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THE VEGETATION OF THE DUNES NEAR OOSTVOORNE (THE NETHERLANDS) WITH A VEGETATION MAP[1])

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1. INTRODUCTION

This publication aims at elaborating the legend of the accompanying vegetation map of the dunes near Oostvoorne (province of South-Holland, The Netherlands). This map has been composed in 1959 by the first author at the request of the owner of the dunes, the "Stichting Het Zuid-Hollands Landschap" (the Provincial Nature Protection Foundation of South-Holland), in order to provide a scientific basis for the management of the area. Such an opportunity is much appreciated by a vegetationist, since the investigator's activity was quite free and assistance was given in many respects.

In an internal report (VAN DER MAAREL, 1960) a survey was given of the geomorphology, the flora, the landscape and the local vegetation types; some suggestions for the management were added.

There is an obvious analogy here to the vegetation study of the Wassenaar Dunes near The Hague (BOERBOOM, 1958), the scientific evaluation based on it (WESTHOFF, 1958) and the advices for the management (WESTHOFF and OTTO, 1958). In both cases the results of the vegetation study are a guide for the landscape planning.

Furthermore, this publication pursues the elucidation of the general methodology of vegetation mapping, with special respect to the method employed here.

Finally it is to be understood as the first of a series of publications dealing with the vegetation of the dunes of the Delta region. Complete information about the floristic composition, the classification and the ecology of the vegetation types will be given in the following papers in the series. In addition geomorphological data will have to be studied in more detail to enable a further interpretation of the vegetation differences.

2. GEOMORPHOLOGY

2.1 SITUATION OF THE AREA

The area investigated forms the bulk of the north-western dunes of the former isle of Voorne. (See situation outline on the vegetation map). It is bounded to the south by the dune area of the "Vereniging tot Behoud van Natuurmonumenten in Nederland" (Dutch Society for the Promotion of Nature Reserves), to the north by the catchment area of the Dune Water Works of Brielle, to the east by the Duinzoom and the Duinstraat (forming a connecting road between Oostvoorne and Rockanje) and to the west by the North Sea.

2.2 DEVELOPMENT

The structure of the dune system of Voorne differs from that of the dunes on the mainland coast of North- and South-Holland. Two dune landscape types can be distinguished there, as JESWIET (1913) a.o. clearly pointed out. The "old dune landscape", also called "beach bank landscape" (FABER, 1960), was probably formed upon

marine clay during the marine regression in the Atlanticum, between 5000 and 3000 B.C. It consists of alternating low beach banks and flats, "strandwallen" and "strandvlakten" (FABER, 1960). In the inner parts of the dune range this landscape still exist, as far as it is not levelled for bulb growing and town building. The "young dune landscape" originated relatively recently, during a regression in the Subatlanticum, probably between 850 and 950 A.D. (VAN DER MEER, 1952) probably even later (ZAGWIJN, pers. comm.). Considerable masses of sand have been blown over all the western part of the old dune landscape, the new dunes rising much higher than the former ones.

In Voorne the situation is quite different. A delta with salt marshes and creeks was built up by the rivers Brielse Maas, Haringvliet and particularly Goote (branch of the Haringvliet) and Strype (branch of the Goote). The latter two disappeared as a result of damming and land reclamation. No remains of an old dune landscape can be traced here, except the remains of a beach bank now underlying the Heveringen dunes. According to KLOK (1939) this bank was destroyed by the sea during the Roman occupation, in the 1st century A.D.

The building up of the new dune landscape has not been completely explained. Data and conclusions given by VAN HOEY SMITH (1930), HOFKER and VAN RIJSINGE (1934, 1935), HOFKER and VAN HOEY SMITH (1935), HOFKER, VAN RIJSINGE and VAN HOEY SMITH (1936) and KLOK (1939) have shown a rather regular periodicity in the formation of the south-western dunes of Voorne. In the area investigated, however, the situation is less clear.

In general, the Voorne dunes resemble the old dune landscape of the mainland coast, consisting of beach banks and flats, which arose as a result of a regression, i.e. a retraction of the shoreline, but wind-blown sand has complicated this simple structure. The sand has been deposed upon clay, the surface level of which is 2,5 m below sea level. Therefore the dunes remain rather low; the maximum height amounts to 18 m above sea level, this height being reached with human help only. Mainland dunes often reach 30 m, at Bloemendaal even 60 m above sea level.

The following assumption about the development of the area investigated is based upon data from the above mentioned authors and on our own vegetational data, which will be described in parts 4 and 5. The dunes around "Weevers' Duin" (squares A–1 and C–1 on the map) are presumed to be the oldest. They are part of an early mediaeval dune system which arose upon the remains of the Heveringen beach bank. The area consisting mainly of fields nowadays (squares C–2, D–2) presumably originally belonged to this zone. Between 1200 and 1600 A.D. new dunes were built up, as suggested on a map by DE KOUTTER from 1608. These dunes were recognised by Hofker et al. southward from the Breede Water lake by their parabolic form—duni parabolici sensu VAN DIEREN (1934).—The vegetation map shows identical forms situated in narrow "stripe dunes" which arose in the prevailing wind direction, from the south-

west. They are easily recognisable on the map (squares A–2,3 and H–2,3) by the course of the height contours and the bright yellow colour.

The surfacial sand of these dunes was probably blown all over the Heveringen dunes, as can be concluded from the disappearance of an old sand-dike protecting the Heveringen in the 13th and 14th century A.D. Furthermore, the map of De Koutter does not show any difference within this complex, nor is it possible to discern two zones nowadays. It should be noted, however, that the retracing of these dunes is thwarted because part of them has been levelled for horticultural purposes.

It has not yet been established how far this late mediaeval dune strip extended seaward. Certainly the great slacks [1]) situated along the west part of the Bunkerpad, the Lange Pad and the Vliegveldpad (squares B–4, F–4, G–4, D–5, E–5) are not more than 50 years old. The dune ridge bounding these slacks to the land side is indicated as the coastal ridge of 1910. In that year the Polder Board of Brielle began the elevation of the outer dunes of that time by planting them with *Ammophila arenaria* [2]) and forbidding the grazing of cattle and horses. The question arises whether all these dunes were built up between 1200 and 1600 A.D. or do in fact partly date from later time, as does a dune area in the south-western part. The lack of parabolic dunes in the outer zone of this complex does indeed suggest a division. Moreover, a narrow dune slack, the Bakenvallei (squares D–4, E–4) separates the complex into two zones. It is supposed that two dune strips must be distinguished, at least in the Bakenvallei region.

In the outer duneslacks a small ridge can be recognised 150 m seaward from the coastal ridge of 1910. This "coastal ridge of 1926" forms the continuation of a sand-dike built in that year, to cut off the Breede Water, (a dune lake), from the sea. The low dune ridge bounding the Vliegveld (a slack) and the adjacent reed-swamp (squares D–5, H–5) arose at the same time, probably with human help. These two ridges do not connect in a straight line, however and this irregularity has also been recognised in former coastal ridges, by HOFKER and VAN RIJSINGE (1934, 1935). They have correlated it with the occurrence of a creek underneath the sand, which could be demonstrated by borings.

The present coastal ridge started to develop between 1930 and 1935 and has grown into a continuous sea-wall of considerable height. After World War II exotic Poplars were planted on the lee-side with an unexpected success. They are rather disharmonious in the scenery but effective in fixing mobile sand. This coastal ridge has been called after the year of this investigation, viz. 1959.

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[1]) The new English term for dune valley, ("vallei", "vlak", "del") derived from the old Norse word slakki and introduced by Tansley (1949).

[2]) Remarks on nomenclature will be given in part 5.5.

2.3 Present geomorphological structure

Summarising the data given above, the following zones can be distinguished:

Zone A: Heveringen dunes from 800–1200 A.D., covered with sand from zone B. Characteristic of this zone are the low height of the dunes, which never exceeds 6 m above sea level, and their rounded tops.

Zone B: Late mediaeval dunes from 1200–1600 A.D. Characteristic are the stripe dunes, within which parabolic dune forms can be distinguished. Between these stripe dunes dune slacks can be retraced. Parts of them seem to be remains of old beach flats, e.g. the Eendenpit (square A–3), most of them being "secondary dune slacks" (in the sense of Van Dieren, 1934), which have been blown out to ground-water level. They are often bounded by a parabolic dune at the north-east side, e.g. the Gymnadeniavallei (square F–3).

Zone C: A small dune strip dating from 1600–1900 A.D. consisting of mobile sand dunes and partly covered with plantations, e.g. the Van Iterson Bos. A narrow slack, the Bakenvallei, presumably forms part of this strip.

Zone D: A system of beach flats bounded seaward by a small coastal ridge of 1926, being desalinated and thus turning into primary dune slacks.

Zone E: Primary dune slacks bounded by the present coastal ridge, within which scattered small and low dunes occur.

In conclusion it may be emphasised that the area investigated represents a very dynamic, differentiated and young Dutch dune landscape, 40 % of the area being less than 50 years old. In this respect the dunes of Voorne are incomparable.

3. SOME ENVIRONMENTAL DATA

3.1 Climate

The climate of the Netherlands shows a rather mild, sub-atlantic character, which is most pronounced in the southern coastal region, i.e. the Delta region. One of the most striking differences with the inland climate is formed by the smaller range in annual temperature. Both the average temperature in the warmest months (July, August) and that in the coldest month (January) are less extreme than inland. This may be illustrated with data from Braak (1930) and Labrijn (1948). (See below) Voorne does not differ much from Flushing, one of the climatic stations of the KNMI, the Royal Dutch Meteorological Institute. However, these data do not give much information about the influence of the climate upon the distribution of plant species and vegetation types.

According to Mörzer Bruijns and Westhoff (1951) a better criterion for judging the biogeographic influence of the climate might be the influence of extreme temperatures. This influence can be estimated by counting the yearly number of "summer days", with

maximum air temperatures above 25 degrees centigrade, and of "icy days" and "frost days", with maximum and minimum air temperatures below zero degrees centigrade respectively. Some data, from BRAAK (1930) and LABRIJN (1948) may illustrate this:

	Maastricht	De Bilt	Flushing
Temp. warmest months (July, August)	19.4, 18.7 d.c.	18.4, 17.5 d.c.	17.8, 17.6 d.c.
Temp. coldest month (January)	3.3	2.6	3.5
Annual range	16	15	14
Number of summer days .	31	20	8 [1]
Number of frost days . . .	52	75	32

[1] At *Hellevoetsluis*, southern part of Voorne, 18.

MÖRZER BRUIJNS and WESTHOFF (1951) have given a provisional division of the Netherlands in climatic regions (recently refined by BARKMAN, 1958), based on the number of summer days and icy days. According to this division Voorne can be placed in the Zeeland region (perhaps better called Delta region), "having mild summers and very mild winters".

Because of these conditions some atlantic-mediterranean species such as *Blackstonia perfoliata, Glaucium flavum* and *Euphorbia paralias* are able to thrive at Voorne, attaining however their northern limit just here or slightly further northwards.

The average annual rainfall in Voorne amounts to approximately 720 mm—according to data from Rockanje,—with a minimum in February, March and April (monthly values 54, 40 and 41 mm respectively) and a maximum in the autumn (monthly values of September, October and November 86, 82 and 80 mm respectively). The autumn maximum is especially characteristic for the coastal region, the maximum falling in August at The Bilt, the headquarters of the KNMI, which is situated inland.

The wind is much stronger in the coastal region than inland, its average velocity being 5,0–7,3 m/sec and 2,5–4,8 m/sec respectively. Southwestern and western winds are prevailing, especially in autumn and winter (BRAAK, 1942). An important difference between the Delta region and the mainland coast is in the limiting influence of the wind upon vegetation. It is supposed that this influence is less strong in the Delta region because the salt content of the sea-water just in front of the coast is lower; this feature is again due to the mixture of sea-water and fresh water from the estuaries.

This assumption has not yet been confirmed by measurements and as yet, only few botanical indications are available. The occurrence of so-called wind trees, showing a unilateral development of leaf branches, as have been recently described by RUNGE (1955) and BOERBOOM (1957), is less striking in Voorne. Moreover, some species

missing in the outer zones of the mainland coastal dunes and presumably sensitive to salt winds, do thrive near the coastal ridge of 1959, e.g. *Rosa rubiginosa* and *Rhamnus catharticus*. The luxurious growth of the Mildenburg-forest, in the village of Oostvoorne, consisting of *Quercus robur*, *Fagus sylvatica* etc., within 100 m from the sea-wall, is also remarkable.

3.2 Soil

The soil consists of quartz sand, which is originnally rather rich in lime, 5–15 % $CaCO_3$, but whose carbonate content decreases with the age of the dunes. The old Heveringen dunes do not contain more than 0,1 %.

Thus Voorne is a typical part of the "Dune district" (sensu Van Soest, 1929), which is characterised by calciphilous species such as *Inula conyza*, *Potentilla tabernaemontani* and *Berberis vulgaris*.

The temporary raising of the NaCl content is another important soil factor, especially in the outer dune slacks, which were regularly inundated by sea-water until 1953. The occurrence of species such as *Juncus gerardi*, *Glaux maritima* and *Scirpus maritimus* shows this influence. The NaCl content of the soil, however, was found not to exceed normal values. It is obvious that the salt ions are washed out rapidly by rain water.

The soil water factor is by far the most important. It may be assumed, that the clay layers underlying the relatively thin sand masses, keep the soil moist. In this respect the area differs from the mainland coast. The contrast is strengthened by the height of the mainland dunes and by their exhaustive desiccation, which is due to the extraction of water on behalf of the drinkwater supply of the coastal region.

The dunes near Oostvoorne undergo some extraction by the Dune Water Works of Brielle and by local gardening behind the dunes. The effect has not been deleterious as yet, though the local influence must not be underestimated: the Gymnadeniavallei (square F–3), a slack situated in the immediate neighbourhood of the catchment area of these Water Works and of some large gardens, is drying up slowly.—In the meanwhile the considerable rainfall in 1961 and 1962 has diminished the danger of desiccation for years.—The effect of drainage by local gardening is also obvious in the Heveringen dunes. For instance *Orchis morio* occurred here in abundance; nowadays this species is almost extinct.

It is expected that the present water regime will continue in the near future. However, the execution of the "Europoort" industrial project of Rotterdam threatens to devaluate the region as a whole. The consequences of this industrial development are rather serious, since the Voorne dunes may be considered as one of the most valuable European reserves of well-developed and differentiated dunes. (Van der Maarel, 1962, Adriani and Van der Maarel, 1962).

4. LANDSCAPE

4.1 Development

Few dates are known about the flora and vegetation of the Voorne dunes in former days. According to verbal tradition cattle and horses have been grazing in the dunes since time immemorial. Presumably only the Heveringen dunes had a continuous well-developed vegetation, the younger dunes being almost entirely barren during parts of the 19th century. The zones B and C became gradually overgrown during the 20th century, after the cattle and horses were removed. The zones D and E in general became overgrown soon after their origin; at some places even a *Betula-Salix* woodland of 8 m height has developed.

4.2 Influences of animals and man

The influence of cattle and horses has been mentioned above: these animals removed most of the herb vegetation and caused a typical pattern in the shrub vegetation, which can be seen up to the present day (e.g. the savanna-like landscape with *Crataegus monogyna*, squares A–2, B–2).

A great influence has been exercised also by rabbits. Their number was kept rather high, mainly in favour of hunting. Their gnawing and playing have become especially noticeable after the cattle and horses disappeared. In the slacks they caused a characteristic mosaic in dwarf shrub and herb vegetations, preventing them from growing to their normal size. In dry dunes they locally caused complete disturbances in the vegetation, thus giving the wind free play to start the blowing out of a parabolic dune.

In 1954 myxomatosis caused a sudden radical change in this situation: nearly all rabbits died and the vegetation restored rapidly. Especially some shrub species such as *Salix repens* and *Hippophae rhamnoides* enlarged their areas. Considerable advance has also been made by some grass species, e.g. *Calamagrostis epigeios*. Similar changes in English dune vegetations were described by Ranwell (1960).

Human influences in this area have been manifold from early times. Several afforestations haven been carried out with *Alnus glutinosa* as a dominant tree, e.g. in the Eendenpit (square A–4); sometimes *Betula verrucosa* has also been planted (square E–4). In this part of the dunes, however, *Alnus glutinosa* is not native, in contrast with the Quackjeswater region in the south-eastern dunes of Voorne. Recently *Alnus glutinosa* has been replaced in some forests by other trees not native here, such as *Fraxinus excelsior*, *Acer pseudoplatanus* and *Populus x canadensis*.

The largest plantation is the Van Iterson Bos (squares C–4, E–4), consisting mainly of *Populus canadensis*. Before having been planted these dunes were scarcely overgrown and hardly fixed. At present *Calamagrostis epigeios* is a dominant species in a rather monotonous herb layer; the trees form an open monotonous canopy, a shrub

layer being almost absent. There are spots with vegetations showing a more natural structure and floristic composition. However, these are moist areas showing a vegetation already present before the afforestation started.

In general, afforestation in young unstabilised dunes is a precarious undertaking, which, in terms of information theory (see VAN LEEUWEN, 1960) can only lead to a levelling-down of the potential differentiation, moreover without bringing in any harmonious isolation from the surrounding landscape. Succesful afforestation is possible only in the dune slacks, but it is just here that spontaneous, superfluous birch-woods occur.

On the map these plantations have been marked by crossed lines; any spontaneous undergrowth has been indicated with its proper legend unit. In addition to these forest imitations, scattered trees of *Populus* species have been planted in the yellow dunes (e.g. square B–4), in order to break the force of the sea-winds, as well as on the lee-side of the present coastal ridge. A rather disharmonious effect on the scenery is obvious.

Besides these plantations on a large scale, man has tried to sow and plant some shrub species and trees which are rare and partly not native in this region. Attempts to establish *Berberis vulgaris* and *Euonymus europaeus*, species which are more common in the Quackjes-water region, have not been succesful. Only a few plants belonging to these species can be observed, most of them having arisen spontaneously! Furthermore *Quercus robur* has been sown on several spots in the older dunes, mostly, however, in open herb or shrub vegetations where the trees are languishing in the sea-winds. In the Nachtegalen-bos (square B–2) *Fagus sylvatica* has been sown and planted with some success. This species is not native to the young dune landscape however.

In World War II a number of bunkers was built. They continue to be a nuisance in the scenery, although they have been planted with grasses (e.g. *Ammophila arenaria*) and fir trees, *(Pinus nigra)*.

Another category of human works concerns the levelling of dune slacks. In the first place the Vliegveld and the adjoining Gentiana-vallei (squares F–4, G–4, F–5, G–5), a former airstrip for sportflying, should be mentioned. Since their levelling about 1930 they have developed a varied and interesting vegetation. In addition some levelling was carried out by the German occupiers in order to obtain sods for covering their bunkers. Finally a lot of pits have arisen as a result of both bomb strikes and human digging. In general they contain a *Scirpus maritimus* vegetation.

In conclusion it can be stated, that both the surface and the vegetation of the dunes near Oostvoorne have been changed by human activities with tendencies to both equalisation and differentiation. As yet, however, this human influence is of little importance and does not have a controlling and dominating effect. By this restriction the area can be considered to have been preserved against the unification and adaptation to noöspherical entities (TEILHARD DE

CHARDIN, 1956), the process carried out on a large scale elsewhere in the Dutch landscape (VAN LEEUWEN, 1960).

4.3 PRESENT LANDSCAPE TYPES

The development of the present landscape has been affected by manifold environmental factors and as a consequence it has an exceptional variety. Moreover it is very dynamic as a result of both continual erosion and rapid vegetation succession. The present vegetation map will be antiquated within a few years!

The usual physiognomical division into herb vegetations, scrubs, woodlands, etc. has been refined; 10 landscape types have been distinguished and are called formations, as will be explained in parts 5.2 and 5.3; see also VAN DER MAAREL (1960, 1961b).

1. **Yellow dune open herb formation** (bright yellow colour on the map), occurring on the coastal ridges (especially that of 1959) and on the stripe dunes within zone B.

2. **Dune slack pioneer formation** (dark yellow), occurring behind the coastal ridge of 1959, zone E (squares C–6 — E–6).

3. **Tall dune grassland formation** (light green), occurring within the Van Iterson Bos (squares C–4 — E–4) and on bunkers (squares E–2 — F–3).

4. **Low dune grassland formation** (medium green), occurring in zone A only (especially squares B–1, C–1).

5. **Low dune marsh formation** (light brown), occurring on the Vliegveld (squares F–5, G–5).

6. **Tall dune marsh formation** (dark brown), mostly occurring in the large young slacks of zone D (especially squares D–5, E–5).

7. **Damp herb and dwarf shrub formation** (light blue), occurring in zones D and E and occasionally in secundary dune slacks in zone B.

8. **Low shrub formation** (dark blue, pink, orange), consisting of *Hippophae rhamnoides* with *Salix repens*, *Hippophae rhamnoides* and *Ligustrum vulgare* respectively. *Hippophae rhamnoides* and *Salix repens* occur in parts of the large slacks of zone E (squares B–5, C–5), the latter group throughout the area, representing the first phase in scrub succession, the third ones in stabilised dunes of zone B; also in zones C and D, however in damp places only.

9. **Tall shrub formation** (purple, red), consisting of *Sambucus nigra* and *Crataegus monogyna* respectively. The former occur on the coastal ridges of 1926 and 1910 and on parts of the stripe dunes, the latter in optima forma in zone A only.

10. **Woodland formation** (dark green), consisting of *Betula verrucosa* and occurring in small shallow slacks, "dellen", within zone B especially. Within this formation are also placed some marsh woodlands (dark brown with dark green), consisting of *Salix* species and occurring in the slacks of zone D (squares D–5, E–5 especially).

A further description of these formations will be given in part 5.7.

5. VEGETATION

5.1 THE AIMS AND METHODS OF VEGETATION MAPPING, WITH SOME REMARKS ON THE METHOD EMPLOYED

Many methods of vegetation mapping are in use and the layman may well have the impression of a kind of chaos since each investigator appears to use his own method. This is a mis-conception, in our opinion. A good vegetation map is as good an adaptation as possible to its practical and theoretical aims. Since there are many aims, there must be many methods, as was clearly demonstrated at the International Symposion on Vegetation Mapping at Stolzenau, 1959 (published 1963) (see FURRER, 1960) and at the exhibition of vegetation maps during the International Botanical Congress at Montreal, 1959 (see KÜCHLER, 1960 and also FOSBERG, 1961).

We do not agree with the striving for a general unification that can be noticed among students of the Braun–Blanquet school of phytocenology. Especially the creation of standardised association maps of countries, presenting associations and other units of the Braun–Blanquet system, should not be over-emphasised.

The following objections may be mentioned:

1. The rather small scale of such maps does not permit the presentation of all available information.
2. It is often hardly possible to judge which assocation should represent a vegetation-complex, that cannot be drawn in all its heterogeneity.
3. In spite of the surveys of plant communities such as those by WESTHOFF *et al.* (1946) for Holland, LEBRUN *et al.* (1949) for Belgium, TÜXEN (1937, 1955) for N.W. Germany, OBERDORFER (1957) for S. Germany, our actual knowledge of vegetation is still rather small. These surveys are indeed very useful as compilations of the knowledge at the time of publication; they should not however be considered to present ultimate information.
4. It is often impossible, or in the stage of investigation not desirable, to classify certain regional plant communities as Braun–Blanquet units.
5. It is not practical to use the same colour on the map for closely related units, since those often occur contiguously, and, therefore, are not readily distinguishable on the map.

If such maps are desirable, and we do not intend to deny this categorically, it would perhaps be preferable to distinguish rough physiognomic units and to draw them as "cartograms" rather than on an ordinary map. A cartogram consists of units, characterized by a dominating type, as used in geography and also in phytocenology, e.g. in Dutch grassland mapping (DE BOER, 1954, 1956). The physiognomic units may also be characterised by floristic features, e.g. the occurrence of species with a striking distributional pattern, as attempted by DOING (1958).

Besides objections against the unification of methods some critical

remarks should be made on an all too strict standardisation of symbols. We agree with the desire for the comparability of maps showing the same vegetation-complex in different parts of the world, or a country, in the same way. (A similar desire was mentioned already by BRAUN-BLANQUET, 1928). In our opinion the majority of vegetation maps cannot be readily adjusted to maps of the same kind already in existence. Therefore we plead for a considerable freedom for the investigator in his choice of colours to enable him to show on his map what he wishes to show and to do so as clearly as his means allow him.

The following survey of current vegetation mapping methods serves to illustrate the range of aims, and the difficulty of standardising these methods.

We may refer to the Proceedings of the International Symposion on Vegetation Mapping at Stolzenau (1959, issued 1963) and further to FURRER (1960), TÜXEN (1956, 1961) and, for the Netherlands, to DE VRIES and DE BOER (1949) and WESTHOFF (1954a, 1957).

A first division to be made is that between mapping of the real vegetation units and that of the so-called "potential natural vegetation". The latter method reminds the type of mapping that aims at reconstructing vegetation as it was before the impact of mankind, but it has well to be distinguished from that.

The potential natural vegetation is to be considered as the complex of plant communities in a given area that would develop if human influence would come to an end now. The factors determining this development do not consist only of the present natural conditions of the habitat, since this habitat has been changed irreversibly by anthropogenic influences in the past, which may partly continue to work after elimination of man. Examples of such factors are erosion, sedimentation, deterioration, increase of salt content, podzolisation, pollution. Therefore, a map of the potential natural vegetation may differ considerably from a map reconstructing the original vegetation. The latter procedure requires many data which cannot be obtained by field work, such as historical, archaeological and palynological processes. On the contrary, a map of the potential natural vegetation can be made via ecological and vegetational field work itself.

It may be a matter of discussion whether maps of the potential natural vegetation are vegetation maps in a strict sense. They have otherwise been defined as maps of qualities of the biosphere, "Raumqualitäten" (Schmithüsen) or as maps of the plesioclimax (Gaussen).

Although such maps can certainly serve many purposes, we do not agree with SCHMITHÜSEN (1963) that they are the best reflection of the "total ecosystem", "Gesamtfaktorenkomplex" our main objection is that one of the master factors in many ecosystems, viz. human influence, is hardly involved in this type of map.

In a region deeply influenced by man and consequently very complicated, such as Europe, a map of the potential natural vegetation may still present a useful simplification of the picture, especially on minor scales (1:100.000 to 1:5.000.000); it may be then considered as a justifiable abstraction.

Vegetation maps (in a broad sense) of a third type are those representing one or more habitat factors; here again we are dealing with maps of qualities of the biosphere. Examples are the bioclimatic maps by Gaussen and the maps of phreatic oscillation by Tüxen *et al.*

Finally a type of map representing ecosystems as a whole may be mentioned. These maps can be considered as syntheses of the previous categories. To the criteria of the legend units of such maps do belong vegetation itself as well as climatic, edaphic, historical and socio-geographical data. Among the examples we mention the vegetation maps of Belgium made by P. Duvigneaud *et al.* (Brussels) and the maps of "naturraümliche Gliederung" by SCHMITHÜSEN (1961).

Apart from this division vegetation maps can be divided into some major groups according to the character of the underlying vegetation units.

I. Maps of physiognomic units, which are not based on the floristic assemblage of vegetation but on characters such as structure and life-forms. In the case of large-scale maps the criterion for the distinction of units may be that of the dominance of single species; in the case of small-scale maps there may be a coincidence with "formation maps", applied in large parts of the world, mainly in the tropics, in the USA, Australia and the Soviet Union.

On a certain level of abstraction it may be preferable not to map the really present vegetation, but to base the legend units on the vegetation unit dominating the considered landscape type. The scale corresponding with this level depends on the rate of differentiation and complexity of the landscape. In a dune region, where vegetation consists of a mosaic of small and very different communities, this method may be useful even on the rather large scales of 1:10.000 to 1:50.000. In this way DOING (1958 and future papers) has mapped parts of the dune region of the mainland coast of the Netherlands. Another example of this method is the grassland mapping of the Netherlands by DE BOER (1956). There is some evidence to indicate such maps as cartograms.

A similar method can be used in the case of mapping the potential natural vegetation, e.g. the map of the dominating plesioclimaxes (raümlich dominierende "Schlussgesellschaften") of Southern Hungary by HORVAT (1963).

II. Maps of vegetation units based on floristic-sociological criteria, in most cases according to the Braun–Blanquet system or derivates from it. Rather small-scale maps of this category (1:25.000 to 1:250.000) mostly aim at mapping the vegetation of a whole country or a region on the base of well-defined and generally accepted syntaxonomic units (associations, and/or alliances and orders). Examples are the vegetation map of France by the centres of Montpellier (Emberger) and Marseille (R. Molinier) and those of Belgium by the centre of Gembloux (Noirfalise). In many cases mapping of the potential natural vegetation is preferred (R. Tüxen).

In the case of mapping on a large scale (1:2500 to 1:10.000) it is more desirable or even necessary to base the legend units on local

combinations of differential species, which are classified in higher units of the Braun–Blanquet system. Examples are manifold; e.g. many maps of the previous Bundesanstalt für Vegetationskartierung at Stolzenau, W. Germany and, as for the Netherlands, WESTHOFF (1957).

Finally, in some cases it is preferable to combine the criteria given under I and II. The result is a map of both physiognomical and floristic-sociological units. This may be arrived at by mapping of a large-scale mosaic of dominance communities and communities characterised by local species combinations within the Braun–Blanquet system; e.g. a map of the transitional region between the Dutch dune area poor in lime and that rich in lime near Bergen (HOFFMANN and WESTHOFF, 1951; map not published, scale 1:2500).

Another possibility is the superposition of local species combinations (classified in in the Braun–Blanquet system as far as possible) upon a physiognomic-structural division into dominant landscape types. The present publication deals with this type of map, which appears to be rather new.

This choice was made for both practical and theoretical reasons (VAN DER MAAREL, 1960, 1961a). For landscape mapping it was considered that:

1. The management of the area would be most efficient if the map was as comprehensible as possible. Therefore a basical division of the vegetation into physiognomic landscape types seemed to be most appropriate.
2. An excellent and up to date air photograph, scale 1:5000, was available. The main landscape types were easily readible from this photograph.
3. An attempt could be made to bridge a part of the gap existing between the classification system of Braun–Blanquet, mainly based on the floristic composition, and those systems, based on structure and dominance of life-forms (Rübel, Schimper). Without striving for a fusion of these two kinds of systems one should try to use as many structural-physiognomical criteria in the Braun–Blanquet system as possible (DOING, 1957, 1962). It appeared to be possible to encompass all vegetation types (see below) in structural-physiognomical units (VAN DER MAAREL, 1960), which units may be termed formations (sensu TANSLEY, 1949).

For vegetation mapping the following considerations held:

1. A considerable number of species and infra-specific taxa occur in the area, ca. 400, many of them having a rather small ecologic range.
2. Dunes in general and this area in particular (cf. part 3), contain a great number of habitats.

It follows from these facts that all kinds of species combinations, each of them reflecting a definite combination of habitat factors, can easily be distinguished. This procedure endeavours a rapid insight in the general ecology of these dunes and consequently offers a good basis for the management of the area.

5.2 Analysis

The single-plot method of analysis according to Braun–Blanquet was followed, after the area was extensively traversed and superficially surveyed. (In terms of Cain and Castro, 1959, this survey combined reconnaissance and primary survey).

The single-plot method was preferred to multiple-plot or plotless sampling, because:

1. The extremely pronounced "continuum" character of the vegetation did not allow much frequency analysis, as a result of the very small areas homogeneously occupied by most vegetation types.
2. Field work had to be carried out in only three months (August–October). It was preferred to have a great number of simple analyses in stead of a small number of detailed ones.
3. A good deal of single plot analyses was already made, in particular by the authors themselves between 1947 and 1959. Such data could of course be most effectively employed if similar data were collected during the course of the work.

In 1959 some 200 single-plot analyses were made. No attempt was made for an at random or regularised laying out of these analyses. The choice of the plots was made after the area was surveyed and the formation types have been distinguished.

The analysis was concerned with both structure and floristic composition. The structure was not all too carefully studied (though more detailed than is usual in common European sociological work). Stratification in vegetation was described by distinguishing a number of vegetation layers.

Within the scope of this paper the following remarks may be important:

a. Though actually three herb layers were distinguished in the field, only one overall herb layer is mentioned in the tables. In the key to the formations (part 5.7) however the three herb layers will be mentioned: lower herb layer comprising all herbs up to 0,3 m; middle herb layer, comprising all herbs from 0,3 up to 1,0 m and upper herb layer, comprising all herbs up from 1,0 m height.

b. Three shrub layers were distinguished: dwarf shrub layer, comprising shrubs up to 0,6 m; middle shrub layer comprising all shrubs from 0,6–3 m and upper shrub layer, comprising all shrubs from 3–8 m, as well as trees from 3–8 m.

c. A tree layer comprising all trees up from 8 m was distinguished.

Two new terms were introduced (Van der Maarel, 1960), i.e. "**shroud layer**" (sluierlaag in Dutch), a layer consisting of climbing and winding species forming a shroud on tall herbs and shrubs; and "**carpeting layer**" (tapijtlaag in Dutch), a layer consisting of creeping species, forming a carpet on and directly above the surface. —The English names were kindly suggested by Dr. M. R. Honer.— The cover and height of each layer were estimated. The floristic composition was described by means of the cover-abundance scale of Braun-Blanquet (1932, 1951). In some cases the refined scale of

DOING (1954) was applied—in this paper symbols of the latter scale have been converted to those of the former.—For most species height and data on the periodicity were noticed.

5.3 TYPIFICATION, WITH SOME REMARKS ON CLASSIFICATION

Our typification was based on the structure of the vegetation, particularly the height and cover of the dominant layer, together with the physiognomy of dominant species. 10 formations were distinguished. It should be stressed, that this distinction is provisional, but with help of more detailed structure analyses, based partly on the suggestions of DANSEREAU (e.g. 1951, 1958), a refined division of dune formations is now being prepared.

Within each formation type, vegetation types have been distinguished, the typification being based on its floristic composition. The characteristic species combination, the "specific assemblage", of these types were determined with help of the already mentioned single-plot analyses. In addition some analyses by DIEMONT, SISSINGH and WESTHOFF (1940), MELTZER (1941) and the authors from 1960 and 1961 were used afterwards.

These analyses were grouped into provisional tables. It appeared that the data of a number of vegetation types were insufficiently representative and therefore no attempt is made to present such tabular documentation in this paper, as is usual in phytosociology, each vegetation type being represented by several analyses. To illustrate the composition of a vegetation type, only one analysis will be presented, this being taken as characteristic in relation to that vegetation type. Until more complete descriptions are available, the underlying typification must be considered as somewhat provisional.

The following categories of indicator species ("characteristic species") will be used:

1. **opulent species** (MAAS and WESTHOFF in DOING, 1956 and MAAS, 1960), being species with a locally optimal development in a certain vegetation type, but with insufficient fidelity. For the criteria of fidelity, constancy, etc. we refer to BRAUN-BLANQUET (1932, 1951), WESTHOFF (1951) and CAIN and CASTRO (1959). Within the scope of this work no attempt could be made to find an objective basis for all these criteria or to subject the data to significance tests. The opulence concept tends to replace the fidelity concept, according to our increasing knowledge of the ecology of species.

2. **faithful species,** being species that occur in analyses of one vegetation type only.

3. **dominant species,** covering more than 50 % of the surface within a vegetation type. If a species was not dominant in all stands of the type, the term locally is added.

4. **constant species,** being present in most of the analyses of a vegetation type.

5. **differential species,** being present in one group of analyses

and absent in another group, each group referring to one vegetation type; to distinguish are positive and negative differential species, being present and absent respectively in the analyses under consideration.

If a species belonging to one of the mentioned categories is conspicuous in the aspect of a vegetation type, the term **aspectional** is added.

A vegetation type is called a community (gezelschap in Dutch), the latter term being understood in the common Anglo-American sense of the word (cf. CAIN and CASTRO, 1959). WESTHOFF *et al.* (1959) proposed the term **cenon** as an international equivalent, a cenon being "a given abstract vegetation unit whose nature is not indicated". According to VAN DER MAAREL (1960), the term may be split up into **phytocenon** and **biocenon,** referring to a vegetation type and a biotic community type respectively.

In some cases it was not possible to consider a vegetation type as a community, because of the extremely small area occupied by it. Such a concrete phytocenosis is termed simply vegetation.

Within many communities minor differences in floristic composition were observed. These differences were mainly due to the presence or absence of species, sometimes to a difference in abundance or dominance of a species. These minor vegetation types are called variant (vorm in Dutch).

Although the number of distinguished vegetation types is rather high, it was by no means possible to typify the whole vegetation on that basis. As already mentioned, the vegetation was recognised as a continuum. According to CURTIS *et al.* (see CURTIS, 1959) and GOODALL (1954b) a vegetational continuum should be treated as a multidimensional "species-space", within which the distribution of all contributing species is plotted. Clusters appearing in this species-space may be considered to represent vegetation types. Principally the underlying vegetation types correspond with such clusters, although the typification was not fully objective and no attempts were made to test the delineation of the types statistically.

The distinguished vegetation types were arranged in a (two-dimensional) ordinative system (VAN DER MAAREL, 1960), as did CURTIS *et al.* (e.g. CURTIS, 1959) and has been emphasised in Europe especially by GAMS (1961).

All vegetations which could not be considered to belong to one of the vegetation types distinguished, were arranged between those two vegetation types which they most closely resembled. In the survey of types (part 5.5) most of these transitions are mentioned.

In many cases a series of transitional forms between two vegetation types was found. Such series were termed **cline,** thus applying the original idiotaxonomic principle of HUXLEY (1940) in vegetation study. This application was suggested for the first time by WESTHOFF (1947), who gave a definition of a vegetational cline as follows (1954b): "a gradual transition in space of one vegetation type to another". In accordance with common sociological nomenclature VAN DER MAAREL

(1960) used the term **syncline** for biosociological transitional series and distinguished **toposyncline** sensu WESTHOFF (1947), **ecosyncline** sensu MEYER DREES (1951) and **chronosyncline** as being gradations in the floristic compositions of vegetation types along geographical, ecological and successional gradients respectively. Where no misunderstanding is possible, the terms **topocline, ecocline** and **chronocline** will be used.

As far as the classification system of Braun–Blanquet is concerned, we remark that in this stage of the investigation it is not possible to classify all distinguished vegetation types, and the question as to whether it is prefarable to do so will not be dealt with. In any case, the main value of the Braun–Blanquet system is that it enables the comparison of vegetations from different regions with respect to their floristic, ecological and geographical differences. For the sake of this advantage we add, if possible, to the description of each vegetation type the appropriate unit of the Braun–Blanquet system (alliance, association, subassociation etc.). In each case we present only one of the synonyms under which that unit may have described; either the oldest or the most common name will be used. We do not enter here into syntaxonomical and nomenclatural discussions.

The vegetation types are named as follows: communities are named after two opulent or dominant species, which are simultaneously conspicuous. In those cases with obvious identity with a Braun–Blanquet association, the names of the two plant species naming the association are used. Variants are indicated with one conspicuous differential species. Thus there is some analogy between the relation community—variant and that of association—subassociation.

5.4 COMPOSITION OF THE MAP

The vegetation map was drawn in on a base map of the area, showing the main paths and contours (two meter intervals). This map had to be composed from a rough map of paths which was already in use by the owner, and from a series of contour maps composed by the Survey Department of the Ministry of Works (Meetkundige Dienst Rijkswaterstaat), all with a scale 1:2500, so that it was practical to give the vegetation map the same scale. Consequently the areas on the already mentioned air photograph, corresponding with physiognomic homogeneous areas, had to be magnified twice before they could be drawn in on the base map.

One of the advantages of this rather accurate scale was the possibility of drawing in small landscape elements such as isolated trees (esp. *Pinus*, *Crataegus*) patches of scrubbery (esp. *Sambucus*, *Crataegus*), and ponds. Also very small patches of certain communities could be drawn in, which would not have been possible otherwise. With help of paths, contour lines and landscape elements, the final boundaries of communities and variants could be drawn in.

Each vegetation type is indicated by a symbol, mainly consisting of the first letter of the generic name of one of two species after which

that type was named. The manifold transitions are indicated by the symbols of the two vegetation types between which they occur, separated by a dash, and by coloured vertical lines. Horizontal lines on the map indicate an ecological relationship with the vegetation type(s) having the basic colour that was given to these lines. In this way the map shows, by means of the vertical and horizontal lines, the main ecoclines and chronoclines.

5.5 Notes on nomenclature

1. For vascular plants we have in general followed the nomenclature of Heukels–Van Ooststroom (1962, recent edition). It appeared that this nomenclature fairly agrees with that of Clapham, Tutin and Warburg (1962, 2nd edition). Exceptions will be mentioned under 4. For mosses we have followed the nomenclature of Margadant (1960), which is almost equal to that of the Index Muscorum by Van der Wijk, Margadant and Florschütz (the Index has not yet been completed). For authorities of these taxa we refer to these publications.

2. The names of the mentioned lichens were kindly suggested by E. Hennipman (Rijksherbarium, Leyden) and are as follows:
Cladonia furcata (Huds.) Schrad.
C. foliacea (Huds.) Schaer var. alcicornis (Lightf.) Wain
C. pyxidata (L.) Fr. var. chlorophaea Flk.
C. rangiformis Hoffm.

3. The following names of vascular plants given by Heukels–Van Ooststroom may be not widely known:
Anthriscus caucalis = *A. vulgaris* Pers.
Carex nigra = *C. fusca* auct.
Dryopteris austriaca = *D. dilatata* (Hoffm.) A. Gray
Elytrigia juncea = *Agropyron junceum* P.B.
E. pungens = *A. pungens* (Pers.) Roem et Schult.
Festuca juncifolia = *F. rubra* ssp. dumetorum Hack.
F. tenuifolia = *F. ovina* var. capillata Hack.
Helictotrichon pubescens = *Avena pubescens* Huds.
Myosotis ramosissima = *M. hispida* Schldl.
Scirpus planifolius = *Blysmus compressus* (L.) Panx ex Link.

4. The following taxa were not recognised as a species by Heukels–Van Ooststroom:
Dactylorchis fuchsii (Druce) Vermeulen
Eleocharis uniglumis (Link) Schult
Plantago intermedia Gil.

5. The following infraspecific taxa are involved in this study. Those taxon names mentioned by Heukels–Van Ooststroom are given without authorities. Except with Festuca rubra and Juncus articulatus the names of the infraspecific taxa are not mentioned in our text

and tables, since no other taxon within the species is involved in this study:

Arenaria serpyllifolia ssp. serpyllifolia
Asparagus officinalis L. ssp. officinalis
Blackstonia perfoliata ssp. serotina
Bromus mollis var. nanus (Weig) A et G
Carex distans var. vikingensis
C. serotina ssp. pulchella
Chenopodium rubrum var. patulum fo. patulum (Merat) Aellen
Cerastium holosteoides ssp. trivialis
Dactylorchis fuchsii (Druce) Vermeulen ssp. fuchsii
Erodium cicutarium ssp. dunense
Festuca rubra L. ssp. rubra
Festuca rubra L. subvar. arenaria Osb.
Galium mollugo ssp. mollugo
G. verum var. maritimum G. Mey
Gentiana amarella ssp. uliginosa
G. campestris ssp. baltica
Hippophae rhamnoides ssp. maritimus Van Soest
Hypnum cupressiforme var. lacunosum
Hypochaeris radicata ssp. radicata
Juncus articulatus var. littoralis Buch.
J. articulatus var. littoralis fo. pygmaeus Westhoff
J. bufonius ssp. ambiguus (Gussone) Schinz et Thell.
Leontodon nudicaulis ssp. taraxacoides (Vill.) Schinz et Thell.
Lotus corniculatus ssp. corniculatus var. ciliatus Koch
Plantago lanceolata var. sphaerostachya W. et G.
Poa pratensis var. humilis (Ehrh.) Gris.
Polygala vulgaris var. dunensis (Dum) Buchen.
Pyrola rotundifolia ssp. maritima (Kenyon) E. F. Warb.
Ranunculus bulbosus L ssp. bulbosus.
Sagina nodosa var. moniliformis
Salix repens ssp. argentea (Sm) G et A Camus
Scirpus maritimus fo. compactus (Hoffm.) Junge
Sonchus arvensis var. maritimus G. Mey
Stellaria media ssp. pallida
Viola hirta L. ssp. hirta
V. tricolor ssp. curtisii

6. The following complex species have not yet been studied in detail thoroughly enough in the area; their names must be considered to indicate an aggregate:

Euphrasia officinalis
Polypodium vulgare
Rumex acetosella
Tortula ruralis

7. The following higher units of the Braun-Blanquet system of

plant associations are mentioned in our study (authority names and year of publication are added; publications are mentioned in the references; for abbreviations see part 5.6)

Agropyro-Rumicion crispi Nordhagen 1940 em. Tüxen 1950 (see also Van Leeuwen 1958)
Alno-Padion Knapp 1942, em. Matuszkiewicz et Borowik 1957
Alno-Salicion cinereae Doing 1962
Alno-Ulmion Oberdorfer 1953
Arctio-Sambucion Doing 1962
Armerion maritimae Br. Bl. et De Leeuw 1936
Berberidion vulgaris Br. Bl. 1950
Bromion erecti Br. Bl. 1936
Calthion palustris Tx 1937
Caricetalia fuscae Koch 1926
Caricion davallianae Klika 1934
Corynephoretea canescentis Br. Bl. et Tx 1943 em. Tx 1962
Epilobietea angustifolii Preising et Tx. 1950
Koelerion albescentis (Br. Bl. 1936) Weevers 1940
Littorellion uniflorae Koch 1926
Loto-Trifolion Westhoff, Van Leeuwen et Adriani 1962
Molinietalia coeruleae Koch 1926
Nardo-Galion saxatile Preising 1950
Oenothero-Hippophaeion Doing 1962
Sambuco-Berberidion Van Leeuwen et Doing 1959
Thero-Airion Tx et Preising 1951
Trifolio-Geranietea Th. Müller 1961

5.6 Abbreviations

1. Referring to part 5.3:

All. = alliance of the Braun–Blanquet system
Asp. = aspectional species
Ass. = association of the Braun–Blanquet system
Char. = characteristic species
Comm. = community
Const. = constant species
Dom. = dominant species
Faithf. = faithful species
Loc. dom. = locally dominant species
Neg. diff. = negative differential species
Opt. = opulent species
Pos. diff. = positive differential species
Var. = variant

2. Referring to part 5.7:

Ex. = example of single plot analysis
Occ. = occurrence in the area investigated
Sq. = square on the vegetation map

Succ. = successional transitions
Syst. = systematical position, i.e. presumed place in the Braun–Blanquet system
T. = table of analyses
Trans. = other transitions

3. Referring to authority names of units of the Braun–Blanquet system and of single plot analyses mentioned in part 5.7 and in the tables:

Br. Bl. = J. Braun–Blanquet
D. S. et W. = W. H. Diemont, G. Sissingh et V. Westhoff
EM = E. van der Maarel
JM = J. Meltzer
Tx = R. Tüxen
VW = V. Westhoff

5.7 Survey of formations and vegetation types

A key to the formations and a scheme of the relationships between the types

This survey is chiefly intended to elucidate the legend of the vegetation map. It presents short descriptions of the distinguished plant communities and variants. A key to the formations introduces these descriptions. The sequence of the formations is defined by the complexity of their structure and by the influence of the free water table: from simple to complex and from xerosere to hydrosere formations.

In addition to the community descriptions some remarks on not-drawn vegetation types will be given.

Key to the formations (and some communities):

A. Vegetation not including shrubs . . . . . B
AA. Vegetation including shrubs . . . . . M
B. Herb layers covering < 70 % C
BB. Herb layers covering > 70 %, often including a carpeting layer; if cover < 70 %, moss layer > 90 % . . . . . E
C. Dry bright yellow sand conspicious in the physiognomy (vegetations from dune ridges) . . . . . D
CC. Moist, grey-yellow sand conspicious (vegetations from slacks) . . . . . formation II (Comm. 3, 4)
D. Middle herb layer prominent, mosses absent, Ammophila arenaria dominant . . . . . formation I (Comm. 1) [1])
DD. Lower herb layer prominent, mosses covering < 70 % (rarely — 100 %), Tortula ruralis locally dominant . . . . . formation I (Comm. 2) [1])
E. Vegetations from dry or moist dunes . . . . . F

[1]) The delimitation of formations I en III appeared not satisfactory afterwards.

EE. Vegetations from dune slacks . . . . . K
F. Middle herb layer prominent, moss layer covering < 30 % G
FF. Carpeting layer (lower herb layer) prominent, moss layer covering > 30 % . . . . . H
G. Calamagrostis epigeios and Carex arenaria conspicious in the physiognomy, lower herb layer covering < 30 % . . . . . formation III (Comm. 5)
GG. Festuca rubra ssp. rubra and Holcus lanatus conspicious, lower herb layer covering > 30 % . . . . . formation III (Comm. 6)
H. Lower herb layer (carpeting layer!) covering < 70 %, moss layer > 90 % . . . . . formation IV (Comm. 7)
HH. Lower herb layer (carpeting layer!) covering > 70 %, moss layer < 90 % . . . . . formation IV (Comm. 8)
K. Lower and middle herb layer prominent L
KK. Upper herb layer prominent, Phragmites communis or Scirpus maritimus conspicious in the physiognomy . . . . . formation VI (Comm. 13–15)
L. Lower herb layer prominent, Glaux maritima and Samolus valerandi conspicious . . . . formation V (Comm. 9–11)
LL. Middle herb layer prominent, Carex nigra and trinervis prominent . . . . . formation V (Comm. 12)
M. Vegetation < 3 m high . . . . . N
MM. Vegetation > 3 m high . . . . . Q
N. Vegetation < 0,6 m high . . . . . O
NN. Vegetation > 0,6 m high . . . . . formation VIII (Comm. 22–25)
O. Salix repens prominent . formation VII (Comm. 16–18)
OO. Salix repens present, not prominent . . . . . P
P. Middle herb layer prominent . . . . . formation VII (Comm. 19, 20)
PP. Carpeting layer prominent formation VII (Comm. 21)
Q. Tall shrub vegetations . . formation IX (Comm. 26–28)
QQ. Woodland vegetations . formation X (Comm. 29–31)

SURVEY OF VEGETATION TYPES

I. YELLOW DUNE OPEN HERB FORMATION (bright yellow)

1. *Comm. of Elymus arenarius and Ammophila arenaria* (*A*)

Char. *Ammophila arenaria* (const. asp.), *Ammocalamagrostis baltica* (const.), *Elymus arenarius* (faithf., asp.).

1-a. *Var. with Elytrigia juncea* (*EA*)

Pos. diff. towards Var. 1b: *Elytrigia juncea* (const.), *Ammophila arenaria* (dom.).

Ex. EM 59.121 (t. I).

Occ. On the seaward slope of the coastal ridge of 1959.

Syst. Subass. *Elymeto-Ammophiletum typicum* Tx 1937.

Succ. Part of a chronocline, starting with Comm. of *Elytrigia juncea* (= Ass. *Agropyretum boreo-atlanticum* Br. Bl. et De Leeuw 1936) as a previous stage. The latter community occurs sporidically on low fore dunes and has not been drawn in on the map. Var. 1a is succeeded by Var. 1b, with which it is connected by a chronocline.

1–b. *Var. with Festuca juncifolia (FA)*

Char. *Ammophila arenaria* (const.).

Pos. diff. towards Var. 1–a: *Festuca juncifolia* (const., asp.), *Sonchus arvensis* (const.), *Erigeron canadensis.*

Ex. EM 59.123 (t. I).

Occ. Top and landward slope of the coastal ridge of 1959 and, less common, the coastal ridge of 1910 (mostly in transitions to Comm. 2).

Syst. Subass. *Elymeto-Ammophiletum festucetosum rubrae dumetorum* Tx 1937

Succ. Mostly to Comm. 23–a, ex. EM 59.124 (t. VII).

Trans. To Comm. 2–a, ex. EM 59.011 (t. I), char. *Cynoglossum officinale*; to Comm. 5–a.

2. *Comm. of Tortula ruralis and Phleum arenarium (T)*

Char. *Tortula ruralis* (asp., loc. dom.), *Phleum arenarium* (const.), *Erodium cicutarium et glutinosum* (const.), *Cerastium semidecandrum* (faithf.), *Sedum acre* (loc. asp.), *Festuca rubra subvar. arenaria* (const.).

2–a. *Var. with Erodium glutinosum (T)*

Char. *Saxifraga tridactylites* (opt.), *Erodium glutinosum (asp.)*, *Erodium cicutarium* (asp.)

Pos. diff. towards var. 2–b: *Cynoglossum officinale, Senecio jacobaea.*

Ex. EM 59.020 (t. II).

Occ. Yellow dunes behind the coastal ridge of 1959, especially on the coastal ridge of 1926, and behind the coastal ridge of 1910 (stripe dune region, sq. B, C–6).

Syst. Ass. *Tortuleto-Phleetum arenariae* Br. Bl. et De Leeuw 1936.

Succ. To Comm. 7–a (chronocline), char. *Brachythecium albicans;* ex VW 57.186 (t. II).

Trans. To Comm. 5–a, char. *Cynoglossum officinale*; to Comm. 5–b, char. *Cynoglossum officinale*, ex. EM 59.143 (t. I); to Comm. 24–b, char. *Cynoglossum officinale*, ex. EM 59.158 (t. VII).

2–b. *Var. with Corynephorus canescens* (C) (green dots on bright yellow)

Char. *Corynephorus canescens* (const., asp.)

Pos. diff. towards Var. 2–a: *Cladonia furcata, Rhacomitrium canescens.*

Ex. EM 60.048..

Occ. Rare in the older dunes (sq. D, F–2). From 1961 onwards an increase of Corynephorus has also been noticed in the younger dunes.

Syst. Ass. *Violeto-Corynephoretum dunense* WESTHOFF 1943.

II. DUNE SLACK PIONEER FORMATION (dark yellow)

3. Comm. of *Centaurium littorale* and *Sagina nodosa (CS)*

Char. *Centaurium littorale* (const., asp.), *Sagina nodosa* (const.), *Blackstonia perfoliata* (const.), *Gnaphalium luteo-album* (faithf.), *Plantago coronopus* (const.).

3–a. *Var. with Leontodon nudicaulis* (TS)

Pos. diff. towards Var. 3–b: *Leontodon nudicaulis* (const.), *Sonchus arvensis* (const.), *Carex arenaria, Festuca rubra subvar. arenaria, Cirsium arvense.*

Ex EM 59.004 (t. III).

Occ. Drier borders of the narrow young dune slacks (sq. C, D, E–6).

Syst. Subass. *Centaurieto-Saginetum* D. S. et W. 1940 thrincietosum WESTHOFF 1947.

Succ. To Comm. 16, char. *Carex serotina*, ex EM 59.014 (t. V).

Trans. To Comm. 2–a, ex. EM 59.069 (t. III); to Comm. 3–b (ecocline), ex. EM 59.013 (t. III).

3–b. *Var. with Samolus valerandi* (SS)

Pos. diff. towards Var. 3–a: *Samolus valerandi* (const., loc. dom.), *Centaurium pulchellum* (const.), *Glaux maritima* (const.), *Potentilla anserina* (const.), *Agrostis stolonifera* (const., loc. dom.).

Ex. EM 60.068 (t. III).

Occ. Wetter parts of the slacks, mentioned under 3–a.

Syst. Subass. *Centaurieto-Saginetum samoletosum* D, S et W 1940.

Succ. To Comm. 9–a (chronocline), ex. EM 59.006 (t. III).

Trans. To Comm. 4; to Comm. 11.

4. *Comm. of Juncus bufonius and Chenopodium rubrum* (JC)

Char. *Juncus bufonius* (const., asp.), *Chenopodium rubrum* (const.), *Agrostis stolonifera* (const.).

Ex. EM 59.017 (t. IV).

Occ. Rare, in lowest spots in the outer dune slacks, drying up only in summer.

Syst. Resembling the sociation of *Chenopodium rubrum* WESTHOFF 1947.

Succ. Probably to Comm. 11.

III. TALL DUNE GRASSLAND FORMATION (light green)

5. *Comm. of Festuca rubra subvar. arenaria and Carex arenaria* (FC)

Char. *Festuca rubra subvar. arenaria* (loc. dom., const.) *Carex arenaria* (const., loc. dom.), *Calamagrostis epigeios* (const.).

5–a. *Var. with Ammophila arenaria* (AC).

Pos. diff. towards Var. 5b, 5c: *Ammophila arenaria, Ammocalamagrostis baltica, Sonchus arvensis.*

Ex. EM 59.113 (t. I).

Occ. On stripe dunes and bunkers in the open area behind the coastal ridge of 1910, mainly forming mosaics with open *Hippophae rhamnoides* scrub (Comm. 24–a).

Syst. *Koelerion albescentis*? Some resemblance with the sociation of *Festuca rubra subvar. arenaria* (BOERBOOM 1960) is evident, although there are structural differences.

Succ. To Comm. 24–a.

5–b. *Var. with Calamagrostis epigeios* (CC).

Char. *Calamagrostis epigeios* (loc. dom.), *Carex arenaria* (const., loc. dom.).

Ex. —

Occ. Stabilised parts of the stripe dunes behind the coastal ridge of 1910; open spots in the Van Iterson–Bos; on bunkers.

Syst. All. *Koelerion albescentis*? The number of species from this all. shows considerable variation, so the comm. does not fit into this all. very well.

Succ. To Comm. 24–c.

Trans. To Comm. 8–d.

5–c. *Var. with Inula conyza* (IC).

Pos. diff. towards Var. 5–a, 5–b: *Inula conyza, Fragaria vesca, Pseudoscleropodium purum.*

Ex. EM 59.131 (t. I).

Occ. Rare on eastern and northern slopes and moist dunes within the influence of the free water table.

Syst. Since the Comm. forms mosaics with Comm. 24–e almost everywhere, it is difficult to classify it in the Braun–Blanquet system. Species of the all. *Berberidion vulgaris*: *Inula conyza*, *Asparagus officinalis*, *Rubus caesius*, are present, as well as species of the all. *Bromion erecti*: *Carlina vulgaris*, *Carduus nutans*. In addition moisture indicators occur: *Prunella vulgaris*, *Fragaria vesca*, *Pyrola rotundifolia*. There is some resemblance to the class *Trifolio-Geranietea*.

Succ. To Comm. 25–b (chronocline), ex. EM 59.136 (t. VIII).

Trans. To Comm. 21–a.

— A fourth variant, with *Polypodium vulgare*, occurs on steep northern slopes, mixed with *Hippophae* scrub of Comm. 23–d. It has been provisionally described, but not drawn in, mainly because of too small areas of occurrence.

6. *Comm. of Holcus lanatus and Festuca rubra ssp. rubra* (HF).

Char. *Holcus lanatus* (const., asp.), *Festuca rubra* ssp. rubra (const.), *Centaurea pratensis* (const.), *Rumex acetosa* (const.), *Lythrum salicaria*, *Cerastium holosteoides*, *Trifolium pratense*.

Ex. EM 61.363 (t. II).

Occ. Moist places in the inner dunes (Heveringen).

Trans. To Comm. 21–a; to Comm. 8–c, ex. EM 60.042 (t. II); to Comm. 20.

IV. LOW DUNE GRASSLAND FORMATION (medium green)

7. *Comm. of Hypnum cupressiforme and Erodium glutinosum et cicutarium* (*HE*)

Char. *Hypnum cupressiforme* (dom.), most species of Comm. 2 (const.), *Myosotis ramosissima* (const.), many species of Comm. 8, especially *Galium verum* (const.), *Hieracium pilosella* (const., loc. dom.), *Plantago lanceolata* (const.), *Cladonia rangiformis*, *Polytrichum juniperinum*.

7–a. *Var. with Cerastium arvense* (HC)

Pos. diff. towards var. 7–b: *Cerastium arvense* and other species of Comm. 8–a and 8–c; *Saxifraga tridactylites* (const.), *Bromus mollis*, *Erodium glutinosum et cicutarium* (loc. asp.), *Veronica arvensis*, *Taraxacum rubicundum*, *Bromus hordeaceus*.

Ex. EM 61.003 (t. II).

Occ. Mainly in the Heveringen dunes and inner parts of zone B, on stabilised, slightly basic soils.

Syst. All. *Koelerion albescentis*, intermediate between *Erodio-Koelerion* and *Luzulo-Koelerion* BOERBOOM 1960. The systematical position of Comm. 7–a and b, and Comm. 8–a, b, c, and d has not yet been clarified. The first author is preparing a paper on the classification

of these vegetations, in which an attempt will be made to combine floristic and structural criteria.

Succ. To Comm. 8–a (chronocline).

Trans. To Comm. 7–b (ecocline).

7–b. *Var. with Corynephorus canescens* (CE)

Char. *Cladonia foliacea var. alcicornis* (loc. dom.)

Pos. diff. towards var. 7–a: *Cladonia pyxidata, Corynephorus canescens* (const., loc. dom.), *Aira praecox, Polytrichum juniperinum.*

Ex. VW 57.197 (t. II).

Occ. Heveringen dunes, on dry decalcified stabilised sand.

Syst. Class *Corynephoretea*?

Succ. To Comm. 8–b (chronocline).

8. *Comm. of Festuca tenuifolia and Galium verum* (FG)

Char. *Festuca tenuifolia* (const., loc. dom.), *Galium verum* (const.), *Lotus corniculatus var. ciliatus* (const.), *Plantago lanceolata* (const.), *Leontodon nudicaulis, Hypochaeris radicata, Luzula campestris, Hypnum cupressiforme, Erigeron acer, Agrostis tenuis* (const.), *Cladonia rangiformis.*

8–a. *Var. with Thymus pulegioides* (*TG*)

Char. *Hypnum cupressiforme* (loc. dom.).

Pos. diff. towards other variants: *Taraxacum rubicundum, Potentilla tabernaemontani.*

Pos. diff. Var. 8–a and 8–d towards var. 8–b and 8–c: *Thymus pulegioides* (opt.), *Cerastium arvense.*

Ex. VW 57.304 (t. II).

Occ. Heveringen dunes and older parts of zone B, on dry, warm and slightly acid soils.

Syst. Elements of all. *Bromion erecti* and *Koelerion* albescentis are present.

Succ. Probably to tall dune grassland with *Carex arenaria* and/or *Calamagrostis epigeios* (which is certainly not identical with Comm. 5–b).

Trans. To Var. 8–b; to Var. 8–d (ecoclines).

8–b. *Var. with Aira praecox* (*AG*)

Char. *Festuca tenuifolia* (asp.)

Pos. diff. towards other variants: *Aira praecox* (const.), *Cladonia gracilis, Polytrichum juniperinum, Polytrichum piliferum.*

Ex. EM 61.365 (t. II).

Occ. Heveringen dunes, on dry acidic soils.

Syst. All. *Thero-Airion.*

Succ. ?

Trans. See Comm. 7–b and 8–a.

8–c. *Var. with Gentiana campestris* (GG)

Pos. diff. towards other variants: *Gentiana campestris, Sieglingia decumbens* (const.), *Rhytidiadelphus squarrosus, Anthoxanthum odoratum, Briza media, Euphrasia officinalis.*

Ex. EM 53.076 (t. II).

Occ. Transitional zones between dune slopes and hollows, in the Heveringen dunes.

Syst. Transitional position between all. *Koelerion albescentis* and *Nardo-Galion saxatile.*

Succ. ?

Trans. To Comm. 6, ex. EM 60.042 (t. II)

8–d. *Var. with Achillea millefolium* (MG)

Pos. diff. towards other variants: *Achillea millefolium* (opt.), *Helictotrichon pubescens* (const.), *Trifolium campestre, Cerastium arvense* (opt.).

Ex. VW 57.189 (t. II).

Occ. Borders of *Crataegus* scrub in the Heveringen dunes and older parts of zone B.

Syst. There is some resemblance to class *Trifolio-Geranietea.*

— Within the area of Comm. 8 a small patch of *Calluna vulgaris* occurs. The population is probably introduced. Some more populations of *Calluna* occur in the innermost parts of the Heveringen dunes; they may be considered as the very beginning of an acid-dune heath.—

V. Low dune marsh formation (light brown)

9. *Comm. of Glaux maritima and Samolus valerandi* (G)

Char. *Glaux maritima* (const., opt.), *Samolus valerandi* (const.), *Potentilla anserina* (const.), *Juncus articulatus*; cf. diff. of Comm. 3–b towards 3–a.

Pos. diff. towards Comm. 3–b: *Juncus gerardi* (const.), *Mentha aquatica* (const.).

Neg. diff. towards Comm. 3: *Carex serotina, Sagina nodosa, Gnaphalium luteo-album.*

9–a. *Var. with Samolus valerandi* (GS)

Pos. doff. towards Var. 9–b: *Samolus valerandi* (opt., loc. dom.).

Neg. diff. towards Comm. 3: *Centaurium littorale.*

Ex. EM 58.048 (t. III).

Occ. Some low spots in the outer slacks, especially Vliegveld (sq. G–4).

Syst. ?

Succ. To Comm. 10–a (chronocline from Comm. 3–b); to Comm. 13.

Trans. To Comm. 9–b.

9–b. *Var. with Trifolium fragiferum* (GT)

Pos. diff. towards Var. 9–a: *Trifolium fragiferum* (const., loc. dom.), *Trifolium repens* (loc. dom.), *Agrostis stolonifera* (dom.), *Centaurium littorale*, *Centaurium pulchellum* (loc. dom.).

Ex. EM 59.052 (t. III).

Occ. Western part of the Vliegveld, especially around a drinking water ditch for cattle.

Syst. There is some affinity to all. *Loto-Trifolion* and to ass. *Centaurieto-Saginetum* D S et W 1940 (the latter affinity not being present with Comm. 9–a).

Succ. Probably to Comm. 10–a.

Trans. To Comm. 10–a; to Comm. 14.

10. *Comm. of Glaux maritima and Juncus gerardi* (GJ)

Char. *Glaux maritima* (const.), *Potentilla anserina* (const.) *Juncus gerardi* (dom.)

Char. of formations V and VI: *Agrostis stolonifera* (dom.), *Mentha aquatica* (const.).

Neg. diff. towards Comm. 9: *Samolus valerandi*, *Juncus articulatus fo. pygmaeus.*

10–a. *Var. with Mentha aquatica* (MJ)

Char. *Mentha aquatica* (dom.).

Neg. diff. towards Comm. 9: *Trifolium fragiferum*, *Centaurium pulchellum.*

Ex. EM 53.095 (t. III).

Occ. Some spots in the Biezenvallei, a slack complex (sq. F–5).

Syst. A mixture of species of all. *Armerion maritimae* and *Agropyro-Rumicion crispi.* Probably a desalination stage of a former *Armerion* comm.

Succ. Probably to Comm. 13.

Trans. To Comm. 12; to Comm. 13; to Comm. 19.

10–b. *Var. with Carex extensa*

This variant was distinguished later; it does not occur in the area investigated.

11. *Comm. of Samolus valerandi and Eleocharis palustris* (SE) (dark brown dots on light brown)

Char. *Eleocharis palustris* (dom.), *Samolus valerandi* (const.).

Char. of formations V and VI: *Agrostis stolonifera* (const., loc. dom.), *Mentha aquatica* (const.), *Hydrocotyle vulgaris* (const.), *Myosotis caespitosa*, *Ranunculus flammula.*

Ex. EM 59.007 (t. IV).

Occ. Lowest spots in the Vliegveld, some ponds in outer valleys.

Syst. Related to ass. *Samoleto-Littorelletum*, all. *Littorellion uniflorae*, described by WESTHOFF 1947 from the Westfrisian islands; we have recently found a similar comm. in Ireland, near Mullagh More, Co. Clare.

Succ. To Comm. 14, ex. EM 59.086 (t. IV); to Comm. 13.

Trans. To Comm. 12.

12. *Comm. of Carex trinervis and Ranunculus flammula* (CR) (dark brown lines on light brown)

Char. *Carex trinervis*, *Carex nigra* and *Carex trinervis x nigra* (dom.), *Eleocharis palustris* (const.).

Char. of formations V and VI: *Agrostis stolonifera* (dom.), *Mentha aquatica* (const.), *Juncus articulatus* (opt.), *Myosotis caespitosa* (const.).

Char. of Comm. 12 and 14: *Phragmites communis* (const.), *Epilobium parviflorum.*

Pos. diff. towards Comm. 11: *Carex trinervis* and *nigra*, *Trifolium fragiferum*, *Calliergonella cuspidata* (const., loc. dom.).

Ex. EM 59.094 (t. IV).

Occ. Parts of the Vliegveld (sq. G–4).

Syst. A resemblance to ass. *Caricetum trinervis-fuscae* as described by WESTHOFF 1947 from the Westfrisian islands, is obvious. The present comm. differs from the latter in the absence of mesotraphentic species such as *Comarum palustre* and the presence of species of all. *Agropyro-Rumicion crispi.*

Succ. To Comm. 14, ex. EM 59.100 (t. IV); to Comm. 17?

Trans. To Comm. 14 and 15 (ecoclinecomplex), ex. EM 58.037 (t. IV).

VI. TALL DUNE MARSH FORMATION (dark brown)

13. *Comm. of Mentha aquatica* and *Scirpus maritimus* (MS) (black lines on dark brown)

Char. *Scirpus maritimus* (dom., 1–1,5 m height), *Mentha aquatica* (dom., 0,5 m height), *Drepanocladus cf. aduncus* (loc. dom.), *Galium palustre.*

Char. of formations V and VI: *Agrostis stolonifera* (const., loc. dom.), *Hydrocotyle vulgaris* (const., loc. dom., 0,2 m height), *Juncus articulatus* (const.), *Ranunculus flammula* (const.), *Calliergonella cuspidata* (loc. dom.), *Myosotis caespitosa, Eleocharis palustris.*

Pos. diff. towards Comm. 14: *Pulicaria dysenterica, Juncus gerardi.*

Ex. EM 59.030 (t. IV).

Occ. Small slacks between coastal ridges of 1959 and 1926, "Biezenvallei", ponds in outer valleys.

Syst. Some affinity to the sociation of *Scirpus maritimus* BEEFTINK 1963 is obvious. A mixture of *Armerion maritimae, Agropyro-Rumicion crispi* and *Caricetalia fuscae.*

Succ. Probably scrub with *Salix repens* and *Salix cinerea* (cf. Comm. 23).

Trans. To Comm. 14; to Comm. 16; to Comm. 22–b; to Comm. 23.

14. *Comm. of Epilobium parviflorum and Phragmites communis* (PP)

Char. *Phragmites communis* (dom., 1–15 m height).

Char. of Comm. 12 and 14: *Epilobium parviflorum, Carex nigra.*

Char. of formations V and VI: *Agrostis stolonifera* (dom., 0,2–0,4 m height), *Juncus articulatus* (const.), *Ranunculus flammula* (const.), *Eleocharis palustris.*

Pos. diff. towards Comm. 13: *Epilobium palustre, Cardamine pratensis, Caltha palustris* (opt.).

Ex. EM 59.054 (t. IV).

Occ. Great parts of the Vliegveld and the adjacent outer valleys (sq. D, E–5,6).

Syst. *Phragmites communis* facies of Comm. 12.

Succ. Probably scrub of *Salix repens* and *Salix cinerea* (probably identical with Comm. 31).

Trans. To Comm. 15, ex. EM 58.037 (t. IV): to Comm. 17; to Comm. 22–b.

15. *Comm. of Eupatorium cannabinum and Phragmites communis* (EP) (orange lines on dark brown)

Char. *Phragmites communis* (const.), *Eupatorium cannabinum* (const., loc.

dom.), *Calamagrostis epigeios* (loc. dom.), many diff. species of Comm. 25–c, e.g. *Cirsium palustre* and *Lythrum salicaria.*

Ex. —

Occ. Open spots in scrub in the dune valleys (e.g. sq. B–2).

Syst. A natural counterpart of the wet scrub clearance ass. of *Eupatorium cannabinum*, class *Epilobietea angustifolii.*

Succ., trans. To Comm. 25–c, with which it is intermixed, ex. EM 59.197 (t. VIII).

VII. DAMP HERB AND DWARF SHRUB FORMATION (light blue)

16. *Comm. of Salix repens and Parnassia palustris* (SP)

Char. of formation VII: *Salix repens* (const., 0,3 m height, sociability 1), *Parnassia palustris* (opt.), *Epipactis palustris* (const.), *Dactylorchis incarnata* (opt.), *Calliergonella cuspidata* (const., loc. dom.).

Char. of formations V and VI: *Agrostis stolonifera* (const.), *Hydrocotyle vulgaris* (const.), *Juncus articulatus* (const.), *Mentha aquatica* (const.). — After the map was finished, two variants were distinguished. It might be useful to present further information on the comm. in two parts, each referring to a variant. —

16–a. *Var. with Centaurium vulgare* (SP)

Pos. diff. towards Var. 16–b: *Centaurium littorale* (const.), *Blackstonia perfoliata, Carex serotina.*

Ex. EM 59.045 (t. V).

Occ. Open slacks in the outer dunes, intermixed with Comm. 3–a.

Syst. According to current knowledge both variants should be placed in all. *Caricion davallianae.* Var. 16–a is then to be considered as a transition between ass. *Centaurieto-Saginetum* D S et W 1940 and all. *Caricion davallianae*, with some relation to all. *Agropyro-Rumicion crispi.*

Succ. Prob. to Comm. 18, ex. EM 59.063 (t. V).

Trans. To Comm. 9–a, ex. EM 58.046 (t. V); to Comm. 13 ex. EM 58.051 (t. V); to Comm. 16–b: to Comm. 17. Comm. 16–a, 16–b, 17 and 18 form one ecocline complex.

16–b. *Var. with Ranunculus repens* (SP, drawn in together with Var. 16–a).

Pos. diff. towards Var. 16–a: *Ranunculus repens* (const.), *Trifolium repens* (const.), *Potentilla reptans* (const.), *Calamagrostis epigeios* (const.), *Prunella vulgaris* (const.), *Holcus lanatus* (const.), *Potentilla anserina Hippophae rhamnoides* (0,3 m height) sociability 1).

Ex. EM 59.153 (t. V).

Occ. Vliegveld, especially in the neighbourhood of the Gentianenvallei; Gentianenvallei itself.

Syst. A mixture of all. *Caricion davallianae* and *Agropyro-Rumicion crispi.* The influence of grazing and treading is obvious.

Succ. Probably to Comm. 21–a, if grazing or treading persists; to Comm. 22–a.

Trans. To Comm. 19; to Comm. 21–a (see Comm. 16–a).

17. *Comm. of Salix repens and Drepanocladus cf. aduncus* (SD) (light brown lines on light blue)

Char. *Salix repens* (const., height 0,3–0,5 m, sociability 1 or 2), *Drepanocladus cf aduncus* (dom.), *Carex trinervis* (const.), *Liparis loeselii* (const., opt.).

Char. of formation V and VI: *Agrostis stolonifera* (const.), *Hydrocotyle vulgaris* (const.), *Juncus articulatus* (const.), *Mentha aquatica* (const.).

Char. of formation VII: *Epipactis palustris, Parnassia palustris.*

Pos. diff. towards Comm. 16: *Scirpus maritimus, Carex nigra, Juncus gerardi.*

Neg. diff. towards Comm. 16–a: species of Comm. 3–a, e.g. *Centaurium littorale.*

Neg. diff. towards Comm. 16–b: *Ranunculus repens, Prunella vulgaris, Potentilla reptans.*

Ex. EM 59.026 (t. V).

Occ. The same slacks as Comm. 13, moreover in sq. B–6; occupies wetter places than Comm. 16.

Syst. All. *Caricion davallianae.* A similar comm. has been described as ass. of *Carex trinervis* and *Drepanocladus aduncus* from the Belgian dunes by DUVIGNEAUD 1947.

Succ. Probably to Comm. 22.

Trans. See Comm. 16.

18. *Comm. of Pyrola rotundifolia and Salix repens* (PS)

Char. *Salix repens* (const., height 0,3–0,6 m, sociability 1 or 2), *Pyrola rotundifolia* (const., loc. dom.), *Gymnadenia conopsea* (faithf.), *Hippophae rhamnoides* (const.), *Carex trinervis* (const.), *Equisetum variegatum.*

Char. of formation VII: *Epipactis palustris, Parnassia palustris, Carex flacca* (const.), *Gentiana amarella.*

Char. of Comm. 16–b and 18: *Prunella vulgaris,* (const.), *Euphrasia officinalis* (const.), *Calamagrostis epigeios* (const.), *Linum catharticum* (const.), *Holcus lanatus.*

Pos. diff. towards Comm. 16 and 17: *Cirsium palustre, Betula verrucosa x pubescens* (juv.).

Ex. EM 59.070 (t. V).

Occ. Mainly in the outer valleys near the Tweede Jachtpad (sq. B–5), locally in the inner dunes, e.g. Gymnadeniavallei (sq. F–3).

Syst. Some resemblance to the ass. *Pyroleto-Salicetum repentis* MELTZER (in WESTHOFF 1947) is obvious. It is possible to consider the Comm. as a (geographical) vicariant with *Hippophae rhamnoides*, native in the calcareous Dune district, and to distinguish a vicariant with *Empetrum nigrum* from the West-Frisian islands.

Succ. To Comm. 22–a.

Trans. To Comm. 22–a.—The Comm. persists, if it is yearly mown.—

19. *Comm. of Carex distans and Festuca arundinacea* (CF) (black dots on light blue)

Char. *Carex distans* (faithf.).

Pos. diff. towards other Comm. of formation VII: *Festuca arundinacea* (const.), *Schoenus nigricans*, *Alnus glutinosa* (height 0,5–1,5 m), *Pulicaria dysenterica.*

Pos. diff. towards Comm. 16–b, 17 and 21: *Leontodon nudicaulis*, *Sonchus arvensis.*

Char. of formation VII: *Parnassia palustris*, *Carex flacca*, *Epipactis palustris*, *Salix repens*, *Carex trinervis*, *Calliergonella cuspidata.*

Char. of Comm. 16–b and 19: *Potentilla anserina*, *Trifolium repens* (loc. dom.), *Trifolium fragiferum*, *Calamagrostis epigeios*, *Holcus lanatus.*

Char. of formation V and VI: *Agrostis stolonifera*, *Hydrocotyle vulgaris*, *Mentha aquatica.*

Ex. EM 59.038 (t. V).

Occ. Some zones within the Vliegveld.

Syst. All. *Agropyro-Rumicion crispi*, with some representation of all. *Caricion davallianae.*

Succ. ? Finally *Salix scrub.*

Trans. See Comm. 10–a, Comm. 16–b.

20. *Comm. of Lysimachia vulgaris and Juncus subnodulosus* (LJ) (black lines on light blue)

Char. and at the same time pos. diff. towards other comm. of formation VII: *Lysimachia vulgaris* (opt.), *Juncus subnodulosus* (opt.), *Valeriana dioica* (const.), *Lythrum salicaria*, *Scutellaria galericulata*, *Caltha palustris*, *Carex disticha*, *Ophioglossum vulgatum*, *Viola palustris.*

Char. of formation VII: *Parnassia palustris*, *Epipactis palustris*, *Calliergonella cuspidata* (dom.).

Char. Of Comm. 18, 20, 21: *Cirsium palustre*, *Potentilla erecta.*

Char. of Comm. 20 and 21–b: *Sieglingia decumbens, Prunella vulgaris* (const.).

Char. of formations V and VI: *Agrostis stolonifera* (const.), *Hydrocotyle vulgaris, Mentha aquatica, Ranunculus flammula.*

Ex. EM 59.110 (t. V).

Occ. Known from two small slacks only, one of which named after *Teucrium scordium* (sq. A–2).

Syst. All. *Calthion palustris*, order *Molinietalia coeruleae* with representation of *Agropyro-Rumicion crispi* and *Nardo-Galion saxatilis.* A similar community has been described by LAMBINON 1956 from the De Panne dunes (Belgium).

Succ. Probably to Comm. 24–c; the succession is held up by yearly mowing.

Trans. To Comm. 21–b: char. *Teucrium scordium* (opt.), ex. EM 59.134 (t. V).

21. *Comm. of Parnassia palustris and Prunella vulgaris* (PB) (light green lines on light blue)

Char. of formation VII *Parnassia palustris, Carex flacca, Epipactis palustris.*

Neg. diff. towards other Comm. of formation VII: *Salix repens.*

Char. of Comm. 16–b, 19, 21: *Potentilla anserina* (const.), *Prunella vulgaris* (opt.), *Trifolium repens* (const.), *Ranunculus repens* (const.).

21–a. *Var. with Holcus lanatus* (HB)

Pos. diff. towards Var. 21–b: *Holcus lanatus, Festuca rubra ssp. rubra, Juncus articulatus, Calamagrostis epigeios.*

Ex. EM 60.003 (t. V).

Occ. Within the area of Comm. 16–b, probably on places which have been heavily grazed and trodden in the recent past.

Syst. Mixture of all. *Agropyro-Rumicion crispi* and *Caricion davallianae.*

Succ. probably to Comm. 16–b.

Trans. To Comm. 21–b (see Comm. 6, Comm. 16–b).

21–b. *Var. with Scirpus planifolius* (SB)

Pos. diff. towards Var. 21–a: *Scirpus planifolius* (opt.), *Potentilla anserina* (loc. dom.), *Trifolium repens* (const.), *Ranunculus repens* (const., loc., dom.).

Ex. EM 60.108 (t. V).

Occ. On paths in slacks with Comm. 16–b or Comm. 20.

Syst. *Agropyro-Rumicion crispi.*

Succ. ? Probably to Comm. 21–a, if treading stops.

Trans. See Comm. 20, Comm. 21.

VIII. Low shrub formation (dark blue, pink, orange)

22. *Comm. of Hippophae rhamnoides and Salix repens* (HR) (dark blue)

Char. *Hippophae rhamnoides* (const., loc. dom., height 1–2 m, sociability 3), *Salix repens* (const., height 1–1,5 m, sociability 2 or 3), *Calamagrostis epigeios* (const.), *Galium uliginosum* (const.), *Eupatorium cannabinum* (const.), *Mentha aquatica* (const.).

22–a. *Var. with Pyrola rotundifolia* (HP)

Pos. diff. towards Var. 22–b: *Pyrola rotundifolia* (const., loc. dom.)o *Epipactis palustris, Festuca rubra subvar. arenaria, Betula verrucosa x pubescens* (height 1–2 m).

Neg. diff. towards Comm. 18: species of all. *Caricion davallianae.*

Ex. EM 59.079 (t. VI).

Occ. Mainly in the outer valleys, in areas within which Comm. 18 occurs.

Syst. Perhaps to be considered as ass. *Pyroleto-Salicetum repentis, Hippophae rhamnoides* vicariant (se Comm. 18).

Succ. To Comm. 29.

Ex. EM 59.071 (t. VI).

Trans. To Comm. 18; to Comm. 22–b, ex. EM 59.106 (t. VI); to Comm. 23–e.

22–b. *Var. with Eupatorium cannabinum* (EH) (dark brown lines on dark blue).

Pos. diff. towards Var. 22–a: (cf. diff. of Comm. 24–c) *Eupatorium cannabinum* (height 1–1,5 m), *Phragmites communis* (const.), *Rubus caesius* (const.), *Salix cinerea.*

Ex. EM 58.032 (t. VI).

Syst. This Comm. might be assigned to the doubtful all. *Alno-Salicion cinereae.*

Occ. Wetter parts in slacks, mainly in transitional zones between slack and dry dune (sq. F–4).

Succ. Probably to Comm. 25–e.

Trans. To Comm. 23, ex. EM 59.031 (t. VI).

23. *Comm. of Salix repens and Hydrocotyle vulgaris* (SH) (not drawn)

Char. *Salix repens* (dom., height 1–1,5 m), *Hydrocotyle vulgaris* (dom., height 0,3–0,5 m), *Calliergonella cuspidata* (dom.).

Neg. diff. towards Comm. 22: *Phragmites communis*, *Hippophae rhamnoides* (present, but never dominant).

Pos. diff. towards Comm. 22: *Galium palustre.*

Ex. EM 59.034 (t. VI).

Occ. Transitional zones between very wet slacks and low dry dunes, especially in the Biezenvallei (sq. F–5).

Syst. Ass. *Acrocladieto-Salicetum* BR. BL. et DE LEEUW 1936; from another point of view, the Comm. might be assigned to all. *Alno-Salicion cinereae.* Both units are doubtful, however.

Succ. Probably to Comm. 31.

Trans. From Comm. 22–b, from Comm. 13.

24. *Comm. of Hippophae rhamnoides* (H) (pink)

Char. *Hippophae rhamnoides* (dom., height 1–1,5 m).

Char. of Comm. 24, 25, 26: *Rubus caesius* (const.).

Pos. diff. of Comm. 24, 26 towards 25, 27: *Cynoglossum officinale* (const., not opt.), *Solanum dulcamara* (const.).

24–a. *Var. with Ammophila arenaria* (AH)

Pos. diff. towards other variants: *Ammophila arenaria*, *Ammocalamagrostis baltica* (both constant, together loc. dom.), *Sonchus arvensis* (const.), *Festuca juncifolia*, *Elytrigia pungens* (loc. dom.).

Ex. EM 59.127 (t. VII).

Occ. Landward side of the coastal ridge of 1959, on the coastal ridge of 1926, widespread on and directly behind the coastal ridge of 1910 (with *Elytrigia pungens* as a dominant species along the Vliegveld).

Syst. This variant as well as Var. b and c has been described by MELTZER (1941) as the initial stage of the *Hippophaeto-Ligustretum*, an association which has later been reckoned to the all. *Sambuco-Berberidion.* It might also be classified as ass. *Oenothero-Hippophaetum maritimi* DOING 1962, all. *Oenothero-Hippophaeion.* The local situation of the scrubs—which was not intensively studied by Doing—can not be described very well with Doing's classification however; this holds also for Comm. 25, 26, 27.

Succ. To Comm. 25–a; probably to Comm. 24–c.

Trans. To Comm. 1–b, ex. EM 59.124 (t. VII), To Comm. 24–b and 24–c (ecocline-complex).

24–b. *Var. with Tortula ruralis* (TH)

Pos. diff. towards other variants: Species of Comm. 2–a, especially *Tortula ruralis*, *Phleum arenarium*, *Myosotis ramosissima*, *Cerastium semidecandrum*, *Stellaria media*, *Anthriscus caucalis.*

Ex. EM 59.060 (t. VII).

Occ. On low, isolated dunes in the outer valleys (especially sq. B–5).

Syst. See Comm. 24–a.

Succ. To Comm. 25–a, 25–b, 26.

Trans. To Comm. 2–a, ex. EM 59.158 (t. VII).

24–c. *Var. with Carex arenaria* (CH)

Pos. diff. of Comm. 24–c, d, e, towards Comm. 24–a, b: *Carex arenaria* (const.), *Festuca rubra subvar. arenaria* (const.), *Elytrygia pungens.*

Pos. diff. towards Comm. 24–d, e: *Cynoglossum officinale, Asparagus officinalis, Bryonia dioica.*

Ex. EM 59.157 (t. VII).

Occ. Mainly in zone B.

Syst. See Comm. 24–a.

Succ. To Comm. 25–a, ex. EM 59.156 (t. VIII); to Comm. 26–a, ex. EM 59.049 (t. VIII).

Trans. From Comm. 5.

24–d. *Var. with Polypodium vulgare* (PH)

Pos. diff. towards other variants: *Polypodium vulgare* (const., loc. dom.), *Hieracium umbellatum.*

Char. of Comm. 24–d, e: a well developed moss-layer with *Pseudoscleropodium purum, Brachythecium rutabulum* a.o.

Ex. —

Occ. Rare on steep northern slopes, intermixed with Comm. 25–d.

Syst. The Comm. resembles the "stage with *Polypodium vulgare* and *Hippophae*", described from the West-Frisian islands by WESTHOFF (1947). All. uncertain.

Succ. To Comm. 25–d.

Trans. To Comm. 25–d; to Comm. 5–d.

24–e. *Var. with Inula conyza* (IH) (dark blue lines on pink)

Pos. diff. towards other variants: *Inula conyza, Pyrola rotundifolia.*

Char. of Comm. 24–d, e: See Comm. 24–d.—*Salix repens* is often dominant in stead of *Hippophae rhamnoides*—

Ex. EM 59.140 (t. VII).

Occ. Some places on the coastal ridge of 1926.

Syst. Transitional position between xerosere (Comm. 24–c) and hygrosere (Comm. 22–a) with *Pyrola rotundifolia* as a transitional species. All. uncertain.

Succ. To Comm. 25–b.

Trans. To Comm. 24–c, ex. EM 59.109 (t. VII); to Comm. 5–c.

25. *Comm. of Hippophae rhamnoides and Ligustrum vulgare* (HL) (orange)

Char. *Hippophae rhamnoides* (opt., loc. dom.), *Ligustrum vulgare* (opt., loc. dom.).

Char. of Comm. 24, 25, 26; *Rubus caesius.*

Char. of Comm. 25, 26, 27: *Rosa rubiginosa* (const.), *Bryonia dioica* (const.), *Sambucus nigra* (const.), *Crataegus monogyna* (const., 0,5–1 m height).

25–a. *Var. with Asparagus officinalis* (AL)

Char. *Hippophae rhamnoides* (loc. dom.), *Ligustrum vulgare* (const., not dom.), *Asparagus officinalis* (opt.).

Pos. diff. towards Comm. 25–b, c; *Lithospermum officinale, Solanum dulcamara.*

Ex. EM 59.112 (t. VIII).

Occ. Mainly zone B, especially sq. A–2, B–2, E–3, G–3.

Syst. Subass. *Hippophaeto-Ligustretum asparagetosum* MELTZER 1941, all. *Berberidion vulgaris,* afterwards restricted to all. *Sambuco-Berberidion.* In the new classification of scrubvegetations by DOING (1962) Comm. 25–a, b and c do not find a place.

Succ. To Comm. 27–a.

Trans. To Comm. 25–b, 26–a; to Comm. 24–c, ex EM 59.156 (t. VIII).

25–b. *Var. with Inula conyza* (IL) (dark blue lines on orange)

Char. *Ligustrum vulgare* (dom.)

Pos. diff. towards Comm. 25–a, c: *Inula conyza, Viola hirta, Fragaria vesca, Pseudoscleropodium purum, Pyrola rotundifolia.*

Pos. diff. of Comm. 25–b, c towards Comm. 25–a: *Salix repens, Eupatorium cannabinum* (0,5–1 m height, not flowering).

Pos. diff. of Comm. 25–b, d towards Comm. 25–a, c: *Lophocolea bidentata, Brachythecium rutabulum, Eurhynchium praelongum.*

Ex. EM 59.102 (t. VIII).

Occ. Within the area of Comm. 25–a, on eastern and gentle northern slopes and on low dunes close to the groundwater table.

Syst. Ass. *Hippophaeto-Ligustretum* MELTZER 1941, all. *Berberidion vulgaris,* afterwards restricted to all. *Sambuco-Berberidion.* Within this ass. the Comm. can be considered as a subass. "*inuletosum conyzae*".

Trans. To Comm. 24–e, to Comm. 5–c, ex. EM 59.136 (t. VIII).

25–c. *Var. with Eupatorium cannabinum* (EL) (dark brown lines on orange)

Char. *Hippophae rhamnoides* or *Salix repens* (dom.), *Ligustrum* (const., but not dom.).

Pos. diff. towards Comm. 25–a, b, d: *Eupatorium cannabinum* (const., loc. dom., height 1–1,5 m), *Pulicaria dysenterica, Mentha aquatica, Salix cinerea, Galium uliginosum.*

Ex. Nr 15 from MELTZER 1941 (t. VIII).

Occ. In the slacks between the coastal ridges of 1926 and 1910, wet places in zone B.

Syst. Subass. *Hippophaeto-Ligustretum eupatorietosum.* MELTZER 1941, all. *Berberidion vulgaris,* afterwards restricted to all. *Sambuco-Berberidion.*

Succ. Probably to Comm. 30–b.

Trans. To Comm. 26–b, ex. EM 59.096 (t. VIII); to Comm. 22–b, ex. EM 59.037 (t. VIII); to Comm. 15 (see Comm. 15)

25–d. *Var. with Polypodium vulgare* (PL)

Char. *Ligustrum vulgare* (dom., height 0,5–1 m)

Pos. diff. towards other var.: *Polypodium vulgare, Hieracium umbellatum, Veronica officinalis.*

Pos. diff. of Comm. 25–b, d towards Comm. 25–a, c: see Comm. 25–b.

Ex. EM 59.162 (t. VIII).

Occ. Rare on steep northern slopes, mainly on the coastal ridge of 1910 along the Vliegveld.

Succ. Probably rather stable.

Syst. Ass. *Polypodio-Ligustretum* BOERBOOM 1960 DOING 1962.

Trans. To Comm. 24–d; to Comm. 5–d (ecocline).

IX. TALL SHRUB FORMATION (purple, red)

26. *Comm. of Hippophae rhamnoides and Sambucus nigra* (HS) (purple)

Char. *Hippophae rhamnoides* (opt., height 2–3 m), *Sambucus nigra* (opt., dom., height 2–4 m).

Char. of Comm. 24, 26: *Solanum dulcamara.*

Char. of Comm. 25, 26, 27: *Ligustrum vulgare, Rosa rubiginosa, Bryonia dioica, Crataegus monogyna* (1–2 m height).

26–a. *Var. with Anthriscus caucalis* (AS)

Pos. diff. towards Var. 26–b: *Anthriscus caucalis, Cynoglossum officinale, Carex arenaria.*

Ex. EM 59.098 (t. VIII).

Occ. On the coastal ridges of 1926 and 1910 and on stripe dunes (the pattern of purple on the map is easily visible).

Syst. *Ass. Hippophaeto-Ligustretum* MELTZER 1941 p.p.; *Hippophaeto-Sambucetum nigrae* BOERBOOM 1960, all. *Berberidion vulgaris*, afterwards restricted to all. *Sambuco-Berberidion.*

Succ. Finally to Comm. 27–a.

Trans. To Comm. 26–b; to Comm. 24–c, ex. EM 59.049 (t. VIII).

26–b. *Var. with Eupatorium cannabinum* (ES) (dark brown lines on purple).

Char. *Hippophae rhamnoides* and *Sambucus nigra* (loc. dom., height 3–5 m).

Pos. diff. towards Var. 26–a: *Eupatorium cannabinum, Humulus lupulus, Phragmites communis, Salix cinerea.*

Ex. EM 59.139 (t. VIII).

Syst. Subass. *Hippophaeto-Ligustretum eupatorietosum* MELTZER 1941 p.p.; according to a more detailed classification: *Hippophaeto-Sambucetum eupatorietosum* DOING 1962.

Succ. ?

Trans. To Comm. 25–c, ex. EM 59.096 (t. VIII).

27. *Comm. of Ligustrum vulgare and Crataegus monogyna* (VC) (red)

Char. *Crataegus monogyna* (dom., height 4–8 m).

27–a. *Var. with Viola hirta* (LC)

Pos. diff. towards Var. 27–b: *Ligustrum vulgare* (const.), *Rosa canina* (opt., height 3–5 m), *Berberis vulgaris, Rhamnus catharticus* (const.), *Viola hirta, Inula conyza, Asparagus officinalis, Lithospermum officinale, Cynoglossum officinale, Rubus caesius, Bryonia dioica.*

Char. of Comm. 27–a and Comm. 30–a: *Moehringia trinervia, Glechoma hederacea, Scrophularia nodosa, Geranium robertianum, Geum urbanum, Viola riviniana.*

Ex. EM 59.151 (t. IX).

Occ. Inner side of zone B (the pattern of red on the map is easily visible).

Syst. This Comm. has not been described (see remark in BOERBOOM 1960, p. 72). All.: *Sambuco-Berberidion.* In the classification of DOING (1962) this Comm. should be compared with ass. *Polygonato odoratae-Euonymetum.* However the former species is not characteristic for this Comm., and *Euonymus europaeus* is only a local characteristic in the dunes near Haarlem. On Voorne it is probably not native. So this latter association-name cannot be maintained.

Succ. Probably to Comm. 30–a, perhaps to woodland with *Quercus robur*, which is known from the Quackjeswater region, Voorne.

Trans. To Comm. 28.

27–b. *Var. with Anthriscus caucalis* (NC)

Neg. diff. towards Var. 27–a: Nearly all species of all. *Berberidion vulgaris.*

Pos. diff. towards Var. 27–a: *Anthriscus caucalis, Stellaria media, Cardamine hirsuta, Chelidonium maius, Aegopodium podagraria.*

Ex. —

Occ. Mainly in zone A, bordering gardens and fields, probably planted.

Syst. Probably all. *Arctio-Sambucion nigrae.* The Comm. shows a resemblance to ass. *Aegopodio-Sambucetum nigrae* DOING 1962.

28. *Comm. of Crataegus monogyna and Populus tremula* (CP) (dark green lines on red).

Char. *Populus tremula* (dom.).

Neg. diff. towards Comm. 27–a: *Crataegus monogyna* (not dom.), shrub species of all. *Berberidion vulgaris.*

Char. of Comm. 28 and 27–a: most herb species of all. *Berberidion vulgaris.*

Ex. —

Occ. Within the area of Comm. 27–a, especially sq. B–2.

Syst. All. *Sambuco-Berberidion.*

Succ. Probably to woodland with *Quercus robur*

Trans. To Comm. 27–a.

X. WOODLAND FORMATION (dark green)

29. Comm. of *Pyrola rotundifolia* and *Betula verrucosa* (BP) (dark blue lines on dark green)

Char. *Betula verrucosa* × *pubescens* (dom., height 3–4 m), *Pyrola rotundifolia* (loc. dom., const.), *Ligustrum vulgare* (const.), *Salix repens, Hippophae rhamnoides, Prunella vulgaris, Calamagrostis epigeios, Epipactis helleborine, Eupatorium cannabinum.*

Ex. EM 58.057 (t. VI).

Occ. Within the area of Comm. 22–a, especially in front of the coastal ridge of 1926 (sq. B, C–5).

Syst. Elements of all. *Caricion davallianae* and *Berberidion vulgaris* are present.

Succ. To Comm. 30–b, ex. EM 59.103 (t. IX).

Trans. To Comm. 22–a, ex. EM 59.071 (t. VI).

30. *Comm. of Ligustrum vulgare and Betula verrucosa* (BB) (dark green)

Char. *Betula verrucosa*, *Betula verrucosa* × *pubescens* (dom., height 4–8 m).

Char. of Comm. 27 and 30. *Ligustrum vulgare* (const.), *Lonicera periclymenum*, *Rhamnus catharticus*, *Viola riviniana*.

Pos. diff. towards Comm. 27–a: *Ajuga reptans*.

Neg. diff. towards Comm. 27–a: *Asparagus officinalis*, *Berberis vulgaris*, *Cynoglossum officinale*.

Char. of Comm. 29 and 30: see Comm. 29.

30–a. *Var. with Listera ovata* (LB)

Pos. diff. towards Var. 30–b: *Crataegus monogyna*, *Listera ovata*, *Viola odorata*, *Dactylorchis fuchsii*, *Moehringia trinervia*, *Geranium robertianum*, *Scrophularia nodosa*.

Ex. VW 57.032 (t. IX).

Occ. Small hollows in zone B.

Syst. *Hippophaeto-Ligustretum betuletosum* MELTZER 1941; *Crataego-Betuletum pubescentis typicum* BOERBOOM 1960. Elements of all. *Sambuco-Berberidion* and *Alno-Padion* are present.

Succ. Probably rather stable; finally regressing, because of the death of *Betula verrucosa*; by exception succession to *Quercus robur* woodland.

Trans. To Comm. 30–b, ex. EM 59.077 (t. IX); to Comm. 27, 29.

30–b. *Var. with Eupatorium cannabinum* (EB) (dark brown lines on dark green)

Pos. diff. towards Var. 30–a: *Eupatorium cannabinum* (const.), *Mentha aquatica*, *Galium uliginosum*, *Urtica dioica*, *Salix cinerea* (const., loc. dom.), *Salix aurita*.

Ex. EM 59.075 (t. IX).

Occ. Inner side of the slacks between the coastal ridges of 1926 and 1910, some wet hollows in zone B.

Syst. Intermediate between all. *Berberidion vulgaris* and *Alno-Salicion cinereae*.

Succ. Probably rather stable.

Trans. To Comm. 25–a, ex. EM 59.165 (t. IX), to Comm. 29, ex. EM 59.103 (t. IX), to Comm. 30–a.

31. *Comm. of Salix cinerea, and Salix aurita* (SM) (dark green lines on dark brown)

Char. *Salix cinerea, Salix aurita* (both const., loc. dom., height 3–5 m), *Salix repens, Salix purpurea, Eupatorium cannabinum, Mentha aquatica, Hydrocotyle vulgaris* (all const.), *Phragmites communis, Calliergonella cuspidata* (dom.), *Galium uliginosum.*

Ex. —

Occ. Mainly in the great slack westwards from the Sipkesslag (sq. D, E–5).

Syst. All. *Alno-Salicion cinereae.* The ass. "*Salicetum arenario-purpurae*" Doing 1962 is not identical with Comm. 31, though its name suggests so.

Succ. ? Probably *Alnus glutinosa* woodland.

Trans. to Comm. 30–b, Comm. 22–b, Comm. 14.

(32. *Comm. of the Potamion eurosybericum* Koch 1926 This Comm. has not been described in detail. It consists of species such as *Potamogeton crispus, Hippuris vulgaris, Lemna species, Ceratophyllum submersum* and occurs in some ponds.)

Table I. Communities 1 and 5

Community	1a	1b	1b 2a	2a 5b	5a	5c
Year of analysis	59	59	59	59	59	59
No. of analysis	121	123	011	143	113	131
Author of analysis	EM	EM	EM	EM	EM	EM
Month of analysis	10	10	8	10	10	10
Area in m^2	48	100	25	9	48	12
Cover herb layer in %	20	70	25	45	100	100
Cover mass layer in %	0	0	<5	25	0	0
Height herb layer in m	0.8	1.0	0.5	0.3	0.8	0.8
Elytrigia juncea *	1.1					
Salsola kali	×.1					
Festuca juncifolia *	×.2	2.3	×.2			
Ammophila arenaria	2.2	4.4	1.2	×.1	2.2	
Ammocalamagrostis baltica	×.1	×.1	2.2		2.1	
Elymus arenarius		2.1				
Senecio jacobaea		×.1	1.1			
Erigeron canadensis		×.1	×.1			
Sonchus arvensis *		1.1	×.1		2.1	
Cynoglossum officinale		×.1	1.1	×.1	×.2	
Solanum dulcamara			×.1			
Sedum acre			×.1			
Tortula ruralis *			×.1	2.2		
Phleum arenarium			2.1	2.2		
Erodium cicutarium *			×.1	1.1		
Hypnum cupressiforme *			×.2	1.2		
Carduus nutans			×.1	×.1		
Hippophae rhamnoides *			×.1	×.1	1.1	
Cirsium arvense			×.1			×.1
Viola tricolor *				×.1		
Erodium glutinosum				×.1		
Peltigera spec.				2.2		
Cerastium semidecandrum				2.1		
Carex arenaria				2.1	3.5	4.5
Festuca rubra * subvar. arenaria				2.3	4.5	2.2
Calamagrostis epigeios				1.1	×.2	3.2
Crepis capillaris				×.1		×.1
Agrostis tenuis					1.1	
Rubus caesius					×.1	1.1
Inula conyza						×.1
Galium uliginosum						2.1
Fragaria vesca						×.1
Agrostis stolonifera						2.3
Pyrola rotundifolia *						2.2
Pastinaca sativa						1.1
Luzula campestris						×.1

Addenda: 1b: Hypochaeris radicata ×.1. 1b/2a: Taraxacum spec. ×.1. 2a/5b: Cladonia spec. 1.1, Peltigera spec. 2.2. 5a: Taraxacum spec. ×.1, Leontodon nudicaulis * ×.1, Achillea millefolium ×.1. 5c: 5 spec. of comm. 24, 2 spec. of comm. 15, ×.1 each.

Table II. Communities 2, 6, 7 and 8

Community	2a	2b	2a 7a	7a	7b	8a	8d	8b	8c	8c b	6
Year of analysis	59	60	57	61	57	57	57	61	53	60	61
No. of analysis	020	048	186	003	197	204	189	365	076	042	363
Author of analysis	EM	EM	VW	EM	VW	VW	VW	EM	EM	EM	EM
Month of analysis	8	8	6	6	6	6	6	7	8	8	7
Area in m^2	20	4	4	1	2	3	2	4	3	2	4
Cover herb layer in %	30	10	60	45	45	84	85	30	90	80	100
Cover mass layer in %	20	45	50	75	95	95	70	90	<5	<5	35
Height herb layer in m	0.1	0.2	0.2	0.2	0.2	0.2	0.3	0.1	0.3	0.3	0.4
Cynoglossum officinale	2.1										
Crepis capillaris	1.1										
Tortula ruralis *	2	2	3.4	×.1	2.2						
Phleum arenarium	2.1		1.2	2.1	2.2						
Erodium glutinosum	2.2		1.2		×.1						
Erodium cicutarium *	×.1	1.1		×.1							
Cerastium semidecandrum	×.1		1.1	1.1	×.1	×.1					
Sedum acre	2.1	1.1	3.3	×.1	2.2	2.2	×.2				
Saxifraga tridactylites					×.1						
Senecio jacobaea	×.1						×.1				
Corynephorus canescens		2.2			2.2						
Viola tricolor *		×.2									
Brachythecium albicans			1.2								
Cladonia foliacea			2.2								
Carex arenaria	2.1		1.1		×.1	1.2	2.1	×.1	×.1		
Festuca rubra subvar. arenaria	×.1	×.2	×.2	×.1	2.2	2.3	2.2	2.2	1.1	2.2	
Hypnum cupressiforme *	2		×.2	5	1.2		5.5	5	×.2		
Peltigera polydactyla			1.2		×.1	×.1					
Cladonia rangiformis					5.5	3.3	1.2	×.2	×.1		
Myosotis ramossima				×.1							
Taraxacum rubicundum				×.1							
Ranunculus bulbosus				×.1							
Veronica arvensis				2.1							
Galium verum *				2.1	2.2	2.3	2.2	2.2	×.2	×.1	
Plantago lanceolata *	( )			2.1		×.1	×.1	2.1	2.2		
Hypochaeris radicata	×.1						×.1	×.1	×.1	×.1	
Bromus hordeaceus				2.1		×.1					
Arenaria serpyllifolia *				1.1		×.1					
Luzula campestris				×.1		×.2	×.1	1.1	×.1	2.1	×.1
Thymus pulegioides						2.2	2.2	×.1			×.1
Cerastium arvense				1.1		2.2	×.2				
Achillea millefolium				×.1			2.2	×.1			
Helictotrichon pubescens *				×.1			2.2				
Trifolium campestre				1.1			2.2				
Vicia lathyroides						1.1	×.1				
Hieracium pilosella						×.1		1.1	×.1	×.1	
Lotus corniculatus *						4.3	1.2	1.1	×.1	×.1	1.1
Allium vineale							×.1				
Rumex acetosella *							×.1	1.1			
Aira praecox								3.2			
Polytrichum juniperinum								1.1			
Agrostis tenuis							2.1	2.2	2.2	2.2	3.2
Rhytidiadelphus squarrosus							×.2		×.2	( )	3
Anthoxanthum adoratum							×.1	×.1	1.1		×.1
Festuca tenuifolia *								2.3		2.1	
Gentiana campestris *									×.1	1.1	
Briza media									×.1	×.1	
Prunella vulgaris									×.1		2.1
Euphrasia officinalis *									×.2		×.1
Sieglingia decumbens									1.2	2.2	1.2
Cerastium holosteoides *									×.1	2.1	2.1
Trifolium pratense									×.2	×.1	3.2
Holcus lanatus									×.2	1.2	2.3
Centaurea pratensis										×.1	×.1
Festuca rubra ssp rubra										1.1	1.1

Table III. Communities 3, 9 and 10

Community	2a 3a	3a	3a b	3b	3b 9a	9a	9b	10a
Year of analysis	59	59	59	60	59	58	59	53
No. of analysis	069	004	013	068	006	048	052	095
Author of analysis	EM	EM	EM	EM	EM	EM	EM	EM
Month of analysis	9	8	8	9	8	9	9	8
Area in m^2	2	1	16	1	2	2	10	5
Cover herb layer in %	10	10	15	90	90	70	95	90
Cover moss layer in %	40	-	-	10	10	40	≤ 5	-
Height herb layer in m	0.1	0.1	0.1	<0.1	0.1	0.2	0.1	0.3
Tortula ruralis *	3.							
Erodium cicutarium *	×.1							
Erodium glutinosum	×.1							
Ammophila arenaria	1.1							
Carex arenaria	1.1		×.1					
Cirsium arvense	×.1	×.1	×.1					
Festuca rubra subvar. arenaria	2.1	2.1			1.2			
Leontodon nudicaulis *	×.1	×.1	×.1				×.2	
Gnaphalium luteo-album	1.2		1.1					
Centaurium littorale	1.2	2.2	1.1	×.1	1.2		×.1	
Sonchus arvensis *		×.1	×.1		×.1			×.1
Sagina nodosa *		×.1	2.2		×.1			
Plantago coronopus		×.1	2.1	×.1	×.1			
Juncus articulatus * fo. pygmaeus			2.2	2.1	2.2	1.1		
Mentha aquatica		×.1	×.1	2.1	×.1	2.1		3.4
Samolus valerandi			×.1	×.1	2.1	3.5	1.2	
Plantago intermedia			2.1	1.1	1.1		×.1	×.1
Glaux maritima			×.1	2.1	2.2	2.1	3.2	1.1
Potentilla anserina			×.1		×.1	×.1	×.1	1.1
Agrostis stolonifera			2.2	3.2	4.5	1.1	4.5	3.3
Carex serotina *				2.1	×.2			
Centaurium pulchellum				×.1	2.2		2.2	
Calliergonella cuspidata				1.		3.		
Hydrocotyle vulgaris					×.2	1.1		
Phragmites communis					×.1		1.2	1.1
Juncus gerardi						2.2	×.2	4.3
Trifolium fragiferum							2.3	
Juncus articulatus *							2.1	
Eleocharis uniglumis *							2.1	

Addenda: 2a/3a: 3 spec. of comm. 2, ×.1 each. 3a: Calamacrostis epiceips ×.1. 3a/b: Salix repens * ×.1, Plantago lanceolata ×.1. 3b/9a: Salix repens * ×.2, *Epilobium palustre* ×.1, *Epilobium parviflorum* ×.1. 9a: Calamagrostis epigeios ×.1. 9b: 5 spec. of comm. 12, ×.1 each. 10a: Althaea officinalis ×.2.

Table IV. Communities 4, 11, 12, 13, 14 and 15

Community	4	11	11 13	12	12 14	14	14 15	13
Year of analysis	59	59	59	59	59	59	58	59
No. of analysis	017	007	086	094	100	054	037	030
Author of analysis	EM	EM	EM	EM	EM	EM	EM	EM
Month of analysis	8	8	9	10	10	9	9	8
Area in m^2	1	4	16	16	25	16	8	20
Cover herb layer in %	15	90	95	100	100	100	100	90
Cover moss layer in %	-	<5	-	70	90	50	5	-
Height herb layer in m	0.05	0.3	0.3	0.5	0.8	1.0	1.4	0.9
Juncus bufonius *	1.2	( )						
Chenopodium rubrum *	1.1	×.1						
Glaux maritima	1.1	( )	1.1					×.1
Samolus valerandi	×.1	2.1	×.1	×.1				×.1
Myosotis caespitosa		2.2	( )	×.2				
Eleocharis palustris *		4.4	3.3	2.2	2.1-2	1.1-2		
Agrostis stolonifera	×.1	1.1	4.4	4.5	5.5	5.5	2.1	3.5
Mentha aquatica	×.1	2.2	×.1	2.1	2.1-2	2.1-2	2.1	3.2-3
Hydrocotyle vulgaris		2.1	×.2	2.1	3.1	1.1	2.1	2.1
Juncus articulatus *			2.2	1.1	1.1	1.1		1.2
Ranunculus flammula			1.1	1.1	×.1	1.1		×.1
Phragmites communis			×.1	1.1	2.1	3.5	3.5	( )
Trifolium tragiferum				2.1-3	×.1	1.1		
Sium erectum *			×.1		×.1			
Epilobium palustre				×.1				
Carex trinervis				2.3	2.2-3			
Carex nigra *				1.3	1.2	1.1		
Salix repens *	×.1			×.1	2.1-2	×.1	×.1	
Calliergonella cuspidata				4	5	3.2	2.1	
Epilobium parviflorum				1.1	1.2	×.1	×.1	
Cardamine pratensis				×.1		×.1		
Caltha palustris				×.1		×.2		
Galium palustre				×.1				1.1
Eupatorium cannabinum			×.1		×.1	×.1	2.1	
Juncus gerardi					1.1-2	×.2		2.2
Trifolium pratense					×.1		2.2	
Lycopus europaeus						×.1		
Eleocharis uniglumis *						2.2		×.2
Lotus uliginosus							2.2	
Holcus lanatus							2.3	
Cirsium palustre							×.1	
Galium uliginosum							×.1	
Oenanthe lachenalii							( )	×.1
Pulicaria dysenterica					×.1		2.1	( )
Scirpus maritimus *								2.1

Addenda: 11: Nostoc spec. ×.1, Alopecurus geniculatus ( ). 11/13: Ranunculus sceleratus 1.1, Ranunculus repens ×.1. 12: Sagina procumbens ×.2, Triglochin palustris ×.1. 12/14: Potentilla anserina ( ). 14/15: Carex serotina * ×.1, Cirsium vulgare ×.1. 13: Calamagrostis epigeios ×.1. Potentilla anserina 1.1, Salix purpurea ×.1.

Table V. Communities 16, 17, 18, 19, 20 and 21

Community	3a 16	16a	16 13	16 10a	17	19	16b	16a 18	18	20	21a	20 21b	21b
Year of analysis	59	49	58	58	59	59	59	59	59	59	60	59	60
No. of analysis	014	045	051	046	026	038	153	063	070	110	003	134	108
Author of analysis	EM	EM	EM	EM	EM	EM	EM	EM	EM	EM	EM	EM	EM
Month of analysis	8	9	9	9	8	9	11	9	9	10	5	10	10
Area in m^2	15	25	10	2	10	14	10	6	6	16	2	4	5
Cover dwarf shrub layer in %	30	30	60	30	15	40	<5	25	↓	10	↓	5	↓
Height dwarf shrub layer in m	0.3	0.2	0.4	0.3	0.3	0.3	0.3	0.2	↓	0.3	↓	0.4	↓
Cover herb layer in %	50	50	30	70	90	95	80	50	95	100	70	100	80
Height herb layer in m	0.1	0.1	0.6	0.2	0.3	0.6	0.3	0.2	0.2	0.6	0.3	0.5	0.05
Cover *moss layer* in %	<5	30	60	90	90	90	85	70	40	90	80	20	10
Centaurium littorale	1.1	×.1											
Juncus articulatus* fo. pygmaeus	2.1	1.1											
Glaux maritima	1.1	2.1	×.1	2.1	×.1								
Eleocharis palustris *	1.1	×.1	2.1		2.1	1.1							
Plantago intermedia *	1.1			×.1			2.1						
Samolus valerandi	×.1			×.1				×.1					
Sonchus arvensis *	×.1					2.1	×.1						
Sagina nodosa *	1.1							×.1					
Carex serotina *	1.2	1.1				×.2		×.1					
Parnassia palustris	×.1	3.3	1.1	2.2	×.2	1.2	2.2	2.1	2.2	×.1	×.1	×.1	( )
Salix repens *	3.1-2	3.1	4.3	3.2	2.1	3.2	1.2	3.2	2.1	2.1	2.1	2.1-2	×.1
Mentha aquatica	1.1	2.1	1.1	3.1	2.1	2.1	2.1	2.1	1.1	1.1	×.1	×.1	2.1
Hudrocotyle vulgaris	×.1	3.1	2.1	2.1	3.5	2.5	1.1	×.1	2.2	1.1	2.1	×.1	
Agostis stolonifera	3.2	1.1	1.1	2	2.1	2.5	3.5	1.1	1.1	2.1		1.1	1.1
Carex flacca	1.2	×.1				×.2	2.2	×.1	1.1		1.1	1.1	×.1
Pulicaria dysenterica	×.1				×.1	1.1	×.1			×.1		×.1	
Lycopus europaeus	×.1			×.1		×.1						×.1	
Calliergonella cuspidata		4	4	5		5	5	4	3	5	×	2	1
Potentilla anserina		1.1	×.1		×.1	2.1	1.1		×.1		1.1	2.1	×.1
Calamagrostis epigeios		2.1	×.1	×.2		2.2	1.1	2.1	2.1	1.2	1.1	1.1	
Hippophae rhamnoides *		×.1				2.2	×.1	1.1	1.1			×.1	×.1
Ranunculus flammula		×.1				1.1				×.1			
Carex nigra *		×.1			3.2	×.2							
Phragmites communis		2.1				2.1	×.1						
Juncus gerardi		2.1		1.2	1.1	2.2	2.1	×.2					
Liparis loeselii		×.1	×.1		2.1			1.1					
Carex trinervis		1.1			2.1-2	2.2	×.2	2.2	×.1	×.1	1.1	×.1	
Gentiana amarella *		×.1				×.1	2.1		1.1	( )			
Dactylorchis incarnata		×.1			×.1	×.1					×.1		
Leontodon nudicaulis *		×.1				×.2	2.1		×.1				1.1

Table V (continued)

Galium palustre			1.1	×.1		×.2							
Drepanocladus aduncus			1		5			×					
Scirpus maritimus *			1.1			×.1							
Epipactis palustris			×.1		×.1	×.1	×.1	×.2	2.1		1.1	×.1	
Eupatorium cannabinum			×.1	×.1	×.1	×.1	×.2	2.1		×.1		×.1	
Blackstonia perfoliata *				×.1			×.1	×.1					
Galium uliginosum				1.1		×.1	1.1		1.1		2.1	2.1	
Euphrasia officinalis *				×.1			×.1	1.1	1.2		×.1	×.1	
Linum catharticum				2.1		1.2	1.1	×.1	×.1			1.1	1.1
Juncus articulatus *					1.1	×.1	1.1	1.2			×.1	×.1	
Schoenus nigricans						2.3							
Carex distans *						2.3					×.1		
Festuca arundinacea						×.2						×.2	
Festuca rubra subvar. arenaria						1.1		2.2			1.1		
Holcus lanatus						×.2	1.2		2.2	1.2	1.2	1.1	×.1
Trifolium repens						3.5	1.1				2.1	×.1	1.1
Potentilla reptans						2.1	1.1				×.1	×.1	
Prunella vulgaris						×.1	1.1		2.1	1.1		1.1	3
Ranunculus repens	1.1						1.1			1.1	×.1	2.1	2.1
Pyrola rotundifolia *								3.2	1.1				
Cirsium palustre								×.1	×.1	×.1	×.1	×.1	×.1
Gymnadenia conopsea									2.1				
Equisetum variegatum									2.1				
Valeriana dioica										2.2	2.2	2.1	
Lysimachia vulgaris										2.1	×.1	2.1	
Carex disticha										×.2		×.1	
Lythrum salicaria										1.2		×.1	
Teucrium scordium										1.1		1.1	
Potentilla erecta										1.1	2.1	1.1	×.1
Juncus subnodulosus										2.2		×.1	×.1
Carex panicea											2.2		
Scirpus planifolius *												1.1	3.5
Plantago major													1.1

Addenda: 3a/16: Centaurium pulchellum ×.1, Plantago coronopus ×.1, Campylium polygamum 1.1, Bryum spec. ×.1, Cirsium arvense ×.1, Salix purpurea ×.1. 16/13: Pellia spec. ×.1, Salix aurita ×.1. 17: Myosotis caespitosa ×.1. 19: Epilobium parviflorum ×.1, Asparagus officinalis * ×.1, Eleocharis uniglumis 2.1, Trifolium fragiferum ×.1, Cirsium arvense 2.1, Alnus glutinosa ×.1. 16b: Taraxacum sect. palustria ×.1, Carex arenaria ×.1, Lotus corniculatus * ×.1, Cirsium vulgare X.1, Trifolium fragiferum ×.1, Cerastium holosteoides *. 16a/18: Betula pubescens x verrucosa ×.1, Carex arenaria ×.1. 20: Equisetum palustre ×.1, Rubus caesius 4.5, Rhamnus catharticus ×.2, Crataegus monogyna ×.1, Caltha palustris ×.1, Scutellaria galericulata ×.1, Iris pseudacorus ×.1, Viola palustris ×.1, Sieglingia decumbens ×.2. 21a: Listera ovata ×.1, Taraxacum sectio palustria ×.1, Cirsium arvense ×.1, Equisetum palustre ×.1, Crataegus monogyna ×.1, Ranunculus acer X.1. 20/21b: Rubus caesius 2.1, Crataegus monogyna ×.1, Trifolium fragiferum ×.1. 21b: Taraxacum spec. ×.1, Cirsium arvense ×.1, Gentiana campestris * ×.1.

Table VI. Communities 22, 24 and 29

Community	23	22b 23	22b	22a b	22a	22a 29	29
Year of analysis	59	59	58	59	59	59	58
No. of analysis	034	031	032	106	079	071	057
Author of analysis	EM	EM	EM	EM	EM	EM	EM
Month of analysis	8	8	9	10	9	9	9
Area in m^2	4	8	10	25	4	48	100
Cover tall shrub layer in %						30	40
Height tall shrub layer in m						3	3.5
Cover low shrub layer in %	25	90	70	80	80	80	40
Height low shrub layer in m	0.5	1.0	1.6	2.0	1.4	2	2
Cover herb layer in %	90	90	90	90	80	20	50
Height herb layer in m	0.5	0.5	1.6	1.0	1.0	1.5	1.5
Cover mass layer in %	50	10	5	<5	90	15	30
Agrostis stolonifera	2.5	2.2					
Eleocharis palustris *	×.1	×.1					
Galium palustre	×.1	×.1					
Juncus gerardi	×.1	×.1					
Hydrocotyle vulgaris	5.5	4.5			×.1		
Calliergonella cuspidata	4	5			5	1	
Mentha aquatica	1.1	1			×.1	×.1	1.1
Salix repens *	3.2	3.3	3.3	2.2	5.2	4.3	3.3
Hippophae rhamnoides *	×.1	×.2	3.3	4.3	3.2	3.2	3.2
Rubus caesius	×.1	×.1	2.1	×.1		1.1	×.1
Carex trinervis	2.3		1.1		×.1	1.1	
Salix purpurea	×.1					×.1	
Calamagrostis epigeios		2.1	3.2	5.5	2.2	2.1	2.1
Eupatorium cannabinum		×.1	2.1	2.2		2.2	1.1
Pulicaria dysenterica		1.1	×.1			×.2	×.1
Holcus lanatus			×.1	2.3			
Phragmites communis			×.1				×.1
Cirsium arvense			×.1			×.1	×.1
Pyrola rotundifolia *				×.1	3.2	2.2	2.2
Betula verrucosa *				×.1	×.1	3.3	3.2
Epipactis palustris					1.1	×.1	
Brachythecium rutabulum						1.2	
Fragaria vesca						×.1	
Cirsium palustre						×.1	1.1
Galium uliginosum						1.1	1.1
Ligustrum vulgare							×.1
Epipactis helleborine							×.1
Prunella vulgaris							1.1

Addenda: 23: Liparis loeselii ×.1, Sonchus arvensis * ×.1, Cirsium vulgare ×.1, Myosotis caespitosa ×.1. 22b/23: Carex serotina * ×.1, Carex flacca ×.2, Drepanocladus aduncus ×.1, Potentilla anserina 1.1, Scirpus maritimus * ×.1, Cardamine pratensis ×.1. 22b: Valeriana officinalis ×.1, Rhamnus catharticus ×.1, Sonchus arvensis * ×.1, Galium verum * 2.1, Lotus corniculatus * ×.1, Lycopus europaeus ×.1, Humulus lupulus ×.1. 22a/b: Crataegus monogyna ×.1, Asparagus officinalis * ×.1, Carex arenaria 1.1, Urtica dioica ×.1. 22a: Fetuca rubra subvar. arenaria ×.1, Taraxacum spec. ×.1. 22a/29: Epilobium parviflorum ×.1, Salix cinerea ×.1, Rhamnus catharticus ×.1, Cirsium vulgare ×.1. 29: Parnassia palustris ×.1, Angelica sylvestris ×.1, Poa pratensis 1.1.

Table VII. Community 24

Community	16 24a	24a	2a 24b	24b	24c	24c e	24e
Year of analysis	59	59	59	59	59	59	59
No. of analysis	124	127	158	060	157	109	140
Author of analysis	EM	EM	EM	EM	EM	EM	EM
Month of analysis	10	10	11	9	11	10	10
Area in m^2	20	100	80	20	80	18	15
Cover low shrub layer in %	15	70	30	50	90	60	50
Height low shrub layer in m	1.0	1.0	0.8	1.2	1.2	1.2	0.8
Shroud layer in ×					5		
Cover herb layer in %	50	70	40	10	70	70	60
Height herb layer in m	0.8	1.0	0.5	0.5	0.8	0.8	0.5
Cover moss layer			10	40			80
Erigeron canadensis	1.1	1.1					
Ammocalamagrostis baltica	1.2	3.3	×.1				
Festuca juncifolia *	( )	2.3		×.1			
Cirsium arvense	×.1	1.1	×.1	1.1			
Sonchus arvensis *	1.1	1.1	×.1	×.1		×.1	
Ammophila arenaria	3.2	3.2	1.2	×.2		1.2	×.2
Hippophae rhamnoides *	2.3	4.5	3.2	4.3	5.4	3.3	2.3
Cynoglossum officinale	1.1	2.1	1.1	1.1	2.1		×.1
Sambucus nigra	×.2				×.1		
Erodium cicutarium *		×.1	×.1				
Asparagus officinalis		×.1			×.1	2.3	
Rubus caesius		1.1			×.1	2.1	×.1
Solanum dulcamara		×.1		×.1	2.1		×.1
Carex arenaria		2.1		×.1	4.5	3.3	3.1
Tortula ruralis *			2.1	3			
Senecio jacobaea		×.1		×.2	×.1		
Festuca rubra subvar. arenaria			3.3		2.1		
Cerastium semidecandrum			1.1	×.1	2.1		
Phleum arenarium			1.1	1.1	1.1		
Calamagrostis epigeios			1.1		2.1	2.2	1.1
Carlina vulgaris				×.2			
Hypnum cupressiforme *				2			
Bryonia dioica					×.1		
Verbascum thapsus					×.1		
Crataegus monogyna						2.2	×.1
Salix repens *						2.3	3.3
Pyrola rotundifolia *						×.1	2.2
Ligustrum vulgare							×.1
Lophocolea bidentata							1.2
Polygonatum odoratum							×.1
Epipactis helleborine							×.1
Viola hirta							×.1
Inula conyza							×.1
Polypodium vulgare *							×.2

Addenda: 16/24a: Anchusa officinalis ×.2. 24a: Elytrigia pungens * ×.2. 2a/24b: Hypochaeris radicata ×.1. 24b: Taraxacum spec. ×.1, Centaurium littorale ×.2. 25c/3: Rhamnus catharticus ×.1, Galium verum * ×.1, Eupatorium cannabinum ×.1. 24e: Galium mollugo * ×.1, Hieracium umbellatum ×.1, Veronica officinalis ×.1, Leontodon nudicaulis ×.2, Carduus nutans * ×.1, Taraxacum spec. ×.2.

Table VIII. Communities 25 and 26

Community	24c 25a	25a	24c 26a	26a	26d	5c 25b	25b	25a 30	15 25c	22b 25c	25c	25c 25b	26b
Year of analysis	59	59	59	59	59	59	59	59	59	59	39	59	59
No. of analysis	156	112	049	098	162	136	102	165	147	037	15	096	139
Author of analysis	EM	EM	EM	EM	EM	EM	EM	EM	EM	EM	JM	EM	EM
Month of analysis	11	10	9	10	11	10	10	11	10	8	8	10	10
Area in m^2	50	15	60	50	6	80	200	100	100	25	200	100	100
Cover tall shrub layer in %								30					
Height tall shrub layer in m								6.0					5.0
Cover low shrub layer in %	60	40	25	65	70	15	85	70	80	50	90	60	5
Height low shrub layer in m	1.5	1.0	2.0	2.5	0.8	1.0	2.0	3.0	2.5	1.0	-	2.5	2.0
Cover shrova laber in %	35	30		50		25		40	10	30			50
Cover herb layer in %	20	70	65	45	75	65	40	80	35	90	40	25	30
Height herb layer in m	1.0		1.0	1.0	0.6	0.5	1.0	1.5	1.0	1.0	-	1.0	1.5
Cover mass layer in %	20	10			10		20				10		10
Cerastium semidecandrum	2.1												
Solanum dulcamara	×.1			1.1									
Galium verum *	×.1						×.1						
Carex arenaria	2.1	×.1	2.2		3.3	2.2		1.1	1.1	×.1			
Rhamnus catharticus	×.1	2.3	×.1			×.1		×.1	×.1	×.1			
Crataegus monogyna	1.2	×.2	×.1		×.1	×.1	1.1	2.2	×.1	×.1	1.2		
Calamagrostis epigeios	2.2	2.2	2.2	3.1	×.1	1.2	2.2	4.3	2.3	2.2	×.2	2.1	
Cynoglossum officinale	1.1	×.1				×.1				×.1	×.1		×.1
Bryonia dioica	2.1	×.1						1.1					×.1
Hippophae rhamnoides *	4.3	2.3	3.2	3.3	( )	2.2	2.3	3.3	1.2	3.2	4	×.2	3.3
Asparagus officinalis *	×.1	×.1	×.1	1.2		×.1	×.1	( )		×.1		×.1	×.1
Rubus caesius	3.1	3.4	4.3	4.4	3.3	3.3	2.1	3.2	2.3	2.1	×.2	4.3	4.3
Rosa rubiginosa	1.1	2.2	×.1	×.1		×.1		×.1	×.2	1.1	1.2	3.3	1.1
Ligustrum vulgare	×.2	3.3		( )	4.4	2.3	4.4	2.3	1.1	1.1	2	1.1	
Sambucus nigra	×.2		1.1	2.2		×.3		×.2			1.1	2.2	4.3
Urtica dioica	×.1	×.1		×.1				×.1	×.1			×.1	1.1
Cirsium arvense	×.1			×.1		2.1			×.1			1.1	×.1
Holcus lanatus	×.1		×.1				×.2		1.2		×.2	×.2	
Festuca rubra subvar. arenaria	2.2			×.2	1.2	3.2	2.2			2.1			
Eurhynchium praelongum	1.2				2.2						1.2		
Brachythecium rutabulum	2.2				1.2		2.2				1.2		
Lophocolea bidentata	×.1				1.2						2.2		
Lithospermum officinale			×.2	×.2		×.2		( )	×.2				×.1
Lonicera periclymenum				1.2				2.2	×.1				
Polypodium vulgare *					3.3								
Lotus corniculatus *					2.1		×.1						

Table VIII (continued)

Salix repens*					×.2	×.1	3.3	×.2	4.4	3.2	2.3		
Carduus nutans						×.1							
Agrostis tenuis						×.2				×.1			
Senecio jacobaea						1.1							
Prunella vulgaris						×.2			×.1			1.1	
Carlina vulgaris						×.1	×.1						
Inula conyza						×.1	×.1						
Polygonatum odoratum						×.2	×.1						
Fragaria vesca						2.1	×.1		2.1				
Rosa pimpinellifolia						×.1	×.1						
Rosa canina							×.1						
Hieracium umbellatum							×.1						
Betula verrucosa							×.1	3.1	1.1				
Pseudoscleropodium purum							1.2						
Viola hirta							×.1		×.1				
Potentilla reptans							×.1		×.1				
Pyrola rotundifolia *							×.1		2.2	1.1			
Eupatorium cannabinum				( )			1.1	2.2	2.3	1.2	1.2	2.2	2.2
Valeriana officinalis								×.1	×.1				
Glechoma hederacea								2.2					
Salix cinerea									×.1	×.1	×.1	2.2	
Cirsium palustre									×.1		×.2		
Angelia sylvestris									×.1			×.1	
Galium uliginosum									×.2			1.1	
Galium palustre									×.1	×.1	×.1		
Hydrocotyle vulgaris										1.1			
Agrostis stolonifera										2.5	1.2		
Phragmites communis										1.1	( )	×.1	( )
Pulicaria dysenterica										1.1	×.2	2.2	
Mentha aquatica											1.1	×.1	
Melandrium rubrum											×.1	×.1	
Lycopus europaeus												1.1	
Humulus lupulus												2.2	×.1

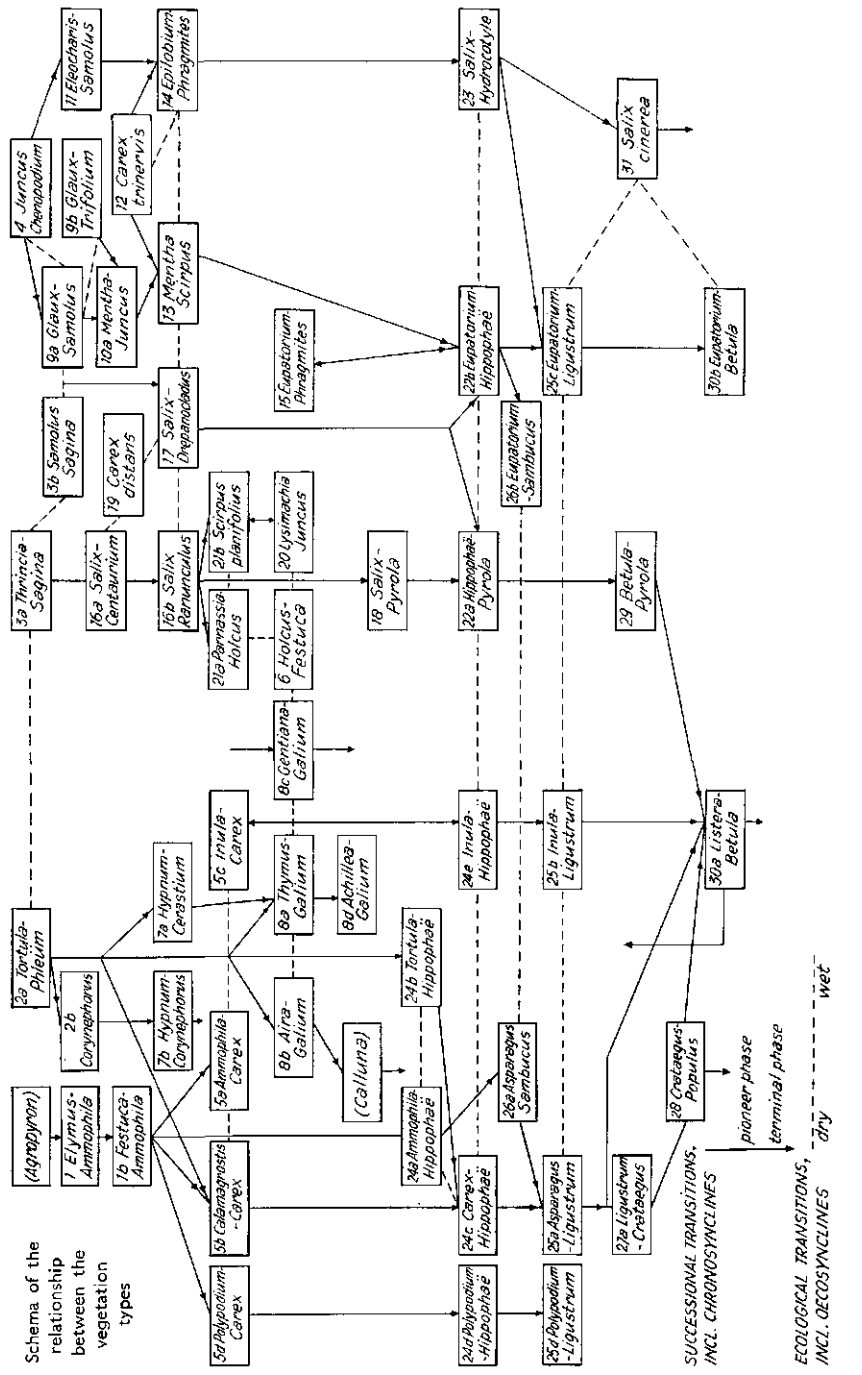
Addenda: 24c/25a: Galium mollugo * ×.1, Ranunculus repens ×.1. 24c/26a: Leontodon nudicaulis * ×.1. 26a: Ribes uva-crispi ×.1, Galium mollugo ×.2. 25d: Ammophila arenaria ×.2, Centaurea pratensis ×.1. 5c/25b: Stellaria media 1.1. 25b: Quercus robur ×.1, Cirsium vulgare ×.1, Succisa pratensis ×.1. 15/25c: Dryopteris austriaca * ×.2, Epilobium palustre ×.1. 22b/25c: Sonchus arvensis * ×.1, Cirsium vulgare ×.1, Potentilla anserina ×.1. 25c: Moehringia trinervia 1.2, Ajuga reptans ×.2, Epipactis helleborine ×.1, Lycopus europaeus ×.2, Veronica officinalis ×.1. 25c/26b: Ribes uva-crispi ×.2, Dryopteris filix-mas ×.1, Epilobium parviflorum ×.1.

Table IX. Communities 27 and 30

Community	27a	29 30	30a	30a b	30b
Year of analysis	59	59	57	59	59
No. of analysis	151	103	032	077	075
Author of analysis	EM	EM	VW	EM	EM
Month of analysis	10	10	5	9	9
Area in m^2	300	54	56	100	400
Cover tree layer in %	-	-	60	50	-
Height tree layer in m	-	-	8	8	-
Cover tall shrub layer in %	90	15	15	-	65
Height tall shrub layer in m	4.0	4.0	5.0	-	5
Cover low shrub layer in %	5	90	70	60	30
Height low shrub layer in m	1.0	2.0	2.0	2.5	2.5
Cover shroud layer in %	15	-	-	-	25
Cover herb layer in %	25	15	20	70	50
Height herb layer in m	1.2	1.5	1.0	2.0	1.5
Cover moss layer in %	5	-	1	10	30
Sambucus nigra	×.1				
Solanum dulcamara	×.1				
Glechoma hederacea	2.1				
Geranium molle	×.1				
Agrimonia eupatoria	×.1				
Inula conyza	×.1				
Rosa pimpinellifolia	×.2				
Berberis vulgaris	×.2				
Serophularia nodosa	1.1				
Cynoglossum officinale	1.1		×.1		
Lithospermum officinale	×.1		×.2		
Polygonatum odoratum	×.1		×.1		
Melandrium rubrum	1.1		×.1		
Mnium undulatum	1.2		×.2		
Brachythecium rutabulum	×.2		×.2		
Geum urbanum	×.1		1.2		
Veronica chamaedrys	×.1		×.1		
Viola hirta	×.1	×.1	1.1		
Bryonia dioica	2.1		×.1	×.1	
Urtica dioica	×.1		×.1	1.1	2.1
Salix repens *	×.2	2.3		×.1	
Asparagus officinalis *	×.1				×.1
Hippophae rhamnoides *	×.1	2.3			1.2 ×.2
Calamagrostis epigeios	2.3	2.2	×.2	1.1	1.1
Rubus caesius	2.1	2.3	2.3	3.2	3.3
Ligustrum vulgare	2.2	4.4	4.4	4.4	2.1
Crataegus monogyna	5.5	1.1	2.1	1.2	1.1
Rhamnus catharticus	×.2	×.1	×.1	×.1	1.3
Potentilla reptans	( )	×.1	×.2	×.1	2.2
Eupatorium cannabinum	×.1	1.1	×.1	2.2	3.4
Holcus lanatus	×.2	×.1	2.2	1.2	1.2
Lonicera periclymenum	×.1		×.2		1.1
Rosa rubiginosa	2.1-3		×.1	×.1	×.1
Geranium robertianum	1.1		×.1		×.1
Rosa canina	×.1	×.1	×.2		×.1
Quercus robur	×.2		×.1		×.1
Viburnum opulus	×.1				×.1
Ribes sylvestre	×.1		×.1		×.1
Fragaria vesca		×.1	×.2		1.1
Pyrola rotundifolia *		1.1	×.2		1.2
Viola odorata			×.2		
Listera ovata			×.2		
Moehringia trinervia			1.2		
Betula verrucosa		2.1	4.1	4.2-3	3.2-3
Cirsium palustre		×.1	×.1	×.1	
Anthoxanthum odoratum			1.2	×.2	
Viola riviniana			×.1	×.1	
Valeriana officinalis			×.2		×.2
Prunella vulgaris				×.1	1.1
Ajuga reptans				2.1	×.2
Phragmites communis				2.1	
Hydrocotyle vulgaris				2.1	×.1
Pulicaria dysenterica				×.1	×.2
Dryopteris filix-mas					2.1
Dryopteris austriaca *					1.2
Frangula alnus					×.1
Salix cinerea					2.3
Salix purpurea					3.4
Galium uliginosum					×.1
Alnus glutinosa					×.1

Addenda: 27a: Carex arenaria ×.1, Galium mollugo * ×.1, 7 species of comm. 8, ×.1 each, Carduus crispus ×.1. 30a: Mentha aquatica ×.1, Dactylis glomerata ×.2, 4 spec. of comm. 8, ×.1 each, 3 spec. of comm. 6, ×.1 each, Myosotis intermedia ×.1, Valeriana dioica 1.2. 29/30: Festuca arundinacea ×.1, Agrostis stolonifera ×.1, Ranunculus repens ×.1. 30a/b: Carex arenaria ×.1, Vicia angustifolia 2.1, Festuca arundinacea 1.2, Rumex obtusifolius ×.1, Lysimachia vulgaris ×.1, Scutellaria galericulata ×.1, 30b: Ranunculus repens ×.1, Cardamine pratensis ×.1, Lycopus europaeus ×.1, Epilobium palustre ×.1, Epilobium parviflorum ×.1.

In the following scheme the most important suggested relationships between the communities and variants are indicated. In horizontal direction ecologic transitions (including ecoclines), in vertical direction successional transitions (including chronoclines), are demonstrated.


Schema of the relationship between the vegetation types
(Agropyron)
1 Elymus-Ammophila
1b Festuca-Ammophila
2a Tortula-Phleum
2b Corynephorus
3a Thinicia Sagina
3b Saxifraga Sagina
4 Juncus Chenopodium
5a Ammophila-Carex
5b Calamagrostis-Carex
5d Polypodium-Carex
6 Holcus-Festuca
7a Hypnum-Cerastium
7b Hypnum-Corynephorus
8a Thymus-Galium
8b Aira-Galium
8c Gentiana-Galium
8d Achillea-Galium
9a Glaux-Samolus
9b Glaux-Trifolium
10a Mentha-Juncus
11 Eleocharis-Samolus
12 Carex trinervis
13 Mentha Scirpus
14 Epilobium Phragmites
15 Eupatorium Phragmites
16a Salix-Centaurium
16b Salix Ramenculus
17 Salix-Drepanocladus
18 Salix-Pyrola
19 Carex distans
20 Lysimachia Juncus
21a Parnassia Holcus
21b Scirpus planifolius
22a Hippophaë Pyrola
23 Salix-Hyarocalyle
24a Inula-Hippophaë
24b Tortula-Hippophaë
24c Carex-Hippophaë
24d Polypodium-Hippophaë
25a Asparagus-Ligustrum
25b Inula-Ligustrum
25c Polypodium-Ligustrum
26a Asparagus Sambucus
26b Eupatorium Sambucus
26c Eupatorium Ligustrum
27 Salix cinerea
28 Crataegus-Populus
29 Betula-Pyrola
30a Listera-Betula
30b Eupatorium-Betula
(Calluna)
2a Ligustrum-Crataegus
SUCCESSIONAL TRANSITIONS, INCL. CHRONOSYNCLINES
pioneer phase
terminal phase
ECOLOGICAL TRANSITIONS, INCL. OECOSYNCLINES
dry
wet

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7. SUMMARY

The vegetation is described of a young, dynamical and periodically built up dune area. Some geomorphological and environmental data are given. 5 zones are described. Manifold animal and human influences are discussed in the light of information theory as applied by Chr. G. van Leeuwen. It is stated that the area has an exceptional variability and consequently a high number of species, ca 400.

Structural description is emphasised. 10 formations were distinguished. A key to the formations and major vegetation types is presented. Two new descriptional terms are introduced: shroud layer and carpeting layer.

Arguments are mentioned for a considerable freedom in choosing method and symbols in vegetation mapping. A survey of current vegetation mapping methods is given. The method followed here is introduced: it concerns a superposition of local species combinations (classified in the Braun–Blanquet system as far as possible) upon a physiognomic-structural division, the latter being interpreted from an air photograph.

Remarks on typification and classification are made. The continuum point of view is emphasised. The cline-concept (Huxley) is applied. Three types of syncline are mentioned: toposyncline, ecosyncline and chronosyncline.

The single-plot analysis method (Braun–Blanquet) was followed. It is argued why no multiple plot analysis method could be employed.

56 Communities and variants are described; a scheme of their relationships is added. Per Community or variant a list of characteristic (constant, dominant and faithful) species is given, as well as a list of differential species towards related communities.

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