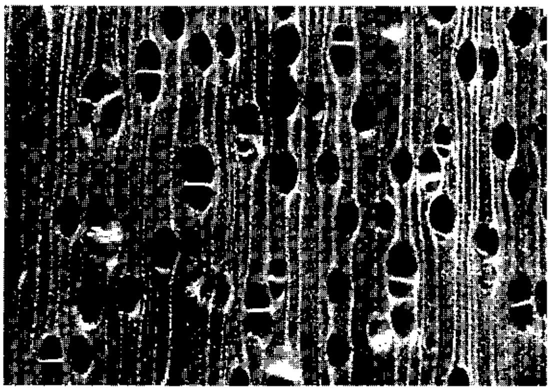
The sour fruits are eaten raw or cooked and used to make vinegar, and in local medicine. Leaves may be used for fodder. Pectin can be extracted from the fruits of *S. caseolaris*. Its aerial roots are sometimes used as a substitute for cork. The bark is locally used for tanning leather and fishing nets. *S. caseolaris* is occasionally planted along the coast in Sarawak as an ornamental.

Production and international trade Very small amounts of *Sonneratia* timber are exported from Papua New Guinea. In 1992 about 5100 m^3 of logs and 1700 m^3 of sawn timber were exported from Sabah at prices of about US$ 73/m^3 and US$ 150/m^3, respectively.

Properties *Sonneratia* yields a lightweight to heavy, usually medium-weight hardwood with a density of 400–1000 kg/m^3 at 15% moisture content. Heartwood pale grey-brown to dark brown, clearly demarcated from the paler, up to 8 cm wide sapwood; grain straight or slightly interlocked; texture fine and even; wood with fishy odour especially when fresh and with salty taste. Growth rings indistinct to just visible; vessels moderately small to medium-sized, solitary and in radial multiples of 2–4, usually blocked by tyloses and with occasional white deposits; parenchyma absent or indistinct; rays extremely fine to very fine; ripple marks absent; occasionally pith flecks or oil cells present.

Shrinkage upon seasoning is moderate. Warping and checking is negligible when carefully seasoned. The wood is moderately hard to hard and strong. It is easy to work and takes a beautiful polish. The wood is moderately durable, but should not be used in contact with the ground in the humid tropics. Under certain conditions it may possess some resistance to marine borer attack; both heartwood and sapwood are resistant to dry-wood termites; the susceptibility of the sapwood to *Lyctus*, however, is contradictory. The high salt content of the wood corrodes iron spikes and bolts. The wood is resistant to preservative pressure treatment.

The energy value of *S. caseolaris* is about 17 230 kJ/kg. The bark of *S. alba* yields 9–12% tannin based on dry weight.



Sonneratia caseolaris
transverse surface (×20)

See also the tables on microscopic wood anatomy and wood properties.

Botany Small to medium-sized, sometimes fairly large trees up to 20(–40) m tall; bole often crooked and fluted at base, branchless for up to 15 m, up to 100 cm in diameter, without buttresses, surrounded by aerial roots arising vertically from long horizontal roots; bark surface initially smooth with lines of lenticels and grey-green to brownish-grey, becoming irregularly fissured and dark grey-brown, inner bark smooth or shallowly flaky, pink to orange-brown, with watery exudate; crown often broad, irregular and lax. Young twigs distinctly jointed above the nodes and 4-angled. Leaves opposite and 2-seriate, simple, entire, leathery, exstipulate. Flowers 1–3 together at the apex of twigs, large, bisexual; calyx thick, leathery, persistent, with (4–)6–8 valvate segments; petals absent or as many as calyx segments and then narrow, caducous; stamens numerous; ovary superior, 10–many-locular with many ovules in each cell, style long and slender. Fruit a depressed-globose, indehiscent many-seeded berry, crowned by the style base. Seed small, irregular and angular, without endosperm. Seedling with epigeal germination; cotyledons emergent; hypocotyl elongated.

S. caseolaris shows Attims's architectural tree model, characterized by axes with continuous growth, differentiated into a monopodial trunk and equivalent branches. *S. alba*, however, develops according to Rauh's architectural tree model, characterized by a monopodial trunk which grows rhythmically and so develops tiers of branches. Flowering of *S. caseolaris* is described as aseasonal, that of *S. alba* and *S. ovata* as seasonal. The flowers open shortly after sunset. They have an offensive smell (described as sour and buttery) and are conspicuous by the numerous exserted white or partly reddish stamens. They are short-lived, lasting one night; petals and stamens soon drop. At anthesis the flowers contain abundant nectar and are visited by bats (e.g. the nectarivorous bats *Eonycterus spelaea* and *Macroglossus minimus*); they are also pollinated by large moths (hawk moths). The fruits float in water and are so dispersed; fruit bats and monkeys may also disperse the seeds.

Hybrids between *S. alba* and *S. caseolaris* and between *S. alba* and *S. ovata* seem to be rather common locally in Brunei, where the parent species grow side by side in a very narrow mangrove belt; the former hybrid is also found in Queensland, Australia (described as *S.* ×*gulngai* N.C. Duke).

The hybrid between *S. alba* and *S. lanceolata* is rare in southern New Guinea and northern Australia.

Together with *Duabanga*, a genus of inland trees, *Sonneratia* constitutes the family *Sonneratiaceae*. These genera are sometimes placed in the *Lythraceae*. Herbarium material is often difficult to identify down to the species, which has caused considerable confusion in literature. For a reliable identification, the colour of flower parts and the poise of the calyx of ripe fruits are important, and identification in the field is generally easy. *S. griffithii* Kurz occurs in southern India, Burma (Myanmar), Thailand, the Andaman Islands and northern Peninsular Malaysia. It is very rare in Peninsular Malaysia, but has often been confused with *S. alba*; probably most information in older literature from Peninsular Malaysia refers to the latter species. Some references to *S. ovata* probably refer to *S. alba*.

Ecology *Sonneratia* occurs in mangrove forest along the sea and on the banks of tidal rivers and creeks; it also grows on coral terraces, whether or not flooded at high tide. *S. caseolaris*, *S. lanceolata* and *S. ovata* grow on less salty, deep muddy soils, often along tidal rivers and creeks, not on coral banks, whereas *S. alba* prefers salt-water and grows along seashores and the mouth of tidal creeks on sandy, rocky or muddy soils, and also on coral terraces. *S. alba* may act as a pioneer, colonizing newly formed sandy mud flats in sheltered situations. *S. alba*, *S. caseolaris* and *S. lanceolata* often occur gregariously, but usually do not form dense stands. *S. ovata* is less common but locally abundant. *S. caseolaris* has been found a few times in freshwater swamps without any connection to the sea.

Silviculture *Sonneratia* can be propagated by seed.

Genetic resources and breeding *S. alba*, *S. caseolaris* and *S. lanceolata* are widespread and common in many regions and do not seem vulnerable, although the destruction of mangrove habitats is alarming. *S. ovata* is rather uncommon, occurring scattered over its large area of distribution. *S. griffithii* has a restricted distribution. The last two species are probably at risk of genetic erosion when the pressure on the forest along river mouths, where they grow, becomes too heavy.

Prospects In mangrove forest *Bruguiera* and *Rhizophora* are usually economically more important, the latter being planted widely in logged mangrove vegetations. Therefore, in the current economic climate the importance of *Sonneratia* for its wood is likely to decrease. However, it has very good potential as a valuable source of raw material for kraft pulp which warrants serious consideration.

Literature 61, 100, 151, 162, 163, 235, 267, 293, 304, 341, 343, 348, 402, 436, 464, 536, 632, 811, 861, 934, 1015, 1048, 1053, 1101, 1123, 1221, 1242, 1253.

Selection of species

Sonneratia alba J.E. Smith

Synonyms *Sonneratia griffithii* auct. non Kurz, *Sonneratia ovata* auct. non Backer.

Vernacular names Brunei: pedada laut. Indonesia: perepat laut (general), posi-posi (Ternate). Malaysia: perepat (Peninsular, Sarawak). Burma (Myanmar): lame. Thailand: pat, ram-pat (peninsular). Vietnam: b[aax]n d[aws]ng, b[aax]n ch[us]t.

Distribution Eastern Africa, Madagascar, the Seychelles, throughout tropical Asia including the entire Malesian region, the Solomon Islands, northern Australia, Vanuatu and New Caledonia.

Sonneratia caseolaris (L.) Engl.

Synonyms *Sonneratia acida* L. f.

Vernacular names Brunei: pedada nasi. Indonesia: berembang (eastern Sumatra), bogem (Javanese, Sundanese), perepat merah (South Kalimantan). Malaysia: berembang (Peninsular), perepat laut (Sabah). Burma (Myanmar): tamoo, tapoo. Cambodia: 'âm'-piё, lop ou. Thailand: lamphu (central). Vietnam: b[aaf]n chua, c[aa]y b[aaf]n, l[aaj]u.

Distribution Throughout tropical Asia including the entire Malesian region, the Solomon Islands, northern Australia and Vanuatu.

Sonneratia lanceolata Blume

Distribution Borneo and Sulawesi to southern New Guinea and northern Australia.

Sonneratia ovata Backer

Vernacular names Brunei: perapat. Indonesia: bogem (Palembang), kedabu (eastern Sumatra). Malaysia: gedabu (Peninsular), pedada rogam (Sarawak). Cambodia: ampea, lapea. Vietnam: b[aas]n [oor]i, b[aas]n h[oo]i.

Distribution Indo-China, southern China, Thailand, Peninsular Malaysia, the Riau Archipelago, Java, Borneo, southern Sulawesi, the Moluccas and southern New Guinea.

E. Boer (general part),
R.H.M.J. Lemmens (general part, selection of species)

Spondias L.

Sp. pl. 1: 371 (1753); Gen. pl., ed. 5: 174 (1754).
ANACARDIACEAE
$x = 16$; *S. mombin*: $n = 16$, *S. pinnata*: $2n = 32$

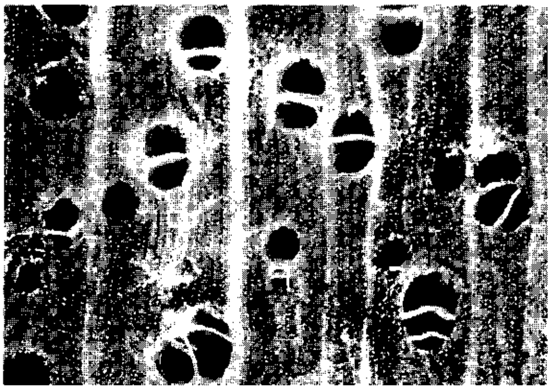
Vernacular names Spondias (En). Indonesia: kedondong. Malaysia: kedondong. Thailand: makok. Vietnam: c[os]c. Kedondong is the trade name for timber of the family *Burseraceae*, but is apparently also used for *Spondias* spp.

Origin and geographic distribution *Spondias* comprises 10 species occurring in tropical America and in India, Burma (Myanmar), Indo-China, southern China, Thailand, throughout the Malesian region and the Solomon Islands. Five species are present within Malesia. Four of them, *S. cytherea*, *S. mombin*, *S. pinnata* and *S. purpurea* are occasionally cultivated throughout the tropics, mainly for their edible fruits.

Uses The wood of *Spondias* is used for mouldings, interior finish, drawers, core stock of plywood, pulp, but because of its lightness and softness more generally for e.g. matchsticks, matchboxes, boxes, crates, carving and turnery articles.
The fruits of several species are eaten raw or made into jams, jellies and juices. Young leaves and flower clusters are eaten as a vegetable and have a sour taste. The fruit of *S. purpurea* is used as an astringent and for the treatment of dysentery, diarrhoea and gonorrhoea. It is also reported to have some antimutagenic effects on mice. The fruits, leaves and bark are used medicinally in the treatment of wounds, sores and burns. Leaves are fed to cattle and fruits to pigs. Large stumps are planted as living fence posts and trees are occasionally planted for shade.

Production and international trade Supplies are limited and the timber is harvested mainly on a local scale. Small amounts of *Spondias* timber are imported by Japan, mainly from Papua New Guinea and the Solomon Islands. In 1996 Papua New Guinea exported about 2865 m^3 of *Spondias* logs at an average free-on-board (FOB) price of US\$ 94/m^3.

Properties *Spondias* yields a lightweight hardwood with a density of (245–)320–480 kg/m^3 at



Spondias cytherea
transverse surface (×20)

15% moisture content. Heartwood pale yellow-brown to grey-brown, sometimes with a pink core, not clearly differentiated from the pale to grey sapwood, which can be up to 22 cm wide; grain straight, rarely interlocked; texture moderately coarse and even. Growth rings usually not distinct; vessels medium-sized to large, solitary, in radial multiples of 2–4 with a few clusters, open or occasionally with tyloses; parenchyma sparse, paratracheal vasicentric to aliform; rays medium-sized to moderately large, visible to the naked eye; ripple marks absent; radial canals present, but rather indistinct because the rays containing the canals are not enlarged.
Shrinkage of the wood upon seasoning is very low to low. It takes about 3 days to kiln dry 25 mm thick boards from green to 12% moisture content; boards with spiral grain or tension wood may twist or bow. The wood is very weak and soft, and very soft around the pith. It is easy to saw and convert, but logs with tension wood may show a woolly finish. It is difficult to obtain a smooth finish in planing. To prevent stain, felled logs must be rapidly extracted, converted and dried. The wood is non-durable, retention of preservatives by pressure treatment is 600–680 kg/m^3 for sapwood and 505–630 kg/m^3 for heartwood, but the heartwood is also reported as erratic to impregnation. The sapwood is susceptible to *Lyctus*. The heartwood is highly susceptible to blue stain, termite and marine borer attack. Wood dust may cause itching and inflammation of the eyelids.
See also the tables on microscopic wood anatomy and wood properties.

Botany Wholly or partly deciduous, small to medium-sized or occasionally large trees up to 30(–45) m tall, rarely a hemi-epiphyte; bole branchless for up to 18 m, up to 100(–150) cm in diameter, spur-rooted or occasionally with small buttresses; bark surface smooth or shallowly furrowed to rugged with corky, spine-like projections and knobs, greyish to pale reddish-brown, inner bark pale brown, with pale yellow, watery exudate; crown compact. All parts with a turpentine smell when bruised. Leaves arranged spirally, imparipinnate, exstipulate; leaflets alternate to opposite, entire to serrate, usually with an intramarginal vein. Inflorescence axillary or terminal, paniculate or rarely racemose. Flowers bisexual, (4–)5-merous; calyx lobed; petals valvate; stamens 10 (or 8); disk intrastaminal; ovary superior, 1-locular or (4–)5-locular with a single ovule in each cell, styles (4–)5 and free, or 1. Fruit a drupe, smooth or ridged; endocarp woody to bony. Seed with testa free from endocarp. Seedling with epigeal germination; cotyledons emergent; hypocotyl elongated; first pair of leaves opposite, subsequent ones arranged spirally.

S. mombin develops according to Scarrone's architectural model, characterized by an indeterminate trunk bearing tiers of orthotropic branches which branch sympodially as a result of terminal flowering. The mean annual diameter increment of a 22-year-old *S. pinnata* tree in India was 1.1 cm. Flowers appear before or with the new leaves. In the humid tropics *S. cytherea* flowers and fruits almost continuously; under seasonal conditions flowering is concentrated in the dry season. In Java *S. cytherea* flowers in July–August and ripe fruits are available in January–April, whereas *S. pinnata* can be found flowering and fruiting in June–October. Flowers are pollinated by bees. Fruits are dispersed by bats.

The taxonomy of *Spondias* is very complex. Recently, Kostermans stated he regards *S. pinnata* as a species occurring from India to Indo-China, whereas the Malesian trees belong to 3 different species: *S. acida* Blume and *S. malayana* Kosterm. occurring in West Malesia, and *S. novoguineensis* found from the Moluccas eastward. He also treats wild material from the Philippines as a distinct species, *S. negrosensis* Kosterm., and different from *S. purpurea* that was introduced to the Philippines long ago from South America.

Ecology *Spondias* occurs scattered in primary forest, up to 1000 m altitude. It is usually found on well-drained sites but occasionally also in floodplains, along the inner border of tidal forest (*S. mombin*), and in drier habitats like teak forest, savanna and on limestone (*S. pinnata*).

Silviculture *Spondias* can be propagated by seed, cuttings and air layering. Large cuttings of *S. purpurea* are used to establish live fences. Depulped fruits (stones) are used for sowing and one stone of *S. pinnata* contains 1–3 viable seeds. Seed viability may be retained for one year. There are about 250 fresh stones/kg. Sown fruits of *S. cytherea* have only 5–20% germination in 12–51 days. For *S. pinnata*, direct sowing proves better than planting bare-rooted seedlings. Stumps have also been successfully used for planting. *S. pinnata* is a light-demander and coppices well. *S. cytherea* is susceptible to severe attacks by caterpillars and by an unidentified beetle completely defoliating the trees; *S. purpurea* is liable to attacks of various insects.

Genetic resources and breeding As most *Spondias* species are planted for their fruits, conservation of their genetic resources seems safeguarded.

Prospects It is unlikely that *Spondias* wood will gain importance, primarily because of its poor quality, but as the fruits of most species are an important commodity, the wood may increasingly be used rather than wasted.

Literature 40, 122, 125, 134, 150, 155, 163, 209, 238, 267, 300, 341, 343, 348, 402, 405, 464, 487, 536, 631, 632, 697, 831, 861, 1104, 1123, 1164, 1232, 1248.

Selection of species

Spondias cytherea Sonnerat

Synonyms *Spondias dulcis* Soland. ex J.G. Forster.

Vernacular names Ambarella, great hog plum, otaheite apple (En). Indonesia: kedongdong (general), coco (Ternate), kedondong manis (Java). Malaysia: kedondong (general). Papua New Guinea: spondias (En). Philippines: hevi (Filipino), viapple (En). Burma (Myanmar): gwe-cho. Thailand: ma kok farang, ma kok waan (central). Vietnam: c[os]c tr[oof]ng.

Distribution Native throughout South and South-East Asia; widely cultivated in other tropical regions.

Spondias mombin L.

Synonyms *Spondias lutea* L.

Vernacular names Yellow mombin, thorny hog plum (En). Prunier mombin (Fr). Indonesia: kedongdong cina, kedongdong cucuk, kedongdong sabrang (Sundanese).

Distribution Native to tropical America; cultivated in tropical countries, in Malesia in Peninsular Malaysia, Sumatra and Java.

Spondias pinnata (L. f.) Kurz

Synonyms *Spondias mangifera* Willd.

Vernacular names Common hog plum (En). Indonesia: kedongdong (general), kacemcem (Bali), kedongdong leuweung (Sundanese). Malaysia: embrah, kedongdong, memberah (Peninsular). Philippines: libas (Filipino). Burma (Myanmar): gwe, pwe-baung. Cambodia: mokak. Laos: kok, kouk, 'mak kok. Thailand: ma-kok (general). Vietnam: c[os]c chua, c[os]c r[uwf]ng.

Distribution Native to India, Burma (Myanmar), Indo-China, southern China, Thailand, and throughout Malesia to the Solomon Islands; also commonly cultivated in western Malesia and locally naturalized.

Spondias purpurea L.

Vernacular names Spanish plum (En). Indonesia: kedongdong cina, kedongdong cucuk, kedongdong sabrang (Sundanese). Philippines: sineguelas (Filipino), saguelas (Iloko), siriguelas (Bikol).

Distribution Native of tropical America; cultivated throughout the tropics, in Malesia mainly in the Philippines.

D.S. Alonzo

Stemonurus Blume

Bijdr. fl. Ned. Ind. 13: 648 (1826).

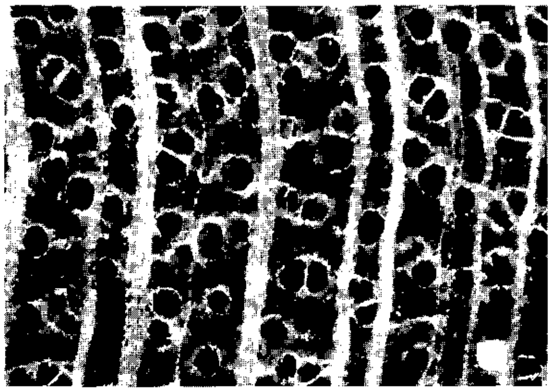
ICACINACEAE

x = unknown; $2n$ = unknown

Origin and geographic distribution *Stemonurus* comprises about 12 species, 9 of which are found in the Malesian region. The genus occurs in Sri Lanka, Indo-China, southern Burma (Myanmar), peninsular Thailand, Peninsular Malaysia, Sumatra, West Java, Borneo, the Philippines, Sulawesi, New Guinea, Palau Island and the Solomon Islands.

Uses The wood of *Stemonurus* is used for construction under cover, beams and planks, and household utensils.

The fruits of *S. scorpioides* are said to be edible. The pyrenes of *S. secundiflorus* are bitter and edible only after special preparation including repeated cooking. The reported medicinal value of leaves of the latter species against swellings is doubtful.



Stemonurus scorpioides
transverse surface (×20)

Production and international trade *Stemonurus* wood is probably used on a local scale only. Supplies are limited. In Sabah *S. scorpioides* is sometimes sold as 'medang', which comprises the wood of several *Lauraceae* genera.

Properties *Stemonurus* yields a medium-weight hardwood with a density of 510–800 kg/m^3 at 15% moisture content. Heartwood yellow-brown or purple-grey-brown, not clearly differentiated from the sapwood; grain interlocked; texture moderately fine and rather uneven due to the broad rays; wood with some silver grain in *S. scorpioides*, aromatic. Growth rings absent; vessels small to medium-sized, solitary and in short multiples and occasional clusters, tending to be tangentially arranged; parenchyma moderately abundant, paratracheal vasicentric to aliform and confluent from the tangential arrangement of vessels, visible with a hand lens; rays small to medium-sized, conspicuous; ripple marks absent.

The wood is soft to moderately hard, not very strong, and non-durable. The sapwood is considered susceptible to *Lyctus*.

See also the table on microscopic wood anatomy.

Botany Evergreen, small to medium-sized trees up to 30(–40) m tall; bole straight, cylindrical, branchless for up to 24 m, up to 60 cm in diameter, sometimes with small buttresses or pneumatophores; bark surface smooth to finely fissured or cracked, occasionally hoop-marked or pustulate, whitish to grey, grey-brown or greenish-grey, inner bark with orange and white mottles; crown moderately dense and compact. Leaves arranged spirally, simple, entire, thick and leathery, glabrous, exstipulate. Inflorescence an axillary, peduncled umbel with its branches bearing the flowers either crowded at the end or in 1–2 rows along the upper part. Flowers sessile, bisexual, fragrant; calyx cup-shaped, truncate or slightly 5-lobed; petals (4–)5, connate at base, white to yellowish, apex inflexed; stamens (4–)5, filaments hairy at apex, anthers distally hairy; disk annular; ovary superior, unilocular with 2 apical ovules, style 1. Fruit a 1-seeded drupe, dark red to purple in the lower part and pale or greenish in the upper. Seedling with epigeal germination; cotyledons emergent, leafy; hypocotyl very elongated; all leaves arranged spirally.

Most *Stemonurus* species bear flowers and fruits throughout the year. The fragrant flowers are probably pollinated by insects. Thanks to the fibrous outer endocarp the fruits float and may thus be dispersed by water.

S. secundiflorus has been divided into 3 varieties based on leaf characteristics.

Ecology The timber-yielding *Stemonurus* species occur scattered in evergreen, primary or rarely secondary, lowland to lower montane rain forest, up to 1400 m altitude. *S. scorpioides* is typical of swamp forest at low altitudes, whereas *S. secundiflorus* occurs in both well-drained locations and swamps.

Silviculture Germination of *S. malaccensis* and *S. scorpioides* in the nursery is fair and more or less simultaneous.

Genetic resources and breeding Since *Stemonurus* species are comparatively widespread and not specifically sought after, there seems little risk of genetic erosion.

Prospects As supplies are small and information on e.g. silviculture and propagation is very scarce, *Stemonurus* wood will probably not become commercially interesting.

Literature 63, 198, 238, 267, 341, 436, 464, 861, 974, 1026, 1038, 1039, 1221.

Selection of species

Stemonurus ammui (Kaneh.) Sleumer

Synonyms *Stemonurus ellipticus* (Schellenb. non Merr.) Sleumer, *Urandra ammui* Kaneh., *Urandra elliptica* Schellenb. non Merr.

Distribution Palau Island, Papua New Guinea including New Britain, and the Solomon Islands.

Stemonurus malaccensis (Masters) Sleumer

Synonyms *Lasianthera malaccensis* Masters, *Stemonurus capitatus* Becc., *Urandra nitida* Howard.

Vernacular names Malaysia: gigi buntol, petom, tarung pelandok (Peninsular). Thailand: ai bao, bao, khriat (peninsular).

Distribution Southern Burma (Myanmar), peninsular Thailand, Peninsular Malaysia and Borneo.

Stemonurus scorpioides Becc.

Synonyms *Urandra scorpioides* (Becc.) O. Kuntze.

Vernacular names Brunei: medang katuk. Indonesia: bahuhu etem (Simeuluë), banol (Bangka), kayu longgaha (eastern Sumatra). Malaysia: entaburok (Iban, Sabah, Sarawak), katok (Dusun, Sabah, Sarawak), perepat paya (Peninsular).

Distribution Peninsular Malaysia, Sumatra (including Simeuluë), Borneo and intervening islands.

Stemonurus secundiflorus Blume

Synonyms *Stemonurus lanceolatus* Becc., *Stemonurus ridleyanus* Sleumer, *Urandra secundiflora* (Blume) O. Kuntze.

Vernacular names Indonesia: bahuhu uding (Simeuluë), lokan (Sumatra), saber bubu (Bangka). Malaysia: kepot dejuku (Dayak, Sarawak), lada-lada hutan, perepat bukit (Peninsular).

Distribution Peninsular Malaysia, Sumatra (including the islands along the west coast), West Java, Borneo and intervening islands.

Stemonurus umbellatus Becc.

Synonyms *Stemonurus evenius* Stapf, *Stemonurus hallieri* (Merr.) Merr., *Stemonurus intercedens* Heine.

Vernacular names Malaysia: entaburok (Iban, Sabah), kelat puteh, sampit kris (Peninsular). Philippines: malatadu (Manobo).

Distribution Peninsular Malaysia, Borneo and the Philippines.

D.S. Alonzo

Stereospermum Cham.

Linnaea 7: 720 (1832).

BIGNONIACEAE

$x = 20$; *S. chelonoides*: $2n = 40$, *S. colais*: $n = 20$

Vernacular names Malaysia: chicha(h) (Penisular). Cambodia: sângkû:ët thma:t. Vietnam: quao.

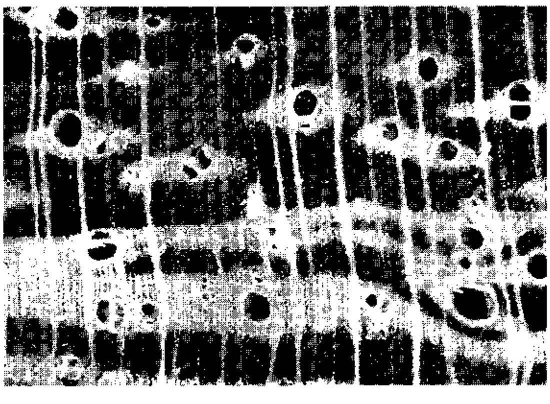
Origin and geographic distribution *Stereospermum* comprises over a dozen species occurring in tropical Africa, Madagascar, India, Sri Lanka, Indo-China towards Thailand and Peninsular Malaysia, possibly also in Sumatra and East Java. There are 3 species within the Malesian region.

Uses The wood of *Stereospermum* is used for temporary constructions and under cover for beams, posts, planking, cladding and shuttering; in Assam and East Bengal it has also been used for canoes and tea-boxes. The wood makes an excellent firewood and yields good charcoal.

S. fimbriatum is planted as an ornamental. A decoction of the roots of *S. fimbriatum* is given after childbirth, juice of its leaves is dropped into the ear for earache, and its leaves pounded with lime are applied against itch. The root and bark of *S. chelonoides* are used as a favourite tonic in native medicine, and display anti-malarial activity. In southern India a cooling drink from the roots and flowers of *S. colais* is given to treat fever and the fragrant flowers are offered in the temples.

Production and international trade Within Malesia *Stereospermum* wood has no commercial value, but in India it is commercially traded under the name 'padri'.

Properties *Stereospermum* yields a medium-weight to heavy hardwood with a density of 700–910 kg/m^3 at 15% moisture content. Heartwood pale yellow-brown with a grey tinge, not clearly differentiated from the paler sapwood; grain interlocked; texture rather coarse due to the abundance of confluent parenchyma; wood with speckled appearance. Growth rings visible with a hand lens, indicated by marginal parenchyma; vessels medium-sized to moderately large, solitary and in radial pairs, tangential in arrangement, rarely in clusters, open or filled with chalky-white deposits; parenchyma abundant, apotracheal in narrow marginal or seemingly marginal bands, visible only with a hand lens, paratracheal confluent, conspicuous to the naked eye; rays very fine or moderately fine and just visible to the naked eye; ripple marks absent.



Stereospermum fimbriatum
transverse surface (×20)

The timber is strong and moderately hard to hard. It is reported to season easily with very little degrade and is rather difficult to work, rapidly blunting tools. The wood is non-durable to moderately durable with a service life of 1–4 years in a graveyard test in Peninsular Malaysia.

The gross energy value of the sapwood of *S. chelonoides* is about 19 370 kJ/kg.

See also the table on microscopic wood anatomy.

Botany Deciduous, medium-sized trees up to 30 m tall; bole up to 100(–160) cm in diameter, without buttresses but sometimes slightly fluted at base; bark surface fissured and scaly or flaky, light grey or pale pinkish, inner bark laminated with distinct white and yellow patches; crown narrow and more or less cylindrical, rather open. Leaves opposite, imparipinnate, exstipulate, with glands below; leaflets 5–13, opposite. Flowers in a terminal or sometimes axillary, large, paniculiform thyrse, 5-merous, fragrant; calyx closed in bud, with short lobes; corolla infundibuliform, delicate, 2-lipped, the lobes variously incised; stamens 5, the 5th rudimentary; disk present; ovary superior, 2-locular with 2 rows of many ovules in each cell, stigma bifid. Fruit a long, linear, terete capsule with thick valves and a thick corky septum, with the seeds alternatingly embedded in notches. Seed trigonous, with narrow hyaline wings on each side. Seedling with epigeal germination; hypocotyl elongated; first few nodes with simple, toothed leaves, subsequent ones compound with an increasing number of entire leaflets.

In natural forest in India *S. chelonoides* trees showed a mean annual diameter increment of 0.1–0.4(–0.9) cm. Flowers appear after the leaves have been shed which is at the start of the dry season, hence in Peninsular Malaysia flowering is between February and June. Flowers are nocturnal (they fall in the morning) and pollination is probably by hawk-moths. Fruits develop within 1–2 months. The winged seeds are dispersed by wind.

There is confusion about the correct names of two of the species. The name *S. chelonoides* has often been applied erroneously to *S. colais* (which is called *S. personatum* in Flora Malesiana). Therefore, information on these species cannot always be attributed to an individual species with certainty.

Ecology *Stereospermum* species are largely confined to areas subject to a seasonal climate. They are found in primary and secondary lowland or hill forest, often on rocky coasts or headlands, but also in thickets and savannas. Altitudinal distribution is from sea-level to 1000 m. They are also frequently encountered in villages and secondary forest.

Silviculture *Stereospermum* can be propagated by seed, including direct seeding, and air layering. Seeds should be sown soon after collection, and fresh seeds of *S. fimbriatum* have 30–50% germination in 9–25 days. Trees are hardy and fire-resistant. Seedlings resist drought, frost and weed competition, although weeds greatly impede their development. *Stereospermum* is a moderate light-demander and under natural conditions in India natural reproduction of seedlings and suckers is abundant. It coppices freely and produces root suckers.

Genetic resources and breeding Because of their fairly wide geographical distribution and their low level of exploitation, the timber-yielding *Stereospermum* species are only slightly vulnerable to genetic erosion.

Prospects Being hardy species, *Stereospermum* may increasingly be used for forestation under less favourable conditions and for erosion control.

Literature 163, 209, 267, 341, 343, 406, 464, 697, 726, 829, 831, 861, 1104, 1221, 1242.

Selection of species

Stereospermum chelonoides (L. f.) DC.

Synonyms *Stereospermum suaveolens* (Roxb.) A. DC.

Vernacular names Indonesia: jati teken, kayu teken (Javanese). Cambodia: snaêng rômduël. Burma (Myanmar): kywema-gyolein. Vietnam: c[aa]y quao.

Distribution From Sri Lanka and India to Burma (Myanmar), Laos, Cambodia and locally in East Java where it is somewhat doubtfully native.

Stereospermum colais (Buch.-Ham. ex Dillw.) Mabb.

Synonyms *Stereospermum chelonoides* auct. non (L. f.) DC., *Stereospermum personatum* (Hassk.) Chatterjee, *Stereospermum tetragonum* A. DC.

Vernacular names Yellow snake tree (En). Burma (Myanmar): thande. Laos: kh'ê: s'a:y. Thailand: khae hin (central and northern), khae han hae (northern), khae khao (peninsular). Vietnam: dinh, m[os]ng b[of], t[af]u m[ows]t.

Distribution From Sri Lanka and India to Burma (Myanmar), Indo-China, southern China, Thailand, Peninsular Malaysia (rare) and Singapore; possibly also in Sumatra.

Stereospermum fimbriatum (Wallich ex G. Don) A. DC.

Synonyms *Stereospermum mekongense* Dop.

Vernacular names Snake tree (En). Malaysia: chechar, chicha(h), lempoyan (Peninsular). Burma (Myanmar): thakut-po. Laos: kh'ê: 'fo:y. Thailand: khae foi, khae sai (northern and peninsular), khae yot dam (peninsular).

Distribution Burma (Myanmar), Laos, Thailand and Peninsular Malaysia; possibly also in Sumatra.

D. Sasmitamihardja

Streblus Lour.

Fl. cochinch.: 614 (1790).

MORACEAE

$x = 13, 14$; *S. asper*: $2n = 26$, *S. indicus* (Bureau) Corner: $n = 14$

Vernacular names Tempinis (trade name). Thailand: khoi (general). Vietnam: ru[oos]i.

Origin and geographic distribution *Streblus* comprises about 23 species and occurs in Africa and Madagascar, and from Nepal, India and Sri Lanka to Indo-China, southern China, Thailand, throughout the Malesian region towards the Solomon Islands, Australia, New Zealand and the Pacific Islands, east to Fiji, Samoa and the Cook Islands, and north to Hawaii. Only 5 species occur within Malesia.

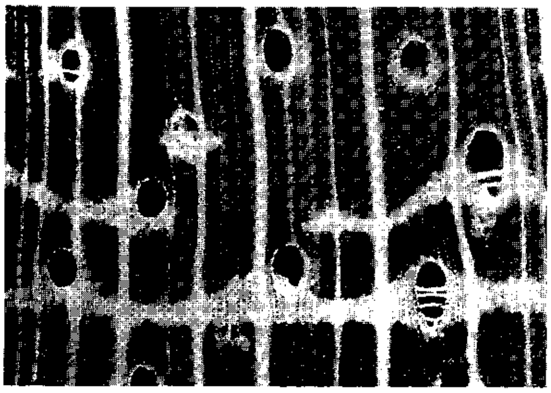
Uses The hard and very durable wood (mainly of *S. elongatus*) can usually only be obtained in small pieces and is mainly used for specialty items such as tool handles (especially the strong and elastic sapwood), carrying sticks, oars, spokes and cartwheels, but also for musical instruments, turnery, anchors, bows and fishing rods. Whenever large logs are available these are suitable for heavy construction, bridge building, wharves, boat building, parquet flooring, heavy-duty flooring, railway sleepers, power transmission poles and interior finish. It is regarded as one of the best local timbers for use in salt-water.

S. asper is a well-known medicinal plant. Its bark is traded as a medicine used to treat leprosy, piles, diarrhoea, dysentery and elephantiasis, and it shows anti-cancer and anti-malaria activities. In

Thailand the bark is also used to manufacture paper; elsewhere in Indo-China also for rope and for rough clothing. In India the latex is put on sore heels and chapped hands, and on glandular swellings. Young leaves are fed to cattle in India and Indo-China. In Malaysia an extract of the leaves of *S. asper* is used to make milk coagulate with a texture similar to that of yoghurt. Old leaves of this species have been applied for polishing ivory. Ripe fruits of *S. asper* and *S. ilicifolia* can be eaten raw or boiled. In the Philippines *S. asper* is planted as an ornamental; in Indonesia it has been grown as cover crop in forest plantations.

Production and international trade Because of the very limited supplies and often small size of *Streblus* timber, it is used on a local scale only. It is, however, highly valued locally. In Peninsular Malaysia 'tempinis' is regarded as a substitute for 'chengal' (*Neobalanocarpus heimii* (King) P. Ashton).

Properties *Streblus* yields a medium-weight to heavy hardwood with a density of 530–750 kg/m^3 for *S. asper* and 920–1200 kg/m^3 for *S. elongatus*. The following wood properties all refer to *S. elongatus*. Heartwood yellow to yellowish-red or brownish-red, darkening to dark chocolate-brown upon exposure, distinctly demarcated from the white to pale yellow-brown, up to 10 cm wide sapwood; grain interlocked, occasionally straight; texture fine to moderately fine and even; wood with distinct odour when freshly cut. Growth rings indistinct, occasionally visible, indicated by darker coloured bands with relatively few vessels and parenchyma; vessels moderately small to medium-sized, mostly solitary, sometimes in radial multiples of 2–4(–5) with occasional clusters, blocked by tyloses or filled with yellow-white deposits; parenchyma abundant, paratracheal aliform in the earlywood becoming confluent towards the end of the growth ring, in some samples apotracheal in marginal or seemingly marginal bands; rays very fine to moderately fine, not prominent on radial surface; ripple marks absent; radial latex canals rare and difficult to see.



Streblus urophyllus Diels
transverse surface (×20)

Shrinkage upon air seasoning is low and the wood seasons without degrade. Boards of *S. elongatus* 13 mm and 38 mm thick take respectively about 2.5 and 3.5 months to air dry. The wood is very hard, very strong and extremely elastic. The wood is fairly difficult to work with hand and machine tools and severely blunts cutting edges. It is rather difficult to plane, but finishes and polishes well. Care must be taken in drilling, moulding and mortising to avoid chipping at the exit of tools. The wood is very durable when exposed to the weather or in contact with the ground. For *S. elongatus* the average service life of test stakes in a graveyard test in Malaysia was 11.3 years. Both sapwood and heartwood are resistant to preservative treatment. The wood is resistant to termite and to some extent to marine borer attack, the sapwood is non-susceptible to *Lyctus* but slightly susceptible to blue stain.

The gross energy value of the wood of *S. asper* is 17830 kJ/kg. Adding the extract of leaves of *S. asper* to milk to curdle it does not change pH; the product is stable at pH 5.5–9.0, and up to 70°C. It has been suggested that the milk coagulation factor may be a proteinase. The bark of *S. asper* contains glucosides with anti-cancer and cardiac activity.

See also the tables on microscopic wood anatomy and wood properties.

Botany Evergreen, monoecious or dioecious, armed or unarmed, shrubs or small to medium-sized trees up to 30 m tall; bole often irregular and fluted, branchless for up to 15 m, up to 60(–75) cm in diameter, without distinct buttresses; bark surface smooth, becoming finely and irregularly cracked or fissured, grey, inner bark yellowish or whitish, with or without milky latex; crown compact, dense. Leaves distichous or sometimes arranged spirally, simple, entire to toothed; stipules free or connate, lateral to completely amplexicaul. Inflorescence axillary, bisexual or unisexual, solitary or paired, cymose, racemose, spicate or capitate, sometimes the female flower solitary. Flowers unisexual. Male flowers 3–5-merous; tepals imbricate or valvate in bud; stamens bending outward at anthesis; pistillode present. Female flowers 4-merous; tepals free or almost free, variably unequal; ovary superior, free, 1-locular with a single ovule, stigmas 2. Fruit drupaceous or a dehiscent or indehiscent capsule; fruiting tepals enlarged or not, not to slightly fleshy. Seedling with hypogeal germination; cotyledons unequal, the larger not emergent, the smaller emergent; hypocotyl not elongated; first few leaves scale-like, lower leaves arranged spirally, subsequent ones distichous.

It seems that seedlings of *S. asper* develop into creeping shrubs that only later develop an upright branch that becomes the trunk. In Peninsular Malaysia *S. elongatus* flowers in January–August and November, but ripe fruits have rarely been collected. *S. elongatus* already flowers when about 1.8 m tall. The seeds of *S. asper* are dispersed by white ants which drag them into their nests, where they often germinate. The ripe fruits of *S. elongatus* are eaten by squirrels, monkeys and birds.

Streblus is a variable genus divided into 5 sections, and includes the genera *Phyllochlamys*, *Sloetia* and *Taxotrophis*. It is very closely related to *Trophis*, from which it mainly differs by the free versus connate tepals.

Ecology *S. elongatus* occurs scattered in lowland forest, and in open vegetation. *S. asper* is a characteristic element of monsoon forest; it also occurs in areas disturbed by man.

Silviculture *S. asper* has been propagated by cuttings to establish a cover crop in forest plantations. Fruit setting of *S. elongatus* is poor as is its natural regeneration, but it coppices easily and may be found, therefore, coppiced in secondary vegetation. *S. elongatus* is considered shade-tolerant.

Genetic resources and breeding In Peninsular Malaysia and Singapore *S. elongatus* has been heavily depleted, because of its highly valued timber. *S. asper* has become rare in Java.

Prospects Although the wood of *S. elongatus* has outstanding qualities for specialty uses, supplies are very limited and dwindling; hence its use will probably decrease further.

Literature 70, 106, 151, 161, 163, 174, 205, 209, 217, 260, 261, 267, 340, 354, 387, 406, 436, 464, 526, 536, 672, 677, 678, 861, 883, 933, 973, 1038, 1169, 1221, 1239, 1242, 1262, 1268.

Selection of species

Streblus asper Lour.

Synonyms *Diplothorax tonkinensis* Gagnep., *Streblus monoicus* Gagnep.

Vernacular names Sandpaper tree, Siamese rough bush, tooth brush tree (En). Indonesia: pelih (Madura), serut (Javanese). Malaysia: kesinai, serinai (Peninsular). Philippines: kalios (Tagalog). Burma (Myanmar): okhne. Laos: 'som² pho¹. Thailand: khoi (general), kak mai foi (northern). Vietnam: c[aa]y ru[oos]i, c[aa]y ru[oos]i nham.

Distribution From Sri Lanka and India to Burma (Myanmar), Indo-China, southern China, Thailand, Peninsular Malaysia, Sumatra, Java, the Philippines, Sulawesi and the Lesser Sunda Islands.

Streblus elongatus (Miq.) Corner

Synonyms *Sloetia pinangeana* Oliv., *Sloetia sideroxylon* Teijsm. & Binnend., *Sloetia wallichii* King.

Vernacular names Tempinis (trade name). Indonesia: tampinis, tempinis (general), kamaria (Aceh). Malaysia: tempinis (general).

Distribution Peninsular Malaysia, Sumatra and Sulawesi.

Streblus ilicifolia (S. Vidal) Corner

Synonyms *Pseudotrophis laxiflora* Warb., *Taxotrophis ilicifolius* S. Vidal, *Taxotrophis triapiculata* Gamble.

Vernacular names Jungle holly (En). Indonesia: kosa-kosa (Sulawesi), lemo-lemo (Halmahera), ulit (Buru). Malaysia: kemuning akar, limau limau, merlimau (Peninsular). Philippines: kuyos-kuyos (Tagalog). Laos: 'khi² hêt, khoy¹, 'nam khoy¹. Thailand: khoi nam (general), khe raet, kra chit (peninsular). Vietnam: dzu[oos]i or[oo], or[oo] nu[i], m[aj]y t[ef]o.

Distribution From north-eastern India to Indo-China, China (Hainan), Thailand, Peninsular Malaysia, the Philippines, Sulawesi, the Lesser Sunda Islands (Timor) and the Moluccas.

Streblus macrophyllus Blume

Synonyms *Paratrophis caudata* Merr., *Taxotrophis balansae* Hutch., *Taxotrophis mindanaensis* (Warb.) Elmer.

Vernacular names Malaysia: limae lelang antan, limau hutan (Peninsular). Philippines: hulos (Bagobo). Vietnam: m[aj]y t[ef]o.

Distribution Indo-China, Peninsular Malaysia, Borneo, the Philippines and Sulawesi.

Nguyen Ba

Strombosia Blume

Bijdr. fl. Ned. Ind. 17: 1154 (1826).
OLACACEAE
x = unknown; $2n$ = unknown

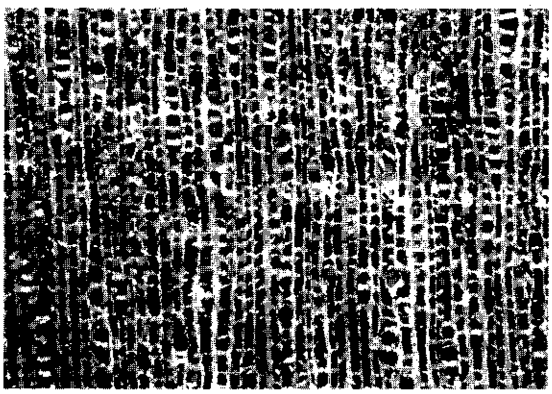
Vernacular names
- Dedali (trade name): *S. javanica*.
- Kamap (trade name): *S. ceylanica* and *S. philippinensis*.

Origin and geographic distribution *Strombosia* comprises about 12 species, about 9 of which occur in tropical Africa and 3 others in Asia from Sri Lanka, south India and Burma (Myanmar) to Thailand, Peninsular Malaysia, Sumatra, Java, Borneo, the Philippines and the Moluccas. All 3 Asian species are present within the Malesian region.

Uses The heavier timber of *Strombosia*, 'kamap', is used for temporary construction, flooring, pallets and posts. *S. philippinensis* is reported as being suitable for making shuttles and bobbins, and the young stem could be made into walking-sticks.
The lighter timber of *Strombosia*, 'dedali', is used for general utility purposes, local house building, medium-heavy construction under cover, interior finish, cabinet work, packing cases and in Indonesia for bent-work like badminton rackets. It is also used for the production of veneer and plywood.
The leaves of *S. javanica* are eaten raw or cooked and taste like groundnuts. The pulp of the fruits of *S. philippinensis* is eaten raw.

Production and international trade As supplies are generally small, *Strombosia* wood is used on a local scale only.

Properties *S. ceylanica* and *S. philippinensis* ('kamap') yield a heavy hardwood with a density of (635–)790–1220 kg/m³ at 15% moisture content, *S. philippinensis* being the harder and heavier of the two. Heartwood chocolate-brown or purple-brown, sharply demarcated from the about 4 cm wide, pale yellow-brown sapwood which may be much wider in small trees; grain straight (*S. philippinensis*) or interlocked (*S. ceylanica*); texture very fine to moderately fine and even; wood lustrous. Growth rings indistinct; vessels moderately small, solitary and in radial multiples of 2–5, tyloses common; parenchyma moderately abundant, apotracheal diffuse to diffuse-in-aggregates, indistinct even with a hand lens; rays very fine to moderately fine; ripple marks absent.
Kamap wood is subject to checking when seasoned in large pieces. It is hard to exceptionally hard. The wood is not difficult to work for such a hard wood and it takes a high polish. After pre-heating, 1.25 mm thick veneer can be produced without difficulty, but it is difficult to obtain thicker veneer. It is moderately durable to very durable; in a graveyard test in the Philippines the average service life of test stakes of *S. philippinensis* was 7 years and 8 months. The heartwood of *S. philippinensis* is very resistant to dry-wood termites, its sapwood is non-susceptible to *Lyctus*.

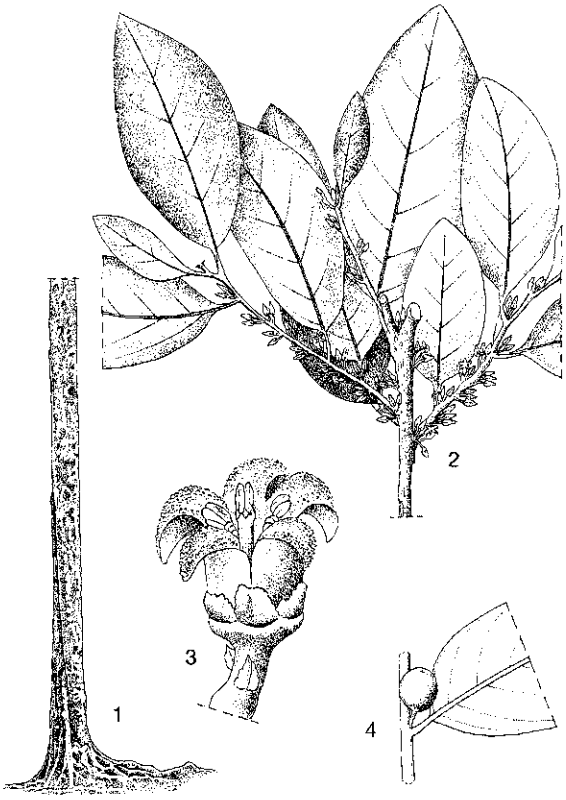


Strombosia philippinensis
transverse surface (×20)

S. javanica ('dedali') yields a medium-weight hardwood with a density of 540–770 kg/m³ at 15% moisture content. Heartwood pale yellow with an olive-brown tinge, darkening to pale orange-brown, moderately sharply differentiated from the paler sapwood, 2–15 cm wide; grain straight or interlocked; texture fine to moderately fine and even. Growth rings indistinct; vessels moderately small, in radial multiples of 2–8, occasionally solitary, usually open; parenchyma abundant, apotracheal diffuse and diffuse-in-aggregates; rays very fine; ripple marks absent.
Shrinkage upon air drying is moderate to high. The wood seasons very slowly: boards 13 mm and 38 mm thick take respectively about 7 and 12 months to air dry. Degrade upon air drying is a moderate amount of cupping, twisting, end-checking and surface-checking, and the wood is very susceptible to insect attack during seasoning. The wood is soft to moderately hard and of moderate strength. It is easy to saw and plane although the radial surface is slightly rough due to picking up of the grain. The wood is moderately durable when exposed to the weather or in contact with the ground, which is remarkable for a moderately soft wood. The wood is resistant to impregnation.
The gross energy value of the sapwood of *S. ceylanica* is about 21 205 kJ/kg.

See also the tables on microscopic wood anatomy and wood properties.

Botany Evergreen, small to medium-sized trees up to 30(–40) m tall, rarely shrubs; bole columnar, sometimes knobbly, up to 70(–120) cm in diameter, sometimes twisted or fluted or rarely with steep buttresses; bark surface shallowly, irregularly fissured or cracked, peeling off with scroll-shaped flakes, yellowish-grey to reddish-brown or purple-brown, inner bark firm, cream with yellow to orange-brown flecks; crown dense, compact. Young twigs often zigzag. Leaves arranged spirally, sometimes almost distichous, simple, entire, exstipulate. Flowers in an axillary, short-peduncled cyme or sessile fascicle; calyx a shallow, 5-lobed cup, accrescent; petals (4–)5, free, greenish, hairy inside; stamens (4–)5, filaments largely adnate to the petals; disk (3–)5-lobed; ovary initially superior, finally partly inferior, 3–5(–6)-locular below, 1-locular above, with 3–5(–6) ovules, style short to elongate, stigma obscurely 3–5(–6)-lobed. Fruit a 1-seeded drupe crowned by the persistent calyx and style base, green ripening cream. Seed with abundant, oily endosperm. Seedling with hypogeal germination; cotyledons not emergent; hypocotyl elongated; first few leaves scale-like and decussate, subsequent leaves arranged spirally on the orthotropic leader, but alternate-distichous on the branches.



Strombosia ceylanica Gardner – 1, bole; 2, flowering twig; 3, flower; 4, fruit.

An individual 24-year-old *S. javanica* tree in the arboretum of the Forest Research Institute Malaysia, Kepong measured 16 m in height and 23 cm in diameter; generally, growth is considered to be slow. The crown is monopodial or ultimately sympodial. *S. philippinensis* flowers from April to May and bears fruits from June to August. *S. javanica* is reported to flower at irregular intervals. The fleshy pericarp and large seeds suggest dispersal by animals, mainly monkeys and birds.

Ecology *Strombosia* is found scattered but may occur locally common in primary, evergreen, lowland rain forest, from near the sea to 800(–1000) m altitude.

Silviculture *Strombosia* can be propagated by seed. *S. ceylanica* has about 405 dry seeds/kg, *S. javanica* 235 dry seeds/kg. Pyrenes of *S. javanica* show complete germination in 64–185 days. *S. javanica* is shade-tolerant.

Genetic resources and breeding *Strombosia* is rather common and does not seem endangered.

Prospects It is unlikely that *Strombosia* timber will be increasingly used. Its use for specialty purposes related to its strong and durable wood will remain locally important.

Literature 151, 163, 235, 238, 260, 261, 267, 319, 320, 341, 354, 387, 406, 436, 464, 632, 677, 678, 740, 741, 780, 804, 829, 831, 832, 861, 933, 934, 955, 1023, 1048, 1221, 1239, 1242, 1268.

Selection of species

Strombosia ceylanica Gardner

Synonyms *Strombosia maingayi* (Mast.) Whitmore, *Strombosia multiflora* King, *Strombosia rotundifolia* King.

Vernacular names Indonesia: petaling air (Indonesian), damonjan (eastern Sumatra), medang huat (Benkulu, Sumatra). Malaysia: belian landak (Sarawak), kamap, petaling gajah (Peninsular).

Distribution Sri Lanka, India, Peninsular Malaysia, Sumatra, Java and Borneo.

Strombosia javanica Blume

Vernacular names Indonesia: entelung (Palembang, Sumatra), kayu kacang (Minangkabau, Sumatra), wuwusu (Halmahera). Malaysia: bayan, dedali badak (Peninsular), belian landak (Iban, Sarawak). Burma (Myanmar): banatha.

Distribution Southern Burma (Myanmar), peninsular Thailand, Peninsular Malaysia, Sumatra, West Java and Borneo.

Strombosia philippinensis (Baillon) Rolfe

Synonyms *Strombosia dubia* S. Vidal, *Strombosia elmeri* Salvosa.

Vernacular names Philippines: tamayuan (Filipino), kamayuan (Tagalog, Samar-Leyte Bisaya), larag (Iloko).

Distribution The Philippines and the Moluccas.

D.S. Alonzo

Sympetalandra Stapf

Hooker's Icon. Pl., ser. IV, 8: t. 2721 (1901).
LEGUMINOSAE
x = unknown; $2n$ = unknown

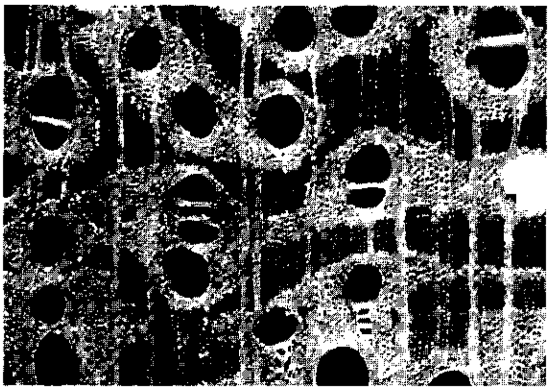
Vernacular names Merbau lalat (trade name).

Origin and geographic distribution *Sympetalandra* comprises 5 species and is confined to the Malesian region. It occurs in Peninsular Malaysia, Sumatra, Borneo, the Philippines and the Lesser Sunda Islands (Flores).

Uses The wood of *Sympetalandra* is used for construction under cover (posts, beams, joists, cladding, ceilings), flooring, and furniture and cabinet work. It is suitable for the production of plywood. In the Philippines it is considered a good substitute for *Dipterocarpus* spp.
In Flores the bark of *S. schmutzii* is used as a fish poison, whereas the oil from its seed is applied for illumination.

Production and international trade The wood of *Sympetalandra* is used rarely and on a local scale only.

Properties *Sympetalandra* yields a medium-weight, occasionally heavy hardwood with a density of 640–910 kg/m^3 at 15% moisture content. Heartwood reddish to reddish-brown or pink-brown to brown, usually distinctly demarcated from the pale-coloured, up to 7 cm wide sapwood, which turns reddish-brown upon drying; grain interlocked; texture fairly fine to moderately coarse and uneven; wood lustrous. Growth rings irregular, delimited by zones with fewer vessels; vessels medium-sized to moderately large, solitary and in radial pairs, sometimes with longer multiples of smaller vessels, with a tendency to be more numerous in the earlywood, sometimes with reddish gummy and a few chalky white deposits; parenchyma very abundant, paratracheal, vasicentric, aliform to confluent, and apotracheal in wavy to irregular confluent bands; rays fine to medium-sized; ripple marks absent.



Sympetalandra densiflora
transverse surface (×20)

Shrinkage of the wood upon seasoning is moderate to very high. Boards of *S. borneensis* 13 mm and 38 mm thick take respectively about 3 months and 6 months to air dry. The main sources of degrade during seasoning are insect attack and cupping and bowing. The wood is hard and strong. It is easy to work and takes a high polish. The wood is only slightly durable when exposed to the weather or in contact with the ground; in a graveyard test in the Philippines the average service life of test stakes of *S. densiflora* was 16 months. The heartwood is resistant to dry-wood termites. The sapwood is susceptible to *Lyctus*.
See also the tables on microscopic wood anatomy and wood properties.

Botany Unarmed, small to medium-sized trees up to 30 m tall; bole cylindrical to irregular, branchless for up to 18 m, up to 85(–150) cm in diameter, usually with prominent buttresses up to 4 m high; bark surface smooth to finely cracking or slightly flaky, pale brown to reddish-brown, inner bark fibrous, pink-brown to red. Leaves arranged spirally, paripinnate or bipinnate, 1–3-jugate, when bipinnate each pinna with 1–6 pairs of opposite or subopposite leaflets with pellucid dots; stipules minute, caducous. Flowers bisexual, in an axillary or terminal, racemose, simple or fascicled, or paniculate inflorescence, 5-merous, pellucid-glandular; bracts persistent; receptacle absent; ca-

lyx shortly campanulate; petals connate at base; disk usually absent; stamens 10, alternately long and short, free but adnate with petals at base, glabrous; ovary superior, 1-locular with 2–6 ovules, hairy, style curved or straight. Fruit a large, woody, dehiscent, 2-valved, compressed, 1–4-seeded pod. Seed large, compressed, with a hard testa.
Sympetalandra is known to form ecto-mycorrhizae. *S. borneensis* flowers in March, April, September and October, *S. densiflora* in April–June, and *S. unijuga* in April–June. *S. densiflora* fruits in July, *S. unijuga* in July and in September–November.
Sympetalandra belongs to the subfamily *Caesalpinioideae*.

Ecology *Sympetalandra* species are found scattered but may be locally common in primary, evergreen rain forest, up to 600 m altitude. They occur in well-drained locations; *S. borneensis* is mainly found in kerangas.

Genetic resources and breeding As most *Sympetalandra* species are endemic and uncommon, they are vulnerable to genetic erosion through destruction of their habitat.

Prospects As the wood is of good quality and can be obtained in sizes large enough for e.g. plywood production, it would be worth establishing trials of *Sympetalandra* species to study their potential for plantations.

Literature 162, 198, 235, 341, 387, 464, 780, 785, 862, 934, 955, 974, 1086, 1143, 1221, 1242.

Selection of species

Sympetalandra borneensis Stapf

Vernacular names Malaysia: merbau laut (Sarawak).

Distribution Borneo (Sarawak).

Sympetalandra densiflora (Elmer) v. Steenis

Synonyms *Cynometra densiflora* Elmer, *Erythrophleum densiflorum* (Elmer) Merr.

Vernacular names Philippines: kamatog (Filipino), baoy (Mindoro), batik (Tagalog).

Distribution The Philippines.

Sympetalandra hildebrandii v. Steenis

Distribution Peninsular Malaysia (very rare).

Sympetalandra schmutzii v. Steenis

Vernacular names Indonesia: naga (Flores).

Distribution The Lesser Sunda Islands (Flores).

Sympetalandra unijuga (Airy Shaw) v. Steenis

Synonyms *Erythrophleum unijugum* Airy Shaw, *Serianthes gigalobium* Kosterm.

Vernacular names Indonesia: mentiring (Sumatra). Malaysia: bellotan, potai munjit (Sabah).

Distribution Sumatra, Borneo and the Philippines (Luzon).

Ding Hou

Symplocos Jacq.

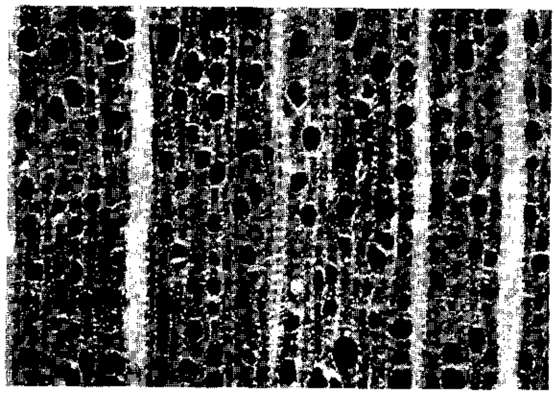
Enum. syst. pl. 5: 24 (1760).
SYMPLOCACEAE
$x = 11$; *S. cochinchinensis*: $2n = 22$, $22 + (1\text{–}2)B$, 24, *S. costata*, *S. fasciculata*, *S. laeteviridis*: $2n = 22$, *S. lucida*: $n = 11$, *S. pendula*: $2n =$ c. 90

Vernacular names Indonesia: jirak (Sundanese), jirek, sasah (Javanese). Philippines: agosip, himamaliu. Thailand: mueat. Vietnam: dung.

Origin and geographic distribution *Symplocos* is a large genus comprising about 250 species and is distributed in tropical and subtropical Asia, to Fiji in western Polynesia, eastern Australia, and in Central and South America, with a few species extending to temperate regions (to Japan and the United States (Virginia)). Fossils have been found in the Lower Eocene in Europe. Approximately 60 species occur in Malesia. Borneo is richest with about 25 species, followed by Peninsular Malaysia, Sumatra and the Philippines, each with about 20 species; other areas in Malesia have much less species. Indo-China and southern China have no less than about 30 species, Thailand slightly less than 20.

Uses The wood of *Symplocos* is used for light and temporary construction, posts, turnery, inlay work, furniture, matches and carving. A good-quality kraft paper can be obtained from some species.
The inner bark and leaves of some species are used as a mordant and yellow to red dye in the batik industry. Young leaves are sometimes eaten raw or steamed as a vegetable. Bark and leaves are used in local medicine, e.g. against thrush, biliousness, haemorrhages, diarrhoea, gonorrhoea and eye diseases. Dayak people extract salt from the wood ash of *S. odoratissima*.

Production and international trade *Sym-*

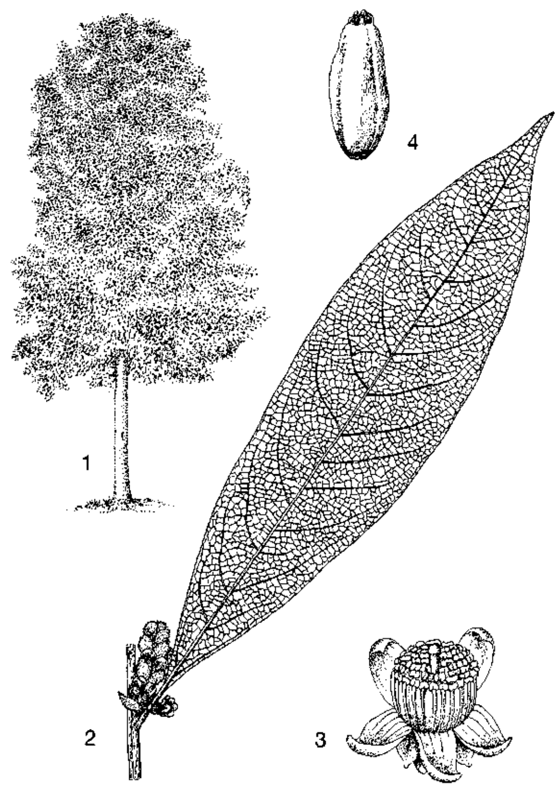


Symplocos cochinchinensis
transverse surface (×20)

plocos timber is probably used on a local scale only. In West Java bark and leaves of *S. odoratissima* are traded locally as a medicine as 'kayu seriawan' or 'kulit seriawan'.

Properties *Symplocos* yields a lightweight to medium-weight hardwood with a density of 290–850 kg/m^3 at 15% moisture content. Heartwood white, pale pink-brown or yellow-brown, not clearly differentiated from the sapwood; grain straight, less often interlocked; texture very fine to fine and even; wood of *S. adenophylla* with watered-silk figure on tangential surface. Growth rings distinct in some species, boundary indicated by a narrow zone of denser tissue and without vessels; vessels very small to moderately small, mostly solitary, occasionally in radial pairs, rarely with tyloses; parenchyma moderately abundant, apotracheal diffuse and diffuse-in-aggregates, visible with a hand lens; rays of two distinct sizes, very fine and medium-sized, the latter visible to the naked eye; ripple marks absent.
The wood is soft to moderately hard and fairly weak. It is moderately durable under cover but non-durable in exposed conditions. The wood is readily attacked by termites; the sapwood is susceptible to *Lyctus*. The energy value of the oven-dry sapwood is 19 980 kJ/kg.
The plants contain a large amount of aluminium, which is the origin of the action as a mordant. Ethanol extracts of the leaves of *S. lucida* showed hypoglycaemic and anti-cancer activity.
See also the table on microscopic wood anatomy.

Botany Evergreen shrubs or small to medium-sized, rarely large trees up to 30(–45) m tall; bole up to 60(–80) cm in diameter; bark often tasting bitter, bark surface often smooth, sometimes flaking, grey or grey-brown, sometimes dark brown, inner bark creamy, orange-brown or yellowish-brown to pinkish, granular or fibrous. Leaves alternate or arranged spirally (rarely pseudoverticillate), simple, often with vesicular or tooth-like glands at margins, pinnately veined, petiolate (rarely almost sessile); stipules absent. Flowers usually in an axillary spike, raceme or panicle, usually bisexual, 3–5-merous; calyx tube very short; corolla sympetalous but often divided nearly to the base, whitish, bluish or purplish; stamens 4–many, connate into a tube or only at the very base and then sometimes in 5 bundles; ovary inferior, 2–5-locular with 2 ovules in each cell, style 1. Fruit a variously shaped drupe with hard stone, crowned by the persistent calyx lobes. Seed with copious endosperm, cotyledons very short and linear. Seedling with epigeal germination; cotyledons emergent, small, linear and green; hypocotyl elongated; first 2 leaves opposite or alternate-spiral.
Growth is continuous or in flushes. Within a given tree all flowers open more or less at the same time. Pollination is probably by insects like bees and bumblebees, but self-pollination already in



Symplocos costata (Blume) Choisy – 1, tree habit; 2, inflorescence and leaf; 3, flower; 4, fruit.

bud is also suggested. Although birds and bats may sometimes eat the fruits, fruit dispersal is unlikely to be abundant. For some species e.g. *S. celastrifolia*, dispersal by water has been noticed. In herbarium material leaves usually have a yellow colour as a result of the aluminium compound reacting with flavonols in the drying leaves. *Symplocos* is the only genus of the family *Symplocaceae*. Two subgenera are distinguished: subgenus *Symplocos* comprising in Malesia *S. henschelii* and *S. pendula*, and subgenus *Hopea* (L.) C.B. Clarke containing all other species.

Ecology *Symplocos* occurs most abundantly in the tropical highlands up to 4000 m altitude, where it is represented by dwarf shrubs, but many species have a fair altitudinal range and are also found in the lowlands. In general, it is a component in mixed, mostly evergreen rain forest. It is usually rather indifferent to soils, and some species even grow on young volcanic soils or limestone.

Silviculture *Symplocos* can be propagated by seed. For *S. fasciculata* there are about 13000 dry fruits/kg, for *S. cochinchinensis* about 27500. Sown stones of *S. henschelii* have about 75% germination in 6–13 months and sown fruits of *S. cochinchinensis* have only about 15% germination in 4–7 months. In *S. cochinchinensis* small leaf galls induced by psyllids cause the leaf halves to curve upward. A gall-midge may occasionally infest stems of *S. fasciculata* and flowers of *S. brandisii*.

Genetic resources and breeding It seems that *Symplocos* is not particularly threatened because it is little used, either for timber or for dye or mordant, and often occurs in more or less inaccessible mountainous locations.

Prospects It is very unlikely that the utilization of *Symplocos* timber will increase since local use is hardly known and supplies are limited.

Literature 70, 163, 209, 235, 267, 341, 343, 405, 436, 464, 543, 696, 780, 790, 829, 831, 849, 860, 861, 947, 1039, 1221.

Selection of species

Symplocos adenophylla Wallich ex G. Don

Synonyms *Symplocos constricta* Brand, *Symplocos fulvosa* King & Gamble, *Symplocos palawanensis* Brand.

Vernacular names Indonesia: kayu kain (western Kalimantan), kayu lattan, kayu porugis (Sumatra). Malaysia: mendong, menugan (Peninsular). *Philippines: magalas* (Panay Bisaya, Tagalog), Palawan agosip (Tagalog). Vietnam: bo cau, d[uj]ng tr[aa]u (Khanh Hoa), ta pan co (Quang Tri).

Distribution Vietnam, southern China, Thailand, and throughout Malesia except for Java, the Lesser Sunda Islands and New Guinea.

Symplocos anomala Brand

Synonyms *Symplocos concolor* Brand.

Vernacular names Indonesia: renak (Bangka). Cambodia: phlong chië (Siem Reap). Vietnam: ch[ef] th[uf] dit (Thua Thiên), [oo]nh (Tuyên Duc).

Distribution Burma (Myanmar), Indo-China (Cambodia, Vietnam), southern China, Japan, Thailand, Peninsular Malaysia, Sumatra, Bangka and Borneo.

Symplocos barringtoniifolia Brand

Synonyms *Symplocos rigida* C.B. Clarke.

Vernacular names Cambodia: trochia mon (Kampot).

Distribution Cambodia, Peninsular Malaysia, Singapore and Borneo (Kalimantan, rare).

Symplocos brandisii Koord. & Valeton

Distribution Java and the Lesser Sunda Islands.

Symplocos celastrifolia Griffith ex C.B. Clarke

Synonyms *Symplocos hutchinsonii* Brand.

Vernacular names Indonesia: adad, bintangur pantai (Kalimantan), kendung (Sumatra). Malaysia: kayu tanyong, kulimbabok (Malay, Sabah), purup (Lundu, Sarawak). Philippines: makanang (Lanao).

Distribution Peninsular Thailand and throughout Malesia except for Java and the Lesser Sunda Islands.

Symplocos cerasifolia Wallich ex DC.

Vernacular names Indonesia: mentapung (Bangka), seseham (Sumatra).

Distribution Peninsular Thailand, Peninsular Malaysia, Sumatra, Bangka, Borneo and western New Guinea (rare).

Symplocos cochinchinensis (Lour.) S. Moore

Synonyms *Symplocos javanica* Kurz, *Symplocos laurina* Wallich ex G. Don, *Symplocos spicata* Roxb.

Vernacular names Indonesia: kayu dyurang (Java), kayu nyari badok, kayu salondung (Sumatra). Philippines: agosip puti (Tagalog), balokbok (Sambali), upunan (Igorot). Cambodia: louôt chom' (Kandal), seu meut (Stung Treng), trom préi. Thailand: lot, luut, pan (peninsular). Vietnam: dung b[oos]p (southern), giung (northern), ba thu'a.
Distribution India, Burma (Myanmar), Indo-China, China, Japan, Thailand, throughout Malesia, the Solomon Islands, eastern Australia, Vanuatu and Fiji.

Symplocos costata (Blume) Choisy

Vernacular names Indonesia: ki gledog, ki telor, ki tomkil (Sundanese).
Distribution Western and central Java.

Symplocos cylindracea Noot.

Distribution New Guinea and New Britain.

Symplocos fasciculata Zoll.

Synonyms *Symplocos phanerophlebia* Merr.
Vernacular names Brunei: pachal ambok. Indonesia: jirak (Sundanese), jirek (Javanese), kayu loba-loba (Sumatra). Malaysia: merpadi paya, nasi-nasi, pokok lukut (Peninsular). Philippines: bangkunai (Panay Bisaya).
Distribution Peninsular Thailand and throughout Malesia except for the Lesser Sunda Islands, the Moluccas and New Guinea.

Symplocos henschelii (Mor.) Benth. ex C.B. Clarke

Synonyms *Symplocos maingayi* Benth. ex C.B. Clarke, *Symplocos stenosepala* v. Steenis.
Vernacular names Brunei: lamau-lamau. Indonesia: kayu dyaram-dyaram bosi (Sumatra). Malaysia: te baradang (Sarawak). Vietnam: nac dao (Khanh Hoa), sap, trum (Lâm Dông).
Distribution Burma (Myanmar), Vietnam, Thailand, Peninsular Malaysia, Sumatra, western Java and Borneo.

Symplocos laeteviridis Stapf

Synonyms *Symplocos forbesii* Brand.
Vernacular names Indonesia: alleban (Sumatra), kayu loba-loba, kayu sae-sae. Malaysia: luroh (Sarawak).
Distribution Peninsular Malaysia, Sumatra, Bangka, Borneo and Sulawesi.

Symplocos lancifolia Siebold & Zucc.

Synonyms *Symplocos betula* Brand, *Symplocos depauperata* Merr., *Symplocos luzoniensis* Rolfe.
Vernacular names Philippines: balokbok-gulod (Tagalog), libas-libas (Cebu Bisaya), ngaraungarau (Negrito). Vietnam: c[aa]y dung.
Distribution India, Vietnam, China and the Philippines.

Symplocos lucida (Thunb.) Siebold & Zucc.

Synonyms *Symplocos ciliata* Miq., *Symplocos loheri* Brand, *Symplocos theaefolia* D. Don.
Vernacular names Indonesia: jirak lulub (Sundanese), jirek (Javanese), kayu hotir (Sumatra). Philippines: bangnon (Manobo), Loher agosip (Tagalog). Cambodia: sao srao (Kampot). Thailand: mueat pla siu (eastern). Vietnam: b'cau, can trang (Lâm Dông).
Distribution India, Burma (Myanmar), Indo-China, China, Japan, Thailand, and throughout Malesia except for Borneo, the Moluccas and New Guinea.

Symplocos odoratissima (Blume) Choisy ex Zoll.

Synonyms *Symplocos acuminatissima* Merr., *Symplocos pulverulenta* King & Gamble, *Symplocos wenzelii* Merr.
Vernacular names Indonesia: ki seriawan (Sundanese), sarigintung (Sumatra), udu (Bali). Philippines: duung (Filipino), himamaliu (Tagalog), mangkunai (Panay Bisaya).
Distribution Throughout Malesia except for New Guinea.

Symplocos ophirensis C.B. Clarke

Synonyms *Symplocos cumingiana* Brand, *Symplocos fragrans* Elmer, *Symplocos perakensis* King & Gamble.
Vernacular names Philippines: lagitikan (Tagalog), pun-pun (Cebu Bisaya), sotsa (Igorot).
Distribution Peninsular Malaysia, Sumatra, the Lingga Islands, Borneo, the Philippines and Sulawesi.

Symplocos pendula Wight

Synonyms *Symplocos albifrons* Brand, *Symplocos confusa* Brand, *Symplocos foxworthyi* Brand.
Vernacular names Philippines: bulangun (Igorot), lauisanan (Bagobo).
Distribution Sri Lanka, southern India, Burma (Myanmar), Vietnam, China, Japan, and throughout Malesia except for Java and the Lesser Sunda Islands.

Symplocos polyandra (Blanco) Brand
Synonyms *Symplocos oblongifolia* Rolfe.
Vernacular names Indonesia: bungur (Bangka), sudyeng (Natuna). Malaysia: beluno-beluno, temasuk jantan (Sabah), merbryot (Sarawak). Philippines: balakbakan (general), bangkunai (Panay Bisaya), ditaman (Tagalog).
Distribution Bangka, Belitung, Natuna, Borneo, the Philippines and south-western Sulawesi.

Symplocos rubiginosa Wallich ex DC.
Vernacular names Indonesia: lempaong kancil (Sumatra). Malaysia: pemasa (Peninsular), smuak (Dayak, Sarawak).
Distribution Peninsular Malaysia, Singapore, Sumatra and Borneo.

T.H. Wardini

Tarennoidea Tirveng. & Sastre

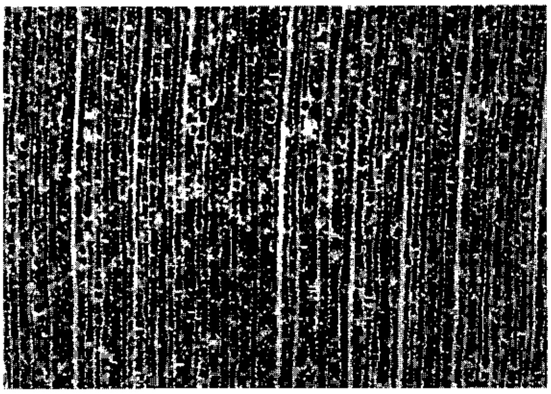
Mauritius Inst. Bull. 8(4): 90 (1979).
RUBIACEAE
x = unknown; $2n$ = unknown
Vernacular names Indonesia: ki cangkudu, ki keuyeup (Sundanese), wuru kudon (Javanese). Burma (Myanmar): katmya. Thailand: lekke (northern).

Origin and geographic distribution *Tarennoidea* comprises 2 species. *T. wallichii* (Hook. f.) Tirveng. & Sastre (synonyms: *Randia wallichii* Hook. f., *Tarenna incerta* Koord. & Valeton) is found in India, Burma (Myanmar), Thailand, Indo-China, southern China, the Philippines and Java. The other species (*T. axillaris* (Ridley) Tirveng. & Sastre) is a small tree found in northern Borneo; it has no importance as a timber tree.

Uses In Java the wood of *T. wallichii* is reported to be valued locally for posts in house building; it is sometimes even planted for this purpose. The wood is also used as a fairly good source of firewood.
T. wallichii has been used as a cover crop in forest plantations of *Pinus merkusii* Jungh. & de Vriese and *Eucalyptus deglupta* Blume.

Production and international trade Utilization of the wood of *T. wallichii* is limited and on a local scale only.

Properties *T. wallichii* yields a medium-weight hardwood with a density of 690–870 kg/m^3 at 15% moisture content. Heartwood pale brown or buff with a slight pinkish tinge; grain mostly straight; texture very fine and even; wood with faint figure on tangential surface due to growth rings. Growth rings indistinct sometimes tending to distinct with boundaries indicated by zones with fewer vessels; vessels very small, barely visible with a hand lens, solitary and in radial multiples of 2–4, the larger vessels open; parenchyma very sparse or absent, scanty paratracheal just visible around the larger vessels; rays very fine to fine; ripple marks absent.


Tarennoidea wallichii
transverse surface (×20)

The wood is durable only under cover and fairly strong.
See also the table on microscopic wood anatomy.

Botany A shrub or small to medium-sized tree up to 18 m tall; bole usually straight but gnarled, up to 30 cm in diameter, without buttresses; bark surface finely fissured, lenticellate, dark grey, inner bark whitish; crown narrowly ovoid, dense. Twigs wrinkled. Leaves opposite, simple, entire, obovate to oblong, leathery, cuneate at base; petioles short; stipules ovate, caducous. Flowers in an axillary or terminal panicle branched from the base, 5(–7)-merous; calyx cup-shaped, lobed or dentate; corolla with a cylindrical tube with a ring of hairs inside, lobes patent and about as long as tube, yellow; stamens as many as corolla lobes, inserted in throat of corolla tube, with short filaments; ovary inferior, 2-locular with 1 or 2 ovules in each cell, style long and slender. Fruit an ovoid to globose berry, dark green when ripe, containing 3–4 seeds.
The tree shows sympodial growth. Seed is dispersed by birds.
Tarennoidea has recently been separated from the large genus *Tarenna*. *Tarenna wallichii* (Hook. f.) Ridley (basionym: *Webera wallichii* Hook. f.) is not synonymous with *Tarennoidea wallichii* (Hook. f.) Tirveng. & Sastre.

Ecology In Java *T. wallichii* occurs in lowland and lower montane forest up to 1350 m altitude, in very dry to very humid localities, in mixed forest and in teak forest. It is locally common, but occurs scattered in the forest.

Silviculture *T. wallichii* can be raised from seed. Fruits can be stored in contact with the air and need an after-ripening period of about 3 weeks. Seed is extracted from the fruit and soaked in water for 24 hours prior to sowing. There are about 17 000 dry seeds/kg. The seeds should be sown in the shade. The germination rate is about 40%. Seedlings have been planted in Indonesia for soil protection in forest plantations (e.g. in *Eucalyptus deglupta* plantations on steep slopes and above 700 m altitude) and for slope stabilization. It is probably not difficult to plant this tree in full light. It is not resistant to fire.

Genetic resources and breeding *T. wallichii* occurs throughout Java and has a wide ecological amplitude. In spite of the deforestation there it does not seem particularly endangered, the more so as it has been planted locally.

Prospects The dimensions and form of the bole of *T. wallichii* make its use for sawn timber unlikely. The use of the wood will probably remain restricted to local applications, including posts and small objects.

Literature 70, 80, 405, 436, 595, 772, 861, 926, 1099a, 1232.

E. Boer (general part),
R.H.M.J. Lemmens (general part),
J. Ilic (wood anatomy)

Teijsmanniodendron Koord.

Ann. Jard. Bot. Buitenzorg 19: 19 (1904).
VERBENACEAE
x = unknown; $2n$ = unknown

Vernacular names Brunei: kulimpapa. Malaysia: buak-buak, leban (Sabah), entapuloh (Peninsular). Papua New Guinea: Papua New Guinea lapome.

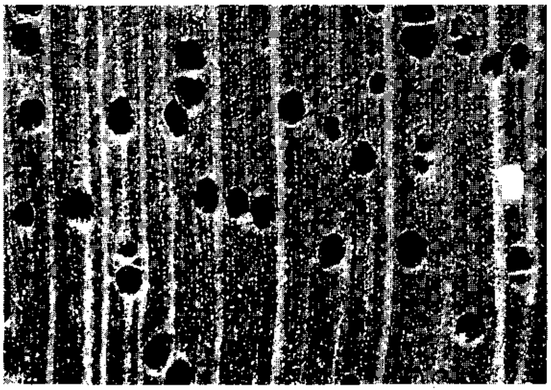
Origin and geographic distribution *Teijsmanniodendron* comprises about 14 species occurring in southern Vietnam, peninsular Thailand, and almost throughout the Malesian region (except for Java and the Lesser Sunda Islands) towards the Solomon Islands. Borneo has the highest number of species (12).

Uses The wood of *Teijsmanniodendron* is used for general purposes, house construction under cover (rafters, posts), interior work, salt-water piling, telegraph poles, light framing, moulding, concrete shuttering, formwork and boxes and crates. It yields a good fuel.

T. pteropodum has ornamental potential. In Java fruits of *T. pteropodum* have been used medicinally, both internally and externally, for intestinal complaints.

Production and international trade Supplies of *Teijsmanniodendron* wood are limited, trees are small and it is likely that it is occasionally sold in mixed consignments of medium hardwood. In 1996 Papua New Guinea exported about 4930 m³ of 'Papua New Guinea lapome' logs at an average free-on-board (FOB) price of US$ 97/m³.

Properties *Teijsmanniodendron* yields a lightweight to heavy hardwood with a density of (335–)430–940(–1290) kg/m³, ranging from 335–560 kg/m³ for *T. bogoriense* to 900–1290 kg/m³ for *T. ahernianum*. Heartwood pale yellowish-brown, pale brown to golden brown, pale grey, turning dark to blackish-brown upon exposure, indistinct to fairly distinct from the pale to yellow sapwood; grain straight or shallowly interlocked; texture fine to moderately fine and even; wood of *T. ahernianum* lustrous. Growth rings mostly indistinct, sometimes boundaries indicated by narrow layers of apparently marginal parenchyma (septate fibres with vitreous silica); vessels moderately small to moderately large, solitary and in radial multiples of 2–3, usually open, with few chalky-white deposits and abundant tyloses in *T. ahernianum*; parenchyma sparse or absent, in apparent narrow marginal bands in *T. bogoriense*, usually only scanty paratracheal and sometimes vasicentric, occasionally apotracheal diffuse evident, but this results from septate fibres occasionally con-



Teijsmanniodendron bogoriense
transverse surface (×20)

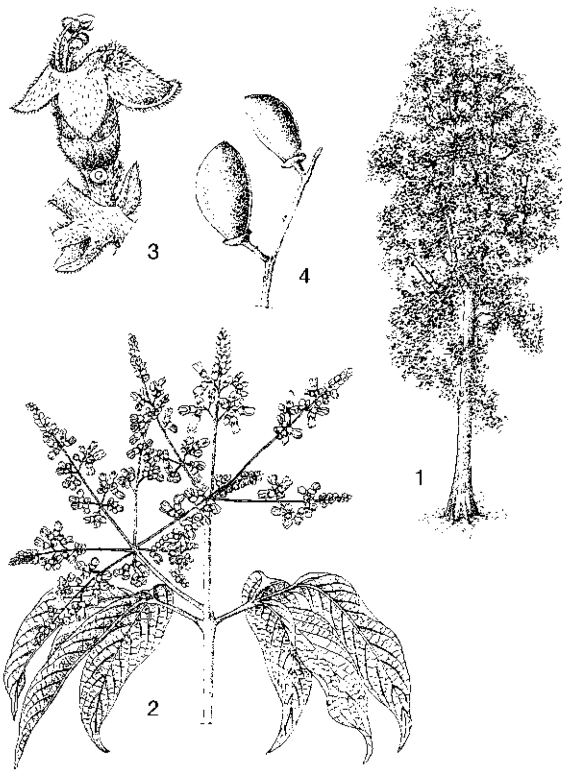
taining vitreous silica; rays very fine to moderately broad; ripple marks absent.

Shrinkage of at least the lighter timbers is low, but that of *T. ahernianum* from green to oven-dry is very high. The wood generally seasons without serious defects, although the harder wood is liable to checking and splitting. The wood is soft and weak (e.g. *T. bogoriense*) to extremely hard and very strong (*T. ahernianum*). It saws and works reasonably well and can be planed to a relatively smooth surface but sharp tools are required. The wood is siliceous. Related to the density the wood is non-durable to very durable when exposed to the weather or in contact with the ground. The wood of *T. bogoriense* is highly susceptible to blue stain. The average service life of test stakes of *T. ahernianum* in a graveyard test in the Philippines was 11 years and 6 months. The heartwood of *T. ahernianum* is very resistant to dry-wood termites. The sapwood of *Teijsmanniodendron* is non-susceptible to *Lyctus*. The wood is highly resistant to pressure treatment.

See also the tables on microscopic wood anatomy and wood properties.

Botany Small to medium-sized trees up to 30 m tall; bole straight or slightly sinuous, branchless for up to 15(–20) m, up to 50(–120) cm in diameter; sometimes fluted or with buttresses up to 1.5 m high; bark surface smooth to slightly fissured, sometimes lenticellate, scaly or flaking in long thin pieces, grey to pale yellowish-grey, inner bark granular, yellow, turning green upon exposure, without exudate. Leaves decussate, simple or palmately compound; leaflets entire; petiole and petiolules generally swollen upwards, petiole occasionally winged; stipules absent. Inflorescence axillary and terminal, composed of cymes combined into a lax panicle. Flowers bisexual, sessile or on a short stalk; calyx campanulate, 5-toothed; corolla with a short tube, 2-lipped, upper lip 2-lobed or entire, lower lip 3-lobed; stamens 4(–5), inserted on the corolla tube, generally of 2 lengths, exserted; ovary superior, incompletely 2-locular, each locule incompletely 2-celled and with 2 ovules, style 1, 2-fid. Fruit a 1-seeded, dry drupe with persistent calyx. Seed without endosperm. Seedling with epigeal germination; cotyledons emergent, leafy; hypocotyl elongated; all leaves opposite, conduplicate.

An individual 23-year-old *T. pteropodum* tree in the arboretum of the Forest Research Institute Malaysia, Kepong had attained 22.6 cm in diameter and 16 m in height. *T. bogoriense* is evergreen. Cultivated specimens in Bogor (Java) produced most new leaves in January and flowered from November to December, ripe fruits were observed in December and January. Flowers are protandrous and pollination is by insects. Ants may build their nests between the winged petioles of *T. pteropodum*.



Teijsmanniodendron bogoriense Koord. – 1, tree habit; 2, flowering twig; 3, flower; 4, fruits.

Teijsmanniodendron is closely related to *Vitex* but the latter does not have swollen petioles and petiolules, and its fruit contains a 4-celled pyrene.

Ecology *Teijsmanniodendron* is found in primary, lowland rain forest, often near streams or rivers, or in swampy localities, up to 800 m altitude.

Silviculture *Teijsmanniodendron* can be propagated by seed. Sown fruits of *T. coriaceum* show 95–100% germination in 14–49 days, those of *T. pteropodum* have about 85% germination in 33–152 days although 1 collection of fruits showed only 8% germination. Seeds of *T. pteropodum* show complete germination in 22–125 days.

Genetic resources and breeding Most *Teijsmanniodendron* species are fairly widespread but rare. As they are seldom harvested, they do not seem endangered.

Prospects As supplies are limited it is unlikely that *Teijsmanniodendron* timber will be increasingly used in the near future.

Literature 70, 93, 151, 163, 182, 267, 300, 304, 346, 436, 437, 464, 553, 592, 598, 612, 648, 653, 740, 741, 780, 829, 831, 832, 933, 934, 955, 974, 1038, 1086, 1221, 1232, 1242.

Selection of species

Teijsmanniodendron ahernianum (Merr.) Bakh.

Synonyms *Vitex ahernianum* Merr., *Vitex bankae* H.J. Lam, *Vitex bogoriensis* H.J. Lam.

Vernacular names Indonesia: kayu melati, melak (Bangka), kayu tehe (Obi). Philippines: dangula (general), sasalit (Tagalog).

Distribution Bangka, the Philippines, the Moluccas (Obi), New Guinea and the Solomon Islands.

Teijsmanniodendron bogoriense Koord.

Synonyms *Teijsmanniodendron glabrum* Merr., *Teijsmanniodendron longifolium* (Merr.) Merr., *Vitex flabelliflora* Hallier f.

Vernacular names Indonesia: mara beliung (Kutai, Kalimantan). Malaysia: buak-buak jari (Sabah). Philippines: atikoko (Cebu Bisaya, Manobo).

Distribution Borneo, the Philippines, Sulawesi, the Moluccas and New Guinea.

Teijsmanniodendron coriaceum (C.B. Clarke) Kosterm.

Synonyms *Vitex coriacea* C.B. Clarke, *Vitex venosa* H.J. Lam.

Vernacular names Indonesia: kerinjing daun talang (Indonesian, Kubu). Malaysia: jali batu, meroyan batu (Peninsular).

Distribution Peninsular Malaysia, Sumatra and Borneo (Kalimantan).

Teijsmanniodendron holophyllum (Baker) Kosterm.

Synonyms *Vitex holophylla* Baker.

Vernacular names Malaysia: buak-buak batu (Sabah).

Distribution Peninsular Malaysia, the Anambas Islands and Borneo (Kalimantan).

Teijsmanniodendron pteropodum (Miq.) Bakh.

Synonyms *Vitex peralata* King, *Vitex philippinensis* Merr., *Vitex pteropoda* Miq.

Vernacular names Indonesia: medang pudi (Bangka), sepundang (Palembang, Sumatra). Malaysia: buak-buak jari itek (Sabah), leban ma'kapang (Sarawak), pokok agak paya (Peninsular). Philippines: tikoko (Cebu Bisaya, Manobo). Thailand: koh (peninsular).

Distribution Peninsular Thailand, Peninsular Malaysia, Singapore, Sumatra, Borneo and the Philippines.

Teijsmanniodendron simplicifolium Merr.

Distribution Sumatra and Borneo.

Teijsmanniodendron simplicioides Kosterm.

Synonyms *Teijsmanniodendron simplicifolium* Merr. var. *kostermansii* Moldenke.

Distribution Borneo (Kalimantan, Sabah).

S.I. Wiselius (general part),
M.S.M. Sosef (general part, selection of species)

Ternstroemia Mutis ex L. f.

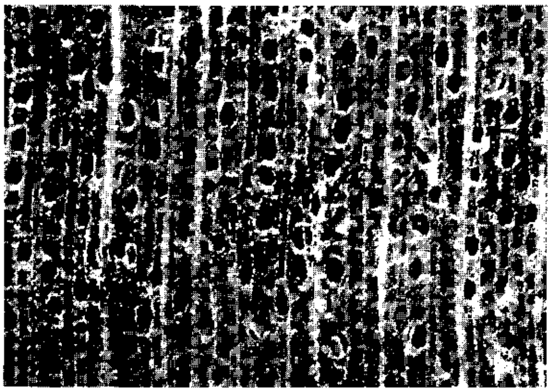
Suppl. pl.: 39, 264 (1782).
THEACEAE
x = unknown; *T. gymnanthera*: $2n = 50$, $n = 20$

Vernacular names Tapmis (trade name).

Origin and geographic distribution *Ternstroemia* comprises about 100 species. Its main centre of distribution lies in Central and South America. Only 2 species are present in Africa. In Asia it extends from Sri Lanka, India and Burma (Myanmar) to Indo-China, China, Japan, Taiwan, Thailand, the entire Malesian region, east to Fiji and south to north-eastern Australia. Some 35 species are present within Malesia.

Uses The wood of *Ternstroemia* is used for light construction under cover, internal flooring, door and window frames, mouldings, furniture, mining timber, joinery, tool handles and shafts, carvings, toys, turnery and, when treated, is suitable for railway sleepers. It is also suitable for the production of veneer and plywood, and of pulp and paper. The bark has been used as a fish poison and is still used in Irian Jaya against head lice. The fruit of *T. cherryi* is scraped and applied to cuts and sores.

Production and international trade *Ternstroemia* wood is probably used on a local scale only. The wood of *T. gymnanthera* is regarded as commercial in Taiwan and Japan, but not in the Malesian region.



Ternstroemia cherryi
transverse surface (×20)

Properties *Ternstroemia* yields a medium-weight hardwood with a density of 530–790 kg/m³ at 15% moisture content. Heartwood pale reddish-brown to dark purple-brown, not differentiated from the paler sapwood; grain straight to slightly interlocked or irregular; texture fine and even; wood with faint silver grain on radial surface. Growth rings usually indistinct, but distinct in *T. gymnanthera*; vessels moderately small, usually angular, sometimes oval, solitary, but the overlapping ends of vessel members in a vertical series produce numerous oblique or tangential pairs; parenchyma sparse to moderately abundant, apotracheal diffuse and diffuse-in-aggregates, indistinct with a hand lens; rays tending to be of 2 distinct sizes, very fine and moderately fine to medium-sized, the broader ones conspicuous on radial surface and visible with the naked eye on the transverse section; ripple marks absent.
Shrinkage upon seasoning is moderate to very high. The wood seasons easily but it has a marked tendency to distort. The wood is moderately hard, fairly weak to strong and very stiff to bend. It is easy to work with all hand and machine tools, has a slightly lustrous finish and takes a high polish. The weathering and wearing properties are reasonably good. The wood of *Ternstroemia* is only moderately durable, that of *T. gymnanthera* is fairly resistant to termites. The sapwood is rarely susceptible to *Lyctus*.
The mean fibre length of *T. gymnanthera* wood is 1.44–2.06 mm.
See also the table on microscopic wood anatomy.

Botany Usually evergreen, dioecious or rarely monoecious, sometimes androdioecious or andromonoecious shrubs or trees up to 30(–35) m tall; bole straight, cylindrical, branchless for up to 20 m, up to 60(–100) cm in diameter, sometimes fluted or rarely with small buttresses at base; bark surface smooth or cracking into scales or flaking, grey to brown, bark often corky, inner bark hard, gritty, red-brown, pink to orange. Leaves arranged spirally, often congested at the end of twigs and in false whorls, simple, entire, exstipulate. Flowers axillary, solitary or in a small fascicle of 2–3, unisexual or occasionally bisexual, with 2 bracteoles, 5-merous; sepals persistent; petals joined at base; stamens many, the outer ones attached to the base of the corolla, anthers basifixed; ovary superior, 2–3-locular, sometimes with false septae, with (1–)2–20 ovules in each cell, style simple or forked. Fruit an irregularly dehiscent berry with arillate seeds. Seedling with epigeal germination; cotyledons emergent, sometimes scale-like; hypocotyl elongated and swollen; first and sometimes second pair of leaves opposite, subsequent ones alternate-spiral, conduplicate and finely toothed.
T. merrilliana develops according to Aubréville's architectural tree model, characterized by a monopodial trunk with rhythmic growth bearing tiers of modular branches; the modules grow indefinitely, as inflorescences are lateral. *T. wallichiana* grows in short flushes, even in the seedling stage, with each flush starting with a few scale leaves. In Java *T. elongata* flowers throughout the year whereas *T. penangiana* has been observed bearing flowers in November and December only.
The Asian members of *Ternstroemia* are in urgent need of a taxonomic revision. At present the taxonomic and floristic information is scarce and very scattered, and often of dubious reliability.

Ecology Most timber-yielding *Ternstroemia* species inhabit lowland to montane, evergreen, primary rain forest, up to 1700(–2350) m altitude. They are particularly often reported from poor soils, swamps and ultrabasic locations. Some species, notably *T. gymnanthera*, extend their ecological range to thickets and bushy grasslands, and to monsoon and deciduous forest.

Silviculture *Ternstroemia* may be raised from seed. Seeds of *T. bancana* show about 90% germination in 10–30 days, *T. wallichiana* seed sown with adhering pulp has only 15% germination in 31–45 days.

Genetic resources and breeding The risk of genetic erosion of *Ternstroemia* is related to the extent of destruction of its habitat.

Prospects When carefully seasoned, the wood of *Ternstroemia* may gain some importance for purposes where a hard and stiff wood is required but supplies are extremely limited.

Literature 18, 70, 92, 93, 163, 198, 238, 267, 304, 364, 402, 436, 443, 464, 536, 580, 581, 595, 701, 774, 780, 829, 831, 861, 933, 941, 1039, 1221.

Selection of species

Ternstroemia bancana Miq.
Synonyms *Adinandra miqueli* King.
Vernacular names Malaysia: kuak, medang pergam, tengar hutan (Peninsular). Thailand: kongkang pa (south-eastern), tam sao, thang khai kai (peninsular).
Distribution Thailand, Peninsular Malaysia and Bangka.

Ternstroemia cherryi (F.M. Bailey) Merr.
Synonyms *Garcinia cherryi* F.M. Bailey, *Ternstroemia rehderana* Kobuski.
Vernacular names Papua New Guinea: pongkei (Manus Island).
Distribution New Guinea, the Bismarck Archipelago and north-eastern Australia.

Ternstroemia coriacea R. Scheffer
Distribution Borneo (Sabah).

Ternstroemia elongata (Korth.) Koord.
Synonyms *Ternstroemia gedehensis* Teijsm. & Binnend., *Ternstroemia micrantha* Choisy.
Distribution Java and Borneo (Sabah).

Ternstroemia gitingensis Elmer
Synonyms *Ternstroemia obovata* Merr.
Vernacular names Philippines: apin (Tagalog), palilag (Ibanag), tapmis (Cebu Bisaya).
Distribution The Philippines.

Ternstroemia gymnanthera (Wight & Arn.) Bedd.
Synonyms *Ternstroemia aneura* Miq., *Ternstroemia japonica* auct. non (Thunb.) Thunb.
Vernacular names Japanese ternstroemia (En). Philippines: apin-bundok (Tagalog). Burma (Myanmar): taung-kan. Thailand: kai daeng, saraphi dong (northern), wa khi nok (north-eastern). Vietnam: ch[ef] h[oo]i.
Distribution India, Burma (Myanmar), Indo-China, China, Taiwan, Japan, Thailand, Java, Borneo and the Philippines.

Ternstroemia magnifica Stapf ex Ridley
Distribution Borneo (Sabah, Sarawak).

Ternstroemia merrilliana Kobuski
Synonyms *Cyclandra papuana* Lauterb.
Distribution New Guinea and the Bismarck Archipelago.

Ternstroemia microcalyx Airy Shaw
Distribution Borneo (Sabah, Sarawak).

Ternstroemia penangiana Choisy
Synonyms *Ternstroemia houtsoortiana* Pierre, *Ternstroemia macrocarpa* R. Scheffer non Triana & Planch.
Vernacular names Indonesia: nang-penangan (Madura). Malaysia: medang bunga lawang (Peninsular).
Distribution Peninsular Malaysia, Singapore and Java.

Ternstroemia philippinensis Merr.
Synonyms *Ternstroemia megacarpa* Merr.
Vernacular names Philippines: arana (Bikol), barangoi (Tagalog), tapmis (Cebu Bisaya).
Distribution The Philippines.

Ternstroemia robinsonii Merr.
Vernacular names Indonesia: anaan merah, walan, waran (Ambon).
Distribution The Moluccas (Ambon).

Ternstroemia urdanatensis (Elmer) Kobuski
Synonyms *Adinandra urdanatensis* Elmer, *Ternstroemia epiphytica* Elmer ex Merr.
Vernacular names Philippines: sangnauan (Manobo).
Distribution The Philippines and Sulawesi.

Ternstroemia wallichiana (Griffith) Engl.
Vernacular names Malaysia: kelat gelugor, medang bunga lawang, tengar hutan (Peninsular). Thailand: tam sao (peninsular).
Distribution Indo-China, the Andaman Islands, Thailand, Peninsular Malaysia and Singapore.

S.I. Wiselius (general part),
M.S.M. Sosef (selection of species)

Tetradium Lour.

Fl. cochinch.: 91 (1790).

RUTACEAE

$x = 9$; *T. daniellii* (Benn.) Hartley: $2n = 72, 80$, *T. fraxinifolia* (Hook.) Hartley: $n = 39$, $2n = 72$, *T. glabrifolium*: $n = 18$

Origin and geographic distribution *Tetradium* comprises 9 species occurring from the Himalayas and north-eastern India to Indo-China, China, Korea, Japan and Taiwan, Thailand, Peninsular Malaysia, Sumatra, Java, the Philippines and the Lesser Sunda Islands (Sumbawa). Its reported occurrence in North Sulawesi is doubtful. Three species are present within the Malesian region.

Uses The wood of *Tetradium* has been applied under cover for house building. That of *T. glabrifolium* is reported to have been used for shingles in Assam (India), but given the non-durable nature of the wood this may be erroneous.

Seed of *T. sambucinum* yields a lamp oil.

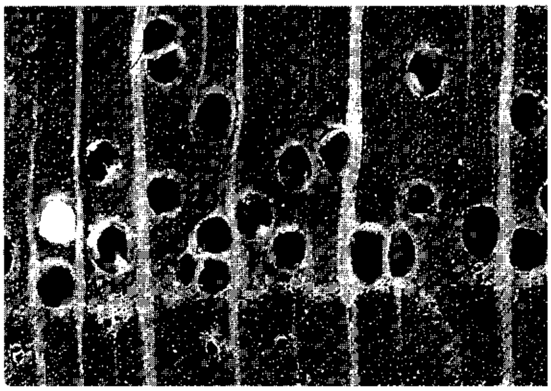
Production and international trade There are no records of trade of *Tetradium* wood. Utilization is probably very limited and on a local scale only.

Properties *Tetradium* yields a medium-weight hardwood. The density of the sapwood of *T. sambucinum* is 350–460 kg/m^3 at 15% moisture content. Heartwood pale golden-brown, not sharply demarcated from the paler sapwood; grain straight to slightly wavy; texture medium to coarse and uneven; wood lustrous. Growth rings distinct, marked by concentric rings of larger vessels and marginal parenchyma; vessels very small to moderately large, semi-ring-porous, earlywood vessels mostly solitary and in short multiples, latewood vessels in oblique arrangement grading in size, often in small clusters or short multiples, larger vessels occasionally blocked by chalky white deposits; parenchyma not abundant, paratracheal vasicentric and more evident around the smaller vessels, apotracheal in marginal or seemingly marginal bands; rays fine to moderately broad, visible to the naked eye; ripple marks absent.

The wood is non-durable and weak.

The isoquinoline alkaloid berberine is reported from *T. glabrifolium*.

See also the table on microscopic wood anatomy.



Tetradium glabrifolium
transverse surface (×20)

Botany Dioecious or rarely monoecious shrubs or small to medium-sized trees up to 30(–42) m tall; bole fairly straight, cylindrical, up to 50(–85) cm in diameter, without buttresses; bark surface grey, with a bitter taste. Leaves opposite, imparipinnate or occasionally paripinnate; leaflets with pellucid dots, margin crenate. Inflorescence terminal and sometimes in the axils of the uppermost leaves, corymbose, subcorymbose or paniculate. Flowers unisexual, 4–5-merous; sepals connate at base, valvate; petals often hooked at apex; functional stamens longer than the petals, anthers dorsifixed, stamens much reduced in female flowers; disk intrastaminal; ovary 4–5-carpellate, carpels free or connate at base, reduced in male flowers, ovules 1–2 per carpel, styles 4–5. Fruits consisting of 1–5, 1–2-seeded, dehiscing follicles with a persistent calyx. Seed shiny, smooth, persistent in the follicle.

Within the Malesian region *Tetradium* species are evergreen, outside this region they are also deciduous. In Java *T. sambucinum* flowers throughout the year.

Tetradium has often been regarded as a synonym of *Euodia* but in recent studies these genera are considered to be distinct. *Tetradium* is characterized by its pinnately compound leaves, its mainly terminal inflorescence and the shiny seeds remaining attached to the follicle.

Ecology *T. sambucinum* occurs scattered in primary and secondary rain forest, often in poorly drained habitats, from sea-level up to 1400 m altitude. *T. glabrifolium* is found in well-drained forest, thickets and open locations, from sea-level up to 1200 m altitude. *T. sumatranum* is recorded from well-drained, primary rain forest at 400 m altitude.

Silviculture *Tetradium* can be propagated by seed. For *T. sambucinum* there are about 237 000 dry seeds per kg with 4–10 seeds per fruit.

Genetic resources and breeding *T. sumatranum* is a narrow endemic species and may easily become endangered through habitat destruction.

Prospects The lack of data on wood properties of *Tetradium* indicates that it is hardly used for timber. It is unlikely that this situation will change in the near future.

Literature 70, 163, 339, 405, 414, 436, 595, 861, 973, 1038, 1221.

Selection of species

Tetradium glabrifolium (Champ. ex Benth.) Hartley

Synonyms *Euodia ailantifolia* Pierre, *Euodia meliaefolia* (Hance ex Walp.) Benth., *Phellodendron burkillii* v. Steenis.

Vernacular names Philippines: galigiuan (Igorot). Thailand: mak kaek, mak khaet (northern).

Distribution From north-eastern India to Indo-China, southern China, Taiwan and southern Japan towards Thailand, Peninsular Malaysia (rare), Sumatra (rare) and the Philippines.

Tetradium sambucinum (Blume) Hartley

Synonyms *Euodia sambucina* (Blume) Hook. f. ex Koord. & Valeton.

Vernacular names Indonesia: malumai (general), kayu menyawak (Javanese), ki bayawak (Sundanese).

Distribution Peninsular Malaysia, Sumatra, Java and Sumbawa.

Tetradium sumatranum Hartley

Distribution Sumatra (east coast).

E. Boer (general part),
M.S.M. Sosef (general part, selection of species),
J. Ilic (wood anatomy)

Tetrameles R. Br.

Denham & Clapperton, Narr. travels Africa: 230 (1826).

DATISCACEAE

x = c. 32; *T. nudiflora*: n = c. 32

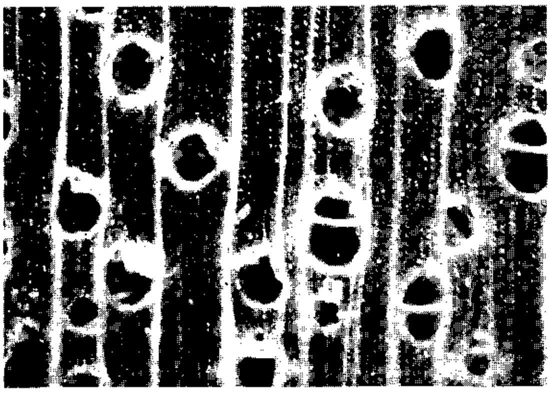
Vernacular names Binung (trade name). Tetrameles (En). Indonesia: binong (Sundanese), kayu tabu (Palembang, Sumatra), winong (Javanese). Malaysia: mengkundor (Peninsular). Burma (Myanmar): baing, sawbya, thitpok. Laos: phoung, 'sa phoung. Thailand: bueng (northern), ka phong (central, peninsular), som phong (south-eastern). Vietnam: d[awl]ng, daoleo, thung.

Origin and geographic distribution *Tetrameles* is monotypic and occurs from Sri Lanka and India to Burma (Myanmar), Indo-China, southern China, Thailand, northern Peninsular Malaysia, Sumatra (extreme north and extreme south), Java, Sulawesi, the Lesser Sunda Islands, New Guinea and northern Australia (Queensland). The only species is *T. nudiflora* R. Br. (synonyms: *T. grahamiana* Wight, *T. horsfieldii* Steud.).

Uses *Tetrameles* wood is used for temporary construction, panelling, partitioning, ceiling boards, cheap planking, weatherboard, mouldings, floats, dugout canoes, packing boxes, tea-chests and matchboxes. It is comparatively often used in the production of low-grade veneer, plywood and blockboard, and for the manufacture of hardboard and wrapping and writing paper. It is also rated as highly suitable for cement-bonded wood-wool board manufacture and for some uses it may prove to be a suitable substitute for 'balsa' (*Ochroma pyramidale* (Cav. ex Lamk) Urban).
In Cambodia the bark has been applied medicinally as a laxative and diuretic, and in decoctions taken for rheumatism, oedema, ascites and jaundice.

Production and international trade In the past large amounts of *Tetrameles* wood were traded in and exported from India and Indo-China, but supplies have become limited. In the 1970s the average annual export from Thailand was about 5000 m^3, from Assam, India about 2000 t and from the Andaman Islands about 600 t. In 1996 Papua New Guinea exported about 5500 m^3 of *Tetrameles* logs at an average free-on-board (FOB) price of US$ 99/m^3.

Properties *T. nudiflora* yields a lightweight hardwood with a density of 250–420 kg/m^3 at 15% moisture content. Heartwood pale brown to grey-brown, occasionally with an olive-green tinge, darkening to yellow-brown upon exposure, not clearly differentiated from the pale yellow sapwood; grain interlocked, occasionally straight; texture moderately coarse to coarse and even; wood with broad stripe figure on quarter-sawn faces due to the alternating or interlocked grain. Growth rings indistinct, occasionally indicated by closer spacing of vessels; vessels medium-sized to moderately large, solitary and in radial multiples of 2–3, open, tyloses sometimes present; parenchyma moderately abundant, sometimes bright yellow in colour, paratracheal vasicentric to aliform; rays very fine to medium-sized; fine ripple marks

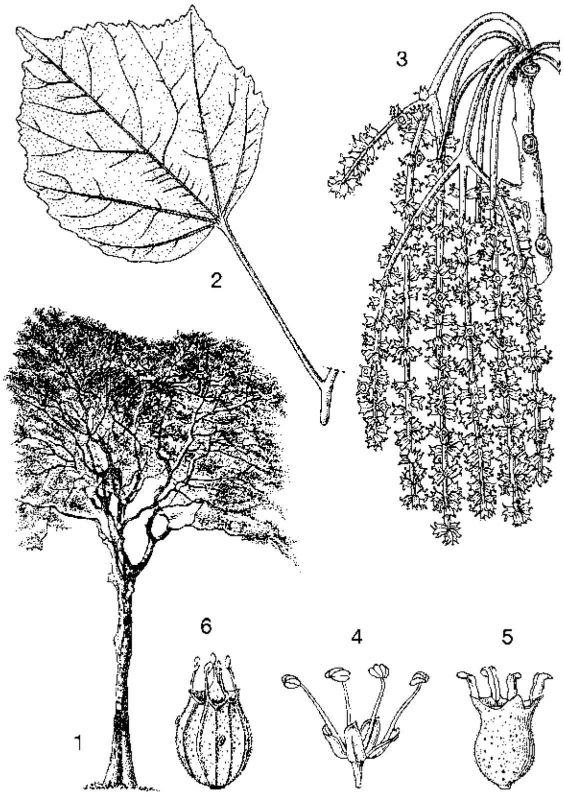


Tetrameles nudiflora
transverse surface (×20)

sometimes distinct resulting from storied fibres.
Shrinkage upon seasoning is low to moderate; sawn timber air dries well but end-splitting and surface checking may occur. Kiln drying can also be satisfactorily applied. The wood is soft and very weak, but strong in relation to its density. The wood should be converted rapidly to avoid blue stain and insect attack; it can be easily sawn and planed to a fairly smooth surface, but it does not polish well. It peels easily but plywood is not very attractive and it is generally used for core stock. The wood is non-durable and in a graveyard test in Thailand the average service life of test stakes was 1.9 years. Preservative treatment under pressure is very easy, the sapwood showing an absorption of CCA solution of 171 kg/m^3 and the heartwood of 208 kg/m^3. The wood is susceptible to termite and ambrosia beetle attack. The sapwood is susceptible to *Lyctus*.
The gross energy value is about 20 670 kJ/kg. The mean fibre length from Indonesian material is 1.148 mm.
See also the tables on microscopic wood anatomy and wood properties.

Botany A deciduous, dioecious, medium-sized to large tree up to 50 m tall; bole columnar, branchless for up to 35 m, up to 120(–200) cm in diameter, often fluted or with steep buttresses up to 5 m high; bark smooth, often pustular, sometimes hoop-marked, silvery grey to brownish, inner bark finely fibrous, ochre. Leaves arranged spirally, simple, dentate to nearly entire, palmately veined, rounded to cordate at base, exstipulate. Flowers in a terminal, fasciculate, pendent, simple or little branched spike (male) or panicle (female); petals absent. Male flower 4-merous; calyx with a short tube; stamens 4, inserted on the cup-shaped receptacle. Female flower 4–5-merous; base of calyx connate with ovary; ovary inferior, 1-locular with many ovules, styles opposite the calyx lobes, with a groove and oblique stigmatic apex. Fruit a globular capsule with an apical pore between the persistent styles. Seed narrowly oblong. Seedling with epigeal germination; cotyledons emergent, leafy; hypocotyl elongated; all leaves arranged spirally.
The mean annual increment of 10-year-old trees planted in West Java was 1 m in height and 1.7 cm in diameter, whereas that of 6-year-old trees planted at 550 m altitude in East Java was 2.2 m in height and 3.0 cm in diameter. In Peninsular Malaysia most trees are leafless in February–April, in Java in September–December during the rainy season. Flowers appear when the tree is leafless and are frequently visited by bees. Maturation of the fruits takes 1–2 months. The small seeds are probably dispersed by wind.

Ecology *T. nudiflora* is found scattered but is fairly common in primary or secondary, deciduous



Tetrameles nudiflora R. Br. – 1, tree habit; 2, leaf; 3, female inflorescence; 4, male flower; 5, female flower; 6, fruit.

forest up to 500(–1000) m altitude. It is restricted to regions with a more or less pronounced dry season. It is common in teak forest and prefers dry, sandy to rocky soils; in Papua New Guinea it prefers limestone.

Silviculture *T. nudiflora* can be propagated by seed. In an uncleaned seedlot about 2 185 000 dry seeds/kg have been counted. Seeds should be sown within 2 weeks after collection as they rapidly lose their viability. The tree is not resistant to fire.

Genetic resources and breeding Supplies of *T. nudiflora* timber have dwindled due the high demand for lightweight timber for cases. Whether this affects the genetic resources of *T. nudiflora* in its natural distribution area is uncertain but not unlikely.

Prospects Because of its fast growth, the relative ease of handling and planting and the demand for lightweight timber *T. nudiflora* is a potentially important plantation tree.

Literature 40, 125, 163, 218, 260, 267, 300, 336, 340, 341, 348, 377, 403, 405, 406, 427, 436, 460, 464, 478, 536, 591, 745, 765, 861, 933, 1038, 1052, 1169, 1177, 1199, 1221, 1242.

E. Boer & M.S.M. Sosef

Thespesia Soland. ex Corrêa

Ann. Mus. Natl. Hist. Nat., Paris 9: 290 (1807).
MALVACEAE

$x = 13$; *T. populnea*: $2n = 24, 26, 28$, *T. populneoides*: $2n = 26, 52$

Vernacular names Milo, Pacific rose-wood, portia tree, thespesia (En). Indonesia: baru laut (general), waru laut (Javanese), waru lot (Sundanese). Malaysia: baru-baru (Peninsular), baru laut (Sabah), bebaru (Sarawak). Philippines: banalo (Tagalog). Burma (Myanmar): sabu-bani. Thailand: pho thale (central).

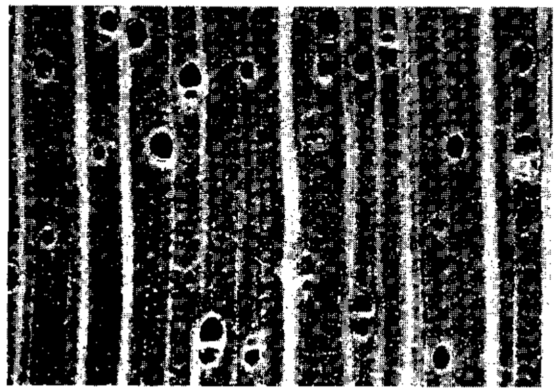
Origin and geographic distribution *Thespesia* comprises about 15 species occurring in the tropics of both hemispheres. Within the Malesian region 8 species are present, 5 of which are endemic to New Guinea and the remaining 3 widespread.

Uses The wood of *Thespesia* is used for light construction, flooring, furniture and cabinet work, interior finish, vehicle bodies, musical instruments, mouldings, scabbards, household utensils, carvings, turnery and pattern making. It is reputed to be durable, especially under water, and has been used in India and Burma (Myanmar) for boat building. In the Pacific islands it is applied for artifacts, bowls, clubs and paddles.

Cordage, which is also used to caulk boats, can be obtained from the fibrous bark. However, *T. lampas* (Cav.) Dalz. & Gibs., which does not yield timber, is most useful for this purpose. The leaves and fruit are applied medicinally against skin diseases. The heartwood, mixed with 'kayu tahi' (*Celtis* spp.), has been used against colic and fevers. The ripe fruit, pounded with coconut oil, is applied as a cure against head louse. The wood can be soaked in water to give an orange-yellow solution used to dye wool deep brown. The yellow gum of the fruit and flowers also yields a dye. The young leaves can be boiled and eaten as a vegetable. *T. populnea* is a sacred tree in many parts of the Pacific and has often been planted near temples. Elsewhere it has been planted as an ornamental or roadside tree.

Production and international trade The wood of *Thespesia* is seldom traded and used on a local scale only. All secondary uses are also local. Branches as little as 5 cm thick are useful for carving.

Properties *Thespesia* yields a lightweight to medium-weight hardwood with a density of 400–770 kg/m³ at 15% moisture content, up to 890 kg/m³ for Indian samples. Heartwood red-brown to dark brown, sharply differentiated from the sapwood, which is white with a pinkish tinge; grain shallowly interlocked to wavy; texture medium to fine; wood with slight ribbon figure on quarter-sawn face. Growth rings indistinct to distinct, sometimes marked by relatively large vessels or irregular marginal parenchyma; vessels moderately small to moderately large, solitary and in radial multiples of 2–4 and in occasional clusters,



Thespesia populnea
transverse surface (×20)

sometimes blocked with dark gummy deposits; parenchyma scarce to moderately abundant, paratracheal vasicentric, and apotracheal diffuse and diffuse-in-aggregates, visible with a hand lens; rays very fine, distinct to the naked eye; ripple marks present.

Shrinkage upon seasoning is very low to low, but moderate to high in Indian material. The wood seasons well and air dries satisfactorily. It is harder than that of the closely related *Hibiscus* spp. and of medium strength. It saws and works well despite its wavy grain. It turns well in both green and dry conditions and can be finished to an attractive polish. The wood contains an oil which slows down drying of varnishes. The heartwood is durable. The sapwood is non-susceptible to *Lyctus*.

The bark contains tannin. Plant extracts of *T. populnea* have significant anti-malarial activity.

See also the tables on microscopic wood anatomy and wood properties.

Botany Evergreen shrubs or small or rarely medium-sized trees up to 30 m tall; bole short and twisted (*T. populnea*) or longer and more or less straight (*T. fissicalyx*), up to 60 cm in diameter, without buttresses; bark surface becoming rough and fissured in older trees, pale grey, inner bark very fibrous, pink; crown broad and dense. Indumentum of scales or stellate hairs. Leaves alternate, simple, entire or palmately lobed, palmately veined, stipulate. Flowers axillary, solitary but often seemingly in a raceme by reduction of the upper leaves, 5-merous; epicalyx with 3–6 free segments; calyx cupular and entire or minutely toothed; corolla large, usually yellow with a dark purple centre; staminal column bearing anthers throughout its length; ovary 5- or 10-locular with 3–many ovules per cell, style 1, stigma clavate or rarely 5-lobed. Fruit a capsule, sometimes dehiscent. Seeds (1–)2–many per cell, glabrous to tomentose. Seedling with epigeal germination; cotyledons emergent, leafy; hypocotyl elongated; all leaves arranged spirally.

In India growth of *T. populnea* is reported as rapid. Trees flower and fruit throughout the year. Flowers open at about 10 a.m. and soon wither but remain on the plant for several days. Pollination is probably by birds. The seeds remain viable in seawater for more than a year and are thus dispersed.

T. populnea and *T. populneoides* have often been regarded as conspecific, making it difficult to assign certain observations to either one of them. *T. populnea* has green, deeply cordate leaves, pedicels 1–5 cm long and indehiscent fruits, whereas *T. populneoides* has bronzed or coppery, shallowly cordate leaves, pedicels 5–12 cm long and fruits with dehiscing outer layer.

Ecology The species endemic to New Guinea are all found in lowland primary or secondary rain forest, up to 1000 m altitude. *T. populnea* and *T. populneoides* are scattered or rarely gregarious on sandy and rocky coasts, in beach forest (e.g. the *Barringtonia* formation), preferring light sandy soils.

Silviculture *Thespesia* is easily raised from seed and from cuttings. The seedweight of *T. lampas* is about 45 500 dry seeds/kg. Seeds have about 50% germination in two weeks. Seedlings 30 cm tall can be planted out. In India stumps of one-year-old seedlings of *T. populnea* (2.5 cm shoot and 20–25 cm root) all failed when planted. For vegetative propagation small cuttings should be rooted in the nursery before planting out, but cuttings 2 m long have also been successfully planted directly in the field. *T. populnea* has been outlawed in cotton-growing areas because it is an alternative host of certain cotton pests.

Genetic resources and breeding Some *Thespesia* species are rare and their survival depends on the conservation of their habitat. The three timber-yielding species cited here are more common; in fact, *T. populnea* and *T. populneoides* have a wide distribution.

Prospects It is unlikely that the importance of *Thespesia* for sawn timber will increase. Its local use (e.g. for carving) will remain and it may become increasingly important as an ornamental.

Literature 40, 151, 161, 163, 192, 209, 267, 300, 348, 352, 405, 436, 464, 495, 536, 799, 829, 934, 955, 974, 1038, 1048, 1104, 1118, 1156, 1221, 1242, 1260.

Selection of species

Thespesia fissicalyx Borss. Waalk.

Vernacular names Indonesia: tangling (Skou, Irian Jaya), twobur (Njau, Irian Jaya).

Distribution New Guinea.

Thespesia populnea (L.) Soland. ex Corrêa

Synonyms *Hibiscus bacciferus* J.G. Forster, *Hibiscus populneus* L., *Malvaviscus populneus* (L.) Gaertn.

Vernacular names Milo, Pacific rose-wood, portia tree (En). Indonesia: baru laut (general), salimuli (Moluccas), waru lot (Javanese). Malaysia: baru, baru-baru (general), bebaru (Sarawak). Philippines: banalo (Tagalog). Thailand: po kamat phrai (south-western).

Distribution Pantropical along sea coasts, occasionally planted inland.

Thespesia populneoides (Roxb.) Kostel.

Synonyms *Thespesia banalo* Blanco, *Thespesia howii* Hu, *Thespesia populnea* (L.) Soland. ex Corrêa var. *populneoides* (Roxb.) Pierre.

Vernacular names Philippines: banalo (Tagalog).

Distribution Along the coasts of the Indian Ocean, Indo-China, Hainan, throughout the Malesian region to Australia; probably introduced into West Africa and cultivated in Brazil and Guyana.

Balu Perumal

Timonius DC.

Prodr. 4: 461 (1830).

RUBIACEAE

x = unknown; $2n$ = unknown

Vernacular names Malaysia: berombong, merombong (Peninsular).

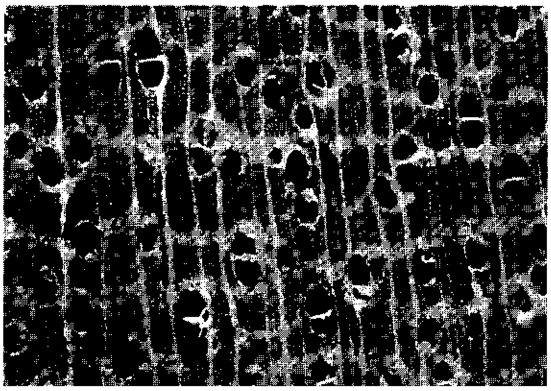
Origin and geographic distribution *Timonius* is a large genus of about 150 species occurring from Mauritius, the Seychelles and Sri Lanka eastward through the Malesian region to tropical Australia, Micronesia and the Pacific. New Guinea is the richest with about 60 species. Specific endemism is high, and only few species are widely distributed (e.g. *T. avenis*, *T. flavescens*, *T. timon*).

Uses The wood of *Timonius* is locally used for house building (poles, beams, rafters); it is also used as firewood.

T. timon has been recommended as a green manure for drier areas. Roots of *T. timon* are used as a febrifuge in traditional medicine in the Moluccas, both internally and externally. The leaves are applied against snakebites in New Guinea.

Production and international trade The wood of *Timonius* is used rarely and only local.

Properties *Timonius* yields a medium-weight to heavy hardwood with a density of (450–)530–880 kg/m^3 at 15% moisture content. Heartwood straw to pale yellow-brown with an orange tinge, not differentiated from the sapwood; grain straight; texture moderately fine and even; some watered-silk figure on tangential faces. Growth



Timonius timon
transverse surface (×20)

rings sometimes visible to the naked eye, when visible boundaries indicated by layers of marginal parenchyma; vessels moderately small to medium-sized, solitary and in radial multiples of 2–3(–5), multiples predominating, often blocked by chalky white deposits; parenchyma abundant, paratracheal vasicentric tending to aliform and often confluent, apotracheal occasionally in marginal or seemingly marginal bands, and in wavy regular, both narrow as well as wide bands; rays very fine to medium-sized; ripple marks absent.

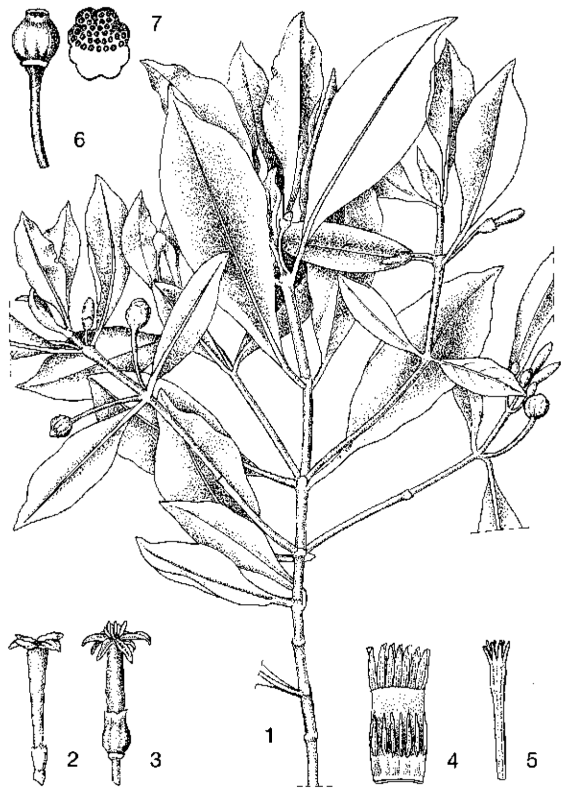
Wood moderately soft to hard, of relative low strength and non-durable.

See also the tables on microscopic wood anatomy and wood properties.

Botany Dioecious, usually shrubs or small trees, or occasionally fairly large or rarely large trees up to 40(–45) m tall; bole sometimes crooked, usually short, up to 60(–80) cm in diameter, without or with small buttresses; bark surface smooth, pustular, scaly or fissured, often with prominent lenticels, grey to brown, inner bark brittle, pink. Leaves opposite or rarely whorled, simple, entire, pinnately veined but veins often not prominent, domatia often present in axils of veins; stipules large, caducous, falling individually or sheath-like and falling together. Flowers in a solitary, axillary, cymose, short inflorescence, unisexual; female flowers usually solitary or 3 together, male flowers many; calyx cupular to tubular, persistent, (1–)4–5(–6)-lobed or truncate; corolla funnel-shaped to trumpet-shaped, 4–10(–12)-lobed, lobes sometimes with appendages at apex (e.g. *T. appendiculatus*), white or yellowish to pale green, often flushed with pink outside, often pubescent outside; stamens 4–10, with short filaments attached below the throat of the corolla tube, staminodes present in female flowers; ovary inferior, 6–many-loculate with 1 ovule in each cell enclosed by a fibrous endocarp, style long, distally divided in 2–10(–12) exserted stigmatic arms. Fruit drupaceous, slightly angular, fleshy, red, purple to black when mature, with numerous single-seeded pyrenes. Seed with thin or no endosperm.

Trials with *T. timon* planted in West Java with a seasonal climate showed a mean annual increment of 1.0 cm in diameter and of 0.8–1.0 m in height 11 years after planting. Many species have been found flowering and fruiting throughout the year. Fruits are eaten by birds, bats and in New Guinea ground animals especially marsupials, which disperse the seeds. The fruits sometimes seem adapted to water dispersal (e.g. *T. rivularis*) by having a prominent central cavity.

Species of the subgenus *Abbottia* (F. v. Mueller) S. Darwin are characterized as hemi-epiphytes. They are initially woody epiphytes, but develop a root connection with the ground (then resembling lianas) and eventually become free-standing trees. This way of development resembles strangling figs, which also have prominent stipules and many-seeded fleshy fruits.



Timonius avenis Valeton – 1, flowering and fruiting twig; 2, male flower; 3, female flower; 4, opened corolla of female flower; 5, style; 6, fruit; 7, cross section of fruit.

Timonius is placed in the tribe *Guettardeae* together with *Guettarda*. It is particularly characterized by the several to numerous locules which develop into separate 1-seeded pyrenes. Some groups which are considered monophyletic have been distinguished within the genus: subgenus *Timonius* with 8 species and subgenus *Abbottia* with about 30 species. However, most of the species have not yet been included in an infrageneric classification and are in need of a thorough taxonomic revision, as identification at species level is often difficult.

Ecology *Timonius* often occurs in coastal sandy or swampy sites, roadsides, river banks, secondary forest, monsoon forest, forest edges, savanna and open woodland. The species can be found in the lowlands up to the mountains, some even over 3500 m altitude (e.g. *T. pubistipulus*). In New Guinea several species occurring in montane forest are commonly associated with *Castanopsis*, *Nothofagus* and *Podocarpus* species. Some species, particularly *T. timon*, occupy a wide variety of habitats. *T. rivularis* is a pioneer dominating in riparian habitats. *T. timon* occurs on slopes of volcanoes in New Britain together with *Gymnostoma papuanum* (S. Moore) L.A.S. Johnson and *Eucalyptus deglupta* Blume in a succession stage preceding mixed rain forest, and is common in pockets of forest in coastal grassland on calcareous soils in northern Australia.

Silviculture *Timonius* may be raised from seed. There are about 574000 dry seeds/kg for *T. timon* with approximately 200 seeds/fruit. In plantation trials in West Java with *T. timon* the canopy was fairly open with a large amount of light reaching the ground. This species is very fire resistant and hardly suffered from a large fire which struck the plantation. Several other species have also been reported as fire-resistant. In the Lesser Sunda Islands *T. timon* is recommended for reforestation in the low mountain areas. After cutting, *T. timon* regenerates easily by coppice shoots.

Genetic resources and breeding Many *Timonius* species are narrow endemics and may be easily threatened when their habitat is destroyed on a large scale. The fact that several of them prefer secondary habitats diminishes this risk. Those species with a comparatively small area of distribution and apparently limited to lowland primary forest are most vulnerable (e.g. *T. appendiculatus* in the Philippines and *T. modestus* in New Guinea).

Prospects It is unlikely that *Timonius* will enter commercial markets as sawn timber in the future; there is no reason to expect a change in local use.

Literature 70, 124, 163, 209, 225, 226, 267, 405, 423, 427, 436, 442, 463, 464, 772, 861, 1209, 1221, 1232, 1238.

Selection of species

Timonius appendiculatus Merr.

Vernacular names Philippines: upong-upong (Filipino), pututan.

Distribution The Philippines.

Timonius avenis Valeton

Vernacular names Indonesia: seranai, tagraea (Kalimantan).

Distribution Eastern Borneo, the Moluccas and New Guinea.

Timonius belensis Merr. & L.M. Perry

Distribution New Guinea.

Timonius bismarckensis S. Darwin

Distribution The Bismarck Archipelago (New Britain, New Ireland and Manus Island).

Timonius corneri K.M. Wong

Vernacular names Thailand: khem chang (peninsular).

Distribution Southern Thailand and northern Peninsular Malaysia.

Timonius flavescens (Jack) Baker

Synonyms *Timonius peduncularis* Ridley.

Distribution The Seychelles, Sri Lanka, the Andaman Islands, Peninsular Malaysia, Singapore, Sumatra and Borneo.

Timonius longitubus Merr. & L.M. Perry

Distribution The Bismarck Archipelago (New Britain), Bougainville and the Solomon Islands.

Timonius meridionalis S. Darwin

Distribution South-eastern Papua New Guinea.

Timonius modestus Merr. & L.M. Perry

Distribution New Guinea.

Timonius pubistipulus S. Darwin

Distribution New Guinea (mainly eastern part).

Timonius rivularis Merr. & L.M. Perry

Distribution Central New Guinea.

Timonius rufescens (Miq.) Boerl.

Vernacular names Indonesia: o biniari (Moluccas).

Distribution The Moluccas and New Guinea (Irian Jaya).

Timonius timon (Sprengel) Merr.

Synonyms *Timonius rumphii* DC., *Timonius sericeus* (Desf.) K. Schumann.

Vernacular names Indonesia: ketimon (Timor), timbu (Sumba), timon (Moluccas).

Distribution Java, the Lesser Sunda Islands, Sulawesi, the Moluccas, New Guinea, the Bismarck Archipelago, the Solomon Islands and tropical Australia; naturalized in the Palau Islands (Micronesia).

Timonius wallichianus (Korth.) Valeton

Vernacular names Malaysia: tulang-tulang jantan (Peninsular).

Distribution Peninsular Malaysia, Singapore, Sumatra, the Riau Archipelago, Bangka and the Anambas Islands.

Timonius wrayi King & Gamble

Vernacular names Malaysia: jenjarum rimau, jenjarum rimba (Peninsular).

Distribution Peninsular Malaysia.

S. Aggarwal (general part),
R.H.M.J. Lemmens (general part, selection of species)

Trewia L.

Sp. pl. 2: 1193 (1753); Gen. pl., ed. 5: 500 (1754).
EUPHORBIACEAE
$x = 11$; *T. nudiflora*: $2n = 22$

Vernacular names Indonesia: bebeka burilang (Lampung, Sumatra), gemblok (Javanese), kayu tanah (Sumatra). Burma (Myanmar): setkadon. Laos: pop, pop[1]. Thailand: ma fo (general), ma pop (northern). Vietnam: l[uw][ow]u b[uw][ow]u.

Origin and geographic distribution Trewia is a monotypic genus occurring in India, Sri Lanka, Burma (Myanmar), Indo-China, southern China, Thailand, Peninsular Malaysia, Sumatra, Java, Borneo (Kalimantan) and the Philippines. The only species is *T. nudiflora* L. (synonyms: *Mallotus cardiophyllus* Merr., *T. macrophylla* Roth, *T. macrostachya* Klotzsch).

Uses The wood of *T. nudiflora* is used for light construction, household implements, matches, packing cases and for rotary veneer. In India it is used for drums and carving.

T. nudiflora contains nudiflorine, a pyridone alkaloid with insecticidal properties and trewiasine, a mytansinoid compound possessing significant cytotoxic activity against various human cancer cell lines in vitro. The seed yields an oil.

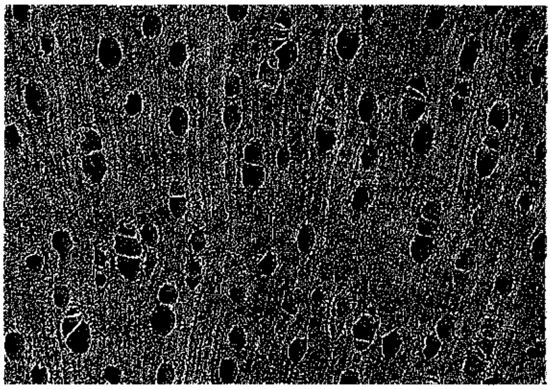
Production and international trade As the available supplies are small, the use of *T. nudiflora* wood is very limited and on a local scale only.

Properties *T. nudiflora* yields a lightweight hardwood with a density of 360–465 kg/m^3 at 15% moisture content. Heartwood white, turning pale brownish-grey upon exposure, not clearly demarcated from the sapwood; grain straight; texture moderately fine and even. Growth rings distinct or lacking; vessels moderately small to moderately large, solitary and in radial multiples of 2–3(–5), open, tyloses rare; parenchyma abundant, paratracheal vasicentric, apotracheal parenchyma diffuse to diffuse-in-aggregates and in narrow bands; rays fine, visible with a hand lens; ripple marks absent.

The wood seasons without degrade, but with high risk of discolouration due to blue stain; therefore it needs to be sawn when green. The wood is soft and weak. It is easy to saw and work to a smooth finish. It is non-durable.

See also the table on microscopic wood anatomy.

Botany A deciduous, dioecious, medium-sized to fairly large or rarely large tree up to 35(–45) m tall; bole fairly straight and cylindrical, up to 80(–200) cm in diameter, without buttresses; bark surface greyish; crown irregular, thin. Twigs grey, turning brown with age. Indumentum of stellate or clustered hairs. Leaves decussate, simple, entire, palmately veined with 3–5 main veins, usually densely hairy below; petioles often unequal; stipules small, caducous. Flowers unisexual; petals absent; disk absent. Male flowers in axillary, few-flowered cymes aggregated into a raceme, about 10 mm across; calyx 5-lobed; stamens numerous; pistillode absent. Female flowers in a lax, axillary, 1–4-flowered raceme; calyx rupturing irregularly; ovary superior, 2–4-locular with 1 ovule in each cell, styles short, stigmas elongated, recurved and plumose. Fruit a leathery drupe. Seedling with epigeal germination; cotyledons emergent; hypocotyl elongated; leaves arranged spirally at first, later on decussate.



Trewia nudiflora
transverse surface (×20)

Early growth of seedlings is slow and they attain only 13–25 cm after the first year. Later on growth is rapid with a mean height of 2.7 m and a mean diameter of 8.0 cm when 4 years old. Indian wood samples showed an annual diameter increment of 0.7–1.7 cm. Flowers appear before or together with the new leaves. In Java *T. nudiflora* has been observed flowering in June–December. The fruits are eaten by mammals like rhinoceros and deer. Seeds eaten by rhinoceros and defecated into grassland latrines developed into robust seedlings. Fruits are buoyant and are also dispersed by streams and rivers.

Trewia closely resembles *Mallotus*, but differs in its large male flowers, few-flowered female inflorescences, strongly elongated stigmas and drupaceous fruit.

Ecology *T. nudiflora* is found very locally and scattered in primary and secondary forest, up to 450(–1200) m altitude. It occurs most frequently near rivers and streams, but also on low ridges, on loams or loamy soils with coral limestone.

Silviculture *T. nudiflora* can be propagated by seed and has 4200–8100 seeds/kg. The seed can be extracted after fruits have been spread out in the sun for several days to soften. Seed viability decreases when seed is stored in airtight containers. In India soaking seed in water for up to 48 hours accelerates germination. Germination of fresh seeds attains 70–80% and starts after 10–14 days. Seedlings raised in the nursery should be copiously watered during dry weather as they are sensitive to drought. Weeding after planting is important. Plants are easily suppressed by more vigorous plants, although side shade is beneficial in the early stages to prevent damage from drought. *T. nudiflora* coppices vigorously and produces root suckers.

Genetic resources and breeding Given the wide geographical distribution of *T. nudiflora*, there is no immediate danger of genetic erosion.

Prospects The very limited supplies together with the poor wood properties make it unlikely that *T. nudiflora* wood will increase in importance.

Literature 17, 26, 28, 33, 34, 70, 174, 238, 364, 436, 697, 736, 834, 874, 883, 974, 1038, 1104, 1169, 1195, 1221, 1226.

Nguyen Nghia Thin

Trichadenia Thwaites

Hooker's Journ. Bot. Kew Gard. Misc. 7: 196, t. 8 (1855).

FLACOURTIACEAE

x = unknown; $2n$ = unknown

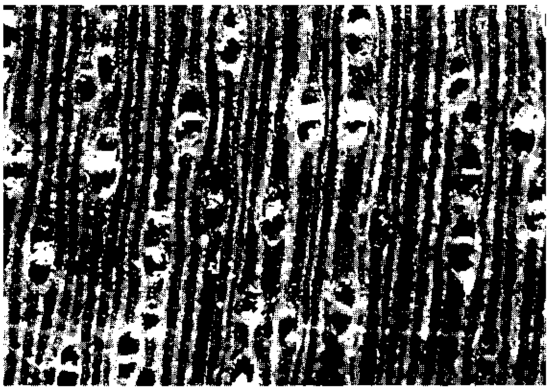
Vernacular names Bakata (trade name). Trichadenia (En). Indonesia: popunti (Moluccas). Philippines: malapinggan (Filipino), bagolipag (Bikol), tandong (Tagalog).

Origin and geographic distribution *Trichadenia* comprises 2 species, one of which is endemic to Sri Lanka. The other, *T. philippinensis* Merr. (synonym: *Vitex curvifrutescens* Elmer), is found in Borneo, the Philippines, Sulawesi, the Moluccas, New Guinea and the Solomon Islands.

Uses The wood of *T. philippinensis* is used for boxes, light construction work, tool handles and turnery. It can be employed as a substitute for wood of *Shorea guiso* (Blanco) Blume.

Production and international trade The wood of *T. philippinensis* is mainly utilized on a local scale. Small amounts have been exported from Sabah and Sarawak to Japan in mixed consignments of medium-weight hardwood and in consignments of meranti (*Shorea* spp.) as it resembles that wood. In 1996 Papua New Guinea exported a volume of about 3800 m^3 of trichadenia timber at an average free-on-board (FOB) price of US$ 97/m^3.

Properties *T. philippinensis* yields a medium-weight to heavy hardwood with a density of 735–1030 kg/m^3 at 15% moisture content. Heartwood pale yellow to yellowish-brown, not distinctly demarcated from the cream-coloured sapwood; grain straight to slightly interlocked; texture moderately fine. Growth rings not distinct; vessels moderately small to moderately large, clearly oval, almost exclusively in multiples of 2–3(–5), tyloses scanty; parenchyma apotracheal diffuse, paratracheal scanty, mostly indistinct or absent; rays moderately narrow to moderately broad, bent around vessels on both sides.



Trichadenia philippinensis
transverse surface (×20)

The wood should be dried slowly as it is liable to checking and splitting. It is hard and strong, fairly easy to work, although sawing is reported as difficult, and its machining properties are good. The wood is very durable for interior work, but non-durable when exposed to the weather or in contact with the ground. The heartwood is susceptible to dry-wood termites and the sapwood to *Lyctus*.

See also the table on microscopic wood anatomy.

Botany A dioecious, medium-sized to fairly large tree up to 40 m tall; bole fairly straight, branchless for up to 28 m, up to 100(–170) cm in diameter, with plank-like buttresses up to 3.5 m high; bark surface smooth becoming minutely dippled, papery, pale grey-brown to yellow-brown, inner bark granular, orange-brown. Twigs densely tawny-brown puberulent, with large leaf scars. Leaves in pseudo-whorls at the end of the twigs, simple, entire or slightly wavy towards the apex; stipules present. Flowers in a simple or paniculate, axillary raceme; calyx splitting irregularly; petals 5, with a scale at base inside. Male flowers with 5 stamens. Female flowers with a superior, 1-locular ovary containing few ovules and 3 short styles. Fruit a spherical, berry-like, indehiscent capsule. Seed with oily endosperm.

Leaves on young trees are deeply 3-lobed. Flowers and fruits have been observed throughout the year.

Ecology *T. philippinensis* grows scattered in primary and old secondary forest in well-drained, level to hilly locations, up to 1000 m altitude. It is occasionally common but generally fairly rare and often found in mixed dipterocarp forest on fertile clay soils.

Genetic resources and breeding *T. philippinensis* does not seem to be endangered.

Prospects The timber is seldom used, and this is unlikely to change in the near future.

Literature 40, 61, 84, 162, 198, 235, 341, 346, 348, 464, 861, 934, 1232.

E. Boer & M.S.M. Sosef

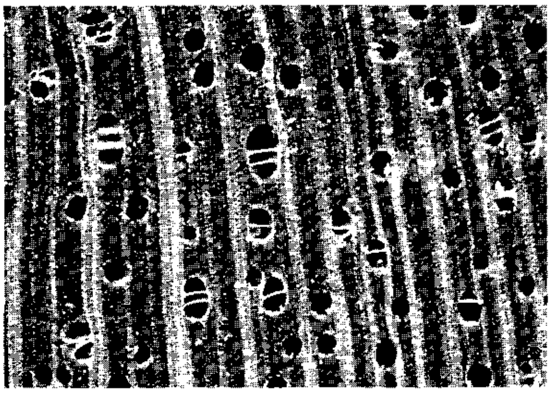
Trichospermum Blume

Bijdr. fl. Ned. Ind. 2: 56 (1825).
TILIACEAE
x = unknown; $2n$ = unknown

Origin and geographic distribution *Trichospermum* comprises about 40 species, 3 of which occur in tropical South America. The other species are found in South-East Asia from Thailand and throughout the Malesian region to Micronesia and the Pacific, eastwards towards Fiji and Samoa. Two species are present in Japan. There is a marked centre of diversity in New Guinea.

Uses The wood of *Trichospermum* is used for poles in temporary constructions and fencing and for wooden clogs. It has also been used as fuelwood. *T. discolor* is regarded as promising for the production of pulp and paper and may be suitable for reforestation in areas frequently hit by typhoons. The Philippine species *T. involucratum* is expected to have considerable potential as a raw material for pulp and paper production and for wood-based panels. In Fiji the endemic but commercial species *T. richii* (A. Gray) Seemann, locally called 'mako', is suitable for panelling, interior trim, furniture, possibly for veneer and low-grade plywood, blockboard, hardboard and as pulpwood. From the bark of most species rough rope or cordage can be obtained used for binding or rough baskets, but in the Philippines also for clothing, twines, bow strings, fishing lines and sacks, and for temporary partitions. In New Britain the bark has been used as a wall covering for houses. In the Philippines sawdust of *T. involucratum* is used as a medium to grow mushrooms.

Production and international trade Utilization of the wood of *Trichospermum* is on a local scale only. That of *T. richii* is traded commercially.



Trichospermum pleiostigma
transverse surface (×20)

Properties *Trichospermum* yields a lightweight hardwood with a density of 140–390 kg/m^3 at 11% moisture content. Heartwood pale pink to pale reddish-brown, yellow with a pinkish tinge or grey-brown with a yellow tinge, not clearly differentiated from the sapwood; grain usually straight, occasionally slightly to heavily interlocked or sometimes with spiral grain; texture moderately fine and even. Growth rings mostly indistinct; vessels medium-sized to moderately large, solitary and in radial multiples of 2–4(–6), open; parenchyma not abundant, paratracheal vasicentric, just visible with a hand lens; rays of 2 distinct widths, extremely fine to moderately fine, the broader ones just visible to the naked eye; ripple marks present, sometimes irregular, not always distinct. The wood is very soft and very weak. There is no information on seasoning and working properties of Malesian species, but shrinkage of timber of *T. richii* is low to moderate. It seasons well without serious degrade and is fairly easy to work, the finish is even but fibrous. Wood of the Malesian species is non-durable, prone to staining, ambrosia beetle attack and dry-wood termites. A debarked piece of *T. discolor* left for 5 months did not show appreciable attack by borers or fungi.
The average fibre length of *T. discolor* is 1.5 mm and of *T. involucratum* 1.1 mm.
See also the tables on microscopic wood anatomy and wood properties.

Botany Small or rarely medium-sized trees up to 25(–33) m tall; bole straight to crooked, branchless for up to 18 m, up to 50(–70) cm in diameter, rarely with low buttresses; bark surface smooth to finely fissured or cracked, sometimes lenticellate, sometimes flaking in long strips, grey or greyish-green to brown, inner bark fibrous, white or straw to orange or reddish-brown. Indumentum of stellate hairs or stellate scales, rarely with simple hairs. Leaves distichous, simple, finely serrate, 3-veined at base, with glands at the base of the petiole; stipules caducous. Flowers in axillary, umbellate cymes, usually in triads, bisexual or unisexual with male and female flowers on different trees or on the same tree, 5-merous; sepals free; petals with a scale at base; stamens many, inserted on the gynandrophore; ovary superior, (1–)2–6-locular with many ovules, style short. Fruit a dehiscent capsule. Seed flattened, with a corona of radial hairs.

Growth of *T. javanicum* is rapid. Annual increment of *T. discolor* is high: 5.9–8.9 cm in diameter and 3.9–6.2 m in height during the first 3 years. Trees are reported to flower when they are still very young. In Java *T. javanicum* flowers from September to May. In Queensland (Australia) flowers and fruits of *T. pleiostigma* have been collected from August to October. Seeds of *T. discolor* are collected from October to December and from April to June.

Trichospermum presently includes the South American genus *Belotia* and the Malesian genus *Althoffia*.

Ecology *Trichospermum* species occur scattered in primary and secondary, evergreen to deciduous forest, up to 700 m altitude. Several, perhaps all species are pioneers found in forest clearings and as colonizers of waste land.

Silviculture Being a pioneer, *Trichospermum* should be easily raised from seed. In a germination trial in Peninsular Malaysia, however, the germination rate of seed of *T. javanicum* was only 2% in 24–34 days. On the other hand, *T. involucratum* was reported to be easily raised from seed in the Philippines. *T. involucratum* is easy to manage in plantations as it is hardy and competes successfully with weeds. Moreover, it can be managed on a very short rotation of five years, the age at which trees naturally start to die. Finally, it regenerates from coppice, which may facilitate regeneration after harvesting. In the Philippines *T. discolor* has been planted at 3–4 m × 3–4 m and has been observed to possess good self-pruning capacity and to develop a straight cylindrical bole.

Genetic resources and breeding The prominent pioneer characteristics of *Trichospermum* species make them less vulnerable to genetic erosion.

Prospects As *Trichospermum* trees grow very fast, have soft wood, a straight-stemmed habit and can be easily regenerated by coppicing, the pulping properties should be further investigated. The Philippine species *T. discolor* seems particularly promising.

Literature 70, 109, 114, 126, 151, 163, 164, 267, 335, 400, 436, 438, 536, 624, 780, 829, 831, 875, 887, 974, 1038, 1039, 1221, 1232.

Selection of species

Trichospermum discolor Elmer

Synonyms *Trichospermum mindanaense* Merr. ex Elmer.

Vernacular names Philippines: bonotan (Filipino), inak-ak (Davao), malmagan (Leyte).

Distribution The Philippines.

Trichospermum grewioides Kosterm.

Distribution New Guinea (Irian Jaya).

Trichospermum involucratum (Merr.) Elmer

Synonyms *Halconia involucrata* Merr., *Trichospermum cuneata* Elmer, *Trichospermum negrosense* (Elmer) Elmer.

Vernacular names Philippines: langosig (Cebu Bisaya).

Distribution The Philippines.

Trichospermum javanicum Blume

Synonyms *Grewia ancolana* Miq., *Trichospermum cymbiforme* Sprague ex Ridley, *Trichospermum kurzii* King.

Vernacular names Indonesia: dolog (Sundanese), endilau nasi, nilau nasi (Palembang, Sumatra). Malaysia: entinong (Sarawak). Thailand: po talap (peninsular).

Distribution The Nicobar Islands, peninsular Thailand, Peninsular Malaysia, Sumatra, Java and Borneo (Sabah, Sarawak?).

Trichospermum peekelii Burret

Distribution The Bismarck Archipelago and the Solomon Islands.

Trichospermum pleiostigma (F. v. Mueller) Kosterm.

Synonyms *Althoffia pleiostigma* (F. v. Mueller) Warb. ex K. Schumann & Lauterb., *Althoffia tetrapyxis* K. Schumann, *Trichospermum quadrivalve* Merr.

Distribution The Lesser Sunda Islands (Timor), the Moluccas (Ambon, the Kai Islands), New

Guinea, the Bismarck Archipelago and northern Australia (Queensland).

Trichospermum tripyxis (K. Schumann) Kosterm.

Synonyms *Althoffia tripyxis* K. Schumann.
Distribution New Guinea.

E. Boer (general part),
M.S.M. Sosef (general part, selection of species)

Trigoniastrum Miq.

Fl. Ind. Bat., Suppl. 1 (Prodr. Fl. Sum.): 394 (1861).

TRIGONIACEAE

x = unknown; $2n$ = unknown

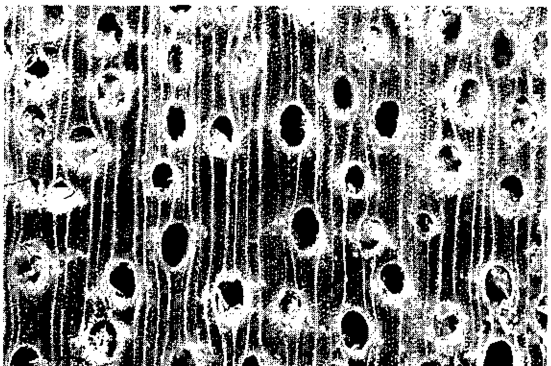
Vernacular names Brunei: mengilas babi (Iban). Indonesia: kayu bras, tinggiran batu (Palembang, Sumatra), mangkudor (Kalimantan). Malaysia: maharajili, mata pasak (Peninsular), nyalin bintek (Iban, Sarawak).

Origin and geographic distribution *Trigoniastrum* is a monotypic genus occurring in Peninsular Malaysia, Singapore, Sumatra and Borneo. The only species is *T. hypoleucum* Miq. (synonym: *Isopterys penangiana* Wallich ex Benn.).

Uses The wood of *T. hypoleucum* has been used for furniture. The tree may be suitable for shade and ornamental purposes.

Production and international trade Utilization of the wood of *T. hypoleucum* is apparently very limited and local.

Properties *T. hypoleucum* yields a medium-weight to heavy hardwood with a density of 620–945 kg/m^3 at 15% moisture content. Heartwood pale yellow with an olive tinge, not clearly differentiated from the sapwood in the only specimen examined (4 cm wide radially); grain straight; texture moderately fine and even. Growth rings not observed; vessels medium-sized, exclusively solitary, open; parenchyma moderately abundant, paratracheal vasicentric to aliform, the wings often very narrow; rays extremely fine to very fine, visible only with a hand lens; ripple marks absent.



Trigoniastrum hypoleucum
transverse surface (×20)

The wood splits badly during drying. It is moderately hard to very hard and strong. The wood is non-durable when exposed to the weather or in contact with the ground.

See also the table on microscopic wood anatomy.

Botany An evergreen, small to medium-sized tree up to 30(–40) m tall; bole usually columnar, up to 50(–60) cm in diameter, sometimes with buttresses up to 1(–2) m high; bark surface smooth, lenticellate, pale greenish-grey to brown, inner bark granular, pale greenish-yellow to yellowish-brown, exuding a yellowish sticky juice which turns reddish upon exposure; crown conical to hemispherical. Leaves alternate, simple, entire, with small glands along the margin and at the top; stipules caducous. Flowers in an axillary or terminal, puberulous panicle, fragrant, zygomorphic; sepals 5, free, unequal; petals 5, free, very unequal, white, one of them saccate at base; stamens 6, united in a tube; ovary superior, 3-locular with 2 pendulous ovules in each cell one of which is aborted in fruit, style simple. Fruit a schizocarp, splitting into 3 flat, winged, 1-seeded samaras. Seedling with epigeal germination; cotyledons emergent, fleshy; hypocotyl elongated; first pair of leaves opposite, subsequent ones alternate, all leaves white puberulous below.

Flowers and fruits have been collected throughout the year but the phenology may be more restricted on a local scale. The flowers are presumably insect-pollinated and the winged fruits are wind-dispersed.

Trigoniastrum is sometimes treated as a member of the family *Polygalaceae* and is easily confused with *Xanthophyllum* (*Polygalaceae*), but is readily distinguishable when in flower or fruit. In vegetative state it differs from the latter by the leaf blade lacking distinct glands and the ultimate twigs being puberulous. There may be 2 ecological forms within *T. hypoleucum*, one growing on nutrient-poor soils and the other one on nutrient-rich soils.

Ecology *T. hypoleucum* occurs scattered in a wide range of lowland to submontane, evergreen forest types like peat-swamp, freshwater swamp, kerangas, alluvial and mixed dipterocarp forest. It can be found up to 1200 m altitude and is sometimes encountered in disturbed forest.

Silviculture *T. hypoleucum* can be propagated by seed. The samaras are the unit of sowing and the germination rate is about 85% in 19–47 days.

Genetic resources and breeding *T. hypoleucum* is widespread but rare and is therefore liable to genetic erosion.

Prospects The timber of *T. hypoleucum* is seldom used (there are no reports of present utilization), probably because of its scattered and rare occurrence. Its use is unlikely to increase.

Literature 61, 163, 267, 341, 829, 831, 861, 1048, 1141, 1221, 1242.

E. Boer & M.S.M. Sosef

Tristaniopsis Brongn. & Gris

Bull. Soc. Bot. France 10: 371 (1863).
MYRTACEAE
x = unknown; *T. laurina* (J.E. Smith) Peter G. Wilson & J.T. Waterh.: $2n = 22$

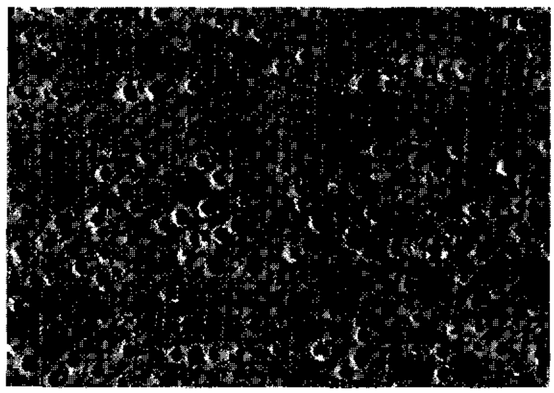
Vernacular names Brunei: selan. Indonesia: pelawan (general). Malaysia: keruntum, pelawan (general), melaban, selunsur (Sarawak). Papua New Guinea: Papua New Guinea swamp box, swamp mahogany. Philippines: malabayabas (Filipino). Burma (Myanmar): duakyat. Thailand: tamsao-nu.

Origin and geographic distribution *Tristaniopsis* is a fairly large genus of about 45 species which occur from Burma (Myanmar) and Thailand, throughout the Malesian region (except central and eastern Java and the Lesser Sunda Islands), to eastern Australia and New Caledonia. About 20 species occur within Malesia.

Uses The hard and durable wood of *Tristaniopsis* is used for heavy constructional work, e.g. for posts and beams for house and bridge construction, wharves and jetties, sleepers, poles, piling, heavy duty flooring, exterior decking, tool handles, mauls and mallets, spokes and wheels, pulleys, bearings, rollers, saw guide blocks, bowling balls, transmission poles and stakes for pepper support. It is sometimes used for paddles, rice pestles, and for high-quality firewood or charcoal.
In Sulawesi an unknown species of *Tristaniopsis* has been planted as a fire-break in *Pinus merkusii* Jungh. & de Vriese plantations.

Production and international trade Export of *Tristaniopsis* has been mainly between Asian Pacific countries, the main consumer being Australia. It is occasionally exported to Japan. In Papua New Guinea *Tristaniopsis* timber is traded together with that of *Lophostemon* and *Welchiodendron* as 'Papua New Guinea swamp box' of which only 150 m^3 was exported at an average free-on-board (FOB) price of US$ 101/m^3 in 1996.

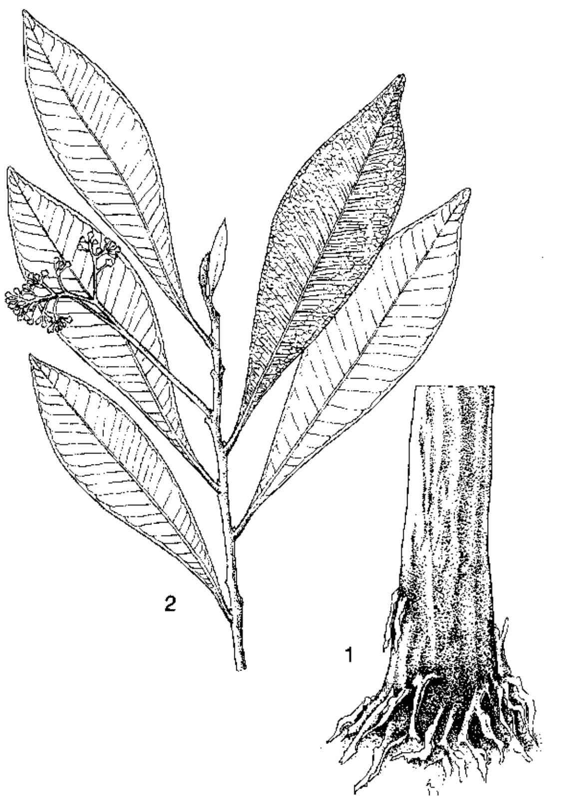
Properties *Tristaniopsis* yields a heavy hardwood with a density of 865–1250 kg/m^3 at 15% moisture content. Heartwood pink-brown, red-brown or purple-grey-brown, only occasionally distinct from the paler sapwood; grain interlocked, sometimes wavy; texture fine and even; wood sometimes with some silver grain. Growth rings indistinct, larger vessels with tendency to align in concentric rings; vessels rather variable in size, from very small to medium-sized, almost exclusively solitary, usually in oblique arrangement, with reddish gum-like deposits or blocked by tyloses; parenchyma sparse, paratracheal and apotracheal diffuse tending to short tangential bands, hardly visible with a hand lens; rays very fine, visible with a hand lens; ripple marks absent.
Shrinkage of the wood upon seasoning is variable, from moderate to very high. It takes about 5 months to air dry boards 40 mm thick during which time the wood is subject to warping (particularly back-sawn boards), distortion and surface checking (not severe relative to its density). Partial air drying to 30% moisture content before kiln drying and a final reconditioning treatment is recommended. In Malaysia kiln-drying schedule D is recommended. The wood is very hard, very strong and tough. It is fairly difficult to work due to its hardness and high silica content. Tool edges blunt rapidly and sawing is especially difficult.



Tristaniopsis decorticata
transverse surface (×18)

The wood can be planed to a relatively smooth surface, although a reduced cutting angle of 15–20° may be necessary. It turns excellently. Pre-boring is necessary before nailing. Bending of *T. decorticata* is rated as fair for boards 2.5 cm thick and very good for boards 0.3 cm thick. The wood is durable to extremely durable when exposed to the weather or in contact with the ground. It is resistant to termite and marine borer attack, whereas the sapwood is non-susceptible to *Lyctus*. The heartwood is extremely resistant to impregnation.
See also the tables on microscopic wood anatomy and wood properties.

Botany Shrubs or small, medium-sized to large trees up to 45 m tall; bole up to 70(–120) cm in diameter, buttresses absent; bark surface smooth, often peeling off in large, spiral, scroll-like pieces, usually accumulating round the base of the trunk, orange-brown to pinkish-grey, inner bark whitish or yellowish. Leaves alternate, simple, entire, with glandular dots and an intramarginal vein; stipules absent. Inflorescence axillary, cymose.



Tristaniopsis whiteana (Griffith) Peter G. Wilson & J.T. Waterh. - 1, trunk base; 2, flowering twig.

Flowers 5-merous; calyx lobes persistent; petals free, white or yellow; stamens numerous, fused into fascicles opposite the petals; ovary half-inferior to superior, (2–)3-locular with numerous pendulous ovules, style filiform with a capitate stigma. Fruit a loculicidal capsule, exserted from the hypanthium, hemispherical in the upper part, with a distinctive column at the centre of the dehisced fruit. Seed usually winged, with a straight embryo and convolute or obvolute, reniform cotyledons. Seedling with epigeal germination; cotyledons leafy, 2-lobed; leaves convolute.
Mass-flowering with intervals of several years has been reported for *T. micrantha* in the Philippines. It has been suggested that sudden changes in temperature may initiate flowering. The flowering trees are mostly leafless. The fruits burst open with some force, slightly scattering the seeds. After the fruits burst, young leaves develop. Young leaves are often pink, old withered leaves red.
Recent studies revealed that *Tristania* sensu lato is heterogeneous and it was split into 5 genera: *Lophostemon* (4 species), *Ristantia* (3 species), *Tristania* sensu stricto (1 species, restricted to Australia), *Welchiodendron* (1 species), and *Tristaniopsis* (comprising the majority of species, including all western Malesian ones formerly referred to as *Tristania* spp.). *Tristaniopsis* is distinguished from the other genera particularly by the combination of its alternate leaves, its fruit exserted from the hypanthium and its winged seeds.

Ecology *Tristaniopsis* species occur in many different types of lowland to lower montane forest up to 1300 m altitude, often along rivers or near the coast, but also in rocky locations. They are often common but do not occur gregariously. Some species, such as *T. whiteana*, grow especially on landslides and open patches along streams, and in secondary forest and are evidently efficient colonizers. They often grow together with *Cratoxylum* species.

Silviculture *Tristaniopsis* may be propagated by seed. The number of dry seeds of *T. obovata* is about 1.4 million. In a germination trial seed of *T. merguensis* germinated for 70–85% in 13–22 days. In Java *Tristaniopsis* has been planted above 1000 m altitude.

Genetic resources and breeding *Tristaniopsis* trees do not seem to be subject to extensive logging as the timber is mainly used locally and has no great economic importance. The supply in the forest still seems to be considerable for many species.

Prospects As the demand for very hard wood for specialty use is increasing in Europe and a fair supply can be generated from parts of Sarawak and Indonesia, *Tristaniopsis* may be expected to gain importance as an export timber.

Literature 1, 151, 154, 162, 163, 209, 218, 235, 260, 267, 296, 300, 302, 360, 436, 487, 536, 775, 780, 829, 831, 861, 934, 1023, 1040, 1221, 1230, 1239, 1242, 1274.

Selection of species

Tristaniopsis decorticata (Merr.) Peter G. Wilson & J.T. Waterh.

Synonyms *Tristania decorticata* Merr.

Vernacular names Philippines: malabayabas (Filipino).

Distribution The Philippines (Luzon, Polillo and Mindanao) and Sulawesi.

Tristaniopsis elliptica (Stapf) Peter G. Wilson & J.T. Waterh.

Synonyms *Tristania elliptica* Stapf.

Distribution Borneo.

Tristaniopsis ferruginea (C.T. White) Peter G. Wilson & J.T. Waterh.

Synonyms *Tristania ferruginea* C.T. White.

Vernacular names Indonesia: mehikah (Irian Jaya).

Distribution New Guinea.

Tristaniopsis grandifolia (Ridley) Peter G. Wilson & J.T. Waterh.

Synonyms *Tristania grandifolia* Ridley.

Distribution Borneo.

Tristaniopsis littoralis (Merr.) Peter G. Wilson & J.T. Waterh.

Synonyms *Tristania littoralis* Merr.

Vernacular names Philippines: taba (Sulu).

Distribution The Philippines (Samar, Mindanao and Basilan).

Tristaniopsis merguensis (Griffith) Peter G. Wilson & J.T. Waterh.

Synonyms *Tristania backhuizenii* Backer, *Tristania maingayi* Duthie, *Tristania merguensis* Griffith, *Tristania subauriculata* King.

Vernacular names Indonesia: pelawan tudak (Belitung). Malaysia: pelawan bukit (Peninsular). Burma (Myanmar): nya-kamaung. Thailand: khang nang (peninsular).

Distribution Southern Burma (Myanmar), southern Thailand, Peninsular Malaysia, Sumatra, the Riau Islands, Bangka, Belitung, the Lingga Islands, West Java and Borneo.

Tristaniopsis micrantha (Merr.) Peter G. Wilson & J.T. Waterh.

Synonyms *Tristania micrantha* Merr.

Vernacular names Philippines: tiga (Bikol, Tagalog).

Distribution The Philippines (Luzon, Samar).

Tristaniopsis obovata (Benn.) Peter G. Wilson & J.T. Waterh.

Synonyms *Tristania obovata* Benn., *Tristania spathulata* Ridley.

Vernacular names Indonesia: pelawan kiring (Belitung). Malaysia: selunsur puteh (Sarawak).

Distribution Peninsular Malaysia, Sumatra, the Riau Islands, Bangka, Belitung, the Lingga Islands and Borneo.

Tristaniopsis whiteana (Griffith) Peter G. Wilson & J.T. Waterh.

Synonyms *Tristania motleyi* Ridley, *Tristania sumatrana* Miq., *Tristania whiteana* Griffith.

Vernacular names Indonesia: kayu mulu, sibelusui (Sumatra). Malaysia: selunsur merah (Sarawak).

Distribution Peninsular Malaysia, Sumatra, the Riau Islands, Bangka, Belitung, Borneo, the Moluccas and New Guinea.

E. Boer (general part),
R.H.M.J. Lemmens (general part, selection of species)

Tristiropsis Radlk.

T. Durand, Index gen. phan.: 76 (1888).

SAPINDACEAE

x = unknown; $2n$ = unknown

Vernacular names Tristiropsis (En, trade name).

Origin and geographic distribution *Tristiropsis* comprises 3 species, one of which is widespread and occurs in Christmas Island, the Kangean Archipelago, Borneo (Kalimantan), the Philippines, Sulawesi (Muna), the Lesser Sunda Islands, the Moluccas, New Guinea, the Marianas (Guam), the Caroline Islands (Palau), the Solomon Islands and northern Australia (Queensland); it is cultivated locally in Java. The other two species are endemic to Borneo and Papua New Guinea, respectively.

Uses The wood of *Tristiropsis* is used for light construction, interior finish, mouldings, light flooring, furniture, joinery, cabinet work, lining, wall panelling, boat building, ladders, turnery, tool handles, and boxes and crates. It is suitable for the production of veneer and plywood as well as for pulp.

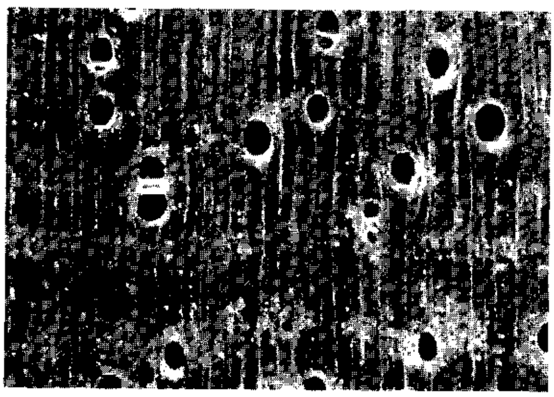
T. acutangula is planted locally in Java as an ornamental.

Production and international trade In 1996 Papua New Guinea exported 3125 m^3 of *Tristiropsis* logs at an average free-on-board (FOB) price of US$ 100/m^3. Sometimes it is shipped in log consignments together with *Pometia pinnata* J.R. Forster & J.G. Forster from Papua New Guinea and the Solomon Islands. In other areas the wood is probably used on a local scale only.

Properties *Tristiropsis* yields a medium-weight hardwood with a density of 580–795 kg/m^3 at 15% moisture content. Heartwood pale brown to pink-brown, sapwood pale pink or straw-coloured, 5–8 cm wide; grain straight or interlocked; texture medium to coarse; wood slightly lustrous; often with streaked figure; *T. acutangula* sometimes with distinct odour. Growth rings indistinct or absent; vessels solitary and in radial multiples of 2–4, visible to the naked eye, with chalky white deposits; parenchyma abundant, apotracheal diffuse and in regular to irregular bands, paratracheal vasicentric, aliform and confluent; rays narrower than the vessels; ripple marks absent.

Shrinkage is very high, but stock can be rapidly kiln dried from the green condition without much degrade. Using moderately severe initial drying conditions, 25 mm thick boards kiln dry from the green condition to 12% moisture content in about 3–4 days and 50 mm thick stock takes 9–10 days. A stress relief treatment is recommended after kiln drying. The wood is moderately weak to moderately strong. It is moderately difficult to saw green stock due to its fibrousness; it is easier to saw when dry. Machining properties are reasonably good, with a satisfactory finish, but grain may pick up on back-sawn material; a cutting angle of 20° is recommended, veneering properties are reasonable. The wood is non-durable. The heartwood is extremely resistant to pressure impregnation, sapwood penetration only patchy. It is liable to sap-stain and subject to pinhole borer and termite attack. The sapwood is susceptible to *Lyctus*. The wood contains saponin and the sawdust may therefore irritate the nose and throat.

See also the tables on microscopic wood anatomy and wood properties.



Tristiropsis acutangula
transverse surface (×20)

Botany Evergreen or semi-deciduous, monoecious, small to fairly large trees up to 35(–53) m tall; bole sometimes straight but often twisted or sinuous, branchless for up to 25(–30) m, up to 100 cm in diameter, often with buttresses up to 3 m high; bark surface smooth to dippled, lenticellate, brownish-grey to brown or reddish-brown, inner bark whitish or pale pinkish tinged with green, with some watery exudate; crown diffuse and somewhat flattened. Leaves alternate, bipinnate, large, exstipulate; pinnae alternate or rarely opposite; leaflets alternate to subopposite, oblique at base, entire. Flowers in an axillary thyrse, unisexual; sepals 5, free, imbricate; petals 5 or absent, creamy white, with a single scale inside; disk entire. Male flower with 8(–13) stamens. Female flower with a superior, 3(–5)-locular ovary with 1 ovule in each cell, style short with a 3-grooved stigma. Fruit a (1–)3(–5)-celled drupe, deep yellow, densely tomentose. Seed brown, without arillode. Seedling with broadly dentate leaflets.

Flowers are sweet-scented and pollinated by insects, probably bees. *T. acutangula* has been observed flowering in January–August and October–November. The fruits take about 3 months to mature. Fruits were observed from January to November and are probably eaten and dispersed by birds.

Ecology *T. acutangula* is a subcanopy or canopy tree of primary or secondary rain forest up to 500(–850) m altitude. It can be locally common and occurs mainly in areas with a permanent high water table and near the coast on coral limestone. In New Guinea and the Solomon Islands *T. acutangula* also grows further inland. *T. ferruginea* is found in primary rain forest on limestone up to 500 m altitude.

Silviculture Natural regeneration is abundant. Seeds apparently germinate readily, but there are no exact data on propagation. *T. acutangula* is not fire-resistant.

Genetic resources and breeding There are no records of ex situ conservation of *Tristiropsis*; both species mentioned below are not very common but do not seem to be endangered.

Prospects The often poorly shaped bole and the relatively uncommon occurrence of *Tristiropsis* suggest that the use of the wood is unlikely to increase in the near future.

Literature 70, 125, 300, 340, 341, 346, 348, 464, 536, 861, 974, 1048, 1132, 1232.

Selection of species

Tristiropsis acutangula Radlk.

Synonyms *Tristiropsis canarioides* Boerl. ex Valeton, *Tristiropsis oblonga* Radlk., *Tristiropsis subfalcata* Radlk.

Vernacular names Indonesia: hende, lere (Flores), kugwo (Mooi, Irian Jaya). Philippines: brayo (Bagobo), gasi-gasi (Chabacano, Sulu), tagum-tagum (Bikol, Manobo).

Distribution Christmas Island, the Kangean Archipelago, south-eastern Borneo, the Philippines, Sulawesi (Muna), the Lesser Sunda Islands, the Moluccas, New Guinea, the Marianas (Guam), the Carolines (Palau), the Solomon Islands and northern Australia (Queensland); cultivated locally in Java.

Tristiropsis ferruginea Leenh.

Vernacular names Indonesia: laras (East Kalimantan).

Distribution Borneo.

P.C. van Welzen

Turpinia Vent.

Mém. Cl. Sci. Math. Inst. Natl. France 1: 3 (1807).
STAPHYLEACEAE

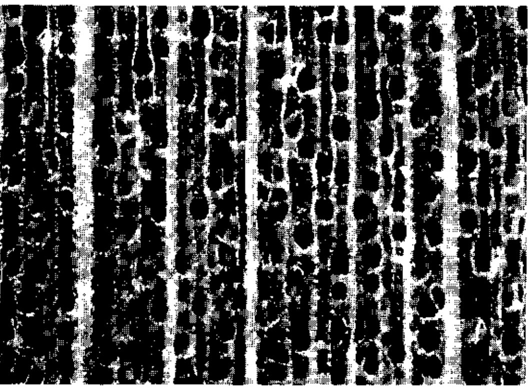
x = 13; *T. cochinchinensis* (Lour.) Merr., *T. pomifera* (Roxb.) DC.: n = 13, *T. nepalensis* Wight & Arn.: n = 13, 14

Origin and geographic distribution *Turpinia* comprises some 40 species occurring in Central and South America and in the Asian tropics from Sri Lanka and India to Indo-China, southern China, Japan, Taiwan, Thailand and throughout the Malesian region. It is represented in Malesia by 11 species.

Uses The wood of *Turpinia* is of inferior quality and only exceptionally used for house building, but is reported to be used for furniture, household implements, packing cases, and in the Philippines for Venetian blinds, popsicle sticks and ice-cream spoons. The wood is suitable for the production of pulp and paper.
Wood extracts of *T. ovalifolia* showed anti-cancer activity against lymphoid leukaemia. In Papua New Guinea it is alleged that eating the leaves of *T. pentandra* with those of *Zingiber* prevents conception.

Production and international trade Because of the poor quality of *Turpinia* wood in combination with the limited supplies and its generally small dimensions, it is used only rarely and locally.

Properties *Turpinia* yields a lightweight, sometimes medium-weight hardwood with a density of 360–560 kg/m³ at 15% moisture content. Heartwood whitish-yellow, not clearly differentiated from the sapwood; grain straight; texture fine to moderately fine; wood occasionally with streaks. Growth rings distinct, indicated by narrow to broad layers of darker coloured wood with relatively few vessels; vessels very small to moderately small, mostly solitary, occasionally in radial or oblique pairs, open; parenchyma sparse, scanty paratracheal tending to aliform, mostly indistinct even with a hand lens; rays very fine to moderately broad, the broader ones sometimes interrupted, conspicuous on radial surface; ripple marks absent.



Turpinia pentandra
transverse surface (×20)

The wood is fairly soft and of moderate strength. Rapid conversion is necessary to prevent blue stain and insect attack. The wood is non-durable. The heartwood of *T. ovalifolia* is susceptible to dry-wood termites. The sapwood is susceptible to *Lyctus*.

The mean fibre length of *T. ovalifolia* is 2.72 mm and of *T. sphaerocarpa* 3.62 mm.

See also the tables on microscopic wood anatomy and wood properties.

Botany Evergreen shrubs or small to medium-sized trees up to 35 m tall; bole sometimes poorly shaped, branchless for up to 22 m, up to 60(–100) cm in diameter, sometimes with buttresses up to 6 m high; bark surface smooth to fissured or sometimes scaly, pale brown or yellowish-brown to dark brown or dark grey, inner bark fibrous, white to cream with orange to brown or red-brown mottles, with pleasant odour. Leaves decussate, imparipinnate, rachis with 2 glands near the insertion of the petiolules; leaflets 1–11, opposite, petiolulate, serrate, with 2 glands near the base of the blade; stipules interpetiolar. Flowers in an axillary or terminal raceme or panicle, 5-merous; sepals free; petals free, yellowish-green to greenish-white; stamens with broad filaments; disk annular; ovary superior, (2–)3(–4)-locular with 1–many ovules in each cell, styles closely appressed, forming 1 peltate stigma. Fruit a globose to 3-lobed, indehiscent berry, crowned by radial lines or horn-like structures. Seed mostly angular, with endosperm. Seedling with epigeal germination; cotyledons emergent; hypocotyl elongated.

In Borneo most species flower in November–May; in Java *T. sphaerocarpa* has been recorded flowering throughout the year; in the Philippines *T. ovalifolia* flowers from December to February. The disk of the sweet-scented flowers produces honey, probably attracting insects for pollination. Fruits take about 5 months to mature. The fruits are probably eaten and dispersed by birds and other animals.

Ecology Timber-yielding *Turpinia* species are found in evergreen, primary and secondary, lowland to montane rain forest, up to 2000(–2800) m altitude.

Silviculture *Turpinia* can be propagated by seed; wildlings have been used in Java by the local population. *T. sphaerocarpa* has about 29 000 dry seeds/kg. *Rhynchites* beetles have been reported puncturing shoots of *T. sphaerocarpa* in Indonesia. Early this century *T. sphaerocarpa* was planted successfully on erosion-prone mountain slopes in Java and grew fairly fast but later records are not available.

Genetic resources and breeding As *Turpinia* is hardly used for timber and both its geographical and ecological distribution are fairly wide, it does not seem endangered.

Prospects It is unlikely that *Turpinia* timber will be increasingly used in the near future; its reportedly fast growth needs confirmation.

Literature 43, 70, 163, 235, 238, 260, 322, 341, 375, 380, 403, 405, 436, 525, 753, 780, 861, 908, 934, 955, 974, 1048, 1221, 1232, 1274.

Selection of species

Turpinia ovalifolia Elmer

Synonyms *Turpinia lucida* Nakai, *Turpinia trifoliata* Ridley.

Vernacular names Philippines: anongo (Filipino), balay balayan (Tagalog), tigatbo (Bikol).

Distribution Peninsular Malaysia and the Philippines.

Turpinia pentandra (Schlechter) B.L. Linden

Synonyms *Turpinia brachypetala* (Schlechter) B.L. Linden, *Turpinia papuana* Merr. & L.M. Perry, *Turpinia versteeghii* Merr. & L.M. Perry.

Distribution New Guinea and the Bismarck Archipelago.

Turpinia sphaerocarpa Hassk.

Synonyms *Turpinia latifolia* Wallich ex Ridley, *Turpinia laxiflora* Ridley, *Turpinia pomifera* auct. non (Roxb.) DC., *Turpinia sambucifolia* Elmer.

Vernacular names Indonesia: bancet (Sundanese), bangkong (Javanese), langkiang etem (Simeuluë). Malaysia: geretak (Peninsular), maba (Iban, Sarawak), tapong-tapong (Dusun, Sabah). Philippines: laloi (Bagobo, Cebu Bisaya).

Distribution Throughout Malesia except for New Guinea.

U.A. Dasuki

Urophyllum Jack ex Wallich

Roxb., Fl. ind. 2: 184 (1824).

RUBIACEAE

x = unknown; $2n$ = unknown

Vernacular names Philippines: dabdaban (general).

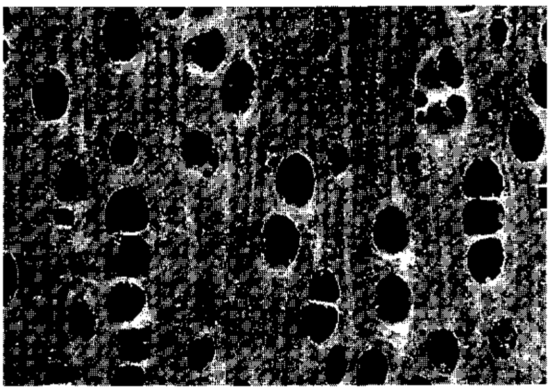
Origin and geographic distribution *Urophyllum* comprises about 150 species and is distributed in southern and eastern Asia to New Guinea. Numerous species occur in Malesia, but only a few are large enough to yield timber.

Uses The wood of *Urophyllum* is used locally for posts and rafters in house building and for handles of implements, and might be suitable for carving; it is also used as firewood.
Some species are used medicinally. *U. hirsutum* is used in Malaysia to make an infusion given after childbirth. *U. arboreum* (Reinw. ex Blume) Korth. is used in Java as a spice; the bruised leaves smell strongly of cloves.

Production and international trade The wood of *Urophyllum* is used on a local scale only, because the trees are generally small.

Properties *Urophyllum* yields a medium-weight hardwood. Heartwood white to reddish white; texture fine. Growth rings indistinct; vessels medium-sized to large, solitary and in radial multiples 2–4, with white or yellow deposits; parenchyma apotracheal diffuse with some scanty paratracheal; rays fine but rather distinct; ripple marks absent.
The wood splits during seasoning and is very hard.
See also the table on microscopic wood anatomy.

Botany Dioecious shrubs or small trees up to 15 m tall; bole usually straight, branches opposite and decussate. Buds frequently several in a single leaf axil and arranged in a row. Leaves opposite, simple, entire, shortly petiolate; stipules interpetiolar, entire. Flowers in an axillary umbelliform cyme or fascicle, unisexual, 4–8-merous; calyx lobed to subtruncate; corolla with short cylindrical tube and valvate lobes, greenish, white or yellow, tube hairy inside; stamens as many as corolla lobes, inserted in throat of corolla tube, with short filaments; disk annular; ovary inferior, 4–8-locular with many ovules per cell, stigma 3–8-lobed. Fruit a usually globose berry, yellow, orange or red, sometimes finally black when ripe, containing 5 to many seeds.
An unidentified *Urophyllum* species from Java showed Roux's architectural tree model, characterized by a monopodial orthotropic trunk with continuous growth and opposite plagiotropic branches. *Urophyllum* trees may flower and fruit almost continuously, as reported from rain forest in East Kalimantan.
In 1940 several genera were split off from *Urophyllum* on the basis of characters such as the type of hairs in the corolla and the type of inflorescences. In modern floras this concept is not always pursued and *Urophyllum* is often treated in a broader sense. *Urophyllum* species have also been described from Africa, but these have all been transferred to the genus *Pauridiantha*.



Urophyllum arboreum
transverse surface (×20)

Ecology *Urophyllum* species are scattered, usually as understorey treelets in lowland and lower montane forest, up to 1400 m altitude; they are also found in swampy locations. Many species are common.

Genetic resources and breeding *Urophyllum* trees are not commonly logged and seem not to be at risk of genetic erosion.

Prospects The logs of *Urophyllum* are too small to be of interest as timber.

Literature 70, 138, 163, 267, 402, 436, 464, 694, 1221.

Selection of species

Urophyllum glabrum Jack ex Wallich

Vernacular names Malaysia: mata itek, melukut, merembong jantan (Peninsular).

Distribution Southern Burma (Myanmar), southern Thailand, Peninsular Malaysia; possibly also Sumatra, Java and Borneo.

Urophyllum hirsutum (Wight) Hook. f.

Vernacular names Malaysia: serepah, sirikan setap, tentulang (Peninsular).

Distribution Southern Thailand and Peninsular Malaysia.

Urophyllum streptopodium Wallich ex Hook. f.

Vernacular names Malaysia: chemperai dadeh, jinteh puteh, mata keli para (Peninsular).

Distribution Peninsular Malaysia and Borneo (Sabah).

Urophyllum trifurcum Pearson ex King & Gamble

Vernacular names Malaysia: kayu chenderus, seburus hitam, segau petaling (Peninsular).

Distribution Peninsular Malaysia.

Wardah

Vavaea Benth.

London Journ. Bot. 2: 212 (1843).

MELIACEAE

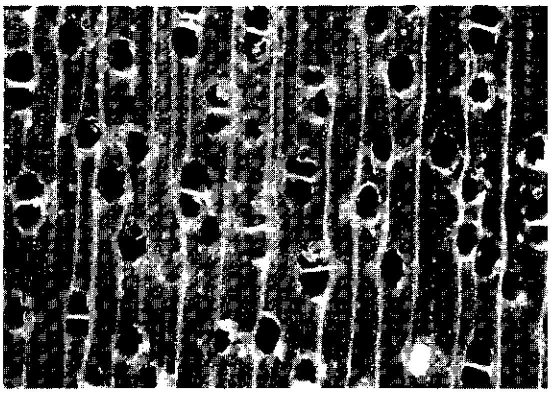
x = unknown; $2n$ = unknown

Origin and geographic distribution *Vavaea* is a small genus comprising 4 species occurring from Java and Borneo eastward through the Malesian region towards tropical Australia, the Caroline Islands, the Solomon Islands, Vanuatu, Fiji and Tonga. One species is endemic to the Fiji Islands, two others are restricted to New Guinea, whereas the fourth, *V. amicorum*, is widespread and covers the whole range of the genus.

Uses The wood of *Vavaea* is only of some importance in the Philippines where it is used for construction, furniture and cabinet work and interior finish. In Papua New Guinea it is recognized as suitable for furniture, cabinet work and joinery. In Fiji and the Caroline Islands it is considered a substitute for 'sandalwood'. In Sabah it is used as an incense wood and in local burial rites.

Production and international trade Utilization of *Vavaea* wood is on a local scale only. In the Philippines *V. amicorum* used to be locally abundant and was formerly traded in mixed consignments with better-known woods like 'guijo' (*Shorea guiso* (Blanco) Blume).

Properties *V. amicorum* yields a medium-weight hardwood with a density of 540–725 kg/m^3 at 15% moisture content. Heartwood cream-coloured to yellow-brown or pinkish-brown to red-brown, not distinct from the very narrow sapwood; grain straight or alternating to interlocked, producing a stripe figure; texture fine to medium and even; wood with distinct, pungent odour similar to that of oxalate of lime or highly fragrant as stated for Papua New Guinean species. Growth rings indistinct to the naked eye, sometimes visible with a hand lens as narrow, darker coloured bands with relatively few or no vessels; vessels very small to moderately small, solitary and in radial pairs, rarely in clusters, with few white deposits; parenchyma apotracheal and paratracheal, the latter narrow vasicentric tending to aliform particularly around smaller vessels, but distinct; rays very fine, not visible to the naked eye; ripple marks absent.



Vavaea amicorum
transverse surface (×20)

The wood seasons well. It is moderately hard and moderately strong, easy to work, and takes a high finish. The wood is moderately durable when exposed to the weather or in contact with the ground. Under cover the heartwood is resistant to dry-wood termites and the sapwood is non-susceptible to *Lyctus*.

See also the table on microscopic wood anatomy.

Botany Evergreen, small to medium-sized trees up to 30 m tall; bole straight and cylindrical but usually short, up to 80 cm in diameter, occasionally with buttresses up to 3 m tall; bark surface smooth to minutely cracked or more rarely scaly, lenticellate, brown or pale grey-brown, inner bark dirty white to pale brown, camphor- or soap-scented in *V. tubiflora*, or highly fragrant. Leaves arranged spirally, clustered at the end of branchlets, simple, exstipulate. Flowers in an axillary or extra-axillary panicle or cyme, bisexual or sometimes female; calyx 4–5(–7)-lobed; petals (3–)4–6, free; filaments united to various lengths, with 9–23 apically attached anthers; disk absent or present; ovary superior, 2–6-locular with 1 ovule, 2(–3) collateral ovules, or 4–10 ovules in 2 rows in each cell, style head capitate or discoid. Fruit a 1–3(–7)-seeded berry. Seed with thin sarcotesta. Seedling with epigeal germination; cotyledons remaining embedded in the seed wall; first pair of leaves opposite, subsequent ones alternate.

Trees show sympodial branching. Flowers are often strongly scented and pollination is probably by

insects. Flowers of *V. amicorum* may be bisexual, functionally female or entirely female.
V. amicorum is highly variable mainly in its vegetative parts and many geographical forms have previously been described as distinct species.

Ecology *Vavaea* species occur in primary and secondary rain forest, up to 1250 m altitude. *V. amicorum* is frequently found on limestone.

Genetic resources and breeding There are no records of ex situ or in situ conservation of *Vavaea* species. Apart from *V. amicorum* of which local populations in West Java and the northern Philippines are threatened, no species seem particularly subject to genetic erosion.

Prospects It is unlikely that the wood of *Vavaea* will be increasingly utilized in the near future, as it is relatively unknown and silvicultural knowledge on the species is lacking.

Literature 70, 162, 304, 341, 464, 780, 861, 876, 878, 934, 1146, 1232.

Selection of species

Vavaea amicorum Benth.

Synonyms *Vavaea archboldiana* Merr. & L.M. Perry, *Vavaea bantamensis* (Koord. & Valeton) Koord. & Merr., *Vavaea chalmersii* C. DC.

Vernacular names Indonesia: antamata (Talaud), mandorin (Biak, Irian Jaya), menako (Manikiong, Irian Jaya). Malaysia: chendana, sendana (Bajau, Sabah). Philippines: nangka-nangka (Filipino), bagodan (Manobo), sandana (Tagalog).

Distribution West Java, Borneo (Sabah, Kalimantan), the Philippines, South Sulawesi, the Moluccas, New Guinea, northern Australia, east to Vanuatu, Fiji and Tonga, north to the Caroline Islands; possibly also in Sumatra.

Vavaea tubiflora T.D. Penn.

Distribution Papua New Guinea (including Rossel Island).

E. Boer (general part),
M.S.M. Sosef (general part, selection of species)

Vernonia Schreber

Gen. pl. 2: 541 (1791).
COMPOSITAE
$x = 9$; *V. arborea*: $2n =$ c. 30

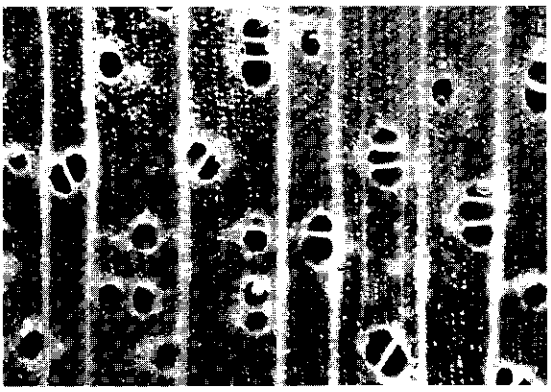
Vernacular names Indonesia: merambung (general). Philippines: malasambong (general).

Origin and geographic distribution *Vernonia* is a very large genus of about 1000 species occurring in tropical, subtropical and temperate regions of America, Africa and Asia with its main centre of diversity in the Neotropics. In the Malesian region about 35 species occur, most of which are herbs, shrubs or climbers; only 2 species are trees.

Uses The wood of *Vernonia* is used for wood-based panels, temporary construction, household appliances and matches. It may be used for carvings and wooden clogs.
V. arborea may be useful in reforestation and erosion control. A decoction of the bark together with other ingredients or an infusion of the root, may be given against fever. In southern Sumatra the bark was chewed at the first signs of sprue.

Production and international trade *Vernonia* wood is used only locally, but the timber is regarded as commercial in Indonesia, probably because of the fairly large local supplies.

Properties *Vernonia* yields a lightweight hardwood with a density of 240–620 kg/m^3 at 15% moisture content. Heartwood pale brown to pale grey, not clearly differentiated from the sapwood; grain straight or slightly interlocked; texture rather coarse but even; wood with conspicuous silver grain. Growth rings indistinct, occasionally visible; vessels medium-sized, solitary and in radial multiples of 2–3, sometimes in clusters, with occasional white deposits; parenchyma rather sparse, paratracheal vasicentric, sometimes tending to aliform, especially near growth ring boundaries; rays medium-sized, visible to the naked eye and conspicuous on tangential surface; ripple marks absent.
The wood seasons well. It is soft, weak to moder-



Vernonia arborea
transverse surface (×20)

ately strong and can be worked easily. It is non-durable and very susceptible to dry-wood termites and fungi.

The energy value of oven-dry sapwood is about 19 750 kJ/kg.

See also the tables on microscopic wood anatomy and wood properties.

Botany Evergreen herbs, shrubs, climbers or rarely small to medium-sized trees up to 30(–40) m tall; bole up to 60(–100) cm in diameter, with short buttresses; bark surface becoming closely narrowly fissured or scaly, dark grey to brown, inner bark fibrous, pale brown to orange-brown turning darker or purplish upon exposure. Leaves arranged spirally, simple, entire, glandular below; exstipulate. Inflorescence terminal or in the upper leaf axils, consisting of widely branched panicles of heads; head with 5–6 white flowers which are much longer than the involucre; involucre campanulate; receptacle naked; corolla tubular with a campanulate to funnel-shaped limb; anthers with sagittate base. Fruit a ribbed, 3-angled achene which is flattened on two sides and rounded on the third; pappus hairs usually 2- or rarely 1-seriate, scabrous.

In general, flowering is during the dry season. In Peninsular Malaysia trees flower from June to August and sometimes also in January and February.

V. arborea is very polymorphic and formerly many varieties were distinguished. The occurrence of an array of intermediate forms, however, makes their separation unrealistic. The tree habit is very rare within the *Compositae*, and *V. arborea* possibly represents a highly derived form or a primitive trait within the genus *Vernonia*.

Ecology *V. arborea* is locally common in secondary forest, along roadsides and also in fields with alang-alang (*Imperata cylindrica* (L.) Raeuschel). It is found from lowland to lower montane habitats up to 2200(–3000) m altitude. In the Philippines it occurs in dipterocarp forest. In mountains in East Java *V. arborea* is conspicuous in the succession to mixed oak-laurel forest. *V. vidalii* is found scattered, chiefly in secondary forest and old clearings, up to 1300 m altitude.

Silviculture *V. arborea* shows a high seed sterility (nearly 100%) but is, paradoxically, a common pioneer of forest edges. Germination starts after 10–14 days after sowing and young seedlings need shelter. They can be pricked out when 10 cm tall. Growth is reportedly fairly rapid. Plants are capable of resprouting after dying back due to drought.

Genetic resources and breeding Being common in secondary vegetation, there seems to be little risk of genetic erosion of *V. arborea*.

Prospects As the wood quality is very poor, increased use of *V. arborea* for sawn timber is unlikely. Increased use for the manufacture of wood-based panels is a possibility.

Literature 70, 101, 163, 198, 209, 239, 260, 267, 436, 464, 526, 597, 827, 933, 934, 947, 974, 1038, 1218, 1221, 1242.

Selection of species

Vernonia arborea Buch.-Ham.

Synonyms *Vernonia celebica* DC., *Vernonia javanica* DC., *Vernonia wallichii* Ridley.

Vernacular names Tree vernonia (En). Indonesia: nangi (Bali), sembang kuwuk (Java). Malaysia: gambong, menggambong (Peninsular), tapong-tapong (Sabah). Philippines: malasambong gubat (general). Thailand: chuang, kaphuam maphrao, nuan paeng (peninsular).

Distribution From India and Sri Lanka through Indo-China and southern China towards Thailand and throughout the Malesian region.

Vernonia vidalii Merr.

Vernacular names Philippines: malasambong (general), palakapak (Tagalog), ulbak (Iloko).

Distribution The Philippines.

B. Ibnu Utomo W.

Viticipremna H.J. Lam

Verben. Mal. Arch.: 162 (1919).

VERBENACEAE

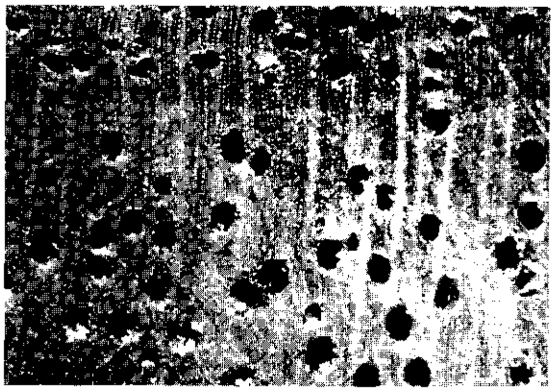
x = unknown; $2n$ = unknown

Origin and geographic distribution *Viticipremna* comprises 5 species. Three of these are present within the Malesian region, 2 of which are endemic to New Guinea and the Bismarck Archipelago. A fourth species is endemic to north-eastern Australia and the fifth to Fiji.

Uses The wood of *Viticipremna* has been used for general construction, household utensils, agricultural implements and musical instruments.

Production and international trade As supplies are very limited, utilization of the wood of *Viticipremna* is on a local scale only.

Properties *Viticipremna* yields a medium-weight hardwood with a density of 525–635 kg/m^3



Viticipremna novae-pommeraniae transverse surface (×20)

at 15% moisture content. Heartwood pale yellow or pale brown, not clearly differentiated from the 3–4 cm wide paler sapwood; grain straight or interlocked; texture moderately fine; wood lustrous. Growth rings fairly distinct indicated by vessel size and vessel density, occasionally with marginal parenchyma, or indistinct; vessels medium-sized, solitary and in radial pairs, open; parenchyma paratracheal vasicentric, indistinct, and apotracheal in marginal or seemingly marginal bands; rays fine; ripple marks absent.

The wood seasons satisfactorily. It is moderately hard and moderately strong. It is easy to work and takes a very high finish, but *V. novae-pommeraniae* is very difficult to saw due to the silica content. The wood is moderately durable when exposed to the weather or in contact with the ground. The sapwood is non-susceptible to *Lyctus*.

See also the table on microscopic wood anatomy.

Botany Shrubs or small to medium-sized trees up to 25(–33.5) m tall; bole fairly straight and short (*V. philippinensis*) or crooked and fluted and branchless for up to 15 m (*V. novae-pommeraniae*), up to 80(–120) cm in diameter; bark surface slightly flaky to peeling in vertical strips, grey to light grey-brown, inner bark cream with orange fibres. Leaves decussate, palmately compound, with 3–5 entire, long-stalked leaflets, exstipulate. Inflorescence terminal or axillary, cymose. Flowers zygomorphic, 4-merous; calyx tubular, truncate or shortly 4-dentate; corolla cream to pale yellow, sometimes with purple markings in the throat, tubular at base, sub-bilabiate in the upper part with the lower lip 3-lobed; stamens alternating with the corolla lobes, inserted inside the corolla tube, 2 long and 2 short ones; ovary superior, 2-carpellate, syncarpous, 4-locular with 1 ovule in each cell, style filiform, stigma shortly bifid. Fruit a small drupe, seated on an enlarged calyx, with a 4-celled, undivided pyrene.

V. philippinensis has been observed flowering in June. *V. novae-pommeraniae* bears flowers in January and February, fruits have been observed in March.

The genus *Viticipremna* shows features of both closely related genera *Vitex* and *Premna* (hence the name), and some authors even merge *Viticipremna* with *Vitex*. It differs from *Premna* by its compound leaves and from *Vitex* by the 4-lobed corolla and truncate or shortly 4-dentate calyx. 'no. 2 bitum' is the local Pidgin name in Papua New Guinea for *V. novae-pommeraniae*, 'no. 1 bitum' is *Vitex cofassus* Reinw. ex Blume.

Ecology *V. philippinensis* is found scattered in primary lowland forest, up to 700 m altitude. *V. novae-pommeraniae* occurs in primary forest, but also in secondary vegetation, up to 400 m altitude. It grows on well-drained sites, including limestone hills, and has been observed in association with *Homalium*, *Pterocarpus* and *Vitex*.

Genetic resources and breeding In the Philippines stands of *V. philippinensis* are heavily depleted due to habitat destruction and it is in serious danger of genetic erosion.

Prospects As supplies are very limited, the importance of the wood is unlikely to increase. In Papua New Guinea *V. novae-pommeraniae* is rarely harvested due to the poor form and the difficulty in sawing.

Literature 235, 304, 348, 464, 648, 780, 785, 814, 934.

Selection of species

Viticipremna novae-pommeraniae (Warb.) H.J. Lam

Synonyms *Clerodendron novae-pommeraniae* (Warb.) K. Schumann, *Vitex novae-pommeraniae* Warb.

Vernacular names Papua New Guinea: viticipremna (En), no. 2 bitum (Pidgin).

Distribution Papua New Guinea (around Lae), Admiralty Island and the Bismarck Islands (New Britain and New Ireland).

Viticipremna philippinensis (Turcz.) H.J. Lam

Synonyms *Vitex turczaninowii* Merr., *Viticipremna turczaninowii* (Merr.) H.J. Lam.

Vernacular names Philippines: lingo-lingo

(Filipino), bongogon (Samar-Leyte Bisaya), malauing-aso (Tagalog).

Distribution The Philippines, the Moluccas (Morotai) and New Guinea.

E. Boer (general part),
M.S.M. Sosef (general part, selection of species)

Wallaceodendron Koord.

Versl. Minahasa, Meded. 's-Lands Plantentuin 19: 446, 630 (1898).

LEGUMINOSAE

$x = 13$; *W. celebicum*: $2n = 26$

Vernacular names Derahm mahogany (En). Indonesia: mawewek, mawewekan, monyolansune (North Sulawesi). Philippines: banuyo (general), bulilising (Iloko), malatagom (Tagalog).

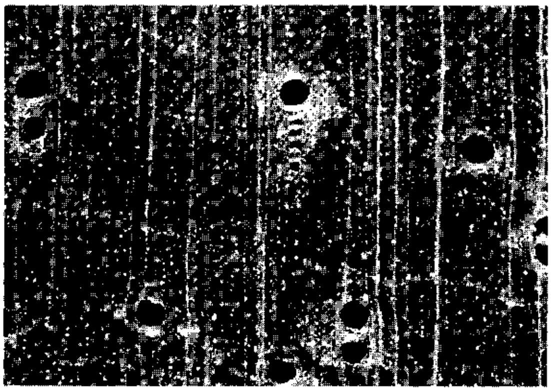
Origin and geographic distribution *Wallaceodendron* is a monotypic genus occurring in the Philippines and North Sulawesi. The only species is *W. celebicum* Koord. (synonym: *Pithecellobium williamsii* Elmer).

Uses The highly figured wood of *W. celebicum* is used for high-grade interior work, ship cabins, flooring, furniture and cabinet work, musical instruments, gunstocks, pistol grips, carving, pattern making, sculptures, and also for power transmission poles. It makes an excellent decorative veneer.

Trees are occasionally planted along roads.

Production and international trade Formerly, *W. celebicum* timber was traded and exported from the Philippines, e.g. as 'Derahm mahogany' to the United States, but because of depleted resources no logs have been exported for several decades.

Properties *W. celebicum* yields a medium-weight hardwood with a density of 510–740 kg/m^3 at 15% moisture content. Heartwood pale golden-brown to yellowish-brown or greyish-red-brown, clearly differentiated from the narrow, pale-coloured sapwood; grain sometimes straight, more often alternating and interlocked or wavy producing striped or mottled figure; texture moderately fine; wood lustrous. Growth rings distinct due to the dense latewood or zone with fewer vessels; vessels medium-sized to moderately large, mostly solitary, when in multiples usually with 1–2 vessels of normal size and other vessels much smaller, occasionally with white deposits, rarely with dark brown deposits; parenchyma moderately abundant, paratracheal vasicentric to aliform, apotracheal diffuse, clearly marked, rarely in marginal or seemingly marginal bands; rays very fine; ripple marks absent.



Wallaceodendron celebicum
transverse surface (×20)

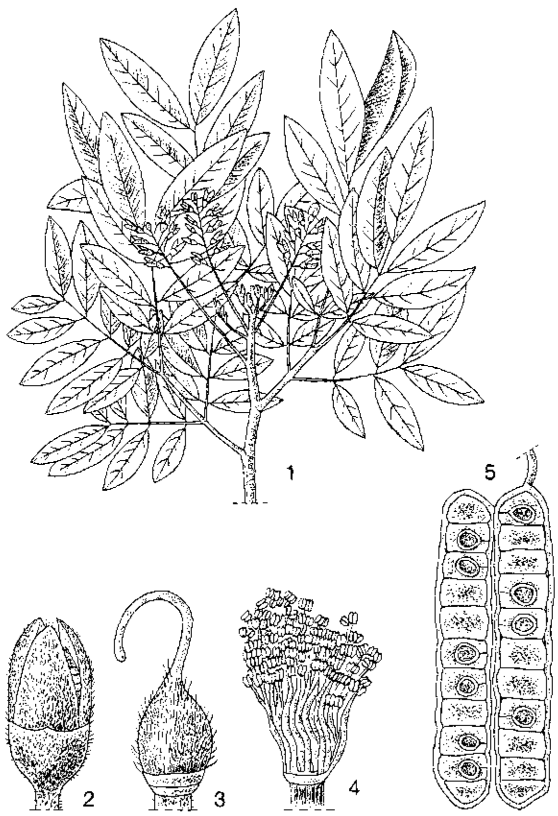
Shrinkage upon seasoning is low and the wood seasons well. The wood is moderately hard and fairly strong. It is very easy to work and takes a high finish. The wood is durable when exposed to the weather or in contact with the ground with an average service life of 6 years in a graveyard test in the Philippines. The heartwood is resistant to dry-wood termites. The sapwood is susceptible to *Lyctus*.

See also the table on microscopic wood anatomy and wood properties.

Botany An unarmed, medium-sized to large tree up to 45 m tall; bole straight, branchless for up to 31 m, up to 160 cm in diameter, sometimes with buttresses; branches lenticellate. Leaves arranged spirally, bipinnate; rachis and pinnae with extrafloral nectaries; leaflets opposite, entire, 3–7 pairs per pinna; stipules caducous. Flowers in an axillary, solitary or paired raceme, bisexual, 5-merous; calyx and corolla connate, valvate; stamens many, united into a tube and with the corolla at base; ovary superior, 1-locular with many ovules, style simple. Fruit a woody, flat, straight or slightly curved, tardily dehiscent pod, tomentose to pubescent when young; endocarp papery, enveloping each seed. Seed circular, flattened, with hard testa and pleurogram, without aril.

Root nodules have been observed in *W. celebicum*. In the Philippines trees flower from December–September, and bear fruit from January–October. The seeds with papery endocarp are adapted to dispersal by wind or water.

Wallaceodendron belongs to the subfamily *Mimosoideae*.



Wallaceodendron celebicum Koord. – 1, flowering twig; 2, flower; 3, pistil; 4, stamens; 5, opened fruit.

Ecology *W. celebicum* is found in primary, lowland rain forest, both inland and near the seashore, up to 850 m altitude.

Genetic resources and breeding *W. celebicum* has become rare due to overexploitation and is regarded endangered. No conservation activities are reported and it has rarely been planted in reforestation projects in the Philippines.

Prospects Due to depleted resources, *W. celebicum* is no longer of importance. It is recommended to investigate the feasibility of plantation establishment.

Literature 12, 193, 235, 261, 341, 436, 571, 632, 780, 785, 804, 861, 866, 934, 1086.

J.P. Rojo

Walsura Roxb.

Fl. ind. (Carey ed.) 2: 386 (1832).

MELIACEAE

x = unknown; *W. trifoliolata* (A. Juss.) Harms: $2n = 28$

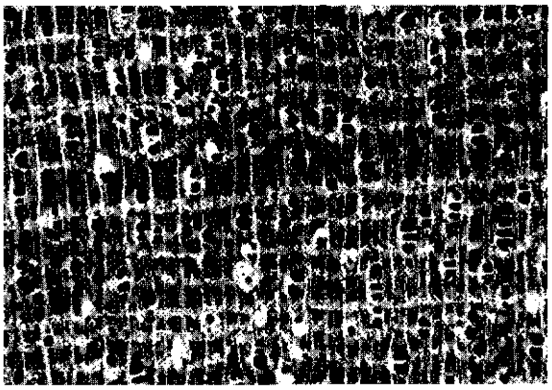
Origin and geographic distribution *Walsura* comprises about 16 species occurring from Sri Lanka, India and Burma (Myanmar) to Indo-China, the Andaman Islands, southern China, Thailand, Peninsular Malaysia, Borneo, the Philippines, the Moluccas (Halmahera) and New Guinea (Irian Jaya). *W. pinnata* is the most widespread species.

Uses *Walsura* wood is used locally for general construction and is excellent for interior work. It has been used in the production of pulp and, when mixed with pulp of other species, good-quality writing paper can be manufactured. In the Philippines the wood of *W. pinnata* is considered a substitute for 'guijo' (*Shorea guiso* (Blanco) Blume).

In Peninsular Malaysia the bark of *W. pinnata* has been used as one of the components of a decoction against diarrhoea and dysentery.

Production and international trade As the supplies of *Walsura* timber are only limited, utilization is on a local scale only. It may occasionally be encountered in mixed consignments of hardwood.

Properties *Walsura* yields a heavy hardwood with a density of about 1005 kg/m^3 at 15% moisture content. Heartwood red to orange-brown, not clearly differentiated from the paler or pink sapwood; grain interlocked or wavy; texture fine. Growth rings visible with a hand lens indicated by marginal parenchyma and slightly darker-



Walsura pinnata
transverse surface (×18)

coloured wood; vessels very small to small, solitary and in radial multiples of 2–3, sometimes with oblique tendency, open or with chalky white deposits; parenchyma moderately abundant and visible to the naked eye, mainly the paratracheal type forming incomplete borders to the vessels and confluent in wavy, interrupted layers, when more continuous and straight appearing marginal; rays very fine; ripple marks absent. The wood is difficult to distinguish from that of *Aglaia* species which tends to be coarser.

The wood seasons well. It is very hard and strong. It is fairly difficult to work but takes a very high finish. The wood is moderately durable under exposed conditions or in contact with the ground. When under cover it is resistant to dry-wood termites. The sapwood is non-susceptible to *Lyctus*.

See also the table on microscopic wood anatomy.

Botany Small to medium-sized trees up to 25(–37) m tall; bole branchless for up to 11(–24) m, up to 75(–150) cm in diameter, sometimes fluted or with small buttresses at base; bark surface smooth or shallowly fissured, becoming scaly, lenticellate, light grey-brown to dark grey-brown or blackish, inner bark pink to pink-red or pink-brown. Indumentum of simple and/or 2-armed hairs. Leaves arranged spirally, unifoliolate or imparipinnate and 1–4-jugate with opposite, entire leaflets, exstipulate. Flowers in an axillary thyrse, bisexual and male or unisexual (and then trees dioecious), (4–)5(–6)-merous; calyx with triangular lobes; petals free; filaments free or united into a tube below, with a truncate or bifid apex; disk annular; ovary superior, 2-locular with 2 ovules in each cell, stigma capitate to short and cylindrical. Fruit a 1–2(–4)-seeded berry or weakly dehiscent capsule. Seed with a transparent fleshy aril. Seedling with hypogeal germination; cotyledons not emergent; hypocotyl not elongated; all leaves arranged spirally, first few simple or 3-foliolate.

Trees show sympodial branching. Glands exuding a sweet colourless liquid are present on the lower leaf surfaces and are regarded as extrafloral nectaries. The flowers are probably insect-pollinated. The fruits are readily eaten by birds and gibbons which disperse the seeds.

Recently, a species formerly accommodated in *Walsura* was segregated and placed in a separate genus, mainly on the basis of the absence of a disk and the 4–5-locular ovary. The wood of this species, *Pseudoclausena chrysogyne* (Miq.) T.P. Clark (synonyms: *Walsura chrysogyne* (Miq.) Bakh. f., *Walsura multijuga* King), has been used for house building and carrying sticks in Peninsular Malaysia.

Ecology *Walsura* species occur scattered, usually as sub-canopy trees in primary evergreen, semi-evergreen or semi-deciduous rain forest. In Peninsular Malaysia they are rare, and found up to 600 m altitude.

Silviculture *Walsura* can be propagated by seed. *W. pinnata* seed was found to germinate in 2–6 months.

Genetic resources and breeding Both *W. pinnata* and *W. robusta* are widespread and not particularly endangered. *W. pachycaulon* Mabb. ex T.P. Clark is an uncommon endemic species of Sabah and Sarawak and may be subject to genetic erosion or extinction due to logging activities and destruction of its habitat.

Prospects As the supplies of *Walsura* wood are only limited, its importance in utilization and trade is unlikely to increase.

Literature 163, 197, 267, 341, 632, 780, 825, 829, 831, 878, 934, 1038, 1169, 1221.

Selection of species

Walsura pinnata Hassk.

Synonyms *Napeodendron altissimum* Ridley, *Walsura aherniana* Perkins, *Walsura neurodes* Hiern.

Vernacular names Philippines: bayit (Filipino), balibayan (Camarines), paling-uair (Bisaya). Laos: kha[1] lin[2] dong, 'khi[2] chak. Thailand: kaeo laow, kat lin (south-eastern).

Distribution Burma (Myanmar), Indo-China, southern China, Hainan, Thailand, Peninsular Malaysia, Borneo, the Philippines, the Moluccas (Halmahera) and New Guinea (Irian Jaya).

Walsura robusta Roxb.

Vernacular names Burma (Myanmar): gyobo. Laos: 'sêng 'mak dap, si din. Thailand: kat lin ling (south-eastern), khee ai (nothern), yaam faai (peninsular).

Distribution Bangladesh, Burma (Myanmar), the Andaman Islands, Laos, Vietnam, Thailand and Peninsular Malaysia.

E. Boer (general part),
M.S.M. Sosef (general part, selection of species)

Weinmannia L.

Syst. nat., ed. 10, 2: 997, 1005, 1367 (1759).
CUNONIACEAE
$x = 15$; *W. racemosa* L. f., *W. sylvicola* Soland. ex A. Cunn.: $2n = 30$

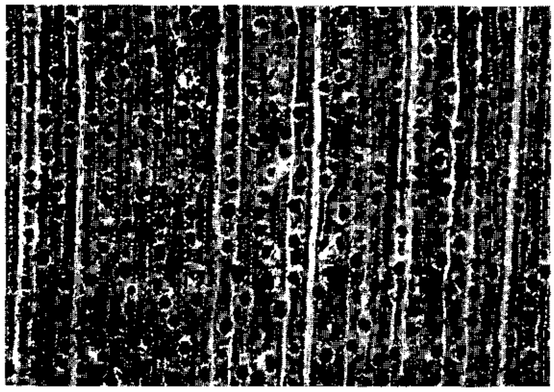
Vernacular names Philippines: itangan (trade name).

Origin and geographic distribution *Weinmannia* comprises about 120 species with a centre of diversity in Central and South America (65 species). Some 20 species are found in Madagascar and islands in the Indian Ocean. About 15 species occur throughout the Malesian region, mostly in the eastern part, and about an equal number is found in Melanesia, Polynesia, New Caledonia and New Zealand. The genus is markedly absent from the African and Australian continents and the Asian mainland.

Uses The wood of *Weinmannia* is used for house building (poles, beams), utility furniture and interior construction; occasionally nicely figured pieces are used for fine furniture and panelling. Species from outside South-East Asia (e.g. New Zealand) produce excellent wood which has a limited use in furniture, cabinet work and turnery.
The bark is occasionally used in the Philippines for tanning.

Production and international trade Because of the generally small size of *Weinmannia* and the limited supplies, the wood is used on a local scale only.

Properties *Weinmannia* yields a medium-weight hardwood with a density of 530–865 kg/m^3 at 15% moisture content. Heartwood reddish-brown, chocolate-brown or purple-grey-brown, not clearly differentiated from the paler, about 5 cm wide sapwood; grain straight to deeply interlocked; texture very fine to fine and even; wood lustrous and with attractive figure due to interlocked grain, occasionally with silver grain. Growth rings indistinct or sometimes marked by darker-coloured tissue and fewer vessels; vessels very small to moderately small, almost exclusively solitary, tyloses sparse; parenchyma sparse, apotracheal diffuse and diffuse-in-aggregates, occasionally appearing as scanty paratracheal, mostly indistinct; rays of 2 distinct sizes, extremely fine or medium-sized; ripple marks absent.
Shrinkage upon seasoning is very high. The wood is moderately hard and fairly strong and with care it can be worked and polished to a good finish. The wood is non-durable to moderately durable, susceptible to termite attack and, when green, to fungi. The sapwood is considered to be susceptible to *Lyctus*.
The mean fibre length is 1.10–1.90 mm.
See also the tables on microscopic wood anatomy and wood properties.



Weinmannia blumei
transverse surface (×20)

Botany Shrubs or small to medium-sized trees up to 25(–33) m tall; bole up to 60(–75) cm in diameter, sometimes with small buttresses; bark surface smooth to thin-scaled and fissured, lenticellate, grey to dark brown, inner bark firm, fibrous, pale red to red-brown with cream wedges; crown spreading. Leaves opposite, imparipinnate; leaflets serrate; stipules interpetiolar, large, sometimes united, caducous. Flowers clustered along the axes or grouped in an axillary or terminal raceme, small; sepals 4–5, free or united at base; petals 4–5, pinkish-white; stamens 8 or 10; disk lobed; ovary superior, 2-locular with many ovules, styles 2. Fruit a small, many-seeded capsule splitting into 2 valves; central column and styles persistent. Seed hairy.
Young leaves are red to pink, old ones wither scarlet.

Ecology Most Malesian *Weinmannia* species occur in upper montane forest, but a few descend to the lowlands or extend to sub-alpine forest (in New Guinea to 3000 m). *W. blumei* may occur gregariously.

Silviculture *W. blumei* is a light-demander known locally to colonize man-made clearings and as an early element of rehabilitating monsoon forest once fire is excluded.

Genetic resources and breeding The timber-yielding *Weinmannia* species are mainly found at higher elevations and as at present harvesting is limited they are not expected to be at risk of genetic erosion.

Prospects The wood of *Weinmannia* is reported to be suitable for craft turnery, furniture and interior construction, but obtaining sufficient supply will remain a problem.

Literature 70, 108, 151, 198, 209, 215, 260, 261, 267, 269, 304, 375, 436, 464, 470, 525, 745, 780, 785, 861, 881, 955, 974, 991, 1090, 1133, 1218, 1221, 1222.

Selection of species

Weinmannia blumei Planch.

Synonyms *Weinmannia ledermannii* Schlechter, *Weinmannia papuana* Schlechter, *Weinmannia sundana* Miq.

Vernacular names Malayan mountain ash (En). Indonesia: antahasi (Batak Toba, Sumatra), gringging (Javanese), ki merak (Sundanese).

Distribution Peninsular Malaysia, Sumatra, Java, Borneo, Sulawesi, the Lesser Sunda Islands, the Moluccas, New Guinea and the Solomon Islands.

Weinmannia luzoniensis S. Vidal

Vernacular names Philippines: itangan (Filipino), bani (Tagalog), saiu (Igorot).

Distribution The Philippines.

Weinmannia tomentella Schlechter

Synonyms *Weinmannia hypoglauca* Kaneh. & Hatus.

Distribution New Guinea.

Weinmannia urdanatensis Elmer

Vernacular names Philippines: kalilan (Filipino).

Distribution The Philippines, North Sulawesi and New Guinea (Irian Jaya).

W.C. Dickison

Welchiodendron Peter G. Wilson & J.T. Waterh.

Austr. Journ. Bot. 30: 440 (1982).

MYRTACEAE

x = unknown; $2n$ = unknown

Vernacular names Papua New Guinea swamp box (En).

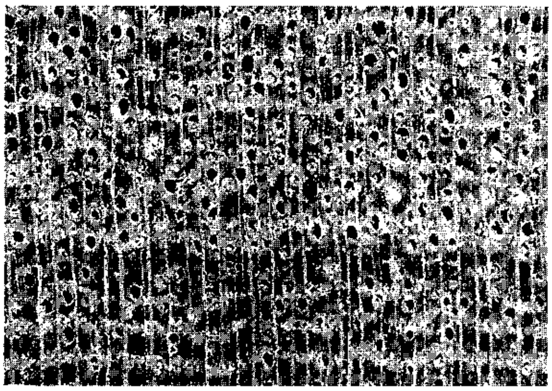
Origin and geographic distribution *Welchiodendron* is a monotypic genus. The only species, *W. longivalve* (F. v. Mueller) Peter G. Wilson & J.T. Waterh. (synonym: *Tristania longivalvis* F. v. Mueller), occurs in Papua New Guinea (Western Province) and north-eastern Australia (Queensland, Cape York Peninsula and Torres Strait Islands).

Uses The hard and heavy wood of *W. longivalve* is suitable for general construction, wharf and bridge decking, heavy structural work, sleepers, flooring, turnery, tool handles, exterior joinery, treads, sills, thresholds, cladding, rails, balusters and fencing.

Production and international trade The timber of *W. longivalve* is known together with that of *Lophostemon* and *Tristaniopsis* as 'Papua New Guinea swamp box', but it is rarely milled. In 1996 a volume of 150 m^3 of Papua New Guinea swamp box logs was exported from Papua New Guinea at an average free-on-board (FOB) price of US$ 101/m^3. It is occasionally imported into Japan.

Properties *W. longivalve* yields a heavy hardwood with a density of about 850 kg/m^3 at 12% moisture content. Heartwood dark red to red-brown, sapwood pale yellow; grain interlocked, sometimes wavy; texture fine and even. Growth rings indistinct, larger vessels tend to align in concentric rings; vessels rather variable in size, from very small to medium-sized, almost exclusively solitary, with a tendency to tangential arrangement, with reddish gum-like deposits or blocked by tyloses; parenchyma sparse, paratracheal scanty and apotracheal diffuse and in narrow to moderately wide bands, visible with a hand lens; rays very fine, visible with a hand lens; ripple marks absent.

Shrinkage of the wood upon seasoning is variable, from moderate to very high. It takes about 5



Welchiodendron longivalve
transverse surface (×20)

months to air dry boards 40 mm thick during which the wood is subject to warping (particularly back-sawn boards), distortion and surface checking (not severe relative to its density). Partial air drying to 30% moisture content before kiln drying and a final reconditioning treatment are recommended. In Malaysia kiln-drying schedule D is recommended. The wood is very hard, very strong and tough. It is fairly difficult to work due to its hardness and high silica content. Tool edges blunt rapidly and sawing is especially difficult. The wood can be planed to a relatively smooth surface, although a reduced cutting angle of 15–20° may be necessary. It can be turned excellently. Pre-boring is necessary before nailing. The wood is durable to very durable when exposed to the weather or in contact with the ground and is resistant to termite and marine borer attack. The sapwood is non-susceptible to *Lyctus*. The heartwood is extremely resistant to impregnation.

See also the table on microscopic wood anatomy.

Botany A shrub or small to medium-sized tree; bark surface fibrous to flaky, greyish-brown. Leaves alternate, simple, entire, obovate to elliptic, petiolate, exstipulate. Flowers in a lax axillary cyme, long-pedicelled, 5-merous; calyx with short persistent lobes; petals contracted into a claw, yellow; stamens numerous, fused into 5 fascicles opposite the petals; ovary half-inferior, 3-locular with 6–12 ovules in each cell, style with a capitate stigma. Fruit a woody capsule with conical apex, dehiscing into 3–4 valves. Seeds few per locule, winged.

Welchiodendron seems to be related to *Lophostemon* and the Australian genus *Syncarpia*. It differs from *Lophostemon* in its fruit which is exserted from the hypanthium and in its winged seed.

Ecology *W. longivalve* occurs in savanna woodland, occasionally in exposed locations where it occurs as a shrub.

Genetic resources and breeding As *W. longivalve* is seldom logged, it does not seem to be threatened.

Prospects Due to processing difficulties and its limited availability, the use of *Welchiodendron* for sawn timber is unlikely to increase. However, due to its hardness and high density the timber will remain interesting for its specialty uses, just like the timber of *Lophostemon* and *Tristaniopsis*.

Literature 40, 300, 1230.

E. Boer & R.H.M.J. Lemmens

Whiteodendron v. Steenis

Acta Bot. Neerl. 1: 436, fig. 1 (1952).

MYRTACEAE

x = unknown; $2n$ = unknown

Vernacular names Malaysia: kawi (Sarawak).

Origin and geographic distribution *Whiteodendron* is a monotypic genus. The only species, *W. moultonianum* (W.W. Smith) v. Steenis (synonym: *Tristania moultoniana* W.W. Smith), is endemic to Sarawak (Borneo).

Uses The wood of *W. moultonianum* is rarely used, mainly as firewood.

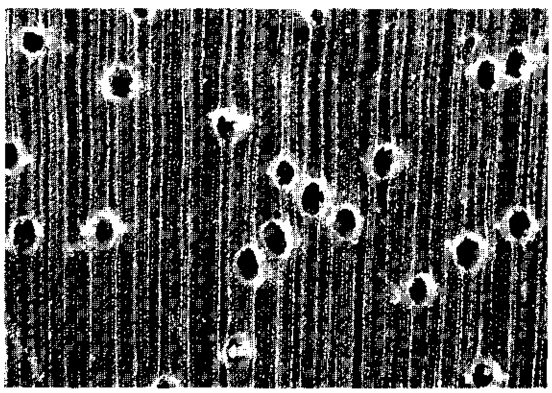
Production and international trade The timber of *W. moultonianum* has no importance at present, but seems to have good prospects.

Properties *W. moultonianum* yields a heavy hardwood with a density of 800–960 kg/m^3 at 15% moisture content. Heartwood brown, not clearly demarcated from the dark yellow to pale brown sapwood; texture rather fine and even. Growth rings indistinct; vessels medium-sized, solitary tending to irregular oblique arrangement, open or blocked by tyloses; parenchyma paratracheal, sometimes slightly aliform, inconspicuous; rays fine and indistinct.

Physical, mechanical and working properties are probably similar to those of *Tristaniopsis* timber.

See also the table on microscopic wood anatomy.

Botany An evergreen, medium-sized tree; bole often crooked or fluted, up to 80 cm in diameter, without buttresses; bark surface nearly smooth or shedding in irregular flakes but not shaggy, brown or purplish-brown, inner bark pinkish-yellow; crown bushy. Leaves arranged spirally, simple, entire, markedly asymmetrical, gradually tapering at base, with a short point at apex, leath-



Whiteodendron moultonianum transverse surface (×20) ery and glabrous, with numerous secondary veins; stipules absent. Flowers in an axillary or terminal cyme, 5-merous; calyx lobes short and broad, persistent; petals free, white; stamens numerous, in fascicles opposite the petals; ovary inferior, adnate to the calyx tube, 3-locular with many ovules, style short. Fruit a 1-seeded capsule splitting in the upper half with 3 valves. Seed large, with an oblique hilum at base.

Trees of *W. moultonianum* flower fairly regularly. They may be confused with 'punah' (*Tetramerista glabra* Miq., which is confined to peat-swamp forest, however) because of the rather similar leaves, but their asymmetrical shape is diagnostic.

The relationship of *Whiteodendron* is uncertain. It is often considered to be related to other *Myrtaceae* genera with capsular fruits such as *Tristaniopsis*. However, it might also be closely related to *Kjellbergiodendron* which has a fleshy and indehiscent fruit.

Ecology *W. moultonianum* occurs frequently in undulating kerangas on podzolic soils, but is also common in mixed dipterocarp forest on white and yellow sandy soils. It may occur frequently on river banks.

Silviculture *W. moultonianum* appears to be a strong light-demander in the early stages, but relatively little is known about its growth and development. Natural regeneration is profuse on skid roads in sandy soils. Even quite large stumps coppice freely.

Genetic resources and breeding *W. moultonianum* is very common in many areas in Sarawak and is not endangered at present. However, if it does become commercially intersting, its limited distribution area should be taken into consideration and some form of protection might be desirable.

Prospects Very little is known about *W. moultonianum* and suitable uses for its timber. Research is needed on the properties of the wood to determine its future importance. It may have good prospects because trees of timber size are encountered fairly commonly in Sarawak. The tree has also been suggested for ornamental purposes.

Literature 151, 1040, 1138.

E. Boer & R.H.M.J. Lemmens

Xanthophyllum Roxb.

Pl. Coromandel 3: 81 (1920).

POLYGALACEAE

x = unknown; $2n$ = unknown

Vernacular names Lilin (trade name). Indonesia: menjalin (general), segilandak (Sumatra). Malaysia: nyalin (trade name), lemak, lima, minyak berok (Peninsular). Papua New Guinea: boxwood (trade name). Laos: 'sêng. Burma (Myanmar): kam-gaw. Thailand: chumsaeng, saeng (central), khangkhao (northern).

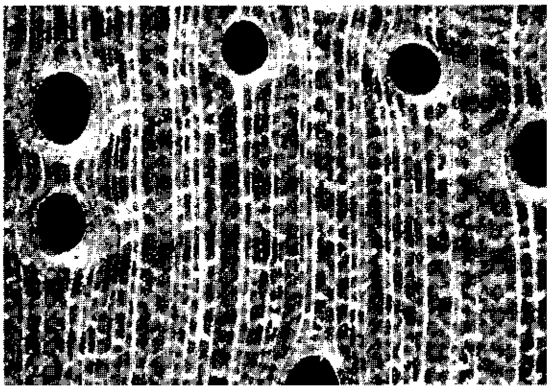
Origin and geographic distribution *Xanthophyllum* comprises about 94 species which occur from India to Indo-China and Thailand, and throughout the Malesian region towards the Solomon Islands and northern Australia; 76 species occur within Malesia. It is assumed that the genus originated in Austro-Malesia from where it spread west and reached its highest number of species in West Malesia.

Uses The wood of *Xanthophyllum* is used for temporary or medium-heavy construction under cover or in protected situations. It is also suitable for flooring, panelling, cabinet making, weatherboards, boxes, pallets, turnery, tool handles, rulers and drawing instruments, but the bulk of the timber is probably processed into plywood and blockboard. The wood is also used as firewood and is reportedly suitable for sulphate pulp.

The seeds of *X. lanceatum* yield an oil that has been used for cooking and against thrush, whereas its bark is administered to treat colic. The leaves and probably also the bark of some species contain a yellow dye. The pulp of fruits of *X. obscurum* is edible.

Production and international trade Small amounts of *Xanthophyllum* timber are imported into Japan from Papua New Guinea and the Solomon Islands. In Malaysia and Indonesia it is traded only locally or sold together with other timber as mixed medium hardwood. In 1996 Papua New Guinea exported about 5600 m^3 of *Xanthophyllum* logs at an average free-on-board (FOB) price of US$ 102/m^3.

Properties *Xanthophyllum* yields a medium-weight to heavy hardwood with a density of (430–)595–1015(–1110) kg/m^3 at 15% moisture content. Heartwood yellowish-white to pale yellowish-brown, darkening to a strong orange-yellow colour, not clearly demarcated from the sapwood; grain straight, sometimes wavy; texture moderately coarse to coarse and uneven. Growth rings indistinct to fairly distinct; vessels exclusively solitary,



Xanthophyllum papuanum
transverse surface (×20)

medium-sized to very large, the wide range being characteristic for the wood, open or with dark gum-like or white deposits; parenchyma moderately abundant to very abundant, paratracheal vasicentric, sometimes aliform, apotracheal in narrow, close and regularly spaced bands more or less continuous although occasionally interrupted, visible without a lens; rays very fine and indistinct, even with a hand lens; ripple marks absent.

Shrinkage of the wood upon seasoning is moderate to high. Air drying of boards 15 mm thick of *X. eurhynchum* takes 4 months, and of boards 40 mm thick 5 months, which is fairly slow. The wood is generally easy to dry but slight cupping, bowing and end-checking may occur. Veneer dries easily without defects, its surface is smooth to fairly smooth. It needs care in gluing. Good-quality general purpose plywood can be manufactured from *Xanthophyllum* wood. The wood is moderately hard and strong, rather easy to work, but sawing may be difficult as the wood is very abrasive; sawdust may cause dermatitis. It is generally regarded as non-durable though the wood of several species has been reported as durable; the heartwood is very resistant to impregnation with preservatives, but penetration in the sapwood is patchy to good. The wood is liable to attack by termites, pinhole borers and marine borers. It is highly susceptible to stain and the sapwood is susceptible to *Lyctus*.

See also the tables on microscopic wood anatomy and wood properties.

Botany Shrubs or small to large trees up to 50 m tall; bole straight, up to 120 cm in diameter, sometimes with small or rarely up to 4 m high buttresses; bark surface usually finely hoopmarked, often rugulose, sometimes lenticellate or pockmarked, inner bark granular, yellowish-brown to orange-brown, without exudate. Leaves alternate, simple, entire, the blade generally with glands beneath, mostly near the base; stipules absent. Flowers zygomorphic; sepals 5, free, slightly unequal; petals 5, free, lower petal boat-shaped and clawed; stamens (7–)8(–10); disk present; ovary superior, 1-locular with 4–many ovules, style slender. Fruit a large, 1(–20)-seeded capsule, indehiscent or rarely dehiscing irregularly with 2 valves. Seed with very thin or no endosperm. Seedling with epigeal or semi-hypogeal germination; cotyledons emergent; hypocotyl either well-developed or undeveloped; first 1–2 pairs of leaves opposite or subopposite.

Growth is in flushes with abortion of the terminal bud and new twigs arising from axillary buds. Flowering is infrequent and irregular, apparently following exceptionally long dry periods. Self-pollination, already in the bud, is apparently the rule in *Xanthophyllum*, but pollination by carpenter bees (*Xylocopa*) has also been observed. Seed dispersal is probably not very efficient because the fruits sink in water and are often too large to be eaten by animals.

Ecology Species of *Xanthophyllum* occur scattered or rarely gregariously in primary, often riverine, lowland rain forest, rarely in lower montane forest, up to 1200(–1500) m altitude. They are also found in freshwater swamp forest, monsoon forest and kerangas.

Silviculture *Xanthophyllum* can be propagated by seed. The fruit pulp must be removed before germination can take place. Germination is rapid, generally starting at 1–7 weeks after sowing, and ranges from 25% to 85%.

Genetic resources and breeding There are no records of *Xanthophyllum* in seed or germplasm banks. Trees are incidentally cultivated in botanical gardens. Many species are rare and hence may easily become endangered by destruction of their habitat.

Prospects No changes in the current use of *Xanthophyllum* timber are foreseen. Too little is known on its propagation, planting and regeneration to be able to assess potential use of *Xanthophyllum* for e.g. enrichment planting.

Literature 40, 57, 125, 163, 260, 267, 300, 302, 304, 318, 320, 341, 346, 348, 387, 436, 536, 677, 678, 741, 823, 825, 830, 831, 861, 933, 934, 955, 984, 1038, 1055, 1120, 1169, 1219, 1221, 1239, 1242, 1243.

Selection of species

Xanthophyllum affine Korth. ex Miq.

Synonyms *Xanthophyllum excelsum* (Blume) Miq. var. *affine* (Miq.) Boerl., *Xanthophyllum sarawakense* Chodat.

Vernacular names Malaysia: gading jantan, lima berok jantan, lima berok puteh (Peninsular). Thailand: min-yoh ba-ko (peninsular).

Distribution India (Assam), Burma (Myanmar), Laos, Thailand, Peninsular Malaysia, Sumatra, Bangka, Borneo (Sarawak, Brunei, Sabah) and the Philippines (Palawan).

Xanthophyllum amoenum Chodat

Synonyms *Xanthophyllum stipitatum* A.W. Benn. var. *nitidum* Chodat, *Xanthophyllum stipitatum* A.W. Benn. var. *pachyphyllum* Chodat.

Vernacular names Malaysia: mesira.

Distribution Peninsular Malaysia, central Sumatra and Borneo.

Xanthophyllum chartaceum v.d. Meijden

Distribution Peninsular Malaysia and central Sumatra.

Xanthophyllum ellipticum Korth. & Miq.

Synonyms *Xanthophyllum citrifolium* Chodat, *Xanthophyllum kingii* Chodat.

Vernacular names Malaysia: beberas telur buaya, champedak hutan, minyak berok laut (Peninsular)

Distribution Southern Thailand, Peninsular Malaysia, Singapore, Sumatra and Borneo.

Xanthophyllum eurhynchum Miq.

Synonyms *Xanthophyllum maingayi* Hook. f. ex A.W. Benn., *Xanthophyllum verrucosum* Chodat.

Vernacular names Malaysia: lemak berok betina, lemak ruwai, lima berok (Peninsular).

Distribution Southern Thailand, Peninsular Malaysia, Singapore and Sumatra.

Xanthophyllum ferrugineum v.d. Meijden

Distribution Borneo.

Xanthophyllum flavescens Roxb.

Synonyms *Xanthophyllum excelsum* (Blume) Miq., *Xanthophyllum glandulosum* Merr., *Xanthophyllum pallidum* Ridley.

Vernacular names Indonesia: endog-endogan, jerukan (Javanese), ki endog (Sundanese). Philippines: banig, bok-bok (Tagalog), dugi (Iloko). Laos: 'sêng dong. Thailand: hu yan (peninsular).

Distribution Burma (Myanmar), Indo-China, Thailand, Peninsular Malaysia, Sumatra, Borneo and the Philippines.

Xanthophyllum griffithii Hook. f. ex A.W. Benn.

Synonyms *Xanthophyllum gracile* Chodat, *Xanthophyllum pseudostipulaceum* Merr.

Vernacular names Malaysia: dedali paya, lima berok, rawai (Peninsular). Philippines: anono (Tagalog).

Distribution Burma (Myanmar), Indo-China, Thailand and throughout the Malesian region.

Xanthophyllum heterophyllum v.d. Meijden

Distribution Borneo (Sarawak, Brunei, Sabah).

Xanthophyllum lanceatum (Miq.) J.J. Smith

Synonyms *Xanthophyllum glaucum* Wallich ex Hassk., *Xanthophyllum microcarpum* Chodat.

Vernacular names Indonesia: siur-siur (Indonesian, Sumatra). Malaysia: sesiyor (Peninsular). Burma (Myanmar): kam-gaw. Laos: 'sêng nam^2, 'som^2 'sêng, soum 'sêng. Thailand: chum saeng (central), khang khao ton kliang (northern), saeng (north-eastern).

Distribution Bangladesh, Burma (Myanmar), Indo-China, Thailand, Peninsular Malaysia and southern Sumatra.

Xanthophyllum obscurum A.W. Benn.

Synonyms *Xanthophyllum insigne* A.W. Benn., *Xanthophyllum scortechinii* King.

Vernacular names Malaysia: buah kapas, lemak berok, mengkapas (Peninsular).

Distribution Peninsular Thailand, Peninsular Malaysia, Singapore, Sumatra and Borneo.

Xanthophyllum papuanum Whitm. ex v.d. Meijden

Distribution Central Sulawesi, the Moluccas (Seram), New Guinea and the Solomon Islands.

Xanthophyllum rufum A.W. Benn.

Synonyms *Xanthophyllum flavum* Ridley, *Xanthophyllum heteropleurum* Chodat.

Vernacular names Malaysia: minyak berok jantan, pokok kapas bulan, pokok telur buaya (Peninsular).

Distribution Peninsular Malaysia, Sumatra and Borneo.

Xanthophyllum stipitatum A.W. Benn.

Distribution Peninsular Malaysia, Sumatra and Borneo.

Xanthophyllum suberosum C.T. White

Distribution New Guinea.

Xanthophyllum tenuipetalum v.d. Meijden

Distribution North and South Sulawesi, the Moluccas (Taliabu and Kai Islands) and New Guinea (north-western Irian Jaya).

Xanthophyllum velutinum Chodat

Distribution Borneo (Sarawak, Brunei, Sabah).

Xanthophyllum virens Roxb.

Synonyms *Xanthophyllum flavescens* Roxb. var. *virens* (Roxb.) A.W. Benn.

Vernacular names Burma (Myanmar): thitpyu. Thailand: khang khao, ma duk (northern).

Distribution Bangladesh, Burma (Myanmar), Thailand and Peninsular Malaysia.

Xanthophyllum vitellinum (Blume) Dietr.

Synonyms *Xanthophyllum hookerianum* King, *Xanthophyllum kunstleri* King, *Xanthophyllum robustum* Chodat.

Vernacular names Malaysia: lima puteh, medang mangas, minyak berok puteh (Peninsular).

Distribution Peninsular Malaysia, Sumatra, Java, Borneo and the Philippines.

E. Boer (general part),
M.S.M. Sosef (general part, selection of species)

Xanthostemon F. v. Mueller

Hook. Journ. Bot. Kew Gard. Misc. 9: 17 (1857).
MYRTACEAE
x = unknown; $2n$ = unknown

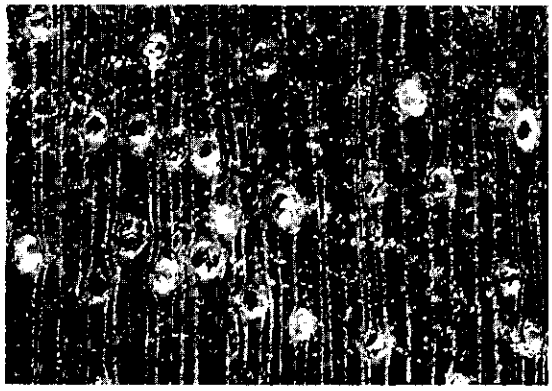
Vernacular names Philippine ironwood (En, trade name). Indonesia: lara. Papua New Guinea: kasi kasi (trade name).

Origin and geographic distribution *Xanthostemon* comprises about 50 species. New Caledonia is the richest in species (approximately 35), Australia has about 8 species, and 11 species occur in Malesia (4 in the Philippines, 4 in New Guinea, 2 in Sulawesi and 1 in the Moluccas).

Uses In the Philippines the wood of *X. verdugonianus* is considered a luxury timber. It is especially used for posts because of its durability, for salt-water piling, tool handles, rollers, pulleys, bearings, bowling balls and other novelties. The timber of other species (e.g. *X. brassii* and *X. verus*) is also rated as very durable and used for house and bridge building, wharves, salt-water piling, rollers, pulleys, fenders, mallets, caulking hammers, and for rudders and anchors of boats. It makes excellent firewood.
The charcoal and sawdust are used medicinally to cure ulcers. The bark is used against diarrhoea.

Production and international trade Supplies of *Xanthostemon* timber are limited, but it is locally in great demand and fetches high prices (e.g. in the Philippines). In 1996 Papua New Guinea exported 455 m^3 of 'kasi kasi' logs at an average free-on-board (FOB) price of US$ 90/m^3, which is low in comparison with the Philippines.

Properties *Xanthostemon* yields a heavy hardwood with a density of (805–)1015–1410 kg/m^3 at 15% moisture content. Heartwood red-brown to dark brown turning very dark brown with age, not sharply demarcated from the pale brown or pale yellow sapwood; grain wavy, alternating or interlocked; texture fine to very fine and even; wood lustrous. Growth rings not distinct; vessels very small to moderately small, almost exclusively solitary, somewhat unevenly distributed, often plugged with tyloses or filled with a dark gum and yellowish-white or pink deposits; parenchyma sparse, paratracheal vasicentric and apotracheal diffuse, fairly inconspicuous; rays fine, only visible with a hand lens, paler than surrounding tissue.
Shrinkage is high and the wood requires careful



Xanthostemon brassii
transverse surface (×20)

seasoning to prevent warping and twisting. The logs are subject to severe end-checking and need protection. The wood is siliceous and very hard, extremely strong and extremely tough. It is very difficult to work, mortise and saw due its hardness, abrasiveness and the interlocked or spiral grain; a low cutting angle improves the finish. The 'glassy' surface after planing is a special feature. The wood has very good wearing and weathering properties. It is extremely durable, even under the most severe conditions, *X. verdugonianus* is considered the most durable wood in the Philippines. The heartwood is extremely resistant to preservative treatment and the sapwood is resistant. The wood is almost immune to termite and marine borer attack. The sapwood is non-susceptible to *Lyctus*.

See also the table on microscopic wood anatomy.

Botany Shrubs to medium-sized trees up to 30(–40) m tall; bole usually straight, branchless for up to 12 m, up to 50(–150) cm in diameter; bark surface smooth, greyish; branches often low on the bole. Leaves alternate or opposite, simple, entire, exstipulate. Inflorescence an axillary, simple or compound pleiochasium or reduced to a few or a single flower. Flowers with a shallow to deep hypanthium, (3–)4(–5)-merous; sepals and petals free, dotted; stamens numerous, free, not grouped, long and with a gland at the apex; ovary superior or half-inferior, 3–5-locular with many ovules, placentas axile and horizontal or inserted obliquely in basal angles of locules, style 1, long. Fruit a woody, many-seeded capsule opening by valves. Seeds in a ring or arc in each locule, more or less semi-circular, laterally flattened, few fertile.

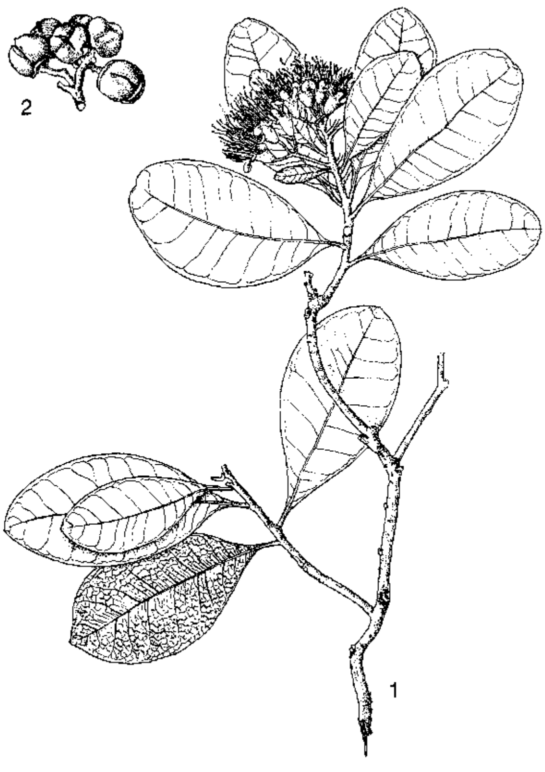
The trees may be briefly deciduous. *X. verus* was reported to flower in the Bogor Botanical Gardens (Java) almost throughout the year. *X. verdugonianus* flowers in the Philippines from July to October. The fruits ripen in 2–3 months. Trees may produce ripe seeds when 2 m tall.

The name *Xanthostemon* is conserved against *Nani* (which was published by Adanson in 1763). *Nani* was formerly considered to be a synonym of the large genus *Metrosideros* (it was often treated as a section of that genus), but recently proved to be identical with *Xanthostemon*.

Ecology *Xanthostemon* occurs in lowland rain forest, but often also in savanna forest. *X. verdugonianus* occurs on sandy and rocky soils, often on steep slopes along the coast, and is usually associated with *Shorea*, *Tristania* and other *Xanthostemon* species.

Silviculture *Xanthostemon* can be propagated by seeds or by wildlings. A seed count from South Sulawesi estimated that there are about 960 000 dry seeds/kg. Germination of *X. verdugonianus* is 30–50% in 7–40 days, the highest germination rate being obtained on a humus medium, but germination on sand is only about 13%. Seedlings attain an average height of 7 cm after 6 months. Wildlings of *X. verdugonianus* collected in October–November showed only 5% mortality 1 week after transfer to the nursery. Height increment, however, is also very small. In Java a plantation trial of a *Xanthostemon* sp. from South Sulawesi was not very successful: seedling mortality was high and 10.5 years after planting the average height of the surviving trees was 6 m and the diameter was 7 cm. Regeneration is sparse or absent in closed forest, but can be abundant in open sites (e.g. on landslides or along trails). Growth of *Xanthostemon* may also be vigorous in open areas on steep sandy slopes and its natural occurrence on rocks prove that it is tolerates low fertility.

Genetic resources and breeding In the Philippines *X. verdugonianus* is considered to be endangered because it has been subjected to exces-



Xanthostemon verdugonianus Naves ex Fernandez-Villar – 1, flowering twig; 2, infructescence.

sive logging due to the high price of its timber. Moreover, it shows poor regeneration and has a limited distribution. The same probably applies to other species such as *X. brassii* and *X. verus*. Protective measures are needed to ensure their survival.

Prospects The future of *Xanthostemon* timber is uncertain. Because of the heavily depleted stands and/or the rarity of some species the availability may even diminish further unless protective measures are implemented.

Literature 39, 231, 300, 304, 348, 405, 427, 436, 536, 632, 786, 861, 934, 1080, 1114, 1228, 1229, 1232, 1257, 1258.

Selection of species

Xanthostemon bracteatus Merr.

Vernacular names Philippines: mapilig (Bikol).

Distribution The Philippines (Luzon, Samar).

Xanthostemon brassii Merr.

Synonyms *Xanthostemon paradoxus* auct. non F. v. Mueller.

Vernacular names Papua New Guinea: kasi kasi (general).

Distribution Papua New Guinea.

Xanthostemon philippinensis Merr.

Vernacular names Philippines: bagoadlau (Samar-Leyte Bisaya).

Distribution The Philippines (Luzon, Samar).

Xanthostemon verdugonianus Naves ex Fernandez-Villar

Vernacular names Philippine ironwood (En). Philippines: mangkono (Cebu Bisaya, Manobo).

Distribution The Philippines (Sibuyan, Panay, Leyte, Dinagat, Tinago and Mindanao).

Xanthostemon verus (Lindl.) Peter G. Wilson

Synonyms *Metrosideros vera* Lindl.

Vernacular names Ironwood (En). Indonesia: makalimbong (Minahassa, North Sulawesi), nani (Moluccas).

Distribution Sulawesi and the Moluccas.

W.G. Keating (general part),
E. Boer (general part),
M.S.M. Sosef (general part, selection of species)

Xerospermum Blume

Rumphia 3: 99 (1847).
SAPINDACEAE
$x = 16$; *X. noronhianum*: $n = 16$

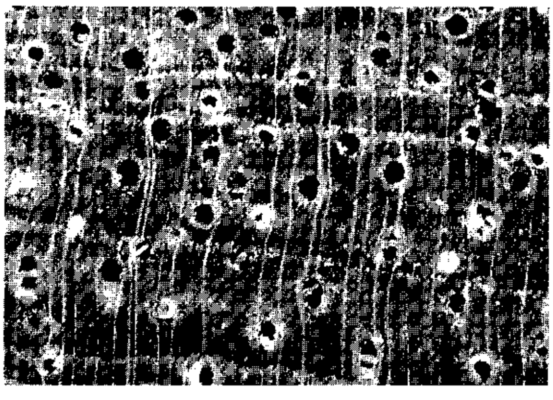
Vernacular names Malaysia: kikik buntal, rambutan pachat (Peninsular).

Origin and geographic distribution *Xerospermum* comprises only 2 species occurring from Bangladesh and India (Assam) to Burma (Myanmar), Indo-China, Thailand, Peninsular Malaysia, Sumatra, Java and Borneo.

Uses The wood of *Xerospermum* has been used for construction, carts, mills, ploughs and rice pounders, and occasionally as a firewood.
The thin sarcotesta is edible and sweet and in Peninsular Malaysia trees are occasionally planted for their fruits. The pulped seeds and leaves are used medicinally to alleviate stomachache.

Production and international trade *Xerospermum* wood is probably used on a local scale only. Fruits are rarely sold on local markets.

Properties *Xerospermum* yields a medium-weight to heavy hardwood with a density of 770–1035 kg/m³ at 15% moisture content. Heartwood pale brown, not differentiated from the sapwood; grain straight; texture fine and even; pale red-brown lines visible on longitudinal surfaces (growth rings). Growth rings distinct, boundaries delimited by a layer of marginal parenchyma; vessels medium-sized, solitary and in radial multiples of 2–4, occasionally in clusters, open or filled with dark-coloured deposits; parenchyma moderately abundant, apotracheal in marginal or seemingly marginal bands, paratracheal vasicentric, occasionally confluent, visible to the naked eye; rays



Xerospermum noronhianum
transverse surface (×20)

extremely fine or very fine, visible with a hand lens; ripple marks absent.

The wood is very durable under cover.

See also the table on microscopic wood anatomy.

Botany Androdioecious, small to medium-sized trees up to 36 m tall, rarely shrubs; bole straight to somewhat twisted, up to 100 cm in diameter, sometimes with small buttresses or stilt roots; bark surface smooth to cracked, lenticellate, dark grey, inner bark pale brownish. Leaves arranged spirally, paripinnate, 1–2(–3)-jugate or rarely 1-foliolate; leaflets opposite, entire, often with orbicular glands below. Inflorescence thyrsoid, solitary in the lower leaf axils and tufted in the upper ones. Flowers bisexual and male, 4–5-merous; sepals free to slightly connate; petals without a scale; stamens (7–)8(–9); disk entire or interrupted; ovary superior, 2(–3)-locular with 1 ovule in each cell, style columnar. Fruit with 1(–2) lobe(s) developed, berry-like but finally dehiscent, spiny to granular. Seed almost completely covered by a thin sarcotesta. Seedling with hypogeal to semi-hypogeal germination; cotyledons not emergent or emerging late; hypocotyl not elongated; epicotyl sometimes with a few scales; first 2 leaves opposite or alternate, pinnate, subsequent ones arranged spirally.

Trees of *X. noronhianum* flower annually, starting between July and November and ending in December to March. The species is slightly self-compatible. Anthers of bisexual flowers are indehiscent at first but release fertile pollen later. Flowers are pollinated by various insect groups like *Coleoptera*, *Diptera*, *Hemiptera*, *Hymenoptera*, *Lepidoptera*, *Orthoptera* and *Thysanoptera* but meliponid bees are most commonly encountered. Fruits are eaten and dispersed by bats and mammals. Observations on fallen fruits of *Xerospermum* showed that those opened by monkeys germinated whereas untouched fruits failed to do so.

X. laevigatum is subdivided into 2 subspecies, subsp. *acuminatum* (Radlk.) Leenh. being confined to peat-swamp forest and kerangas in Borneo. *X. noronhianum* is highly variable, e.g. the fruits being rough with tiny tubercles to prickly with large conical protuberances.

Ecology *Xerospermum* species are fairly common understorey or canopy trees in primary and secondary rain forest, up to 700(–1500) m altitude. They are found in a wide range of habitats such as mixed dipterocarp forest, peat-swamp forest and kerangas to bamboo forest, from well-drained to periodically flooded areas, and on sandy clay, sand, peat, volcanic loam and limestone soils.

Silviculture *Xerospermum* can be propagated by seed. Seeds of *X. noronhianum* have 70–100% germination in 6–32(–84) days whereas its fruits show about 80% germination in 24–53 days. In a 50-ha plot at Pasoh Forest Reserve, Peninsular Malaysia, *X. noronhianum* was the most abundant species with 2.5% (i.e. 9000 trees) of the total number of trees and 2.3% (i.e. 563 trees) of the trees with a diameter of over 10 cm.

Genetic resources and breeding There are no records of ex situ conservation of *Xerospermum*. It is not endangered as it is relatively common, produces edible fruits (which prevents them from being cut for timber by the local population) and has a wide distribution.

Prospects It is unlikely that the use of *Xerospermum* wood will increase in the near future. However, it has potential to become more important for fruit production.

Literature 55, 163, 209, 267, 341, 436, 553, 583, 595, 688, 827, 829, 831, 861, 1038, 1048, 1123, 1164, 1169, 1221, 1242.

Selection of species

Xerospermum laevigatum Radlk.

Synonyms *Xerospermum acuminatum* Radlk., *Xerospermum unijugum* Radlk.

Vernacular names Malaysia: gong, rambutan pachat (Peninsular).

Distribution Burma (Myanmar, Mergui Archipelago), Peninsular Malaysia, Sumatra and Borneo.

Xerospermum noronhianum (Blume) Blume

Synonyms *Xerospermum intermedium* Radlk., *Xerospermum muricatum* Radlk., *Xerospermum wallichii* King.

Vernacular names Indonesia: burundul, corogol monyet (Sundanese). Malaysia: geresek hitam, gigi buntal, rambutan pachet (Peninsular). Burma (Myanmar): taung-kyetmauk. Laos: kho lên, ngèo. Thailand: kho laen (eastern), kho hia (south-eastern), laen ban (peninsular).

Distribution From Bangladesh, India (Assam) and Burma (Myanmar) to Indo-China, Thailand, Peninsular Malaysia, Sumatra, Java and Borneo.

E. Boer (general part),
M.S.M. Sosef (general part, selection of species)

Xylia Benth.

Journ. Bot. (Hooker) 4: 417 (1842).
LEGUMINOSAE
$x = 12$; *X. xylocarpa*: $n = 12$

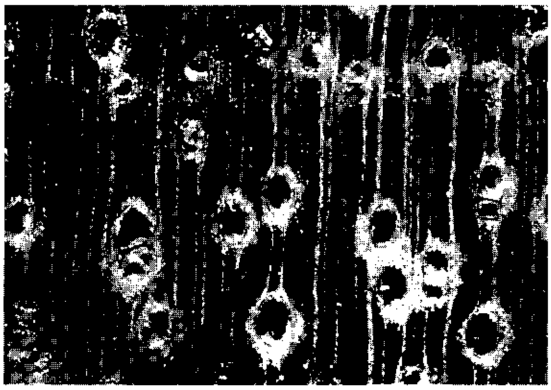
Vernacular names Burma (Myanmar): pyinkado. Cambodia: sô-kra:ch, sô-krâm krâhâ:m, sôkrâm sâ:r. Laos: dêng. Thailand: daeng (general). Vietnam: c[aw]m xe.

Origin and geographic distribution *Xylia* comprises about 12 species, most of which occur in tropical Africa and Madagascar. Only one species occurs in South-East Asia: *X. xylocarpa* (Roxb.) Taubert (synonym: *X. dolabriformis* Benth.); it is not found in the wild in Malesia, but occurs in India, Burma (Myanmar), Indo-China and Thailand. It is also planted within its natural area of distribution, rarely outside this region, occasionally so in Singapore and Peninsular Malaysia.

Uses The hard and durable wood of *X. xylocarpa* is used for heavy construction, e.g. for posts and flooring, bridges, marine piling, railway sleepers, boat construction, freshwater locks, paving blocks, rubbing fenders, chutes and for furniture, turnery and household implements.
The bark and fruits are used in local medicine; in Indo-China in a decoction against haemoptysis.

Production and international trade Large supplies of timber of *X. xylocarpa* are available, particularly in Burma (Myanmar). At the beginning of the 1980s the annual production of logs in Burma (Myanmar) was about 20 000 t.

Properties *X. xylocarpa* yields a heavy hardwood with a density of 880–1170(–1330) kg/m^3 at 15% moisture content. Heartwood reddish-brown to dark brown, distinct from the up to 2.5 cm wide paler sapwood; grain interlocked or wavy; texture moderately fine to medium and even; surface somewhat gummy causing a speckled appearance. Growth rings distinct to indistinct, when distinct indicated by narrow parenchyma bands; vessels moderately small to moderately large, solitary and in radial multiples of 2–4, occasionally in oblique arrangement, frequent orange-brown gum deposits and chalky white deposits; parenchyma moderately abundant to abundant, paratracheal vasicentric, aliform and confluent, with occasional apotracheal parenchyma in very narrow marginal or seemingly marginal bands; rays very fine, visible with a hand lens; ripple marks absent.
Shrinkage is low, but the wood requires careful and slow seasoning to prevent checking and splitting; in kiln drying it needs a mild and slow drying schedule. The wood is very hard and very strong. It is difficult to work and plane and has a serious blunting effect on tools, but a good finish can be obtained. Green stock, however, is easier to saw. The wood is very durable: untreated sleepers lasted for 12 years in Thailand and for 20–24 years in India. The heartwood is very resistant to preservative treatment, the sapwood is readily treatable. The wood is susceptible to longhorn and buprestid beetle attack, the sapwood to *Lyctus*, but the wood is resistant to termites and marine borers.
See also the tables on microscopic wood anatomy and wood properties.



Xylia xylocarpa
transverse surface (×20)

Botany A deciduous, medium-sized tree up to 25(–40) m tall; bole straight and cylindrical, sometimes fluted, branchless for up to 12(–25) m and up to 75(–120) cm in diameter, buttresses small or absent; bark surface flaky, with small lenticels, greyish to reddish or yellow-brown, inner bark pinkish; crown dense. Leaves arranged spirally, bipinnate with 1 pair of pinnae, rachis and pinnae glandular; leaflets opposite, 3–6 pairs per pinna, entire; stipules filiform. Flowers in stalked globose heads, male or bisexual, 5-merous; calyx funnel-shaped, hairy, with valvate lobes; petals free, hairy; stamens 10, free; ovary superior, sessile, hairy, 2-locular, style 1. Fruit a boomerang-shaped, flat, woody pod, dehiscing from the apex in 2 recurving valves, 7–10-seeded. Seed ellipsoid, flat, testa hard and brown, with pleurogram. Seedling with epigeal germination; cotyledons emergent; hypocotyl elongated; first pair of leaves opposite, with 1(–2) pairs of leaflets, sometimes 3-foliolate, subsequent leaves arranged spirally.
The growth rate of young trees is reportedly fairly high: in India trees were on average 5.7 m tall and

8 cm in diameter after 5 years, in Bangladesh 16 m tall and 19 cm in diameter after 10 years. In Malaysia a 23-year-old tree grown in the arboretum of the Forest Research Institute Malaysia, Kepong measured 22 m tall and 30 cm in diameter. Flowering is in March–June, fruiting in November–December.

Xylia belongs to the tribe *Mimoseae* of the subfamily *Mimosoideae*, and seems most closely related to the West African genus *Calpocalyx*. Within *X. xylocarpa* two varieties are distinguished: var. *xylocarpa* from India and Burma (Myanmar) with subglabrous leaflets and glandular anthers, and var. *kerrii* (Craib & Hutch.) I.C. Nielsen (synonym: *X. kerrii* Craib & Hutch.) from Burma (Myanmar), Indo-China and Thailand with hairy leaflets and eglandular anthers.

Ecology *X. xylocarpa* occurs in dry evergreen forest, mixed deciduous forest and dry deciduous dipterocarp forest, on well-drained, sandy and rocky soils, up to 850 m altitude.

Silviculture *X. xylocarpa* can be raised from seed, which can be stored for 1 year if kept dry. Seed viability is high and germination occurs readily when sown under shade and with adequate watering. Direct seeding is recommended, as seedlings do not stand the shock of planting well, probably because the taproot develops rapidly and attains 30 cm in 1–2 months. Stumps of 8–10 months, however, can also be successfully used, but are more costly. In India direct seeding is done at a spacing of 2 m × 3 m and plantations require weeding for 2 years. In Vietnam and Laos direct seeding in enrichment plantings failed. Natural regeneration is enhanced by slightly opening the canopy around seed-bearing individuals and burning the debris; seedling establishment is favoured on loose, bare, well-drained soils under shade. The young seedlings must be protected from fire. A gradual opening of the canopy is necessary for further development of the established seedlings; weeds only become a problem when the canopy is opened too fast. *X. xylocarpa* coppices and pollards well and can produce abundant root suckers. Well-established trees resprout from burnt stumps. Trees of 26 years produced about 10 t/ha of litter annually. In Bangladesh a 10–15-year rotation for the production of power transmission poles has been suggested. *X. xylocarpa* is fire-resistant.

Genetic resources and breeding In many regions within its natural area of distribution *X. xylocarpa* is common, and large supplies of timber are available. However, many stands are already much depleted provoking genetic erosion.

In Cambodia two forms are distinguished which differ in wood colour: one is red-brown, the other pale red-brown.

Prospects The wood of *X. xylocarpa* is of excellent quality. The tree has a high potential to be grown in plantations as it grows fairly fast. However, techniques of establishment and the management of the light regime during the first years need to be further investigated. *X. xylocarpa* has been proposed in taungya systems to be interplanted with teak (*Tectona grandis* L. f.) as it has good soil-improving properties.

Literature 163, 174, 193, 218, 306, 341, 343, 364, 464, 536, 571, 697, 832, 874, 924, 933, 1039, 1052, 1098, 1104, 1177.

Nguyen Ba

Xylocarpus J. König

Naturforscher (Halle) 20: 2 (1784).

MELIACEAE

$x = 26$; *X. granatum*, *X. moluccensis*: $2n = 52$

Vernacular names Nyireh (trade name). Mangrove cedar, pussur wood (En). Philippines: tabigi (general). Thailand: kra buun, ta buun.

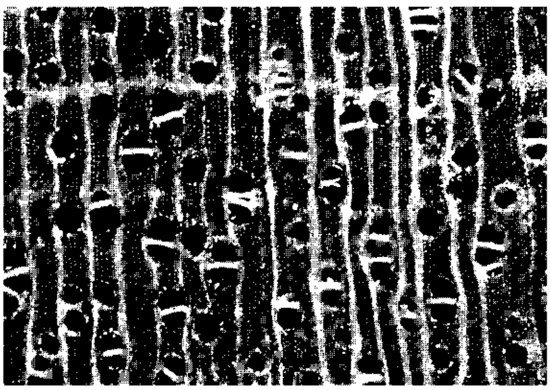
Origin and geographic distribution *Xylocarpus* comprises 3 species and is found along the coasts of East Africa and Madagascar towards India, Burma (Myanmar), Indo-China, China, the Ryukyu Islands, Thailand, the Malesian region, tropical Australia and the Pacific, east to Tonga and Fiji. All three species are widespread and occur throughout Malesia.

Uses The wood is used mainly for high-quality furniture and cabinet work, carving and the manufacture of fancy articles. Other reported uses are for light construction, bridge building, interior finish and panelling, flooring, doors, posts, joists, beams, rafters, mouldings, ship and boat building, fence posts, salt-water piling, gun stocks, billiard tables and billiard cue butts, tool handles, tobacco pipes, wooden pins and sliced decorative veneer. In India the wood is regarded suitable for second grade pencils. The wood is sometimes used as firewood and for charcoal production, but these applications are not recommended.

The oil extracted from seeds of *X. granatum* has been used as an illuminant and as hair oil. Burned seeds of the same species have been used mixed with sulphur and coconut oil against itchy skin. An oil extracted from *X. moluccensis* seeds is used in the Philippines to treat insect bites. A decoction of the bark is used in the treatment of cholera and is also applied to cure dysentery, diarrhoea and other abdominal troubles, and as a febrifuge. Formerly, the bark was used to make a fairly bitter 'palm wine'. The bark yields a tannin which has been used quite extensively in Java to tan fishing lines and nets and has been applied to tan heavy hides and to dye cloth umber.

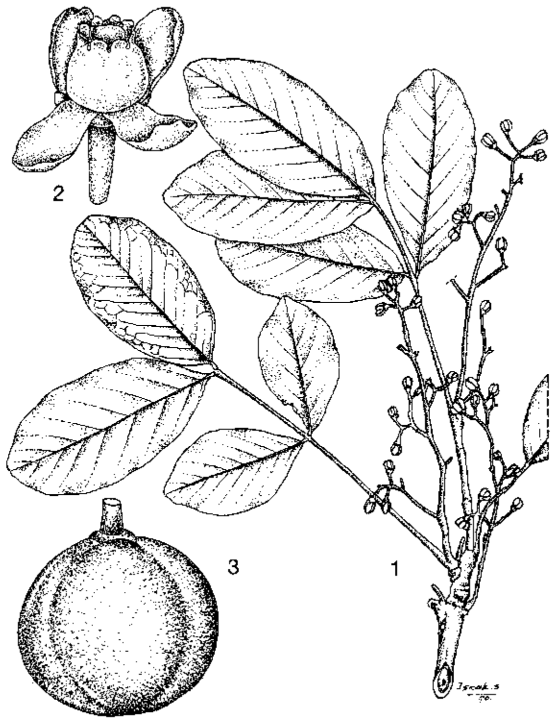
Production and international trade *Xylocarpus* wood is generally used on a local scale. Very small amounts of 'mangrove cedar' are imported by Japan. In 1996 Papua New Guinea exported only 55 m^3 of mangrove cedar logs at an average free-on-board (FOB) price of US$ 107/m^3.

Properties *Xylocarpus* yields a medium-weight hardwood with a density of 615–880 kg/m^3 at 15% moisture content. Heartwood reddish, darkening to a deep warm brown on exposure, usually sharply demarcated from the narrow, buff-coloured, pale pink or silver-grey sapwood; grain straight or alternating to slightly interlocked; texture fine and even; wood with darker streaks producing attractive watered-silk figure on tangential surfaces; *X. moluccensis* sometimes with a faint cedar-like odour. Growth rings visible or hardly visible, marked by narrow marginal parenchyma; vessels very small to medium-sized, mostly in radial pairs, occasionally solitary or in radial multiples of up to 4 (*X. granatum*) or more than 4 (*X. moluccensis*), open or filled with dark-coloured, gum-like deposits; parenchyma sparse to abundant, apotracheal in narrow to moderately broad closely-spaced bands and paratracheal vasicentric; rays moderately fine to medium-sized; fine ripple marks present but not always distinct.
Shrinkage is very low to low, the wood seasons well, but is liable to splitting, end-checking and insect attack. Boards of *X. moluccensis* take about 3 months to air dry when 13 mm thick and about 5 months when 38 mm thick; the wood kiln dries satisfactorily. The wood is moderately hard, moderately strong and tough. It is easy to work and turn, occasionally it is reported as difficult to saw due to interlocked grain, it finishes well and takes a high polish. The pulping and paper making properties of *X. granatum* are rated as poor. The wood is moderately durable when exposed to the weather or in contact with the ground, and is resistant to pressure preservative treatment. It is resistant to teredo attack in some situations and to dry-wood termites in protected situations. The sapwood is non-susceptible to *Lyctus*.
The bark of mature trees contains 20–34% tannin on dry matter base. Seeds contain 1–2% oil. The charcoal has a somewhat low density and high burning rate making *Xylocarpus* an unfavourable source. Firewood burns quickly and produces great heat, which is why other sources are preferred.
See also the tables on microscopic wood anatomy and wood properties.



Xylocarpus granatum
transverse surface (×20)

Botany Evergreen or sometimes deciduous, monoecious or rarely dioecious, small to medium-sized trees up to 20(–30) m tall; bole crooked (*X. granatum*) to straight and cylindrical (*X. moluccensis*), branchless for up to 10 m, up to 90(–100) cm in diameter, usually with small buttresses and snail roots, those of *X. moluccensis* bearing many short pneumatophores; bark surface smooth, irregularly flaking, whitish to yellow-brown (*X. granatum*) or rough, longitudinally fissured, flaking into oblong pieces, dark brown (*X. moluccensis*), inner bark green, red or pink; crown narrow and compact to bushy. Leaves arranged spirally, paripinnate with (1–)2–4(–5) pairs of leaflets, exstipulate; leaflets entire. Flowers in an axillary thyrse, 4-merous; calyx lobed; petals free, pinkish-yellow; staminal tube urceolate to cupular bearing 8 anthers; disk cushion-shaped, red; ovary superior, 4(–5)-locular with 3–4(–6) ovules in each cell, style short with a discoid stigma. Fruit a large, tardily dehiscing, subglobose capsule. Seeds 5–20, irregularly tetrahedral or pyramidal, attached to a central columella, with a corky testa. Seedling with hypogeal germination; cotyledons not emergent; hypocotyl not elongated; epicotyl bearing scales followed by simple leaves.
Growth is according to Rauh's architectural model, characterized by a monopodial trunk which grows rhythmically and so develops tiers of branches. Each new flush is marked by a few



Xylocarpus granatum J. König – 1, flowering twig; 2, female flower; 3, fruit.

scales followed by pinnate leaves. In India early growth is rapid, over 60 cm in height in 2 months, and an annual diameter increment of 0.8 cm has been recorded. In Thailand a mean annual diameter increment of 1.3 cm was recorded for trees of approximately 10 cm in diameter. On the other hand, in Bangladesh the annual diameter increment of *X. moluccensis* was very small being 0.2 cm over a 13-year period. Growth characteristics vary greatly between different provenances. Flowering is usually in March–April; fruiting in June–July. Flowers are pollinated by bees. Usually only one fruit is present per inflorescence. The seeds float just below the water surface and are dispersed by ocean currents.

In the past there was much confusion about which name should be applied to which species. There has been complete confusion in the literature making it sometimes impossible to attribute certain data to a given species. The two most common species (*X. granatum* and *X. moluccensis*) are easily recognized by their bark features but are difficult to distinguish in the herbarium. *X. rumphii* can be recognized by its ovate to cordate leaflets.

Ecology *Xylocarpus* species are locally common in mangrove swamps, beaches and coastal woodlands on rock, sand and other substrates, generally on locations only flooded at exceptionally high tides. They occur in areas with seasonal climates as well as in those with non-seasonal climates. *X. moluccensis* is found in the *Bruguiera gymnorhiza* (L.) Savigny type of mangrove forest. *X. granatum* is often associated with *Nypa* and *Sonneratia* species and may be locally gregarious. *X. granatum* tolerates a salinity of 0.1–3%. *Xylocarpus* is a moderate light demander, enduring more shade when young than it does later on. A decrease in freshwater supply during the dry season can result in high mortality.

Silviculture *Xylocarpus* may be propagated by seed. Seeds of *X. granatum* have about 70% germination in 1–2.5 months. Seed viability decreases rapidly upon storage. Seed should to be sown with the convex side upwards. Seedlings can attain 50 cm height in 3 months. Direct sowing has been successfully applied in a trial plantation of *X. granatum* at 1 m × 1 m. In Aceh (Sumatra) natural regeneration in mangrove forest is good, but *X. granatum* is cut to allow the more valued *Rhizophora* spp. to become dominant. It is also reported that roots of *X. granatum* tend to promote silting up and thus raise the soil level. This, plus the dense crown of *X. granatum*, hampers the adequate regeneration of *Rhizophora*. In Peninsular Malaysia *Rhizophora* and *Bruguiera* species are considered more valuable in the mangrove forest and *Xylocarpus* is considered of no economic importance. Large trees are often hollow and it is difficult to obtain large sizes for conversion to timber. Moreover, *X. granatum* trees are often crooked and gnarled, which further limits their use for sawn timber. *X. moluccensis* is generally straight-stemmed and reproduces by coppice. Like other *Meliaceae* of the subfamily *Swietenioideae*, *Xylocarpus* is also attacked by *Hypsipyla* shoot borers. To obtain tannin, the bark is peeled off but the trees recover easily.

Genetic resources and breeding All three *Xylocarpus* species are comparatively common and widespread and do not seem endangered, except that mangroves are being cleared locally for other uses.

Prospects Given the desirability of wood of *X. moluccensis* for high quality furniture and cabinet work, it is worth considering the cultivation of favourable provenances in dry mangrove areas. However, much more needs to be known about its growth and silvicultural aspects. *Xylocarpus* may also be used increasingly for reforestation and afforestation of coastal wetland.

Literature 40, 70, 124, 151, 162, 163, 267, 300, 341, 348, 371, 387, 390, 436, 464, 526, 536, 568, 632, 663, 696, 732, 780, 829, 831, 845, 846, 878, 880, 933, 934, 951, 993, 1008, 1038, 1052, 1056, 1066, 1071, 1098, 1101, 1104, 1168, 1189, 1221, 1239, 1242.

Selection of species

Xylocarpus granatum J. König

Synonyms *Carapa granatum* (J. König) Alston, *Carapa obovata* Blume, *Xylocarpus obovata* (Blume) A. Juss.

Vernacular names Cannonball mangrove. Indonesia: nyireh bunga (general), giliki gota (Moluccas), niri (Sundanese). Malaysia: nyireh bunga (general), nyireh ayer (Sarawak), nyireh hudang (Peninsular). Philippines: tabigi (general), kalumbabau (Zambales), kolimbauing (Iloko). Singapore: nyireh bunga. Burma (Myanmar): pinle-on. Cambodia: châm'-puu praèk, t'bôôn. Thailand: kra buun khao, ta buun, ta buun khao (central, peninsular). Vietnam: xu'o'ng cá, dang dinh.

Distribution From East Africa and Madagascar towards India, Indo-China, the Ryukyu Islands, the Malesian area, northern Australia and the Pacific, east to Fiji and Tonga.

Xylocarpus moluccensis (Lamk) M. Roem.

Synonyms *Carapa moluccensis* Lamk, *Xylocarpus australasicus* Ridley, *Xylocarpus gangeticus* (Prain) C.E. Parkinson, *Xylocarpus mekongensis* Pierre.

Vernacular names Cedar mangrove (En). Indonesia: niri batu, nyireh batu (general), nyirih gundik (Javanese). Malaysia: nyireh batu (general), delima wanita (Peninsular). Philippines: piagau (general), sangkuyong (Cotabato), tambutambu (Zamboanga). Singapore: nyireh batu. Burma (Myanmar): kyana, kyatnan, pinle-on. Thailand: ta ban (central, peninsular), ta buun dam (general). Vietnam: xu'o'ng cá.

Distribution From India, Burma (Myanmar), Indo-China and Thailand to the Malesian region and tropical Australia.

Xylocarpus rumphii (Kostel.) Mabb.

Synonyms *Aglaia zollingeri* C. DC., *Amoora zollingeri* (C. DC.) Koord., *Carapa rumphii* Kostel.

Vernacular names Indonesia: niri, nyireh (general). Malaysia: nyireh (general). Philippines: malapiagau (general).

Distribution From East Africa and Madagascar to India, Indo-China, the Malesian region except for Borneo, tropical Australia, and the Pacific, east to Fiji and Tonga.

S. Sukardjo

Xylopia L.

Syst. Nat., ed. 10, 2: 1250 (1759).

ANNONACEAE

x = unknown; $2n$ = unknown

Vernacular names Mempisang (trade name). Brunei: bangkoh (Malay). Indonesia: jangkang (general). Malaysia: jangkang, pisang-pisang (Peninsular), kelili (Sarawak). Vietnam: d[eef]n.

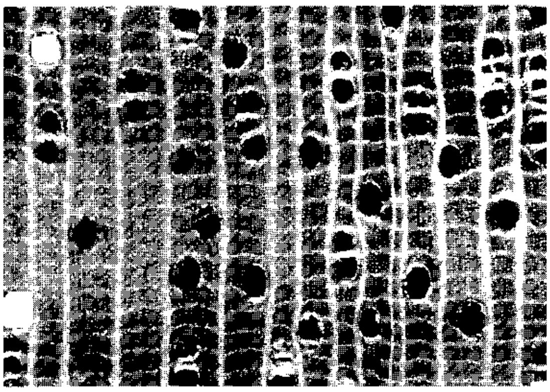
Origin and geographic distribution *Xylopia* comprises some 100 to 150 species and occurs throughout the tropics. In Asia it is found in Sri Lanka, southern India, Indo-China, Thailand, throughout the Malesian region except for Java, and in New Caledonia and Fiji. The largest number of species is found in Africa; some 30 species occur in Malesia.

Uses The wood of *Xylopia* is used for light construction, interior joinery, light-duty parquet and strip flooring, packing boxes, crates, tool handles, low grade furniture, sliced veneer, matchboxes and match splints.

A decoction of the bark of *X. ferruginea* is reputed to stop vomiting. In Peninsular Malaysia the boiled roots of *X. malayana* have been given to women after childbirth.

Production and international trade 'Mempisang' is a general trade name comprising most of the genera of *Annonaceae*, and *Xylopia* probably comprises a fair proportion of the wood traded under this name. In 1992 the export of mempisang wood from Sabah amounted to 25 000 m^3 of sawn timber and 42 500 m^3 of logs with a total value of about US$ 7.2 million. Small amounts of mempisang are imported by Japan, mainly from Sabah and Sarawak. In Mindanao, the Philippines, *X. ferruginea* is planted on a small scale for matchstick production.

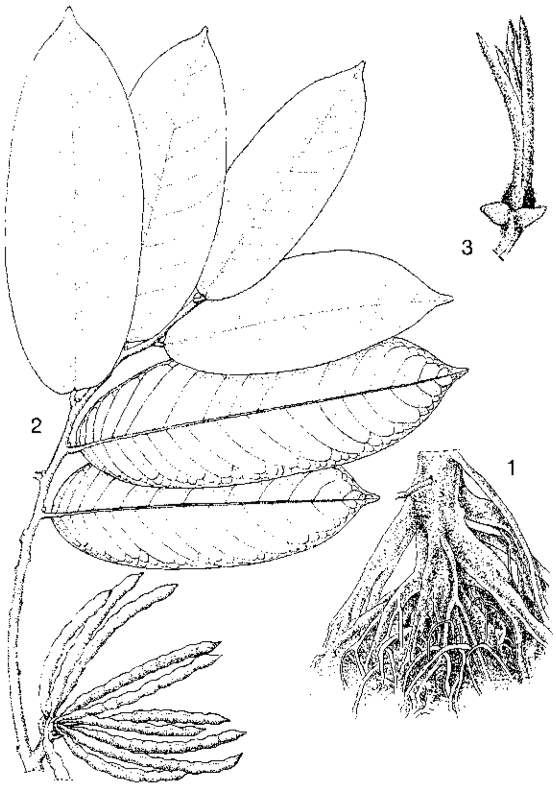
Properties *Xylopia* yields a lightweight to heavy hardwood with a density varying from 295 to 975 kg/m^3; *X. caudata* and *X. magna* yield heavy wood, *X. ferruginea* and *X. fusca* yield lightweight wood, whereas *X. malayana* yields lightweight to heavy wood (density 410–870 kg/m^3).



Xylopia dehiscens
transverse surface (×20)

Heartwood pale yellow-brown, dark yellow-brown in *X. caudata*, sometimes with a green tinge, not clearly differentiated from the sapwood; grain straight; texture rather coarse and even to uneven; wood sometimes with silver grain. Growth rings occasionally distinct; vessels medium-sized in species with heavy wood, medium-sized to moderately large in others, solitary and in radial multiples of 2–4(–6) and occasional clusters, sometimes white, yellow or reddish deposits present; parenchyma abundant, apotracheal in regular, narrow bands (scalariform); rays moderately fine to medium-sized, sometimes moderately broad in *X. fusca*; ripple marks absent.
Shrinkage upon air drying is moderate; board of *X. fusca* 13 mm and 38 mm thick take respectively 3 and 5 months to air dry. There is moderate risk of cupping, bowing and stain during drying. Sawing of green logs of *X. fusca* is very easy, yielding a smooth surface; turning of *X. caudata* wood produces a rather rough and fibrous surface. The lightweight wood of *X. fusca* is non-durable. *Xylopia* wood is easy to treat with preservatives.
See also the tables on microscopic wood anatomy and wood properties.

Botany Evergreen, small to fairly large trees up to 40 m tall; bole straight, up to 70 cm in diameter, often with small buttresses or stilt roots; bark surface smooth to cracking or scaly, sometimes lenticellate, greyish-white to brown or orange-brown or red, inner bark fibrous, mottled, pinkish-brown, dull yellow or with brown and white patches. Leaves alternate, simple, entire, exstipulate. Flowers axillary, solitary, cymose or fascicled, often fragrant, bisexual; sepals 3, valvate, connate; petals 6, in 2 rows, valvate, narrow, subequal or the outer ones longer, white to greenish, yellow or reddish; stamens few to many, with an enlarged, obtuse to pointed connective; carpels 2–many, free, each with 1–8 ovules in 1 or 2 rows, style usually long, stigma club-shaped to linear. Fruit apocarpous, with 1–30(–40) monocarps, each monocarp sessile or stipitate, not dehiscing or dehiscent along the dorsal suture, globose to narrowly oblong, 1–16-seeded, sometimes constricted between the seeds, with a woody wall. Seed ellipsoid to broadly ellipsoid; testa crustaceous; endosperm hard. Seedling with epigeal germination; cotyledons not emergent; hypocotyl elongated; leaves arranged spirally on the orthotropic leader, distichous on the branches.
Early growth of planted *X. ferruginea* is fairly rapid, with a mean annual increment of about 1 m in height and about 3 cm in diameter during the first 3–5 years. The tree form of *Xylopia* is according to Roux's architectural tree model, characterized by a continuously growing monopodial orthotropic trunk with plagiotropic branches and distichous leaf arrangement, flowering does not



Xylopia fusca Maingay ex Hook. f. & Thomson – 1, stilt roots. – X. ferruginea (Hook. f. & Thomson) Hook. f. & Thomson – 2, fruiting twig; 3, flower.

influence the architecture. Flowers of *X. ferruginea* open at dusk and last for several nights; in Mindanao, the Philippines, it flowers from August to September and fruits from November to December. *X. papuana* has been observed flowering and fruiting in May–July and October. In Peninsular Malaysia *X. stenopetala* flowers regularly after the early year dry season, whereas *X. malayana* fruits in October and November. Fruits are eaten and dispersed by birds, mainly pigeons, and by squirrels, macaques and orang-utans.
Many of the Malesian species of *Xylopia* are still poorly known and are in need of a taxonomic revision.

Ecology *Xylopia* is found scattered in primary and secondary, lowland and hill rain forest. *X. fusca* is characteristic of swamp forest where it may be common but seldom abundant. In a peat-swamp forest in Thailand *X. fusca* and *X. malayana* were observed as the dominant trees. *X. ferruginea* is found gregarious in forests in Mindanao, the Philippines. *X. coriifolia* is found in swamp forest and kerangas.

Silviculture *Xylopia* can be propagated by seed. Germination experiments have been executed in Peninsular Malaysia. One seedlot of *X. caudata* showed about 65% germination in 40–75 days, but another achieved only about 10% germination, possibly because the seeds were not fully mature when collected. Seeds of *X. malayana* had about 85% germination in 33–45 days. In nursery experiments with watering twice a day *X. caudata* was very vulnerable, as the cotyledons and epicotyl became trapped in the testa causing the seedling to rot. In the Philippines fresh seeds of *X. ferruginea* germinated in 20–40 days. When seedlings are 2 weeks old (3 cm tall and with 2 leaves) they are pricked out and transferred to shaded polybags; shade is gradually removed over a period of 1.5 months. Two weeks later they can be planted at a spacing of 4 m × 8 m. Survival is 75–80% provided weeding is adequate.

Genetic resources and breeding Some *Xylopia* species have a narrow geographical distribution and are at risk of genetic erosion by destruction of their habitat.

Prospects As the growth of *Xylopia* is rapid, it is worthwhile to determine experimentally its potential for forest plantations.

Literature 151, 162, 163, 209, 267, 302, 304, 387, 402, 464, 526, 544, 547, 550, 553, 554, 632, 678, 694, 707, 740, 770, 785, 827, 829, 831, 844, 861, 958, 1017, 1038, 1040, 1098, 1126, 1134, 1218, 1221, 1242.

Selection of species

Xylopia caudata Hook. f. & Thomson

Synonyms *Xylopia tooropiana* R. Scheffer.

Vernacular names Malaysia: benitan, mempunai, pokok tapis (Peninsular)

Distribution Peninsular Malaysia, Singapore, Sumatra and Borneo.

Xylopia coriifolia Ridley

Vernacular names Malaysia: akau (Sarawak).

Distribution Borneo.

Xylopia dehiscens (Blanco) Merr.

Synonyms *Xylopia blancoi* S. Vidal.

Vernacular names Philippines: lanutan (general), banitan (Iloko), tangisang-bagio (Tagalog).

Distribution The Philippines.

Xylopia elliptica Maingay ex Hook. f. & Thomson

Vernacular names Malaysia: kayu lilin (Peninsular).

Distribution Peninsular Malaysia and Borneo (Kalimantan).

Xylopia ferruginea (Hook. f. & Thomson) Hook. f. & Thomson

Synonyms *Xylopia altissima* Boerl., *Xylopia oxyantha* Hook. f. & Thomson.

Vernacular names Stilted antoi (En). Indonesia: banitan merah (Kalimantan). Malaysia: antoi jangkang, jangkang bukit, pisang pisang jari (Peninsular). Philippines: banlag (general). Thailand: thurian nok, yang kang lian (peninsular).

Distribution Thailand, Peninsular Malaysia, Singapore, Sumatra, Borneo and the Philippines (Mindanao).

Xylopia fusca Maingay ex Hook. f. & Thomson

Synonyms *Xylopia havilandii* Ridley, *Xylopia obtusifolia* Hook. f. & Thomson.

Vernacular names Malaysia: ako (Sarawak), jangkang paya (Peninsular).

Distribution Peninsular Malaysia and Borneo (Sarawak).

Xylopia magna Maingay ex Hook. f. & Thomson

Distribution Peninsular Malaysia and Singapore.

Xylopia malayana Hook. f. & Thomson

Synonyms *Xylopia maingayi* Hook. f. & Thomson, *Xylopia mucronata* Boerl., *Xylopia pustulata* Hook. f. & Thomson.

Vernacular names Indonesia: jangkang (general). Malaysia: banik kijang, kayu belinchi, kayu tapis (Peninsular). Thailand: krai (south-eastern).

Distribution Thailand, Peninsular Malaysia, Singapore, Sumatra, Borneo, Sulawesi, the Lesser Sunda Islands and the Moluccas.

Xylopia papuana Diels

Distribution Papua New Guinea.

Xylopia stenopetala Oliv.

Vernacular names Malaysia: jangkang bukit (Peninsular).

Distribution Peninsular Malaysia, Sumatra and Borneo (Sarawak).

E. Boer (general part),
M.S.M. Sosef (general part, selection of species)

Zanthoxylum L.

Sp. pl. 1: 270 (1753); Gen. pl., ed. 5: 130 (1754).
RUTACEAE

x = 16, 17, 18; *Z. acanthopodium* DC.: n = 32, *Z. nitidum* (Roxb.) DC., *Z. rhetsa*, *Z. scandens* Blume: n = 34

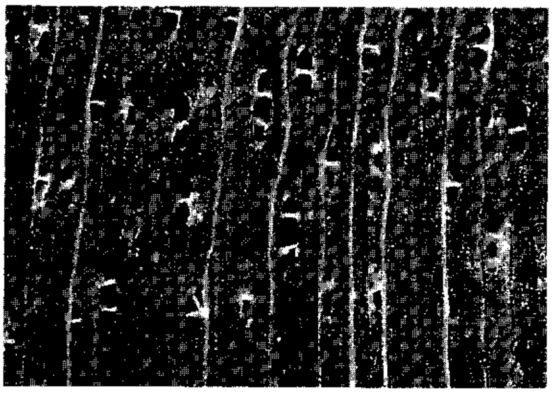
Vernacular names Ivy-rue, thorny yellowwood (En). Malaysia: chenkring, hantu duri (Peninsular). Vietnam: s[er]n.

Origin and geographic distribution *Zanthoxylum* comprises about 200 species and has a pantropical distribution with a few representatives in temperate eastern Asia and North America. Most species occur in South America. The genus is found throughout South-East Asia and in northern Australia and the Pacific; there are 20 species within Malesia.

Uses The wood of *Zanthoxylum* is used for house building (planking, rafters, scantlings), furniture and various small articles like jewelry boxes, kris handles and sheaths, axe handles, walking-sticks, inlay work, gun stocks, carving and novelties.
The fruits of *Z. rhetsa* are used as a spice and yield an essential oil that shows anthelmintic activity. In the Philippines its pounded bark mixed with oil has been used externally against stomach-ache, and a decoction of it is taken internally to cure pains in the chest. The chewed bark is applied to snake bites. The soft, fibrous material from the roots of *Z. integrifoliolum* has been used in the Philippines to caulk canoes.

Production and international trade *Zanthoxylum* wood is sold in local markets, and may be exported in mixed consignments of yellow hardwood. The fruits were formerly sold in local markets in Java and are traded in parts of Thailand.

Properties *Zanthoxylum* yields a lightweight to medium-weight hardwood with a density of (290–)335–790 kg/m^3 at 15% moisture content with samples of *Z. rhetsa* covering the whole range. Heartwood bright yellow to pale brown, not clearly differentiated from the pale brown sapwood; grain straight; texture fine to moderately fine and even; wood of several species lustrous. Growth rings usually distinct to the naked eye, boundaries indicated by layers of narrow marginal parenchyma, latewood slightly denser than earlywood, occasionally with a ring of solitary vessels in the earlywood; vessels very small to medium-sized, solitary and in radial multiples of 2–4, open, occasionally filled with chalky white deposits; parenchyma sparse to moderately abundant, paratracheal scanty to vasicentric, apotracheal banded in marginal or seemingly marginal bands; rays moderately fine to medium-sized, of the larger ones visible to the naked eye; ripple marks mostly absent, sometimes with a tendency to irregularly storied arrangement.
Shrinkage is high but the wood seasons well without degrade. The wood of *Z. rhetsa* is hard and tough, that of *Z. myriacanthum* is soft. It is easy to work by hand and machine and finishes to a shiny surface. The heartwood of *Z. rhetsa* is resis-



Zanthoxylum conspercipunctatum Merr. & L.M. Perry
transverse surface (×20)

tant to dry-wood termites and moderately resistant to fungi. The sapwood is usually non-susceptible to *Lyctus*. In a graveyard test in the Philippines the average service life of *Z. rhetsa* was 40 months, which is classified as moderately durable. The average fibre length of *Z. rhetsa* is 1.15 mm. The most important chemical constituents of Malesian *Zanthoxylum* species are alkaloids and coumarins. The bark of several species contains alkaloids. The fruits of *Z. rhetsa* yield a volatile oil, about 50% of which consists of sabinene.
See also the tables on microscopic wood anatomy and wood properties.

Botany Evergreen or deciduous, dioecious or rarely monoecious, scandent or erect shrubs or small to medium-sized trees up to 35 m tall; bole up to 60 cm in diameter, occasionally larger, without buttresses; bark surface often studded with spines or prickles, grey or brownish, inner bark fibrous, aromatic. Twigs armed. Leaves alternate, paripinnate or imparipinnate; leaflets 1–15, opposite to alternate, entire or glandular-dentate, with pellucid dots; stipules absent. Flowers in an axillary or terminal panicle, raceme or cyme or rarely solitary, unisexual or bisexual, small; perianth with 6–8 tepals or differentiated into 4–5 sepals and petals; stamens 4–6, rudimentary in female flower; disk flat to cushion-like; ovary superior, 1–5-carpellate, rudimentary in male flower, carpels free or fused at base, each with 2 ovules, styles fused to divergent, stigma capitate. Fruit composed of 1–5 free or basally fused follicles; exocarp glandular, red to black. Seed ovoid to globose, 1 per follicle, often hanging from a funiculus; testa black or reddish, glossy; endosperm present. Seedling with epigeal germination; cotyledons emergent; hypocotyl elongated.

Zanthoxylum myriacanthum Wallich ex Hook. f. – 1, flowering twig; 2, dehisced fruit.

Several species are myrmecophytes with hollow branches showing slit-like openings in which ants of the genera *Camponotus* and *Crematogaster* live.
In Peninsular Malaysia *Z. rhetsa* is deciduous around March or April and flowers just after or just before the new leaves. In Java it flowers in December. The fragrant flowers are probably pollinated by insects. In Java ripe fruits of *Z. rhetsa* are available in February and March.
Zanthoxylum belongs to the subfamily *Rutioideae* and includes the genus *Fagara*. It is often misspelled as *Xanthoxylum*.

Ecology The timber-yielding *Zanthoxylum* species are found in primary and secondary forest and thickets, up to 2100 m altitude. *Z. myriacanthum* is locally common in secondary forest and thickets on hills and mountains. *Z. rhetsa* is generally found in rather dry, often monsoonal forest and thickets, up to 500 m altitude.

Silviculture *Z. rhetsa* can be planted in the open provided it is above 400 m altitude. At lower altitudes it will benefit from some shade. It is not resistant to fire.

Genetic resources and breeding The narrow geographical distribution of some *Zanthoxylum* species may make them vulnerable to genetic erosion. The availability of *Z. rhetsa* in Bali is seriously reduced due to exploitation for the handicraft industry.

Prospects The pale-coloured wood of *Zanthoxylum* has potential for decorative articles. Since there is no experience with planting *Zanthoxylum*, silvicultural information should be obtained through experimentation.

Literature 70, 150, 163, 209, 238, 260, 267, 304, 410, 412, 436, 464, 508, 772, 861, 933, 934, 955, 968, 974, 1038, 1048, 1089, 1090, 1169, 1183, 1221, 1242.

Selection of species

Zanthoxylum celebicum Koord.

Vernacular names Indonesia: kumaroko, tokulu (Minahassa, Sulawesi).

Distribution North-eastern Sulawesi and the Moluccas (Morotai).

Zanthoxylum integrifoliolum (Merr.) Merr.

Synonyms *Fagara integrifoliola* Merr.

Vernacular names Philippines: salai (Bisaya, Tagalog).

Distribution Taiwan and the Philippines.

Zanthoxylum myriacanthum Wallich ex Hook. f.

Synonyms *Fagara myriacantha* (Wallich ex Hook. f.) Engl., *Zanthoxylum diabolicum* Elmer, *Zanthoxylum rhetsoides* Drake.

Vernacular names Thorny ivy-rue (En). Malaysia: chenkring, kabu-kabu utan (Peninsular). Philippines: madbad (Samar-Leyte Bisaya). Vietnam: c[aa]y s[er]n.

Distribution India (Assam), northern Vietnam, southern China, Peninsular Malaysia, Sumatra, Borneo (Sabah, Sarawak) and the Philippines.

Zanthoxylum pluviatile T.G. Hartley

Vernacular names Papua New Guinea: thorny yellow-wood (En).

Distribution Papua New Guinea, the Bismarck Archipelago and the Solomon Islands.

Zanthoxylum rhetsa (Roxb.) DC.

Synonyms *Fagara rhetsa* Roxb., *Zanthoxylum budrunga* (Roxb.) DC., *Zanthoxylum limonella* (Dennst.) Alston.

Vernacular names Indian ivy-rue (En). Indonesia: kayu lemah (Javanese), kayu tana (Madurese), ki tanah (Sundanese). Malaysia: hantu duri (Peninsular). Philippines: kayutana (Filipino), kaitana (Bisaya, Tagalog), kasabang (Iloko). Burma (Myanmar): kathit-pyu. Laos: khên[1], khouang. Thailand: kamehat ton, luk ra mat (central), ma khuang (northern). Vietnam: c[aa]y ho[af]ng m[ooj]c h[oo]i, c[os]c h[oo]i.

Distribution From India and Sri Lanka to Burma (Myanmar), Indo-China, Thailand, Peninsular Malaysia, Java, the Philippines, Sulawesi, the Lesser Sunda Islands and southern Papua New Guinea.

E. Boer (general part),
M.S.M. Sosef (general part, selection of species),
J. Ilic (wood anatomy)

Ziziphus Mill.

Gard. dict., abr. ed. 4 (1754).
RHAMNACEAE
$x = 12$; *Z. mauritiana*: $2n = 24, 48, 60, 72, 96$

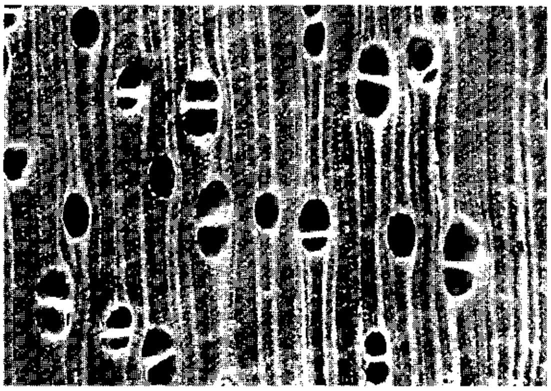
Vernacular names Indonesia: bidara, widara. Malaysia: bedara, bidara (Peninsular). Thailand: phutsan. Vietnam: t[as]o ta.

Origin and geographic distribution *Ziziphus* comprises about 100 species and has a pantropical distribution centred in tropical America and South-East Asia. It extends into temperate and even arid regions. About 25 species occur within Malesia.

Uses The wood of *Ziziphus* is used for general construction, furniture and cabinet work, tool handles, turnery, household utensils, bowling pins, baseball bats, chisels and packaging. It is suitable for the production of veneer and plywood. Several species, notably *Z. jujuba* Mill. and *Z. mauritiana*, are widely cultivated for their edible fruits. In Indonesia young leaves of *Z. mauritiana* are cooked as a vegetable and also serve as fodder. In India and in Indonesia it is used to rear lac insects. Its bark and fruit yield a dye. The roots, bark, leaves, seeds and fruits of *Z. mauritiana* are all applied medicinally, in particular to aid digestion and to poultice wounds. It is a well-known firewood in semi-arid regions. In the Philippines *Z. talanai* is planted as an ornamental.

Production and international trade Supplies of *Ziziphus* wood are very small. In the Philippines it may be found mixed with 'white seraya' (*Parashorea* spp.) or in consignments of 'white miscellaneous'.

Properties *Ziziphus* yields a medium-weight to heavy hardwood with a density of 535–1180 kg/m^3 at 15% moisture content; the wood of *Z. talanai* is of medium density and *Z. celtidifolia* yields a heavy wood. Heartwood buff-coloured, pale red or brown to dark brown, sometimes banded or with dark streaks, not sharply demarcated from the pale brown sapwood; grain straight, occasionally wavy; texture fine to coarse; wood fairly lustrous. Growth rings indistinct but some species exhibit bands of woody tissue with relatively few vessels; vessels medium-sized, solitary and in radial multiples of 2–5, occasionally in clusters, open; parenchyma paratracheal aliform to confluent, distinct, and apotracheal in marginal, interrupted



Ziziphus talanai
transverse surface (×20)

bands, the latter type indistinct; rays extremely fine; ripple marks absent.
The wood seasons well but may split slightly during seasoning. It is moderately hard to hard and strong to very strong. It is easy to work and takes a high finish. It is reported as non-durable to durable when exposed to the weather or in contact with the ground, but in a graveyard test in the Philippines the average service life of test stakes of *Z. talanai* was only 1 year. Some species are moderately resistant to insect attack, the heartwood of *Z. talanai* is susceptible to dry-wood termites. Its sapwood is susceptible to *Lyctus*.
The gross energy value of *Z. talanai* is 18 285–19 560 kJ/kg.
See also the tables on microscopic wood anatomy and wood properties.

Botany Deciduous or evergreen, woody climbers, erect or straggling shrubs or small to medium-sized trees up to 33 m tall; bole straight or crooked, branchless for up to 20 m, up to 70(–120) cm in diameter, sometimes with small to fairly large buttresses; bark surface smooth, greyish, with densely spaced lenticels, sometimes with large pyramidal spines; inner bark yellow to brownish or bright orange near cambium layer. Leaves alternate, simple, entire or serrate to crenate, generally 3-veined from the base; stipules caducous or transformed into spines. Flowers in a small axillary fascicle or umbel-like cyme, rarely in an axillary or terminal thyrse, perigynous; sepals 5; petals 5 or rarely absent, hooded, yellowish to greenish; disk fleshy, 5–10-lobed; stamens 5, opposite the petals; ovary semi-inferior, 2–3 (–4)-locular with 1 ovule in each cell, styles 2–4. Fruit a fleshy to almost dry, 1-seeded drupe; endocarp hard. Seed nearly plano-convex. Seedling with epigeal germination; cotyledons emergent, fleshy; hypocotyl elongated; first leaves opposite or whorled, subsequent ones alternate, conduplicate.
In trials in West Java the mean annual increment of 10.5-year-old *Z. celtidifolia* trees was 0.8–1.5 m in height and 0.9–1.8 cm in diameter, the faster-growing trees originating from seed from North Sulawesi, the slower-growing trees from seed from Timor. In India the annual diameter increment of *Z. mauritiana* as determined from wood samples is 0.8–1.3 cm; in semi-arid regions it is one of the most rapidly growing trees. In South-East Asia *Z. mauritiana* flowers concurrently with shoot growth in the wet season. The nectar produced by the disk and the fragrance of the flowers attract insects. Flowers are protandrous. The fruits take 4–6 months to mature; they are dispersed by mammals and birds.
The name *Ziziphus* is often erroneously written as *Zizyphus*.

Ecology Timber-yielding *Ziziphus* species are found scattered in lowland, primary or secondary rain forest or thickets, up to 1000 m altitude. *Z. mauritiana* can cope with extreme temperatures and thrives under semi-arid conditions. It prefers light, deep soils, but can grow on alkaline to slightly acid, saline, heavy, and occasionally waterlogged soils.

Silviculture *Ziziphus* can be propagated by seed (including direct sowing) and by transplanting root suckers; propagation by cuttings failed. Grafting is used for cultivars of *Z. mauritiana* for fruit production. The following seed counts are available from Indonesia: *Z. celtidifolia* with about 33 000 dry seeds/kg and *Z. mauritiana* 3300 dry pyrenes/kg. The germination rate of *Z. mauritiana* seed increases during the first year of storage. In Indonesia it is recommended to sow seeds or pyrenes of *Z. celtidifolia* in the shade but in India *Z. mauritiana* seeds do not germinate when sown in even slight shade. Pyrenes in pulp of *Z. calophylla* Wallich ex Hook. f. show only about 5% germination in 33–254 days but *Z. celtidifolia* seeds germinate well. In India stumps of *Z. mauritiana* with 5 cm shoot and 15 cm root length are used as planting stock. *Z. mauritiana* coppices and pollards well and it forms root suckers. The root system of *Z. celtidifolia* is very resistant to oxygen deficiency e.g. in the case of waterlogging.

Genetic resources and breeding In India about 125 cultivars of *Z. mauritiana* are grown for their fruits.

Prospects The use of *Ziziphus* timber is unlikely to increase in the near future.

Literature 11, 70, 130, 160, 163, 209, 235, 238, 266, 348, 364, 405, 427, 436, 464, 632, 697, 772, 780, 785, 817, 829, 831, 861, 933, 934, 955, 974, 1038, 1048, 1104, 1164, 1169, 1221, 1222, 1268.

Selection of species

Ziziphus angustifolius (Miq.) Hatus. ex v. Steenis

Synonyms *Ziziphus forbesii* Baker f., *Ziziphus grewioides* (Warb.) L.M. Perry ex v. Steenis.

Vernacular names Malaysia: kayu labu (Kadazan, Sabah), pasil-pasil (Bajau, Sabah). Philippines: ligaa (Bikol, Tagalog).

Distribution From India and Burma (Myanmar) to Thailand, throughout Malesia (except for the Lesser Sunda Islands), and the Solomon Islands.

Ziziphus celtidifolia DC.

Synonyms *Ziziphus timoriensis* DC.

Vernacular names Indonesia: asinasi (Roti), jharibuk ghunung (Kangean Archipelago), kaingasi (Timor).

Distribution Java, Sulawesi, the Lesser Sunda Islands, the Moluccas and New Guinea.

Ziziphus hutchinsonii Merr.

Vernacular names Philippines: bila (Bagobo), lumulas, mangaluas (Magindanao).

Distribution The Philippines.

Ziziphus mauritiana Lamk

Synonyms *Ziziphus jujuba* (L.) Gaertn. auct. non Mill.

Vernacular names Indian jujube (En). Jujubier (Fr). Indonesia: bidara, dara, widara. Malaysia: bidara, epal siam, jujub (Peninsular). Philippines: manzanita (Tagalog). Burma (Myanmar): eng-si, zee-pen. Cambodia: putrea. Laos: than. Thailand: ma tan (northern), ma thong (south-western), phutsa (central). Vietnam: c[aa]y t[as]o ta.

Distribution Probably originally from the Middle East or the Indian subcontinent, but now cultivated throughout the tropics and subtropics and regularly escaping and becoming naturalized.

Ziziphus talanai (Blanco) Merr.

Synonyms *Ziziphus arborea* Merr., *Ziziphus zonulata* Blanco.

Vernacular names Philippines: balakat (Filipino), aligamen (Iloko), talanai (Tagalog).

Distribution The Philippines.

Ziziphus trinervia (Cav.) Poir.

Synonyms *Ziziphus exserta* DC.

Vernacular names Philippines: deklap (Iloko), duklap (Tagalog), laba-laba (Iloko).

Distribution The Philippines.

S.I. Wiselius

Microscopic wood anatomy

The wood anatomical descriptions of all genera treated in this volume (with the exception of the palms) are presented in coded form, following the IAWA List of Microscopic Features for Hardwood Identification (Wheeler et al., 1989) which is becoming an international standard. That list contains 163 features, but only 130 have been used in compiling the present codes. The 33 that were deleted are quantitative ones that would require much more extensive sampling and time-consuming measurements, or qualitative ones that are difficult to observe or interpret by unexperienced users, or are so uncommon in South-East Asian woods that they are of limited use for diagnostic purposes. These are features 15–19, 28, 44, 51–55, 71–74, 81, 82, 87, 88, 112, 113, 123, 145–148, 152, 153, 155, 157, 158 and 163. The full list of wood anatomical features is reproduced below with permission from the International Association of Wood Anatomists (IAWA). Brief explanations of terms used in this list can be found in the glossary in this volume. However, users not familiar with the IAWA List of Microscopic Features are urged to consult the definitions, explanations, and illustrations in Wheeler et al. (1989) very carefully, because individual wood anatomists have interpreted certain anatomical terms differently.

List of wood anatomical features

Growth rings

1. Growth ring boundaries distinct
2. Growth ring boundaries indistinct or absent

Vessels

Porosity

3. Wood ring-porous
4. Wood semi-ring-porous
5. Wood diffuse-porous

Vessel arrangement

6. Vessels in tangential bands
7. Vessels in diagonal and/or radial pattern
8. Vessels in dendritic pattern

Vessel groupings

9. Vessels exclusively solitary (90% or more)
10. Vessels in radial multiples of 4 or more common
11. Vessel clusters common

Solitary vessel outline

12. Solitary vessel outline angular

Perforation plates
13. Simple perforation plates
14. Scalariform perforation plates
15. Scalariform perforation plates with $\leq$ 10 bars
16. Scalariform perforation plates with 10–20 bars
17. Scalariform perforation plates with 20–40 bars
18. Scalariform perforation plates with $\geq$ 40 bars
19. Reticulate, foraminate, and/or other types of multiple perforation plates

Intervessel pits: arrangement and size
20. Intervessel pits scalariform
21. Intervessel pits opposite
22. Intervessel pits alternate
23. Shape of alternate pits polygonal
24. Minute ($\leq$ 4 µm)
25. Small (4–7 µm)
26. Medium (7–10 µm)
27. Large ($\geq$ 10 µm)
28. Range of intervessel pit size (µm)

Vestured pits
29. Vestured pits

Vessel-ray pitting
30. Vessel-ray pits with distinct borders; similar to intervessel pits in size and shape throughout the ray cell
31. Vessel-ray pits with much reduced borders to apparently simple: pits rounded or angular
32. Vessel-ray pits with much reduced borders to apparently simple: pits horizontal (scalariform, gash-like) to vertical (palisade)
33. Vessel-ray pits of two distinct sizes or types in the same ray cell
34. Vessel-ray pits unilaterally compound and coarse (over 10 µm)
35. Vessel-ray pits restricted to marginal rows

Helical thickenings
36. Helical thickenings in vessel elements present
37. Helical thickenings throughout body of vessel element
38. Helical thickenings only in vessel element tails
39. Helical thickenings only in narrower vessel elements

Tangential diameter of vessel lumina
40. Mean tangential diameter of vessel lumina $\leq$ 50 µm
41. Mean tangential diameter of vessel lumina 50–100 µm
42. Mean tangential diameter of vessel lumina 100–200 µm
43. Mean tangential diameter of vessel lumina $\geq$ 200 µm
44. Mean, +/– Standard Deviation, Range, n = x
45. Vessels of two distinct diameter classes, wood not ring-porous

Vessels per square millimetre
46. $\leq$ 5 vessels per square millimetre
47. 5–20 vessels per square millimetre
48. 20–40 vessels per square millimetre
49. 40–100 vessels per square millimetre
50. $\geq$ 100 vessels per square millimetre
51. Mean, +/– Standard Deviation, Range, n = x

Mean vessel element length
52. Mean vessel element length $\leq$ 350 µm
53. Mean vessel element length 350–800 µm
54. Mean vessel element length $\geq$ 800 µm
55. Mean, +/– Standard Deviation, Range, n = x
Tyloses and deposits in vessels
56. Tyloses common
57. Tyloses sclerotic
58. Gums and other deposits in heartwood vessels
Wood vesselless
59. Wood vesselless

Tracheids and fibres
60. Vascular/vasicentric tracheids present
Ground tissue fibres
61. Fibres with simple to minutely bordered pits
62. Fibres with distinctly bordered pits
63. Fibre pits common in both radial and tangential walls
64. Helical thickenings in ground tissue fibres
Septate fibres and parenchyma-like fibre bands
65. Septate fibres present
66. Non-septate fibres present
67. Parenchyma-like fibre bands alternating with ordinary fibres
Fibre wall thickness
68. Fibres very thin-walled
69. Fibres thin- to thick-walled
70. Fibres very thick-walled
Mean fibre length
71. Mean fibre length $\leq$ 900 µm
72. Mean fibre length 900–1600 µm
73. Mean fibre length $\geq$ 1600 µm
74. Mean, +/– Standard Deviation, Range, n = x

Axial parenchyma
75. Axial parenchyma absent or extremely rare
Apotracheal axial parenchyma
76. Axial parenchyma diffuse
77. Axial parenchyma diffuse-in-aggregates
Paratracheal axial parenchyma
78. Axial parenchyma scanty paratracheal
79. Axial parenchyma vasicentric
80. Axial parenchyma aliform
81. Axial parenchyma lozenge-aliform
82. Axial parenchyma winged-aliform
83. Axial parenchyma confluent
84. Axial parenchyma unilateral paratracheal
Banded parenchyma
85. Axial parenchyma bands more than three cells wide
86. Axial parenchyma in narrow bands or lines up to three cells wide

87. Axial parenchyma reticulate
88. Axial parenchyma scalariform
89. Axial parenchyma in marginal or in seemingly marginal bands

Axial parenchyma cell type / strand length

90. Fusiform parenchyma cells
91. Two cells per parenchyma strand
92. Four (3–4) cells per parenchyma strand
93. Eight (5–8) cells per parenchyma strand
94. Over eight cells per parenchyma strand
95. Unlignified parenchyma

Rays

Ray width

96. Rays exclusively uniseriate
97. Ray width 1–3 cells
98. Larger rays commonly 4- to 10-seriate
99. Larger rays commonly > 10-seriate
100. Rays with multiseriate portion(s) as wide as uniseriate portions

Aggregate rays

101. Aggregate rays

Ray height

102. Ray height > 1 mm

Rays of two distinct sizes

103. Rays of two distinct sizes

Rays: cellular composition

104. All ray cells procumbent
105. All ray cells upright and/or square
106. Body ray cells procumbent with one row of upright and/or square marginal cells
107. Body ray cells procumbent with mostly 2–4 rows of upright and/or square marginal cells
108. Body ray cells procumbent with over 4 rows of upright and/or square marginal cells
109. Rays with procumbent, square and upright cells mixed throughout the ray

Sheath cells

110. Sheath cells present

Tile cells

111. Tile cells present

Perforated ray cells

112. Perforated ray cells present

Disjunctive ray parenchyma cell walls

113. Disjunctive ray parenchyma cell walls present

Rays per millimetre

114. $\leq$ 4 rays per mm
115. 4–12 rays per mm
116. $\geq$ 12 rays per mm

Wood rayless

117. Wood rayless

Storied structure

118. All rays storied
119. Low rays storied, high rays non-storied
120. Axial parenchyma and/or vessel elements storied
121. Fibres storied
122. Rays and/or axial elements irregularly storied
123. Number of ray tiers per axial mm

Secretory elements and cambial variants

Oil and mucilage cells

124. Oil and/or mucilage cells associated with ray parenchyma
125. Oil and/or mucilage cells associated with axial parenchyma
126. Oil and/or mucilage cells present among fibres

Intercellular canals

127. Axial canals in long tangential lines
128. Axial canals in short tangential lines
129. Axial canals diffuse
130. Radial canals
131. Intercellular canals of traumatic origin

Tubes / tubules

132. Laticifers or tanniferous tubes

Cambial variants

133. Included phloem, concentric
134. Included phloem, diffuse
135. Other cambial variants

Mineral inclusions

Prismatic crystals

136. Prismatic crystals present
137. Prismatic crystals in upright and/or square ray cells
138. Prismatic crystals in procumbent ray cells
139. Prismatic crystals in radial alignment in procumbent ray cells
140. Prismatic crystals in chambered upright and/or square ray cells
141. Prismatic crystals in non-chambered axial parenchyma cells
142. Prismatic crystals in chambered axial parenchyma cells
143. Prismatic crystals in fibres

Druses

144. Druses present
145. Druses in ray parenchyma cells
146. Druses in axial parenchyma cells
147. Druses in fibres
148. Druses in chambered cells

Other crystal types

149. Raphides
150. Acicular crystals
151. Styloids and/or elongated crystals
152. Crystals of other shapes (mostly small)
153. Crystal sand

Other diagnostic crystal features
154. More than one crystal of about the same size per cell or chamber
155. Two distinct sizes of crystals per cell or chamber
156. Crystals in enlarged cells
157. Crystals in tyloses
158. Cystoliths

Silica
159. Silica bodies present
160. Silica bodies in ray cells
161. Silica bodies in axial parenchyma cells
162. Silica bodies in fibres
163. Vitreous silica

Before using the data presented below to identify wood, the reader should be aware of a number of limitations. Coded descriptions are much more rigid than textual ones and require a degree of conformity that is hard to achieve for a biological material such as wood. Several wood anatomical features vary within individual trees (largely depending on age and position in the tree), among trees of the same species, and within genera, especially within species-rich genera with a wide ecological range. Therefore, because the number of species and samples studied or recorded in the literature is often limited, some of the generic codes presented below may be incomplete. However, in all cases the most important qualitative features (vessel perforation type, types of vessel wall pitting, pitting of the fibre walls, septate fibres, parenchyma distribution, ray composition and ray width, crystal complement, and secretory cells or cavities) will apply to most, if not all, species of the genus concerned.

The character codes given in parentheses () are variable or rarely occur within the material studied. Note that the parentheses indicate one of the following:
- The feature occurs in only some of the species or samples studied.
- The feature is very rare in all samples or species, and can easily be overlooked in a single section.
- The feature concerns the less frequently occurring part of a continuous range in quantitative or semi-quantitative characters such as vessel diameter and frequency classes, parenchyma strand length, ray width, and number of rows of marginal cells.
- Although the feature is always present, it is difficult to observe and thus likely to be overlooked during a rapid microscopic survey.

When matching an unknown wood sample with any generic code it is advisable to allow for one or two mismatching features, to account for:
- possible incompleteness of the generic code;
- observational errors, or a difference between the users' and code compiler's interpretations.

If all the above caveats are observed, the coded descriptions are extremely useful, providing a wealth of diagnostic information.

List of numerical codes

The name of the compiler is given after each generic code, sometimes together with literature (number referring to the general list of literature in this volume) crucial in preparing that code. Most of the references consulted are not listed here, however, but many may be found under the generic treatments. For a full bibliography on wood anatomical descriptions the user is therefore referred to Gregory (1994). The codes were arrived at by studying slides specifically for this purpose, and were checked and updated using data from the OPCN (Oxford, Princes Risborough Laboratory, Centre Technique Forestier Tropical, North Carolina State University) database.

Acer: (1) (2) 5 13 22 (23) 26 (27) 30 (36) (37) 41 42 47 61 66 68 (69) 76 78 89 (91) (92) 97 104 115 136 142. Species studied: *A. laurinum*. (J.M. Fundter & Y.I. Mandang)

Acmena: 2 5 13 22 23 26 27 29 31 32 (41) 42 47 48 (56) (58) 61 66 69 70 76 79 80 83 (85) 86 93 (94) (97) (98) (103) (106) 107 (108) 115 (136) (141). Species studied: *A. acuminatissima*, *A. hemilampra*. (J. Ilic)

Acrocarpus: 2 5 13 22 23 26 29 30 31 42 43 46 (47) 61 (63) 65 66 68 79 80 83 89 92 93 98 106 115 136 137 138 139 140 141 (142). Species studied: *A. fraxinifolius*. (W. Hanvongjirawat)

Acronychia: 2 5 (7) (12) 13 22 (23) 24 30 41 47 48 61 66 69 78 79 (85) 86 (92) (93) (97) (98) 104 106 115 159 160. Species studied: *A. pedunculata*, *A. trifoliolata*. (Y.S. Chang)

Actinodaphne: 1 (2) 5 (12) 13 (14) (20) 22 (25) 26 31 32 33 (36) 41 47 (48) 56 61 (65) 66 68 69 79 (80) 91 92 93 97 106 107 115 (124) (125) (126) (153). Species studied: *A. angustifolia*, *A. macrophylla*, *A. malaccensis*, *A. mushaensis* (Hay.) Hay., *A. nantoensis* (Hay.) Hay., *A. nitida* Teschner, *A. sesquipedalis*. (W. Hanvongjirawat)

Adenanthera: (1) 2 5 13 22 25 29 30 42 (43) 46 (58) 61 66 69 (70) (76) 80 (83) 89 91 92 97 104 115 136 142 143. Species studied: *A. intermedia*, *A. pavonina*, *A. tamarindifolia* Pierre. (J. Ilic)

Adinandra: (1) 2 5 (9) 12 14 (20) 21 (22) 25 26 27 30 (32) (37) 40 41 (47) (48) (49) 50 (56) 62 63 66 (68) 69 76 78 92 93 97 (98) 102 106 107 108 (114) 115 116. Species studied: *A. dumosa*, *A. forbesii*, *A. sarosanthera*. Literature: 262, 263. (I. Bernad)

Adinauclea: 2 5 (9) (12) 13 22 24 25 29 30 40 41 48 49 62 63 66 69 70 76 77 78 92 93 97 (98) (100) 107 108 (110) 116. Species studied: *A. fagifolia*. Literature: 585. (P. Baas)

Agrostistachys: 2 5 (7) (10) 13 (14) 20 (21) 22 25 26 31 32 40 41 48 49 (56) (57) 61 (62) 66 69 (76) (77) 78 (86) (89) 93 (94) 97 (100) (102) 108 116 159 160. Species studied: *A. borneensis*. (E.A. Wheeler)

Alangium sect. *Alangium* and sect. *Rhytidandra*: (1) 2 5 13 22 (23) 26 27 31 32 40 41 42 46 47 48 56 61 66 69 76 77 92 93 94 97 102 107 108 115 116 136 137 138 139 140 141 142. Species studied: *A. longiflorum*, *A. salvifolium*. (Y.I. Mandang)

Alangium sect. *Conostigma*: (1) 2 5 14 22 23 25 26 31 32 41 42 46 47 48 (56) 61 66 70 76 77 93 94 97 98 102 107 108 110 115 116 (136) (137) (138) 141 (159). Species studied: *A. havilandii* Bloemb., *A. javanicum*, *A. nobile*, *A. ridleyi*. (Y.I. Mandang)

Alangium sect. *Marlea*: (1) (2) (4) 13 22 23 26 27 31 32 41 42 46 47 48 56 61 66 69 76 77 78 79 86 89 92 93 94 97 98 102 107 108 115 116 136 137 138 (140) (141) (144). Species studied: *A. chinense*, *A. griffithii*, *A. kurzii*, *A. rotundifolium*. Literature: 855. (Y.I. Mandang)

Albizia: (1) 2 5 13 22 25 26 29 30 42 46 (58) 61 (65) 66 (68) 69 70 76 (79) 80 83 89 90 91 92 93 97 98 104 115 136 142. Species studied: *A. chinensis*, *A. ferruginea* (Guill. & Perrottet) Benth., *A. gummifera* (J.F. Gmelin) C.A. Smith, *A. lebbeck*, *A. lebbekoides*, *A. odoratissima* (L. f.) Benth., *A. procera*. Literature: 915. (W. Hanvongjirawat)

Allophylus: (1) 2 5 13 22 25 26 30 (36) (37) 40 41 47 48 49 58 61 65 (67) 69 (75) 92 93 (96) 97 104 106 115 136 142 143. Species studied: *A. cobbe*. Literature: 570. (P. Baas)

Alloxylon: 2 5 (6) (12) 13 22 26 30 42 46 58 61 65 69 (80) (85) 86 92 93 99 102 103 (104) 106 (110) 114. Species studied: *A. brachycarpum*. (J. Ilic)

Alphitonia: (1) 2 5 13 22 (23) 25 26 30 (31) (32) (41) 42 47 61 (62) 66 68 (69) (76) 78 79 (92) 93 (96) (97) (104) 106 (107) 115 116 (136) (138) (142). Species studied: *A. excelsa*, *A. macrocarpa*, *A. zizyphoides* (Sprengel) A. Gray. (A. Tukau Salang)

Alphonsea: 2 5 13 22 23 24 30 41 42 47 (58) 61 (63) 66 (68) 69 (78) (79) 86 92 (97) 98 102 104

106 115 (124). Species studied: *A. elliptica*, *A. javanica*, *A. maingayi*. Literature: 468. (K. Sidiyasa)

Alseodaphne: 1 2 5 (10) (12) 13 (14) 22 23 26 27 31 32 (33) (36) 42 47 56 61 65 66 69 (70) (78) 79 (85) 89 92 93 97 (98) 106 107 115 (124) (125) (126) (136) (137). Species studied: *A. bancana*, *A. dura*, *A. insignis*, *A. semecarpifolia* (Wallich ex Nees) Nees. (W. Hanvogjirawat)

Anisophyllea: 2 5 13 22 (23) 25 30 42 43 46 (60) 62 (63) 66 (69) 70 (76) 77 (83) 85 93 94 99 102 103 107 (108) (110) (114) 115 136 137 138 141 142. Species studied: many. Literature: 1149. (P. Baas)

Anogeissus: 1 2 5 (7) 13 22 (23) 25 29 30 41 42 47 48 49 (58) 61 65 66 69 70 (76) 78 79 80 83 (89) (92) 93 96 97 109 115 116 136 137 138 139 141 156. Species studied: *A. acuminata*, *A. latifolia*, *A. leiocarpus* Guill. & Perr., *A. pendula* Edgw., *A. sericea* Brandis. Literature: 1150. (A. Aglua)

Antiaris: (1) 2 5 (7) (8) (12) 13 22 23 26 27 31 (32) 42 43 (45) 46 47 61 65 (66) 68 (69) 79 80 (83) 91 92 93 (97) 98 106 107 (110) 115 132 (136) (137) (138) (139). Species studied: *A. toxicaria*. (W. Hanvongjirawat)

Antidesma: (1) 2 5 (12) 13 (14) 22 23 25 26 31 32 40 41 48 (56) 61 66 69 70 75 (76) 78 92 (97) 98 102 (103) 107 108 (109) (110) 116 (159) (160). Species studied: *A. coriaceum*, *A. ghaesembilla*, *A. leucopodium* Miq. (A.B. Ella)

Aphanamixis: (1) 2 5 13 22 (23) (25) (26) 30 (41) (42) 47 (58) 61 65 (68) (69) 78 85 86 93 94 (96) (97) 104 (106) 115 116 (136) (141) (142) 159 160 (161). Species studied: *A. polystachya*. (Nguyen Dinh Hung)

Aphananthe: (1) (2) 5 13 22 23 24 26 30 (34) 41 42 47 (57) 61 66 70 79 80 83 85 91 92 93 97 98 106 (107) 115 136 137 (138). Species studied: *A. philippinensis*. (I. Bernad)

Aporosa: 2 5 12 13 14 22 23 26 (27) 31 32 41 (42) 47 48 (49) (56) 61 66 70 (76) 77 (86) 92 93 (94) 98 102 103 108 (109) 110 115 (116) 136 137 138 (139) (140) (141). Species studied: *A. grandistipula* Merr., *A. microstachya*, *A. nervosa*, *A. nigricans*, *A. papuana*, *A. prainiana*. (A.B. Ella)

Archidendron: (1) (2) 5 13 22 23 25 29 30 (41) 42 43 46 (47) (58) 61 66 68 (69) 79 80 83 (89) 90 91 92 96 (97) 104 115 (136) (143). Species studied: *A. borneense* (Benth.) I.C. Nielsen, *A. clypearia*, *A. cockburnii*, *A. ellipticum*, *A. fagifolium* (Blume ex Miq.) I.C. Nielsen, *A. kunstleri*. Literature: 90, 1088. (I. Bernad)

Ardisia: 2 5 (7) (10) 12 13 (20) 22 23 (24) 25 (26) 30 (40) 41 47 48 61 62 63 65 66 68 69 79 (91) 92 (93) (98) 99 102 105 114 124 (136) (137). Species studied: *A.* cf. *fortis* Mez., *A. lanceolata*, *A. macrocalyx* R. Scheffer, *A. macrophylla* Reinw. ex Blume, *A. oblanceolata* Standl. (breakdown areas in rays), *A. steiranthera* B.C. Stone. (K. Sidiyasa)

Arytera: 1 2 5 13 11 24 25 30 (36) (37) 41 48 48 61 65 (66) 69 78 79 (92) 93 (96) (97) (104) (106) 115 136 142 143. Species studied: *A. divaricata* F. v. Mueller, *A. litoralis*. Literature: 570. (P. Baas)

Astronia: 2 5 (12) 13 (20) (22) 23 24 25 29 31 32 (40) 41 (42) 47 (48) 61 65 67 68 76 78 91 92 96 105 116 153. Species studied: *A. hollrungii*, *A. papetaria*. Literature: 1151. (Nguyen Dinh Hung)

Atuna: 2 5 9 13 22 25 30 31 32 (33) 42 43 46 (47) (56) 62 63 66 69 76 77 78 86 93 94 97 (102) (104) (106) (107) 116 159 160. Species studied: *A. cordata*, *A. nannodes* (Kosterm.) Kosterm., *A. racemosa*. (I. Bernad)

Avicennia: 2 5 (10) 13 22 (23) 24 (25) 30 41 42 (45) 47 (48) (58) 61 66 69 (70) 79 80 83 92 (97) (98) (99) 102 (103) (105) 109 115 116 133 136 137 138. Species studied: *A. alba*, *A. marina*, *A. officinalis*. (I. Bernad)

Baccaurea: 2 5 (10) 13 (14) 22 (23) (24) (25) (26) 31 32 (41) (42) (47) 48 61 (63) 66 (69) (70) (76) 77 78 (86) (92) 93 94 98 102 (103) 108 115 136 137 (138) (142). Species studied: *B. bracteata*, *B. kunstleri*, *B. macrocarpa*, *B. parviflora*, *B. racemosa*. (A.B. Ella)

Barringtonia: 2 5 (12) 13 (14) 22 23 (26) 27 31 32 (34) 42 (46) 47 61 (65) 66 69 70 76 77 (78) 79 80 (83) (85) (86) (89) 92 93 94 98 102 106 107 108 115 136 137 138 139 140 141. Species studied: *B. acutangula*, *B. asiatica*, *B. gigantostachya* Koord. & Valeton, *B. lanceolata*, *B. pendula*, *B. racemosa*, *B. scortechinii*. (W. Hanvongjirawat)

Bauhinia: 2 5 (10) 13 22 23 26 29 30 31 42 (43) (45) 46 47 61 (65) 66 70 80 83 85 (86) 91 92 93 (96) 97 104 (106) 115 116 (118) (120) (122) 136 142. Species studied: *B. ampla* Span., *B. malabarica*, *B. purpurea* L., *B. variegata* L. (W. Hanvongjirawat)

Berrya: 1 5 (10) 13 22 24 (31) 42 47 (56) 61 66 69 (70) 76 83 (85) 86 89 92 93 97 98 (104) 106 115 118 136 137 138 141. Species studied: *B. cordifolia*, *B. mollis*. (I. Bernad)

Bhesa: 2 5 (10) 14 22 23 26 (27) (30) 31 (32) (33) 41 47 48 61 66 70 77 78 86 (87) 93 94 98 102 106 107 108 115 136 140 142. Species studied: *B. archboldiana*, *B. ceylanica* (Arn. ex Thwaites)

Ding Hou, *B. paniculata*, *B. robusta*. Literature: 1270. (P. Baas)

Blumeodendron: (1) 2 5 13 22 23 27 31 (32) 42 (46) 47 (61) (62) 66 69 (76) 77 (78) 86 (87) 93 94 97 (98) (99) (100) (101) 102 (103) 107 108 (110) 116 136 137 (138) 140 142. Species studied: *B. kurzii*, *B. subrotundifolium*, *B. tokbrai*. (E.A. Wheeler)

Bombax: 2 5 13 22 (23) (26) 27 31 (32) 43 46 (56) 61 65 66 68 69 (76) 77 78 79 (91) 92 (93) 98 (102) 104 106 (110) 115 (119) 120 (121) Species studied: *B. ceiba*, *B. valetonii*. (K. Sidiyasa)

Borneodendron: 2 5 13 22 23 26 27 31 42 47 56 61 66 69 (78) 86 88 92 93 97 106 115 116 130 136 137 138 141 142. Species studied: *B. aenigmaticum*. (A.B. Ella)

Bouea: 2 5 13 22 23 (26) 27 31 32 42 46 (47) 56 58 61 66 69 79 (80) 85 (91) 92 93 (94) 97 106 107 115 (116) 136 137 138 (141). Species studied: *B. macrophylla*, *B. oppositifolia*. Literature: 1093. (Y.I. Mandang)

Brachychiton: 2 5 13 22 23 26 (27) 30 31 42 (43) 46 47 61 66 (68) (69) (70) (76) 77 78 79 (80) 85 91 92 (98) 99 102 (103) 107 (108) 110 (114) (115) 120 121 136 142 143. Species studied: *B. acerifolius*, *B. carruthersii*, *B. discolor*, *B. diversifolius* R. Br. (Suleka Madhavan)

Brackenridgea: 2 5 9 (12) 13 22 (24) (25) (29) 30 41 42 (47) 48 (49) 58 62 63 66 70 76 77 (78) (79) 84 93 (94) 97 (98) 102 (103) 107 (108) 115 (116) 159. Species studied: *B. forbesii*, *B. hookeri*, *B. palustris*. (Suleka Madhavan)

Bridelia: 2 5 7 13 22 23 26 27 32 (41) 42 47 56 61 65 (66) 68 69 76 78 (79) 93 94 97 (98) (102) 107 (108) (109) 115 136 137 140 (141) (142). Species studied: *B. glauca*, *B. retusa*, *B. stenocarpa* Müll. Arg., *B. tomentosa*. (A.B. Ella)

Broussonetia: 2 5 13 22 23 26 27 31 42 (45) 47 61 66 68 78 79 91 92 98 106 107 (110) 115 (132) 136 137 138 141. Species studied: *B. papyrifera*. (Vu-Cong Quy)

Brownlowia: 1 5 (10) 13 22 24 31 32 42 47 61 (63) 66 69 76 77 79 92 93 94 95 97 98 (102) 106 115 (118) (119) (121) (136) (137) (138) (141) (142) (159) (160) (161). Species studied: *B. argentata*, *B. glabrata* Stapf ex Ridley, *B. ovalis* Kosterm. (I. Bernad)

Bruguiera: 2 5 14 20 30 31 32 34 41 (47) 48 (56) 61 (62) (63) 65 66 (69) 70 (75) (76) 78 (79) 93 (94) 98 102 106 (107) (110) 115 136 137. Species studied: many. Literature: 1149. (T. Fujii)

Buchanania: (1) 2 5 13 22 (23) 26 (27) 31 (32) 35 42 (43) 46 47 (56) 61 65 66 68 69 78 79 91 92 93 97 (98) 106 107 (108) 115 130 136 137 (138) (159) (160). Species studied: *B. amboinensis*, *B. arborescens*, *B. glabra* Wallich, *B. insignis*, *B. macrocarpa*, *B. sessifolia*. Literature: 1093. (Y.I. Mandang)

Callerya: 2 5 13 22 (23) 26 29 30 43 46 47 61 66 70 76 80 83 91 92 (97) (98) (99) (102) 104 115 (118) (120) (122) 136 142. Species studied: *C. atropurpurea*. (T. Veenin)

Callicarpa: (1) (2) 5 13 22 (24) 25 30 41 42 47 48 49 (56) 61 (62) (63) 65 (66) (68) 69 (75) 78 (79) 92 97 98 (106) (107) (108) 115. Species studied: *C. havilandii* (King & Gamble) H.J. Lam, *C. longifolia*, *C. tomentosa*. (I. Bernad)

Camptostemon: (1) 2 5 (12) 13 22 24 30 (36) (39) 41 47 48 (58) 61 63 66 68 69 77 78 79 86 90 91 92 (96) 97 104 106 116 118 120 (121) 136 137 (138). Species studied: *C. philippinense*. (T. Fujii)

Canthium: 2 5 13 (20) 22 25 29 30 40 41 42 47 48 49 62 63 66 67 76 77 78 94 98 100 (102) 107 108 115. Species studied: *C. monstrosum* (A. Rich.) Merr. (A. Tukau Salang)

Cantleya: 2 5 9 13 (14) 20 21 30 (32) 41 42 46 47 56 57 62 63 66 70 76 (78) (79) (84) 92 93 97 98 102 107 (108) (110) 115 . Species studied: *C. corniculata*. (J.P. Rojo)

Carallia: 2 5 13 22 23 25 26 30 (31) (32) 33 (34) 42 (43) (46) (47) 56 62 63 66 70 (76) (77) (80) (83) (85) (86) 94 99 102 103 107 108 (110) 115 136 137 (138) (140) (142). Species studied: *C. brachiata*. Literature: 1149. (A. Tukau Salang)

Carapa: 1 2 5 13 22 24 30 (41) 42 46 47 58 61 65 68 69 (76) 79 (80) 92 93 94 97 (98) 106 (107) 115 (122) 131 136 137. Species studied: *C. guianensis*. (Nguyen Dinh Hung)

Careya: 2 5 13 22 23 26 27 31 32 42 47 56 61 66 70 77 78 86 92 93 94 98 (102) 106 107 108 115 136 137 138 141. Species studied: *C. arborea*. (W. Hanvongsirawat)

Casearia: 2 5 13 (14) 22 23 24 25 30 (40) 41 (47) 48 (49) (56) (61) 62 65 69 75 94 97 (98) 102 108 (109) 115 116 136 137 138. Species studied: *C. flavovirens*, *C. grewiaefolia*. Literature: 483, 794. (J.P. Rojo)

Cassia: (1) 2 5 13 22 23 26 29 30 42 (43) 46 58 61 65 66 69 70 (76) 80 83 (85) 89 91 92 97 (98) 104 (106) 115 116 (120) (122) 136 142. Species studied: *C. fistula*, *C. javanica*. (W. Hanvongjirawat)

Casuarina: (1) 2 5 7 9 13 (14) 22 24 30 (41) (42) (46) (47) 58 (60) 62 63 66 (69) 70 76 77 86 93 94 97 98 (99) (101) 102 103 104 115 116 (136) (138) (142). Species studied: *C. cunninghamiana* Miq., *C. equisetifolia*, *C. glauca*, *C. junghuhniana*. (A. Aglua)

Cathormion: 2 5 13 22 25 26 29 30 31 42 43 46 47

58 61 65 (66) 69 (76) (79) 80 83 91 92 97 104 115 136 142 143. Species studied: *C. altissimum* (Hook. f.) Hutch. & Dandy, *C. umbellatum*. Literature: 790. (T. Veenin)

Celtis: (1) (2) 5 13 22 25 (26) 30 31 42 (43) 47 61 66 (68) 69 (79) 80 (83) (85) (92) 93 (94) (97) 98 (103) 106 107 (108) 136 137 138 (140) (141). Species studied: *C. hildebrandii*, *C. latifolia*, *C. luzonica*, *C. philippensis*, *C. rigescens*. (J.M. Fundter & E.A. Wheeler)

Ceratopetalum: (1) 2 5 12 13 14 20 21 30 (32) 41 47 48 62 (63) 66 69 (70) 86 (89) 93 94 97 (106) (107) 115 (135) 136 (138) 142 156. Species studied: *C. apetalum* D. Don, *C. succirubrum*. Literature: 269. (A. Aglua)

Cerbera: (1) 2 5 (7) (10) (12) 13 22 23 24 (25) 29 30 (40) (41) (47) (48) (61) 62 (63) 66 68 78 (86) (89) 92 93 97 (100) 107 (108) 115 (136) (142). Species studied: *C. floribunda*, *C. manghas*, *C. odollam*. Literature: 468. (K. Sidiyasa)

Chaetocarpus: 2 5 12 13 22 23 27 30 31 42 46 (56) 57 (58) 61 66 69 (70) 86 92 93 (94) 97 (98) (100) 107 108 115 (116) 136 (141) 142. Species studied: *C. castanocarpus*, *C. pearcei* Rusby, *C. schomburgkianus* (kuntze) Pax & K. Hoffm. (A.B. Ella)

Chionanthus: (1) 2 5 13 22 (23) 24 25 (26) (29) 30 (36) 41 42 (46) 47 48 (49) 61 69 (78) 78 79 80 (83) (85) 89 92 93 97 98 (103) 106 107 115 116 (150). Species studied: *C. celebicus* Koord., *C. evenius*, *C. hahlii* (Rech.) ined., *C. laxiflorus*, *C. macrocarpus*, *C. macrophyllus* (Wallich ex G. Don) Blume, *C. oblongifolius* Koord. & Valeton, *C. pachyphyllus* (Merr.) Kiew, *C. pluriflorus*, *C. ramiflorus*, *C. sessiliflorus* (Hemsl.) ined., *C. terniflorus* (Kurz) Griff. Literature: 67. (Vu-Cong Quy)

Chisocheton: (1) 2 5 13 22 24 (25) 30 (41) 42 (43) 46 (47) 58 61 65 (68) 69 (70) 78 (79) (85) (86) 93 (94) 97 104 (106) 115 (116) 136 (140) 142 (159) (160) (161). Species studied: *C. cumingianus*, *C. pentandrus*, *C.* spec. (T. Fujii)

Chrysophyllum: (1) 2 5 7 (10) (11) 13 22 23 (25) 26 27 32 (33) (41) 42 47 (48) (56) (60) 61 66 69 77 (86) 92 93 97 (98) (100) 107 108 115 (116) (136) (142) (153) (159). Species studied: *C. cainito*, *C. lanceolatum*, *C. macrophyllum* Sabine, *C. pruniforme* Engl. (J. Ilic & P. Baas)

Cleistanthus: 2 5 7 12 13 22 24 30 (35) 41 (47) (48) 61 65 69 76 77 (78) 79 (91) 92 (93) 97 102 108 (109) 116 159. Species studied: *C. angularis* Kaneh., *C. myrianthus*, *C. pseudopodocarpus* Jabl. (A.B. Ella)

Colubrina: (1) 2 5 (7) 10 13 22 23 (24) 25 30 41 42 47 58 61 66 69 70 (76) 78 79 (89) (92) 93 97 (102) (106) 107 108 115 136 137 138 (142). Species studied: *C. beccariana*. (A. Tukau Salang)

Combretocarpus: 2 5 13 22 (23) 25 26 30 (31) (32) (34) 42 43 46 58 62 66 69 70 (76) 85 93 94 (98) (99) 102 103 107 (110) 114 115 (136) (137) (138) (140) (142) (156) (159). Species studied: *C. rotundatus*. Literature: 1149. (K. Sidiyasa)

Croton: 2 5 (10) 13 22 25 26 30 41 42 46 47 61 66 68 69 76 77 78 86 92 93 97 (98) 107 (108) 116 (136) (137) (138) (139). Species studied: *C. amabilis* Müll. Arg., *C. argyratus*, *C. elliotianus* Baillon, *C. glabellus* L., *C. krabas* Gagnep., *C. oblongus* Burm. f. (A.B. Ella)

Crudia: 2 5 13 22 25 29 30 (41) 42 46 47 58 61 66 (69) 70 (80) 83 85 86 (91) 92 97 (104) 106 115 136 (141) 142 (143). Species studied: *C. obliqua* Griseb., *C. scortechinii*. (T. Veenin)

Crypteronia: (1) 2 5 13 22 (23) 25 26 29 30 (31) (32) 41 42 47 (61) 62 66 69 76 77 78 79 (86) (92) 93 97 (106) 107 116. Species studied: *C. macrophylla*, *C. paniculata*. Literature: 1148. (A. Aglua)

Ctenolophon: 2 5 9 12 14 (20) (21) (22) 30 (41) 42 47 48 60 62 63 66 (69) 70 76 (77) (78) (80) 84 93 (94) 97 (98) (102) 107 108 (115) 116 136 137 (138) 140 142. Species studied: *C. engleriana* Mildbr., *C. parvifolius*. (A. Aglua)

Cubilia: (1) 2 5 13 22 (25) 26 30 (36) (37) (38) 42 46 47 58 61 65 (67) (66) 69 75 78 91 92 93 96 97 104 (106) 115 136 138. Species studied: *C. cubili*. Literature: 570. (P. Baas)

Cyathocalyx: (1) 2 5 13 22 (23) 24 25 30 42 46 (47) 61 63 66 69 78 (79) 86 (91) 92 93 98 102 (104) (106) (107) (108) 114 (115) (124). Species studied: *C. biovulatus* Boerl., *C. carinatus* (Ridley) J. Sinclair, *C. martabanicus*, *C. pahangensis* (M.R. Hend.) J. Sinclair, *C. pruniferus*, *C. sumatranus*. Literature: 468. (K. Sidiyasa)

Dacryodes: 2 5 13 22 23 26 31 32 42 47 (48) (56) 61 65 66 (68) 69 (78) 79 92 (96) (97) 106 107 115 (130) (136) (137) (159) (160) (162). Species studied: *D. costata*, *D. incurvata*, *D. longifolia*, *D. macrocarpa*, *D. rubiginosa*, *D. rugosa*. (A. Aglua)

Dactylocladus: 2 5 13 22 (23) 25 26 29 30 31 32 34 41 42 47 62 63 66 69 (76) 80 (83) 92 93 96 (97) (106) 116 135 (radial phloem strands). Species studied: *D. stenostachys*. Literature: 1148. (A. Aglua)

Decaspermum: 1 2 5 9 13 22 24 25 29 30 41 42 47 (60) 62 (63) 66 69 76 (77) 78 (91) 92 (93) 97 98 (103) 107 (108) 115. Species studied: *D. forbesii* E.G. Baker, *D. parviflorum*, *D. ray-*

mundi Diels. Literature: 470. (Vu-Cong Quy)

Dehaasia: 2 5 (10) (11) (12) 13 22 26 27 31 32 34 42 (45) 47 56 61 65 (78) 79 80 (86) 89 92 93 97 106 107 115 124 125 (126) (159) (160). Species studied: *D. caesia*, *D. corynantha* Kosterm., *D. cuneata*, *D. incrassata*, *D. pauciflora*, *D. polyneura*. (W. Hanvongjirawat)

Deplanchea: (1) 2 5 13 22 23 26 30 42 46 47 (56) (61) (62) 66 68 (69) 80 83 (86) (91) 92 (93) 97 104 106 115 (150) (151). Species studied: *D. bancana*. Literature: 744. (Y.I. Mandang)

Dichrostachys: (1) 2 13 22 (23) 25 29 30 42 47 58 61 66 70 79 (80) 83 (84) (89) 92 97 (98) 104 115 136 142. Species studied: *D. cinerea*. (T. Veenin)

Diploknema: 2 5 (10) 12 13 22 (23) 26 31 32 33 42 46 56 (58) 61 66 69 76 78 86 92 (93) 97 100 102 107 108 109 115 153. Species studied: *D. butyracea* (Roxb.) H.J. Lam, *D. ramiflora*, *D. sebifera*. (Suleka Madhavan)

Dolichandrone: 1 2 5 (12) 13 22 23 25 26 30 41 42 (45) (46) (60) 61 66 (68) 69 79 80 83 85 86 89 91 92 93 (96) (97) (98) (104) (106) 115 (136). Species studied: *D. platycalyx* Baker, *D. spathacea*. (Y.I. Mandang)

Dryadodaphne: (1) (2) (4) (5) 12 14 20 32 (41) (42) 48 49 62 (65) 66 69 75 (76) (92) (93) (94) 98 106 (107) (114) (115) (124). Species studied: *D. novoguineensis*. (Y.S. Chang)

Drypetes: 2 5 (11) 13 14 22 24 30 41 42 47 61 66 70 76 77 (86) (88) 92 93 94 97 (100) 102 108 116 136 137 138 (139) (141) (156) 159 160 161. Species studied: *D. crassipes*, *D. longifolia*, *D.* aff. *longifolia*, *D. principium* (Müll. Arg.) Hutch. (A.B. Ella)

Dysoxylum: 1 2 5 13 22 23 24 25 30 42 43 46 47 48 (58) 61 65 66 69 (70) 80 83 86 (89) (92) 93 (94) (96) (97) (102) 106 (107) 115 (136) (137) (142). Species studied: *D. acutangulum*, *D. alliaceum*, *D. binectariferum* (Roxb.) Hook. f., *D. densiflorum*, *D. excelsum*, *D. gaudichaudianum*, *D. hongkongense* (Tutch.) Merr., *D. macrocarpum*, *D. malabaricum* Beddome ex C. DC., *D. mollissimum*, *D. oppositifolium*, *D. parasiticum*. (E.A. Wheeler & J.M. Fundter)

Ehretia: 1 (3) (5) (6) (7) (8) (10) 11 (12) 13 22 (23) 25 26 30 (36) (37) (38) (39) (41) (42) 47 (60) 61 66 69 (70) 77 78 86 89 91 (92) (97) (98) (103) (104) (106) (114) 115. Species studied: *E. acuminata*, *E. cymosa* Thonn., *E. dichotoma*. (Y.I. Mandang)

Elaeocarpus: (1) 2 5 (10) 13 22 23 27 (30) 31 (36) (39) 42 (46) 47 (48) (56) 61 65 66 (67) 68 (69) 75 (86) (89) (92) 93 (97) (98) 107 108 (110) 116 (136) (137) (138) (140). Species studied: many. Literature: 367. (A.B. Ella & J.M. Fundter)

Elateriospermum: 2 5 13 22 23 (26) 27 31 42 43 46 (47) 56 (57) 61 66 69 78 86 93 94 97 (100) 106 107 (108) (109) 115 116 (136) (140) (141) (142). Species studied: *E. tapos*. (A.B. Ella)

Eleutherandra: 2 5 (10) 13 22 25 26 31 32 42 47 (56) (57) 61 65 70 75 97 102 108 116 136 137 138. Species studied: *E. pes-cervi*. Literature: 794. (R.B. Miller)

Endiandra: (1) 2 5 (12) 13 (14) 22 23 (25) 26 27 31 32 42 (46) 47 56 61 (65) 66 68 69 76 (78) 79 80 83 85 86 (91) 92 93 97 98 106 107 (108) 115 (124) 125 126 159 160. Species studied: *E. firma* (Wallich ex Nees) Nees, *E. ledermannii*, *E. macrophylla*, *E. maingayi*, *E. palmerstonii*, *E. schlechteri* Teschner (W. Hanvongjirawat)

Endocomia: 2 5 (12) 13 (14) 22 23 26 27 31 32 34 42 46 61 (65) 66 68 69 78 79 (86) (89) 92 93 97 102 106 107 115 (132). Species studied: *E. macrocoma*, *E. rufirachis*. Literature: 789. (J. Ilic)

Engelhardtia: (1) (2) 5 13 (14) 22 25 (26) 31 32 42 46 47 (56) (61) (62) 66 68 69 77 78 79 86 92 93 97 106 107 (108) 115 (136) (141) (142). Species studied: *E. roxburghiana* Lindl. ex Wallich, *E. serrata* Blume, *E. spicata* Lesch. ex Blume. (W. Hanvongjirawat)

Eriobotrya: 1 2 5 9 13 (14) 22 24 30 (36) 41 48 (58) 49 62 63 66 70 76 77 78 93 97 100 106 (107) 115 (136) (141). Species studied: *E. bengalensis*. Literature: 1269. (A. Tukau Salang)

Erythrina: 2 5 13 22 (25) 26 29 30 (42) 43 46 61 66 (68) 69 (83) 85 90 91 98 99 104 (106) 114 120 (121) 136 142 (143). Species studied: *E. fusca*, *E. rosea* A. Dietr., *E. stricta* Roxb., *E. subumbrans*, *E. variegata*. (T. Veenin)

Erythroxylum: (1) 2 5 13 22 24 31 32 41 48 61 66 70 80 83 (84) 92 93 97 106 107 115 136 142. Species studied: *E. cuneatum*. Literature: 696. (W. Hanvongjirawat)

Eucalyptopsis: (1) 2 5 7 13 22 25 26 31 32 42 47 56 61 66 69 76 78 79 80 (83) 92 93 96 (97) (104) 106 115. Species studied: *E. papuana*. (J. Ilic)

Euonymus: 1 5 (9) 12 13 22 25 30 36 37 40 50 62 63 64 65 66 69 75 96 (97) 104 116. Species studied: *E. pendulus* Wallich ex Roxb. (A. Aglua)

Euroschinus: 2 5 3 22 23 26 31 32 42 47 61 66 (68) 69 78 (79) (80) 92 (93) 97 106 107 (108) 115 130 136 137. Species studied: *E. papuanus*, *E. falcata* Hook. f. Literature: 465. (E.A. Wheeler)

Exbucklandia: 2 5 9 12 14 20 32 41 49 62 63 66 69 (70) 76 93 97 106 107 115 136 137 138 140. Species studied: *E. populnea*. (E.A. Wheeler)

Excoecaria: (1) 2 5 (10) 13 22 (23) (25) 26 30 (41) 42 46 (47) 61 66 68 (69) 76 (77) (86) 92 93 96

(104) 106 (107) 115 116 136 137 138 (141). Species studied: *E. agallocha*. (A.B. Ella)

Fernandoa: 1 (2) 5 (7) 13 22 24 30 36 37 42 47 61 (64) 66 69 79 83 89 90 91 92 97 (98) 104 (106) 115. Species studied: *F. adolfi-friderici* (Gilg & Mildbr.) Heine, *F. macroloba*. Literature: 744. (Y.I. Mandang)

Ficus: 2 5 13 22 (23) (25) (26) (27) (30) (31) (34) 41 42 43 46 47 (56) 61 66 68 69 79 85 86 92 93 94 98 (99) (103) 106 107 (108) (110) 114 115 132 (136) (137) (138) (141). Species studied: *F. elastica*, *F. fistulosa*, *F. microcarpa*, *F. religiosa* L., *F. variegata*. (Vu-Cong Quy)

Firmiana: (1) 2 (4) 5 13 22 23 25 30 42 (43) 61 66 (68) 69 (76) (79) (80) 83 (85) 91 92 98 (99) 102 103 106 107 110 115 119 120 121 136 138 141 142 144. Species studied: *F. malayana*, *F. papuana*, *F. simplex*. (Suleka Madhavan)

Flindersia: 2 5 13 22 (23) (24) (25) 30 (41) (42) (46) 47 (58) 61 66 68 (69) 76 78 79 (86) (91) (92) (97) (98) 104 115 136 (138) 142. Species studied: *F. acuminata* C.T. White, *F. amboinensis*, *F. australis* R. Br., *F. brayleyana*, *F. ifflaiana*, *F. laevicarpa*, *F. maculosa* (Lindl.) Benth., *F. pimenteliana*, *F. schottiana*, *F. xanthoxyla* (A. Cunn. ex Hook.) Domin. (Y.S. Chang)

Galbulimima: 2 5 12 13 22 (23) 26 30 41 42 47 58 61 66 68 69 86 92 93 97 102 104 106 115 (136) (142). Species studied: *G. belgraveana*. (J.P. Rojo)

Ganophyllum: (1) 2 5 13 22 (23) 25 30 42 (43) 47 48 (49) (58) 61 62 65 69 (76) 79 80 83 89 92 93 (96) 97 104 115 (118) 136 142. Species studied: *G. falcatum*. Literature: 570. (Suleka Madhavan)

Garcinia: 2 5 (10) 13 22 23 (24) (25) 30 42 46 47 61 66 69 70 80 83 86 92 93 98 102 106 107 115 (136) (137) (138) (141) (142). Species studied: *G. borneensis* Pierre, *G. celebica*, *G. dulcis*, *G. latissima*, *G. parvifolia*. (J.P. Rojo)

Gardenia: 1 2 5 9 12 13 22 23 24 30 (40) 41 49 (50) 61 62 (63) 66 69 70 (75) 76 (77) (78) 92 93 94 97 (100) (107) (108) 115. Species studied: *G. abbeokutae* Hiern, *G. collinsae* Craib, *G. tubifera*. (A. Tukau Salang)

Garuga: 2 5 13 22 23 26 31 32 42 47 56 61 65 69 78 79 92 (97) (98) 106 107 115 130 136 137 (138) (140) (141). Species studied: *G. floribunda*. (A. Aglua)

Gastonia: 2 5 12 13 21 22 23 26 27 30 42 46 61 69 (78) 79 92 98 102 104 106 115. Species studied: *G. spectabilis*. (K. Sidiyasa)

Geijera: 2 5 13 22 25 30 41 47 58 61 66 70 (76) (78) 79 (83) (85) (86) 92 (97) (98) 104 (106) 115 136 142. Species studied: *G. salicifolia*. (Y.S. Chang)

Gironniera: 2 5 (12) 13 22 23 26 27 31 32 (34) 42 46 47 61 66 69 79 80 86 (89) 92 93 98 102 103 107 108 109 115. Species studied: *G. nervosa* Planch. (I. Bernad)

Glenniea: 1 5 13 22 (23) 25 26 30 42 61 66 69 79 (89) 91 92 96 97 104 136 138. Species studied: *G. penangensis*, *G. thorelii*. Literature: 570. (Suleka Madhavan)

Glochidion: 2 5 (12) 13 22 23 (24) 25 (30) 31 42 (43) 47 48 61 65 (66) 68 69 75 (76) 78 (79) 92 (93) 97 (98) 102 108 (110) 115 (116) (136) (137) (141) (151) (156). Species studied: *G. angulatum* C.B. Rob., *G. lanceolarium* Voigt, *G. obscurum*, *G. philippicum* (Cav.) C.B. Rob., *G. rubrum*, *G. sericeum*, *G. superbum*. (A.B. Ella)

Gomphia: 2 5 9 (12) 13 22 24 30 41 48 62 63 66 70 76 77 78 93 98 102 103 107 108 (110) 115. Species studied: *G. serrata*. (A. Tukau Salang)

Gonocaryum: 2 5 9 12 13(20) (21) 22 (23) 25 26 (27) 30 (31) (32) 41 42 47 48 62 63 66 70 76 77 78 92 93 98 102 (106) (107) (108) (110) 115 (136) (137) (138). Species studied: *G. calleryanum*, *G. litorale*, *G. minus* Sleumer (J.P. Rojo)

Gordonia: (1) 2 5 (9) 12 14 20 21 26 27 (30) 32 (34) (36) (38) 40 41 (48) 49 50 62 63 66 69 76 78 92 93 97 (102) 106 107 (108) 115 116. Species studied: *G. amboinensis*, *G. multinervis*, *G. singaporeana*, *G. taipingensis* Burkill. Literature: 262, 263. (I. Bernad)

Grevillea: 2 5 6 11 (12) 13 22 (23) 24 (25) 30 (36) (37) (39) 42 47 58 60 61 (63) 66 69 (70) 78 (80) (83) 84 (85) (86) (90) 91 92 (93) 99 102 103 106 110 114 (131). Species studied: many. (A. Tukau Salang)

Grewia: (1) (2) (4) 5 13 22 (24) 25 30 42 43 47 (48) (56) (58) 61 66 (68) 69 (70) 76 77 78 79 93 (97) 98 102 107 (108) (110) 111 115 (120) (121) 136 137 138 (140) 141 (142). Species studied: *G. excelsa* Vahl, *G. mollis* Juss. (I. Bernad)

Guettarda: (1) 2 5 (10) 13 22 (24) 25 26 29 30 41 42 (47) 48 49 61 65 69 75 76 97 (98) (100) 107 108 (115) 116 (136) (137) (153). Species studied: many species. Literature: 1092. (R.B. Miller)

Guioa: 1 5 13 22 23 24 25 30 (36) (37) (41) (42) (47) (48) (58) 61 65 (66) (67) 69 (76) 78 79 92 93 96 (97) 104 106 115 116 (136) (142) (143). Species studied: *G. bijuga*, *G. koelreuteria*, *G. pleuropteris*. Literature: 570. (Suleka Madhavan)

Gymnostoma: 2 5 7 9 13 22 25 30 42 (43) 46 47 (56) (58) (60) (61) (62) 63 66 70 76 78 86 93 94 99 102 103 104 115 (116) 136 138 (139).

Species studied: *G. papuanum*, *G. rumphianum*, *G. sumatranum*. Literature: 745. (Y.I. Mandang)

Gynotroches: 2 5 13 (14) 20 (21) 31 32 (34) 41 (42) 47 54 61 63 66 70 (77) (79) 80 (83) 86 (92) 93 (94) 99 102 103 107 108 (110) 114 115 (136) (137) (138) (142) (160). Species studied: *G. axillaris*. Literature: 1149. (A. Tukau Salang)

Gyrocarpus: (1) 2 5 13 22 23 27 31 32 42 43 46 61 66 68 69 79 80 83 90 91 92 (97) 98 102 104 114 115. Species studied: *G. americanus*. Literature: 1010. (J.P. Rojo)

Haldina: 2 5 (9) (12) 13 22 25 26 29 30 41 48 49 62 63 66 69 76 77 78 93 94 97 107 108 116. Species studied: *H. cordifolia*. (R.B. Miller)

Halfordia: 2 5 13 22 23 24 30 41 42 47 (58) 61 66 70 (76) (77) (78) 79 89 92 93 96 (97) 104 115 136 142. Species studied: *H. papuana*, *H. scleroxyla* F. v. Mueller (Y.S. Chang)

Haplolobus: (1) 2 5 (11) 13 22 23 26 31 32 42 47 56 61 65 68 69 75 78 92 93 (96) 97 106 115 136 137 (138) (140) (156) 159 160. Species studied: *H. floribundus*. (J. Ilic)

Harpullia: (1) 2 5 13 22 (23) 25 30 41 42 48 58 61 66 69 (76) (77) 79 80 (83) 92 (93) 97 106 107 115 136 142. Species studied: *H. arborea*, *H. cupanioides*, *H. myrmecophila* Merr. & L.M. Perry. Literature: 570. (Suleka Madhavan)

Helicia: 2 5 (6) 13 22 (25) (26) 30 43 46 62 63 66 69 78 79 86 92 93 99 102 103 (106) 114. Species studied: *H. albiflora* Sleumer, *H. forbesiana* F. v. Mueller, *H. rufescens* Prain. (A. Tukau Salang)

Heliciopsis: 2 5 (6) 13 22 (23) 25 26 30 (36) 39 (42) 43 46 58 61 (62) (63) 66 69 79 80 86 92 93 99 102 103 106 107 (110) 114. Species studied: *H. cockburnii*, *H. montana*, *H. rufidula*. (A. Tukau Salang)

Hernandia: 2 5 13 22 (23) 27 31 (32) 33 42 43 46 (56) 61 66 68 69 80 (83) 92 (95) 97 104 (106) 114 115 125 (136) (138) (141). Species studied: *H. didymantha* Donn. Smith, *H. nymphaeifolia*, *H. ovigera*. Literature: 789, 1010. (P. Baas & J.M. Fundter)

Hibiscus: 1 2 5 (10) (11) 13 22 23 24 25 30 (41) 42 (45) 47 48 61 66 68 69 79 80 (83) (86) 89 91 92 98 106 (107) 110 115 118 (119) 120 121 (130) (136) (137) (138) (141) 144. Species studied: *H. d'albertisii*, *H. elatus* Swartz, *H. lasiococcus* Baillon, *H. macrophyllus*, *H. mutabilis* L., *H. tiliaceus*. (Nguyen Dinh Hung)

Horsfieldia: 2 5 13 (14) (20) (21) 22 23 26 27 (30) (31) 32 33 42 46 47 61 (65) 66 69 78 79 (85) (86) (89) 93 97 106 107 108 (109) 115 132. Species studied: *H. bracteosa*, *H. grandis*, *H. irya*, *H. polyspherula*, *H. sylvestris* (Houtt.) Warb. Literature: 59. (A. Tukau Salang)

Hydnocarpus: 2 5 (10) 12 14 21 22 (23) 25 26 (27) (31) 32 (33) 41 48 49 (56) (58) 62 65 69 70 75 97 102 107 108 (109) 116 (136) (137) (138). Species studied: *H. anomala*, *H. castanea*, *H. ilicifolia* King, *H. kunstleri*, *H. sumatrana*, *H. woodii*, *H. yatesii* Merr. Literature: 483, 794. (J.P. Rojo)

Hymenodictyon: 2 5 13 22 23 25 29 30 (34) 42 46 47 62 63 66 68 69 76 77 78 (79) (86) (92) 93 97 100 102 107 108 115. Species studied: *H. orixense*. (A. Tukau Salang)

Ilex: (1) 2 5 (10) (12) 14 (20) 21 22 25 26 30 36 37 (40) 41 (47) (48) (49) 62 (63) (64) 66 69 76 77 (78) 93 94 (98) (99) 102 103 106 107 108 110 115 116 (136) (137) (140) (156). Species studied: *I. curranii* Merr., *I. cymosa*, *I. havilandii* Loes., *I. hypoglauca* (Miq.) Loes., *I. laurifolia* Zipp. ex Loes., *I. ledermannii* Loes., *I. sclerophylloides* Loes., *I. versteeghii* Merr. & L.M. Perry. Literature: 66. (K. Sidayasa)

Irvingia: 2 5 13 22 26 31 42 (46) 47 56 57 61 66 70 78 79 80 85 93 94 (97) (98) (102) 104 (106) 115 136 (141) 142. Species studied: *I. malayana*. (Suleka Madhavan)

Itoa: 2 5 13 22 (23) 26 27 31 32 34 42 47 61 (65) 66 (68) 69 75 78 (79) 93 94 107 108 115 116 136 137 (138). Species studied: *I. stapfii*. Literature: 483, 794. (J.P. Rojo)

Ixonanthes: 2 5 (7) 9 13 (20) (21) 22 30 31 32 42 (45) 46 47 60 62 63 66 70 86 94 (96) (97) 104 106 116. Species studied: *I. icosandra* Jack, *I. reticulata* Jack. (W. Hanvongjirawat)

Ixora type '**A**': 2 5 9 13 22 25 29 30 40 49 62 63 66 (69) 70 76 (77) 78 93 97 102 108 116 136. Species studied: *I. beckleri* Benth., *I. divaricata* Hutch. & Dalz., *I. macrantha* (Steud.) Bremek., *I. paludosa* Blume. (A. Tukau Salang)

Ixora type '**B**': 2 5 9 13 22 25 29 30 (40) (41) 48 62 63 66 (69) (70) 76 77 78 (85) 86 93 (94) (96) (97) 102 108 116 151. Species studied: *I. grandifolia*, *I. havilandii* Ridley, *I. malayana* Bremek., *I. parviflora* Vahl, *I. samoensis* A. Gray. (A. Tukau Salang)

Jackiopsis: 2 5 (9) (12) 13 22 24 29 30 42 47 62 63 66 70 76 (77) 78 92 97 (100) 107 108 116. Species studied: *J. ornata*. (P. Baas)

Kalappia: 2 5 13 22 23 25 26 29 30 43 46 (58) 61 66 69 80 (83) 89 (91) 92 (93) 97 (104) 106 115 118 120 (121) (136) (142). Species studied: *K. celebica*. (T. Fujii)

Khaya: 2 5 13 22 24 30 42 (43) 46 58 61 65 (66) 68 69 (76) 79 92 93 (97) 98 106 (107) 115 136 137

141 156. Species studied: *K. anthotheca*, *K. ivorensis*. (Nguyen Dinh Hung)

Kibatalia: 2 5 13 22 23 24 (25) 29 30 (41) (42) 47 62 (63) 66 68 76 77 78 92 93 97 102 (106) 107 108 (115) (116) 136 (140) 142. Species studied: *K. arborea*, *K. borneensis* (Stapf) Merr., *K. maingayi*. (K. Sidiyasa)

Kingiodendron: 2 5 13 22 23 25 26 29 30 42 46 47 (58) 61 66 69 79 80 (83) (85) (86) (89) 91 92 97 (98) (104) 106 (107) 115 129 136 137 (138) (140) 142. Species studied: *K. alternifolium*. (J.P. Rojo)

Knema: (1) 2 5 14 (20) 21 (23) 31 32 42 46 47 61 66 68 69 79 (85) 86 89 92 93 97 (100) 106 107 (108) 115 132. Species studied: *K. alvarezii* Merr., *K. cinerea*, *K. conferta*, *K. curtisii*, *K. furfuracea*, *K. intermedia*, *K. kunstleri*, *K. latifolia* Warb., *K. laurina*, *K. malayana*, *K. oblongifolia* (King) Warb., *K. rigidifolia* J. Sinclair, *K. subhirtella* W.J. de Wilde. (A. Tukau Salang)

Koilodepas: 2 5 13 22 26 31 32 42 48 56 57 (61) (62) 66 69 (70) 77 86 93 97 (100) 108 116 136 137 140. Species studied: *Koilodepas* spec. (E.A. Wheeler)

Kostermansia: 2 5 (12) 13 22 25 30 42 46 61 66 69 (76) 77 78 92 93 98 111 115 (136) (137) (142). Species studied: *K. malayana*. (K. Sidiyasa)

Lagerstroemia: (1) (2) (3) (4) (5) 13 22 (23) (24) (25) (26) (27) 29 (30) 31 (32) (34) (41) (42) (43) (46) (47) (48) (49) 61 65 (67) 69 (78) (79) (80) 83 85 (86) (90) 91 92 (93) (94) 96 (97) 104 (106) (115) 116 136 (138) 142 143. Species studied: many. Literature: 69. (T. Veenin)

Lepisanthes: (1) 2 5 13 22 (23) 25 (26) 30 41 42 47 (58) 61 65 (66) 70 (76) (80) (83) 85 86 (89) 92 93 (96) (97) 104 115 136 142. Species studied: *L. amoena* (Hassk.) Leenh., *L. divaricata* (Radlk.) Leenh., *L. rubiginosa*, *L. tetraphylla*. Literature: 570. (P. Baas)

Leptospermum: 2 5 (9) 13 22 (23) 24 25 29 30 40 41 42 45 48 49 (58) 60 62 63 66 69 70 76 (77) 78 91 92 97 (104) 106 107 115 116. Species studied: *L. javanicum*. Literature: 470, 498. (Vu-Cong Quy)

Licania: 2 5 (7) 9 13 22 (26) (27) 31 32 (33) 42 (43) 46 (47) 56 57 62 63 66 70 (76) (78) 86 93 94 (96) 97 106 116 159 160 161. Species studied: *L. splendens*. Literature: 465, 790. (P. Baas)

Lindera: (1) 2 5 13 14 22 (23) 26 (30) 32 (33) (36) (41) 42 47 (48) 56 61 (65) 66 68 (76) 78 79 (80) (83) 92 93 97 (104) 115 (124) 125. Species studied: *L. lucida*, *L. oxyphylla*. (K. Sidiyasa)

Lophostemon: (1) 2 5 (7) 9 13 22 25 29 (30) 31 32 (41) 42 47 56 60 62 63 66 69 76 (77) 78 (84) 92 (93) 96 (97) (104) (106) (107) 115 (116) 159 160. Species studied: *L. confertus*, *L. suaveolens*. (J. Ilic)

Ludekia: (1) (2) 5 9 13 22 25 29 30 (41) 42 (45) 47 (58) 62 63 66 69 76 77 78 93 97 (100) (106) (107) 108 116. Species studied: *L. bernardoi*. (T. Fujii)

Lumnitzera: 2 5 10 13 22 25 29 30 41 48 (49) (58) 61 66 69 (70) 78 (79) (89) 91 92 (93) 96 (97) 104 106 115 116. Species studied: *L. littorea*, *L. racemosa*. Literature: 1150. (I. Bernad)

Macaranga: (1) 2 5 13 (14) 22 23 26 27 (30) 31 32 41 42 43 46 47 (56) 61 66 68 (69) (76) (77) 78 86 92 93 94 97 (100) 102 (107) 108 116 (136) (137) (138) (140) (142). Species studied: many. (J.P. Rojo)

Maclurodendron: (1) 2 5 (12) 13 22 24 30 (41) 42 47 (58) 61 66 68 69 78 (79) 86 89 91 92 93 97 (102) 104 106 115. Species studied: *M. porteri*. (P. Baas)

Magnolia: 1 (2) 5 12 (13) 14 20 (21) (30) 31 32 (40) 41 42 47 48 (49) (50) (56) (61) 62 66 68 (69) 85 89 (92) 93 97 (104) 106 115. Species studied: *M. acuminata* L., *M. hypoleuca* Sieb. & Zucc., *M. macklottii*, *M. maingayi* King, *M. sororum* Seibert. (Nguyen Dinh Hung)

Mallotus: (1) 2 5 (10) 13 22 23 26 27 31 32 41 42 46 47 (56) 61 66 68 69 76 77 78 (86) 92 93 94 (96) 97 (100) 102 104 108 116 (136) (137) (138) (140) (142). Species studied: *M. macrostachyus*, *M. peltatus* (Geisel.) Müll. Arg., *M. penangensis* Müll. Arg., *M. philippensis*, *M. tenuipes* Airy Shaw. (J.P. Rojo)

Mammea: 2 5 9 13 21 26 32 (36) (38) 41 (42) (47) 48 (56) 62 63 66 69 (70) 76 77 78 80 (83) (92) 93 97 (102) 107 108 115 (130). Species studied: *M. calciphila* Kosterm., *M. reticulata* Kosterm., *M. woodii* Kosterm. (A. Tukau Salang)

Manglietia: 1 2 5 (10) (12) 14 20 21 (31) 32 (41) 42 (47) (48) 49 62 (65) 66 68 85 (86) 89 93 97 106 115. Species studied: *M. fordiana* Oliv., *M. glauca*, *M. insignis* Blume. (Nguyen Dinh Hung)

Maniltoa: (1) (2) 5 13 22 25 29 30 42 46 (47) 61 66 69 (70) 85 (89) 92 (93) 97 106 107 115 136 137 138 140 142. Species studied: *M. psilogyne*. (T. Fujii)

Maranthes: 2 5 7 9 13 22 26 32 43 (45) 46 (60) 62 63 66 (70) (76) (77) 78 86 93 94 (96) 97 (102) (104) 106 116 159 160 (161). Species studied: *M. corymbosa*. (S.C. Lim)

Mastixia: 2 5 9 12 14 20 21 26 31 32 (34) 36 38 (40) 41 (42) (47) 48 49 56 62 63 66 69 77 78 93 94 98 102 103 106 107 108 110 115 127 (136) (137) (138) (144). Species studied: *M. arborea* (Wight) Bedd., *M. kaniensis*, *M. rostrata*, *M. tetrapetala*

Merr. Literature: 854. (A. Aglua)

Mastixiodendron: (1) 2 5 (12) 13 22 (23) (24) (25) 29 30 (41) (42) (47) (48) 61 65 66 69 (70) (75) (76) 78 (91) (92) (93) 97 (98) (106) 107 115 (153). Species studied: *M. flavidum* (Seem.) A.C. Smith, *M. pachyclados*. (Y.S. Chang)

Meiogyne: (1) (2) 5 13 22 24 30 (40) 41 (46) 47 48 61 (63) 66 69 86 92 93 98 (102) 103 (104) (106) 115 (124). Species studied: *M. mindorensis* (Merr.) v. Heusden, *M. virgata*. Literature: 789. (P. Baas)

Melanochyla: 2 5 13 22 23 (26) (27) 31 (32) 42 (46) (47) 56 61 66 (68) 69 (79) 80 (83) 92 93 94 97 106 (107) 115 (130) (136) (138v). Species studied: *M. angustifolia*, *M. auriculata*, *M. beccariana* Oliv., *M. bracteata*, *M. caesia*, *M. fulvinervis*, *M. tomentosa*. Literature: 1093. (Y.I. Mandang)

Melicope: 2 5 (12) 13 22 (23) 24 25 30 41 42 46 47 61 66 68 (69) 79 80 83 (84) (85) (86) (92) (93) 97 (98) 104 115 (159) (160). Species studied: *M. bonwickii*, *M. elleryana*, *M. lunu-ankenda*. (Y.S. Chang)

Meliosma: (1) (2) 5 12 14 22 (23) (26) 27 31 32 41 42 46 47 (61) 62 (65) 66 (68) (69) (76) 78 (79) 92 (93) (94) 97 (98) (99) 102 105 107 108 109 115. Species studied: *M. pinnata*, *M. pinnata* subsp. *humilis* (Merr. & L.M. Perry) v. Beusekom, *M. pinnata* subsp. *macrophylla* (Merr.) v. Beusekom, *M. sumatrana*. (Y.S. Chang)

Memecylon: (1) 2 5 (9) 13 22 (23) 24 25 29 30 31 32 41 (42) 47 (48) (56) (58) 62 63 66 (69) 70 76 77 79 80 (83) (91) 92 93 97 (98) 106 107 108 115 134. Species studied: *M. garcinioides*, *M. paniculatum*, *M. pubescens*. Literature: 1151. (Nguyen Dinh Hung)

Merrillia: 1 5 13 22 24 30 41 48 58 61 66 69 (76) 78 (79) (85) (86) 89 92 96 (97) 104 115 136 142. Species studied: *M. caloxylon*. (T. Veenin)

Metadina: 2 5 (9) (12) 13 22 24 25 29 30 41 47 48 62 63 66 70 76 77 78 92 (93) 97 100 107 108 116. Species studied: *M. trichotoma*. Literature: 585. (P. Baas)

Mezzettia: (1) (2) 5 13 22 23 25 26 30 42 43 46 47 61 63 66 69 78 79 86 91 92 93 98 (99) 102 (104) (106) (107) 114 (124). Species studied: *M. parviflora*. Literature: 468. (K. Sidiyasa)

Michelia: 1 5 (12) 14 20 21 (31) 32 (41) 42 47 (48) 62 66 68 (69) 85 86 89 93 97 106 115 124 (125). Species studied: *M. baillonii* (Pierre) Finet & Gagnep., *M. champaca*, *M. montana*, *M. philippinensis*. (Nguyen Dinh Hung)

Microcos: 1 (2) 5 13 22 24 30 42 (46) 47 61 (63) 66 (68) 69 (70) 76 77 78 92 (93) 98 102 (103) 106 107 111 115 (136) (138) (141) (142). Species studied: *M. antidesmifolia*, *M. blattifolia*, *M. grandiflora*, *M. paniculata*. (I. Bernad)

Miliusa: 1 (2) 5 13 22 (23) 24 30 (41) 42 47 (48) (58) 61 (63) 66 69 (70) 86 (89) (91) 92 (93) (97) 98 102 106 (107) 115. Species studied: *M. koolsii*, *M. unguiculatum* (C.E.C. Fischer) J. Sinclair, *M. velutina* (DC.) Hook. f. & Thomson. (K. Sidiyasa)

Mimusops: 2 5 10 13 22 26 (27) 31 32 (33) 42 47 48 (56) 61 66 (69) 70 (76) 77 86 (92) 94 97 (100) 107 115 159 160 161. Species studied: *M. elengi*. (Suleka Madhavan)

Mitrephora: 2 5 (12) 13 22 23 24 30 41 47 61 66 69 86 91 92 97 98 (102) 104 106 (107) 115. Species studied: *M. maingayi*. (K. Sidiyasa)

Monocarpia: 1 (2) 5 13 22 25 30 (31) 36 37 (41) 42 47 61 63 66 (68) 69 77 (78) 86 92 93 98 102 103 106 107 (110) 115. Species studied: *M. euneura*. (S.C. Lim)

Morus: 1 2 3 4 (5) (6) (7) (11) 13 22 23 26 27 30 31 32 36 37 39 42 (45) 47 48 56 61 66 68 69 78 79 89 91 92 93 98 (103) 106 107 (110) 115 136 137 (141). Species studied: *M. alba*, *M. indica* L., *M. macroura*. (J.P. Rojo)

Murraya: 2 5 13 22 (23) 24 30 (41) (42) 47 58 61 65v 66 69 70 (76) 78 79 86 89 92 93 97 104 (106) 115 136 142. Species studied: *M. exotica*, *M. paniculata*. (Y.S. Chang)

Mussaendopsis: 2 5 (12) 13 22 (23) 24 (25) 29 30 (36) (37) 41 47 61 65 66 70 (75) 76 78 92 93 97 107 (108) 115. Species studied: *M. beccariana*. (Y.S. Chang)

Nauclea: 2 5 (9) 13 22 25 29 30 42 (46) 47 (58) 62 63 66 69 76 77 (78) 93 97 (100) 102 107 108 (115) (116). Species studied: *N. diderrichii* Merr., *N. officinalis*, *N. orientalis*. (Y.S. Chang)

Neesia: 2 5 13 22 23 25 26 30 (42) 43 46 61 66 68 69 (76) 77 78 79 (86) (92) 93 97 98 102 111 115 136 141 (142). Species studied: *N. altissima*, *N. kostermansiana*, *N. malayana*, *N. synandra*. (K. Sidiyasa)

Neolitsea: (1) 2 5 (12) 13 14 22 (23) (25) (26) (30) 32 (33) 41 48 56 61 (65) 66 68 69 (76) 78 (79) 91 92 (93) 97 106 (107) 115 (124) 125 (150) (153). Species studied: *N. cassia*, *N. javanica*. (K. Sidiyasa)

Neonauclea: 2 5 (9) 13 22 25 29 30 (35) 41 42 (45) 47 (48) (58) 62 63 66 69 76 77 78 94 97 (100) 102 108 (115) (116) (136) (138). Species studied: many. (T. Fujii)

Neoscortechinia: 2 5 13 22 23 (26) 27 31 (32) 42 47 (61) (62) 66 69 (70) (76) 77 86 (87) (92) 93 97 (100) (102) (107) 108 116 136 (137) (138) (140)

(142). Species studied: *N. forbesii, N. kingii, N. nicobarica*. (E.A. Wheeler)

Nephelium: 1 2 5 13 22 23 25 30 (36) (37) (38) (41) 42 (43) 46 47 58 61 65 (66) 70 (76) 80 83 89 92 93 115 116 136 141 142. Species studied: many. Literature: 570. (P. Baas)

Neuburgia: 2 5 (12) 13 22 24 25 29 30 42 46 47 61 63 66 68 69 76 (77) 78 93 94 96 (102) 105 115 (116). Species studied: *N. corynocarpa*. (T. Veenin)

Norrisia: 2 5 10 13 22 23 (24) 25 29 30 41 42 47 (48) 61 63 66 68 (75) 76 78 93 (94) 96 104 115 116 134 (135) (phloem in rays). Species studied: *N. maior, N. malaccensis*. (T. Veenin)

Nothaphoebe: 2 5 (7) (12) 13 22 23 26 27 31 32 (34) 42 47 56 61 65 68 69 78 79 (80) 92 93 (94) 97 106 107 115 124 125 (126). Species studied: *N. elata, N. heterophylla* Merr., *N. kingiana, N. panduriformis, N. umbelliflora*. (W. Hanvongjirawat)

Nyssa: 2 5 (12) 14 20 21 25 26 27 31 (32) 36 38 41 42 47 48 62 63 65 66 69 76 77 78 92 93 94 98 106 107 108 136 142. Species studied: *N. arborea, N. javanica*. Literature: 854. (A. Aglua)

Ochreinauclea: 2 5 (10) 13 22 25 29 30 41 42 47 48 62 (63) 66 69 76 77 78 92 93 97 (100) 106 107 (108) 116. Species studied: *O. maingayi*. Literature: 1069. (P. Baas)

Ochroma: 2 5 13 22 23 26 31 32 42 43 46 47 61 66 68 77* 79 92 93 98 102 (103) (106) 107 108 109 110 111 114 115 136 137. * Parenchyma in *Ochroma* consititutes a major part of the ground tissue and is difficult to classify. Species studied: *O. pyramidale*. (T. Fujii)

Ormosia: (1) (2) 5 13 22 (23) 25 (26) 29 30 41 42 46 47 (58) 61 66 (68) 69 (70) (76) 80 83 (89) 91 92 97 (98) (104) 106 115 (120) 136 142 (143). Species studied: *O. bancana, O. calavensis, O. polita, O. villamilii* Merr., *O. watsonii* C.E.C. Fisher. (T. Veenin)

Orophea: 1 (2) 5 (12) 13 22 23 24 (25) 30 41 42 47 61 66 69 78 86 (91) 92 93 98 (99) 102 (103) 104 106 (107) (110) 114 (115) 124. Species studied: *O. cumingiana* S. Vidal, *O. hexandra* Blume. (K. Sidiyasa)

Osbornia: 2 5 9 13 22 25 29 31 40 41 49 (56) (60) 62 63 66 70 76 77 78 92 96 106 107 116 159 160. Species studied: *O. octodonta*. (J. Ilic)

Osmelia: 2 5 (10) 12 13 (14) 22 (23) 24 30 (40) 41 48 49 61 65 69 (70) 75 97 (98) 102 (110) 107 108 115 116 136 137 138. Species studied: *O. grandistipulata, O. philippina*. Literature: 794. (R.B. Miller)

Pajanelia: (1) (2) 5 (12) 13 22 (23) 26 27 (30) 31 (42) (43) 46 (47) (56) 61 66 (68) 69 80 83 91 92 93 97 104 (114) 115. Species studied: *P. longifolia*. (Y.I. Mandang)

Parartocarpus: 2 5 13 22 23 26 27 30 31 32 34 43 46 (56) (57) 61 66 69 80 83 92 93 97 (98) (102) (104) (106) (107) 115 132 (136) (141). Species studied: *P. venenosus*. (J.P. Rojo)

Parastemon: 2 5 7 9 13 22 (25) (26) 32 42 (43) 45 46 (47) 62 63 66 70 (77) (78) 86 93 94 (96) (97) (100) (102) (104) (106) (107) 116 136 142. Species studied: *P. urophyllus*. (A. Tukau Salang)

Parinari: 2 5 7 9 13 22 23 26 32 34 42 43 45 46 47 62 63 66 (69) 70 76 77 78 86 93 94 (96) 97 102 (104) 106 (107) 116 159 160 (161). Species studied: *P. costata, P. sumatrana*. (A. Aglua)

Parkia: 1 4 13 22 23 25 29 30 42 46 (58) 61 66 (68) 69 (70) 76 80 83 (91) 92 97 (98) 104 115 136 142 (143). Species studied: *P. singularis, P. sumatrana, P. timoriana*. (T. Veenin)

Pellacalyx: 2 5 (6) (11) 13 (14) (20) 21 26 30 31 32 42 47 62 63 66 69 80 83 86 (93) (94) 99 102 103 (107) (108) 109 (110) 114 (115). Species studied: *P. axillaris, P. saccardianus*. Literature: 1149. (A. Tukau Salang)

Pemphis: (1) (2) (4) 5 13 22 25 29 30 41 48 56 58 61 66 70 (76) 79 80 (83) (91) 92 97 107 108 110 115 116. Species studied: *P. acidula*. Literature: 69. (P. Baas)

Perrottetia: 2 5 14 20 22 30 32 41 48 49 61 65 69 75 98 103 108 109 110 (136) (137) (138). Species studied: *P. alpestris* subsp. *moluccana, P. sandwicensis* A. Gray. (A. Aglua)

Persea: (1) 2 5 (11) (12) 13 (14) 22 (23) 26 (31) 32 (36) (39) 41 42 47 48 56 (58) 61 65 69 (76) 78 79 (91) 92 97 (104) 106 115 125. Species studied: *P. villosa* (Roxb.) Kosterm., *P.* spec. Literature: 789. (T. Veenin)

Pertusadina: (1) 2 5 (9) (12) 13 22 24 25 29 30 41 42 47 58 62 63 66 69 70 76 77 78 92 93 97 100 107 108 116. Species studied: *P. eurhyncha, P. multifolia*. Literature: 585. (P. Baas)

Petersianthus: 2 5 13 22 23 27 (30) 31 32 42 46 47 (56) 61 66 69 (70) 79 80 83 (86) 92 93 98 102 106 107 115 136 137 138 159 160 161. Species studied: *P. quadrialatus*. (J.P. Rojo)

Phoebe: (1) 2 5 (12) 13 (14) 22 23 27 31 32 42 47 56 61 65 68 69 78 79 92 93 97 106 107 115 124 (125) 126. Species studied: *P. elliptica, P. forbesii* Gamble, *P. grandis*. (W. Hanvongjirawat)

Pimelodendron: 2 5 (10) 13 22 23 27 31 41 42 46 47 (56) 61 66 69 (70) 76 77 86 (92) 93 94 97 (100) 102 (107) 108 116 (132) 136 (137) (141) 142 (159) (160). Species studied: *P. amboinicum*, *P. griffithianum*. (J.P. Rojo)

Pistacia: 1 (3) (4) 7 11 13 22 23 27 31 36 37 39 56 60 61 65 66 69 (70) 78 91 92 93 (94) 97 98 106 115 130 136 137. Species studied: *P. chinensis*. Literature: 1093. (Y.I. Mandang)

Pittosporum: (1) 2 5 (7) (11) (12) 22 (23) 25 30 36 37 (40) 41 49 (50) 61 (62) 65 69 (70) (76) 77 78 (79) 92 (93) 97 (98) (104) 106 (107) 115 (136) (137) (138) (140) (156). Species studied: *P. ferrugineum*, *P. floribundum* Wight & Arn., *P. pentandrum*, *P. poueboense* Guill., *P. rhombifolium* A. Cunn. ex Hook., *P. viridiflorum* Sims. (T. Fujii)

Planchonia: 2 5 (10) 13 22 23 25 26 (30) 31 32 (33) 42 47 56 61 66 69 70 76 77 78 86 93 94 97 107 108 115 116 (136) (137) (138) (142). Species studied: *P. grandis*, *P. papuana*, *P. spectabilis*, *P. valida*. (W. Hanvongjirawat)

Platea: 2 5 (10) 12 14 20 21 30 32 41 47 62 63 66 68 69 76 77 78 (86) 93 94 (97) 98 102 (103) 107 108 (110) 115 136 138. Species studied: *P. excelsa*, *P. latifolia*. (W. Hanvongjirawat)

Platymitra: (1) (2) 5 13 22 23 24 25 30 (41) 42 47 61 63 66 69 86 91 92 98 102 103 104 106 114 115. Species studied: *P. arborea*. Literature: 789. (J. Ilic)

Pleiogynium: 2 5 (12) 13 22 23 26 27 31 (32) (41) 42 47 56 61 65 69 (78) 79 (80) 89 92 93 97 106 107 115 (130) 136 137 138 140 (141) (142). Species studied: *P. timorense*. Literature: 1093. (K. Sidiyasa)

Pleurostylia: 1 2 5 9 13 22 23 24 30 40 (41) (48) 49 (61) 62 63 66 70 85 (86) 93 94 97 107 108 116 136 137 138 140 141. Species studied: *P. opposita*. (A. Aglua)

Ploiarium: 2 5 9 (12) 13 (31) 32 41 42 47 (56) 62 63 66 69 70 76 (77) 78 (79) (89) 91 92 (93) 97 (102) (103) 106 107 115 116. Species studied: *P. alternifolium*, *P. pulcherrimum*. Literature: 89. (P. Baas)

Polyalthia: 1 (2) 5 12 13 22 (23) 24 30 41 42 (46) 47 (48) (58) 61 (63) 66 (68) 69 (78) 86 (91) 92 (93) 98 (99) 102 103 104 106 107 114 115 (124) (136) (138) (150). Species studied: many. Literature: 468. (K. Sidiyasa)

Polyosma: 2 5 (7) 12 14 21 25 26 30 41 48 49 61 (62) 66 69 (70) (76) 77 78 92 93 (94) 97 102 (107) 108 (110) 115. Species studied: *P. integrifolia*, *P. laetevirens*, *P.* spec. (E.A. Wheeler)

Polyscias: (1) 2 5 (11) (12) (13) (14) (22) (23) (27) (31) 32 (41) (42) (46) (47) (48) 61 (65) 66 (68) (69) 78 (79) 91 92 (93) 98 (102) (103) (106) (107) (100) (114) (115). Species studied: *P. corticata* L.S. Gibbs, *P. elegans* (C. Moore & F. v. Mueller) Harms, *P. fulva* (Hiern) Harms, *P. kikuyuensis* Summerh., *P. repanda* Baker. (Y.I. Mandang)

Porterandia: 2 5 9 (12) 13 22 25 29 30 41 48 62 63 66 69 76 78 92 93 97 (98) 107 115. Species studied: *P. anisophylla*. (A. Tukau Salang)

Potoxylon: 2 5 13 22 (26) 27 (30) 31 32 (33) 42 (46) 47 (56) 61 66 69 (70) (76) (79) 80 83 93 (94) 97 (98) 106 (107) 115 124 125. Species studied: *P. melagangai*. (T. Fujii)

Prainea: (1) (2) 5 13 22 25 26 30 31 32 42 (43) 46 47 56 61 65 (66) 69 (70) 80 83 85 92 93 (97) (98) 106 (107) 115. Species studied: *P. frutescens*, *P. limpato*, *P. papuana*. (T. Veenin)

Premna: 1 (2) (4) 5 13 22 (23) 25 (30) 31 42 43 47 56 61 65 (68) 69 (78) 79 (91) 92 (97) (98) 106 114 (136) (138) (150). Species studied: *P. maxima* Fries, *P. regularis* H.J. Lam, *P. serratifolia*, *P. tomentosa*. (I. Bernad)

Protium: (1) 2 (4) 5 13 22 23 26 31 32 42 47 (48) 56 61 65 69 (78) 79 92 97 106 107 115 136 137 (138) (141). Species studied: *P. guianense* (Aubl.) March., *P. macgregorii*. (A. Aglua)

Prunus: (1) 2 5 13 22 23 24 (25) 30 (34) (36) (37) (38) (39) 42 47 48 (58) 61 (63) 68 69 (76) 78 79 (80) 92 93 (94) (97) 98 (102) 106 107 (108) (144). Species studied: *P. arborea*, *P. gazelle-peninsulae*, *P. javanica*, *P. polystachya*, all belonging to the *Pygeum* group. Literature: 1269. (A. Tukau Salang)

Pteleocarpa: 2 5 9 (12) 13 22 23 25 30 42 48 62 63 66 69 70 (76) (77) 78 (80) (83) (84) 93 94 97 (98) 106 107 115. Species studied: *P. lamponga*. (A. Aglua)

Pternandra: (1) 2 5 (9) 13 22 (25) 26 29 (30) 31 32 41 42 47 48 (56) 62 (63) 66 69 76 78 (79) 91 92 96 (97) (105) (115) 116 (133) 134 (135) (phloem in rays) 136. Species studied: *P. azurea*, *P. coerulescens*, *P. echinata*, *P. multiflora* Cogn., *P. rostrata* (Cogn.) Nayar. Literature: 1151. (Nguyen Dinh Hung)

Pterospermum: (1) 2 5 13 22 24 30 (41) (42) (43) (46) (47) (58) 61 66 (68) 69 (76) 77 78 (79) (89) 92 97 (98) (99) (102) (103) 104 106 109 111 (115) (116) (119) (120) 136 137 (140) (141) (142). Species studied: *P. acerifolium*, *P. diversifolium*, *P. elongatum*, *P. subpeltatum*. (Suleka Madhavan)

Pterygota: 2 5 13 22 23 25 30 (42) 43 46 61 66 69 (70) 79 (83) 85 86 (91) 92 98 102 (103) (106) (107) (108) 110 115 120 136 (137) (138) (139) 141. Species studied: *P. alata*, *P. horsfieldii*, *P. macrocarpa* K. Schumann. (Suleka Madhavan)

Ptychopyxis: 2 5 13 22 23 (26) (27) (31) 32 42 46 47 61 66 69 (70) (77) 86 (87) 93 94 97 (100)

(102) (107) 108 116 136 137 (140) 142. Species studied: *P. arborea*, *P. grandis*, *P. kingii*. (E.A. Wheeler)

Pyrenaria: 1 2 5 14 20 21 27 32 (35) 40 41 49 50 62 63 66 69 76 77 78 92 93 98 (103) 106 107 108 115. Species studied: *P. championi* (Nakai) H. Keng, *P. microcarpa* (Dunn.) H. Keng. Literature: 262, 263. (P. Baas)

Radermachera: (1) (2) 5 (12) 13 22 (23) 24 25 30 (41) 42 47 (48) 61 66 (68) 69 (78) (79) (80) (83) (91) 92 93 97 98 104 (106) 115. Species studied: *R. gigantea*, *R. pinnata*. (Y.I. Mandang)

Rapanea: 2 5 11 12 13 22 (23) 25 30 (40) 41 48 (49) 61 63 65 (66) 69 70 78 79 92 (93) 98 99 102 107 108 (109) 110 114 136 137 138. Species studied: *R. leuconeura* Mez, *R. melanophloeos* Mez, *R. rhododendroides* Mez. (Vu-Cong Quy)

Reinwardtiodendron: 2 5 13 22 24 30 41 42 47 48 58 61 66 70 77 78 79 80 (85) 86 93 97 104 115 136 142 159 161. Species studied: *R. celebicum*. (T. Fujii)

Rhodamnia: (1) 2 5 9 13 22 (24) 25 29 30 (41) 42 46 47 (56) (58) 60 62 63 66 69 70 76 (77) (78) (79) 80 83 (84) (85) 93 (94) 97 (98) 103 107 108 116 (136) (141) (151). Species studied: *R. cinerea*, *R. rubescens* (Benth.) Miq., *R.* spec. (J. Ilic)

Rhodoleia: (1) 2 5 (9) 12 14 20 21 32 41 48 62 63 66 69 76 92 (96) 97 (100) 107 108 116 (136) (137) (140). Species studied: *R. championi*. (J.P. Rojo)

Ryparosa: 2 5 (10) 13 14 (20) 22 23 26 27 31 32 41 42 47 61 62 65 66 69 70 75 78 92 94 97 102 108 115 136 137 (138). Species studied: *R. acuminata* Merr., *R. fasciculata*, *R.* cf. *javanica*, *R. hullettii*. Literature: 483, 794. (J.P. Rojo)

Sageraea: 1 5 13 22 23 24 30 41 42 47 48 61 (62) (63) 66 68 69 86 92 93 (97) 98 102 104 106 (107) (114) 115 (150) (151). Species studied: *S. elliptica*, *S. lanceolata*. Literature: 468. (K. Sidiyasa)

Sandoricum: 2 5 (12) 13 22 24 30 42 47 (58) 61 (62) 66 68 (76) 80 83 (85) (86) 92 93 97 (98) 106 107 (108) 115 (136) (140) (142). Species studied: *S. borneense*, *S. koetjape*. (Nguyen Dinh Hung)

Sapium: 2 5 (10) 13 22 (23) 26 (27) 31 43 46 47 61 66 68 69 76 77 86 93 94 96 102 105 108 (115) 116 (136) (137) (140) 159 160 161. Species studied: *S. baccatum*, *S. luzonicum*. (J.P. Rojo)

Saraca: 1 5 13 22 25 29 30 42 46 47 58 61 66 68 69 (79) 80 83 (89) 91 92 (93) (96) (97) 106 (107) 115 (116) 136 142 143. Species studied: *S. declinata*, *S. indica*, *S. thaipingensis*. (T. Veenin)

Sarcosperma: 2 5 7 10 12 13 22 23 26 27 31 42 47 (56) 62 66 68 69 76 77 86 92 93 97 100 108 115 116. Species studied: *S. paniculatum*. (J. Ilic)

Sarcotheca: (1) 2 5 13 22 23 26 27 31 (32) 42 (46) 47 (56) 61 65 66 68 69 (76) 78 79 93 94 96 104 106 115 116 136 142 143. Species studied: *S. diversifolia*, *S. glauca* (Hook. f.) Hallier f. (Vu-Cong Quy)

Schima: (1) 2 5 12 14 20 21 26 27 32 34 (36) (38) 41 (42) 48 49 (56) 62 63 66 69 (70) 76 (77) 78 92 93 97 106 107 (108) 115 116 (136) (142) (156). Species studied: *S. wallichii*. Literature: 262, 263. (I. Bernad)

Schizomeria: 2 5 (12) 13 14 21 22 26 (27) 30 31 32 33 41 42 (47) 48 (49) (56) 62 63 66 69 (76) (77) 78 86 93 97 (100) (102) 106 107 108 115 136 (137) 142. Species studied: *S. katastega*, *S. ovata* D. Don, *S. serrata*, *S.* spec. (T. Fujii)

Schoutenia: (1) 2 5 13 22 24 30 42 47 61 66 69 70 76 77 78 (79) (86) (89) 92 (93) (97) (98) (102) 106 (107) 115 (119) (122) 136 137 138 (139) (140) (142) (151) (154) (156). Species studied: *S. accrescens*, *S. buurmanii*, *S. ovata*. (E.A. Wheeler)

Scolopia: 2 5 (10) (12) 13 22 23 24 25 30 40 41 48 49 61 65 69 (70) 75 (78) 97 98 (100) 102 (103) 108 116 136 137 (138) 140 (143). Species studied: *S. brownii* F. v. Mueller, *S. luzonensis* (Presl) Warb., *S. spinosa*. Literature: 483, 794. (J.P. Rojo)

Scorodocarpus: 2 5 14 (20) (21) (22) 27 31 (32) 33 42 43 47 (48) 56 58 61 66 70 76 77 86 (92) 93 94 97 (100) 102 108 (115) 116. Species studied: *S. borneensis*. (Suleka Madhavan)

Scutinanthe: 2 5 13 22 26 27 31 (34) 42 46 47 61 65 68 78 79 92 (93) 97 106 107 115 159 160 161 162. Species studied: *S. brunnea*. Literature: 1191. (I. Bernad)

Scyphiphora: 2 5 9 12 13 22 23 24 25 29 30 41 47 58 62 63 66 (69) 70 76 (77) 78 94 96 (97) 100 (107) 108 115. Species studied: *S. hydrophyllacea*. (Y.S. Chang)

Securinega: 2 5 (7) 13 22 (24) 25 (26) (30) 31 32 41 42 47 56 61 65 69 75 (91) (92) 93 (94) 97 98 (103) 108 (110) 115 136 137 138. Species studied: *S. flexuosa*. Literature: 782. (J. Ilic & E.A. Wheeler)

Semecarpus: 2 5 (12) 13 22 23 26 (27) 31 (32) 42 43 46 (56) 61 66 68 80 (83) (91) 92 (93) 97 106 (107) 115 (136) (137) (140) (142). Species studied: *S. australiensis*, *S. lucens*, *S.* cf. *rufovelutinus* Ridl. Literature: 1093. (K. Sidiyasa)

Senna: 2 5 13 22 (25) 26 (27) 29 30 42 43 46 47 58 61 (65) 66 69 70 83 85 (91) 92 (93) 97 104 115 136 142. Species studied: *S. siamea*, *S. timoriensis*. (E.A. Wheeler)

Serianthes: 2 5 13 22 25 29 30 41 42 46 47 (58) 61 66 (68) (79) 80 91 92 (96) (97) 115 136 142 143. Species studied: *S. grandiflora*, *S. minahassae*, *S. myriadena*. (T. Veenin)

Siphonodon: 2 5 13 22 (23) (24) (25) 30 41 42 47 61 62 (65) 66 (69) (70) 75 98 102 (107) 108 116 136 137 138 139 140 156. Species studied: *S. australe* Benth., *S. celastrineus*. (A. Aglua)

Sloanea: (1) 2 5 13 (21) 22 (23) 26 27 31 32 42 (43) (46) 47 (56) (61) (62) (65) (66) 68 69 78 (89) 92 93 98 (99) 102 103 107 108 (110) 115 (136) (137). Species studied: *S. aberrans*, *S. chingiana* Hu, *S. clemensiae*, *S. insularis*, *S. obtusa* Planch. ex Benth., *S. pulchra*, *S. woolsiae* F. v. Mueller (J. Ilic)

Sonneratia: 2 5 (12) 13 22 (23) (25) 26 (27) 29 31 32 (33) 42 (43) 47 48 (56) 61 65 (66) 69 75 96 (97) 106 109 115 116 136 137 138 139. Species studied: *S. alba*, *S. caseolaris*, *S. griffithii*, *S. ovata*. (Suleka Madhavan)

Spondias: (1) 2 5 13 22 23 (26) 27 31 (32) 42 43 46 47 (56) 61 (65) (66) 68 78 79 (80) 92 (93) 98 (102) 106 107 (114) (115) 130 (136) (137) (138). Species studied: *S. cytherea*, *S. malayana* Kosterm., *S. mombin*, *S. philippinensis* (Elmer) Airy Shaw & Forman, *S. pinnata*. Literature: 1093. (K. Sidiyasa)

Stemonurus: 2 5 (6) (11) 13 (20) (21) (22) (23) 30 31 32 (41) (42) 47 (56) (57) 61 (63) 66 70 78 (79) 94 97 98 102 103 108 (110) 114 (136) (137) . Species studied: *S. scorpioides*, *S. secundiflorus*, *S. umbellatus*. (W. Hanvongjirawat)

Stereospermum: 1 (2) 5 (12) 13 22 23 25 26 30 42 (46) 47 61 69 (70) (79) 80 83 (89) 91 92 (93) 97 104 115. Species studied: *S. chelonoides*, *S. fimbriatum*, *S. kunthianum* Cham. (Y.I. Mandang)

Streblus: 2 5 (11) 13 22 25 31 (41) 42 48 56 58 61 66 (69) 70 79 80 83 (85) (86) 91 92 (93) 97 (102) 106 (107) 115 132 136 137 138 142. Species studied: *S. elongatus*, *S. glaber* (Merr.) Corner, *S. ilicifolia*, *S. taxoides* (Heyne) Kurz. (S.C. Lim)

Strombosia: 2 5 (10) (12) 14 (20) (21) (22) (27) (31) 32 41 42 48 49 (56) (57) 61 66 69 70 76 (77) 93 94 (96) 97 (100) 102 107 108 116 136 137 138 (140) (142). Species studied: *S. javanica*, *S. maingayi*, *S. philippinensis*, *S. pustulata* Oliv. (Suleka Madhavan)

Sympetalandra: 1 5 13 22 25 29 30 42 46 47 (58) 66 (69) 70 79 (80) (83) (84) (89) (91) 92 97 104 115 136 142 143. Species studied: *S. densiflora*. (T. Veenin)

Sympetalandra: (1) 2 5 13 22 23 25 29 30 42 43 46 (47) (58) 61 66 69 (70) 80 83 89 91 92 (96) 97 104 115 136 142. Species studied: *S. densiflora*. (J.P. Rojo)

Symplocos: (1) (2) 5 (9) (12) 14 20 21 (22) 25 (30) (31) (32) (36) (37) (38) 41 42 46 47 48 49 (50) 62 63 (64) 69 (75) 76 78 92 93 98 (99) (102) 103 107 108 (110) (115) (116) (136) (137) (138) (140) (141). Species studied: many. Literature: 1121. (P. Baas)

Tarennoidea: 2 5 13 22 24 29 30 40 49 50 62 63 66 69 76 78 92 93 97 (98) 107 108 110 116. Species studied: *T. wallichii*. Literature: 586. (P. Baas)

Teijsmanniodendron: 2 5 13 22 23 25 26 (30) 31 32 33 (42) (43) 47 61 65 (68) 69 78 (79) (91) 92 98 (102) 106 107 (108) 114 163. Species studied: *T. bogoriense*, *T. pteropodum*, *T. simplicifolium*. (I. Bernad)

Ternstroemia: 2 5 9 12 14 21 25 26 30 40 41 48 49 62 63 66 (69) (70) 76 84 93 (94) 97 98 102 (103) 107 108 (110) 115. Species studied: *T. bancana*, *T. cherryi*, *T. hosei* Ridley, *T. penangiana*. Literature: 262, 263. (I. Bernad)

Tetradium: 2 5 13 22 25 30 (36) (38) 42 46 (58) 61 66 69 78 79 (92) (93) 99 103 104 114 136 142. Species studied: *T. glabrifolium*. (Y.S. Chang)

Tetrameles: 1 2 5 13 22 23 25 26 32 (33) (34) 42 43 46 47 61 66 68 69 79 (80) (83) 91 92 (97) 98 102 106 114 (120) (121). *T. nudiflora*. (A.B. Ella)

Thespesia: 1 2 5 (11) 13 22 23 24 (25) 30 41 42 45 47 58 61 63 66 68 69 76 77 79 86 89 90 91 92 97 98 106 107 110 115 118 119 120. Species studied: *T. fissicalyx*, *T. patellifera* Borss. Waalk., *T. populnea*. (Nguyen Dinh Hung)

Timonius: (1) 2 5 (12) 13 22 (23) 24 25 29 30 41 42 47 61 (62) 66 69 70 76 (79) 80 83 (85) (86) (89) 92 93 94 (97) (98) (106) (107) 108 115 (136) (137) (138) (142). Species studied: *T. lasianthoides* Valeton, *T. nitens* Merr. & L.M. Perry, *T. timon*, *T. wallichianus*. (Y.S. Chang)

Trewia: 2 5 13 22 23 27 31 (36) (37) 42 46 47 (56) 61 62 66 68 76 77 79 86 92 97 100 108 115 116 (136) (137) (140). Species studied: *T. nudiflora*. (J.P. Rojo)

Trichadenia: 2 5 13 22 26 31 (32) 42 47 (56) 61 62 65 70 (75) (76) (78) (92) (93) 97 (98) 102 107 (108) 136 137 138 141. Species studied: *T. philippinensis*. Literature: 483, 794. (J. Ilic)

Trichospermum: 1 2 5 (9) 13 22 23 26 30 42 43 46 (47) 61 (63) 66 68 76 79 92 93 94 95 98 102 103 107 108 110 111 115 116 (119) (136) (137) (138) (139) (140) (141). Species studied: *T. discolor*, *T. javanicum*, *T. ledermannii* Burret. (I. Bernad)

Trigoniastrum: 1 5 9 13 22 25 30 42 46 47 62 63 66 70 76 77 78 (79) (80) 93 97 104 106 116 136 138 141 142. Species studied: *T. hypoleucum*. (I. Bernad)

Tristaniopsis: 2 5 7 9 13 22 25 (26) 29 31 32 42

47 56 (58) 60 62 63 66 70 76 (77) 78 (80) 84 (86) 92 (93) 96 (97) (105) 106 107 (108) 115 116 159 160. Species studied: *T. elliptica*, *T. ferruginea*, *T. merguensis*, *T. whiteana*. (J. Ilic)

Tristiropsis: 1 (2) 5 13 22 25 26 30 42 (46) 47 (58) 61 65 66 69 76 80 83 85 89 92 93 97 104 115 136 142. Species studied: *T. acutangula*. Literature: 570. (P. Baas)

Turpinia: (1) 2 5 12 14 20 21 (22) 26 30 (31) 32 41 42 47 48 49 (61) 62 63 66 69 78 (84) 92 93 (97) 98 102 (103) (107) (108) (110) 115. Species studied: *T. brachypetala*, *T. formosana* Nakai, *T. ovalifolia*, *T. paniculata* Vent., *T. pomifera*. Literature: 171. (Suleka Madhavan)

Urophyllum: 2 5 (12) 13 22 23 (24) 25 29 30 40 41 (42) 47 48 62 63 (65) 66 (68) 69 76 (77) 78 (79) (92) (93) 94 97 (98) (100) 102 (103) 107 108 115 116. Species studied: *U.* aff. *arboreum*, *U. glabrum*. (Y.S. Chang)

Vavaea: 2 5 13 22 (23) 24 30 42 47 58 61 (65) (66) 69 78 79 92 93 97 106 107 115 136 142. Species studied: *V. amicorum*. (Y.S. Chang)

Vernonia: (1) 2 5 (12) 13 22 23 24 30 (31) (32) (34) 42 (46) 47 (56) 61 (65) 66 78 (79) (91) 92 93 (102) 103 105 106 107 109 110 114 115. Species studied: *V. arborea*, *V. baccharoides* Humb., Bonpl. & Kunth., *V. conferta* Benth., *V. patens* Less. (A. Aglua)

Viticipremna: (1) 2 5 13 22 23 26 30 31 32 42 47 61 65 68 69 75 (78) 92 93 (97) 98 106 (107) 115 159 162. Species studied: *V. novae-pommeraniae*. (J. Ilic)

Wallaceodendron: (1) (2) 5 (7) 13 22 23 24 25 29 30 42 (43) 46 61 66 68 69 (79) 80 83 91 92 97 104 115 136 (142) 143. Species studied: *W. celebicum*. Literature: 915. (T. Veenin)

Walsura: 2 5 (12) 13 22 23 24 30 (41) (42) (46) 47 58 61 66 (69) 70 79 (83) (85) 86 92 93 (96) (97) 104 (106) (107) 115 (116) (136) (142). Species studied: *W. pinnata*. (Y.S. Chang)

Weinmannia: 2 5 9 12 14 20 21 32 41 48 (56) 62 63 66 69 76 78 92 93 97 (103) 107 (108) 115 136 141 143. Species studied: *W. blumei*, *W. luzoniensis*. Literature: 268, 269. (A.B. Ella)

Welchiodendron: (1) 2 5 9 13 22 25 29 31 (32) 41 48 56 60 62 63 66 69 70 76 78 (85) 86 93 94 96 104 (106) 115 116 159 160. Species studied: *W. longivalve*. (J. Ilic)

Whiteodendron: 2 5 (7) 9 13 22 26 29 31 32 43 45 47 56 60 62 63 66 70 78 80 83 94 97 106 107 115 136 142. Species studied: *W. moultonianum*. (A. Tukau Salang)

Xanthophyllum: 2 5 (7) 9 13 22 24 30 43 (45) 46 (58) 62 63 66 69 70 (76) 79 (80) (83) 86 (93) 94 (96) (97) (106) 107 (109) (136) (137) (142) (159). Species studied: many. Literature: 143. (A. Tukau Salang)

Xanthostemon: 2 5 9 13 22 25 26 29 31 32 (33) 42 (45) 47 48 56 (60) 61 62 (63) 66 70 76 78 (79) 92 93 94 96 106 107 (108) 116 159 160. Species studied: *X. bracteatus*, *X. brassii*. (Vu-Cong Quy)

Xerospermum: 1 (2) 5 13 22 (23) 24 30 (36) (37) (38) 41 42 47 (58) 61 65 66 69 (78) 79 (80) (83) (85) (86) 89 91 92 93 96 (97) 104 (106) 115 116 (136) (139) (142) (143). Species studied: *X. noronhianum*. Literature: 196, 570. (W. Hanvongjirawat)

Xylia: 1 2 (4) 13 22 (23) (24) 25 29 30 41 42 47 58 61 65 66 70 76 80 83 (84) 92 93 97 104 115 136 142 (143). Species studied: *X. xylocarpa*. Literature: 915. (T. Veenin)

Xylocarpus: 2 5 13 22 23 24 30 41 42 46 47 (48) (58) 61 65 (66) 69 (76) (78) 79 85 86 89 97 98 (104) 106 (107) 115 118 (120) (122) (131) 136 137 (138) (141). Species studied: *X. granatum*, *X. moluccensis*. (J. Ilic)

Xylopia: (1) 2 5 13 22 23 25 26 30 42 (43) 46 47 (58) 61 66 (68) 69 78 86 (91) 92 (93) 97 (98) 102 (104) 106 (107) (108) 115. Species studied: *X. ferruginea*, *X. malayana*. (K. Sidiyasa)

Zanthoxylum: 1 5 (12) 13 22 (24) (25) 30 (41) (42) 47 48 58 61 (65) 66 (68) (69) (78) (79) 89 (91) 92 (93) (97) (98) (104) (106) 114 115 (131) (136) (142). Species studied: *Z. integrifoliolum*, *Z. myriacanthum*, *Z. rhetsa*, *Z. vitiense* A.C. Smith. (Y.S. Chang)

Ziziphus type 'A': 1 5 13 (14) 22 (25) 26 27 (29) 30 42 47 58 61 (63) 66 69 70 (76) 78 79 (80) 83 86 89 92 (96) (97) (102) 104 (106) 116 136 138 141. Species studied: *Z. talanai*. Literature: 989. (P. Baas)

Ziziphus type 'B': 1 2 5 13 22 25 26 (29) 30 42 47 48 (58) 61 (63) 66 69 70 78 79 80 83 (89) 91 92 (93) 98 106 107 108 115 136 137 141 142. Species studied: *Z. affinis* Hemsl., *Z. angustifolius*. Literature: 989. (P. Baas)

Table on wood properties of selected species

This table lists the wood properties of species for which information was available in the literature.

Explanation of abbreviations

gr = green condition
AFR = Africa
AUS = Australia
BRU = Brunei
BUR = Burma (Myanmar)
CHI = China
FIJ = Fiji
IC = Indo-China
IJA = Irian Jaya
INA = India
IND = Indonesia
JAV = Java
MAL = Malaysia
NG = New Guinea
PHI = the Philippines
PMA = Peninsular Malaysia
PNG = Papua New Guinea
SA = South America
SAB = Sabah
SAR = Sarawak
SUM = Sumatra
THA = Thailand
VIE = Vietnam

Botanical name	Physical properties						shrinkage					Mechanical properties							compression			cleavage		Janka hardness			
							green to moisture content (m.c.)			green to oven-dry																	
	source	number of trees tested	origin of trees	density	at moisture content of	specific gravity (moisture content 0%)	m.c.	rad.	tang.	rad.	tang.	source	number of trees tested	origin of trees	density when tested	moisture content when tested	modulus of rupture	modulus of elasticity	parallel to grain	perpendicular to grain	shear	rad.	tang.	rad.	tang.	side	end
				kg/m³	%		%	%	%	%	%				kg/m³	%	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm	N/mm	N	N	N	N
Acrocarpus																											
A. fraxinifolius	.	.	.	.	.	.	.	.	.	.	.	924	.	INA	.	gr	79	12350	41.5	.	.	.	.	.	.	.	.
												924	.	INA	690	12	109.5	15140	50.5	.	.	.	.	.	.	.	.
Adenanthera																											
A. intermedia	934	.	PHI	910	12	.	12	3.2	3.2	6.6	7.3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
A. pavonina	.	.	.	.	.	.	.	.	.	.	.	261	1	IND	.	15	116.5	12740	67.5	.	11	49	59	.	.	.	10780
Adinandra																											
A. dumosa	678	12	PMA	610	15	0.53	.	.	.	.	.	678	12	PMA	1010	97	60.5	10835	32.5	3	8	47.5	54.5	.	.	3070	.
	387	1	PMA	.	.	.	17	2.3	2.4	.	.	678	12	PMA	.	17	87	12350	43.5	4.5	10.5	54.5	56	.	.	3650	.
A. villosa	1242	.	MAL	.	.	.	15	1.7	4.4	.	.	378	1	PMA	.	18	65	10455	37	4	8.5	36	51	.	.	3490	.
Alangium																											
A. longiflorum	934	.	PHI	.	.	.	15	0.8	1.9	3.3	6.6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Albizia																											
A. acle	934	.	PHI	760	12	.	12	1.9	3.1	4.1	6.2	934	.	PHI	1010	96	58.5	7250	22	9.5	8	.	.	.	.	4930	4585
A. lebbeck	.	.	.	.	.	.	.	.	.	.	.	267	5	INA	945	74	66	10965	35	7.5	.	.	.	.	.	4540	4650
												267	5	INA	625	8	99.5	12595	60.5	10.5	.	.	.	.	.	5540	5520
												874	.	INA	675	11	108	14200	71	.	17	.	.	.	.	6385	7230
A. procera	300	.	PNG	680	12	.	12	2.1	4.0	.	.	259	2	IND	740	16	107	12545	54.5	.	9.5–12.5	34.5	56	.	.	.	6635
A. splendens	677	3	PMA	.	.	0.54	.	.	.	2.3	4.0	677	3	PMA	945	85	71.5	10425	35.5	4	10–10.5	61	61	4730	4355	.	4830
	387	3	PMA	.	.	.	18	0.6	0.9	.	.																
												677	3	PMA	625	15	89.5	10725	44	6.5	12.5–13	49	70.5	4595	4535	.	5765
Alphitonia																											
A. excelsa	568	5	AUS	685	12	.	12	2.4	5.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Botanical name	Physical properties											Mechanical properties															
	source	number of trees tested	origin of trees	density	at moisture content of	specific gravity (moisture content 0%)	shrinkage: green to moisture content (m.c.): m.c.	shrinkage: green to moisture content (m.c.): rad.	shrinkage: green to moisture content (m.c.): tang.	shrinkage: green to oven-dry: rad.	shrinkage: green to oven-dry: tang.	source	number of trees tested	origin of trees	density when tested	moisture content when tested	modulus of rupture	modulus of elasticity	compression: parallel to grain	compression: perpendicular to grain	compression: shear	cleavage: rad.	cleavage: tang.	Janka hardness: rad.	Janka hardness: tang.	Janka hardness: side	Janka hardness: end
				kg/m³	%		%	%	%	%	%				kg/m³	%	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm	N/mm	N	N	N	N
Alseodaphne																											
A. insignis	387	3	PMA	.	.	.	15	1.6	3.2	4.0	8.1	677	3	PMA	865	45	.	.	40	4	8.5–9.5	.	.	3345	3380	.	3095
A. nigrescens	387	3	PMA	.	.	.	15	0.9	2.5	2.4	6.6	677	3	PMA	895	66	.	.	32.5	3	7–8	.	.	3055	3055	.	3380
Anisophyllea																											
A. griffithii	.	.	.	.	.	.	.	.	.	.	.	678	1	PMA	1185	58	79.5	16975	43	7	9	49	58	.	.	8275	.
												378	1	PMA	.	18	95	16835	51.5	5	11	31	74	.	.	8070	.
Anogeissus																											
A. acuminata	924	.	INA	850–880	12	.	.	.	.	4.0–4.2	7.8–8.1	924	.	INA	.	gr	86–90.5	11435–13190	42.5–45.5	.	.	.	.	.	.	.	.
												924	.	INA	850–880	12	120–142	12595–15300	55.5–68.5	.	.	.	.	.	.	.	.
A. latifolia	924	.	INA	895–960	12	.	.	.	.	3.9–4.2	7.2–7.3	924	.	INA	.	gr	79–88	10340–11965	35.5–39.5	.	.	.	.	.	.	.	.
												924	.	INA	895–960	12	95.5–108	11415–13170	43.5–51.5	.	.	.	.	.	.	.	.
Antiaris																											
A. toxicaria	300	.	PNG	380–420	12	.	12	2.2	4.3	.	.	125	5	PNG	.	gr	35	6180	18.5	.	4	29	29	1380	.	.	.
												125	5	PNG	395	12	50.5	7385	32	.	5.5–6.5	.	38.5	1690	.	.	.
Aphananthe																											
A. philippinensis	383	6	AUS	.	.	.	12	2.3	3.7	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Baccaurea																											
B. spp.	.	.	.	.	.	.	.	.	.	.	.	741	.	MAL	.	15	143	16900	64	.	16	.	.	.	.	.	.

Botanical name	Physical properties: source	number of trees tested	origin of trees	density	at moisture content of	specific gravity (moisture content 0%)	shrinkage: green to moisture content (m.c.): m.c.	rad.	tang.	green to oven-dry: rad.	tang.	Mechanical properties: source	number of trees tested	origin of trees	density when tested	moisture content when tested	modulus of rupture	modulus of elasticity	compression: parallel to grain	perpendicular to grain	shear	cleavage: rad.	tang.	Janka hardness: rad.	tang.	side	end
				kg/m³	%		%	%	%	%	%				kg/m³	%	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm	N/mm	N	N	N	N
Barringtonia *B. pendula*	678	1	PMA	650	15	0.56	.	.	.	.	.	678	1	PMA	995	91	56.5	11245	29.5	5	8	52.5	58	.	.	3785	.
	387	1	PMA	.	.	.	15	1.9	3.1	4.0	6.7	678	1	PMA	.	17	75	12350	39	7	9.5	33.5	44	.	.	3915	.
Bauhinia *B. malabarica*	934	.	PHI	.	.	.	15	1.0	2.7	2.5	4.9	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Berrya *B. cordifolia*	.	.	.	.	.	.	.	.	.	.	.	192	.	BUR	.	gr	92.5	13105	44	.	.	.	.	.	.	.	.
												192	.	BUR	960	12	117	14425	55	.	.	.	.	.	.	.	.
Blumeodendron *B. tokbrai*	387	3	PMA	.	.	.	15	2.9	5.3	4.7	8.8	677	4	PMA	1060	82	57.5	12135	26.5	4	6.5–10.5	48	63	3530	3430	.	3620
												677	4	PMA	690	18	80.5	13455	41.5	3.5	7.5–12	56	74.5	5200	5075	.	5600
B. spp.	.	.	.	.	.	.	.	.	.	.	.	741	.	MAL	.	15	109	14800	55	.	11	.	.	.	.	.	.
Bombax *B. ceiba*	.	.	.	.	.	.	.	.	.	.	.	373	5	JAV	.	117	29.5	5095	16.5	2.5	3–3.5	20	23	.	.	1570	1540
												373	5	JAV	.	17	40	6370	20	3.5	3.5–4	20	24.5	.	.	1805	1850
B. valetonii	678	1	PMA	305	15	0.27	.	.	.	.	.	678	1	PMA	625	132	23.5	4830	14	1	3.5	19.5	21	.	.	980	.
	387	1	PMA	.	.	.	15	1.7	2.4	.	.	678	1	PMA	.	17	27.5	4970	20.5	1.5	3	19.5	21	.	.	1070	.
Brachychiton *B. carruthersii*	.	.	.	.	.	.	.	.	.	.	.	125	5	PNG	.	gr	23	4155	12	.	3	.	24	980	.	.	.
												125	5	PNG	275	12	29	4775	19.5	.	4	.	26	935	.	.	.

Botanical name	Physical properties: source	number of trees tested	origin of trees	density	at moisture content of	specific gravity (moisture content 0%)	shrinkage: green to moisture content (m.c.): m.c.	rad.	tang.	green to oven-dry: rad.	tang.	Mechanical properties: source	number of trees tested	origin of trees	density when tested	moisture content when tested	modulus of rupture	modulus of elasticity	compression: parallel to grain	perpendicular to grain	shear	cleavage: rad.	tang.	Janka hardness: rad.	tang.	side	end
				kg/m³	%		%	%	%	%	%				kg/m³	%	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm	N/mm	N	N	N	N
Bridelia																											
B. insulana	.	.	.	.	.	.	.	.	.	.	.	125	5	PNG	.	gr	49	9800	26	.	6.5	.	43.5	2315	.	.	.
												125	5	PNG	550	12	67	10765	39.5	.	9	.	56	2315	2045	.	.
B. spp.	300	.	PNG	540	12	.	12	1.3	4.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bruguiera																											
B. gymnorhiza	757	.	IND	.	.	.	12	2.5	5.5	.	.	757	.	IND	.	gr	108	14700	54.5	.	12–	59	69	.	.	7960	8710
	568	3	PNG	965	12	.	12	2.5	5.5	.	.										12.5						
	934	.	PHI	975	15	.	15	1.1	4.1	4.3	12.3	757	.	IND	.	15	123.5	14505	68	.	13.5–	45	63.5	.	.	10300	7960
																					16						
B. parviflora	568	2	PNG	900	12	.	12	3.1	9.7	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Buchanania																											
B. arborescens	.	.	.	.	.	.	.	.	.	.	.	259	4	IND	.	16	67	8820	34	.	6.5–	30.5	45	.	.	.	4225
																					7.5						
B. macrocarpa	.	.	.	.	.	.	.	.	.	.	.	125	5	PNG	.	gr	28	6805	13.5	.	3.5	.	25	1070	.	.	.
												125	5	PNG	550	12	49.5	8140	28	.	6.5	.	43	1245	.	.	.
Cantleya																											
C. corniculata	678	1	PMA	930	15	0.81	.	.	.	.	.	678	1	PMA	1235	54	108	17320	53.5	.	12	73.5	91	.	.	9480	.
	387	1	PMA	.	.	.	18	1.3	1.9	.	.	678	1	PMA	.	17	128.5	18355	63	.	13	52.5	72	.	.	10280	.
												1073	8	SAR	1210	38	146	19505	67	.	13	.	17	.	.	11790	.
												1073	8	SAR	1070	14	189	20760	103	.	18	.	18	.	.	13905	.
												259	2	IND	1030–	12–	135.5–	17050–	71–	.	10–	26.5–	59–	.	.	.	11220–
															1080	15	166.5	19990	91		11.5	56	93				12375
Carallia																											
C. brachiata	568	4	AUS	710	12	.	12	0.8	3.9	.	.	124	6	AUS	.	gr	68.5	.	34.5	.	7.5–9	.	.	5785	5605	.	.
												924	.	INA	.	gr	90	12350	44.5	.	.	.	.	.	.	.	.
												924	.	INA	755	12	117.5	13855	55.5	.	.	.	.	.	.	.	.

Botanical name	Physical properties											Mechanical properties																
							shrinkage												compression			cleavage		Janka hardness				
							green to moisture content (m.c.)			green to oven-dry																		
	source	number of trees tested	origin of trees	density	at moisture content of	specific gravity (moisture content 0%)	m.c.	rad.	tang.	rad.	tang.	source	number of trees tested	origin of trees	density when tested	moisture content when tested	modulus of rupture	modulus of elasticity	parallel to grain	perpendicular to grain	shear	rad.	tang.	rad.	tang.	side	end
				kg/m³	%		%	%	%	%	%				kg/m³	%	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm	N/mm	N	N	N	N
C. spp.	678	1	PMA	755	15	0.66	.	.	.	.	.	678	1	PMA	1075	66	83.5	12420	43	7.5	11.5	61.5	72	.	.	7385	.
	387	1	PMA	.	.	.	15	0.6	2.3	2.0	7.7	678	1	PMA	755	15	103.5	13180	54.5	10.5	11	30	54.5	.	.	6765	.
Carapa																											
C. guianensis	1227	.	SA	.	.	.	.	.	.	3.1–	7.6–	1227	.	SA	815–	gr	71–	10800–	32–	.	7–9	.	31–	.	.	3900–	4200–
										5.4	8.3				960		76	12800	34			.	58			4700	5100
												1227	.	SA	580–	12	95–	12800–	44–	.	10–	.	43	.	.	5000–	6700–
															660		108	13900	56		12					5400	7500
												369	.	SA	.	58	68.5	13525	35.5	5	8.5	.	56	.	.	3695	4540
												369	.	SA	.	12	100.5	14630	59.5	5.5	10.5	.	77	.	.	5030	6900
C. procera	1227	.	SA	.	.	.	.	.	.	4.7–	8.3–	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
										6.3	9.2																
Casearia																											
C. grewiaefolia	348	1	PNG	.	.	.	12	1.9	4.0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cassia																											
C. javanica	934	.	PHI	880	16	.	15	0.8	1.3	2.8	4.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Casuarina																											
C. equisetifolia	678	3	MAL	995	15	0.86	.	.	.	.	.	678	3	MAL	1170	44	98.5	14905	52.5	9	15.5	82.5	126	.	.	11080	.
	193	.	.	.	.	.	.	.	.	6.4	11.7	678	3	MAL	.	17	123.5	16420	63.5	11	19	63	91	.	.	12905	.
	300	.	PNG	920	12	.	12	1.5	3.2	.	.	259	4	IND	840	19	93.5	14110	53	.	.	41	64.5	.	.	.	7475
	387	3	PMA	.	.	.	17	1.6	3.4	.	.	933	7	PHI	1105	12	160–	19800–	76.5–	18.5–	18.5–	.	.	.	.	14195–	13375–
																	175	21300	83	21.5	19					15600	14700
Cathormion																											
C. umbellatum	.	.	.	.	.	.	.	.	.	.	.	125	5	PNG	.	gr	96.5	15730	54.5	.	14.5	.	80.5	8765	.	.	.
												125	5	PNG	810	12	144	16905	81.5	.	19.5	.	.	7030	.	.	.

Botanical name	Physical properties											Mechanical properties															
							shrinkage												compression			cleavage		Janka hardness			
							green to moisture content (m.c.)			green to oven-dry																	
	source	number of trees tested	origin of trees	density	at moisture content of	specific gravity (moisture content 0%)	m.c.	rad.	tang.	rad.	tang.	source	number of trees tested	origin of trees	density when tested	moisture content when tested	modulus of rupture	modulus of elasticity	parallel to grain	perpendicular to grain	shear	rad.	tang.	rad.	tang.	side	end
				kg/m³	%		%	%	%	%	%				kg/m³	%	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm	N/mm	N	N	N	N
Celtis																											
C. luzonica	.	.	.	.	.	.	.	.	.	.	.	933	2	PHI	650	12	76.5–83	9550–10300	41.5–45	7.5–9	13	.	.	.	.	4395–4830	5735–6300
C. philippensis	.	.	.	.	.	.	.	.	.	.	.	259	4	IND	840	16	113.5	13915	48.5	.	11–13	43	61.5	.	.	.	7595
C. rigescens	.	.	.	.	.	.	.	.	.	.	.	125	7	PNG	.	gr	52.5	9520	27.5	1.5	4.5–8	36	52.5	2045	2090	.	1935
												125	8	PNG	570	12	79.5	11935	47	3–4	7–11.5	42.5	50.5	4160	2270	.	3960
Ceratopetalum																											
C. succirubrum	.	.	.	.	.	.	.	.	.	.	.	124	2	AUS	.	gr	.	.	32.5	.	.	.	.	3425	3295	.	4715
												124	7	AUS	610	12	107	12970	55	.	13–14.5	.	.	4115	4270	.	.
Cerbera																											
C. floribunda	348	.	PNG	450	12	.	12	2.8	5.0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Chisocheton																											
C. pentandrus	.	.	.	.	.	.	.	.	.	.	.	933	1	PHI	650	12	86–94	9740–10500	44.5–48	.	7.5	.	.	.	.	4360–4790	5525–6070
C. sp.	389	5	IJA	530	12	0.44	12	1.7	3.8	3.8	7.3	389	5	IJA	530	12	85	10800	48	5	7–7.5	.	.	3100	3400	4600	.
C. spp.	300	.	PNG	470–590	12	.	12	2.8	6.5	.	.	125	10	PNG	.	gr	61	11525	30.5	.	6.5–7.5	46.5	55.5	3205	3340	.	.
												125	10	PNG	595	12	91	13455	53	.	9.5	22	58.5	3580	3985	.	.
Chrysophyllum																											
C. lanceolatum	389	.	IJA	.	.	0.47	12	2.2	3.8	4.3	6.8	389	17	IJA	560	12	90	12000	56	6.5	8–9	.	.	3400	3700	.	5500
	538	1	PNG	445	12	0.37	12	1.9	3.6	3.4	6.0																

Botanical name	Physical properties: source	number of trees tested	origin of trees	density	at moisture content of	specific gravity (moisture content 0%)	shrinkage: green to moisture content (m.c.): m.c.	rad.	tang.	green to oven-dry: rad.	tang.	Mechanical properties: source	number of trees tested	origin of trees	density when tested	moisture content when tested	modulus of rupture	modulus of elasticity	compression: parallel to grain	perpendicular to grain	shear	cleavage: rad.	tang.	Janka hardness: rad.	tang.	side	end
				kg/m³	%		%	%	%	%	%				kg/m³	%	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm	N/mm	N	N	N	N
Combreto-carpus *C. rotundatus*	741	.	SAR	640–800	15	.	15	2.9	4.8	.	.	741	.	SAR	.	.	105	14100	50	.	9	.	.	.	.	.	.
												259	.	IND	.	gr	47	10290	32	.	.	19.5	37	.	.	.	4175
	387	3	SAR	.	.	.	19	2.2	3.6	.	.	259	.	IND	.	17	71	11170	47	.	8–10	30.5	46	.	.	.	4655
Crudia *C. curtisii*	.	.	.	.	.	.	.	.	.	.	.	267	1	PMA	1060	18	136.5	16905	69.5	.	.	.	.	13930	13750	.	13795
Ctenolophon *C. parvifolius*	387	3	PMA	.	.	.	18	2.0	3.3	.	.	677	3	PMA	1140	50	100	15730	49.5	.	13–14	74.5	101.5	6960	7140	.	7855
												677	3	PMA	940	16	122.5	18100	61.5	.	14.5–15.5	53	58.5	9875	10040	.	10850
Dactylocladus *D. stenostachys*	741	.	MAL	495–610	15	.	15	0.9–1.1	1.8–2.1	.	.	741	.	MAL	495–610	15	63–82	10800–11600	32.5–44	.	9–9.5	.	.	.	.	.	.
	756	.	IND	.	.	.	12	2.1	4.1	.	.	756	.	IND	.	15	101	12545	54	.	8–8.5	42.5	67.5	.	.	4195	4055
	387	3	BRU	.	.	.	18	1.1	1.8	.	.	162	.	SAR	685	76	45	9275	24	.	6.5–7	34.5	36.5	1750	1800	.	2620
	568	8	SAR	540	12	.	12	1.2–2.9	3.0–5.2	.	.	162	.	SAR	480	18	63	10780	32.5	.	9.5	36.5	39	1960	1915	.	3290
												571	.	.	515–570	12	86.5–96.5	.	49–55	.	8.5–0 9.5	.	.	.	.	2850–3560	.
Deplanchea *D. tetraphylla*	568	3	AUS	495	12	.	12	2.7	4.2	.	.	124	2	AUS	.	gr	35.5	.	20.5	.	.	.	.	1890	1915	.	2560
												124	2	AUS	500	12	63	8140	34.5	.	7–8.5	.	.	3050	2760	.	4025
Diploknema *D. sebifera*	387	1	SAB	.	.	.	20	2.0	3.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Botanical name	Physical properties						shrinkage					Mechanical properties							compression			cleavage		Janka hardness			
							green to moisture content (m.c.)			green to oven-dry																	
	source	number of trees tested	origin of trees	density	at moisture content of	specific gravity (moisture content 0%)	m.c.	rad.	tang.	rad.	tang.	source	number of trees tested	origin of trees	density when tested	moisture content when tested	modulus of rupture	modulus of elasticity	parallel to grain	perpendicular to grain	shear	rad.	tang.	rad.	tang.	side	end
				kg/m³	%		%	%	%	%	%				kg/m³	%	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm	N/mm	N	N	N	N
Dolichandrone *D. spathacea*	934	.	PHI	.	.	.	15	1.5	3.0	2.7	5.4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dryadodaphne *D. novoguineensis*	300	.	PNG	530	12	.	12	2.2	4.8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Drypetes *D. sibuyanensis*	.	.	.	.	.	.	.	.	.	.	.	525	5	IND	660	18	81	9900	43.5	14.5	9.5–10.5	56.5	84	.	.	5380	5870
Dysoxylum *D. alliaceum*	.	.	.	.	.	.	.	.	.	.	.	933	.	MAL	760	15	84–86	8900–9215	41.5–44	.	8.5–9.5	.	.	.	.	.	.
D. densiflorum	757	.	IND	.	.	.	.	.	.	3.8	7.2	757	.	IND	.	gr	67.5	11370	35	.	6.5–7	56.5	55	.	.	2745	4715
												757	.	IND	.	15	97.5	13230	56	.	9–9.5	47	54	.	.	4800	7085
D. excelsum	1248	1	PNG	460	15	.	15	1.4	3.3	3.4	6.8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
D. mollissimum subsp. *molle*	568	4	AUS	640	12	.	12	2.7	4.3	.	.	126	5	FIJ	.	gr	64.5	9455	31	6.5	9–9.5	59.5	64	4915	4525	.	5035
												126	5	FIJ	600	12	91	10820	50.5	9.5	13–13.5	56.5	62	4755	4970	.	6815
Ehretia *E. acuminata*	568	5	AUS	525–705	12	.	12	2.6–4.4	3.5–11.0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Elaeocarpus *E. angustifolius*	348	.	PNG	395	12	.	12	1.1	3.9	.	.	125	5	PNG	.	gr	40	7040	19.5	.	6	.	49.5	1735	.	.	.
	387	1	PMA	.	.	.	18	0.8	2.2	.	.	125	5	PNG	385	12	56.5	7865	32.5	.	8.5	.	44	1690	.	.	.
	678	1	PMA	515	15	0.44	.	.	.	.	.	678	1	PMA	770	79	46.5	9110	24.5	.	7	40.5	54.5	.	.	2270	.
												678	1	PMA	.	17	60.5	10280	34	.	7	35	47.5	.	.	2670	.

Botanical name	Physical properties: source	number of trees tested	origin of trees	density	at moisture content of	specific gravity (moisture content 0%)	shrinkage, green to moisture content (m.c.): m.c.	rad.	tang.	shrinkage, green to oven-dry: rad.	tang.	Mechanical properties: source	number of trees tested	origin of trees	density when tested	moisture content when tested	modulus of rupture	modulus of elasticity	compression: parallel to grain	perpendicular to grain	shear	cleavage: rad.	tang.	Janka hardness: rad.	tang.	side	end
				kg/m³	%		%	%	%	%	%				kg/m³	%	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm	N/mm	N	N	N	N
Elateriospermum																											
E. tapos	267	3	MAL	.	.	.	16	1.4–1.7	2.3–2.6	.	.	677	3	PMA	1075	39	.	.	54.5	5	10–13.5	.	.	7900	8015	.	8070
	387	3	PMA	.	.	.	15	2.4	3.3	5.2	7.2																
Engelhardtia																											
E. roxburghiana	.	.	.	.	.	.	.	.	.	.	.	933	.	CHI	570	15	91	10100	44	.	9–10	.	.	.	.	.	.
E. spicata	.	.	.	.	.	.	.	.	.	.	.	162	5	INA	945	107	41	6085	19	.	6.5	.	.	.	.	3325	.
												162	1	INA	575	12	67.5	9400	34.5	.	9.5	.	.	.	.	3905	.
Eriobotrya																											
E. japonica	.	.	.	.	.	.	.	.	.	.	.	1009	.	INA	965	89	34	3470	17.5	3.5	6–6.5	.	.	2135	2850	.	.
												1009	.	INA	645	12	58	7450	41	9	8–8.5	.	.	5430	4745	.	.
Erythrina																											
E. variegata	934	.	PHI	240	16	.	15	1.9	4.6	3.3	7.7	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Euonymus																											
E. javanicus	.	.	.	.	.	.	.	.	.	.	.	259	3	IND	630	17	79.5	10290	44.5	.	6.5–7.5	29.5	44	.	.	.	5900
Exbucklandia																											
E. populnea	.	.	.	.	.	.	.	.	.	.	.	193	.	INA	.	gr	60.5	10210	30.5	.	.	.	.	.	.	2780	.
												193	.	INA	.	12	108.5	13975	60.5	.	.	.	.	.	.	5095	.
												874	.	INA	640	12	71	9550	39.5	.	.	.	.	.	.	.	.
Ficus																											
F. callosa	678	1	PMA	400	15	0.35	.	.	.	.	.	678	1	PMA	850	144	.	.	19	2	5	30	40.5	.	.	1690	.
	387	1	PMA	.	.	.	17	1.0	2.2	.	.	678	1	PMA	.	16	42.5	6970	25	3	5.5	24.5	28	.	.	1690	.

Botanical name	Physical properties: source	Physical: number of trees tested	Physical: origin of trees	Physical: density (kg/m³)	Physical: at moisture content of (%)	Physical: specific gravity (moisture content 0%)	Shrinkage green to moisture content (m.c.): m.c. (%)	Shrinkage green to m.c.: rad. (%)	Shrinkage green to m.c.: tang. (%)	Shrinkage green to oven-dry: rad. (%)	Shrinkage green to oven-dry: tang. (%)	Mechanical properties: source	Mechanical: number of trees tested	Mechanical: origin of trees	density when tested (kg/m³)	moisture content when tested (%)	modulus of rupture (N/mm²)	modulus of elasticity (N/mm²)	compression: parallel to grain (N/mm²)	compression: perpendicular to grain (N/mm²)	compression: shear (N/mm²)	cleavage: rad. (N/mm)	cleavage: tang. (N/mm)	Janka hardness: rad. (N)	Janka hardness: tang. (N)	Janka hardness: side (N)	Janka hardness: end (N)
F. racemosa	568	4	AUS	480	12	.	12	1.6	4.6	.	.	124	7	AUS	395	gr	43	.	22	.	4–4.5	.	.	1760	1760	.	.
F. variegata	.	.	.	.	.	.	.	.	.	.	.	525	5	IND	240	56	23	3820	10.5	1	3.5	20	20	.	.	805	1060
												375	5	IND	290	15	31	4215	19.5	2	3.5–4	21	25	.	.	765	1315
Flindersia																											
F. amboinensis	.	.	.	.	.	.	.	.	.	.	.	125	5	PNG	.	gr	52	9455	28.5	.	8.5	.	57.5	2895	.	.	.
												125	5	PNG	555	12	86.5	12005	50	.	14.5	.	70.5	3580	.	.	.
F. brayleyana	568	20	AUS	555	12	.	12	2.9	7.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
F. ifflaiana	568	5	AUS	985	12	.	12	3.2	4.4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
F. laevicarpa	348	.	PNG	560	12	.	12	3.0	6.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	568	7	AUS	720	12	.	12	3.2	6.3																		
F. pimenteliana	348	.	PNG	560	12	.	12	3.0	6.5	.	.	125	13	PNG	.	gr	50	9175	25.5	4	7	40.5	47	2850	2805	.	.
												125	13	PNG	560	12	85.5	11455	49.5	.	13	.	75.5	3225	.	.	.
F. schottiana	568	25	AUS	670–715	12	.	12	3.1–3.6	4.8–6.2	.	.	124	16	AUS	.	gr	69.5	10555	32.5	7	8–8.5	51	52.5	.	4405	.	.
												124	19	AUS	680	12	103	13040	56	11.5	12–13	63	67	.	5340	.	.
Galbulimima																											
G. belgraveana	568	4	AUS	550	12	.	12	1.9	3.8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ganophyllum																											
G. falcatum	300	.	PNG	700–780	12	.	12	3.4	6.6	.	.	125	5	PNG	.	gr	70.5	11180	35.5	.	10	61.5	.	.	6365	.	.
												125	9	PNG	765	12	105.5	13870	59	.	16	80	105	.	8010	.	.
												933	.	IND	925	13	83–88.5	11740–12550	55.5–58	.	12–13	.	.	.	.	.	.
												124	5	AUS	825	12	105.5	8695	66	.	19–20.5	.	.	8945	8900	.	.
Garcinia																											
G. latissima	1248	1	PNG	730	15	0.70	15	1.9	4.6	4.9	10.2	1248	1	PNG	740	13	104	12840	.	.	.	.	.	.	.	.	.
G. sp.	.	.	.	.	.	.	.	.	.	.	.	259	.	IND	900	13	134.5	17150	87.5	.	9–10	23.5	46	.	.	.	.

Botanical name	Physical properties											Mechanical properties																
							shrinkage												compression			cleavage		Janka hardness				
							green to moisture content (m.c.)			green to oven-dry																		
	source	number of trees tested	origin of trees	density	at moisture content of	specific gravity (moisture content 0%)	m.c.	rad.	tang.	rad.	tang.	source	number of trees tested	origin of trees	density when tested	moisture content when tested	modulus of rupture	modulus of elasticity	parallel to grain	perpendicular to grain	shear	rad.	tang.	rad.	tang.	side	end
				kg/m³	%		%	%	%	%	%				kg/m³	%	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm	N/mm	N	N	N	N
Garuga *G. floribunda*	300	.	PNG	590– 620	12	.	12	1.5	3.2	.	.	125 125	4 4	PNG PNG	. 765	gr 12	74 97.5	11660 12970	39 53	. .	10.5 14	61.5 80	. 105	. .	6365 8010	. .	. .
Geijera *G. salicifolia*	300	.	PNG	1080	12	.	12	4.3	6.6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Glochidion *G. philippicum*	300	.	PNG	440– 650	12	.	12	2.3	8.0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Grevillea *G. robusta*	568	12	AUS	610	12	.	12	2.1	6.5	.	.	124	6	AUS	645	12	92.5	.	.	.	.	.	.	3940	3540	.	.
Haldina *H. cordifolia*	.	.	.	.	.	.	.	.	.	.	.	933 874	. .	MAL INA	760 655	15 15	84– 86 84.5	8900– 9215 9240	41.5– 44 41.5	. 9	8.5– 9.5 8.5	. .	. .	. .	. .	. 5075	. 6275
Halfordia *H. papuana*	300	.	PNG	1040	12	.	12	4.0	7.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Haplolobus *H. floribundus*	.	.	.	.	.	.	.	.	.	.	.	126 126	1 1	FIJ FIJ	. 575	gr 12	39 .	4555 .	20.5 42	4–4.5 6–7.5	5.5 11– 12.5	61 69	61.5 87.5	2690 4185	2490 3940	. .	2560 5565
Harpullia *H. arborea*	.	.	.	.	.	.	.	.	.	.	.	933	1	PHI	695	12	90– 98	9830– 10600	42.5– 46	.	13.5– 14	.	.	.	.	5340– 5870	7715– 8480

Botanical name	Physical properties						shrinkage					Mechanical properties							compression			cleavage		Janka hardness			
							green to moisture content (m.c.)			green to oven-dry																	
	source	number of trees tested	origin of trees	density	at moisture content of	specific gravity (moisture content 0%)	m.c.	rad.	tang.	rad.	tang.	source	number of trees tested	origin of trees	density when tested	moisture content when tested	modulus of rupture	modulus of elasticity	parallel to grain	perpendicular to grain	shear	rad.	tang.	rad.	tang.	side	end
				kg/m³	%		%	%	%	%	%				kg/m³	%	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm	N/mm	N	N	N	N
Hibiscus																											
H. campylosiphon	934	.	PHI	595	15	.	15	1.8	3.9	3.7	7.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
H. macrophyllus	.	.	.	.	.	.	.	.	.	.	.	192	.	INA	.	gr	83	10660	41	.	.	.	.	.	.	.	.
H. tiliaceus	568	2	AUS	550	12	.	12	1.2	2.8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Horsfieldia																											
H. irya	.	.	.	.	.	.	.	.	.	.	.	125	5	PNG	.	gr	35	8765	17.5	.	4.5	.	33.5	1335	.	.	.
												125	5	PNG	445	12	60.5	10280	34.5	.	5	.	39.5	1845	.	.	.
Ilex																											
I. cymosa	.	.	.	.	.	.	.	.	.	.	.	373	5	JAV	.	80	48.5	8035	23	7	6.5–7.5	48	62.5	.	.	2815	3105
												373	5	JAV	.	15	64	9310	30.5	9.5	7.5–9	49	64.5	.	.	3040	3470
Irvingia																											
I. malayana	387	3	PMA	.	.	.	15	2.7	4.3	5.7	9.3	677	3	PMA	1170	40	.	.	59	5.5	12.5–13.5	.	.	11335	11350	.	10295
												677	3	PMA	1040	17	.	.	70.5	12.5	16.5–18	.	.	13450	12870	.	12370
Khaya																											
K. anthotheca	.	.	.	.	.	.	.	.	.	.	.	973	2	AFR	620	12	106.5–110.5	.	48.5–52.5	.	.	.	.	.	.	.	.
K. grandifoliola	.	.	.	.	.	.	.	.	.	.	.	973	1	AFR	730	12	119.5	.	56.5	.	.	.	.	.	.	.	.
K. ivorensis	.	.	.	.	.	.	.	.	.	.	.	973	8	AFR	460–550	12	84.5–116.5	.	35.5–47	.	.	.	.	.	.	.	.
												334	.	AFR	650	gr	53	7400	25	.	7	6.5	7.5	.	.	3300	.
												334	.	AFR	530	12	83	9000	44	.	11	7	9	.	.	4200	.

Botanical name	Physical properties: source	number of trees tested	origin of trees	density	at moisture content of	specific gravity (moisture content 0%)	shrinkage green to moisture content (m.c.): m.c.	rad.	tang.	shrinkage green to oven-dry: rad.	tang.	Mechanical properties: source	number of trees tested	origin of trees	density when tested	moisture content when tested	modulus of rupture	modulus of elasticity	compression: parallel to grain	perpendicular to grain	shear	cleavage: rad.	tang.	Janka hardness: rad.	tang.	side	end
				kg/m³	%		%	%	%	%	%				kg/m³	%	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm	N/mm	N	N	N	N
K. senegalensis	.	.	.	.	.	.	.	.	.	.	.	973	3	AFR	710–810	12	114.5–127.5	.	44.5–57.5	.	.	.	.	.	.	.	.
Kibatalia																											
K. arborea	1175	3	IND	380	12	.	12	1.3	3.2	3.4	6.2	1175	3	IND	380	12	50.5	6780	24.5	4	6	10	.	.	.	.	.
Kingiodendron																											
K. alternifolium	934	.	PHI	675	16	.	15	1.5	5.7	3.6	9.7	934	.	PHI	760	52	58	12545	.	.	.	.	.	.	.	.	.
Lagerstroemia																											
L. piriformis	934	.	PHI	.	.	.	15	2.8	3.6	5.8	7.3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
L. speciosa	757	.	IND	.	.	.	.	.	.	3.8	7.2	757	.	IND	.	gr	67	9995	33	4.5–6	6.5–8.5	61.5	81	.	.	.	5605
	934	.	PHI	.	.	.	15	1.9	4.0	4.4	8.1	757	.	IND	.	15	84.5	9505	42.5	6.5–7	9–9.5	75	85	.	.	5320	5820
												259	.	IND	.	gr	62.5	8085	31	.	.	49.5	57.5	.	.	4685	.
												259	8	IND	680	17	78	9210	41	.	9–10	44	57	.	.	5880	.
												804	2	PHI	650	gr	63.5	8940	30.5	11	9.5	408.5	.	.	.	4615	5000
												933	2	PHI	670	12	88.5–96.5	9830–10600	46–50	8–9.5	10.5–11	.	.	.	.	5735–6300	6635–7290
Livistona																											
L. rotundifolia																											
butt	323	5	PHI	.	.	.	16	7.3	6.9	.	.	323	5	PHI	.	15	63	8900	32	.	1.5–2	.	.	1400	2200	.	700
middle	323	5	PHI	.	.	.	16	7.4	7.8	.	.	323	5	PHI	.	15	47	6600	.	.	1–1.5	.	.	500	1700	.	400
top	323	5	PHI	.	.	.	16	11.3	9.4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
L. rotundifolia																											
at 1 m	.	.	.	.	.	.	.	.	.	.	.	566	.	PHI	.	gr	20–74	2400–11800	13–41	.	7–54	.	.	.	.	200–600	100–200
at 7 m	.	.	.	.	.	.	.	.	.	.	.	566	.	PHI	.	gr	8–59	1200–7700	7–26	.	6–34	.	.	.	.	200–300	100–700

Botanical name	Physical properties											Mechanical properties															
							shrinkage												compression			cleavage		Janka hardness			
							green to moisture content (m.c.)			green to oven-dry																	
	source	number of trees tested	origin of trees	density	at moisture content of	specific gravity (moisture content 0%)	m.c.	rad.	tang.	rad.	tang.	source	number of trees tested	origin of trees	density when tested	moisture content when tested	modulus of rupture	modulus of elasticity	parallel to grain	perpendicular to grain	shear	rad.	tang.	rad.	tang.	side	end
				kg/m³	%		%	%	%	%	%				kg/m³	%	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm	N/mm	N	N	N	N
L. saribus																											
butt	323	5	PHI	.	.	.	16	6.7	7.1	.	.	323	5	PHI	.	15	34.5	4900	20.5	.	4–7	.	.	.	.	.	.
middle	323	5	PHI	.	.	.	16	8.7	8.0	.	.	323	5	PHI	.	15	21.5	2800	14	.	4.5–5	.	.	.	.	.	.
top	323	5	PHI	.	.	.	16	12.4	10.4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lophostemon																											
L. confertus	218	.	AUS	.	.	.	15	4.8	9.7	.	.	124	19	AUS	.	gr	78.5	11730	39	.	10.5–12.5	67	83.5	7920	7745	.	7030
												124	18	AUS	885	12	121.5	15320	64	.	16.5–18	98	110.5	9080	9125	.	8765
												933	.	IND	.	68	72–125.5	12160–16750	35.5–69.5	.	5.5–15.5	.	.	.	.	.	.
L. suaveolens	.	.	.	.	.	.	.	.	.	.	.	124	8	AUS	.	gr	62	6970	30	.	8.5–9	56.5	56.5	6230	6230	.	6185
												124	5	AUS	640	15	79.5	9385	54	.	14.5–16	92	81.5	9655	10055	.	11350
Lumnitzera																											
L. littorea	934	.	PHI	785	15	.	15	1.0	1.3	5.8	6.6	741	.	MAL	.	gr	77	14800	42	.	9.5	.	.	.	.	.	.
Macaranga																											
M. aleuritoides	348	.	PNG	385	12	.	12	1.5	3.4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
M. hosei	.	.	.	.	.	.	.	.	.	.	.	565	1	PMA	290	20	42	4940	18.5	.	.	.	.	1380	1490	.	.
M. hypoleuca	.	.	.	.	.	.	.	.	.	.	.	428	8	SAB	290	13	43	5660	23	.	.	.	.	1080	990	.	.
Magnolia																											
M. elegans	.	.	.	.	.	.	.	.	.	.	.	933	.	IND	790	14	71	10130–10590	39.5–41	.	3.5–4.5	.	.	.	.	.	.

Botanical name	Physical properties											Mechanical properties															
							shrinkage												compression			cleavage		Janka hardness			
							green to moisture content (m.c.)			green to oven-dry																	
	source	number of trees tested	origin of trees	density	at moisture content of	specific gravity (moisture content 0%)	m.c.	rad.	tang.	rad.	tang.	source	number of trees tested	origin of trees	density when tested	moisture content when tested	modulus of rupture	modulus of elasticity	parallel to grain	perpendicular to grain	shear	rad.	tang.	rad.	tang.	side	end
				kg/m³	%		%	%	%	%	%				kg/m³	%	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm	N/mm	N	N	N	N
Mallotus																											
M. floribundus	934	.	PHI	.	.	.	12	3.2	6.7	6.0	11.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
M. muticus	678	2	PMA	755	15	0.65	.	.	.	.	.	678	2	PMA	995	56	66	13250	38	4.5	9.5	49	73.5	.	.	5030	.
	387	1	PMA	.	.	.	17	2.4	.	.	.	678	2	PMA	.	18	100.5	15870	50.5	6.5	11.5	52.5	72	.	.	6050	.
M. philippensis	162	.	.	.	.	.	.	.	.	2.9	7.1	162	5	INA	1010	76	53	7370	23.5	.	8	.	.	.	.	3970	.
												162	5	INA	655	12	80.5	8805	41	.	10	.	.	.	.	5395	.
Manglietia																											
M. glauca	.	.	.	.	.	.	.	.	.	.	.	373	3	JAV	.	99	44	6860	25	4	5–5.5	33	41.5	.	.	1815	2205
												373	3	JAV	.	17	53	7350	26	4.5	5.5–7	35	41.5	.	.	1880	2460
Maniltoa																											
M. psilogyne	.	.	.	.	.	.	.	.	.	.	.	125	5	PNG	.	gr	81.5	12490	37.5	.	9	61	.	.	5385	.	.
												125	5	PNG	770	15	129.5	16420	66	.	14	68	.	.	6585	.	.
Maranthes																											
M. corymbosa	757	.	IND	.	.	.	.	.	.	4.9	9.2	757	.	.	.	gr	96	15485	49.5	.	7.5–10	57.5	101	.	.	4275	6105
	300	.	PNG	670–860	12	.	12	2.8	5.4	.	.	757	.	.	.	15	126	16660	61	.	7.5–8.5	57	73	.	.	5900	6685
	1248	1	PNG	1020	15	0.99	15	3.1–4.4	5.1–6.7	7.1–9.3	10.1–12.6	933	3	PHI	1000	12	142–155	19300–20800	74–80	.	14–14.5	.	.	.	.	10830–11900	11830–13000
												1248	1	PNG	.	14	136–194	20285–24795	.	.	.	.	.	.	.	.	.
Mastixia																											
M. pentandra	.	.	.	.	.	.	.	.	.	.	.	678	2	PMA	915	70	58	12625	29.5	4	7.5	54.5	70	.	.	3740	.
												933	1	PHI	615	12	91–99	10900–11800	45.5–49	5–6	10	.	.	.	.	3675–4040	5405–5940

Botanical name	Physical properties: source	number of trees tested	origin of trees	density (kg/m³)	at moisture content of (%)	specific gravity (moisture content 0%)	shrinkage: green to moisture content (m.c.): m.c. (%)	rad. (%)	tang. (%)	green to oven-dry: rad. (%)	tang. (%)	Mechanical properties: source	number of trees tested	origin of trees	density when tested (kg/m³)	moisture content when tested (%)	modulus of rupture (N/mm²)	modulus of elasticity (N/mm²)	compression: parallel to grain (N/mm²)	perpendicular to grain (N/mm²)	shear (N/mm²)	cleavage: rad. (N/mm)	tang. (N/mm)	Janka hardness: rad. (N)	tang. (N)	side (N)	end (N)
Mastixiodendron																											
M. pachyclados	300	.	PNG	700–760	12	.	12	3.2	8.6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	568	8	NG	810–935	12	.	12	3.0	5.4	.	.																
M. spp.	.	.	.	.	.	.	.	.	.	.	.	571	.	.	650–720	gr	69–77.5	11110–12420	34.5–38.5	.	8.5–9.5	44–49	.	.	.	4495–4985	.
Melicope																											
M. bonwickii	300	1	PNG	470	12	.	12	3.2	5.9	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
M. elleryana	348	1	PNG	385	12	.	12	1.2	3.0	.	.	124	4	AUS	605	12	93	13730	47.5	.	10	.	.	4850	4205	.	.
M. lunu-ankenda	.	.	.	.	.	.	.	.	.	.	.	376	1	JAV	.	61	39	5585	24.5	.	4.5–5.5	27.5	34.5	.	.	1410	1950
												376	1	JAV	.	15	48.5	6470	27	6	4–5	28.5	34.5	.	.	1615	2470
Memecylon																											
M. pubescens	387	3	PMA	.	.	.	15	2.7	4.0	6.4	9.4	677	3	PMA	1090	36	.	.	50.5	6.5	11–12	.	.	8595	8545	.	8900
												677	3	PMA	945	16	.	.	67	11	12	.	.	8720	8860	.	9795
Mezzettia																											
M. parviflora	678	3	PMA	705	15	0.61	.	.	.	.	.	678	3	PMA	895	61	59	12490	34.5	2.5	6.5	35	51	.	.	3250	.
	387	1	PMA	.	.	.	14	4.0	4.4	.	.	678	3	PMA	.	16	80.5	14765	51	4.5	8	35	49	.	.	3740	.
Michelia																											
M. champaca	.	.	.	.	.	.	.	.	.	.	.	259	6	IND	450	14	67	8920	39	.	5.5–6.5	26.5	34.5	.	.	.	3490
												933	.	IND	700	14	70.5–71	7980–8335	42.5–44	.	10.5–13	.	.	.	.	.	.
												267	5	INA	915	113	55.5	8240	27.5	.	.	.	.	.	.	2780	2850

Botanical name	Physical properties: source	number of trees tested	origin of trees	density (kg/m³)	at moisture content of (%)	specific gravity (moisture content 0%)	shrinkage green to moisture content (m.c.): m.c. (%)	rad. (%)	tang. (%)	shrinkage green to oven-dry: rad. (%)	tang. (%)	Mechanical properties: source	number of trees tested	origin of trees	density when tested (kg/m³)	moisture content when tested (%)	modulus of rupture (N/mm²)	modulus of elasticity (N/mm²)	compression parallel to grain (N/mm²)	compression perpendicular to grain (N/mm²)	shear (N/mm²)	cleavage rad. (N/mm)	cleavage tang. (N/mm)	Janka hardness rad. (N)	Janka hardness tang. (N)	Janka hardness side (N)	Janka hardness end (N)
M. champaca												267	5	INA	480	9	64	9570	44.5	.	.	.	.	.	.	3560	4470
												822	.	INA	895–905	113–136	55–66	8220–11925	27.5–36.5	4.5–6	6–7	.	.	2725–3165	2840–3530	.	2850–3645
												822	.	INA	490–590	12–15	62–92.5	9320–12975	36–58	5.5–8.5	7–10.5	.	.	2930–4645	3155–4480	.	3775–4430
M. spp.	387	1	PMA	.	.	.	16	1.2	1.4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Mimusops *M. elengi*	757	.	IND	.	.	.	.	.	.	4.7	11.4	757	.	IND	.	gr	98.5	15190	52	.	8.5	64.5	57	.	.	.	8360
	568	3	AUS	1010	12	.	12	3.2	5.1	.	.	757	.	IND	.	15	139	15190	65.5	.	7.5–9.5	105	110.5	.	.	9430	10270
												375	1	JAV	630	48	77	11075	39	13.5	7–7.5	54	56.5	.	.	4820	5390
												375	1	JAV	780	17	92	11370	43	12.5	8–9	51.5	60	.	.	5715	7380
												934	.	PHI	1060	39	95	12740	36.5	11	11.5	.	.	.	.	7975	8005
Monocarpia *M. euneura*	387	3	PMA	.	.	.	15	1.5	2.7	3.8	6.7	677	3	PMA	705	43	66	12970	36.5	3	7.5	41.5	47	2955	2815	.	3945
												677	3	PMA	595	17	85	13870	46	4	8.5	32	42	4315	4200	.	5165
Murraya *M. ? paniculata*	.	.	.	.	.	.	.	.	.	.	.	874	.	INA	.	12	106	12055	73.5	.	.	.	.	.	.	.	.
Mussaendopsis *M. beccariana*	.	.	.	.	.	.	.	.	.	.	.	933	.	IND	1095	16	128–139	17030–17260	70.5–81	.	.	.	.	.	.	.	.
Nauclea *N. orientalis*	300	.	PNG	500–560	12	.	12	2.4	3.9	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	568	5	AUS	440–645	12	.	12	1.6	2.8	.	.																

Botanical name	Physical properties											Mechanical properties															
							shrinkage												compression			cleavage		Janka hardness			
							green to moisture content (m.c.)			green to oven-dry																	
	source	number of trees tested	origin of trees	density	at moisture content of	specific gravity (moisture content 0%)	m.c.	rad.	tang.	rad.	tang.	source	number of trees tested	origin of trees	density when tested	moisture content when tested	modulus of rupture	modulus of elasticity	parallel to grain	perpendicular to grain	shear	rad.	tang.	rad.	tang.	side	end
				kg/m³	%		%	%	%	%	%				kg/m³	%	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm	N/mm	N	N	N	N
Neesia																											
N. altissima	387	3	PMA	.	.	.	15	1.3	2.4	3.2	5.9	677	3	PMA	625	60	50.5	8665	26.5	2.5	5.5–6	38.5	42	1970	2155	.	2890
												677	3	PMA	435	17	65	9550	32.5	2.5	7	39.5	40.5	2515	2440	.	3550
Neonauclea																											
N. calycina	934	.	PHI	860	15	.	15	1.2	2.5	3.4	6.0	934	.	PHI	930	36	95	12640	35.5	11	11	.	.	.	.	6430	6980
N. hagenii	.	.	.	.	.	.	.	.	.	.	.	125	5	PNG	.	gr	89	14075	50.5	.	13	.	65.5	7875	.	.	.
												125	5	PNG	810	12	130.5	16075	78	.	22.5	.	49	8365	.	.	.
												1248	1	PNG	730	14	98	11270	.	.	.	.	.	.	.	.	.
N. sp.	568	3	NG	680	15	.	15	1.4	3.5	4.2	8.3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Neoscortech-inia																											
N. forbesii	300	.	PNG	700	12	.	12	2.0	4.0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Neuburgia																											
N. coryno-carpa	300	.	PNG	540	12	.	12	2.9	6.7	.	.	125	5	PNG	.	gr	45.5	9455	21.5	.	6	40	39.5	2025	.	.	.
												125	5	PNG	560	12	80	12970	47	.	10.5–11	54.5	74.5	3225	.	.	.
Nothaphoebe																											
N. malabonga	934	.	PHI	495	17	.	15	1.3	3.3	1.8	3.6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Nyssa																											
N. javanica	.	.	.	.	.	.	.	.	.	.	.	933	.	IND	720	14	71	11050–11570	49–50	.	7–8	.	.	.	.	.	.
Ochroma																											
O. pyramidale	1248	1	PNG	120	15	0.10	15	0.4–0.6	2.4–3.9	1.0–1.5	4.4–5.3	1248	1	PNG	100–130	13	8.5–12.5	1155–1645	.	.	.	.	.	.	.	.	.

Botanical name	Physical properties											Mechanical properties															
							shrinkage												compression			cleavage		Janka hardness			
							green to moisture content (m.c.)			green to oven-dry																	
	source	number of trees tested	origin of trees	density	at moisture content of	specific gravity (moisture content 0%)	m.c.	rad.	tang.	rad.	tang.	source	number of trees tested	origin of trees	density when tested	moisture content when tested	modulus of rupture	modulus of elasticity	parallel to grain	perpendicular to grain	shear	rad.	tang.	rad.	tang.	side	end
				kg/m³	%		%	%	%	%	%				kg/m³	%	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm	N/mm	N	N	N	N
O. pyramidale												1172	.	PHI	.	gr	31	4605	16.5	2.5	.	.	.	.	.	.	1625
												1172	.	PHI	.	12	56.5	6410	23.5	5	.	.	.	.	.	.	2410
Oncosperma																											
O. tigillarium																											
at 2 m	.	.	.	.	.	.	.	.	.	.	.	566	.	THA	.	17	170	22000	98	.	17	.	.	.	.	.	.
at 12 m	.	.	.	.	.	.	.	.	.	.	.	566	.	THA	.	17	80	10000	40	.	6	.	.	.	.	.	.
Parartocarpus																											
P. venenosus	1248	1	PNG	430	15	.	15	1.8	4.0	3.9	7.8	1248	1	PNG	450	15	62	8495	.	.	.	.	.	.	.	.	.
	387	3	PMA	.	.	.	15	2.0	4.4	4.2	9.4	677	3	PMA	850	69	44.5	10315	23	2.5	6–6.5	40	45.5	2235	2100	.	2680
												677	3	PMA	610	17	68.5	12025	35	3	9–9.5	45.5	50	3300	3280	.	4195
Parastemon																											
P. urophyllus	387	2	PMA	.	.	.	15	2.7	4.8	.	.	677	3	PMA	1250	49	93.5	17540	48	.	14–14.5	79.5	89.5	8420	7990	.	8365
												677	3	PMA	1075	18	130	21130	67	.	15.5–16.5	44	65.5	12610	11880	.	12670
Parinari																											
P. costata	387	5	PMA	.	.	.	16	1.6	2.6	.	.	677	5	PMA	1120	51	96	18210	48	.	10–11.5	59.5	80.5	6230	5815	.	7190
	678	5	PMA	895	15	0.77	.	.	.	.	.																
Parkia																											
P. singularis	.	.	.	.	.	.	.	.	.	.	.	933	.	MAL	700	15	55–57.5	10400–10700	31–33.5	.	7.5–8.5	.	.	.	.	.	.
P. speciosa	387	3	PMA	.	.	.	19	1.3	1.8	.	.	16	.	MAL	.	15	55	10700	31	.	7.5	.	.	.	.	.	.
												677	3	PMA	940	119	48.5	9590	24.5	.	8–8.5	44.5	45.5	2410	2445	.	3375
P. timoriana	387	1	PMA	.	.	.	17	0.8	2.0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Botanical name	Physical properties											Mechanical properties															
							shrinkage												compression			cleavage		Janka hardness			
							green to moisture content (m.c.)			green to oven-dry																	
	source	number of trees tested	origin of trees	density	at moisture content of	specific gravity (moisture content 0%)	m.c.	rad.	tang.	rad.	tang.	source	number of trees tested	origin of trees	density when tested	moisture content when tested	modulus of rupture	modulus of elasticity	parallel to grain	perpendicular to grain	shear	rad.	tang.	rad.	tang.	side	end
				kg/m³	%		%	%	%	%	%				kg/m³	%	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm	N/mm	N	N	N	N
Pemphis *P. acidula*	934	.	PHI	.	.	.	15	0.5	0.7	5.4	8.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Persea *P. ? rimosa*	.	.	.	.	.	.	.	.	.	.	.	374	.	IND	.	50	56.5	.	25	7.5	7–9	40.5	51.5	.	.	3010	3490
												374	.	IND	.	16	71.5	.	31.5	10	7.5–10	45	55	.	.	3310	4370
Petersianthus *P. quadria-latus*	804	1	PHI	.	.	.	12	3.2	5.5	5.6	11.8	665	1	PHI	.	gr	69	11180	33.5	4.5	8.5	.	58.5	.	.	5160	5205
												665	1	PHI	.	17	122	14350	58.5	7	12	.	43.5	.	.	8320	10190
												666	1	PHI	.	gr	69	11170	25	7.5	8	.	27.5	.	.	5175	4470
												666	1	PHI	.	12	118.5	14310	49	10	16.5	.	13	.	.	8260	10585
Pimeloden-dron *P. amboinicum*	300	.	PNG	510–600	12	.	12	2.5	5.2	.	.	125	4	PNG	.	gr	51	12835	29	.	7.5	.	56.5	2895	.	.	.
												125	4	PNG	625	12	95	16010	53.5	.	11.5	.	62.5	4140	.	.	.
	1248	1	PNG	660	15	.	15	1.4	3.8	3.9	8.1	1248	1	PNG	670	13	98.5	12935	.	.	.	.	.	.	.	.	.
	348	.	PNG	600–625	12	.	12	2.1	4.4	.	.																
Planchonia *P. papuana*	300	1	PNG	680–720	12	.	12	2.7	7.2	.	.	125	5	PNG	.	gr	62	11245	34.5	.	10.5	.	78	6410	5160	.	.
												125	5	PNG	745	12	104	13110	53	.	16.5	.	98	6230	.	.	.
P. spectabilis	.	.	.	.	.	.	.	.	.	.	.	934	.	PHI	1030	43	64.5	8820	21	9	10	.	.	.	.	7320	6850
P. valida	.	.	.	.	.	.	.	.	.	.	.	933	.	IND	.	65	78.5–123.5	12160–16480	39.5–68.5	.	6–7.5	.	.	.	.	.	.

Botanical name	Physical properties											Mechanical properties															
							shrinkage												compression			cleavage		Janka hardness			
							green to moisture content (m.c.)			green to oven-dry																	
	source	number of trees tested	origin of trees	density	at moisture content of	specific gravity (moisture content 0%)	m.c.	rad.	tang.	rad.	tang.	source	number of trees tested	origin of trees	density when tested	moisture content when tested	modulus of rupture	modulus of elasticity	parallel to grain	perpendicular to grain	shear	rad.	tang.	rad.	tang.	side	end
				kg/m³	%		%	%	%	%	%				kg/m³	%	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm	N/mm	N	N	N	N
Platymitra *P. arborea*	.	.	.	.	.	.	.	.	.	.	.	933	2	PHI	865	12	127–138	15200–16400	57–61.5	10–12	12–12.5	.	.	.	.	8525–9370	8680–9540
Pleiogynium *P. timorense*	300	.	PNG	630–950	12	.	12	2.4	5.1	.	.	125 125	5 5	PNG PNG	. 735	gr 12	92 134.5	14905 15870	56.5 84	. .	12 20.5	. .	65 95	7830 7565	. .	. .	. .
Polyalthia *P. oblongifolia*	300	1	PNG	550	12	.	12	1.5	4.5	.	.	125 125	5 4	PNG PNG	. 590	gr 12	56 86.5	10280 12215	31.5 58	. .	4–6.5 7.5–12	39.5 26	53.5 52.5	3270 4050	3470 .	. .	. .
P. rumphii	934	.	PHI	.	.	.	15	0.9	2.3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Polyscias *P. nodosa*	934	.	PHI	515	15	.	15	2.0	4.8	4.0	7.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Potoxylon *P. melagangai*	1099 741	1 .	SAR MAL	995 590–850	18 15	. .	15 15	1.1 2.4	2.4 4.4	4.6 .	7.5 .	1099 1099	1 1	SAR SAR	1130 890	55 17	115 135	15200 15000	58 69	. .	10.5 14	14 14	. .	. .	. .	7680 8420	. .
Prunus *P. arborea* *P. turneriana*	. 568	. 2	. AUS	. 540	. 12	. .	. 12	. 2.6	. 5.9	. .	. .	933 124	. 3	IC AUS	435 515	12 12	64 87	. .	40–43 44.5	. .	. .	. .	. .	. 3405	. 3470	. .	. .
Pterospermum *P. javanicum*	678 757 387	1 . 1	PMA IND PMA	495 . .	15 . .	0.43 . .	. . 15	. . 2.0	. . 3.7	. 3.6 4.0	. 8.5 5.8	678 757 757	1 . .	MAL IND IND	675 . .	62 gr 15	47 40.5 48	7865 7350 8135	23 19 24.5	4 2–2.5 2.5	7.5 3 1.5–2	40.5 33.5 32.5	47.5 34.5 37	. . .	. . .	2895 1765 .	. 1850 .

Botanical name	Physical properties											Mechanical properties															
							shrinkage												compression			cleavage		Janka hardness			
							green to moisture content (m.c.)			green to oven-dry																	
	source	number of trees tested	origin of trees	density	at moisture content of	specific gravity (moisture content 0%)	m.c.	rad.	tang.	rad.	tang.	source	number of trees tested	origin of trees	density when tested	moisture content when tested	modulus of rupture	modulus of elasticity	parallel to grain	perpendicular to grain	shear	rad.	tang.	rad.	tang.	side	end
				kg/m³	%		%	%	%	%	%				kg/m³	%	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm	N/mm	N	N	N	N
P. javanicum												259	4	IND	510	17	74	9015	36	.	5.5–7.5	26.5	36.5	.	.	.	3745
												376	1	SUM	.	67	52.5	7545	29	2–2.5	4.5–5.5	35.5	40	.	.	2325	2755
												376	1	SUM	440	17	62.5	7840	32.5	6.5–8	4–5	35.5	41	.	.	2315	3040
												933	1	MAL	495	18	54–68	7000–7500	29–35.5	4–4.5	7–8.5	45	47	.	.	3290–3555	.
Pterygota *P. horsfieldii*	300	.	PNG	640–750	12	.	12	2.3	5.9	.	.	125	5	PNG	.	gr	72	12970	37.5	.	7	.	52	5205	.	.	.
												125	5	PNG	775	12	109	15665	6.5	.	10.5	.	59.5	6495	.	.	.
												378	1	MAL	.	13	71	11015	41	6.5	9	39	60	.	.	3410	.
												678	1	PMA	865	80	51.5	9245	27.5	3	7.5	44	59.5	.	.	3470	.
Sapium *S. baccatum*	387	3	PMA	.	.	.	15	0.8	1.8	2.1	4.9	677	3	PMA	620	75	.	.	19.5	2	5–5.5	.	.	1285	1230	.	2060
Saraca *S. thaipingensis*	387	3	PMA	.	.	.	15	1.3	3.3	3.1	8.2	677	3	PMA	1025	78	.	.	27	3	7–7.5	.	.	3785	3905	.	3755
Schima *S. wallichii*	757	2	IND	.	.	.	.	.	.	4.7–4.8	8.6–10.6	757	.	IND	.	gr	61	10290	43	.	4–4.5	59.5	58	.	.	2830	3820
												757	.	IND	.	15	78.5	11170	43	.	4.5	59.5	73	.	.	3390	4095
	387	3	PMA	.	.	.	19	2.1	3.4	.	.	259	6	IND	700	15	98	14600	54	.	8–10.5	34.5	51	.	.	.	4950
												677	3	PMA	980	64	65.5	10390	32.5	4	9–10	64	72	4230	4310	.	4515
												677	3	PMA	735	17	88	12070	46.5	5.5	12–13	67.5	89.5	5650	5655	.	5855

Botanical name	Physical properties						shrinkage					Mechanical properties							compression			cleavage		Janka hardness			
							green to moisture content (m.c.)			green to oven-dry																	
	source	number of trees tested	origin of trees	density	at moisture content of	specific gravity (moisture content 0%)	m.c.	rad.	tang.	rad.	tang.	source	number of trees tested	origin of trees	density when tested	moisture content when tested	modulus of rupture	modulus of elasticity	parallel to grain	perpendicular to grain	shear	rad.	tang.	rad.	tang.	side	end
				kg/m³	%		%	%	%	%	%				kg/m³	%	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm	N/mm	N	N	N	N
Schizomeria *S. serrata*	.	.	.	.	.	.	.	.	.	.	.	125	5	PNG	.	gr	68.5	14005	34	.	9	.	67.5	4115	.	.	.
												125	5	PNG	645	12	112.5	16420	64	.	12.5	.	72.5	4805	.	.	.
Schoutenia *S. ovata*	.	.	.	.	.	.	.	.	.	.	.	259	3	IND	960	18	142.5	14895	69.5	.	12–15.5	55	61.5	.	.	.	11955
												376	.	JAV	.	52	106.5	11660	57	19	8.5–9.5	81.5	88	.	.	6675	7595
												376	.	JAV	.	17	125	12350	60.5	22	10–13.5	64.5	74.5	.	.	8400	9800
Scorodocarpus *S. borneensis*	757	.	IND	.	.	.	.	.	.	4.8	5.7	757	.	IND	.	gr	61.5	7940	35.5	.	8–9.5	55.5	77	.	.	6960	7965
	387	3	PMA	.	.	.	16	1.7	3.2	.	.	259	.	IND	.	gr	99.5	11415	53	.	.	30.5	58.5	.	.	.	7250
	1052	.	SUM	.	.	.	.	.	.	4.1	9.3	259	5	IND	940	18	122.5	14895	65.5	.	8.5–12.5	34.5	63.5	.	.	.	8695
												677	4	PMA	1085	64	77.5	13315	44.5	4.5	7.5–10	45.5	61.5	5875	5605	.	5965
												677	4	PMA	840	16	107	14905	57	5	8.5–12	45.5	66.5	6230	5965	.	7075
Senna *S. siamea*	.	.	.	.	.	.	.	.	.	.	.	933	.	IND	1010	15	120.5–124.5	11670–12060	58.5–63	.	9.5–11.5	.	.	.	.	.	.
Sloanea *S. insularis*	.	.	.	.	.	.	.	.	.	.	.	1248	1	PNG	510	14	73.5	9095	.	.	.	.	.	.	.	.	.
S. sigun	.	.	.	.	.	.	.	.	.	.	.	373	5	JAV	.	67	68.5	8920	30	8.5	6.5–7.5	47.5	61.5	.	.	3215	3735

Botanical name	Physical properties											Mechanical properties															
							shrinkage												compression			cleavage		Janka hardness			
							green to moisture content (m.c.)			green to oven-dry																	
	source	number of trees tested	origin of trees	density	at moisture content of	specific gravity (moisture content 0%)	m.c.	rad.	tang.	rad.	tang.	source	number of trees tested	origin of trees	density when tested	moisture content when tested	modulus of rupture	modulus of elasticity	parallel to grain	perpendicular to grain	shear	rad.	tang.	rad.	tang.	side	end
				kg/m³	%		%	%	%	%	%				kg/m³	%	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm	N/mm	N	N	N	N
S. sigun												373	5	JAV	.	17	72.5	9700	34.5	9	6.5–7.5	55	62.5	.	.	3265	3860
S. spp.	.	.	.	.	.	.	.	.	.	.	.	125	10	PNG	.	gr	61.5	9245	31.5	.	8	50	.	.	3470	.	.
												125	10	PNG	555	12	78	10075	50.5	.	10.5–11.5	47.5	54	.	3625	.	.
Sonneratia																											
S. caseolaris	934	.	PHI	815	16	.	15	0.8	1.6	2.9	5.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Spondias																											
S. cytherea	300	.	PNG	320–410	12	.	12	1.6	3.9	.	.	125	5	PNG	.	gr	34	7245	21.5	.	4	.	34	1780	.	.	.
												125	5	PNG	425	12	54.5	8695	31	.	6.5	.	42.5	2025	.	.	.
	1248	1	PNG	360	15	.	15	1.3	3.7	2.9	6.5	1248	1	PNG	380	13	51.5	7495	.	.	.	.	.	.	.	.	.
Streblus																											
S. elongatus	387	3	PMA	.	.	.	15	0.8	1.0	3.6	4.5	261	1	IND	950–1200	15	147	16660	80.5	.	11–13.5	39	54	.	.	11760	.
												677	3	PMA	1140	42	.	.	75	11	13.5	.	.	12840	12525	.	11070
												677	3	PMA	980	14	.	.	89.5	15.5	17.5–20	.	.	12925	12085	.	14530
Strombosia																											
S. javanica	387	3	PMA	.	.	.	15	1.4	3.5	3.6	8.7	677	3	PMA	1060	94	59	10855	30	3.5	6–7.5	.	.	3500	3460	.	3295
												677	3	PMA	640	16	78.5	11170	40	3.5	8–9	.	.	3210	3160	.	3255
S. philippinensis	804	1	PHI	.	.	0.74	12	2.7	4.9	5.3	9.1	804	1	PHI	.	gr	96.5	12350	49	16.5	13	560.5	.	.	.	10290	8985
												933	1	PHI	885	12	111–121	12600–13600	61–66	14.5–17	15–15.5	.	.	.	.	1055–1160	1230–1350

Botanical name	Physical properties						shrinkage					Mechanical properties							compression			cleavage		Janka hardness			
							green to moisture content (m.c.)			green to oven-dry																	
	source	number of trees tested	origin of trees	density (kg/m³)	at moisture content of (%)	specific gravity (moisture content 0%)	m.c. (%)	rad. (%)	tang. (%)	rad. (%)	tang. (%)	source	number of trees tested	origin of trees	density when tested (kg/m³)	moisture content when tested (%)	modulus of rupture (N/mm²)	modulus of elasticity (N/mm²)	parallel to grain (N/mm²)	perpendicular to grain (N/mm²)	shear (N/mm²)	rad. (N/mm)	tang. (N/mm)	rad. (N)	tang. (N)	side (N)	end (N)
Sympetalandra																											
S. borneensis	387	3	SAB	.	.	.	19	1.7	2.4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
S. densiflora	934	.	PHI	.	.	.	15	3.1	5.6	6.1	10.3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Teijsmannio-dendron																											
T. ahernianum	934	.	PHI	.	.	.	15	1.8	3.0	5.9	9.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
T. sp.	.	.	.	.	.	.	.	.	.	.	.	933	.	MAL	765	15	90–94	11360–11700	45–49	.	10–11.5	.	.	.	.	.	.
Tetrameles																											
T. nudiflora	336	.	THA	.	.	.	15	1.4	2.7	3.3	6.4	336	.	THA	.	gr	33.5	4415	15	.	6.5	.	.	1375	.	.	.
	300	.	PNG	.	.	.	12	1.4	4.7	.	.	336	.	THA	350	12	50	6110	29	.	9	.	.	1990	.	.	.
	478	.	INA	.	.	.	.	.	.	3.3	6.2	478	.	INA	655	126	29	4780	15	2	3.5–4	.	.	1255	1285	.	1665
												478	.	INA	330	12	38.5	6115	22	3	4.5	.	.	1460	1460	.	2060
												125	6	PNG	.	gr	29.5	5880	17	.	4	.	24	1155	1045	.	.
												125	6	PNG	330	12	44	6970	28.5	.	5	.	30.5	1155	.	.	.
												933	.	.	.	17	57	7250	35.5	.	8–9.5	.	.	.	.	.	.
Thespesia																											
T. populnea	192	.	INA	770	12	.	.	.	.	3.8	6.9	192	.	INA	.	gr	92.5	10155	44	.	.	.	.	.	.	.	.
												192	.	INA	770	12	118	11680	56.5	.	.	.	.	.	.	.	.
Timonius																											
T. timon	.	.	.	.	.	.	.	.	.	.	.	124	12	AUS	.	gr	53.5	.	26	.	7–7.5	.	.	3580	3740	.	.
Trichospermum																											
T. richii	.	.	.	.	.	.	.	.	.	.	.	126	5	FIJ	.	gr	30	5865	13	.	4	33	39	1225	1245	.	1690
												126	5	FIJ	360	12	49.5	7385	25.5	.	6.5	38.5	43.5	1670	1715	.	2960

Botanical name	Physical properties						shrinkage					Mechanical properties							compression			cleavage		Janka hardness			
							green to moisture content (m.c.)			green to oven-dry																	
	source	number of trees tested	origin of trees	density	at moisture content of	specific gravity (moisture content 0%)	m.c.	rad.	tang.	rad.	tang.	source	number of trees tested	origin of trees	density when tested	moisture content when tested	modulus of rupture	modulus of elasticity	parallel to grain	perpendicular to grain	shear	rad.	tang.	rad.	tang.	side	end
				kg/m³	%		%	%	%	%	%				kg/m³	%	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm	N/mm	N	N	N	N
Tristaniopsis																											
T. ferruginea	300	.	PNG	850	12	.	12	5.2	10.0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
T. obovata	1	.	MAL	.	.	.	15	2.6	3.8	.	.	1	.	MAL	.	gr	111	14165	51.5	.	12.5	.	.	.	.	.	.
												1	.	MAL	.	15	170	20730	72.5	.	18.5	.	.	.	.	.	.
Tristiropsis																											
T. acutangula	300	.	PNG	660	12	.	12	3.7	7.2	.	.	125	6	PNG	.	gr	59	11455	27.5	.	8–8.5	55	52	4270	3650	.	.
												125	6	PNG	680	12	103.5	14285	51	.	13.5–16	75	87	5295	5295	.	.
Turpinia																											
T. ovalifolia	.	.	.	.	.	.	.	.	.	.	.	322	.	PHI	.	gr	39	5880	18	2	5	.	.	.	.	.	.
												322	.	PHI	.	12	61.5	7155	29.5	3.5	6.5	.	.	.	.	.	.
T. sp.	.	.	.	.	.	.	.	.	.	.	.	375	5	JAV	420	15	52.5	9015	34	7	4.5–6	37.5	47	.	.	2235	2625
T. sp.	.	.	.	.	.	.	.	.	.	.	.	525	5	JAV	.	63	46	7280	26.5	3.5	5–6	39.5	38.5	.	.	1950	2675
Vernonia																											
V. arborea	.	.	.	.	.	.	.	.	.	.	.	933	.	IND	355	13	36–37	.	21.5–23	.	.	.	.	.	.	.	.
Wallaceodendron																											
W. celebicum	934	.	PHI	.	.	.	15	1.0	2.2	4.0	7.2	934	.	PHI	950	60	74.5	11860	29.5	6	9	.	.	.	.	4370	4360
Weinmannia																											
W. blumei	.	.	.	.	.	.	.	.	.	.	.	525	4	JAV	580	63	60	8135	32	7	8.5	60	66.5	.	.	3555	3745
												375	4	JAV	640	15	62	12250	44	14	10–12	88	98	.	.	4565	4775

Botanical name	Physical properties											Mechanical properties															
							shrinkage												compression			cleavage		Janka hardness			
							green to moisture content (m.c.)			green to oven-dry																	
	source	number of trees tested	origin of trees	density	at moisture content of	specific gravity (moisture content 0%)	m.c.	rad.	tang.	rad.	tang.	source	number of trees tested	origin of trees	density when tested	moisture content when tested	modulus of rupture	modulus of elasticity	parallel to grain	perpendicular to grain	shear	rad.	tang.	rad.	tang.	side	end
				kg/m³	%		%	%	%	%	%				kg/m³	%	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm	N/mm	N	N	N	N
Xanthophyllum																											
X. eurhynchum	387	3	PMA	.	.	.	15	2.6	4.9	5.2	9.9	677	4	PMA	1010	58	76	13090	37	5.5	10–11.5	65.5	75	5560	5765	.	6165
												677	4	PMA	800	17	101.5	14855	53	8	12.5–15	51.5	64	7715	7685	.	8500
X. flavescens	.	.	.	.	.	.	.	.	.	.	.	933	5	PHI	805	12	110–120	14100–15200	57–72	.	12–12.5	.	.	.	.	6890–7570	8445–9280
X. papuanum	.	.	.	.	.	.	.	.	.	.	.	125	7	PNG	.	gr	77.5	14005	40	.	7.5–9	42	85	5965	6095	.	.
												125	5	PNG	800	12	130.5	18490	78.5	.	14–15	37	105	7565	7300	.	.
X. spp.	300	.	PNG	1000	12	.	12	3.8	5.8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	348	.	PNG	800	12	.	12	1.4	4.5	.	.																
Xylia																											
X. xylocarpa	.	.	.	.	.	.	.	.	.	.	.	571	.	.	730–800	gr	96.5–110.5	15525–17250	55.5–62	.	11–12.5	.	.	.	.	8055–8900	.
												571	.	.	905–1010	12	124.5–138	15525–17250	69–77.5	.	14–15.5	.	.	.	.	8945–9970	.
												924	.	BUR	.	gr	107	15600	55	.	.	.	.	.	.	.	.
												924	.	BUR	915	12	137.5	17210	74.5	.	.	.	.	.	.	.	.
												924	.	INA	.	gr	79.5	11405	43	.	.	.	.	.	.	.	.
												924	.	INA	835	12	107.5	13925	70	.	.	.	.	.	.	.	.
												933	.	VIE	1140	12	134.5	.	76.5	.	.	.	.	.	.	.	.
Xylocarpus																											
X. moluccensis	387	1	PMA	.	.	.	16	2.0	3.2	.	.	124	4	AUS	645	12	99.5	.	51.5	.	12.5–14	.	.	5385	5205	.	.
	568	4	AUS	710	12	.	12	1.4	2.2	.	.																
												371	.	BUR	.	gr	76.5	10155	39.5	.	.	.	.	.	.	.	.
												371	.	BUR	785	12	99	11885	60.5	.	.	.	.	.	.	.	.

Botanical name	Physical properties											Mechanical properties															
							shrinkage												compression			cleavage		Janka hardness			
							green to moisture content (m.c.)			green to oven-dry																	
	source	number of trees tested	origin of trees	density	at moisture content of	specific gravity (moisture content 0%)	m.c.	rad.	tang.	rad.	tang.	source	number of trees tested	origin of trees	density when tested	moisture content when tested	modulus of rupture	modulus of elasticity	parallel to grain	perpendicular to grain	shear	rad.	tang.	rad.	tang.	side	end
				kg/m³	%		%	%	%	%	%				kg/m³	%	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm	N/mm	N	N	N	N
Xylopia *X. fusca*	678	4	PMA	690	15	0.59	.	.	.	.	.	678	4	PMA	1025	82	57.5	12075	26.5	4	7	47.5	63	.	.	3470	.
	387	1	PMA	.	.	.	18	2.8	4.5	.	.	678	4	PMA	.	18	80.5	13455	41.5	3.5	11.5	56	73.5	.	.	5120	.
Zanthoxylum *Z. rhetsa*	.	.	.	.	.	.	.	.	.	.	.	259	3	IND	610	14	.	.	48	.	8.5–9.5	36.5	43	.	.	.	4860
												933	1	PHI	385	12	58	6930–8050	26.5–28.5	2.5–3	5.5	.	.	.	.	1530–1680	2430–2670
Ziziphus *Z. talanai*	.	.	.	.	.	.	.	.	.	.	.	933	1	PHI	660	12	95.5–104	10900–11800	45.5–49.5	7.5–9	13–13.5	.	.	.	.	5105–5610	6970–7660

Timber-yielding species with other primary use

Tentative list of species in other commodity groups (parenthesis), which are used also as timber. Synonyms in the indented lines.
All bamboos and rattans used for construction and other purposes similar to timber are omitted from this list. The reader is referred to the Prosea volumes 6 and 7 on rattans and bamboos, respectively, for further information.

Acacia farnesiana (L.) Willd. (essential-oil plants)
Acacia flavescens A. Cunn. ex Benth. (auxiliary plants)
Acacia glauca (L.) Moench (auxiliary plants)
Acacia nilotica (L.) Willd. ex Del. (dye and tannin-producing plants)
Acacia oraria F. v. Mueller (auxiliary plants)
Acacia tomentosa Willd. (auxiliary plants)
Aegiceras corniculatus (L.) Blanco (medicinal and poisonous plants)
Aegle marmelos (L.) Correa (edible fruits and nuts)
Aeschynomene indica L. (auxiliary plants)
Agathis vitiensis Benth. (plants producing exudates)
Aglaia everettii Merr. (edible fruits and nuts)
Aglaia oligophylla Miq. (edible fruits and nuts)
    Aglaia oligantha DC.
Agrostistachys sessilifolia (Kurz) Pax & K. Hoffm. (fibre plants)
Albizia odoratissima (L. f.) Benth. (auxiliary plants)
Aleurites moluccana (L.) Willd. (spices)
Alnus japonica (Thunb.) Steud. (auxiliary plants)
Alnus nepalensis D. Don (auxiliary plants)
Alstonia grandifolia Miq. (plants producing exudates)
Altingia gracilipes Hemsley (plants producing exudates)
Anacardium occidentale L. (edible fruits and nuts)
Anacolosa frutescens (Blume) Blume (edible fruits and nuts)
    Anacolosa heptandra Maing. ex Masters
    Anacolosa luzoniensis Merr.
Anaxagorea javanica Blume var. *tripetala* Corner (medicinal and poisonous plants)
    Anaxagorea scortechinii King
Andira inermis (W. Wright) DC. (auxiliary plants)
Annona glabra L. (edible fruits and nuts)
Annona reticulata L. (edible fruits and nuts)
Aquilaria hirta Ridley (essential-oil plants)
    Aquilaria moszkowskii Gilg
Aquilaria malaccensis Lamk (essential-oil plants)
    Aquilaria agallocha Roxb.
Aralidium pinnatifidum (Jungh. & de Vriese) Miq. (medicinal and poisonous plants)
Ardisia oxyphylla Wallich (medicinal and poisonous plants)
Ardisia solanacea Roxb. (dye and tannin-producing plants)

Areca catechu L. (stimulants)
Areca triandra Roxb. (stimulants)
  Areca borneensis Becc.
Arenga obtusifolia Mart. (plants yielding non-seed carbohydrates)
Arenga pinnata (Wurmb) Merr. (plants yielding non-seed carbohydrates)
Arenga westerhoutii Griffith (plants yielding non-seed carbohydrates)
Argusia argentea (L. f.) H. Heine (vegetables)
  Tournefortia argentea L. f.
Artocarpus altilis (Parkinson) Fosberg (edible fruits and nuts)
  Artocarpus communis J.R. & J.G. Forster
  Artocarpus camansi Blanco
Artocarpus chaplasha Roxb. (edible fruits and nuts)
Artocarpus heterophyllus Lamk (edible fruits and nuts)
Artocarpus integer (Thunb.) Merr. (edible fruits and nuts)
  Artocarpus champeden (Lour.) Stokes
Averrhoa bilimbi L. (edible fruits and nuts)
Averrhoa carambola L. (edible fruits and nuts)
Bactris gasipaes Kunth (edible fruits and nuts)
  Bactris utilis Benth. & Hook. f. ex Hemsley
Baeckea frutescens L. (medicinal and poisonous plants)
Baphia nitida Lodd. (dye and tannin-producing plants)
Bauhinia purpurea L. (ornamental plants)
Bauhinia tomentosa L. (ornamental plants)
Borassus flabellifer L. (plants yielding non-seed carbohydrates)
Butea monosperma (Lamk) Taubert (dye and tannin-producing plants)
Buxus rolfei S. Vidal (medicinal and poisonous plants)
Caesalpinia coriaria (Jacq.) Willd. (dye and tannin-producing plants)
Caesalpinia pulcherrima (L.) Swartz (ornamental plants)
Caesalpinia sappan L. (dye and tannin-producing plants)
Calyptrocalyx spicatus (Lamk) Blume (stimulants)
Cananga odorata (Lamk) Hook. f. & Thomson (essential-oil plants)
  Canangium odoratum Baillon
  Canangium scortechinii King
Canarium album (Lour.) Raeuschel ex DC. (edible fruits and nuts)
Canarium bengalense Roxb. (plants producing exudates)
Canarium euphyllum Kurz (plants producing exudates)
Canarium tramdenum Dai & Yakovlev (edible fruits and nuts)
  Canarium nigrum (Lour.) Engl. non Roxb.
  Canarium pimela Leenh.
Canavalia ensiformis (L.) DC. (forages)
Canavalia gladiata (Jacq.) DC. (vegetables)
Carallia suffruticosa Ridley (medicinal and poisonous plants)
Carissa carandas L. (edible fruits and nuts)
Caryocar nuciferum L. (edible fruits and nuts)
Caryocar villosum (Aublet) Pers. (edible fruits and nuts)
Caryota majestica Linden (ornamental plants)
Caryota urens L. (plants yielding non-seed carbohydrates)
Cassia auriculata L. (dye and tannin-producing plants)
Cassia fistula L. (medicinal and poisonous plants)

Cassine glauca (Rottb.) Kuntze (medicinal and poisonous plants)
  Elaeodendron roxburghii Wight & Arn.
Castanopsis inermis (Lindley ex Wallich) Benth. & Hook. (edible fruits and nuts)
  Castanea sumatrana (Miq.) Oerst.
Castanopsis malaccensis Gamble (edible fruits and nuts)
Castanopsis wallichii King ex Hook. f. (edible fruits and nuts)
Ceratonia siliqua L. (forages)
Ceriops decandra (Griffith) Ding Hou (dye and tannin-producing plants)
  Ceriops roxburghiana Arn.
Ceriops tagal (Perr.) C.B. Rob. (dye and tannin-producing plants)
  Ceriops candolliana Arn.
Chamaecyparis obtusa Siebold & Zucc. (ornamental plants)
Cheilosa malayana (Hook. f.) Corner ex Airy Shaw (edible fruits and nuts)
  Baccaurea malayana King ex Hook. f.
Cinnamomum burmani (C.G. & Th. Nees) Nees ex Blume (spices)
  Cinnamomum mindanense Elmer
Citrus aurantium L. (edible fruits and nuts)
Citrus hystrix DC. (edible fruits and nuts)
Citrus maxima (Burm.) Merr. (edible fruits and nuts)
  Citrus aurantium L. var. *grandis* L.
  Citrus decumana L.
  Citrus grandis (L.) Osbeck
Clausena excavata Burm. f. (medicinal and poisonous plants)
Clavija longifolia Mez (ornamental plants)
Coccoloba uvifera (L.) L. (edible fruits and nuts)
Cocos nucifera L. (vegetable oils and fats)
Colona javanica (Blume) Burret (fibre plants)
  Columbia javanica Blume
Commersonia bartramia (L.) Merr. (fibre plants)
Cordia alliodora (Ruiz & Pavon) Oken (auxiliary plants)
Corypha utan Lamk (plants yielding non-seed carbohydrates)
  Corypha elata Roxb.
Crateva magna (Lour.) DC. (medicinal and poisonous plants)
  Crateva nurvala Ham.
Crescentia cujete L. (ornamental plants)
Croton griffithii Hook. f. (medicinal and poisonous plants)
Cyathea amboinensis (Alderw.) Merr. (cryptogams)
  Alsophila amboinensis Alderw.
Cyathea contaminans (Wallich ex Hook.) Copel. (cryptogams)
  Alsophila glauca (Blume) J. Smith
Cyathea lurida (Blume) Copel. (cryptogams)
  Alsophila lurida (Blume) Hook.
Cycas revoluta Thunb. (ornamental plants)
Cynometra cauliflora L. (edible fruits and nuts)
Cyrtosiphonia madurensis Teijsm. & Binnend. (medicinal and poisonous plants)
Dactyladenia barteri (Hook. f. ex Oliver) Prance & F. White (auxiliary plants)
Delonix regia (Bojer ex Hook.) Raf. (ornamental plants)

Poinciana regia Bojer ex Hook.
Derris microphylla (Miq.) B.D. Jackson (auxiliary plants)
Derris dalbergioides Baker
Derris trifoliata Lour. (medicinal and poisonous plants)
Derris heterophylla (Willd.) Backer ex Heyne
Derris uliginosa Benth.
Dimocarpus longan Lour. (edible fruits and nuts)
Euphoria longana Lamk
Euphoria malaiensis Radlk.
Euphoria nephelioides Radlk.
Nephelium longana Cambess.
Nephelium malaiense Griffith
Diospyros kaki L. f. (edible fruits and nuts)
Diplodiscus paniculatus Turcz. (edible fruits and nuts)
Diploknema butyracea (Roxb.) H.J. Lam (vegetable oils and fats)
Diplospora malaccense Hook. f. (stimulants)
Diplospora singularis Korth. (stimulants)
Dipteryx odorata (Aublet) Willd. (spices)
Dodonaea viscosa Jacq. (medicinal and poisonous plants)
Eperua grandiflora Benth. & Hook. f. (ornamental plants)
Erythrina poeppigiana (Walpers) O.F. Cook (auxiliary plants)
Erythrina micropteryx Poeppig ex Walpers
Eugeissona insignis Becc. (plants yielding non-seed carbohydrates)
Eugeissona tristis Griffith (fibre plants)
Eugeissona utilis Becc. (plants yielding non-seed carbohydrates)
Eugenia rumphii Merr. (dye and tannin-producing plants)
Euphorbia neriifolia L. (medicinal and poisonous plants)
Eurya acuminata DC. (auxiliary plants)
Eurya japonica auct. non Thunb.
Eurycoma longifolia Jack (medicinal and poisonous plants)
Euterpe oleracea Mart. (edible fruits and nuts)
Feroniella lucida (Scheffer) Swingle (vegetables)
Feronia lucida Scheffer
Ficus sinuata Thunb. (edible fruits and nuts)
Ficus rostrata Lamk
Filicium decipiens (Wight & Arn.) Thwaites (ornamental plants)
Finschia chloroxantha Diels (edible fruits and nuts)
Flacourtia jangomas (Lour.) Raeuschel (edible fruits and nuts)
Flacourtia rukam Zoll. & Moritzi (edible fruits and nuts)
Flacourtia euphlebia Merr.
Flagellaria indica L. (fibre plants)
Galearia filiformis Pax (ornamental plants)
Ganua curtisii (King & Gamble) H.J. Lam (plants producing exudates)
Ganua motleyana (de Vriese) Dubard var. *motleyana* (plants producing exudates)
Garcinia hanburi Hook. f. (dye and tannin-producing plants)
Garcinia merguensis Wight (plants producing exudates)
Garcinia morella (Gaertn.) Desr. (vegetable oils and fats)
Garcinia gaudichaudii Planch. & Triana

Garcinia lateriflora Blume
Garcinia xanthochymus Hook. f. (edible fruits and nuts)
Genipa americana L.
Geunsia farinosa Blume (medicinal and poisonous plants)
Gliricidia sepium (Jacq.) Kunth ex Walp. (forages, auxiliary plants)
Gmelina elliptica J.E. Smith (medicinal and poisonous plants)
Gmelina asiatica L. var. *villosa* Bakh.
Gmelina villosa Roxb.
Gnetum gnemon L. (edible fruits and nuts)
Goniothalamus sumatranus Miq. (fibre plants)
Grevillea pteridifolia Knight (auxiliary plants)
Guazuma ulmifolia Lamk var. *tomentosa* K. Schumann (fibre plants)
Haematoxylum campechianum L. (dye and tannin-producing plants)
Holarrhena pubescens (Buch.-Ham.) Wallich ex G. Don (medicinal and poisonous plants)
Holarrhena antidysenterica Wallich
Horsfieldia ridleyana (King) Warb. (edible fruits and nuts)
Hullettia dumosa King ex Hook. f. (edible fruits and nuts)
Hunteria zeylanica (Retz.) Gardner ex Thwaites (medicinal and poisonous plants)
Hunteria corymbosa Roxb.
Hura crepitans L. (ornamental plants)
Hymenaea courbaril L. (plants producing exudates)
Inocarpus fagifer (Parkinson) Fosberg (auxiliary plants)
Inocarpus edulis J.R. & J.G. Forster
Juniperus chinensis L. (ornamental plants)
Juniperus excelsa M. Bieb. (ornamental plants)
Kandelia candel (L.) Druce (auxiliary plants)
Kandelia rheedei Wight & Arn.
Kleinhovia hospita L. (auxiliary plants)
Kydia calycina Roxb. (fibre plants)
Lannea coromandelica (Houtt.) Merr. (ornamental plants)
Lannea grandis (Dennst.) Engl.
Lansium domesticum Correa (edible fruits and nuts)
Lansium domesticum Jack
Lasianthus maingayi Hook. f. (medicinal and poisonous plants)
Latania loddigesii Mart. (ornamental plants)
Latania lontaroides (Gaertn.) H.E. Moore (ornamental plants)
Latania commersonii J.F. Gmelin
Latania verschaffeltii Lemaire (ornamental plants)
Lawsonia inermis L. (dye and tannin-producing plants)
Lecythis ollaria Loefl. (vegetable oils and fats)
Lecythis pisonis Cambess. (vegetable oils and fats)
Lecythis zabucayo Aublet (vegetable oils and fats)
Lepisanthes amoena (Hassk.) Leenh. (edible fruits and nuts)
Otophora imbricata Blume
Otophora spectabilis Blume
Leucaena diversifolia (Schlechter) Benth. (auxiliary plants)
Leucaena leucocephala (Lamk) de Wit (auxiliary plants)

Leucaena glauca (Willd.) Benth.
Ligustrum glomeratum Blume (ornamental plants)
Ligustrum lucidum Aiton (forages)
Limonia acidissima L. (edible fruits and nuts)
Feronia elephantum Correa
Feronia limonia (L.) Swingle
Litchi chinensis Sonn. (edible fruits and nuts)
Euphoria didyma Blanco
Litchi philippinensis Radlk.
Nephelium litchi Cambess.
Litsea garciae S. Vidal (edible fruits and nuts)
Litsea sebifera (Blume) Blume
Litsea pipericarpa (Miq.) Kosterm. (essential-oil plants)
Lysidice rhodostegia Hance (ornamental plants)
Macadamia integrifolia Maiden & Betche (edible fruits and nuts)
Macadamia ternifolia F. v. Mueller var. *integrifolia* (Maiden & Betche) Maiden & Betche
Madhuca longifolia (Koenig) J.F. Macbr. (vegetable oils and fats)
Madhuca latifolia J.F. Macbr.
Madhuca ovata H.J. Lam (plants producing exudates)
Maesa indica (Roxb.) A. DC. (medicinal and poisonous plants)
Maesa ramentacea Wallich (medicinal and poisonous plants)
Maesopsis eminii Engl. (auxiliary plants)
Malpighia glabra L. (edible fruits and nuts)
Malpighia punicifolia L.
Mangifera duperreana Pierre (edible fruits and nuts)
Mangifera minutifolia Evrard (edible fruits and nuts)
Manilkara zapota (L.) P. v. Royen (edible fruits and nuts)
Achras zapota L.
Margaritaria indica (Dalz.) Airy Shaw (medicinal and poisonous plants)
Phyllanthus indicus (Dalz.) Müll. Arg.
Mascarenhasia arborescens A. DC. (plants producing exudates)
Mascarenhasia elastica K. Schum.
Mascarenhasia variegata Britten & Rendle
Melaleuca leucadendra (L.) L. (essential-oil plants)
Melaleuca viridiflora Blume
Melastoma malabathricum L. (medicinal and poisonous plants)
Melastoma sanguineum Sims (medicinal and poisonous plants)
Melastoma decemfidum Roxb.
Melia azedarach L. (auxiliary plants)
Melia dubia Cav.
Melientha suavis Pierre (vegetables)
Melochia umbellata (Houtt.) O. Stapf (ornamental plants)
Merope angulata (Willd.) Swingle (medicinal and poisonous plants)
Atalantia spinosa Koord.
Paramignya angulata (Willd.) Kurz
Metroxylon sagu Rottb. (plants yielding non-seed carbohydrates)
Metroxylon rumphii (Willd.) Mart.
Metroxylon squarrosum Becc.

Metroxylon warburghii (Heim) Becc. (plants yielding non-seed carbohydrates)
Meyna spinosa Roxb. ex Link (edible fruits and nuts)
Vangueria spinosa Roxb.
Michelia figo (Lour.) Sprengel (essential-oil plants)
Micromelum minutum (G. Forster) Wight & Arn. (medicinal and poisonous plants)
Micromelum pubescens Blume
Millingtonia hortensis L. f. (ornamental plants)
Miscanthus japonicus Andersson (fibre plants)
Mitragyna speciosa (Korth.) Havil. (medicinal and poisonous plants)
Morinda citrifolia L. (dye and tannin-producing plants)
Morinda bracteata Roxb.
Muntingia calabura L. (edible fruits and nuts)
Myrica esculenta Buch.-Ham. (edible fruits and nuts)
Myrica farquhariana Wallich
Myrica sapida Wallich
Myroxylon balsamum (L.) Harms (plants producing exudates)
Nyctanthes arbor-tristis L. (dye and tannin-producing plants)
Ochrosia oppositifolia (Lamk) K. Schumann (medicinal and poisonous plants)
Omalanthus populneus (Geiseler) Pax (dye and tannin-producing plants)
Homalanthus populneus (Geiseler) Pax
Oroxylum indicum (L.) Kurz (medicinal and poisonous plants)
Pahudia galedupa Backer ex Heyne (plants producing exudates)
Pandanus amboinensis Warb. (fibre plants)
Pangium edule Reinw. (medicinal and poisonous plants)
Paulownia tomentosa (Thunb.) Steud. (auxiliary plants)
Peltophorum dasyrhachis (Miq.) Kurz (auxiliary plants)
Peltophorum pterocarpum (DC.) Backer ex Heyne (dye and tannin-producing plants)
Pentadesma butyracea D. Don (vegetable oils and fats)
Phoenix dactylifera L. (edible fruits and nuts)
Phoenix sylvestris (L.) Roxb. (plants yielding non-seed carbohydrates)
Pholidocarpus ihur (Giseke) Blume (plants yielding non-seed carbohydrates)
Phyllanthus ciccoides Müll. Arg. (auxiliary plants)
Phyllanthus emblica L. (dye and tannin-producing plants)
Emblica officinalis Gaertn.
Phyllanthus reticulatus Poir. (dye and tannin-producing plants)
Pimenta dioica (L.) Merr. (spices)
Pimenta officinalis Lindl.
Pimenta racemosa (Miller) J.W. Moore (essential-oil plants)
Pimenta acris (Sw.) Kostel.
Piper aduncum L. (essential-oil plants)
Pithecellobium dulce (Roxb.) Benth. (dye and tannin-producing plants)
Plumeria rubra L. (ornamental plants)
Plumeria acuminata Aiton
Plumeria acutifolia Poir.
Plumiera acuminata Aiton
Pongamia pinnata (L.) Pierre (auxiliary plants)
Pouteria sapota (Jacq.) H.E. Moore & Stearn (edible fruits and nuts)

Calocarpum sapota (Jacq.) Merr.
Lucuma mammosa (L.) Gaertn. f.
Prosopis juliflora (Sw.) DC. (auxiliary plants)
Prunus cerasoides D. Don (edible fruits and nuts)
Psidium friedrichsthalianum (O. Berg) Niedenzu (edible fruits and nuts)
Psidium guajava L. (edible fruits and nuts)
Psidium guineense Swartz (edible fruits and nuts)
Punica granatum L. (edible fruits and nuts)
Putranjiva roxburghii Wallich (medicinal and poisonous plants)
Pyrus pyrifolia (Burm. f.) Nakai (edible fruits and nuts)
Reutealis trisperma (Blanco) Airy Shaw (vegetable oils and fats)
Aleurites trisperma Blanco
Rhapis excelsa (Thunb. ex Murray) A. Henry (ornamental plants)
Rhapis flabelliformis L'Her. ex Aiton
Rheedia edulis Planch. & Triana (edible fruits and nuts)
Rhizophora apiculata Blume (auxiliary plants)
Rhizophora candelaria DC.
Rhizophora conjugata Arn., non L.
Rhizophora mucronata Poir. (dye and tannin-producing plants)
Rhodomyrtus tomentosa (Aiton) Hassk. (edible fruits and nuts)
Rollinia mucosa (Jacq.) Baillon (edible fruits and nuts)
Rollinia deliciosa Safford
Rollinia orthopetala A. DC.
Rourea minor (Gaertn.) Leenh. (medicinal and poisonous plants)
Connaropsis rubescens Ridley
Rourea erecta Merr.
Santaloides erectum Schellenb.
Santaloides floridum (Jack) O. Kuntze
Santaloides minus Schellenb.
Santaloides pulchellum (Planch.) O. Kuntze
Santaloides volubile Schellenb.
Roystonea oleracea (Jacq.) O.F. Cook (ornamental plants)
Roystonea regia (Kunth) O.F. Cook (ornamental plants)
Salacca wallichiana C. Mart. (edible fruits and nuts)
Salacia grandiflora Kurz (edible fruits and nuts)
Salix tetrasperma Roxb. (auxiliary plants)
Samanea saman (Jacq.) Merr. (auxiliary plants)
Enterolobium saman (Jacq.) Prain
Santalum album L. (essential-oil plants)
Sapindus rarak DC. (medicinal and poisonous plants)
Sapindus saponaria L. (medicinal and poisonous plants)
Sapindus mukorossi Gaertn.
Sarcotheca griffithii (Planch. ex Hook. f.) Hallier f. (edible fruits and nuts)
Connaropsis griffithii Planch. ex Hook. f.
Scaevola sericea Vahl (medicinal and poisonous plants)
Scaevola frutescens Krause
Schinopsis quebracho-colorado (Schldl.) F. Barkley & T. Meyer (dye and tannin-producing plants)
Schinopsis lorentzii (Griseb.) Engl.

Schleichera oleosa (Lour.) Oken (auxiliary plants)
Scolopia luzonensis (Presl) Warb. (edible fruits and nuts)
Securinega virosa (Roxb. ex Willd.) Baillon (dye and tannin-producing plants)
Semecarpus anacardium L. f. (edible fruits and nuts)
Sesbania grandiflora (L.) Poir. (forages)
Sesbania javanica Miq. (auxiliary plants)
    Sesbania roxburghii Merr.
Sesbania sesban (L.) Merr. (forages)
    Sesbania aegyptiaca Poir.
Smilax leucophylla Blume (vegetables)
    Smilax glycyphylla Hassk.
Sophora japonica L. (dye and tannin-producing plants)
Sophora tomentosa L. (medicinal and poisonous plants)
Soymida febrifuga A. Juss. (medicinal and poisonous plants)
Stelechocarpus burahol (Blume) Hook. f. & Thomson (edible fruits and nuts)
Strychnos lucida R. Br. (medicinal and poisonous plants)
    Strychnos ligustrina Blume
Strychnos nux-vomica L. (medicinal and poisonous plants)
Styrax benzoides Craib (plants producing exudates)
Styrax benzoin Dryander (plants producing exudates)
Styrax paralleloneurum Perkins (plants producing exudates)
    Styrax sumatrana J.J. Smith
Styrax serrulatum Roxb. (plants producing exudates)
Styrax serrulatum Roxb. var. *mollissimum* v. Steenis (plants producing exudates)
    Styrax subpaniculatum Jungh. & de Vriese
Styrax siamensis Rordorf (plants producing exudates)
Styrax tonkinensis (Pierre) Craib ex Hartwich (plants producing exudates)
    Anthostyrax tonkinensis Pierre
Suregada glomerulata (Blume) Baillon (medicinal and poisonous plants)
    Gelonium glomerulatum (Blume) Hassk.
Suregada multiflora (A. Juss.) Baillon (ornamental plants)
    Gelonium multiflorum A. Juss.
Syzygium aqueum (Burm. f.) Alston (edible fruits and nuts)
    Eugenia aquea Burm. f.
    Eugenia grandis Wight
Syzygium aromaticum (L.) Merr. & L.M. Perry (spices)
    Eugenia aromatica (L.) Baillon
    Eugenia caryophyllata Thunb.
Syzygium cumini (L.) Skeels (edible fruits and nuts)
    Eugenia cumini (L.) Druce
Syzygium jambos (L.) Alston (edible fruits and nuts)
    Eugenia jambos L.
Syzygium malaccense (L.) Merr. & L.M. Perry (edible fruits and nuts)
    Eugenia malaccense L.
Syzygium polycephalum (Miq.) Merr. & L.M. Perry (edible fruits and nuts)
    Eugenia polycephala Miq.
Syzygium samarangense (Blume) Merr. & L.M. Perry (edible fruits and nuts)
    Eugenia javanica Lamk p.p.

Eugenia mananquil Blanco
Tamarindus indica L. (edible fruits and nuts)
Trachylobium verrucosum (Gaertn.) Oliver (plants producing exudates)
Trema orientalis (L.) Blume (auxiliary plants)
Trigonopleura malayana Hook. f. (dye and tannin-producing plants)
Trigonostemon longifolius Baillon (medicinal and poisonous plants)
Triphasia trifolia (Burm. f.) P. Wilson (edible fruits and nuts)
Triphasia aurantiola Lour.
Uvaria grandiflora Roxb. (edible fruits and nuts)
Uvaria purpurea Blume
Vaccinium littoreum Miq. (edible fruits and nuts)
Vaccinium hasseltii Miq.
Vernicia montana Lour. (vegetable oils and fats)
Aleurites montana (Lour.) Wilson
Voacanga foetida (Blume) Rolfe (medicinal and poisonous plants)
Wrightia tinctoria R. Br. (dye and tannin-producing plants)
Ximenia americana L. (edible fruits and nuts)
Zanthoxylum avicennae (Lamk) DC. (spices)
Fagara avicennae (Lamk) DC.
Ziziphus calophylla Wallich (edible fruits and nuts)

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Glossary

See also the introduction of Prosea 5(1) for an explanation of terms concerning tree architecture (1.4.2), wood structure (1.4.2), climatic types (1.5.1), soils (1.5.2) and wood properties including kiln schedules (1.6).

abaxial: on the side facing away from the axis or stem (dorsal)

abortive: imperfectly developed

abscess: a swollen, inflamed area in body tissues, in which pus gathers

accrescent: increasing in size with age

achene: a small dry indehiscent one-seeded fruit

acicular: needle-shaped; with a sharp point

actinomorphic: radially symmetrical; applied to flowers which can be bisected in more than one vertical plane

acuminate: ending in a narrowed, tapering point with concave sides

adjacent-ligular: in germination, the new shoot developing next to the seed and enclosed by a ligule

adnate: united with another part; with unlike parts fused, e.g. ovary and calyx tube

aerial root: any root that grows above the ground

afforestation: the establishment of forest on a formerly non-forested area by artificial methods such as planting or sowing

aggregate ray (wood anatomy): when the rays so closely associated with one another that they appear macroscopically as a single large ray

agroforestry: land-use systems in which trees or shrubs are grown in association with crops (agricultural crops or pastures) in a spatial arrangement or a rotation and in which there are both ecological and economic interactions between the trees and the other components of the system

air layering: a form of layering in which soil (rooting medium) is brought to the branch to be layered: the ball of soil in a polyethene cover is wrapped around the girdled branch, after adventitious roots grow out above the girdle, the layer can be separated

aliform: wing-shaped

aliform parenchyma: parenchyma surrounding or to one side of the vessel and with lateral extensions

alkaloid: large group of organic bases containing nitrogen and usually oxygen that occur for the most part in the form of salts with acids, usually optically and biologically active

allelopathy: the reputed baneful influence of one living plant upon another due to secretion of toxic substances

alluvium: soil material deposited by running water in recent geological time

alternate: leaves, etc., inserted at different levels along the stem, as distinct from opposite or whorled

ambrosia beetle: a general name for beetles of the families *Platypodidae* and *Scolytidae* that tunnel in wood but feed principally on fungi that develop in their tunnels

amenorrhea: abnormal absence or suppression of the menses

amplexicaul: stem-clasping, when the base of a sessile leaf or a stipule is dilated at the base, and embraces the stem

anaesthetic: a substance causing loss of sensation and usually of consciousness

anastomosis: cross connection of branches or roots; union of one vein or parenchyma band with another, the connection forming a reticulation

anatropous: of an ovule, reversed, with micropyle close to the side of the hilum and the chalaza at the opposite end

andesite: an extrusive, usually dark greyish rock type, consisting essentially of oligoclase or andesine feldspar

androdioecious: having male and bisexual flowers on different plants

androecium: the male element; the stamens as a unit of the flower

androgynophore: a column on which stamens and carpels are borne

andromonoecious: having bisexual and male flowers, but no female flowers, on the same plant

annular: used of any organs disposed in a circle

anthelmintic: a drug or agent that destroys or causes expulsion of intestinal worms

anther: the part of the stamen containing the pollen *anthesis*: the time the flower is expanded, or, more strictly, the time when pollination may take place

antifeedant: preventing something from being eaten

antispasmodic: an agent that prevents or relieves spasms or a remedy for spasms

apetalous: without petals

apex (plural apices): the tip or summit of an organ

aphrodisiac: a food or drug stimulating sexual desire

apical: at the apex of any structure

apocarpous: with the carpels free from each other

apomixis: reproduction by seed formed without sexual fusion (apomictic)

apotracheal parenchyma: parenchyma not associated or contiguous with vessels or vascular tracheids

arbuscular: branched like a tree

architectural model: model describing the branching habit of a tree as determined by the pattern of activity of axes, the pattern including timing, positioning and fate (e.g. terminating in an inflorescence) of active axes

arecoid: of palms, belonging to the subfamily *Arecoideae*

areolate: with irregular squares or angular spaces marked out on a surface, e.g. of a fruit; with small cells or cavities

aril: an expansion of the funicle enveloping the seed, arising from the placenta, sometimes occurring as a pulpy cover (arillus)

arillate: possessing an aril

arillode: a false aril, a coat of the seed not arising from the placenta

arilloid: like an aril

armed: bearing some form of spines

articulate: jointed, or with places where separation takes place naturally

ascites: accumulation of serous fluid in the abdominal cavity

asthma: a chronic disorder characterized by paroxysms of the bronchi, shortness of breath, wheezing, a suffocating feeling, and laboured coughing to remove tenacious mucus from the air passages

astringent: an agent or substance causing shrinkage of mucous membranes or raw or exposed tissues

attenuate: gradually tapering

auct.: auctorum (Latin); of authors

auct., non: auctorum, non (Latin); of authors, not ... (author name); used after a scientific name when this name is erroneously applied by several authors to material actually belonging to a different species than the species described by the mentioned author

auricle: a small lobe or ear

axial: in the direction of the axis; in longitudinal direction

axil: the upper angle between the leaf and the stem

axillary: arising from the axil

back-sawn: of timber, converted so that the growth rings meet the face in any part at an angle of less than 45°

bark: the tissue external to the vascular cambium collectively, being the secondary phloem, cortex and periderm

basifixed: attached or fixed by the base

basionym: the synonym of a scientific name that supplies the epithet for the correct name

batik: an Indonesian method of hand-printing textiles by coating parts of the fabric with wax to resist dye, dipping in a cold dye solution, boiling off the wax, and repeating the process for each colour used

beak: a long, prominent and substantial point, applied particularly to prolongations of fruits

berry: a juicy indehiscent fruit with the seeds immersed in pulp, usually several-seeded without a stony layer surrounding the seeds

bifid: forked, divided in two but not to the base

bilabiate: two-lipped

bilateral (botany): having 2, often opposite, sides

biliousness: a situation marked or accompanied by a disordered liver function due to or associated with excessive secretion of bile

bipinnate: when the primary divisions (pinnae) of a pinnate leaf are themselves pinnate

bird's-eye grain: decorative figure on rotary-cut or back-sawn wood caused by small conical depressions in the outer annual ring, so that later growth follows the same contour for many years and forms concentric circles

bisexual: having both sexes present and functional in the same flower

blade: the expanded part, e.g. of a leaf or petal

blockboard: a plywood in which the core layers are replaced by blocks of wood

blue stain: a common form of bluish discoloration, generally of sapwood, caused by various fungi

bole: the main trunk of a tree, generally from the base up to the first main branch

bordered pit (wood anatomy): a pit in which the membrane is overarched by the secondary cell wall

bostrychid borer: a beetle, e.g. a powder-post beetle, of the family *Bostrychidae* which tunnels in wood

brachyblast: a short reproductive branch

bract: a reduced leaf subtending a flower, flower stalk or the whole or part of an inflorescence

bracteole: a secondary bract on the pedicel or close under the flower

breeding: the propagation of plants or animals to improve certain characteristics

bud: the nascent state of a flower or branch, often applied to those primordial vegetative or reproductive branches that are enclosed in a prophyll and have a resting stage

budding: the process of inserting a scion, which consists of the bud in a leaf axil on a shield of rind, with or without a small piece of wood attached, into a plant (rootstock) with the intention that it will unite and grow there, usually in order to propagate a desired cultivar

buprestid: belonging to the beetle family *Buprestidae*, which often have brilliant metallic colours and whose larvae bore in wood or damage trees

buttress: the enlargement of the base of trunks of tropical trees that ranges from a small spur or swelling to massive structures, partly root, partly stem, reaching as high as 10 m up the stem, thin and flat to thick, twisted or anastomose

cabbage: of palms, a terminal bud of a palm tree that resembles a head of a cabbage and is eaten as a vegetable

caducous: falling off

calcareous: consisting of or containing chalk (calcium carbonate)

calico: printed cotton fabric

calyptrate: operculate, having a deciduous lid

calyx: the outer envelope of the flower, consisting of sepals, free or united

campanulate: bell-shaped

canaliculate: channelled, with a longitudinal groove

canopy: the uppermost leafy layer of a tree, forest or crop

capitate: headed, like the head of a pin in some stigmas, or collected into compact headlike clusters as in some inflorescences

capsule: a dry dehiscent fruit composed of two or more carpels and either splitting when ripe into valves, or opening by slits or pores

cardiac: acting on the heart

carminative: expelling gas from the stomach and intestines

carpel: one of the foliar units of a compound pistil or ovary; a simple pistil has only one carpel

cartilaginous: hard and tough

caruncle: an outgrowth of a seed near the hilum

cataphyll: reduced or scale-like leaf present in certain seedlings on the lower stem nodes and sometimes elsewhere on the seedling stem

catkin: a close bracteate, often pendulous spike, usually with unisexual flowers

cauliflorous: with the flowers borne on the trunk

chalaza: the basal part of the ovule or seed where it is attached to the funicle and the point at which vascular tissues enter and spread into the ovule

chambered cell (anatomy): an axial parenchyma strand cell or ray parenchyma cell subdivided by septa or by thin to thick cell walls

check: in wood, a small separation of the wood fibres along the grain forming a crack or fissure not penetrating as far as the opposite or adjoining side of a piece of sawn timber

chipboard: a fibreboard made from depulped wood chips

cholera: any of several diseases of man and domestic animals usually marked by severe gastrointestinal symptoms

chronic: recurring frequently over a long period of time

circumscissile: dehiscing or falling off along a circular line

clavate: club-shaped or thickened towards the end

claw: the basal, narrow part of a petal or sepal

cleavage: a measure for the resistance of wood to splitting

cleistogamous: pollination and fertilization taking place within the unopened flower

coalescent: united by growth

coccous: referring to the parts of a lobed fruit

coherent: the incorporation of one part with another, as the petals to form a tubular corolla

colic: a paroxysm of acute abdominal pain localized in a hollow organ or tube and caused by spasm, obstruction, or twisting

collapse: in wood, a defect due to abnormal and irregular shrinkage and resulting in a wrinkled or corrugated appearance of the surface and sometimes also an internal honeycombing

collateral: standing side by side

colleter: a multicellular glandular hair

columella: a persistent central axis round which the carpels of some fruits are arranged

column (botany): a cylindrical body, e.g. a tube of connate stamen filaments or the central axis of a fruit

coma: the hairs at the end of some seeds; a tuft of leafy bracts or leaves at the top of an inflorescence (e.g. pineapple, *Curcuma* inflorescence) *compression parallel to grain*: a measure for the compression strength parallel to the direction of the fibres necessary to bring about failure in a sample (maximum crushing strength)

compression perpendicular to grain: a measure for the compression strength perpendicular to the direction of the fibres necessary to bring about failure in a sample (stress at limit proportionality)

concolourous: similarly coloured on both sides or throughout; of the same colour as a specified structure

conduplicate: folded lengthwise

cone: the fruit of a pine or fir tree (gymnosperms), largely made up of imbricated scales

confluent: blended into one, passing by degrees from one into the other

congeneric: belonging to the same genus or forming a single genus

conglutinate: as if glued together

conical: having the shape of a cone (cone-shaped)

connate: united or joined

connective (botany): tissue between the pollen sacs of an anther

constipation: a condition of the bowels in which the expulsion of waste matter is infrequent and difficult

contiguous: touching but not united, directly bordering

contorted: twisted or bent

coppice: a small wood which is regularly cut at stated intervals, the new growth arising from the stools

corewood: the often darker coloured inner portion of the heartwood

coriaceous: of leathery texture

corolla: the inner envelope of the flower consisting of free or united petals

corrugate (corrugated): wrinkled

cortex: the bark or rind

corymb: a flat-topped indeterminate inflorescence in which the branches or pedicels sprout from different points, but attain approximately the same level, with the outer flowers opening first

corymbose: with flowers arranged in a corymb

costapalmate: shaped like the palm of a hand and having a short midrib or costa

cotyledon: seed-leaf, the primary leaf; dicotylous embryos have two cotyledons and monocotylous embryos have one

cover crop: a close-growing crop primarily grown for the purpose of protecting and improving soil between periods of regular crop production or between trees or vines in orchards and plantations

crenate: the margin notched with blunt or rounded teeth

cross-pollination: the transfer of pollen from one flower to the stigma of a flower of another plant which is not of the same clone

crown-shaft: in palms, a conspicuous cylinder formed by tubular leaf sheaths at the top of the stem

crustaceous: of hard but brittle texture

cryptocotylar: of germination, condition in which the cotyledons remain enveloped in the persistent fruit wall and/or testa

cucullate: hooded; hood-shaped

cuneate: wedge-shaped; triangular, with the narrow end at the point of attachment, as the bases of leaves or petals

cupping: the curvature of a piece of sawn timber across its width

cupule: a small cup-like structure; the cup of such fruits as the acorn, consisting of an involucre composed of adherent bracts

cuspidate: abruptly tipped with a sharp rigid point

cutting: a portion of a plant, used for vegetative propagation

cyanogenetic: elaborating hydrocyanic acid

cyme: a determinate inflorescence, often flat-topped, in which each growing point ends in a flower and the central flowers open first

cymose: with flowers arranged in a cyme

cymule: a diminutive, usually few-flowered cyme or portion of one

cytotoxic: poisonous to cells

damping-off: a disease of seeds or seedlings caused by fungi which cause various effects, from failure to germinate to the dying off of the seedling

deciduous: shedding, applied to leaves, petals, etc.

decoction: a medicinal preparation made by boiling parts of a plant in water

decurrent: extending down and adnate to the petiole or stem, as occurs in some leaves

decussate: of leaves, arranged in opposite pairs on the stem, with each pair perpendicular to the preceding pair

dehiscent: opening spontaneously when ripe, e.g. of capsules, anthers

deltoid: shaped like an equal-sided triangle

dendritic: dendroid, tree-like in form or branching

density: weight (kg) per volume (m^3) at a certain moisture content

dentate: margin prominently toothed with the pointed teeth directed outwards

denticulate: minutely toothed

depulping: removing the outer, soft, fleshy part of a fruit

depurative: removes impurities or waste materials; 'purifies' the blood

dermatitis: inflammation of the skin typically marked by reddening, swelling, oozing, crusting or scaling

diabetes: an abnormal condition characterized by the secretion and excretion of excessive amounts of urine

diadelphous: in two bundles

diarrhoea: a profuse, frequent, and loose discharge from the bowels

dichasium (plural dichasia): a cymose inflorescence with 2 equal or nearly equal lateral branches arising below the terminal flower, this pattern being repeated or not (compound and simple dichasium respectively)

dichotomous: forked, parted by pairs

dieback: the dying off of parts of the above-ground structure of the plant, generally from the top downward

diffuse-in-aggregates (wood anatomy): of apotracheal parenchyma, grouped into short discontinuous tangential or oblique lines

diffuse-porous (wood anatomy): with vessels of about the same diameter throughout the growth ring

digitate: a compound leaf whose leaflets diverge from the same point like the fingers of a hand

dilated: expanded into a flat structure

dimorphic: of two forms, as may occur with branches, etc.

dioecious: with unisexual flowers and with the staminate and pistillate flowers on different plants (dioecy)

dippled: of the bark surface, with depressions or indentations

dipterocarp forest: woodland dominated by trees belonging to the family *Dipterocarpaceae*

discoid: resembling a disk or discus, being flat and circular, e.g. of a leaf with a round thickened lamina and rounded margins

discolourous: dissimilarly coloured on both sides or throughout; of a different colour as a specified structure

disk: a fleshy or elevated development of the receptacle within the calyx, corolla or stamens, often lobed and nectariferous

dispersal: the various ways by which seeds are scattered, e.g. by wind, water or animals

distal: situated farthest from the place of attachment

distichous: regularly arranged in two opposite rows on either side of an axis

diuretic (diureticum): an agent increasing the urinary discharge

divaricate: extremely divergent

domatium (plural domatia): a modified projection that provides shelter for other organisms

dormancy: a term used to denote the inability of a resting plant or plant part (e.g. the seed, bulb, tuber, or in tree crops usually the buds) to grow or to leaf out, even under favourable environmental conditions

dorsal: back; referring to the back or outer surface of a part or organ (abaxial)

dorsifixed: attached by the back, as in the case of the attachment of a filament to an anther

dropsy: an abnormal accumulation of serous fluid in connective tissue, causing puffy swelling

drupaceous: resembling a drupe, whether actually a drupe or not

drupe: a fleshy one-seeded indehiscent fruit with the seed enclosed in a strong endocarp

drupelet: a small drupe

druse (anatomy): a globular cluster of crystals

dry rot: a decay of seasoned timber caused by certain fungi

dysentery: any of various intestinal diseases characterized by inflammation, abdominal pain, toxaemia, and diarrhoea with bloody, mucous faeces

earlywood: the less dense wood with comparatively wide vessels formed during the early stage of annual growth

echinate: bearing spines or bristles

ecto-: in compositions, referring to the outside or the outer surface or part

ectomycorrhiza: see mycorrhiza

ellipsoid: a solid which is elliptic in outline

elliptical: oval in outline but widest about the middle

embrocation: a liquid ointment

emergent: of a tree, one of which the crown reaches distinctly above the forest canopy; of cotyledons, becoming free from the seed-coat and other external tissues

emetic: an agent that induces vomiting

endemic: exclusively native to a specified or comparatively small region; also used as a noun for a taxon thus distributed

endo-: prefix, referring to the inside or the inner surface or part

endocarp: the innermost layer of the pericarp or fruit wall

endogenous: originating from within the organism

endosperm: the starchy or oily nutritive material stored within some seeds, sometimes referred to as albumen; it is triploid, having arisen from the triple fusion of a sperm nucleus and the two polar nuclei of the embryo sac

endotrophic: in mycorrhizae, finding nourishment from inside

energy value: the heat produced by the combustion of a unit weight of a fuel or food

enrichment planting: a term embracing various measures for improving the percentage of desirable species in a natural forest

entire (botany): with an even margin without teeth, lobes, etc.

eophyll: the first fully developed foliar leaf in a seedling above the cotyledons

epicalyx: an involucre of bracts below the flower, resembling an extra calyx

epicotyl: the young stem above the cotyledons

epigeal: above the ground; in epigeal germination the cotyledons are raised above the ground

epilepsy: a chronic nervous disorder that involves unconsciousness and uncontrolled motion

epiphyllous: growing on the leaves; united to the perianth, e.g. of stamens

epiphyte: a plant that grows on another plant but without deriving nourishment from it

epithelium: the layer of secretory parenchymatous cells that surrounds an intercellular canal or cavity

epithet: the second part of the scientific name of a species, the first part denoting the genus to which the species belongs

evergreen: bearing foliage all year long; a plant that changes its leaves gradually

ex situ: in an artificial environment or unnatural habitat

exocarp: the outer layer of the pericarp or fruit wall

exotesta: the outer layer (epiderm) of the seed-coat (testa)

exsert, exserted: protrude beyond, as stamens beyond the tube of the corolla

exstipulate: without stipules

extra-axillary: beyond or outside the axil

extrafloral: of nectaries, beyond the flower

exudate: the secreted substance

fagaceous forest: a generally montane forest type with a comparatively large number of trees belonging to the *Fagaceae* family

fascicle: a cluster of flowers, leaves, etc., arising from the same point

fastigiate: with branches close to and parallel to the stem

febrifuge: an agent serving to reduce fever

ferruginous: rust-coloured

fertile (botany): capable of completing fertilization and producing seed; producing seed capable of germination; having functional sexual organs

fertilization (biology): union of the gametes (egg and sperm) to form a zygote

fibre (wood anatomy): any long, narrow cell of wood or bark other than vessel or parenchyma elements

fibreboard: sheet material manufactured under pressure and heat from fibres of any wood substances (see also hardboard)

fibrous: composed of or including fibres

fiddleback: resembling the shape of a fiddle; in wood anatomy: a wavy grain giving an undulating appearance to a smooth surface

fig: the fleshy multiple fruit, derived from the inflorescence of *Ficus* spp. (syconium)

filament: thread; the stalk supporting the anther

filiform: slender; threadlike

fimbriate: fringed

flush: a brief period of rapid shoot growth, with unfolding of the leaf primordia which had accumulated during the previous quiescent period

fluted: of a bole, with rounded grooves and folds

fodder: something fed to domesticated animals, especially coarse, dried food from plants (hay, straw, leaves)

foliaceous: leaf-like

foliolate: 2-, 3-, 4- etc., with 2-, 3-, 4- leaflets

follicle: a dry, unicarpellate fruit, dehiscing by the ventral suture to which the seeds are attached

foraminate: sieve-like, perforated in a manner reminiscent of a sieve

free: neither adhering nor united

fringed: fimbriate; with hair-like appendages along the margin

frugivorous: feeding on fruit

full-cell process: a process to leave the maximum concentration of preservative in a piece of wood by the subsequent application of vacuum, pressure and again vacuum

fusiform: spindle-shaped; tapering towards each end from a swollen centre

gallery forest: fringing forest, forest growing along a watercourse in an otherwise non-forested area

gamopetalous: with united petals either throughout their length or at the base

gangrene: local death of tissue caused by loss of blood supply

genetic erosion: the decline or loss of genetic variability

geniculate: abruptly bent so as to resemble the knee-joint

genus (plural genera): the smallest natural group containing distinct species
geocarpic: having the fruits mature underground
germplasm: the genetic material that provides the physical basis of heredity
glabrescent: becoming glabrous or nearly so
glaucous: pale bluish-green, or with a whitish bloom which rubs off
globose: spherical or nearly so
glycosides: compounds that are acetal derivatives of sugars and that on hydrolysis yield one or more molecules of a sugar and often a non-carbohydrate
gonorrhoea: a venereal disease characterized by inflammation of the mucous membrane of the genitourinary tract and a discharge of mucus and pus
grafting: the process of inserting a scion, which consists of a piece of stem and two or more buds of the plant to be propagated, into another plant (rootstock) with the intention that it will unite and grow
grain (wood anatomy): the general direction or arrangement of the fibres; texture
graveyard test: a test to measure the durability of wood in contact with the ground
green wood: wood before drying, directly after harvesting
gregarious: growing in associated groups or clusters but not matted; at the same time
growth ring: the layer of wood formed during one growing season
gum: a colloidal polysaccharide substance that is gelatinous when moist but hardens on drying and is exuded by or extracted from plants
gum up: of a saw, when wood resin gets stuck between the saw teeth which hinders the sawing
gynodioecious: having female and bisexual flowers on different plants
gynoecium: the female part or pistil of a flower, consisting, when complete, of one or more ovaries with their styles and stigmas
gynophore: a stalk supporting the gynoecium formed by elongation of the receptacle
habitat: the kind of locality in which a plant grows
haemoptysis: expectoration of blood from some part of the respiratory tract
haemorrhage: bleeding; an escape of blood from blood vessels
hallucinogenic: inducing hallucinations
hapaxanthic: describing plants (e.g. some palms) having a single flowering period after which the plant dies (cf. pleonanthic)
hardboard: homogenous thin fibreboard having a density of not more than 16 kg/m^3
hardwood: the wood of an angiospermous tree as distinguished from that of a coniferous tree
hastate: with more or less triangular basal lobes diverging laterally
head: a dense inflorescence of small crowded often stalkless flowers (a capitulum)
heartwood: wood from the inner portion of a tree in which the cells are dead and no longer engaged in sap conduction and food storage
heath forest: = kerangas
helical thickenings (wood anatomy): ridges on the inner face of a vessel element wall in a helical pattern, spiral thickenings
hemi-: prefix, meaning half
hepatalgia: pain in the liver
herb: any vascular plant which is not woody
hermaphrodite: bisexual; in flowers, with stamens and pistil in the same flower
heterogeneous: lacking in uniformity; exhibiting variability
heteromorphic: varying in number or form
heterostylous: having styles of two or more distinct forms or of different lengths
hilum: the scar left on a seed indicating its point of attachment
hirsute: with rather coarse stiff hairs
honeycombing: of wood, becoming pitted or checked upon drying
hoop mark: a ring-shaped marking, often used to denote such a mark around a tree trunk
hyaline: almost transparent
hybrid: the first generation offspring of a cross between two individuals of different species or taxa
hybridization: the crossing of individuals of different species or taxa
hydrocele: accumulation of serous fluid in a sacculate cavity, especially the scrotum
hypanthium: a cup-like receptacle usually derived from the fusion of the floral envelopes and androecium on which are seemingly borne the calyx, corolla and stamens
hypertension: abnormally high arterial blood pressure
hypocarp: a fleshy, modified peduncle of certain fruits
hypocotyl: the young stem below the cotyledons
hypocrateriform: saucer-shaped, with a long and narrow tube and limbs at right angles to the tube
hypogeal: below ground; in hypogeal germination the cotyledons remain below ground within the testa

hypoglyc(a)emic: decreasing the amount of sugar in the blood

hypsophyll: a reduced or modified leaf towards the upper end of a shoot

idioblast: a cell differing markedly in form and contents from other constituents of the same tissue, like crystalliferous cells, oil and mucilage cells

imbricate: overlapping like tiles; in a flower bud when one sepal or petal is wholly external and one wholly internal and the others overlapping at the edges only

imparipinnate: of leaves, pinnate with an unpaired terminal leaflet

in situ: in the natural environment

inarching: grafting by approach, the scion remaining attached to its parent until union has taken place

indehiscent: not opening when ripe

indigenous: native to a particular area or region

indumentum: a covering, as of hairs, scales, etc.

induplicate: with the margins bent inwards and the external face of these edges applied to each other without twisting; V-shaped in cross section, trough-shaped

indurated: becoming firmer or harder

inferior: beneath, lower, below; an inferior ovary is one which is situated below the sepals, petals and stamens

inflammation: a diseased condition of some part of the body, resulting from injury, infection, irritation, etc. and characterized by redness, pain, heat, and swelling

inflorescence: the arrangement and mode of development of the flowers on the floral axis; the branch that bears the flowers, including all its bracts and branches

infructescence: a ripened inflorescence in the fruiting stage

infundibular: funnel-shaped

inlaying: of wood, to put pieces of wood in cavities in another, generally differently coloured wood for decorative purposes

inner bark: the secondary phloem; the living part of the tissue outside the cambium

insecticidal: destroying or controlling insects

insomnia: sleeplessness

integument: the envelope of an ovule

intercellular canal (wood anatomy): a tubular intercellular duct surrounded by an epithelium, generally containing secondary plant products such as resin, gum, etc.

interfloral: between the flowers

interlocked grain: a wood grain in which the fibres incline in one direction over some width and in a reverse direction in succeeding layers

interpetiolar: of stipules placed between the petioles of opposite leaves

intervessel pit: see pits

intramarginal: of a vein, running near and parallel with the margin

intrapetiolar: of stipules, positioned within the petiole axil

intrastaminal: within the stamens

involucre: a ring of bracts (involucral bracts) surrounding several flowers or their supports, as in the heads of *Compositae* or the umbels in *Umbelliferae*

involute: having the edges of the leaves rolled inwards

isodiametric: having equal diameters

Janka hardness: the load required to embed a steel ball to half its diameter, causing a depression of 100 mm^2; Janka end hardness is determined on transverse sections, Janka side hardness is the average of tests on radial and tangential surfaces

jaundice: a disease characterized by yellowish pigmentation of the skin, tissues and body fluids caused by the deposition of bile pigments

joinery: the construction of articles by joining pieces of wood

joint, jointed: an articulation (e.g. a node); articulated

jugate: connected or yoked together; e.g. in leaves 1–n-jugate: with 1–n pairs of leaflets

keel (carina): a ridge like the keel of a boat; the two anterior and united petals of a papilionaceous corolla; the principal vein of a sepal or glume

kerangas: heath forest, a type of tropical forest generally consisting of comparatively small trees with thin trunks (pole forest), often overlying a podsolic soil

kernel: the nucellus of an ovule or of a seed, that is, the whole body within the coats

kiln drying: see seasoning

kiln schedule: see Introduction, Prosea 5(1): Timber trees: Major commercial timbers

kraft pulp: = sulphate pulp

lac insect: a scale insect (*Laccifer lacca*, synonym *Kerria lacca*) that produces lac, a resinous gold-coloured substance used for lacquerware

lacunose: having many cavities

laminate, laminated: consisting of plates or layers

lanate: with woolly hairs

lanceolate: lance-shaped; much longer than broad, being widest at the base and tapering to the

apex
lateral: on or at the side
latewood: the denser wood formed during the later stages of annual growth
latex: a juice, usually white and sometimes sticky, exuding from broken surfaces of some plants
laticifer: a latex-bearing cell or vessel
laticiferous: latex-bearing
laxative: having a tendency to loosen or relax; a drug making the bowels loose and relieving constipation
leaflet: one part of a compound leaf
lenticel: lenticular masses of loose cells protruding through fissures in the periderm on stems, fruits and roots, usually arising beneath individual stomata and their main function is gaseous exchange
lenticellate: having lenticels
lepidote: covered with small scales
leprosy: a chronic infectious disease that attacks the skin, tissues, or nerves, characterized by nodules, ulcers, white scaly scabs, deformities, and wasting of body parts, and is apparently communicated only after long and close contact
leucorrhoea: a discharge of whitish mucus and pus from the female genitals
leukemia: a disease in which the white corpuscles (leucocytes) multiply uncontrollably in the body tissue and usually in the blood
lignified: converted into wood or woody tissue
limb: the expanded part of a tubular corolla, as distinct from the tube or throat; the lamina of a leaf or of a petal; the branch of a tree
linear: long and narrow with parallel sides
live fencing: the use of living plants (trees, shrubs, lianas) to enclose a certain piece of land
lobed: divided, but not to the base
locular: divided by internal partitions into compartments as in anthers and ovaries
locule: the cavity of an ovary or anther
loculicidal: the cavity of a pericarp dehiscent by the back, the dorsal suture
log: a section cross cut from the stem or a branch of a tree. Round log: bark, branches and protuberances removed. Squared log: if a log has been sawn to an approximately rectangular cross-section
longitudinal: lengthwise
lozenge-aliform: of axial parenchyma, surrounding or to one side of the vessel with lateral extensions forming a diamond-shaped outline
Lyctus: a lyctid or bostrychid beetle damaging wood by characteristic round holes of about 1–3 mm in diameter with the wood reduced to flour-like dust
lysigenous: formed by degeneration and breaking down of cell walls in centre of mass
Malesia: the biogeographical region including Malaysia, Indonesia, the Philippines, Singapore, Brunei and Papua New Guinea
mangrove: a brackish-water coastal swamp of tropical and subtropical areas that is partly inundated by tidal flow
marcotting: = air layering
marginal parenchyma band: parenchyma band which forms a more or less continuous layer at the margin of a growth ring
marine borer: a salt or brackish water mollusc (e.g. *Teredo*), commonly called shipworm, damaging wood by producing tunnels with calcareous lining increasing rapidly in diameter from the surface inwards, or certain *Crustacea* attacking the wood surface
meiosis: nuclear divisions in which the diploid chromosome number is reduced to half that of the parent cell to give the haploid number, as in gametes
meliponid bee: a bee belonging to the subfamily *Meliponinae*
membranous: thin and semi-transparent, like a fine membrane
meristem: undifferentiated tissue of the growing point whose cells are capable of dividing and developing into various organs and tissues
merous: 4-, 5- etc., with 4, 5 etc. parts or numbers of sepals, petals etc.
mesocarp: the middle layer of the pericarp or fruit wall which is often fleshy or succulent
micropyle: a minute opening in the integument of an ovule through which the pollen tube penetrates
midrib: the main vein of a leaf which is a continuation of the petiole
module: shoot unit with determinate growth either by apical abortion or conversion of the apex to an inflorescence
modulus of elasticity: a measure of the stiffness of beams or long columns
modulus of rupture: a measure of the load-carrying capacity in bending until breaking occurs
moisture content: the weight of water expressed as a percentage of the dry weight
monoaxial: with a single axis or stem
monocarp: a plant that flowers and fruits only once during its lifetime; the single carpel of an apocarpous fruit
monocaul: with a single stem
monoecious: with unisexual flowers, but male and

female flowers borne on the same plant

monomorphic: with a single form, uniform

monophyletic: of a group of species, one which includes the known or hypothesized common ancestor and all of its descendants

monopodial: of a primary axis which continues its original line of growth from the same apical meristem to produce successive lateral branches

monotypic: consisting of a single element, e.g. of a genus consisting of only one species

monsoon forest: a deciduous tropical woodland experiencing periodic drought

mordant: a compound that serves to fix a dye in or on a substance, e.g. a textile fibre, often a salt or hydroxide of chromium, aluminium or tin

moulding: of wood or plywood, shaping by cutting and/or pressing into various contours

mucilage (mucilaginous): a gelatinous substance that is similar to gum but that swells in water without dissolving and forms a slimy mass

mucronate: ending abruptly in a short stiff point

mucronulate: diminutive of mucronate

multiple (anatomy): a vessel arrangement where clusters of adjacent vessels are aligned parallel to the rays (radial multiple) or in a line oblique to the rays (oblique multiple)

multiseriate: arranged in several rows

muricate: rough, with short and hard tubercular excrescences

mutagenic: capable of inducing mutation

mycorrhiza: a symbiotic association of roots with a fungal mycelium which may form a layer outside the root (ectotrophic) or within the outer root tissue (endotrophic)

myrmecophyte: a plant that has special adaptations for housing ants from which it benefits

narcotic: a drug that in moderate doses dulls the senses, relieves pain and induces profound sleep, but in excessive doses causes stupor, coma or convulsions

naturalized: introduced into a new area and established there, giving the impression of wild growth

nectar: a sweet fluid extruded from various parts of the plant (e.g. by the flower to attract pollinators)

nectariferous: containing or exuding nectar

nectarivorous: feeding on nectar

nectary: a group of modified subepidermal cells in flowers or leaves (extrafloral) secreting nectar

nematicide: an agent that destroys nematodes

nephritis: acute or chronic inflammation of the kidney caused by infection, degenerative process, or vascular disease

nocturnal: of flowers, flowering during the night

node: the point on the stem or branch at which a leaf or lateral shoot is borne

nodule: a small knot or rounded body, often in roots of leguminous plants, where bacteria of the genus *Rhizobium* are active in the fixation of nitrogen from the air

nut: a one-seeded indehiscent fruit with a hard dry pericarp or shell

nutlet: a little nut

ob-: prefix, indication inverse or opposite condition (obtriangular, obcordate, etc.)

oblique multiple: see multiple

oblong: longer than broad, with the sides parallel or almost so

ocrea: a tubular stipule or pair of opposite stipules so combined; an extension of the leaf sheath beyond the petiole insertion

oedema: abnormal accumulation of serous fluid in connective tissue or in a serous cavity

oil cell (anatomy): a parenchymatous idioblast filled with oil

oil gland: a glandular cell which secretes oil

open tank method: a treatment by immersing timber in a preservative solution contained in an open tank

operculum: a lid or cover which separates by a transverse line of division

opposite: of leaves and branches when two are borne at the same node on opposite sides of the stem

orchitis: inflammation of the testis

orthotropic: having a more or less vertical direction of growth

orthotropous: of an ovule, straight, positioned vertically with the chalaza and hilum at the base and micropyle at the top

outer bark: the periderm or rhytidome; the non-living layer of fibrous or corky tissue outside the cambium in woody plants which may be shed or retained

ovary: that part of the pistil, usually the enlarged base, which contains the ovules and eventually becomes the fruit

ovate: egg-shaped in outline or in section; a flat surface which is scarcely twice as long as broad with the widest portion below the middle

ovoid: a solid object which is egg-shaped (ovate in section)

ovule: the immature seed (egg) in the ovary before fertilization

pachycaul: with a thick or massive primary stem

palisade markings: in wood, a pattern of fine and evenly spaced pale or silvery markings along the grain, usually seen on radial faces and resulting from axial parenchyma bands

palmate: of leaflets, leaf-lobes or veins, with the different elements arising from the same point

panelling: to furnish or decorate with panels (rectangular boards)

panicle: an indeterminate branched racemose inflorescence

paniculate: resembling a panicle

pantropical: distributed throughout the tropics

papilionaceous flower: a butterfly-like, pea-like flower, with standard, wings and keel

papillose: covered with minute nipple-like protuberances

paratracheal (anatomy): applied to wood-elements arranged about the vessels

parenchyma: ground tissue composed of thin-walled, relatively undifferentiated cells, e.g. the pith and mesophyll

parietal: placentation type, when the ovules are attached to the wall of a one-celled ovary

paripinnate: a pinnate leaf with all leaflets in pairs

particle board: board made from bonded particles of wood and/or other ligno-cellulosic material

partite (parted): cleft, but not quite to the base

pectin: a substance yielding viscous solutions with water and, in combination with acid and sugar, forming a gel constituting the base of fruit jellies

pedicel: the stalk of an individual flower

peduncle: the stalk of an inflorescence or partial inflorescence

peduncular bract: in palms, empty bract on main inflorescence axis (peduncle) between prophyll and the first rachis bract

peeling: of a log, producing a continuous sheet of veneer by feeding a knife mounted parallel to the axis onto a rotating log

pellucid: translucent

peltate: of a leaf, with the stalk attached to the lower surface, not at the edge

pendent, pendulous: drooping; hanging down from its support

perforation plate (anatomy): the originally imperforate wall involved in the coalescence of two elements of a vessel

perianth: the floral leaves as a whole, including both sepals and petals if both are present

pericarp: the wall of the ripened ovary or fruit whose layers may be fused into one, or may be more or less divisible into exocarp, mesocarp and endocarp

perigynous: of flowers, with the receptacle developing into a flat or concave structure between the base of the gynoecium and the insertion of the perianth

persistent: remaining attached; not falling off, not deciduous; applies to organs that remain in place after they have fulfilled their natural functions

petal: a member of the inner series of perianth segments (corolla) which are often brightly coloured

petiolate: having a petiole

petiole: the stalk of a leaf

petiolule: the stalk of a leaflet

phanerocotylar: of germination, condition in which the (para)cotyledons become entirely exposed, free from the fruit wall and/or testa

phenology: the complex annual course of flushing, quiescence, flowering, fruiting and leaf fall in a given environment

phloem: the principal food-conducting tissue of vascular plants; the bast element of a vascular bundle and basically composed of sieve elements, parenchyma cells, fibres and sclereids

phyllomorphic branch: a determinate, short-lived and strongly plagiotropic branch with some or many biological characteristics of a compound leaf

picking up: of wood, the release of fibres, generally during planing, giving the surface a more of less woolly appearance

pilose: hairy with rather long soft hairs

pinhole borer: generally an ambrosia beetle damaging wood producing a worm-hole of up to about 1.5 mm across which is generally darkly stained and without bore-dust

pinna (plural pinnae): a primary division or leaflet of a pinnate leaf

pinnate: arranged in pairs along each side of a common axis

pinnatifid: pinnately divided about halfway to the midrib

pinnatisect: pinnately divided down to the midrib

pioneer species: a species able to establish itself on bare ground, starting primary succession, often showing rapid growth and producing large amounts of diaspores

piscidal: poisonous to or controlling fish

pistil: the female part of a flower (gynoecium) of one or more carpels, consisting, when complete, of one or more ovaries, styles and stigmas

pistillode: a sterile, often reduced pistil

pith: the soft core occurring in the structural centre of a log; the tissue, sometimes soft, in the centre of the stem of a non-woody dicotyledon *pits*: recesses in the secondary wall of a cell, often in walls connecting two elements of a vessel (intervessel pits), these can be arranged in ladder-like series (scalariform), in horizontal rows (opposite) or in diagonal rows (alternate)

placenta: the part of the ovary to which the ovules are attached

plagiotropic: having an oblique or horizontal direction of growth

plagiotropic by apposition: with an oblique or horizontal orientation resulting from a continued active terminal meristem being replaced by a more vigorous lateral meristem

planing: smoothing the timber surface by using a plane

plano-convex: flat on one side and convex on the other

pleiochasium (plural pleiochasia): a cymose inflorescence in which each axis produces more than 2 branches

pleonanthic: plants (e.g. some palms) flowering continuously, not dying after flowering (cf. hapaxanthic)

pleurisy: inflammation of the pleura (the membrane between thorax and lung)

pleurogram: a characteristic fissure in the epidermal palisade layer in some leguminous seeds (*Caesalpinioideae*, *Mimosoideae*); it is a U-shaped or horseshoe-shaped single or double line found on both faces of the seed and sometimes continuous between them and an important constant character to identify genera

plicate: folded to and fro, like a fan

plumose: feather-like with fine hairs

plywood: a panel material consisting of wood veneers glued together with the grains of adjacent layers arranged at right angles or at a wide angle

pneumatophore: used of air vessels of any description; a root often functioning as a respiratory organ in swampy conditions

pod: a dry fruit composed of a single carpel and dehiscing by sutures, like in legumes; a general term for a dry dehiscent fruit

podzol: a zonal soil having an organic mat and a thin organic-mineral layer above a grey leached layer resting on a dark illuvial horizon

pole (tree): a young tree with a diameter of 10-30 cm at breast height

polish: a smooth and glossy surface produced by a mechanical process, usually by friction

pollarding: cutting a tree back to the trunk to promote the growth of a dense head of foliage

pollen: spores or grains borne by the anthers containing the male element (gametophyte)

pollination: the transfer of pollen from the dehiscing anther to the receptive stigma

polyembryony: the production of two or more embryos within an ovule

polygamo-monoecious: with unisexual and bisexual flowers on the same plant

polygamous: with unisexual and bisexual flowers in the same plant

polymorphic, polymorphous: with several or various forms; variable as to habit

polyphyletic: of a group of species or taxa, a non-natural group in which the most recent common ancestor for all species (or taxa) is assigned to another group, the characterization of the group being based on convergent similarity

polyploid: with more than two sets (genomes) of chromosomes in the somatic cells

poultice: a soft, usually heated and sometimes medicated mass spread on cloth and applied to sores or other lesions

praemorse: jaggedly toothed, as if bitten

preservative: chemical formulation (usually in liquid form) used for the treatment of timber to increase its durability

pressure treating method: the application of pressure in the preservative treatment of timber

primary vegetation: the original, undisturbed plant cover

procumbent: lying along the ground; in wood anatomy also of ray parenchyma cells with their longest dimension in radial direction

proliferous: multiplying quickly; bearing progeny as offshoot

prolific: fruitful, producing offspring

prophyll: the first bract borne on the inflorescence; the bracteole at the base of an individual flower

protandrous: of flowers, shedding pollen before the stigma is receptive

proteoid: similar to *Protea*

protogynous: of flowers, the stigma is receptive before the pollen is shed; of inflorescences, the female flowers mature before the male ones

pruning: cutting off the superfluous branches or shoots of a plant for better shape or more fruitful growth

pseudocarp: false fruit, a fruit not derived solely from the ovary, but also from adnate parts, e.g. a pome, an aggregate fruit

pseudogemmula: in pinnate leaves, a terminal bud from which leaflets keep unfolding at intervals, even when the leaf seems mature

psyllid: belonging to the homopterous insect fami-

ly *Psyllidae* (including e.g. the jumping plant lice)
puberulous: minutely pubescent
pubescent: covered with soft short hairs
pulp: the soft fleshy part of the fruit; mechanically ground or chemically digested wood used in manufacturing paper and allied products
pulvinus: a minute gland or swollen petiole base.
punctate: marked with dots or translucent glands
pungent: bearing a sharp point; causing a sharp or irritating sensation
purgative: a medicine causing vigorous evacuation from the bowels
pustular, pustulate: with blister-like prominences
pyrene: a nutlet or kernel; the stone of a drupe or similar fruit
pyriform: resembling a pear in shape
quarter-sawn: of timber, converted so that the growth rings meet the face in any part at an angle of not less than 45°
raceme: an unbranched elongated indeterminate inflorescence with stalked flowers opening from the base upwards
racemose: with flowers arranged in a raceme
rachilla: a diminutive or secondary axis, e.g. the branch that bears a flower or the stalk of the spikelet in grasses
rachis (plural rachides): the principal axis of an inflorescence or a compound leaf beyond the peduncle or petiole
radial: lengthwise, in a plane that passes through the pith; radiating, as from a centre (cf. tangential)
radial multiple: see multiple
rain forest: a tropical forest receiving an annual rainfall of at least 1800 mm, characterized by lofty evergreen trees forming a continuous canopy below which terrestrial herbs and shrubs are poorly developed
ramiflorous: bearing flowers on the branches
raphid (plural raphides): a needle-shaped crystal occurring typically as one of a closely packed, sheaf-like bundle and consisting of calcium oxalate
rash: an eruption of red spots on the skin, usually of a temporary nature
rays: in wood, ribbons of parenchymatous tissue which are seen on a cross-section of timber as lighter coloured lines radiating from the pith outwards, and extending right up to the bark
recalcitrant: of seeds, not tolerating desiccation or temperatures below 10°C
receptacle (botany): the flat, concave or convex part of the axis from which the parts of the flower arise
reduplicate: of leaflets, inversed V-shaped in cross section
reflexed: abruptly bent or turned downward or backward
reforestation: the planting of a formerly forested area with forest trees
remote-ligular: in germination, the young plant connected to the seed by a long tubular cotyledonary petiole, bearing a ligule
remote-tubular: in germination, the young plant connected to the seed by a long tubular cotyledonary petiole, lacking a ligule
reniform: kidney-shaped
repand: with an undulating margin
resin: solid to soft semisolid amorphous fusible flammable substance obtained as exudate or as an extract of plants
resinous: exuding, made of, or similar to resin
reticulate: netted, as when the smallest veins of a leaf are connected together like the meshes of a net
revolute: of leaves with the margins, rolled downwards towards the midrib
rheumatism: any of various painful conditions of the joints and muscles
rhizome: an underground stem which is distinguished from a root by the presence of nodes, buds, and leaves or scales
rhombic: shaped like a rhomb, an equilateral oblique-angled figure
ribbon figure: a banded figure with elongated markings, especially in quarter-sawn timber with an interlocked grain
rind: the tough outer layer of the fruit
ring-porous: of wood, with vessels of the earlywood distinctly larger than those of the latewood and forming a well-defined zone or ring
riparian forest: forest growing on the banks of streams or rivers
ripple mark: fine horizontal striations visible on the tangential surface of wood, due to the storied arrangement of rays or of axial elements or both
riverine forest: = riparian forest
root-nodule: small dwelling on the roots of leguminous and other plants, containing nitrogen-fixing bacteria (rhizobia)
root sucker: a shoot originating from adventitious buds on the roots
rootstock: see rhizome; a stock for grafting consisting of a root and part of the main axis
rotary-cut: = peeled, see peeling
rotate: wheel-shaped; circular and flat

rotund: rounded in outline, somewhat orbicular, but a little inclined towards oblong
rudimentary: of organs, imperfectly developed and non-functional
rugose: wrinkled
ruminate: of endosperm, mottled in appearance, due to the infolding of a dark inner layer of the seed-coat into the paler coloured endosperm
saccate: pouched
sagittate: shaped like an arrowhead; of a leaf base with two acute straight lobes directed downwards
samara: an indehiscent winged fruit
sap-stain: discoloration of wood (often sapwood) caused by fungi
sapling: a young tree of more than 1.5 m tall and with a bole of less than 10 cm in diameter
saponin: a glycoside with soap properties
sapraemia: a toxic state in which toxic products of putrefactive bacteria are present in the blood
sapwood: the outer layers of wood adjacent to the bark which in the living tree contain living cells and reserve materials
sarcotesta: the fleshy outer seed-coat
scabies: a contagious skin disease caused by certain mites that burrow under the skin and deposit eggs, causing intense itching
scabrid, scabrous: rough to the touch
scalariform: ladder-like, having markings or perforations suggestive of a ladder
scale: a thin scarious body, often a degenerate leaf or a trichome of epidermal origin
scandent: climbing
scantling: a piece of timber converted to a specific size
scarification: of seed, the cutting or softening of the wall of a hard seed to hasten germination
schizocarp: a dry fruit formed from a syncarpous ovary which splits into one-seeded portions, mericarps or 'split fruits'
scion: the plant which is being propagated vegetatively in grafting; the part of the plant above the graft union
sclerophyll forest: a dry type of evergreen or deciduous forest characterized by species with thickened and hardened leaves
sclerotic: hardened, stony in texture
scorpioid: circinate; coiled as to resemble a scorpion
scurf: abnormal skin condition in which small flakes or scales become detached
seasoning: of timber, the reduction of the moisture content of timber either by air drying (air season) or kiln drying (kiln season). Timber is fully seasoned when the moisture content has dropped to the equilibrium moisture content of the ambient climate
secondary vegetation: a plant cover that has been disturbed by natural causes or by man
section (botany): a taxonomic rank between the genus and the species accommodating a single or several related species
seed: the reproductive unit formed from a fertilized ovule, consisting of embryo and seed-coat, and, in some cases, also endosperm
seed orchard: a plantation of selected trees, isolated to reduce pollination from outside, cultivated for the production of seed
seedling: the juvenile plant, grown from a seed
selective logging: a system to harvest only certain a priori selected tree species from a forest
self-pollination: pollination with pollen from the same flower or from other flowers of plants of the same clone
semi-: prefix, meaning half or incompletely, e.g. semi-inferior
sepal: a member of the outer series of perianth segments
septate: divided by one or more partitions
septicidal: dehiscing along the septa of the ovary
septum (plural septa): a partition or cross-wall
seriate: serial, disposed in series of rows
sericeous: silky
serrate: toothed like a saw, with regular pointed teeth pointing forwards
sessile: without a stalk
setose: set with bristles or bristle-like elements
shear: a measure for the resistance of wood when the forces acting on it tend to make one part slide over another in the direction parallel to the grain
sheath cell (anatomy): a ray cell located along the side of a broad ray (> 3-seriate) as viewed in tangential section and which is larger than the central cells
shot-hole borer: a beetle of the family *Scolytidae* which creates small tunnels in wood
shrub: a woody plant which branches from the base, all branches being equivalent (see also tree)
silica body: globular or amorphous conglomerate of siliceous material, generally included in parenchymatous cells
siliceous: containing silica
silver grain: an attractive figure formed by the conspicuous rays in quarter-sawn wood (as in oak), which is much paler than the rest of the wood

silviculture: the theory and practice of controlling the establishment, composition, constitution, and growth of forests; the science and art of cultivating forest crops
simple (botany): not compound, as in leaves with a single blade
sinuate: with a deep wavy margin
slash: a cut or stroke along the stem of a tree to reveal exudates and colours of bark and sapwood
sliced veneer: a thin sheet of wood cut from a stationary block of wood by a knife mounted approximately parallel with and moving to and fro across the longitudinal axis of the block
soda pulp: a chemical wood pulp obtained through application of a solution of sodium hydroxide
spat(h)ulate: spoon-shaped
specific gravity: ratio of the weight of a volume of material to the weight of an equal volume of water of 4°C, in wood measured at 0% moisture content
spherical: globular
spicate: spike-like
spike: a simple indeterminate inflorescence with sessile flowers along a single axis
spine: a short, stiff, straight, sharp-pointed hard structure usually arising from the wood of a stem
spinose, spinous: having spines
spiral: as though wound round an axis
splenomegaly: enlargement of the spleen
spongy heart: situation where the wood of the pith of a bole is softened by saturation with water
sporophyll: a leaf or leaf-like structure bearing or subtending a sporangium
sprue: a chronic deficiency disease characterized by digestive disturbances, a sore mouth and tongue, and macrocytic anaemia
spur root: a root projecting from the base of the trunk
stain: discoloration or variation from natural colour due to fungi, chemical action or other causes
stamen: one of the male reproductive organs of a flower; a unit of the androecium
staminode: an abortive or rudimentary stamen without or with an imperfect anther
standard (botany): the fifth, posterior or upper petal of a papilionaceous corolla
stegmata: flat, tabular cells containing a mass of silica in contact with their inner wall
stellate: star-shaped, as of hairs with radiating branches, or of petals arranged in the form of a star
sterile: failing to complete fertilization and produce seed as a result of defective pollen or ovules; not producing seed capable of germination; lacking functional sexual organs (sterility)
stickering: using a stick or strip of wood (sticker) to separate the layers in a stack of wood to improve air circulation during drying
stigma: the portion of the pistil which receives the pollen
stilt root: an oblique adventitious root as in mangrove trees and similar forms
stipe: the stalk supporting a carpel or gynoecium
stipel: small secondary stipule at the base of a leaflet
stipitate: borne on a stipe or short stalk
stipulate: with or bearing stipules
stipule: a scale-like or leaf-like appendage at the base of a petiole
stomachic: a digestive tonic stimulating the action of the stomach
stone: the hard endocarp of a drupe containing the seed or seeds
stone cell (anatomy): a sclereid that has become hardened by secondary deposits, as in pear
storied (anatomy): of cells, arranged in horizontal series as viewed on the tangential surface
straggling: extremely divergent, spreading very far apart; irregular, bushy
stratification: a moist, cold treatment of seed to overcome physiological dormancy
striate: marked with fine longitudinal parallel lines, as grooves or ridges
strip planting: setting trees in two or more parallel lines in a long narrow area that has been wholly or partially cleared
stripling: seedling stripped of all but its terminal leaves and used as planting stock
stump: seedling with trimmed roots and shoot and used as planting stock; also the part of a tree remaining attached to the root after the trunk is cut
style: the part of the pistil connecting the ovary with the stigma
styloid: of crystals, elongated, typically at least four times as long as broad, with pointed or square ends
sub-: prefix, meaning somewhat or slightly (e.g. subacute), or below (e.g. subterranean) or less than, imperfectly
subfamily: a taxonomic rank between the family and the tribe denoting a part of a family
subspecies: a subdivision of a species, in rank between a variety and a species
subulate: awl-shaped, sharply pointed
succulent: juicy, fleshy

sucker: a shoot, usually originating from adventitious buds on the roots or basal stem parts, which does not fit in the architectural model, but is capable of repeating the model
sudorific: causing or inducing sweat
sulphate pulp: a chemical wood pulp obtained by digesting wood chips at high temperate and pressure in a solution of sodium hydroxide and sodium sulphate
superior: of an ovary, with the perianth inserted below or around its base, the ovary being attached at its base only
syllepsis: development of a lateral branch without a period of dormancy, i.e. contemporaneous with its parent axis
symbiont: an individual living in symbiosis
symbiosis: the intimate living together of two dissimilar organisms in a mutually beneficial relationship
sympetalous: with united petals
sympodial: of a stem in which the growing point either terminates in an inflorescence or dies, growth being continued by a new lateral growing point
syncarp: a multiple or fleshy aggregate fruit, including fruit produced from a more or less entire inflorescence (as in *Ananas*, *Artocarpus*, *Morus*)
syncarpous: of an ovary composed of two or more united carpels
syphilis: a disease communicated by sexual contact, or via the blood or bite of an infected person, caused by a spirochaete (*Treponema pallidum*) and characterized by a clinical course in 3 stages continued over many years
tangential: lengthwise, in a plane at right angles to the radius but not passing through the pith (cf. radial)
tanniferous: yielding or containing tannin
taproot: the primary descending root, forming a direct continuation of the radicle
taungya system: an agroforestry method where a forest crop is raised in conjunction with a temporary agricultural crop
taxon (plural taxa): a term applied to any taxonomic unit irrespective of its classification level, e.g. variety, species, genus, etc.
taxonomy: the study of principles and practice of classifying living organisms (systematics)
tension wood: reaction wood formed typically on the upper sides of branches and leaning or crooked stems with an abnormally high longitudinal shrinkage tending to cause distortion and splitting
tepal: a segment of a perianth, applied when no distinction between sepals and petals can be made
terete: cylindrical; circular in transverse section
terminal: borne at the end or apex
termite: ant-like organism of the order *Isoptera* damaging wood by characteristic irregular honeycombing or wide channels with dry bore-dust or dust cemented together
ternate: in threes
tertiary venation: generally the collection of the smallest veins of a leaf blade
tessellate: marked with a fine chequered pattern, like a mosaic
testa: the outer coat of the seed
tetrahedral: having or made up of four sides
thinning: removing trees, stems or plants from immature or mâture stands in order to stimulate the growth of the remaining trees, stems or plants
throat: of a corolla, the orifice of a gamopetalous corolla
thrush: a disease, especially of children, caused by a fungus and characterized by the formation of milky, white lesions on the membranes of the mouth, lips and throat
thyrse: a compound inflorescence composed of a panicle (indeterminate axis) with the secondary and ultimate axes cymose (determinate)
thyrsoid: like a thyrse
tile cell: a special type of apparently empty upright ray cell of approximately the same height as the procumbent ray cells and occurring in indeterminate horizontal series usually interspersed among the procumbent cells
timber: any wood other than fuelwood
tissue culture: a body of tissue growing in a culture medium outside the organism
tomentose: densely covered with short soft hairs
tonic: medicinal preparation believed to have the power of restoring normal activity
tracheid: an imperforate wood cell with bordered pits to congeneric elements
transverse: straight across; of tertiary veins, connecting the secondary veins, not necessarily in a perpendicular way
traumatic duct: canal formed in response to injury, generally irregular in outline
tree: a perennial woody plant with a single evident trunk (see also shrub)
triad: a group composed of 3 elements; a special group of 2 lateral staminate and a central pistillate flower, structurally a short cincinnus
tribe (plural tribae): a taxonomic rank between the family and the genus

trigonous: three-angled, with plane faces
tripliveined: with 3 main veins
truncate: cut off more or less squarely at the end
trunk: the main stem of a tree apart from its limbs and roots
tuberculosis: an acute or chronic disease caused by the tubercle bacillus, found especially in the respiratory tract and characterized by toxic symptoms (fever, sweating, loss of weight) or allergic manifestations
tufa: a porous, usually calcareous rock type formed as a deposit from springs or streams
turbinate: top-shaped
turnery: articles made by the process of turning
turning: of wood, shaping, especially in a rounded form, by applying a cutting tool while revolving in a lathe
tylosis (plural tyloses): an outgrowth of a parenchyma cell through a pit cavity in a vessel wall
tympanites: meteorismus, the accumulation of intestine gases
tympanitis: inflammation of the lining membrane of the tympanum (middle ear)
ultrabasic: of soil, very low in silica and rich in ferromagnesian minerals as in e.g. serpentine soils
ultramafic: of rock, containing high concentrations (more than 70%) of magnesium (ma) and iron (f) hence the term ultramafic
umbel: an indeterminate, often flat-topped inflorescence whose divergent peduncles (rays) and pedicels arise from a common point; in a compound umbel each ray itself bears an umbellule (small umbel)
umbelliform: umbrella-shaped
umbellule: see umbel
undulate: wavy, said for instance of a leaf margin if the waves run in a plane at right angles to the plane of the leaf blade
unifoliolate: with one leaflet only, but in origin a compound leaf
unilateral: one-sided
unilocular: one-celled
uniseriate: in one horizontal row or series
unisexual: of one sex, having stamens or pistils only
urceolate: urn-shaped
utricular: shaped like a utricle or small bladder
vacuum-pressure method: the application of vacuum and pressure in the preservation of timber
valvate: of perianth segments, with their edges in contact, but not overlapping in the bud
valve: one of the parts produced by a dehiscing capsule
variety: a botanical variety which is a subdivision of a species (an agricultural or horticultural variety is referred to as a cultivar)
vascular strand: a bundle of specialized cells (vessels), consisting of xylem and phloem, sometimes with a strip of cambium
vasicentric (wood anatomy): of axial parenchyma, forming a complete circular or oval sheath around a vessel or vessel multiple
vein: a strand of vascular tissue in a flat organ, such as a leaf
velvety: with a coating of fine soft hairs; the same as tomentose but denser so that the surface resembles (and feels like) velvet
venation: the arrangement of the veins in a leaf
veneer: a thin sheet of wood
ventral: facing the central axis (adaxial), opposed to dorsal (abaxial)
vermifuge: a drug serving to destroy or expel parasitic worms of the intestine
versatile (botany): turning freely on its support, as anthers on their filaments
verticil: whorl
verticillate: in a whorl with several elements arising at the same node
vertigo: dizziness
vesicular: bladder-like
vesicular arbuscular mycorrhiza: a common endomycorrhizal association characterized by 2 types of fungal structures: small structures within root cells known as arbuscules, and storage organs between root cells known as vesicles
vessel (anatomy): a continuous tube formed by superposition of numerous cells whose common walls are perforated or have broken down
vestured pit: an intervessel pit with the pit cavity and/or aperture wholly or partially lined with projections from the secondary cell wall
villose (villous): with long weak hairs
viviparous: germinating or sprouting from seed or bud while attached to the parent plant
warp: distortion of a piece of sawn timber usually occurring during seasoning
watered-silk figure: in wood, a pattern reminiscent of wetted silk or with a water stain, usually seen on a tangential surface
waterlogged: flooded with water, generally for a period of at least a few weeks
weatherboard: board forming the exposed surface of outside walls of frame buildings
whorl: arrangement with more than two organs of the same kind arising at the same level
wildling: a seedling taken from natural regeneration to serve as planting stock

wing: any membraneous expansion attached to an organ; a lateral petal of a papilionaceous corolla

winged-aliform (wood anatomy): of axial parenchyma, surrounding or to one side of the vessel with the lateral extensions being elongated and narrow

Wolman salt: aqueous wood preservative of fluoride-phenol-chrome composition, with or without the addition of insecticidal and fire-resistant chemicals

wood: the hard, compact, fibrous substance between pith and bark

wood-wool board: a panel material in which wood shavings or shredded waste paper is bonded with inorganic cement

woolly: clothed with long and tortuous or matted hairs

xerophytic: relating to a plant structurally adapted for life and growth with a limited water supply

zygomorphic: irregular and divisible into equal halves in one plane only

Sources of illustrations

Photographs

All photographs are by J. Ilic except for those of *Acmena acuminatissima*, *Berrya cordifolia*, *Broussonetia luzonica*, *Camptostemon philippinense*, *Ctenolophon parvifolius*, *Dacryodes incurvata*, *Diploknema ramiflora*, *Licania splendens*, *Ludekia bernardoi*, *Murraya paniculata*, *Nephelium ramboutan-ake*, *Ormosia calavensis*, *Osbornia octodonta*, *Parkia timoriana*, *Pemphis acidula*, *Petersianthus quadrialatus*, *Phoebe sterculioides*, *Pistacia chinensis*, *Platymitra arborea*, *Polyscias nodosa*, *Securinega flexuosa*, *Tristaniopsis decorticata* and *Walsura pinnata* which were taken from Reyes (1938).

Drawings

Acrocarpus fraxinifolius: Koorders, S.H. & Valeton, T., 1913. Atlas der Baumarten von Java. Vol. 1. P.W.M. Trap, Leiden. Fig. 12 (tree habit, leaf, dehisced pod); Larsen, K., Larsen, S.S. & Vidal, J.E., 1980. Légumineuses–Césalpinioidées. Flore du Cambodge, du Laos et du Viêtnam. Vol. 18. Muséum National d'Histoire Naturelle, Paris. p. 75, Pl. 13 (inflorescence, flower). Redrawn and adapted by Iskak Syamsudin.

Adenanthera pavonina: Photograph taken by E. Boer at the Bogor Botanic Gardens, Java (tree habit); Nielsen, I. & Guinet, P., 1992. Synopsis of Adenanthera (Leguminosae–Mimosoideae). Nordic Journal of Botany: 12: 85–114. Fig. 15 (leaf, inflorescence, flower, pod, seed). Redrawn and adapted by Iskak Syamsudin.

Alangium chinense: Koorders, S.H. & Valeton, T., 1913. Atlas der Baumarten von Java. Vol. 1. P.W.M. Trap, Leiden. Fig. 187 (flowering twig); Li, Hui-lin, 1977. Alangiaceae. Flora of Taiwan. Vol. 3. Epoch Publishing Co., Ltd., Taipei. p. 907, Pl. 861 (flower, fruit). Redrawn and adapted by Iskak Syamsudin.

Albizia saponaria: Photograph taken by E. Boer at the Bogor Botanic Gardens, Java (bole); Nielsen, I., 1985. The Malesian species of Acacia and Albizia (Leguminosae–Mimosoideae). Opera Botanica 81. p. 34, Fig. 15 (leaf, inflorescence); Herbarium material of Herbarium Bogoriense (pod). Redrawn and adapted by Iskak Syamsudin.

Anisophyllea ferruginea: Ashton, P.S., 1988. Manual of the non-dipterocarp trees of Sarawak. Vol. 2. Dewan Bahasa dan Pustaka. Sarawak Branch for Forest Department Sarawak. Pl. 38 (bole), Fig. on p. 369 (sterile twig, fruit). Redrawn and adapted by Iskak Syamsudin.

Antiaris toxicaria: Chew, W.L., 1989. Moraceae. Flora of Australia. Vol. 3. Hamamelidales to Casuarinales. Australian Government Publishing Service, Canberra. p. 25, Fig. 29 D–E (fruiting twig, male inflorescence); Berg, C.C., 1977. Revision of African Moraceae (excluding Dorstenia, Ficus, Musanga and Myrianthus). Bulletin du Jardin Botanique National de Belgique 47: 315, Fig. 9 (staminate flower, female inflorescence). Redrawn and adapted by Iskak Syamsudin.

Aporosa lagenocarpa: Airy Shaw, H.K., 1974. Noteworthy Euphorbiaceae from tropical Asia (Burma to New Guinea). Hooker's Icones Plantarum, ser. 5, vol. 38: Tab. 3701 (fruiting twig, stipule, male inflorescence, sectioned ovary and styles). Redrawn and adapted by Iskak Syamsudin.

Avicennia alba: Watson, J.G., 1928. Mangrove forests of the Malay Peninsula. Malayan Forest Records No 6. Forest Department, Kuala Lumpur. p. 62, Fig. 31 (bole); Koorders, S.H. & Valeton, T., 1914. Atlas der Baumarten von Java. Vol. 2. P.W.M. Trap, Leiden. Fig. 273 (flowering twig, flower); Tomlinson, P.B., 1986. The botany of mangroves. Cambridge Tropical Biology Series. Press Syndicate of the University of Cambridge, Cambridge. p. 190, Fig. B.9 (fruit). Redrawn and adapted by Iskak Syamsudin and Achmad Satiri Nurhaman.

Baccaurea motleyana: Soejarto, D.D., 1965. Baccaurea and its uses. Botanical Museum Leaflets, Harvard University 21(3): 65–104, Pl. XII

(sterile twig, female inflorescence, infructescence, fruit in cross section, female flower, male flower with 2 sepals removed). Redrawn and adapted by Achmad Satiri Nurhaman.

Barringtonia racemosa: Sangai, G.R.W., 1971. Lecythidaceae. In: Milne-Redhead, E. & Polhill, R.M. (Editors): Flora of Tropical East Africa. Crown Agents for Oversea Governments and Administrations, London. p. 3, Fig. 1 (flowering twig, young infructescence, gynoecium, mature fruit). Redrawn and adapted by Achmad Satiri Nurhaman.

Blumeodendron tokbrai: Kessler, P.J.A. & Sidiyasa, K., 1994. Trees of the Balikpapan-Samarinda area, East Kalimantan, Indonesia. Tropenbos Series 7. The Tropenbos Foundation, Wageningen. p. 339, Fig. 9 (sterile twig, young fruits); Whitmore, T.C., 1983. Euphorbiaceae. In: Whitmore, T.C. (Editor): Tree flora of Malaya. Vol. 2. Revised edition. Malayan Forest Records No 26. Longman Malaysia Sdn. Berhad, Kuala Lumpur. p. 71, Fig. 3 (fruits). Redrawn and adapted by Achmad Satiri Nurhaman.

Bombax ceiba/*Bombax valetonii*: Photograph taken by E. Boer at the Bogor Botanic Gardens, Java (tree habit of *B. valetonii*); Kraemer, J.H., 1951. Trees of the western Pacific region. Tri-State Offset Company, Cincinnatti. p. 238, Fig. 86 (leaf, inflorescence, fruit of *B. ceiba*). Redrawn and adapted by Iskak Syamsudin.

Bridelia pustulata: Dressler, S., 1996. The genus Bridelia (Euphorbiaceae) in Malesia and Indo-China - A regional revision. Blumea 41: p. 319, Fig. 5 (flowering twig, male flower, female flower, fruits). Redrawn and adapted by Iskak Syamsudin.

Bruguiera gymnorhiza: Koorders, S.H. & Valeton, T., 1913. Atlas der Baumarten von Java. Vol. 1. P.W.M. Trap, Leiden. Fig. 103 (tree habit); Lewis, J., 1956. Rhizophoraceae. In: Turrill, W.B. & Milne-Redhead, E. (Editors): Flora of Tropical East Africa. Crown Agents for Oversea Government and Administrations, London. p. 7, Fig. 3 (flowering twig, petal with enclosed stamen-pair, fruit and hypocotyl). Redrawn and adapted by Achmad Satiri Nurhaman.

Buchanania arborescens: Koorders, S.H. & Valeton, T., 1913. Atlas der Baumarten von Java. Vol. 1. P.W.M. Trap, Leiden. Fig. 76 (tree habit, flowering twig, fruiting twig, flower). Redrawn and adapted by Iskak Syamsudin.

Cantleya corniculata: Sleumer, H., 1971. Icacinaceae. In: van Steenis, C.G.G.J. (Editor): Flora Malesiana. Ser. I, Vol. 7. Noordhoff International Publishing, Leyden. p. 52–53, Figs. 21 & 22 (tree habit, flowering twig, stamen, petal). Redrawn and adapted by Iskak Syamsudin.

Carallia brachiata: Ding Hou, 1958. Rhizophoraceae. In: van Steenis, C.G.G.J. (Editor): Flora Malesiana. Ser. I, Vol. 5. Noordhoff-Kolff N.V., Djakarta. p. 486, Fig. 31 (tree habit); Ashton, P.S., 1988. Manual of the non-dipterocarp trees of Sarawak. Vol. 2. Dewan Bahasa dan Pustaka, Kuala Lumpur. p. 358, Pl. 41 (trunk base); Kochummen, K.M., 1989. Rhizophoraceae. In: Ng, F.S.P. (Editor): Tree flora of Malaya. Vol. 4. Revised edition. Malayan Forest Records No 26. Longman Malaysia Sdn. Berhad, Petaling Jaya. p. 314, Fig. 4 (fruiting twig); Schimper, A.F.W., 1892. Rhizophoraceae. In: Engler, A. & Prantl, K. (Editors): Die natürlichen Pflanzenfamilien III, 7. Wilhelm Engelmann, Leipzig. p. 53, Fig. 27 (flower). Redrawn and adapted by Iskak Syamsudin.

Caryota mitis: Koorders, S.H., 1926. Exkursionsflora von Java. Vol. 4, Atlas. Gustav Fisher, Jena. p. 138–139, Figs. 321 & 322 (habit, habit with tillers, leaflet, part of inflorescence, part of infructescence). Redrawn and adapted by P. Verheij-Hayes.

Cassia javanica: Corner, E.J.H., 1988. Wayside trees of Malaya. 3rd edition. Vol. 1. The Malayan Nature Society, Kuala Lumpur. Pl. 102 (tree habit); de Wit, H.C.D., 1956. A revision of the genus Cassia (Caesalp.) as occurring in Malaysia. Webbia 11: p. 221, Fig. 1 (flowering twig, flower); Irwin, H.S. & Barneby, R.C., 1982. The American Cassiinae. A synoptical revision of the Leguminosae tribe Cassieae subtribe Cassiinae in the New World. Memoirs of the New York Botanical Garden 35: p. 6, Fig. 2 (pod). Redrawn and adapted by Achmad Satiri Nurhaman.

Casuarina equisetifolia: Corner, E.J.H., 1988. Wayside trees of Malaya. 3rd edition. Vol. 1. The Malayan Nature Society, Kuala Lumpur. Pl. 45 (habit of young tree); Wilmot-Dear, C.M., 1985. Casuarinaceae. In: Polhill, R.M. (Editor): Flora of tropical East Africa. Balkema, Rotterdam. p. 6, Fig. 2 (flowering twig, male inflorescence, female inflorescence, fruit); Wilson, K.L. & Johnson, L.A.S., 1989. Casuarinaceae. Flora of Australia. Vol. 3. Australian Government Publishing Service, Canberra. p. 105, Fig. 46 (cone, branchlet). Redrawn and adapted by P. Verheij-Hayes.

Celtis philippensis/*Celtis rigescens*: Photograph

taken by E. Boer at the Bogor Botanic Gardens, Java (tree habit of *C. rigescens*); Soepadmo, E., 1977. Ulmaceae. In: van Steenis, C.G.G.J. (Editor): Flora Malesiana. Ser. I, Vol. 8. Sijthoff & Noordhoff International Publishers, Alphen aan den Rijn. p. 56, Fig. 18 (flowering twig, male flower, bisexual flower, fruits of *C. philippensis*). Redrawn and adapted by Achmad Satiri Nurhaman.

Chisocheton macrophyllus: Koorders, S.H. & Valeton, T., 1913. Atlas der Baumarten von Java. Vol. 1. P.W.M. Trap, Leiden. Fig. 166 (tree habit, leaf, flower); Mabberley, D.J., Pannell, C.M. & Sing, A.M., 1995. Meliaceae. In: de Wilde, W.J.J.O. (Editor): Flora Malesiana. Ser. I, Vol. 12. Rijksherbarium/Hortus Botanicus, Leiden. p. 177, Fig. 27 (inflorescence, fruit). Redrawn and adapted by Achmad Satiri Nurhaman.

Combretocarpus rotundatus: Whitmore, T.C., 1984. Tropical rainforest of the Far East. 2nd edition. Clarendon Press, Oxford. p. 189, Fig. 13.12 (tree habit); Ding Hou, 1958. Rhizophoraceae. In: van Steenis, C.G.G.J. (Editor): Flora Malesiana. Ser. I, Vol. 5. Noordhoff-Kolff N.V., Djakarta. p. 481, Fig. 29 (flowering twig, flower, fruit). Redrawn and adapted by Iskak Syamsudin.

Ctenolophon parvifolius: van Hooren, A.M.N. & Nooteboom, H.P., 1989. Ctenolophonaceae. In: van Steenis, C.G.G.J. & de Wilde, W.J.J.O (Editors): Flora Malesiana. Ser. I, Vol. 10. Kluwer Academic Publishers, Dordrecht. p. 632–633, Fig. 1 & 2 (tree habit, flowering twig, flower, fruit, seed). Redrawn and adapted by Iskak Syamsudin.

Dacryodes costata: Leenhouts, P.W., 1956. Burseraceae. In: van Steenis, C.G.G.J. (Editor): Flora Malesiana. Ser. I, Vol. 5. Noordhoff-Kolff N.V., Djakarta. p. 223, Fig. 10 (flowering twig, female flower with petal removed, sectioned male flower, infructescence). Redrawn and adapted by Achmad Satiri Nurhaman.

Dactylocladus stenostachys: Smythies, B.E., 1965. Common Sarawak trees. Borneo Literature Bureau, South China Morning Post, Hong Kong. p. 91, Pl. 30 (trunk); van Beusekom-Osinga, R.J., 1977. Crypteroniaceae. In: van Steenis, C.G.G.J. (Editor): Flora Malesiana. Ser. I, Vol. 8. Sijthoff & Noordhoff International Publishers, Alphen aan den Rijn. p. 199, Fig. 9 (flowering twig, flower, seed). Redrawn and adapted by Iskak Syamsudin and Achmad Satiri Nurhaman.

Dehaasia caesia: Koorders, S.H. & Valeton, T., 1913. Atlas der Baumarten von Java. Vol. 2. P.W.M. Trap, Leiden. Fig. 216 (tree habit, flowering twig, fruits). Redrawn and adapted by Iskak Syamsudin.

Drypetes polyneura: Airy Shaw, H.K., 1974. Noteworthy Euphorbiaceae from tropical Asia (Burma to New Guinea). Hooker's Icones Plantarum, ser. 5, vol. 38: Tab. 3710 (sterile twig, male flower, female flower, fruiting twig). Redrawn and adapted by Achmad Satiri Nurhaman.

Dysoxylum parasiticum: Koorders, S.H. & Valeton, T., 1913. Atlas der Baumarten von Java. Vol. 1. P.W.M. Trap, Leiden. Fig. 100 & 172 (habit of young tree, leaf, dehisced fruit); Mabberley, D.J., Pannell, C.M. & Sing, A.M., 1995. Meliaceae. In: de Wilde, W.J.J.O. (Editor): Flora Malesiana. Ser. I, Vol. 12. Rijksherbarium/Hortus Botanicus, Leiden. p. 79, Fig. 11 (inflorescence); Pennington, T.D. & Styles, B.T., 1975. A generic monograph of the Meliaceae. Blumea 22: p. 506, Fig. 14a (cross section of male flower). Redrawn and adapted by Iskak Syamsudin.

Elaeocarpus angustifolius: Photograph taken by E. Boer at Cibodas Botanic Garden, Java (tree habit); Phengklai, C., 1981. Elaeocarpaceae. In: Smitinand, T. & Larsen, K. (Editors): Flora of Thailand. Vol. 2. TISTR Press, Bangkok. p. 413, Fig. 4 (flowering twig, petal, anther); Koorders, S.H. & Valeton, T., 1914. Atlas der Baumarten von Java. Vol. 3. P.W.M. Trap, Leiden. Fig. 426 (infructescence, pyrene). Redrawn and adapted by Achmad Satiri Nurhaman.

Engelhardtia roxburghiana: Ng, F.S.P., 1983. Juglandaceae. In: Whitmore, T.C. (Editor): Tree flora of Malaya. Vol. 1. Revised edition. Longman Malaysia Sdn. Berhad, Kuala Lumpur. p. 235, Fig. 1 (twig with male inflorescence, fruiting twig); Pham Hoang Ho, 1992. Juglandaceae. Flore du Cambodge, du Laos et du Viêtnam. Vol. 26. Muséum National d'Histoire Naturelle, Paris. p. 21, Pl. 3 (part of male inflorescence); Jacobs, M., 1960. Juglandaceae. In: van Steenis, C.G.G.J. (Editor): Flora Malesiana. Ser. I, Vol. 6. Wolters-Noordhoff Publishing, Groningen. p. 149, Fig. 4 (fruit). Redrawn and adapted by Achmad Satiri Nurhaman.

Eucalyptopsis papuana: White, C.T., 1951. Some noteworthy Myrtaceae from the Moluccas, New Guinea, and the Solomon Islands. Journal of the Arnold Arboretum 32: Pl. 1, opposite p. 148 (sterile twig, twig with young infructescence, flower, part of infructescence, seed front and back view). Redrawn and adapted by Achmad Satiri Nurhaman.

Ficus callosa: Koorders, S.H. & Valeton, T., 1916. Atlas der Baumarten von Java. Vol. 4. P.W.M. Trap, Leiden. Fig. 747 (tree habit, leaf of young tree, sapling leaf, fruiting twig, male flower, female flower). Redrawn and adapted by Iskak Syamsudin.

Ganophyllum falcatum: Adema, F., Leenhouts, P.W. & van Welzen, P.C., 1994. Sapindaceae. In: de Wilde, W.J.J.O. (Editor): Flora Malesiana. Ser. I, Vol. 11. Rijksherbarium/Hortus Botanicus, Leiden. p. 539, Fig. 29 (flowering twig, fruit); Koorders, S.H. & Valeton, T., 1913. Atlas der Baumarten von Java. Vol. 1. P.W.M. Trap, Leiden. Fig. 87 (female flower, male flower). Redrawn and adapted by Achmad Satiri Nurhaman.

Garuga floribunda: Leenhouts, P.W., 1956. Burseraceae. In: van Steenis, C.G.G.J. (Editor): Flora Malesiana. Ser. I, Vol. 5. Noordhoff-Kolff N.V., Djakarta. p. 217, Fig. 6 (leaf, inflorescence, sectioned flower, infructescence). Redrawn and adapted by Achmad Satiri Nurhaman.

Gastonia spectabilis: Philipson, W.R., 1979. Araliaceae – I. In: van Steenis, C.G.G.J. (Editor): Flora Malesiana. Ser. I, Vol. 9. Martinus Nijhoff, Dr. W. Junk Publishers, The Hague. p. 70, Fig. 27 (tree habit); Harms, H., 1926. Über eine neue Gattung der Araliaceen aus Papuasien. Notizblatt des Botanischen Gartens und Museums zu Berlin-Dahlem 9(87): p. 480, Fig. 10 (leaf, part of inflorescence, flower). Redrawn and adapted by Achmad Satiri Nurhaman.

Grevillea robusta: Boland, D.J. et al., 1984. Forest trees of Australia. Industrial Research Organisation, Melbourne. p. 607 (tree habit); Heywood, V.H., 1978. Flowering plants of the world. Oxford University Press, Oxford. p. 170 (leaf, inflorescence, flowers and flower parts, fruits, seed). Redrawn and adapted by P. Verheij-Hayes.

Gymnostoma sumatranum: Photograph taken by E. Boer at Cibodas Botanic Garden, Java (tree habit); Cockburn, P.F., 1980. Trees of Sabah. Vol. 2. Sabah Forest Records No 10. Forest Department Sabah, Sandakan. p. 24, Fig. 8 (twig with infructescence, part of twig); Pungga, R.S., 1996. Casuarinaceae. In: Soepadmo, E., Wong, K.M. & Saw, L.G. (Editors): Tree flora of Sabah and Sarawak. Vol. 2. Sabah Forestry Department, Forest Research Institute Malaysia and Sarawak Forestry Department, Kepong. p. 126, Fig. 3 (male inflorescence, female inflorescence). Redrawn and adapted by Achmad Satiri Nurhaman.

Hibiscus tiliaceus: Koorders, S.H. & Valeton, T., 1914. Atlas der Baumarten von Java. Vol. 3. P.W.M. Trap, Leiden. Fig. 437 (flowering twig, fruit, seed, stamens and styles). Redrawn and adapted by Iskak Syamsudin.

Horsfieldia sylvestris: Photograph taken by E. Boer at the Bogor Botanic Gardens, Java (tree habit); de Wilde, W.J.J.O., 1985. A new account of the genus Horsfieldia (Myristicaceae), pt. 2. Gardens' Bulletin, Singapore 38: p. 85, Fig. 11 (sterile twig, male inflorescence, male flower, female flower, fruits). Redrawn and adapted by Achmad Satiri Nurhaman.

Irvingia malayana: Nooteboom, H.P., 1962. Simaroubaceae. In: van Steenis, C.G.G.J. (Editor): Flora Malesiana. Ser. I, Vol. 6. Wolters-Noordhoff Publishing, Groningen. p. 224, Fig. 23 (tree habit); Kulip, J. & Wong, K.M., 1995. Simaroubaceae. In: Soepadmo, E. & Wong, K.M. (Editors): Tree flora of Sabah and Sarawak. Vol. 1. Sabah Forestry Department, Forest Research Institute Malaysia and Sarawak Forestry Department, Kepong. p. 432, Fig. 5 (flowering twig, flower, twig with fruit, fibrous mesocarp of fruit). Redrawn and adapted by Iskak Syamsudin.

Jackiopsis ornata: Wong, K.M., 1989. Rubiaceae. In: Ng, F.S.P. (Editor): Tree flora of Malaya. Vol. 4. Revised edition. Malayan Forest Records No 26. Longman Malaysia Sdn. Berhad, Petaling Jaya. p. 365, Fig. 3 (twig with old inflorescence); Wallich, N., 1832. Plantae Asiaticae rariores. Vol. 3. London. Pl. 293 (flower); Robbrecht, E., 1988. Tropical woody Rubiaceae. Nationale Plantentuin van België, Meise. p. 99, Fig. 40E (fruit). Redrawn and adapted by Iskak Syamsudin.

Kalappia celebica: Kostermans, A.J.G.H., 1952. Notes on two leguminous genera from eastern Indonesia. Reinwardtia 1: p. 453, Fig. 1 (flowering twig, flower, pods). Redrawn and adapted by Iskak Syamsudin.

Khaya anthotheca: Styles, B.T. & White, F., 1991. Meliaceae. In: Polhill, R.M. (Editor): Flora of tropical East Africa. A.A. Balkema, Rotterdam. p. 48, Fig. 14 (flowering twig, sectioned male flower, sectioned female flower, dehisced fruit). Redrawn and adapted by Achmad Satiri Nurhaman.

Kibatalia arborea: Photograph taken by A.J.M. Leeuwenberg at Kokap, Kulon Progo, Central Java (tree habit); Rudjiman, 1986. A revision of

Beaumontia Wallich, Kibatalia G. Don and Vallariopsis Woodson (Apocynaceae). Agricultural University Wageningen Papers 86-5: p. 44, Fig. 11 (flowering twig, flower, fruit, seed). Redrawn and adapted by Achmad Satiri Nurhaman.

Knema laurina: Sinclair, J., 1958. A revision of the Malayan Myristicaceae. Gardens' Bulletin, Singapore 16: p. 329, Fig. 19 (twig with male flowers, sectioned male flower, sectioned female flower, infructescence, opened fruit). Redrawn and adapted by Achmad Satiri Nurhaman.

Lagerstroemia speciosa: Photograph taken by E. Boer at Bogor Botanic Gardens, Java (tree habit); Cockburn, P.F., 1976. Trees of Sabah. Vol. 1. Sabah Forest Records No 10. Forest Department Sabah, Sandakan. p. 213, Fig. 45 (leaf, inflorescence); Koorders, S.H. & Valeton, T., 1918. Atlas der Baumarten von Java. Vol. 4. P.W.M. Trap, Leiden. Fig. 783 (fruit). Redrawn and adapted by Achmad Satiri Nurhaman.

Ludekia borneensis: Ridsdale, C.E., 1978. A revision of the tribe Naucleeae s.s. (Rubiaceae). Blumea 24: p. 336, Fig. 5 (flowering twig, twig apex, flower, part of fruiting head). Redrawn and adapted by Achmad Satiri Nurhaman.

Lumnitzera littorea: Exell, A.W., 1954. Combretaceae. In: van Steenis, C.G.G.J. (Editor): Flora Malesiana. Ser. I, Vol. 4. Noordhoff-Kolff N.V., Djakarta. p. 587, Fig. 32 (flowering twig, fruits); Tomlinson, P.B. et al., 1978. Lumnitzera rosea (Combretaceae) – its status and floral morphology. Journal of the Arnold Arboretum 59: p. 346, Fig. 4 (flower). Redrawn and adapted by Achmad Satiri Nurhaman.

Magnolia candollii: Nooteboom, H.P., 1988. Magnoliaceae. In: van Steenis, C.G.G.J. & de Wilde, W.J.J.O. (Editors): Flora Malesiana. Ser. I, Vol. 10. Kluwer Academic Publishers, Dordrecht. p. 584, Fig. 6 (flowering twig, stamen, gynoecium, fruit).

Mallotus subpeltatus: Airy Shaw, H.K., 1974. Mallotus subpeltatus (Bl.) Muell. Arg. Hooker's Icones Plantarum, ser. 5, vol. 38: Tab. 3715 (male flowering twig, female flowering twig, male flower, female flower, fruit). Redrawn and adapted by Achmad Satiri Nurhaman.

Manglietia glauca: Blume, C.L., 1829. Flora Javae, fasc. 19 & 20, Magnoliaceae. J. Frank, Bruxellis. Tab. VI (ripe fruit, dehisced carpel with seeds, flower with tepals removed); Koorders, S.H., 1912. Exkursionsflora von Java. Vol. 2. Dikotyledonen (Archichlamydeae). Gustav Fisher, Jena. p. 239, Fig. 47 (flowering twig, immature fruit).

Maniltoa schefferi: Verdcourt, B., 1979. A manual of New Guinea legumes. Botany Bulletin No 11. Office of Forests, Division of Botany, Lae. p. 72–73, Fig. 16 & 17 (young flush of leaves, flowering twig, infructescence). Redrawn and adapted by Achmad Satiri Nurhaman.

Maranthes corymbosa: Koorders, S.H. & Valeton, T., 1913. Atlas der Baumarten von Java. Vol. 1. P.W.M. Trap, Leiden. Fig. 94 (tree habit); Prance, G.T., 1989. Chrysobalanaceae. In: van Steenis, C.G.G.J. & de Wilde, W.J.J.O. (Editors): Flora Malesiana. Ser. I, Vol. 10. Kluwer Academic Publishers, Dordrecht. p. 672, Fig. 21 (flowering twig, flower and bud). Redrawn and adapted by Achmad Satiri Nurhaman.

Mastixiodendron pachyclados: Melchior, H., 1925. Die Cornaceen Papuasiens. Botanische Jahrbücher 60: Pl. 1 (flowering twig with twig apex); Darwin, S.P., 1977. The genus Mastixiodendron (Rubiaceae). Journal of the Arnold Arboretum 58: p. 360, Fig. 10c–e (terminal portion of inflorescence with flower buds, flower with 1 petal removed, fruit). Redrawn and adapted by Achmad Satiri Nurhaman.

Memecylon edule: Koorders, S.H. & Valeton, T., 1914. Atlas der Baumarten von Java. Vol. 2. P.W.M. Trap, Leiden. Fig. 312 (flowering twig, fruiting twig, flower, stamen). Redrawn and adapted by Iskak Syamsudin.

Mezzetia parviflora: Boerlage, J.G., 1899. Notes sur les Anonacées du Jardin Botanique de Buitenzorg. Icones Bogorienses. Vol. 1. E.J. Brill, Leiden. Tab. 32 (inflorescence, flower); Kessler, P.J.A. & Sidiyasa, K., 1994. Trees of the Balikpapan-Samarinda area, East Kalimantan, Indonesia. Tropenbos Series 7. The Tropenbos Foundation, Wageningen. p. 253, Fig. 11 (sterile twig, fruit). Redrawn and adapted by Iskak Syamsudin.

Michelia champaca: Koorders, S.H. & Valeton, T., 1918. Atlas der Baumarten von Java. Vol. 4. P.W.M. Trap, Leiden. Fig. 799 (tree habit); Marais, W., 1980. 33. Magnoliacées. In: Bosser, J., Cadet, T., Julien, H.R. & Marais, W. (Editors): Flore des Mascareignes – 31. Renonculacées à 50. Théacées. The Sugar Industry Research Institute, Mauritius, L'Office de la Recherche Scientifique et Technique Outre-Mer, Paris & The Royal Botanic Gardens, Kew. p. 2 (flowering twig, infructescence, sectioned flower, stamen, seed).

Microcos tomentosa: Koorders, S.H. & Valeton, T., 1914. Atlas der Baumarten von Java. Vol. 2. P.W.M. Trap, Leiden. Fig. 392 & 393 (tree habit, fruiting twig, flower). Redrawn and adapted by Achmad Satiri Nurhaman.

Mimusops elengi: Corner, E.J.H., 1988. Wayside trees of Malaya. 3rd edition. Vol. 2. The Malayan Nature Society, Kuala Lumpur. Pl. 213 (tree habit); Koorders, S.H. & Valeton, T., 1916. Atlas der Baumarten von Java. Vol. 3. P.W.M. Trap, Leiden. Fig. 620 (flowering twig, flower, stamen and staminode, fruit). Redrawn and adapted by Iskak Syamsudin.

Nauclea parva: Ridsdale, C.E., 1978. A revision of the tribe Naucleeae s.s. (Rubiaceae). Blumea 24: p. 326, Fig. 4 (flowering twig, flower, fruiting twig, fruit, longitudinal section of fruit). Redrawn and adapted by Iskak Syamsudin.

Neonauclea ventricosa: Ridsdale, C.E., 1978. A revision of Neonauclea (Rubiaceae). Blumea 34: p. 208, Fig. 11 (twig with young flowering head and myrmedome, flowering head, fruiting head). Redrawn and adapted by Achmad Satiri Nurhaman.

Nothaphoebe macrocarpa: Koorders, S.H. & Valeton, T., 1913. Atlas der Baumarten von Java. Vol. 2. P.W.M. Trap, Leiden. Fig. 244 (tree habit, flowering twig, flower bud, opened flower, stamen, fruit). Redrawn and adapted by Achmad Satiri Nurhaman.

Ochroma pyramidale: Lorenzi, H., 1992. Arvores brasileiras. Editora Plantarum LTDA, Nova Odessa. p. 65 (tree habit); Robyns, A., 1964. Flora of Panama, part VI. Family 116. Bombacaceae. Annals of the Missouri Botanical Garden 51: p. 65, Fig. 9 (flowering twig, flower, longitudinal section of flower, dehisced fruit). Redrawn and adapted by Achmad Satiri Nurhaman.

Oncosperma tigillarium: Koorders, S.H., 1926. Excursionsflora von Java. Vol. 4, Atlas. Gustav Fischer, Jena. p. 147, Fig. 334 (habit, fruits); Durant, C.C.L., 1940. Nibong. The Malayan Forester 9: Pl. 5 (habit); Uhl, N.W. & Dransfield, J., 1987. Genera palmarum. The L.H. Bailey Hortorium and The International Palm Society, Allen Press, Lawrence, Kansas. p. 465, Fig. 160 (male flower, seed). Redrawn and adapted by Achmad Satiri Nurhaman.

Parartocarpus venenosus: Photograph taken by E. Boer at the Bogor Botanic Gardens, Java (tree habit); Smith, J.J., 1922. Plantae novae vel criticae ex herbario et horto Bogoriensi II. Bulletin du Jardin Botanique de Buitenzorg, ser. III, 4: 230–240, Tab. 6 & 8 (fruiting twig, fruit in longitudinal section). Redrawn and adapted by Iskak Syamsudin.

Parkia timoriana: Whitford, H.N., 1911. The forests of the Philippines. Part II: The principal forest trees. Bulletin No 10. Department of the Interior, Bureau of Forestry. Bureau of Printing, Manila. Pl. 25 (base of trunk); Nielsen, I.C. & Fortune Hopkins, H.C., 1992. Mimosaceae (Leguminosae–Mimosoideae). In: Kalkman, C., Kirkup, D.W., Nooteboom, H.P., Stevens, P.F. & de Wilde, W.J.J.O. (Editors): Flora Malesiana. Ser. I, Vol. 11. Rijksherbarium/Hortus Botanicus, Leiden. p. 202, Fig. 37 (leaf, flowering heads, flower, fruit). Redrawn and adapted by Achmad Satiri Nurhaman.

Pertusadina eurhyncha: Foxworthy, F.W., 1927. Commercial timber trees of the Malay Peninsula. Malayan Forest Records No 3. Forest Department, Kuala Lumpur. Photo opposite p. 178 (bole); Valeton, T., 1914. Adina minutiflora. Icones Bogorienses. Vol. 4. E.J. Brill, Leiden. Pl. 390 (flowering branch, inflorescences). Redrawn and adapted by Achmad Satiri Nurhaman.

Pigafetta elata: Stewart, L., 1994. A guide to palms & cycads of the world. Cassell Publishers Ltd., London. p. 155 (habit); Uhl, N.W. & Dransfield, J., 1987. Genera palmarum. The L.H. Bailey Hortorium and The International Palm Society. Allen Press, Lawrence, Kansas. p. 272, Fig. 56 (part of male inflorescence, part of female inflorescence, fruit). Redrawn and adapted by Achmad Satiri Nurhaman.

Pimelodendron amboinicum: Foreman, D.B., 1971. A check list of the vascular plants of Bougainville with descriptions of some common forest trees. Botany Bulletin No 5. Division of Botany, Department of Forests, Lae. p. 153 (male flowering twig, fruits). Redrawn and adapted by Iskak Syamsudin.

Platymitra arborea: Kessler, P.J.A., 1988. Studies on the tribe Saccopetaleae (Annonaceae) – I. Revision of the genus Platymitra Boerlage. Blumea 33: p. 474, Fig. 1 (flowering twig, flower bud, outer petal, inner petal, stamen, opened carpel, fruit). Redrawn and adapted by Iskak Syamsudin.

Polyalthia rumphii: Photograph taken by E. Boer at the Bogor Botanic Gardens, Java (tree habit); King, G., 1893. The Anonaceae of British India. Annals of the Royal Botanic Garden, Calcutta 4: Pl. 95 (flowering twig, infructescence). Redrawn and adapted by Iskak Syamsudin.

Prunus arborea: Koorders, S.H. & Valeton, T., 1913. Atlas der Baumarten von Java. Vol. 1. P.W.M. Trap, Leiden. Fig. 113 (tree habit, fruit); Kalkman, C., 1993. Rosaceae. In: Kalkman, C., Kirkup, D.W., Nooteboom, H.P., Stevens, P.F. & de Wilde, W.J.J.O. (Editors): Flora Malesiana. Ser. I, Vol. 11. Rijksherbarium/Hortus Botanicus, Leiden. p. 330, Fig. 18 (sterile twig, inflorescence, sectioned flower). Redrawn and adapted by Iskak Syamsudin.

Pterospermum javanicum: Koorders, S.H. & Valeton, T., 1913. Atlas der Baumarten von Java. Vol. 1. P.W.M. Trap, Leiden. Fig. 81 (tree habit, inflorescence in leaf axil); Kessler, P.J.A. & Sidiyasa, K., 1994. Trees of the Balikpapan-Samarinda area, East Kalimantan, Indonesia. Tropenbos Series 7. The Tropenbos Foundation, Wageningen. p. 434, Fig. 185 (flowering twig with petals fallen); Cockburn, P.F., 1976. Trees of Sabah. Vol. 1. Sabah Forest Records No 10. Forest Department Sabah, Sandakan. p. 236, Fig. 50 (dehisced fruit). Redrawn and adapted by Iskak Syamsudin.

Radermachera pinnata: Berhaman, A., 1995. Bignoniaceae. In: Soepadmo, E. & Wong, K.M. (Editors): Tree flora of Sabah and Sarawak. Vol. 1. Sabah Forestry Department, Forest Research Institute Malaysia and Sarawak Forestry Department, Kepong. p. 43, Fig. 4 (leaf, lower side leaflet, inflorescence, sectioned flower, fruit, seed). Redrawn and adapted by Achmad Satiri Nurhaman.

Sandoricum koetjape: Corner, E.J.H., 1988. Wayside trees of Malaya. 3rd edition. Vol. 2. The Malayan Nature Society, Kuala Lumpur. p. 504, Pl. 152 (tree habit); Mabberley, D.J. & Pannell, C.M., 1989. Meliaceae. In: Ng, F.S.P. (Editor): Tree flora of Malaya. A manual for foresters. 2nd edition. Vol. 4. Malayan Forest Records No 26. Longman Malaysia Sdn. Berhad, Petaling Jaya. p. 250, Fig. 8 (flowering twig, sectioned flower, fruit). Redrawn and adapted by Iskak Syamsudin.

Schima wallichii: Corner, E.J.H., 1988. Wayside trees of Malaya. 3rd edition. Vol. 2. The Malayan Nature Society, Kuala Lumpur. Pl. 220 (tree habit); Cockburn, P.F., 1980. Trees of Sabah. Vol. 2. Sabah Forest Records No 10. Forest Department Sabah, Sandakan. p. 118, Fig. 31 (flowering twig); Bloembergen, S., 1952. A critical study in the complex-polymorphous genus Schima (Theaceae). Reinwardtia 2: p. 152, Fig. B (dehisced fruit). Redrawn and adapted by Achmad Satiri Nurhaman.

Schoutenia ovata: Koorders, S.H. & Valeton, T., 1913. Atlas der Baumarten von Java. Vol. 1. P.W.M. Trap, Leiden. Fig. 84 (tree habit, flowering twig); Roekmowati-Hartono, 1965. A monograph of the genus Schoutenia Korth. (Tiliaceae). Reinwardtia 7: p. 125, Fig. 1 (fruiting calyx). Redrawn and adapted by Achmad Satiri Nurhaman.

Scorodocarpus borneensis: Foxworthy, F.W., 1927. Commercial timber trees of the Malay Peninsula. Malayan Forest Records No 3. Forest Department, Kuala Lumpur. p. 121 (bole); Sleumer, H., 1984. Olacaceae. In: van Steenis, C.G.G.J. & de Wilde, W.J.J.O. (Editors): Flora Malesiana. Ser. I, Vol. 10. Kluwer Academic Publishers, Dordrecht. p. 16, Fig. 7 (flowering twig, flower bud, flower, fruit).

Senna siamea: Corner, E.J.H., 1988. Wayside trees of Malaya. 3rd edition. Vol. 1. The Malayan Nature Society, Kuala Lumpur. p. 432, Pl. 104 (tree habit); Koorders, S.H., 1913–1937. Exkursionsflora von Java. Vol. 4, Atlas. Gustav Fischer, Jena. p. 901, Fig. 1189 (flower); Little, E.L. & Wadsworth, F.H., 1964. Common trees of Puerto Rico and the Virgin Islands. Vol. 1. Agricultural Handbook No 249. United States Department of Agriculture, Washington D.C. Fig. 74 (flowering twig, fruits). Redrawn and adapted by P. Verheij-Hayes.

Strombosia ceylanica: Photograph taken by E. Boer at the Bogor Botanic Gardens, Java (bole); Koorders, S.H. & Valeton, T., 1913. Atlas der Baumarten von Java. Vol. 1. P.W.M. Trap, Leiden. Fig. 125 (flowering twig, flower); Sleumer, H., 1984. Olacaceae. In: van Steenis, C.G.G.J. & de Wilde, W.J.J.O. (Editors): Flora Malesiana. Ser. I, Vol. 10. Kluwer Academic Publishers, Dordrecht. p. 20, Fig. 9 (fruit).

Symplocos costata: Nooteboom, H.P., 1975. Revision of the Symplocaceae of the Old World, New Caledonia excepted. Leiden University Press, Leiden. p. 308, Pl. 8, Photo 1 (tree habit, inflorescence and leaf, fruit); Koorders, S.H. & Valeton, T., 1914. Atlas der Baumarten von Java. Vol. 2. P.W.M. Trap, Leiden. Fig. 380 (flower). Redrawn and adapted by Iskak Syamsudin.

Teijsmanniodendron bogoriense: Photograph taken by E. Boer at the Bogor Botanic Gardens, Java (tree habit); Koorders, S.H., 1904. Teijsmanniodendron, eine neue Gattung der Verbenaceae im Botanischen Garten von Buitenzorg. Annales du Jardin Botanique de Buitenzorg, sér. 2, vol. 4: Pl. II (flowering twig, flower); Kessler, P.J.A. & Sidiyasa, K., 1994. Trees of the Balikpapan-Samarinda area, East Kalimantan, Indonesia. Tropenbos Series 7. The Tropenbos Foundation, Wageningen. p. 445, Fig. 196 (fruits). Redrawn and adapted by Iskak Syam-

sudin.

Tetrameles nudiflora: Koopman, M.J.F. & Verhoef, L., 1938. Octomeles sumatrana Miq. (benoeang) en Tetrameles nudiflora R.Br. (winong). Tectona 31: 786b, Fig. 4 (tree habit); van Steenis, C.G.G.J., 1953. Datiscaceae. In: van Steenis, C.G.G.J. (Editor): Flora Malesiana. Ser. I, Vol. 4. Noordhoff-Kolff N.V., Djakarta. p. 386, Fig. 4 (leaf, female inflorescence, fruit, male flower, female flower).

Timonius avenis: Valeton, T., 1909. Nova Guinea (Botany) 8, III (Atlas): Tab. 72A (flowering and fruiting twig, male flower, female flower, opened corolla of female flower, style, fruit, cross section of fruit). Redrawn and adapted by Achmad Satiri Nurhaman.

Tristaniopsis whiteana: Smythies, B.E., 1965. Common Sarawak trees. Borneo Literature Bureau, South China Morning Post, Hong Kong. p. 110, Pl. 34 (trunk base); Kessler, P.J.A. & Sidiyasa, K., 1994. Trees of the Balikpapan-Samarinda area, East Kalimantan, Indonesia. Tropenbos Series 7. The Tropenbos Foundation, Wageningen. p. 397, Fig. 148 (flowering twig). Redrawn and adapted by Iskak Syamsudin.

Wallaceodendron celebicum: Koorders, S.H., 1918. Supplement op het eerste overzicht der Flora van N.O. Celebes. Deel 1(1). Visser & Co., Batavia. Pl. 1 (flowering twig, flower, pistil, stamens, opened fruit). Redrawn and adapted by Achmad Satiri Nurhaman.

Xanthostemon verdugonianus: Whitford, H.N., 1911. The forests of the Philippines. Part II: The principal forest trees. Bulletin No 10. Department of the Interior, Bureau of Forestry. Bureau of Printing, Manila. Pl. 93 (flowering twig, infructescence). Redrawn and adapted by Iskak Syamsudin.

Xylocarpus granatum: Matthew, K.M., 1982. Illustrations on the flora of the Tamilnadu Carnatic. The Rapinat Herbarium, Tiruchirapalli. Pl. 134 (flowering twig); Tomlinson, P.B., 1986. The botany of mangroves. Cambridge Tropical Biology Series. Press Syndicate of the University of Cambridge, Cambridge. Fig. B42a, B43b (female flower, fruit). Redrawn and adapted by Iskak Syamsudin.

Xylopia ferruginea/Xylopia fusca: Niyomdham, C., 1988. Some important characters and a special note on the flora of peat swamp forest in Thailand. Thai Forest Bulletin (Botany) 17: p. 112 (stilt roots of *X. fusca*); Kessler, P.J.A. & Sidiyasa, K., 1994. Trees of the Balikpapan-Samarinda area, East Kalimantan, Indonesia. Tropenbos Series 7. The Tropenbos Foundation, Wageningen. p. 256, Fig. 14 (fruiting twig of *X. ferruginea*); King, G., 1893. The Anonaceae of British India. Annals of the Royal Botanic Garden, Calcutta 4: Pl. 198 (flower of *X. ferruginea*). Redrawn and adapted by Iskak Syamsudin.

Zanthoxylum myriacanthum: Jones, D.T., 1995. Rutaceae. In: Soepadmo, E. & Wong, K.M. (Editors): Tree flora of Sabah and Sarawak. Vol. 1. Sabah Forestry Department, Forest Research Institute Malaysia and Sarawak Forestry Department, Kepong. p. 418, Fig. 17 (flowering twig, dehisced fruit). Redrawn and adapted by Achmad Satiri Nurhaman.

Index of scientific plant names

Page numbers printed in bold refer to main treatment.

Index of vernacular plant names

Page numbers printed in bold refer to main treatment. For transcriptions of Vietnamese names, see at the end of this index.

Transcriptions of Vietnamese characters

[aa] = â	[ar] = ả	[ax] = ã	[ej] = ẹ	[oo] = ô	[ow] = ơ	[uj] = ụ	[uwx] = ữ
[aaf] = ầ	[as] = á	[ee] = ê	[er] = ẻ	[oof] = ồ	[owf] = ờ	[ur] = ủ	[ux] = ũ
[aaj] = ậ	[aw] = ă	[eef] = ề	[es] = é	[ooj] = ộ	[ooj] = ợ	[us] = ú	
[aar] = ẩ	[awf] = ằ	[eej] = ệ	[ex] = ẽ	[oor] = ổ	[owr] = ở	[uw] = ư	
[aas] = ấ	[awj] = ặ	[eer] = ể	[if] = ì	[oos] = ố	[ows] = ớ	[uwf] = ừ	
[aax] = ẫ	[awr] = ẳ	[ees] = ế	[is] = í	[oox] = ỗ	[owx] = ỡ	[uwj] = ự	
[af] = à	[aws] = ắ	[eex] = ễ	[of] = ò	[or] = ỏ	[ox] = õ	[uwr] = ử	
[aj] = ạ	[awx] = ẵ	[ef] = è	[oj] = ọ	[os] = ó	[uf] = ù	[uws] = ứ	

General index of genera and families of Volume 5

Containing the names of genera and families treated in the 3 volumes on timber trees.

General index of trade groups of Volume 5

Containing the names of the trade groups treated in the 3 volumes on timber trees.

The Prosea Foundation
(Plant Resources of South-East Asia)

Name, location, legal status and structure

- Prosea is a Foundation under Indonesian law, with an international charter, domiciled in Bogor. It is an autonomous, non-profit, international agency, governed by a Board of Trustees. It seeks linkage with existing regional and international organizations;
- Prosea is an international programme focusing on the documentation of information on plant resources of South-East Asia;
- Prosea consists of a Network Office in Bogor (Indonesia) coordinating 6 Country Offices in South-East Asia, and a Publication Office in Wageningen (the Netherlands).

Participating institutions

- Forest Research Institute of Malaysia (FRIM), Karung Berkunci 201, Jalan FRIM Kepong, 52109 Kuala Lumpur, Malaysia;
- Indonesian Institute of Sciences (LIPI), Sasana Widya Sarwono, Jalan Gatot Subroto 10, Jakarta 12710, Indonesia;
- Institute of Ecology and Biological Resources (IEBR), Nghia Do, Tu Liem, Hanoi, Vietnam;
- Papua New Guinea University of Technology (UNITECH), Private Mail Bag, Lae, Papua New Guinea;
- Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD), Los Baños, Laguna, the Philippines;
- Thailand Institute of Scientific and Technological Research (TISTR), 196 Phahonyothin Road, Chatuchak, Bangkok 10900, Thailand;
- Wageningen Agricultural University (WAU), Costerweg 50, 6701 BH Wageningen, the Netherlands.

Objectives

- to document and make available the existing wealth of information on the plant resources of South-East Asia for education, extension work, research and industry;
- to make operational a computerized data bank on the plant resources of South-East Asia;
- to publish the results in the form of an illustrated, multi-volume handbook in English;
- to promote the dissemination of the information gathered.

Target groups

- those professionally concerned with plant resources in South-East Asia and working in education, extension work, research and commercial production (direct users);
- those in South-East Asia depending directly on plant resources, obtaining relevant information through extension (indirect users).

Activities

- the establishment and operation of data bases;
- the publication of books;
- the sponsorship, support and organization of training courses;
- research into topics relevant to Prosea's purpose;
- the publication and dissemination of reports and the research results.

Implementation

The programme period has been tentatively divided into 3 phases:
- preliminary phase (1985–1986): publication of 'Plant Resources of South-East Asia, Proposal for a Handbook' (1986);
- preparatory phase (1987–1990): establishing cooperation with South-East Asia through internationalization, documentation, consultation and publication; reaching agreement on the scientific, organizational and financial structure of Prosea;
- implementation phase (1991–2000): compiling, editing and publishing of the handbook; making operational the computerized data bank with the texts and additional information; promoting the dissemination of the information obtained.

Documentation

A documentation system has been developed for information storage and retrieval called Prosea Data Bank. It consists of 6 data bases:
- BASELIST: primarily a checklist of more than 6200 plant species;
- CATALOG: references to secondary literature;
- PREPHASE: references to literature from South-East Asia;
- ORGANYM: references to institutions and their research activities;
- PERSONYM: references to specialists;
- TEXTFILE: all Prosea publications and additional information;
- PHOTPHILE: photographs of useful plants of South-East Asia.

Publication

The handbook in blue cover (hardbound) is distributed by Backhuys Publishers, Leiden, the Netherlands (formerly by Pudoc, Wageningen, the Netherlands). The handbook in green cover (paperback) is distributed in two price-classes: a low-price paperback, distributed by Prosea South-East Asia for all developing countries; a medium-price paperback, distributed by Backhuys

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The handbook

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In brief, Prosea is

- an international programme, focused on plant resources of South-East Asia;
- interdisciplinary, covering the fields of agriculture, forestry, horticulture and botany;
- a research programme, making knowledge available for education and extension;
- ecologically focused on promoting plant resources for sustainable tropical land-use systems;
- committed to conservation of biodiversity;
- committed to rural development through diversification of resources and application of farmers' knowledge.

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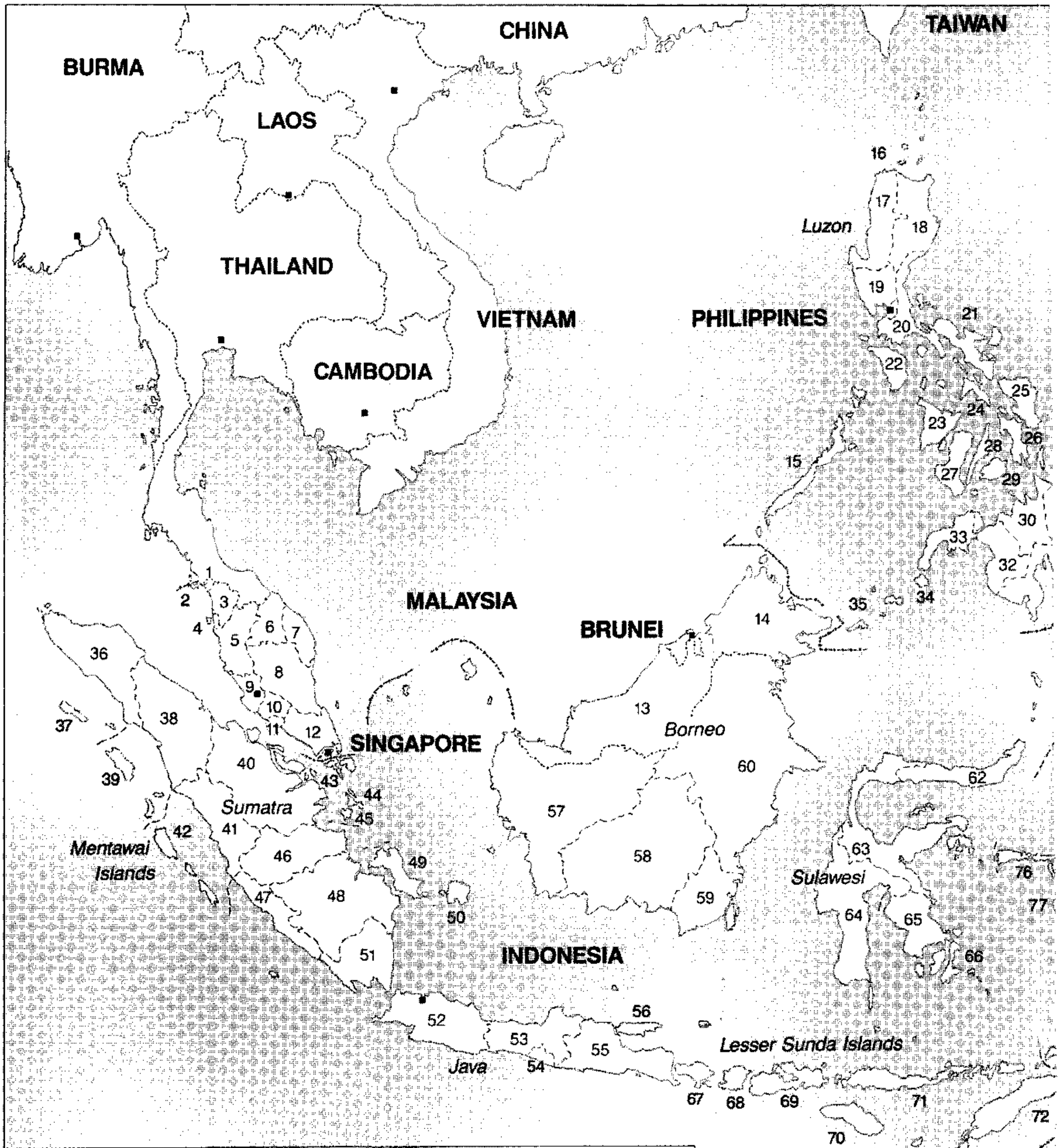

MAP OF SOUTH-EAST ASIA FOR PROSEA

Names of countries in capital letters and islands in lower case; numbers refer to the key.

Key of islands (*i*), states (*s*), regions (*r*) and provinces (*p*).

MALAYSIA
East Malaysia *r* 13-14
Johor *s* 12
Kedah *s* 3
Kelantan *s* 6
Langkawi *i* 2
Melaka *s* 11
Negeri Sembilan *s* 10
Pahang *s* 8
Peninsular Malaysia (West Malaysia) *r* 1-12
Perak *s* 5
Perlis *s* 1
Pinang *s* 4
Sabah *s* 14
Sarawak *s* 13
Selangor *s* 9
Terengganu *s* 7

PHILIPPINES
Babuyan Islands *i* 16
Basilan *i* 34
Bicol *r* 21
Bohol *i* 29
Cagayan Valley *r* 18
Cebu *i* 28
Central Mindanao *r* 32
Central Luzon *r* 19
Ilocos *r* 17
Leyte *i* 26
Masbate *i* 24
Mindoro *i* 22
Negros *i* 27
Northern Mindanao *r* 30
Palawan *i* 15
Panay *i* 23
Samar *i* 25
Southern Tagalog *r* 20
Southern Mindanao *r* 31
Sulu Archipelago *i* 35
Western Mindanao *r* 33

INDONESIA
Aceh *p* 36
Ambon *i* 79
Aru Islands *i* 82
Bali *i* 67
Bangka *i* 49
Belitung *i* 50
Bengkulu *p* 47
Buru *i* 77
Butung *i* 66
Central Java *p* 53
Central Kalimantan *p* 58
Central Sulawesi *p* 63
East Java *p* 55
East Kalimantan *p* 60
Flores *i* 71
Halmahera *i* 74
Irian Jaya *p* 84
Jambi *p* 46
Kai Islands *i* 83
Lampung *p* 51
Lingga *i* 44
Lombok *i* 68
Madura *i* 56
Morotai *i* 73
Nias *i* 39
North Sulawesi *p* 62
North Sumatra *p* 38
Obi *i* 75
Riau *p* 40
Riau Archipelago *i* 43
Seram *i* 78
Siberut *i* 42
Simeuluë *i* 37
Singkep *i* 45
South-East Sulawesi *p* 65
South Kalimantan *p* 59
South Sulawesi *p* 64
South Sumatra *p* 48
Sula Islands *i* 76
Sumba *i* 70
Sumbawa *i* 69
Talaud Islands *i* 61
Tanimbar Islands *i* 81
Timor *i* 72
West Daya Islands *i* 80
West Java *p* 52
West Kalimantan *p* 57
West Sumatra *p* 41
Yogyakarta *p* 54

PAPUA NEW GUINEA
Bougainville Island *i* 87
D'Entrecasteaux Islands *i* 88
Louisiade Archipelago *i* 89
New Britain *i* 86
Papua *r* 85