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U.N.D.P. (S.F.) BOTSWANA PROJECT 359

THE ECOLOGY OF THE OKAVANGO SWAMPS

TECHNICAL NOTE NO. 19

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C O R R I G E N D U M

PLANT SPECIES OF THE OKAVANGO REGION

B 4166 For Alternanthera philoxeroides (Mart.) Griseb.
read Alternanthera sessilis (L.) DC.

B 4172 For Eleocharis acicularis (L.) R. & S.
read Scirpus inclinatus (Del.) Aschers & Schweinf.

B 4155 For Eleocharis dulcis (Burm.f.)
read Eleocharis fistulosa Link.

B 4160 For Hydrocotyle umbellata L.
read Hydrocotyle verticillata Thunb.

B 4154 For Lagarosiphon major
read Lagarosiphon ilicifolius Oberm.

B 4167 For Ludwigia stolonifera (Guill. & Perr.) Raven
read Ludwigia octovalvis (Jacq.) Raven
subsp. octovalvis

B 4165 For Ludwigia stolonifera (Guill. & Perr.) Raven
read Rotala myriophylloides Welw. ex Hiern

B 4163 For Oldenlandia sp.
read Oldenlandia herbacea (L.) Roxb.

B 4164 For Potamogeton richardii Solms.
read Potamogeton thunbergii Cham. & Schlechtd.

B 4151 For Pycnostachys sp.
read Pycnostachys coerulea Hook.

B 4146 For Pycreus mundtii Nees
read Cyperus nudicaulis Poir.

B 4158 For Pycreus tremulus (Poir.) Solms.
read Pycreus chrysanthus L.

B 4142 For Saggitaria guayanensis Kunth
read Caldesia reniformis (D.Don) Makino

B 4157 For Scirpus juncoides Roxb.
read Scirpus corymbosus Roth.

B 4145 For Typha australis Schumach.
read Typha latifolia L. subsp. capensis Rohrb.

B 4153 For Utricularia sp.
read Utricularia thonningii Schumach.

B 4162 For Vossia cuspidata Griff.
read Vossia cuspidata (Roxb.) W. Griff.

B 4156 For Sedge
read Eleocharis dulcis (Burm.f.) Trin.

C O N T E N T S

ACKNOWLEDGMENTS

My thanks are due to the Project Manager for making arrangements for my visits to the Okavango swamps.

EXPLANATORY NOTES AND DEFINITIONS

Catena - A catena is a chaim or connected series of soil types, generally extending from the crest of a slope to the bottom, and supporting a characteristic zonation of vegetation associations or plant communites.

Levee - A levee consists of relatively high-lying ground built up along river banks from deposits carried by flood water. The areas behind the levee banks are lower in elevation and are flooded to a greater depth than the levees.

1. INTRODUCTION

The Okavango swamps are situated in north-western Botswana. They are approximately 15,000 square kilometres in extent and are almost round to oval in outline. The swamps are mainly fed from the Okavango catchment in Angola.

The northern part of the swamps, comprising the Okavango, Ng'gokha and Upper Boro rivers, is largely under a deep water flood regime. The most dominant features are wide deep river channels with clear water and fast flowing currents. The river banks are lined with extensive massive growth of Cyperus papyrus.

Tree growth is limited to occasional islands or elevated river banks or levees with Syzygium guineense being most characteristic.

The Central/Southern sector extends from the Taoge and Kunyere rivers in the west to the central and lower Boro in the middle, to the Moanachira and Santantadibe in the east. The latter, with the confluence of the Boro becomes the Thamalakane that branches westwards into the Lake river flowing to Lake Ngami and eastwards into the Boteti that flows to the west of the Makarikari depression and into Lake Xau.

In the central and southern areas are local variations of water depth, time of flooding and inundation patterns which form a continuously changing mosaic. There is a marked increase in vegetation species including a large number of aquatic plants which greatly impede stream flow. The swamp vegetation is most varied throughout this zone and comprises a large number of aquatic and semi-aquatic species.

Another noticeable feature as one proceeds southward is the increasing number of islands with a corresponding increase in size. There is also a marked increase in the number of trees and a noticeable change in the type of woody plants. The islands gradually give way to well-wooded river banks and mainland.

Some of the most characteristic vegetation species and their habitats are discussed in relation to the two major sectors of deep water and medium/shallow water zones.

The "catena" sequence in some of the river sections with variations appears to be approximately as follows:-

1) Open Water

2) Vossia cuspidata - fringes over-hanging and floating in the water, particularly in bays and at junctions of streams

3) Cyperus papyrus - associated species include Ampelopteris prolifera and Polygonum pulchrum

4) Cyperus papyrus - associated with increasing amounts of Miscanthidium teretifolium, Phragmites mauritianus and Typha australis

5) Miscanthidium teretifolium

6) Phoenix reclinata/Syzygium guineense - semi-submerged and on islands and banks.

7) Grassland fringes and Sedges with Vossia cuspidata, Echinochloa stagnina, Oryza longistaminata, Leersia hexandra, Cyperus articulatus, Panicum repens, Acroceras macrum

8) Hyphaene ventricosa and woodlands along swamp fringes

9) Dry banks with mixed woodlands extending to the mainland areas

2. DEEP WATER SECTOR/NORTHERN AREAS - Cyperus papyrus

Cyperus papyrus grows generally in the deep water zone of the more permanent northern swamp sector. It fringes the inundated banks of the deep rivers and where the channels narrow it almost creates a tunnel effect. In some places it occurs on sand in fairly shallow water, or even above the water level on banks of sand. Some of these may consist of freshly accumulated sand that is deposited due to variations in current velocity and direction of flow. Sandbanks are prevalent around some of the shoulders of oxbows and on corners of beds along the river, where they accumulate due to changing currents and velocity. The currents alternate from one side of the channel to the other around sharp corners with equalising or compensatory effects of scouring and deposition.

Along the main deep-water channels Cyperus papyrus is tall and robust, growing 4 to 5 m.high. In places with shallower water, for example along the Seronga channel and in the vicinity of the Xo flats, papyrus is much shorter and rather stunted in appearance. This also applies to 'islands' of papyrus deposited lower down the river system when high flood water recedes.

Ampelopteris prolifera, a robust aquatic fern growing from thick brown rhizomes with masses of fine roots, is a very characteristic co-dominant of Cyperus papyrus.

In some places Cyperus papyrus is intermingled with Phragmites mauritianus, Typha australis and Miscanthidium teretifolium. The latter species in some places occurs over extensive areas apparently on higher-lying areas.

Along the river banks, particularly in the bays, is a fringe of Vossia cuspidata between the deep water and the papyrus.

Some of the most noticeable aquatic swamp vegetation species are characterised by massive rhizomatous growth or consist of typical water plants of specialised cellular tissue.

3. MEDIUM WATER DEPTH TO SHALLOW WATER SECTOR/CENTRAL AND SOUTHERN AREAS

Transition Formations - Phragmites mauritianus
Miscanthidium teretifolium
Typha australis

The change from a deep water regime to shallow water and seasonal swamp conditions takes place through an uneven transitional phase. Although very abrupt in places there is nothing completely linear and clear cut as it depends upon locally varying conditions of water accumulations throughout the area.

The most striking feature is the change from fast-flowing, deep water channels to shallow water, dispersed over large areas where the channels become indistinct and in some places almost completely blocked by massive and extensive growth of Phragmites mauritianus, Miscanthidium teretifolium, Typha australis and other aquatic plants.

Phragmites mauritianus

The reeds follow the shallower river banks and sand ledges, with sandbanks in some places protruding 1 m. or more above the water level. It increases in extent and prominence in the central and southern sectors of the swamps where flooding levels are generally much lower and where flooding is seasonal and of considerably shorter duration, for example on the Xo flats of the Boro river system and on the Santantadibe.

The relatively small amount of Phragmites mauritianus in the northern sector is very noticeable. It increases southwards and in the Ghonga island area it is locally abundant but still very much secondary to Cyperus papyrus.

Phragmites mauritianus can grow in water of considerable depth, in shallow water and on dry sand river beds. It seems quite adaptable to a considerable range of moisture conditions provided that it has sufficient sand on which to grow.

Miscanthidium teretifolium

This massive tussock grass growing 4 to 5 m. high occurs on extensive areas in the Cyperus papyrus swamps. It occurs on the relatively high levee banks where flooding is generally shallower and less persistent. These alternate from one bank to the other indicating the alternating pattern of deeper flooding due to the levee formation along the river system. It is possible that these areas have firmer soil and possibly a higher clay content. Large areas of Miscanthidium teretifolium fringe some of the islands with tree growth.

On proceeding southwards from Moshupatshila towards the Xo flats there is a marked increase in Miscanthidium teretifolium and a corresponding decline in the stature of Cyperus papyrus until it practically disappears.

The decrease in Cyperus papyrus is also marked by an increase in Phragmites mauritianus and generally wider and shallower bodies of water with more aquatic floating vegetation.

In the vicinity of Xakue and on large areas of the Xo flats Miscanthidium teretifolium is the dominant species while Phragmites mauritianus also occurs extensively. Cyperus papyrus, Ampelopteris prolifera and Phoenix reclinata become less noticeable, except for small patches of papyrus, some of which might have been brought down by peak floods.

The Boro channel becomes most confused with large expanses of water flowing in diverse directions. The water is variable in depth but generally shallow with sand beds and a profusion of sandbanks.

The progress of flow is blocked by massive growth of Phragmites mauritianus, Miscanthidium teretifolium, Vossia cuspidata, Echinochloa stagnina, Nymphaea caerulea, Trapa natans, Oryza longistaminata, Nymphoides indica, Potamogeton crispus, Rotala myriophylloides, Ottelia ulvifolia, Ceratophyllum demersum, Leersia hexandra, sedges and other "clogging" aquatic species.

Below N'garaga and Matsoketsane the growth of Miscanthidium teretifolium seems to be much shorter than further north. The river channel becomes more confined and increased in depth although massive growth of aquatic species continues along both sides of the channel and outwards in the bays.

Tree growth becomes more prominent, growing close to the river with an increase in dryland woody species.

Very narrow channels through the Phragmites mauritianus and Miscanthidium teretifolium repeatedly open into wider expanses of shallow water. The increase in island space and woody vegetation in the vicinity of the Xo flats results in a rapid increase of tsetse fly southward.

Phoenix reclinata

The wild date palm is very abundant in the upper and central areas of the swamps. In the region of the Xo flats it gradually disappears. In the southern region it is entirely replaced by an abundance of Hyphaene ventricosa.

4. THE EFFECT OF FIRE IN THE UPPER AND CENTRAL OKAVANGO

Fierce fires in the Cyperus papyrus, Phragmites mauritianus and Miscanthidium teretifolium are frequent. They vary from small local burns to entensive fires over vast areas. The immediate water fringes sometimes escape burning. If there is an accumulation of dry herbage burning takes place above the water surface during periods of high floods and very extensive fires were observed in the Seronga region at the beginning of September 1970. In places where burning took place previously, there is re-growth in various stages of development and some of the young re-growth exceeded 1 m. in height.

Typha australis

The bullrush is also relatively scarce in the northern papyrus areas and it was hardly noticeable until approaching Kwihum on the Boro river. It increases southwards, similarly to Phragmites mauritianus and Miscanthidium teretifolium and grows intermingled with each other and with papyrus in the northern sector. In the southern areas it grows extensively and in some places occurs almost in pure stands of considerable extent.

Vossia cuspidata

In the northern region hippo grass fringes the river junctions, side channels, bays and lagoons and grows in association with Nymphaea caerulea and Ottelia muricata.

In the central and southern regions it is most characteristic of the river banks and occurs very extensively in some areas. It grows along the river banks and lagoons with its long runners floating in the water. These have a characteristic movement, upwards and downwards due to wave action from passing boats. Portions which break loose due to action of hippopotami or to boat movement float downstream and accumulate in blockage areas with floating debris of papyrus and other aquatic plants.

Vossia cuspidata is frequently intermingled with Echinochloa stagnina which is of identical growth habit. These two grasses are almost indistinguishable when flowering culms are not available.

Hippo grass is also associated and intermingled with Oryza longistaminata, Leersia hexandra, Aeschynomene fluitans, Cyperus articulatus and a number of other sedges and aquatic plants.

Nymphaea caerulea

The water lily is widely distributed throughout the swamps and is particularly abundant in some of the relatively shallow water areas of the central and southern regions where it grows intermingled with Vossia cuspidata, Phragmites mauritianus, sedges and other aquatic species.

5. DISCUSSION OF VARIOUS SPECIES GROWING IN RELATIVELY SHALLOW WATER WHERE THE FLOW IS IMPEDED

Ottelia muricata

This species is abundant in some of the bays and lagoons, in the deep water zone of the swamps where the banks are fringed with papyrus and hippo grass. Ottelia ulvifolia seems more prevalent in the southern areas in relatively shallow water.

Polygonum pulchrum

This plant is also frequently noticeable in the deep water zone while Polygonum limbatum is abundant and widespread in the southern area and along the river channels where the water is relatively shallow.

Ceratophyllum demersum

This aquatic species is locally abundant along channels with relatively shallow water and is one of the troublesome species in respect of problems of impeded water flow.

Rotala myriophylloides

This aquatic plant grows abundantly in the shallow water areas of the lower Boro river and Santantadibe systems. It produces vast masses of fine floating filamentous leaves with small brownish green succulent leaves floating on the surface of the water and prolific development of light bluish flowers protruding above the water surface. It is commonly associated with Nymphaea caerulea, Ottelia ulvifolia, Cyperus articulatus and other sedges.

Trapa natans

This floating aquatic plant produces rosettes of dark reddish brown leaves. It is widely distributed in the Okavango swamps and occurs in side channels and streams of medium to shallow depth. It is generally associated with Nymphaea caerulea, Ottelia muricata and other aquatic plants and is troublesome in impeding water flow.

Ludwigia stolonifera

This is a common aquatic plant in the lower Okavango growing in shallow water with light reddish brown stems floating on the water or trailing on the damp ground and rooting at the nodes. The flowers are bright yellow. It is a troublesome plant in respect of impeding water flow.

Potamogeton crispus and Potamogeton thunbergii

These plants are common in shallow water in the lower Okavango and grow in confusion with other aquatic plants impeding water flow in the shallow channels to a large extent.

There are many other species of aquatic plants falling into this category and some of these will be listed.

6. THE ISLANDS

The islands become more numerous and much larger as one proceeds southwards. Syzygium guineense trees in some of the swamp areas were partly submerged for considerable periods but continued to thrive. Further south it is a typical water-edge river bank tree. Large clumps of Phoenix reclinata are abundant and very conspicuous in the northern and central parts but in the southern central zone it disappears while Hyphaene ventricosa becomes more abundant. Dryland tree species such as Acacia nigrescens, Kigelia pinnata, Lonchocarpus capassa and Sclerocarya caffra occur occasionally on the islands in the northern and north central regions while Myrica serrata and Hibiscus diversifolius grow along the river banks.

The size and frequency of the islands increased southwards and so did the prominence of the woodlands and the number of species. These include many of the riverine and mainland species such as:

Acacia nigrescens
Asparagus africanus
Boscia albitrunca
Capparis tomentosa
Ficus sycamorus
Garcinia livingstonei
Kigelia pinnata
Lonchocarpus capassa
Maytenus senegalensis
Rhus quartiniana
Sansevieria aethiopica
Sclerocarya caffra
Sesbania bispinosa
Vernonia amygdalina and
Ximenia caffra

The river-edge and swamp-edge grasses include:

Chloris gayana
Cynodon dactylon
Hemarthria fassiculata
Hyparrhenia rufa
Panicum maximum
Panicum repens and
Setaria sphacelata

The soils on some islands is very saline and there is a tremendous accumulation of sodium salts forming a white deposit on the surface. Characteristic plants on some of these places include:

Aloe sp.
Chloris gayana
Nicolasia costata
Nidorella resedifolia
Senecio apiifolius
Sporobolus marginatus and
Sporobolus spicatus

7. THE EFFECT OF FIRE IN THE SOUTHERN SECTOR

Woody vegetation on the islands and along the river banks and swamp edges gets burnt back severely and much damage is done to Syzygium guineense and Phoenix reclinata. The frequency of fire in the southern region increases due to the increased dryness and to the increased population pursuing occupations of fishing, hunting and limited cultivation. In the extreme southernmost parts livestock are kept and swamp margins provide green herbage for grazing, subsequent to burning masses of dry accumulated herbage. The swamp-edge grasses like Panicum repens being rhizomatous or being coarse deep-rooted tussock species do not seem to be adversely affected by burning.

8. GAME

Bird life is very prolific with large numbers of fish eagles, kingfishers, cormorants, herons and storks.

A considerable number of hippopotami and a few crocodiles were seen. Three lechwe were seen north of Duba camp and some reedbuck and waterbuck on the lower Boro river. Hyena were heard on the islands along the lower Boro river. Buffalo droppings and spoor were abundant on most of the islands.

9. PLANT SPECIES IN THE OKAVANGO SYSTEM WHICH IMPEDE STREAM FLOW

Any plant species can in some way or other impede the flow of water, for example, branches of trees or floating papyrus can be responsible for the blockage of streams. We are, however, more concerned here with aquatic plants which grow in shallow water where the depth might range from a few cm. to about 2 m. deep. In the Okavango system there is a continuous change of water level and general flood regime, throughout the year. Large areas which are dry or nearly dry at certain times of the year or during certain seasons would be flooded to a depth of more than 1 m. for several months. The pattern is also complicated because the main flooding takes place in the middle of the dry season when the flood waters from the upper Okavango reach the southern region of the swamps and the rivers flowing out of the swamps. This secondary flooding takes place when the effect of the rainy season has disappeared. It is similar to the dry season flooding in the Kafue basin in Zambia where the flood waters from northern Zambia reach the Kafue flats about May.

Due to the nature of the topography in the swamps and the wide flat channels with shallow water in the southern section, a large number of plants are responsible for impeding stream flow and some of these are listed:

Aeschynomene fluitans
Alternanthera philoxeroides
Brasenia schreberi
Ceratophyllum demersum
Cyperus articulatus
Cyperus spp.
Diclis petiolaris
Echinochloa stagnina
Eleocharis acicularis
Eleocharis dulcis
Ficus verruculosa
Floscopa sp.
Hydrocotyle umbellata
Lagarosiphon major
Leersia hexandra
Ludwigia
Miscanthidium teretifolium
Nymphaea caerulea
Nymphoides indica
Oryza longistaminata
Ottelia muricata
Ottelia ulvifolia
Paspalidium platyrrhachis
Phragmites mauritianus
Polygonum limbatum
Potamogeton crispus
Potamogeton richardii
Potamogeton thunbergii
Pycreus mundtii
Pycreus tremulus
Rotala myriophylloides
Sacciolepis africanus
Saggitaria guayanensis
Scirpus juncoides
Trapa natans
Typha australis
Utricularia sp.
Vossia cuspidata

10. PLANTS WHICH ARE COMMON IN THE NORTHERN OKAVANGO

(a) Deep water species:

Ampelopteris prolifera
Cyperus papyrus
Ipomoea rubens
Mikania cordata
Polygonum pulchrum

(b) Relatively shallow water species (islands, banks and shallows):

Hibiscus diversifolius
Miscanthidium teretifolium
Myrica serrata
Nymphaea caerulea
Ottelia muricata
Phoenix reclinata
Phragmites mauritianus
Syzygium quineense
Trapa natans
Typha australis
Vossia cuspidata

11. GRASSES GROWING ALONG RIVER BANKS AND AROUND SWAMP EDGES AND LAGOONS

These include some valuable natural pasture grasses. Pasture conditions in the southern swamps region and along the western and eastern flanks are very favourable with great potential. There are other problems though which hamper livestock development in this region. The swampy conditions favour the build-up of internal parasite populations and tsetse fly occurs throughout the area. Several dead cattle were noticed along the river banks in November. It is likely that they died from trypanosomiasis, from exhaustion after sticking in the mud and from general poverty.

The grasses include:

Acroceras macrum
Brachiaria brizantha
Chloris gayana
Cynodon dactylon
Digitaria eriantha
Echinochloa pyramidalis
Hemarthria altissima
Hyparrhenia rufa
Imperata cylindrica
Panicum maximum
Panicum repens
Paspalum commersonii
Setaria avettae
Setaria sphacelata, and a number of sedges which are readily grazed.

There are also various other plant species, including palatable legumes, which are palatable and useful browse plants.

12. PLANTS GROWING ON HIGHLY SALINE SOILS

There are high salinity concentrations on some of the islands and many of the plants which occur are typical salinity indicators and species which can tolerate high levels of salinity:

Aloe sp.
Boscia albitrunca
Chloris gayana
Cynodon dactylon
Hyphaene ventricosa
Imperata cylindrica
Nicolasia costata
Nidorella resedifolia
Panicum repens
Phoenix reclinata
Sansevieria aethiopica
Senecio appiifolius
Sporobolus marginatus
Sporobolus spicatus, and
Typha australis

13. TREES AND SHRUBS TYPICAL OF THE ISLANDS AND RIVER BANKS

Some trees like Syzygium quineense and Phoenix reclinata will stand flooding and inundation over considerable periods and are most characteristic of the northern and upper central regions of the swamps. Other species such as Lonchocarpus capassa and Garcinia livingstonei are characteristic of the higher-lying and better drained river banks. Their general occurrence and distribution are likely to be closely related to earlier drainage patterns which were bound to be very complex with constantly changing features due to scouring and deposition. The woody species include:

Acacia karroo
Acacia nigrescens
Acacia sieberana
Acacia tortilis
Acacia xanthophloea
Albizia harveyi
Antedesma venosum
Berchemia discolor
Boscia albitrunca
Capparis tomentosa
Carissa edulis
Combretum hereroense
Combretum imberbe
Croton megalobotrys
Dichrostachys cinerea
Diospyros mespiliformis
Ficus sycamorus
Garcinia livingstonei
Hyphaene ventricosa
Kigelia pinnata
Maytenus senegalensis
Peltophorum africanum
Phoenix reclinata
Rhus quartiniana
Sclerocarya caffra
Spirostachys africana
Syzygium quineense
Ximenia caffra, and
Ziziphus mucronata

14. CONCLUSIONS AND RECOMMENDATIONS

1) Particular vigilance and precautions should be taken to prevent the spread of troublesome aquatic plants such as:

Eichhornia crassipes - water hyacinth
Salvinia auriculata, and
Pistia stratiotes - water lettuce

The proximity of Salvinia auriculata in the Chobe river warrants constant attention to prevent its spreading into the Okavango system.

2) The crux of the channel blockage problems hinges on depth of water and velocity of flow. The most practical and soundest approach would be mechanical opening and maintenance of suitable channels to promote adequate flow. This will provide maximum efficiency and economy in terms of cost and volume of water removed from the swamps.

Limited chemical and weedicide control should be borne in mind and could be considered. This might become feasible in conjunction with mechanical channel clearance and channel maintenance.

Extensive application of chemicals and weedicides, however, should not be attempted for the following reasons:-

(a) Exorbitant cost to cover the vast swamp areas of the lower Okavango system.

(b) The ineffective results which could be expected from such an operation due to the topographical conditions and the shallow nature of flooding.

(c) Due to the biological devastation that is likely to result and the effect on fish, birds and other forms of wild life.

3) The continuation of environmental studies is necessary: to keep abreast with information on vegetation behaviour, flood regimes, resource utilization and wildlife preservation.

LIST OF SOME PLANT SPECIES OF THE OKAVANGO REGION

/* Specimen names not yet finally checked with Pretoria herbarium material /

	Acacia karroo Hayne
	Acacia nigrescens Oliv.
	Acacia sieberana DC.
	Acacia tortilis (Forsk.) Hayne
	Acacia xanthophloea Benth.
	Achyranthes aspera L.
	Acroceras macrum Stapf
	Aeschynomene fluitans Peter
	Albizia harveyi Fourn.
	Aloe sp.
B 4166*	Alternanthera philoxeroides (Mart.) Griseb.
B 4110	Ampelopteris prolifera (Retz.) Copel.
B 4131	Antedesma venosum E.Mey. ex Tul.
	Asparagus africanus Lam.
B 4094	Berchemia discolor (Klotzsch.) Heml.
B 4117	Boscia albitrunca (Burch.) Gilg & Ben.
	Brachiaria brizantha (A.Rich.) Stapf
B 4143*	Brasenia schreberi Gmel.
	Capparis tomentosa Lam.
	Carissa edulis Vahl
	Ceratophyllum demersum L.
	Chloris gayana Kunth
	Combretum hereroense Schinz
	Combretum imberbe Wawra
	Commelina africana L.
	Croton megalobotrys Muell. Arg.
	Cynodon dactylon (L.) Pers.
B 4091)	
B 4139(a))	Cyperus articulatus L.
	Cyperus esculentus L.
B 4159*	Cyperus papyrus L.
B 4128)	
B 4134)	Cyperus sp.
	Dichrostachys cinerea (L.) Wight & Arn.
B 4122	Diclis petiolaris Benth.
B 4169*	Digitaria
	Diospyros mespiliformis Hochst ex A.DC.
	Echinochloa stagnina (Retz.) Beauv.
B 4172*	Eleocharis acicularis (L.) R. & S.
B 4155	Eleocharis dulcis (Burm. f.)
	Euphorbia tirucalli L.
	Ficus sycamorus L.
	Ficus verruculosa Warb.
B 4095	Flaveria bidentis (L.) Kuntze
	Floscopa
B 4093)	
B 4130)	Garcinia livingstonei T. Anders
	Henarthria altissima Stapf & C.E. Hubb.
B 4119	Hibiscus diversifolius Jacq.
B 4160*	Hydrocotyle umbellata L.
	Hyparrhenia rufa (Nees) Stapf
	Hyphaene ventricosa Kirk

	Imperata cylindrica (L.) Beauv.
B 4125	Iponoea rubens Choisy
	Kigelia pinnata (Jacq.) DC.
B 4154*	Lagarosiphon major.
	Leersia hexandra Sw.
	Leonotis nepetifolia (L.) R.Br.
B 4167*)	
B 4165*)	Ludwigia stolonifera (Guill. & Perr.) Raven
	Maytenus senegalensis (Lam.) Excll
B 4118	Mikania cordata (Burm.f.) Robinson
B 4121)	
B 4137)	Miscanthidium teretifolium (Stapf) Stapf
B 4120	Myrica serrata Lam.
	Nelsonia canescens (Lam.) Spreng.
B 4115	Nicolasia costata (Klatt) Thellg.
B 4116	Nidorella resedifolia DC.
B 4126)	
B 4144*)	Nymphaea caerulea Sav.
B 4161*	Nymphoides indica (L.) Kuntze
B 4163*	Oldenlandia sp.
B 4170	Oryza longistaminata Chev. & Roehr.
B 4111	Ottelia muricata (Wright) Dandy
B 4127(a)	Ottelia ulvifolia (Planch.) Walp.
	Panicum maximum Jacq.
	Panicum repens L.
	Paspalidium platyrrhachis C.E. Hubb.
	Paspalum commersoni Lam.
B 4092	Pechuel-loeschea leubnitziae (Kuntze) O. Hoffm.
	Peltophorum africanum Sond.
	Pergularia extensa (Jacq.) N.E. Br.
	Phoenix reclinata Jacq.
	Phragmites mauritianus Kunth
B 4133	Polygonum limbatum Meisn.
B 4113)	
B 4152*)	Polygonum pulchrum Blume
B 4132	Potamogeton crispus L.
B 4164*	Potamogeton richardii Solms.
B 4135	Potamogeton thunbergii Cham ex Schltnde.
B 4151*	Pycnostachys sp.
B 4146*	Pycreus mundtii Nees
B 4158	Pycreus tremulus (Poir.) Solms.
	Rhamphicarpa tubulosa Benth.
	Rhus quartiniana A.Rich.
B 4165)	
B 4127(b))	Rotala myriophylloides Welw. ex Hiern
B 4129)	
B 4138)	

	Sacciolepis africanus C.E. Hubb.
B 4142*	Saggitaria guayanensis Kunth
	Sansevieria aethiopica Thunb.
B 4157*	Scirpus juncoides Roxb.
	Sclerocarya caffra Sond.
B 4114	Senecio appiifolius (DC.) Benth. ex Hook.f. ex O.Hoffm.
	Sesbania bispinosa (Jacq.) W.F. Wright
	Setaria avettae Pir.
	Setaria sphacelata (Schumach.) Stapf & C.E.Hubb. ex M.B. Moss
	Solanum nigrum L.
	Sonchus cloraceus L.
	Spirostachys africanus Sond.
	Sporobolus marginatus Hochst. ex A.Rich.
	Sporobolus spicatus Kunth
	Syzygium quineense (Willd.) DC.
B 4112	Trapa natans L.
B 4145*	Typha australis Schumach.
B 4153*	Utricularia sp.
B 4124	Vernonia amygdalina Del.
	Vetiveria nigritana (Benth.) Stapf
B 4162*	Vossia cuspidata Griff.
	Ximenia caffra Sond.
	Ziziphus mucronata Willd.
B 4156*	Sedge

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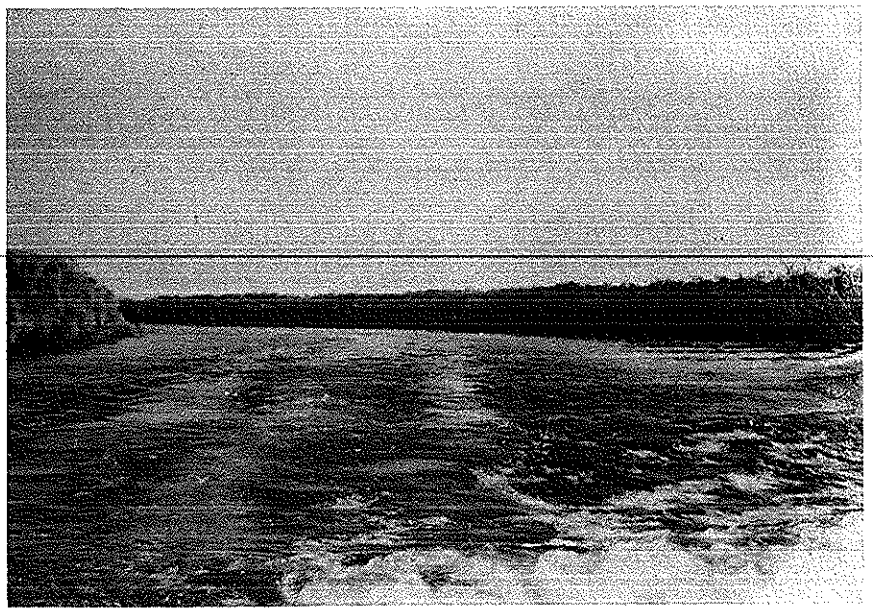
CORRIGENDUM TO CAPTIONS OF PHOTOGRAPHS

Plate	1	line 1	-	Okavango river, Okavango Swamps	- add , & S
"	2	" 1	-	Swamps	- S
"	3	" 3	-	both sides	- d
"	4	" 3	-	Typha latifolia	- delete australis
"	4	" 5	-	variation in the velocity	- add in
"	4	" 7	-	Vossia cuspidata	- o
"	5	" 3	-	camp	- c
"	8	" 3 & 4		Cyperus articulatus, other species of sedge	- add , & join 2 lines
"	8	" 7	-	Ficus syconorus, Lonchocarpus	
"	9	" 1	-	Swamps	- S
"	10	" 1	-	Swamps	- S
"	10	" 4	-	Ficus syconorus	- o
"	10	" 5	-	Sclerocarya	- Scle
"	11	" 1	-	Swamps	- S
"	12	" 1	-	Swamps	- S
"	12	" 5	-	articulatus	- add a



Okavango river Okavango swamps

The wide deep river channel lined with *Cyperus papyrus* and *Ampelopteris prolifera* downstream from Sepopa.

Okavango swamps

Islands near Seronga with large clumps of *Phoenix reclinata* and various tree species, with an undergrowth of *Panicum repens, P. maximum* and *Chloris gayana.*

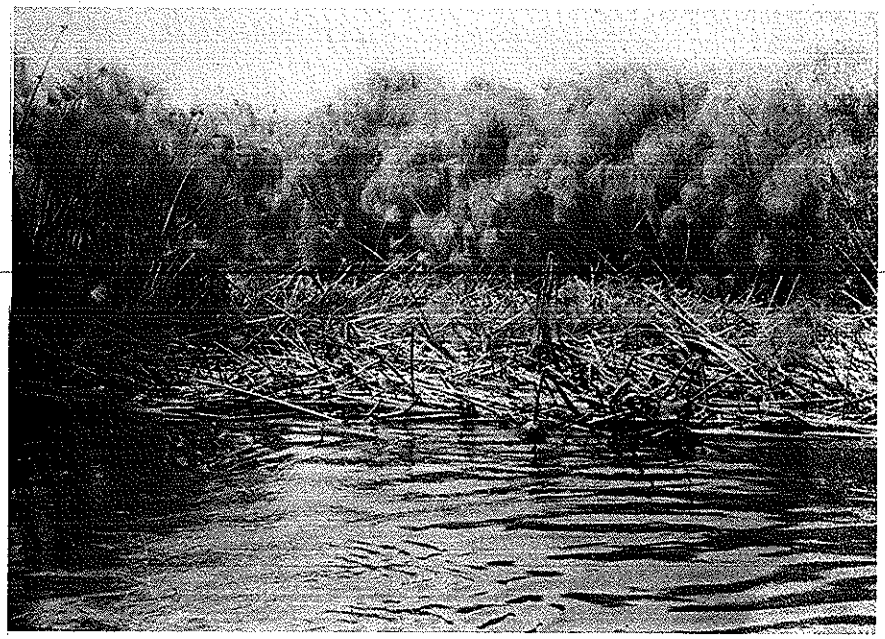
Ng'okha river, Okavango Swamps

Narrow river channel downstream from blockage gauge near river blockage. There is a tall massive growth of *Cyperus papyrus* and *Ampelopteris prolifera* on both siles of the channel.

Okavango Swamps. Impeded Stream flow:

Very narrow channel of the Boro river 5½ hours downstream from Kwihum. The banks are lined with a dense growth of *Cyperus papyrus* and a little *Typha australis*. The depth of water under the Papyrus is about 2 m. Sandbanks occur around the corners and bends due to the alternating variation the velocity of flow. There were local blockages in the channel on some of the sharp corners.

Nymphaea caerulea, Ottelia muricata, Ottelia ulvifolia and *Vissia cuspidata* were growing in the quiet bays and lagoons.



River blockage, Okavango Swamps.

The Ng'okha blockage 5 minutes from blockage gauge downstream from Gaenga island eamp. The river channel completely blocked with a mass of *Cyperus papyrus*.

Boro river, Okavango Swamps

Boro river, 9 hours downstream from Kwihum

The river breaks up into narrow channels through very dense growth of *Phragmites mauritianus* and then opens up again into wide expanses of shallow water.

Boro river, Okavango Swamps, 1¼ hours downstream from Boro Camp 2.

The river channel and flooded bays are grassed with aquatic species such as *Vossia cuspida, Echinocloa stagnina* and sedges and fringed with woodland.

Okavango Swamps Obstruction to Stream flow:

Vast expanses of water but only very narrow open channels through a dense growth of *Cyperus articulatus*

Other species of sedge and various floating aquatic weeds. These are fringed by a dense tall growth of *Miscanthidium teretifolium*. Further outwards along the tree covered banks are excellent pasture grasses including *Panicum repens, Setaria sphacelata, Chloris gayana* and *Hyparrhenia rufa*. The tree species include *Syzygium quineense, Ficus sycanorus, Lonchocarpa capassa* and clumps of *Phoenix reclinata*

Photo taken on the Boro river along the Xo flats about 8 hours downstream from Kwihum.

Okavango swamps

Boro river 3 hours upstream from Maun.

An impressive stand of *Hyphaene ventricosa* and a very dense growth of *Miscanthidium teretifolium* in the foreground.

Okavango swamps

Boro river $2\frac{1}{4}$ hours upstream from Maun.

An extensive system of fish nets stretch across the stream. The open stream is fringed with *Vossia cuspidata*. The riverine woodland include *Ficus sycamorus, Kigelia pinnata, Acacia nigrescens, Combretum imberbe, Garcinia livingstonei* and *Selorocarya caffra*.

Okavango swamps

Phragmites mauritianus for building being brought down the Santantadibe river by canoe, along a narrow water channel lined with reeds.

Okavango swamps

Plants which impede the flow of water.

Dense growth of *Ficus verruculosus* along the Santantadibe near Xotrongo village. On the right is a dense growth of *Miscanthidium teretifolium* with some *Phragmites mauritianus, Cyperus rticulatus* and other sedges.