

CONSPECTUS OF THE PHANEROGAMIC SALT PLANT COMMUNITIES IN THE NETHERLANDS

by

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Introduction.

After VLIEGER (1937) and WESTHOFF c.s. (1942, 1946) published their surveys of plant communities in the Netherlands, the development of phytocoenology made great progress and lead to extensive specialism. This divergency makes it increasingly difficult to comprise the present syntaxonomic status of phytocoenology as a whole.

The present conspectus only covers the phanerogamic salt plant communities occurring in the Netherlands, worked out according to the principles of the School of J. Braun-Blanquet and R. Tüxen (BRAUN-BLANQUET, 1932, 1951; MELTZER and WESTHOFF, 1944; WESTHOFF, 1950; R. TüXEN, 1950, 1955; ELLENBERG, 1956). This survey is the result of a study of vegetation and environment of the mud flats and salt marshes in the SW part of the Netherlands (Deltaic Area). For an adequate classification of these communities a thorough study of the vegetation of other European regions, by means of a perusal of the literature as well as by field-trips, was indicated. The result of such studies was an attempt to unify the different regional classifications in Europe into a single system. This attempt will be published later on (BEEFTINK, in preparation).

The problems of classification of phytocoenoses growing in an extensive area (in this case Europe) particularly involve the determina-

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tion of faithful taxa of relevant vegetation units. On the one hand locally established faithful taxa of associations must sometimes be deleted after enlargement of the field of investigation, on the other hand regionally established faithful taxa of alliances or orders may sometimes no longer be upheld on comparison with similar (vicarious) higher vegetation units from other regions. Such difficulties increase in magnitude as local phenomena are studied in a broader sense.

The solution is to consider the faithful taxon as a special case of the differential taxon (cf. TUOMIKOSKI, 1942). Contrary to the faithful taxon the differential one only typifies a vegetation unit with respect to a limited number of other vegetation units. Considering a specific combination of differential taxa, a vegetation unit can finally be typically distinguished from all others. In the same way as a specific combination of letters characterizes a letter-lock and this combination distinguishes the lock from all other ones, a combination of sufficient differential taxa will characterize a vegetation unit. After discussion with Dr. V. Westhoff (Bilthoven) the author proposes to use the term « Differential Species Combination » in this respect.

For instance, the mutual floristic differences between the Atlantic and West Baltic alliances *Puccinellion maritimae* and *Armerion maritimae* are much smaller than the differences between both alliances on the one and the other regional groups of vicarious communities — Arctic, Pontic-Pannonic and Mediterranean — on the other hand. Incorporating these two alliances into a separate order, however, it is impossible to find faithful taxa for this unit. This order — named *Glauceto-Puccinellietalia* after the — both Atlantic and West Baltic — taxa *Glaux maritima* and *Puccinellia maritima* — can only be characterized by a differential species combination of:

Plantago maritima — differential with respect to the Mediterranean *Salicornietalia* and *Juncetalia maritimi* (cf. BRAUN-BLANQUET c.s., 1952),

Limonium vulgare (ssp. *pseudolimonium* (Rchb.) Gams) — differential with respect to the Arctic *Puccinellion phryganodis* and *Caricion glareosae* (cf. NORDHAGEN, 1954) and the Pontic-Pannonic *Puccinellietalia* (cf. SOÓ, 1947, 1957; WENDELBERGER, 1943, 1950) and

Spergularia marginata — differential with respect to the Arctic *Puccinellion phryganodis* and *Caricion glareosae* (cf. NORDHAGEN, 1954).

In the present paper, only those salt plant communities are described, which occur mainly within the reach of the tides. The communities growing on saline terrains, situated on the landside of the dikes, are yet insufficiently investigated.

Abbreviations and general concepts.

Tidal levels : MLW — average low-water line;
 MHW — average high-water line;
 MLWS — average low-water line during spring tides,
 and MHWS — average high-water line during spring tides.

The coastal belt is divided into three regions, viz. :

- (1) the sublittoral region, occurring between the line below which no vegetable growth is possible and the line lying about MLWS or MLW;
- (2) the eu-littoral region being the belt between the upper limit of the sublittoral region and the line which generally lies some centimeters below MHW, and
- (3) the supralittoral region included between the upper limit of the eu-littoral region and the line above which no influence of surf takes place. With regard to the salt marsh vegetation only the lower part of the supralittoral region is of importance, viz. the belt between the lower limit and the storm flood zone.

The salinity of waters is classified into zones according to the Venice-system (Final Resolution of the Symposium on the Classification of brackish waters, 1959), viz. :

Eu-halinićum	from av. 22	to av. 16,5 ‰	Cl—
Polyhalinićum	» »	16,5 » » 10 ‰	Cl—
Mesohalinićum	» »	10 » » 3 ‰	Cl—
α -mesohalinićum	» »	10 » » 5,5 ‰	Cl—
β -mesohalinićum	» »	5,5 » » 3 ‰	Cl—
Oligohalinićum	» »	3 » » 0,3 ‰	Cl—
Fresh water zone	» »	0,3 downwards.	

The zonation of the salt plant communities coincides very well with these salinity-zones.

In this survey the terms « mud flat » and « sand flat » are always used in the sense of the Dutch word « slik », meaning generally scarcely overgrown terrains situated below MHW (coinciding with terrains in the eu-littoral region). The term « salt marsh » is used in the sense of the Dutch word « schor », meaning the terrains situated between MHW and the storm flood zone (lower supralittoral region).

For the nomenclature the Illustrated Flora of the Netherlands by HEUKELS-VAN OOSTSTROOM (1956) is used. Only for the *Agropyron* (= *Elytrigia*) species the nomenclature proposed by HANSEN (1961) is followed.

Conspectus of the salt plant communities.

Class : **ZOSTERETEA MARINAE** Pignatti 1953 (cf. R. TüXEN and OBERDORFER, 1958).

Order : **ZOSTERETALIA** Bég. 1941 em. Br.Bl. et R. Tüxen 1943.

Alliance : *Zosterion* W. Christiansen 1934.

Eel-grass communities of the Westeuropean and Baltic coasts as well as those of the Mediterranean.

Faithful taxon : *Zostera marina* s.l.

Synecology : On sheltered mud and sand flats in the sublittoral and

eu-littoral. In the Netherlands down to 3-4 m in the sublittoral; the upper limit of the alliance and its associations is related to the degree of desiccation to which the vegetation has been exposed during the period of emergence. Optimal in the eu-halinicum and polyhalinicum; in mesohaline waters absent or mixed with elements of the Ruppion maritimae. Locally in inland pools and canals.

Distribution : Wadden Area : Chiefly on the inside of the Frisian Islands and along the coasts of the mainland.

Deltaic Area : In the Grevelingen, Oosterschelde, Zandkreek, Veerse Gat and Eendracht. Formerly in the Westerschelde.

Association 1 : *Zosteretum marinae* Harmsen 1936.

Faithful taxon : *Zostera marina* var. *marina*.

Synecology : On muddy to sandy soils in the sublittoral from about MLW to 3-4 m below. Sensitive to erosion; a moderate sedimentation stimulates its development.

Distribution : As a result of the epidemic in 1930-34 and the following erosion of the habitats the association is rare in the Netherlands.

Wadden Area : Before the epidemic occurring in an area of about 15.000 ha (VAN GOOR, 1919, 1921, 1922). At present only found in creeks, intersecting the salt marshes in Terschelling and in Schiermonnikoog, and in the inland pools of brackish water at « De Bol » in Texel (DEN HARTOG, 1959).

Deltaic Area : Only found in the harbour-canal of Goes (Zuid-Beveland). Probably before the epidemic rare too.

Association 2 : *Zosteretum marinae stenophyllae* Harmsen 1936.

Syn. : *Zosteretum nano-stenophyllae* Den Hartog 1958 p.p.

Faithful taxon : *Zostera marina* var. *stenophylla* A. et G.

Synecology : On muddy to sandy soils in the eu-littoral from 30-100 cm below MHW to the low-water line. Sometimes a zone without phanerogams separates the association from the *Zosteretum marinae* (HARMSSEN, 1936). In the upper part the *Zosteretum marinae stenophyllae* frequently forms a mosaic with the following association, the *Zosteretum nanae* : The first association in wet and muddy depressions, the second one on higher and therefore during the period of emergence drier parts. The difference between these associations is more conspicuous in the Deltaic Area than in the Wadden Area (cf. DEN HARTOG, 1958). All or nearly all rhizoms of the var. *stenophylla* are killed by frost each year. Consequently the association is annual.

Distribution : Wadden Area : Scattered on the inside of the Frisian Islands and e.g. on the Balgzand (Noord-Holland). After the enclosure of the Zuiderzee in 1932 the area of this association decreased as a result of the higher tides.

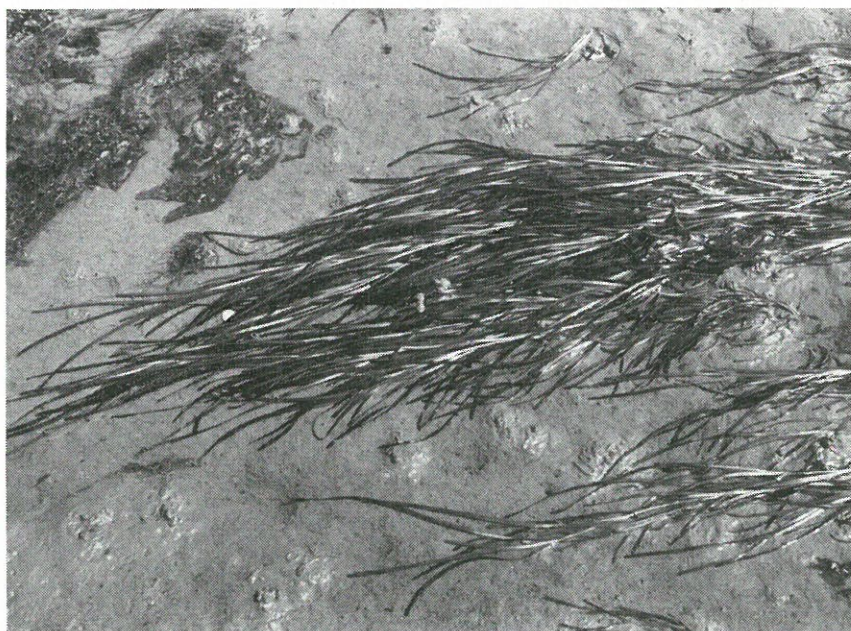
Deltaic Area : In the Grevelingen (Hompelvoet), Oosterschelde (rare) and Zandkreek (mainly on the Middelpaten).

Association 3 : *Zosteretum nanae* Harmsen 1936.

Syn. : *Zosteretum nano-stenophyllae* Den Hartog 1958 p.p.

Faithful taxon : *Zostera nana*.

Synecology : In the upper half of the eu-littoral, on generally firmer and, during the period of emergence, drier parts of the mud flats than the former association. On the lower side sometimes connected with the *Zosteretum marinae stenophyllae*, forming a mosaic with it. In the Deltaic Area, on the upper side sometimes passing into the *Salicornietum strictae*; in the Wadden Area, however, mostly separated from the latter association by a zone of microphytes only (cf. DEN HARTOG, 1958).



1. — *Zostera marina* var. *stenophylla* A. et G. during ebb-tide.

Distribution : Wadden Area : Principally on the inside of the Frisian Islands, but also along the mainland : Lauwerszee, Balgzand.

Deltaic Area : Grevelingen (e.g. Hompelvoet), Oosterschelde, Veerse Gat, Zandkreek (e.g. Middelpaten), Eendracht. Formerly in the Zuid-Sloe (Westerschelde).

Locally superseded by *Spartina townsendii*.

Class : **RUPPIETEA** J. Tüxen 1960.

Order : *RUPPIETALIA* J. Tüxen 1960.

Alliance : *Ruppion maritimae* Br.-Bl. 1931 n.n.

Aquatic plant communities of the European brackish waters.

Faithful taxa (on the authority of J. TüXEN, 1960) : *Ruppia maritima*, *Zannichellia palustris* ssp. *pedicellata*, *Chara crinita*, *Ch. baltica*, *Potamogeton pectinatus* var. *zosteraceus* and *Ranunculus obtusiflorus*.

Synecology : In brackish pools and creeks of the beach- and dune-landscape; brackish inland pools and seas; brackish ditches and canals in the polder-land. Up to the present the associations have not been sufficiently investigated in the Netherlands (cf. VAN GOOR, 1922; WESTHOFF, 1943; WESTHOFF c.s., 1946).

Distribution : Wadden Area : In the Frisian islands and in the polder-land of the mainland. Formerly common in the Zuiderzee where, locally, it was mixed with elements of the *Zosterion* (VAN GOOR, 1922).

Deltaic Area : Common in brackish waters of the polders. Very rare outside the dikes : only fragmentary in pools of some salt marshes in the Eendracht (communities of *Zannichellia palustris* ssp. *pedicellata*).

Class : **THERO-SALICORNIETEA** R. Tüxen 1954 (cf. R. TüXEN and OBERDORFER, 1958).

Syn. : *Puccinellio-Salicornietea* Tzopa 1939 p.p. (cf. WESTHOFF c.s., 1946).

Order : *THERO-SALICORNIETALIA* R. Tüxen 1954 (cf. R. TüXEN and OBERDORFER, 1958).

Syn. : *Puccinellio-Salicornietalia* Br.-Bl. et De Leeuw 1936 p.p.

Alliance : *Thero-Salicornion* Br.-Bl. 1933 em. R. Tüxen 1954.

Syn. : *Puccinellio-Salicornion* Br.-Bl. et De Leeuw 1936 p.p.; *Salicornion* Corillion 1953 p.p.; non *Thero-Suaedion* Br.-Bl. (1931) 1933 em. R. Tüxen 1950.

Communities of annual *Salicornia*'s along the coasts and in the interior of Europe.

Faithful taxon : *Salicornia europaea* coll.

Synecology : Outside the dikes : Pioneer communities of the halosere on mud flats and salt marshes as well as on beach-plains partly cut off from the sea by banks or dunes; Consequently in the highest parts of the eu-littoral or ecologically equivalent habitats. The communities on the mud flats are always inundated except during very low HW-tides. On the salt marshes they occur only in saline and temporarily (mainly in winter) moist to very wet depressions. On the beach-plains the habitat is superficially rather dry in summer but a little clay mixed with the sand prevents total desiccation. Practically confined to the eu-halinicum and polyhalinicum.

On the landside of the dikes : Pioneer communities along the borders of eu-haline and polyhaline waters and in saline and temporarily wet to moist depressions.

The soil is always very superficially aerated ($\frac{1}{2}$ -1 cm only) and shows black iron sulphides underneath.

Distribution : Widely distributed all over the Wadden and Deltaic Areas as well as the adjacent polders. Along the Haringvliet only in the mouth (Kwaden Hoek, Goeree), along the Westerschelde up to the Belgian frontier. Formerly locally along the coasts of the Zuiderzee (VAN GOOR, 1922; DE LEEUW, 1929). In the last twenty five years ousted in most localities by *Spartina townsendii*, except in the polders.

Association-group : *Salicornietum europaeae* (Warming 1906) auct.

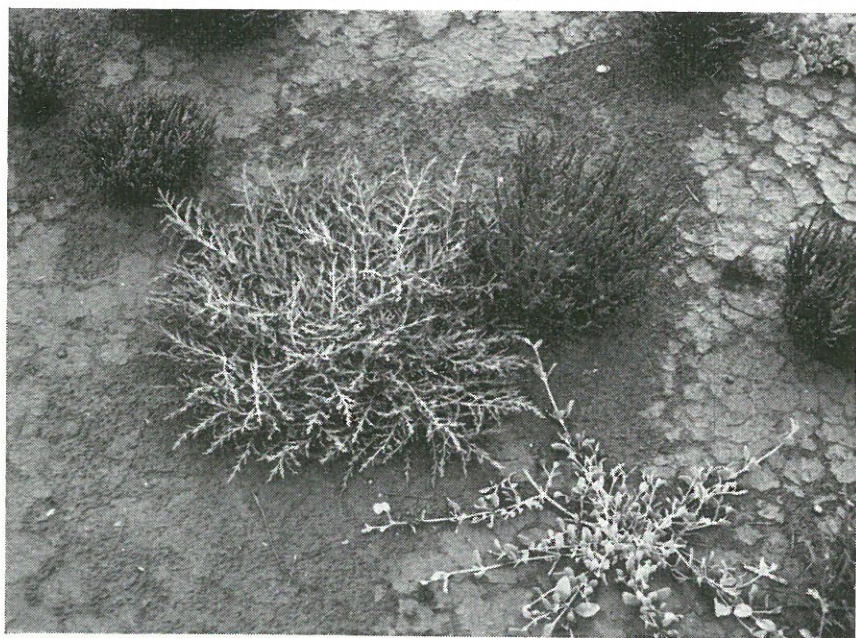
Syn. : *Salicornieto-Spartinetum* Br.-Bl. et De Leeuw 1936 p.p.

Faithful taxon : *Salicornia europaea* coll.

Constant companion : *Spartina townsendii* (only outside the dikes).

Synecology : Vide under the alliance.

Distribution : Vide under the alliance.



2. — Some types of *Salicornia europaea* as well as a young individual of *Halimione portulacoides*.

Note : *Salicornia europaea* must be split into a number of species and/or subspecific taxa, which appear to grow on different habitats. Awaiting further taxonomic investigations it seems better to class the *Salicornia*-communities into an association-group. Presumably it may be possible to distinguish a number of distinct associations, eventually subassociations.

In Germany CHRISTIANSEN (1955) distinguishes two associations, viz. :

Association 1 : *Salicornietum strictae* W. Christiansen 1955.

Syn. : *Salicornietum strictissimae* Gillner 1960.

Faithful taxon : *Salicornia europaea* var. *stricta* Dum. em. König.

Synecology : On the highest parts of the mud flats. Exclusively within the daily reach of the tides.

Association 2 : *Salicornietum patulae* (Schultz 1939) W. Christiansen 1955.

Faithful taxon : *Salicornia europaea* var. *patula* Duval-Jouve em. König.

Synecology : On less extreme habitats than the former association : In saline and temporarily wet depressions of the salt marshes and in the polders.

Note : R. TüXEN (1957) and R. TüXEN and OBERDORFER (1958) class this association into the Thero-Suaedion Br.-Bl. 1931 em. R. Tüxen 1950 on account of the constant presence of *Suaeda maritima* and its occurrence on small tidal drift lines lying on the mud flats. The correctness of this view cannot be denied, but seems to be a little premature.

Phase : *Salicornietum europaeae* (*Salicornietum strictae*), degeneration phase with *Suaeda maritima*.

Differential taxa : *Suaeda maritima* and *Halimione portulacoides*.

Synecology : On low creek banks in the highest part of the eu-littoral. The phase forms the transitional stage in the succession from the *Salicornietum europaeae* to the *Halimionetum portulacoidis* on the creek banks.

Distribution : In the province of Zeeland only found on increasing salt marshes where *Spartina townsendii* has not yet disturbed the succession : Schotsman in the Veerse Gat; islets in the Eendracht, north of Oud-Vossemeer (Tholen).

Class : *SPARTINETEA* R. Tüxen 1961.

Order : *SPARTINETALIA* Conard 1935.

Alliance : *Spartinion* Conard 1952.

Syn. : Puccinellio-Salicornion Br.-Bl. et De Leeuw 1936 p.p.; Salicornion Corillion 1953 p.p.

Spartina communities along the coasts of Western Europe and the east coasts of North America.

Faithful taxon : The genus *Spartina*.

Synecology : On soils ranging from very heavy clay to sandy clays. Optimal in the eu-littoral : In the province of Zeeland from about 1 m below MHW to 10-15 cm above MHW. Optimal in the polyhalinicum, but also in the eu-halinicum and α -mesohalinicum; in the latter salinity-zone, however, in a smaller vertical amplitude. In the polders locally on saline and very wet habitats and in similar ditches and canals.

Distribution : Wadden Area : On the inside of the Frisian Islands especially in the neighbourhood of tidal divides; Common along the coasts of the mainland.

Deltaic Area : Very common.

Association 1 : *Spartinetum maritimae* Corillion 1953.

Syn. : Association with *Spartina stricta* and *Salicornia* Br.-Bl. 1933 prov. p.p.; *Salicornieto-Spartinetum* Br.-Bl. et De Leeuw 1936 p.p. (cf. WESTHOFF c.s., 1942, 1946).

Faithful taxa : *Spartina maritima* and the phaeophyte *Fucus vesiculosus* L. var. *lutarius* Chauv. (the latter only faithful in the Netherlands).

Constant companion : *Spartina townsendii*.

Synecology : In a narrow zone closely below MHW. Limited to the polyhalinicum. Prefers soft, water-logged mud and is therefore also found in the lowest parts of the basins in the salt marsh. Can nowadays only maintain itself on terrains where *Spartina townsendii* is moderately established.

Distribution : Reaches the northern limit of its area of distribution on the south coast of Goeree and Overflakkee. Formerly common along the Grevelingen, Krammer, Oosterschelde, Krabbenkreek, Eendracht, Veerse Gat and Zandkreek; along the Westerschelde, the Braakman included, to west of Bath and on the Verdrongen Land van Saafinge. At present nearly entirely superseded by *Spartina townsendii* and only known from some places along the Zandkreek, Oosterschelde and Eendracht. In Overflakkee found on the landside of the dike.

Association 2 : *Spartinetum townsendii* (auct.) Corillion 1953.

Faithful taxon : *Spartina townsendii*.

Synecology : Outside the dikes often in a broad zone, which zone ranges from about 1 m below MHW to 10-15 cm above MHW in the province of Zeeland. Optimal on soft muds of the eu-littoral. Also in the lowest parts of the basins and in creeks of the salt marsh. Favours sedimentation owing to its dense growth and thus exerts a levelling influence on the landscape. Furthermore, *Spartina townsendii* supersedes a number of other associations (*Zosteretum nanae* p.p., *Salicornietum strictae*, *Spartinetum maritimae* and *Puccinellietum*

maritimae p.p.). Optimal in the polyhalinicum but penetrates into the α -mesohalinicum.

On the landside of the dikes rather common in saline (polyhaline) pools and ditches where seepage of sea water takes place, e.g. Inlaag 1887 near Ellewoutsdijk (Zuid-Beveland), Braakmanpolder (Zeeuwsch-Vlaanderen).

In its optimal form the association consists exclusively of *Spartina townsendii*; even algae and molluscs are scarce or entirely lacking.

Distribution: Wadden Area: Common along the coast of the mainland; on the inside of the Frisian Islands especially in the neighbourhood of tidal divides.

Deltaic Area: Very common from the Haringvliet to the estuary of the river Scheldt. But in the Oosterschelde and adjacent waters less abundant than in the Westerschelde. Along the Westerschelde upstream to Fort Ste Marie in Belgium. Locally in the polders.

Class : **ASTERETEA TRIPOLIUM** Westhoff et Beeftink cl. nov.

Syn.: *Juncetea maritimi* Br.-Bl. 1931 p.p.; *Puccinellio-Salicornietea Tzopa* 1939 p.p. (cf. WESTHOFF c.s. 1946).

Communities of European salt marshes and saline terrains in the interior from the Arctic to the Mediterranean coasts and from the Westeuropean coasts to the Pontic region in the East.

Faithful taxa: *Aster tripolium* s.l. and *Triglochin maritimum*.

Order : **GLAUCETO-PUCCINELLIETALIA** Beeftink et Westhoff ordo nov.

Syn.: *Puccinellio-Salicornietalia* Br.-Bl. et De Leeuw 1936 p.p.; *Junceto-Caricetalia* Corillion 1953 p.p.; non *Juncetalia maritimi* Br.-Bl. 1931.

Communities of the Westeuropean salt marshes from the Lofoten in Norway to the coasts of Spain and Portugal, along the Skagerrak, Cattegat and West Baltic, on saline terrains in the Westeuropean polders and in Central Europe (Germany).

Differential species combination: *Plantago maritima*, *Limonium vulgare* and *Spergularia marginata*.

Alliance 1: *Puccinellion maritimae* (W. Christiansen 1927 p.p.) R. Tüxen 1937.

Syn.: *Festucion maritimae* W. Christiansen 1927 p.p.; *Puccinellio-Salicornion* Br.-Bl. et De Leeuw 1936 p.p.; *Puccinellion* Corillion 1953.

Faithful taxon: *Puccinellia maritima* (degree of fidelity: selective).

Synecology: On the lower parts of the salt marshes from about MHW to a little below MHWS (lower part of the lower supralittoral). Optimal in the polyhalinicum but also in the eu-haline and α -mesohaline zones. In the last zone mixed with *Glaux maritima*, *Juncus gerardi*, *Agrostis stolonifera* subvar. *salina* J. et W. and elements of

the *Agropyro-Rumicion crispi*. Also on higher parts of the salt marsh which are trodden by man or cattle.

On the landside of the dikes on terrains with eu-haline to poly-haline soil moisture and upwards from the level where the water stagnates during winter. On mesohaline habitats replaced by communities of the *Armerion maritimae* or the *Agropyro-Rumicion crispi*.

Distribution : Very common all over the Wadden and Deltaic Areas. On the landside of the dikes common on suitable habitats in the provinces of Groningen, Friesland, Noord-Holland but especially in the isles of Zuid-Holland and in Zeeland. Formerly along the borders of the Zuiderzee.



3. — Springergors near Ouddorp
(Isle of Goeree and Overflakkee).
Puccinellietum maritimae, variant with *Limonium vulgare*; in
the foreground and to the right the edge of the *Halimionetum*
portulacoidis.

Association 1 : **Puccinellietum maritimae** (Warming 1906) W. Christiansen 1927.

Syn.: Association with *Atropis maritima* and *Aster tripolium* Hocquette 1927; *Astereto-Glycerietum* Van Langendonck 1931, 1933; *Staticetum Limonii* Van Langendonck 1933 p.p.; *Astereto-Puccinellietum maritimae* Dahl et Hadac 1941.

Faithful taxa: *Puccinellia maritima* (degree of fidelity: preferent) and *Halimione pedunculata*.

Constant taxa: *Aster tripolium*, *Salicornia europaea*, *Suaeda maritima*, *Triglochin maritimum* and *Limonium vulgare* (the latter exclusively in the eu-haline and polyhaline zones within the reach of the tides).

Synecology: The most common association on the salt marsh; corresponding to the « General Salt Marsh (G.S.M.) » distinguished by English authors (e.g. CHAPMAN, 1934, 1960; TANSLEY, 1949). It occupies the low parts adjoining the *Salicornia* and *Spartina* communities, particularly the basins between the creek banks. Optimal in the polyhalinum, but penetrates far into the α -mesohaline zone. On the landside of the dikes bordering eu-haline and polyhaline waters. The association is rather variable in its floristic and structural composition.

Distribution: Very common all over the Wadden and Deltaic Areas. Also common on suitable habitats on the landside of the dikes.

Subassociation 1 : **Puccinellietum maritimae typicum** Westhoff 1947.

Differential taxon: *Limonium vulgare*.

Synecology: On clay- and sandy clay-soils, exclusively in the polyhaline and eu-haline zones. On the landside of the dikes very rare and exclusively where heavy seepage of sea water takes place through the dikes.

Distribution: Common all over the Wadden and Deltaic Areas.

Variant: **P. maritimae typicum**, variant with *Limonium vulgare* var. nov.

Syn.: *Staticetum Limonii* Van Langendonck 1933 p.p.; *Artemisietum maritimae*, facies with *Statice Limonium Adriani* 1945; *Puccinellietum maritimae*, « dry » phase with very much *Limonium* and first degeneration phase Mörzer Bruyns c.s. 1953.

Differential (dominant) taxon: *Limonium vulgare*.

Synecology: On clay-soils in water-logged basins; grazing keeps down its development. Sometimes also on sandy soils at the foot of little dunes or beach-banks and where the soil is water-logged.

Distribution: Wadden Area: In the Frisian Islands locally where grazing is absent. Recently extending on formerly sandy terrains with continually increasing sedimentation of silt.

Deltaic Area: Common in the eu-haline and polyhaline zones, e.g. on the Springersgors (Goeree), the Kaloot (Zuid-Beveland), in the

former Braakman (Zeeuwsch-Vlaanderen) and in the Zwin (Zeeuwsch-Vlaanderen, at the Dutch-Belgian frontier).

Phase 1 : *P. maritimae* typicum, initial phase with *Puccinellia maritima* Westhoff 1947.

Differential (dominant) taxon : *Puccinellia maritima*.

Synecology : *Puccinellia maritima* vegetations, poor in species, originating from the *Salicornietum strictae* after sufficient sedimentation of silt. Since *Puccinellia maritima* holds more silt than the *Salicornia*'s an undulating pattern often develops with the initial phase on the elevations and *Salicornia* vegetations in the depressions.

Distribution : Wadden Area : Mainly in the Frisian Islands e.g. Terschelling (WESTHOFF, 1947) and Schiermonnikoog (WESTHOFF, written communication). Moreover on the Balgzand, Noord-Holland (DEN HARTOG, 1958).

Deltaic Area : Not observed.

Probably this initial phase has a northern distribution and reaches its southern limit in the Dutch Wadden Area. Southwards its place has been taken by the initial phase with *Spartina maritima* (cf. BEEFTINK, 1956).

Phase 2 : *P. maritimae* typicum, initial phase with *Spartina maritima* nom. nov.

Syn. : *Astereto-Glycerietum Spartinetosum strictae* Van Langendonck 1931.

Differential (subdominant) taxon : *Spartina maritima*.

Synecology : This phase forms the transitional zone between the *Spartinetum maritimae* and the *Puccinellietum maritimae* typicum. On increasing coasts it is characteristic for the transition from mud flat to salt marsh. Otherwise it has been found in lower, water-logged parts of the basins in the salt marsh.

Distribution : Wadden Area : absent.

Deltaic Area : Formerly common in the eu-haliniticum and polyhaliniticum, south of the isle of Goeree and Overflakkee. Nowadays rare along the Veerse Gat, Zandkreek and Eendracht. VAN LANGENDONCK (1931) describes the phase from the Verdrongen Land van Saaftinge.

Phase 3 : *P. maritimae* typicum, terminal phase with *Halimione portulacoides* nom. nov.

Syn. : *Astereto-Puccinellietum*, variant with *Obione portulacoides* Van Langendonck 1933.

Differential (subdominant) taxon : *Halimione portulacoides*.

Synecology : Of the three terminal phases the one with *Halimione portulacoides* occurs on soils particularly rich in clay. The phase develops in highly silted basins and on the transition from basins to creek banks. Grazing may lead to its development by degenerating the

Halimionetum portulacoidis. Often *Suaeda maritima* is abundant. It must be considered as the transitional stage in time and space from the *Puccinellietum maritimae* typicum towards the following *Halimionetum portulacoidis*.

Distribution : Wadden Area : Locally, especially where sedimentation of silt takes place in a sandy *Puccinellietum maritimae* typicum (cf. BEEFTINK, 1959).

Deltaic Area : Common, e.g. on the Springergors (Goeree), on the Kaloot and the salt marsh near Ellewoutsdijk (Zuid-Beveland).

Phase 4 : *P. maritima* typicum, terminal phase with *Plantago maritima* and *Limonium vulgare* Beeftink 1959.

Syn. : *Plantagineto-Limonietum* Westhoff et Segal 1961.

Differential species combination : *Plantago maritima* and *Limonium vulgare*.

Synecology : On silty soils with an important sand component situated on the outer slopes of the creek banks (cf. BEEFTINK, 1959) and at the foot of low dunes and beach banks. Salinity of the soil moisture corresponds to that of the previous phase. Grazing keeps down its development. The phase may form the transitional stage from the *Puccinellietum maritimae* typicum and *pholiuretosum* towards the *Artemisietum maritimae* typicum and *armerietosum*.

Distribution : Wadden Area : Locally in the Frisian Islands where grazing is absent (cf. WESTHOFF and BROUWER, 1951).

Deltaic Area : rare; along the Veerse Gat and Zandkreek locally and mostly fragmentary on the outer slopes of sandy creek banks; on the Kaloot (Zuid-Beveland) on the inside of the beach bank.

Phase 5 : *P. maritima* typicum, terminal phase with *Halimione pedunculata* nom. nov.

Differential taxon : *Halimione pedunculata*.

Synecology : Generally this phase consists of an open vegetation and develops optimally on sandy soils. The average salinity of the soil moisture seems to be a little lower than in the case of the previous two phases, but the amplitude is probably much larger. Influence of fresh water flowing off dunes, beach banks, etc., may be important.

Distribution : Wadden Area : As such not distinguished but locally present in the Frisian Islands as appears from analyses of BRAUN-BLANQUET and DE LEEUW (1936), WESTHOFF (1947, manuscript) and VAN DER TOORN (1959).

Deltaic Area : Mostly fringing the variant with *Juncus gerardi* of the *Armerieto-Festucetum* on the lower side. Within the reach of the tides on the inner side of dunes or beach banks : Groene Strand (De Haak) near Oostvoorne, Schotsman (Noord-Beveland), Verdronken Zwarte Polder and Zwin (Zeeuwsch-Vlaanderen). On the landside of the dikes : Westenschouwen Inlagen (Schouwen) and Inlaag 1887 near Ellewoutsdijk (Zuid-Beveland).

Subassociation 2: *Puccinellietum maritimae pholiuretosum* Westhoff 1947.

Differential taxa (on the authority of WESTHOFF, 1947): *Parapholis strigosa* (= *Pholurus filiformis*), *Agrostis stolonifera* f. *subarenaria*, *Salicornia europaea* ssp. *ramosissima*, *Elytrigia juncea* (L.) Nevski.

Synecology: On sandy to very sandy soils of beach-plains. In summer the vegetation, which is open, is flooded rarely. The salinity of the soil moisture has a very large amplitude and may fall to zero, owing to precipitation.

Distribution: Wadden Area: On the beach-plains of the Frisian Islands (WESTHOFF, 1947). Beyond the reach of the tides very rare: only found along the Balgkanaal, Noord-Holland (DEN HARTOG, 1958).

Deltaic Area: Very rare on account of shortage of beach-plains: only found on the Kwaden Hoek, on the north coast of Goeree.

Subassociation 3: *Puccinellietum maritimae agrostidetosum* subass. nov.

Differential species combination: *Agrostis stolonifera* subvar. *salina* J. et W., *Glaux maritima* and *Juncus gerardi*.

Synecology: In the α -mesohaliniticum this subassociation takes the place of the *Puccinellietum maritimae typicum*. Its habitat resembles that of the latter subassociation, the soil being in general more clayey and the soil moisture less saline. Besides by the presence of the above-mentioned differential taxa the *P. maritimae agrostidetosum* is also characterized by the absence of halophytes « pur sang » such as *Limonium vulgare*, *Halimione portulacoides*, *Spergularia marginata* and the therophytes *Salicornia europaea* and *Suaeda maritima*.

Distribution: Wadden Area: In the Dollard (DE VRIES, 1940). Formerly probably common along the borders of the Zuiderzee.

Deltaic Area: Common along the Haringvliet and the estuary of the river Scheldt from Bath and the Verdrongen Land van Saafftinge up to the former Fort Pijp Tabak, about two kilometers downstream of Antwerp.

Phase: *P. maritimae agrostidetosum*, initial phase with *Aster tripolium* nom. nov.

Differential (dominant) taxon: *Aster tripolium*, especially var. *tripolium*.

Synecology: Mostly on soft, muddy soil, rich in clay. In the α -mesohaliniticum; sometimes in a more saline environment but then developed under the local influence of fresh water flowing off dunes, beach-banks or pleistocene sediments (Groene Strand near Oostvoorne). Grazing hampers the development of the phase.

Distribution: Wadden Area: Only known from the Dollard (DE VRIES, 1940).



4. — Zonation on the salt marsh north of Oud-Vossemeer (Tholen). Lower part of the basin: *Spartinetum maritimae* (centre and right) and *Spartina townsendii* (left). Higher part of the basin: *Puccinellietum maritimae* typicum (in the foreground and behind the *Spartinetum maritimae*). On the creek banks: *Halimionetum portulacoidis*.

Deltaic Area: Groene Strand (De Haak) near Oostvoorne; perhaps locally along the Haringvliet; along the Scheldt-estuary rare, e.g. Galgeschoor north of Lilloo (Belgium).

Facies: *Puccinellietum maritimae* typicum, et agrostidetosum, facies of *Puccinellia maritima*.

Dominant taxon: *Puccinellia maritima*.

Synecology: Heavy grazing stimulates the development of *Puccinellia maritima*, so as to form a closed turf, while other species as *Aster tripolium*, *Halimione portulacoides*, *Triglochin maritimum*, *Limonium vulgare* and *Plantago maritima* are kept down. Land reclamation works (trenching) as e.g. those along the coasts of the provinces of Groningen and Friesland, lead also to the development of the facies. The facies develops as well in the *P. maritimae* typicum as in the *P. maritimae* agrostidetosum but is more spectacular in the former subassociation. It should not be confused with the initial phase with *Puccinellia maritima* of the *P. maritimae* typicum which also develops without grazing.

Note: In the Zwin MÖRZER BRUIJNS c.s. (1953) distinguishes **degenerating stadia** of the *Puccinellietum maritimae*, characterized mainly by the presence of elements of the *Armerion maritimae* and the *Agropyro-Rumicion crispis* s.l. (cf. also VANDE VYVERE, 1957).

Association 2: *Halimionetum portulacoidis* (Kuhnholz-Lordat 1927)
Des Abbayes et Corillion 1949.

Syn.: Association of *Obione portulacoides* Kuhnholz-Lordat 1927; *Atropidetum maritimae*, facies of *Atriplex portulacoides* De Litardière et Malcuit 1927; the *Obionetum* of English authors, o.a. Chapman 1934; *Obione community* De Vries 1940; *Artemisietum maritimae*, facies of *Obione portulacoides* Adriani 1945; *Puccinellietum maritimae*, facies of *Obione portulacoides* Westhoff 1947; sociation of *Obione portulacoides* and *Bostrychia scorpioides* Mörzer Bruijns et Westhoff 1951; *Obione portulacoides* sociation Den Hartog et Schroevers 1952; *Puccinellietum maritimae*, facies of *Suaeda maritima* and *Halimione portulacoides* Mörzer Bruijns c.s. 1953.

Faithful taxa: *Halimione portulacoides* and the rhodophyte *Bostrychia scorpioides*.

Constant taxa: *Puccinellia maritima*, *Suaeda maritima*, *Limonium vulgare*, *Aster tripolium* and *Salicornia europaea*.

Synecology: Exclusively on more drained clay- and sandy clay-soils. However, after establishment *Halimione portulacoides* is able to endure sedimentation of sand, either by wind or by flooding very well (e.g. on the low beach bank of the Kaloot, Zuid-Beveland, and along the north coast of Noord-Beveland). On the salt marsh the association develops on the low creek banks and the outer slopes of large creek banks, as well as in a narrow zone on the inside of the creek banks. Rarely, too, in basins which have been silted up very highly (e.g. on the Springersgors, Goeree). Where tidal drift is absent, the association also forms a well-developed zone at the foot of dikes. The association is confined to the eu-haline and polyhaline zones. It tolerates grazing badly (cf. *Puccinellietum maritimae* typicum, terminal phase with *Halimione portulacoides*).

Distribution: Wadden Area: Rare; mainly on the inside of the Frisian Islands in the neighbourhood of tidal divides.

Deltaic Area: Very common along the Grevelingen, Oosterschelde, Veerse Gat, Zandkreek and Eendracht; along the Westerschelde from the mouth to the salt marshes near 's Gravenpolder and Ossensisse.

Phase: *H. portulacoidis*, terminal phase with *Artemisia maritima* nom. nov.

Differential taxa: *Artemisia maritima* and *Festuca rubra* f. *litoralis* Hackel.

Synecology: On a little higher and therefore more drained parts of the creek banks. Forms the transitional stage from the *Halimionetum portulacoidis* to the *Artemisietum maritimae*. Also at the foot of dikes.

Distribution : Wadden Area : Rare in the Frisian Islands.
Deltaic Area : Common, wherever the association occurs.

Association 3 : **Puccinellietum distantis** Feekes (1934) 1943.

Syn. : Puccinellieto distantis- Spergularietum salinae (Feekes 1936) Vlieger 1938; Spergularia salina association R. Tüxen et Volk 1937 prov. (vide R. TüXEN, 1937); Puccinellia distans association R. Tüxen 1957, Gillner 1960.

Faithful taxa : Spergularia salina, Puccinellia distans, P. retroflexa, P. rupestris and P. fasciculata.

Constant taxa (in the Deltaic Area) : Puccinellia maritima and Aster tripolium.

Syncology : Outside the dikes : Mostly in the combination of Spergularia salina with Puccinellia distans. Locally in the Puccinellietum maritimae, in associations of the Armerion maritimae and in the Atripliceto-Elytrigietum pungentis, which are trodden or where sods have been cut. Preferably in the neighbourhood of tidal drifts, e.g. at the foot of dikes. Probably the association is to some extent nitrophilous. The firm character of the soil together with a small cover of the vegetation imply large contrasts in salinity and soil moisture content. The presence of elements of the Polygonion avicularis and the Agropyro-Rumicion crispis also indicates on this property of the habitat. Rarely on occasionally flooded beach-plains. Optimal in the α -mesohaliniticum; also in the polyhaliniticum but then on a higher level.

On the landside of the dikes : On the same habitats but also bordering polyhaline and α -mesohaline creeks and pools. The association often develops after a lowering of the water-table in the creeks, etc., e.g. in the isles of Walcheren and Schouwen and Duiveland after the flood disaster of 1953.

Distribution : Wadden Area : Locally all over the area; Formerly common along the coasts of the Zuiderzee (DE LEEUW, 1929; SLOFF, 1931; FEEKES, 1934) and, after the closure of this inland sea, in large masses on the emerging flats and in the young Yselmeerpolders (FEEKES, 1936, 1943; FEEKES and BAKKER, 1954).

Deltaic Area : Locally all over the area from the Haringvliet to the estuary of the river Scheldt. Along the latter it occurs from Ellewoutsdijk (Zuid-Beveland) and the salt marshes of the Braakman (Zeeuwsch-Vlaanderen) up to the former Fort Pijp Tabak, about two kilometers downstream of Antwerp. On the inside of the dikes the association is locally all over the area.

Note : On the landside of the dikes this association is still insufficiently investigated. Consequently its subdivision can only be incomplete.

Subassociation 1 : **Puccinellietum distantis polygonetosum** R. Tüxen 1956 em. Beeftink.

Differential taxa : Polygonum aviculare, Elytrigia pungens (Pers.)

Tutin, *Plantago major*, *Lolium perenne*, *Coronopus squamatus* and other species characteristic of the Plantaginetalia.

Synecology : On clay- and sandy clay-soils. The communities with *Juncus ambiguus* Guss., which R. TüXEN (1957) places in this subassociation, can better be classified among the *P. distantis juncetosum* as distinguished by WESTHOFF (1947). The former subassociation shows an affinity to the Plantagineto-Lolietum, an association of the *Polygonion avicularis* (vide p. 354).

Distribution : Outside the dikes mainly along estuaries, e.g. that of the river Scheldt and along landing-stages. On the landside of the dikes probably locally common.

Subassociation 2 : **Puccinellietum distantis pholiuretosum** nom. mut.

Syn. : *Puccinellietum distantis agrostidetosum* Westhoff 1947.

Differential taxa (on the authority of WESTHOFF, 1947) : *Puccinellia distans* var. *tenuis*, *P. retroflexa* ssp. *borealis*, *Agrostis stolonifera* f. *subarenaria*, *Parapholis strigosa* and *Salicornia europaea* ssp. *ramosissima*.

Synecology : On beach-plains and valleys partly cut off from the sea by ranges of dunes or banks, which are flooded irregularly, mainly in autumn and winter. *Agrostis stolonifera* is a constant taxon in the previous subassociation as well. Therefore it seems better to name the present subassociation after *Parapholis strigosa* (= *Pholurus filiformis*) in analogy to the *Puccinellietum maritimae pholiuretosum*.

Distribution : Wadden Area : Locally in the Frisian Islands, e.g. the Boschplaat, Terschelling; formerly in Wieringen (SLOFF, 1931).

Deltaic Area : Rarely, only found in the Kwaden Hoek, Goeree.

Subassociation 3 : **Puccinellietum distantis juncetosum** Westhoff 1947.

Differential taxa (on the authority of WESTHOFF, 1947) : *Juncus bufonius* (probably mostly *J. ambiguus* Guss.), *Triglochin maritimum*, *T. palustre* and *Scirpus maritimus*.

Synecology and distribution : In the Frisian Islands restricted to dead ends of shallow creeks ending in extensive sandy plains and cut off from the sea. The salinity of the soil moisture is lower here than in the previous subassociation. In the Deltaic Area allied communities have been found along o.a. inland creeks near Westkapelle and Veere in the isle of Walcheren.

Alliance 2 : *Armerion maritimae* Br.-Bl. et De Leeuw 1936.

Syn. : *Festucion maritimae* W. Christiansen 1927 p.p.; *Junceto-Caricion* Corillion 1953 p.p. + *Festucion* Corillion 1953 p.p.

Differential species combination : *Armeria maritima* (faithful taxon within the salt marsh formation), *Glaux maritima*, *Festuca rubra* f. *litoralis* Hackel and *Juncus gerardi*.

Synecology : On clayey to sandy soils occurring in the supralittoral region of the salt marshes and beach-plains, from a little below

MHWS to the storm flood zone. Sometimes in the top layer of the soil a beginning formation of humus. Soil moisture content (drainage) and aeration differ to a large extent from place to place. Salinity level is rather low and its amplitude as a rule not large. The alliance runs the length of the eu-haline and polyhaline zones but is fragmentarily also found in the α -mesohalanicum. In the storm flood zone and in the α -mesohalanicum communities of the alliance are mixed or even superseded by communities of the *Atriplicion littoralis*, *Agropyro-Rumicion crisp*i or *Saginion maritimae*. The alliance also occurs on temporarily wet to rather dry, saline soils along the borders of inland creeks and pools, and in corresponding depressions.

Distribution: Very common all over the Wadden and Deltaic Areas. On the landside of the dikes likewise common.

Association 1 : *Artemisietum maritimae* Hocquette 1927.

Syn.: *Stacietum Limonii* Van Langendonck 1933 p.p.; Association of *Artemisia maritima* and *Statice Limonium* Van Langendonck 1933; *Artemisia maritima*-*Obione portulacoides*-Association (*Artemisietum maritimae*) Br.-Bl. et De Leeuw 1936.

Faithful taxon: *Artemisia maritima*.

Constant taxa: *Festuca rubra* f. *litoralis* Hackel (mostly dominant), *Aster tripolium*, *Plantago maritima*, *Limonium vulgare* and *Halimione portulacoides*.

Synecology: On creek banks with sandy to sandy clay-soils; also on sandy elevations and dams in the salt marsh as well as at the foot of dikes. The association is confined to well-drained and therefore well-aerated soils. The salinity-level is still rather high, but its amplitude narrow. In case of deposition of some tidal drift and, generally, of a higher clay-content in the top soil-layers the association is replaced by the *Atripliceto-Elytrigietum pungentis* (vide p. 353).

Distribution: Common in the Wadden and Deltaic Areas; exclusively within the direct reach of the tides.

Subassociation 1 : *Artemisietum maritimae typicum* subass. nov.

Characterized by want of taxa differential to the two following subassociations.

Synecology: On creek banks, elevations and dams in the salt marshes rather rich in clay.

Distribution: Wadden Area : rather rare. Deltaic Area : common, especially along the estuary of the river Scheldt.

Phase : *A. maritimae typicum*, initial phase with *Halimione portulacoides* nom. nov.

Differential (subdominant) taxon: *Halimione portulacoides*.

Synecology: On low creek banks and the outer slopes of larger creek banks where the soil is rich in clay.

Distribution: Wadden Area : rare. Deltaic Area : common, especially along the estuary of the river Scheldt.

Subassociation 2: *Artemisietum maritimae armerietosum* subass. nov.

Differential taxa: *Armeria maritima*, *Parapholis strigosa*, *Juncus gerardi* and *Agrostis stolonifera* subvar. *salina* J. et W.

Synecology: On fairly sandy creek banks and elevations in the salt marsh. Compared with the previous subassociation this one occurs on more sandy soils.

Distribution: Wadden Area: More common than the previous subassociation.

Deltaic Area: Especially along the Oosterschelde and the adjacent waters: Veerse Gat, Zandkreek and Eendracht.

Variant: *A. maritimae armerietosum*, variant with *Cochlearia anglica* var. nov.

Differential taxon: *Cochlearia anglica*.

Synecology: Probably this variant develops under the influence of birds staying on the elevations during high tides and leaving behind their droppings.

Distribution: Confined to the Frisian Islands, e.g. the Boschplaat in Terschelling.

Subassociation 3: *Artemisietum maritimae agrostidetosum* subass. nov.

Differential taxa: *Agrostis stolonifera* subvar. *salina* J. et W. and other taxa which are characteristic of the *Plantaginietalia* such as *Lolium perenne*, *Hordeum secalinum*, *Trifolium fragiferum*, *Festuca arundinacea*, *Alopecurus geniculatus*, etc.

Synecology: The subassociation is found on similar — but less saline — habitats as the previous two subassociations. It develops in the least saline part of the polyhalinicum and extends into the α -mesohalinicum of the estuaries. However, in the latter salinity-zone it soon reaches a fragmentary developmental stage, since the faithful taxon, *Artemisia maritima*, and other halophytes — such as *Limonium vulgare*, *Halimione portulacoides* and *Spergularia marginata* — disappear. Upstream *Festuca f. litoralis* is gradually replaced by *Agrostis stolonifera* subvar. *salina*. In its extreme form the fragmentary stage may better be considered as a sociation with *Agrostis stolonifera salina* of the order *Glauceto-Puccinellietalia* (vide p. 349).

Distribution: Only known from the Deltaic Area: along the Haringvliet, the Volkerak and the estuary of the river Scheldt from the salt marsh east of Waarde up to the Boudewijn sluices of the docks of Antwerp.

Association 2: *Armerieto-Festucetum litoralis* Br.-Bl. et De Leeuw 1936.

Syn.: *Juncetum gerardi* Warming 1906; *Festucetum rubrae* Yapp et Johns 1917, De Vries 1935; Association of *Juncus gerardi* and *Plantago maritima* Feekes 1936; *Armerietum maritimae* (Christiansen 1927) R. Tüxen 1937; *Juncus gerardi-Plantago maritima*-community Fröde 1950 (cf. VODERBERG, 1955).

Faithful taxon (regional) : *Armeria maritima*.

Differential taxon with respect to the *Artemisietum maritimae* :
Juncus gerardi.

Differential taxa with respect to the *Junceto-Caricetum extensae* :
Festuca rubra f. *litoralis* Hackel, *Limonium vulgare* and *Spergularia marginata*.

Constant taxa (in addition to the above mentioned ones) : *Plantago maritima*, *Glaux maritima*, *Agrostis stolonifera* subvar. *salina* and *Parapholis strigosa* (locally).

Synecology : The association is confined to the eu-haliniticum and the polyhaliniticum, between MHWS and the storm flood zone on — mostly — sandy soils. On the landside of the dikes the habitats are usually more clayey. The salinity-level is rather low and fluctuates more than in the *Artemisietum maritimae*. The soil may differ from temporarily wet (especially in winter months) to rather dry. In the first case *Juncus gerardi* dominates, in the latter *Festuca rubra* f. *litoralis*.

In case of lower average salinity owing to river-water or fresh water flowing off dunes etc., elements of the saline component of the *Agropyro-Rumicion crispi* (Loto-Trifolion Westhoff et Van Leeuwen 1961) may develop, notably *Agrostis stolonifera* subvar. *salina*, followed by *Carex distans* var. *vikingensis*, *Leontodon autumnalis*, *Trifolium fragiferum*, *Plantago major*, *Potentilla anserina*, *Lotus tenuifolius*, *Trifolium repens*, *Euphrasia odontites*, *Juncus maritimus* etc.

In case of disturbance of the vegetation by sedimentation of sand and deposition of some tidal drift the association is replaced by communities with dominance of *Elytrigia pungens* (Pers.) Tutin.

In case of a temporarily sharp superficial desiccation resulting in the formation of a stone-hard crust by luting of sand-grains in the top layer, communities develop composed of small, principally annual species, viz. in the first place *Parapholis strigosa*, followed by *Sagina maritima*, *Plantago coronopus*, *Catapodium maritimum*, *Cochlearia danica* (in case of deposition of tidal drift), *Bupleurum tenuissimum*, *Sagina nodosa* and *Centaureum vulgare*. These communities will be treated below (vide *Saginetea*, p. 354).

Transitional stages with different floristic and structural composition may occur.

Distribution : Common all over the Wadden and Deltaic Areas. Also common in saline inland terrains in all coastal provinces.

Note : The association may be divided into two subassociations as well as into three variants.

Subassociation 1 : *Armerieto-Festucetum litoralis typicum* subass. nov.

Characterized by want of taxa characteristic of the saline component of the *Agropyro-Rumicion crispi* (Loto-Trifolion).

Synecology : Vide under the association.

Distribution : Vide under the association.

Subassociation 2: *Armerieto-Festucetum litoralis*, subassociation of *Leontodon autumnalis* Raabe 1950.

Syn.: *Armerieto-Festucetum*, variant with *Carex distans* Westhoff 1947.

Differential taxa: *Leontodon autumnalis* and other taxa characteristic of the saline component of the *Agropyro-Rumicion crispi* (*Loto-Trifolion*), e.g. *Agrostis stolonifera* subvar. *salina*, *Carex distans* var. *vikingensis*, *Trifolium fragiferum*, etc. (vide under the association).

Synecology: Vide under the association.

Distribution: Wadden Area: Mainly in the Frisian Islands.

Deltaic Area: Locally, e.g. along the Haringvliet, the Krammer and the salt marsh south of Bergen op Zoom (province of Noord-Brabant). Probably, the subassociation reaches the southern limit of its area of distribution in the Netherlands.

Variant 1: *Armerieto-Festucetum litoralis*, variant with *Juncus gerardi* var. nov.

Syn.: *Juncetum gerardi* auct. s.s.

Differential (dominant) taxon: *Juncus gerardi*.

Synecology: Predominantly on grazed salt marsh. On habitats with stagnating water, especially in the winter months, e.g. in creeks partly filled up with wind blown sand; also on habitats under the influence of fresh water flowing off dunes, beach banks, or other higher terrains.

Distribution: Common both within the reach of the tides and on suitable habitats in the polders of the coastal provinces.

Variant 2: *Armerieto-Festucetum litoralis*, variant with *Festuca rubra* f. *litoralis* var. nov.

Syn.: *Festucetum rubrae* Yapp et Johns 1917, De Vries 1935; *Festucetum rubrae litoralis* W. Christiansen 1927; *Festucetum arenariae* Corillion 1953.

Differential (dominant) taxon: *Festuca rubra* f. *litoralis* Hackel.

Synecology: On dryer habitats than the previous variant: at the foot of low dunes or beach banks, on elevations in the higher salt marsh; along inland pools and creeks on corresponding habitats. The variant often follows the previous one in the zonation. On salt marshes free from grazing, however, this variant replaces the previous one for the major part of its amplitude.

Distribution: Common both within the reach of the tides and on suitable habitats in the polders of the coastal provinces.

Variant 3: *Armerieto-Festucetum litoralis*, variant with *Limonium vulgare* var. nov.

Differential taxon: *Limonium vulgare*.

Synecology: Along the inside of low dunes and beach banks on the

salt marsh. Probably developed out of a *Puccinellietum maritimae*, gradually covered by wind blown sand. The variant is confined to the eu-halinicum and the saline part of the polyhalinicum, only within the reach of the tides.

Distribution : In the Netherlands only known from the Westerschelde (Kaloot) and the Zwin (Zeeuwsch-Vlaanderen).

Association 3 : *Junceto-Caricetum extensae* (Van Dieren 1934) Br.-Bl. et De Leeuw 1936.

Faithful taxa : *Carex extensa* and *Euphrasia litoralis* (locally).

Constant taxa : *Glaux maritima*, *Agrostis stolonifera* subvar. *salina* J. et W., *Juncus gerardi* and, locally, *Triglochin maritimum* and *Festuca rubra* f. *litoralis* Hackel.

Synecology : On humid beach-plains, occasionally inundated, holding some silt and partly cut off from the sea by dunes or beach banks. Also on corresponding habitats cut off from the sea by embankments. The average salinity of the soil moisture is rather low, but the fluctuations may still be considerable.

Distribution : Wadden Area : In the Frisian Islands covering large stretches, e.g. on the Boschplaat, Terschelling (WESTHOFF, 1947). Also along the Balgkanaal, Noord-Holland (DEN HARTOG, 1958).

Deltaic Area : Rather rare on account of lack of beach-plains, e.g. on the Groene Strand (De Haak) near Oostvoorne, the Kwaden Hoek (Goeree) and in the nature reserve of the Braakmanpolder (Zeeuwsch-Vlaanderen).

Subassociation 1 : *Junceto-Caricetum extensae pholiuretosum* Westhoff 1947.

Differential taxa : *Parapholis strigosa*, *Armeria maritima* and *Carex distans*.

Synecology : On beach-plains with a small silt content; developed out of the *Puccinellietum maritimae pholiuretosum*. This subassociation is more under the influence of the tides than the following one, as it is often flooded by high tides when strong winds are blowing. The salinity of the soil moisture fluctuates considerably.

Distribution : Wadden Area : In the Frisian Islands and along the Balgkanaal (vide under the association).

Deltaic Area : On the Kwaden Hoek (Goeree).

Subassociation 2 : *Junceto-Caricetum extensae blysmetosum rufi* (Meltzer) Westhoff 1947.

Differential taxa : *Scirpus (Blysmus) rufus*, *Eleocharis palustris* ssp. *uniglumis*, *Phragmites communis*, *Juncus anceps*, and other species characterizing the *Agropyro-Rumicion crispi*.

Synecology : This subassociation is found in brackish dune valleys on the margin of submerged silty sand shallows, where rain water

accumulates (WESTHOFF, 1947). The habitats are less exposed to tidal influences; the soil is water-logged except in dry spring; fluctuations in the salinity of the soil moisture are probably less. For the greater part the habitat resembles a contact-zone between saline and fresh water regimes.

Distribution : Confined to the Frisian Islands. May be considered as the southern extension of the boreal (Norwegian and Baltic) *Scirpetum rufi*.

Note : Within both subassociations WESTHOFF (1947) distinguished « desalinating phases » characterized by a large number of species which are characteristic of the *Agropyro-Rumicion crispi*. According to Dr. V. Westhoff and the author, these phases should now be assigned to the latter alliance (suballiance *Loto-Trifolion*, vide p. 353).

Sociations of the order *Glauceto-Puccinellietalia*.

Sociation with *Glaux maritima* Beeftink 1951.

Syn. : *Staticetum Limonii*, variant rich in *Glaux maritima* Van Langendonck 1933; *Glaucetum maritimae* Dahl et Hadac 1941; *Armerieto-Festucetum*, facies of *Glaux maritima* Westhoff 1947.

Dominant taxon : *Glaux maritima*.

Subdominant taxa : *Puccinellia maritima*, *Spergularia salina*, *Agrostis stolonifera* subvar. *salina* J. et W., *Elytrigia pungens*, *Triglochin maritimum* or *Phragmites communis* (the latter always with reduced vitality).

Synecology : Secondary pioneer communities which develop on sand or clay-soils where the original vegetation has been destroyed, either totally or partly by drastic changes in the environment. These changes may be: (1) covering of wet depressions by wind blown sand, (2) blowing out by wind of sandy valleys as far as the ground water-table, (3) treading by man or cattle and (4) sod-cutting. The sociation occurs also on beach plains partly cut off from the sea. The salinity of the soil moisture may fluctuate strongly. The sociation develops optimally in the polyhalinicum and the α -mesohalinicum, but in the latter zone only on clay-soils.

Distribution : Locally common in the whole Wadden and Deltaic Areas.

Sociation with *Agrostis stolonifera salina* soc. nov.

Dominant taxon : *Agrostis stolonifera* subvar. *salina* J. et W.

Subdominant taxa : *Puccinellia maritima*, *Festuca rubra* f. *litoralis* Hackel, *Juncus gerardi*, sometimes *Lolium perenne* and *Elytrigia repens* (L.) Nevski.

Synecology : In the α -mesohalinicum this sociation develops on similar habitats as the *Halimionetum portulacoidis* does in the euhaline and polyhaline zones, viz. on clay-soils on the transition between basin and creek bank. The group of taxa characteristic of the *Glauceto-*

Puccinellietalia has a larger total combined degree of abundance-coverage (combined estimation) than the group of Plantaginietalia-species.

Distribution : Wadden Area : Probably confined to the Dollard (DE VRIES, 1940).

Deltaic Area : On salt marshes along the Haringvliet; in the estuary of the river Scheldt from Bath and the Verdronken Land van Saaf-tinge up to the former Fort Pijp Tabak.

Class : **CAKILETEA MARITIMAE** R. Tüxen et Preising 1950.

Faithful taxa : (on the authority of R. TüXEN, 1950) : *Cakile mari-tima* and *Salsola kali* var. *polysarca* G.F.W. Meyer.

Order 1 : **ATRIPLICETALIA LITTORALIS** Sissingh 1946.

Syn. : *Cakiletales maritimae* R. Tüxen apud Oberdorfer 1949.

Halophilic, nitrophilic and especially annual communities, developing on young tidal drifts deposited on the West- and Northeuropean sea coasts. When further supply of tidal drift stops the communities are followed by those of the *Agropyro-Rumicion crispis*, often already the next year.

Faithful taxa (on the authority of R. TüXEN, 1950) : *Cakile mari-tima*, *Atriplex hastata*, *Matricaria maritima* (incl. *M. inodora* var. *salina* (Rchb.) Lange), *Senecio vulgaris* f. *litoralis* Mort., *Polygonum aviculare* var. *litorale* Koch.

Alliance 1 : *Salsolo-Honckenyon peploidis* R. Tüxen 1950.

Syn. : *Atriplicion littoralis* Nordhagen 1940 p.p.

Communities developing on tidal drift covered by wind blown sand.

Faithful taxa (on the authority of R. TüXEN, 1950) : *Salsola kali* var. *polysarca* G.F.W. Meyer, *Atriplex calotheca*, *Atriplex sabulosa*, *Polygonum oxyspermum* Mey. et Bge., *Polygonum aviculare* div. var.

Differential taxon (with respect to the *Atriplicion littoralis*) : *Honckenya peploides*.

Association : **Cakiletum friscum** (Hocquette 1927) R. Tüxen 1950.

Syn. : *Agropyretum juncei* Hocquette 1927 p.p.; *Cakiletum mariti-mae* Van Dieren 1934.

Synecology : From West Jutland to Belgium these communities are reduced, owing to insufficient supply of tidal drift. If they are to be distinguished as a separate unit, the above-mentioned name, proposed by R. TüXEN (1950), may be used.

Distribution : Locally on the beaches in the whole Wadden and Deltaic Areas.

Alliance 2 : *Atriplicion littoralis* (Nordhagen 1940 p.p.) R. Tüxen 1950.

Communities developing on tidal drift deposited on sand or clay-

soils but not covered by inorganic material (wind blown sand or silt), or only slightly mixed with such material.

Faithful taxon : *Atriplex littoralis*.

Association : ***Atriplicetum littoralis*** (W. Christiansen 1934) Westhoff et Beertink 1950.

Syn. : *Atriplicetum* Warming 1906; *Atriplicetum littoralis* Feekes 1936 p.p.; *Atriplex litorale* association Tüxen 1937 p.p., non Libbert 1940; *Atriplicetum litoralis* + *Atriplicetum latifolii* Nordhagen 1940 p.p.; *Matricario maritimae*-*Atriplicetum litoralis* R. Tüxen 1950.

Differential species combination : *Atriplex littoralis* and *Atriplex hastata*.

Synecology : Pioneer communities developing on packets of tidal drift deposited on (sandy) clay-soils (e.g. the foot of dikes). When *Spartina townsendii* dies after being cut off from the tides as a result of embankment, it is often totally replaced by this association, but only during one year.

Distribution : Common in the eu-haliniticum and polyhaliniticum all over the Wadden and Deltaic Areas, especially at the foot of dikes. Probably this association came to the fore after the establishment of *Spartina townsendii*, the most important supplier of drift-material.

Subassociation : ***Atriplicetum littoralis*, subassociation with *Salsola kali*** subass. nov.

Syn. : *Atriplex litoralis*-*Salsola kali*-association (Nordhagen 1940) R. Tüxen 1950.

Differential taxon : *Salsola kali*.

Synecology : Pioneer communities developing on beaches on packets of tidal drift, uncovered or only slightly covered by wind blown sand.

Distribution : Still insufficiently investigated. Probably locally on the beaches of the whole Wadden and Deltaic Areas. The association has been found on the beach near Koudekerke, isle of Walcheren (exp. SW).

Order 2 : *THERO-SUAEDETALIA* ordo nov. prov.

Alliance : *Thero-Suaedion* Br.-Bl. (1931) 1933 em. R. Tüxen 1950.

Suaeda maritima communities which develop on humid saline soils rich in organic material.

Note : The *Suaeda maritima* communities, which R. TüXEN (1950) rightly separates from the *Salicornia* communities, may better not be incorporated in the *Atriplicetalia littoralis* because (1) the faithful taxa of this order do not occur in the *Thero-Suaedion* except *Atriplex hastata* and (2) the distribution area of the *Thero-Suaedion* is much larger than those of the *Salsolo-Honckenyon peploidis* and the *Atriplicion littoralis*.

Association : **Suaedetum maritimae** (Conard 1935) prov.

Syn. : *Salicornietum europaeae* auct. p.p.; *Suaedetum maritimae* sous-stade ou pré-*Obionetum* Arènes 1933; *Salicornieto-Spartinetum* Br.-Bl. et De Leeuw 1936 p.p.; *Suaedetum maritimae* Bellot 1951 n.n.

Faithful taxon : *Suaeda maritima*.

Synecology : The association develops on habitats rich in quickly decomposing organic material, deposited on the transitional zone between mud flat and salt marsh (especially on low creek banks) and on low-levelled localities at the foot of dikes. On increasing salt marshes it forms the precursor of the *Halimionetum portulacoidis* on the creek banks. Confined to the eu-halinitic and polyhalinitic. Creeks and other parts of salt marshes cut off from the tides as a result of embankment, are often entirely overgrown by this association during the first years.

Distribution : Common in the Wadden and Deltaic Areas.

Class : **PLANTAGINETEA MAIORIS** R. Tüxen et Preising 1950.

Order : **PLANTAGINETALIA MAIORIS** R. Tüxen (1947) 1950.

Communities of contact zones between contrasting regimes of environment : viz. saline-fresh (both humid), wet-dry and rich-poor in nutrition or combinations of these regimes. These contrasts in time and space make the environment an unstable one and induce disturbances in the vegetation as well as impermeability and even — in extreme cases — compactness of the top soil. Grazing and treading (on beaten paths, roadsides, yards) evoke similar environmental circumstances (WESTHOFF and VAN LEEUWEN, 1961; WESTHOFF c.s., 1962).

Faithful taxa : (on the authority of R. TüXEN, 1950) : (*Potentilla anserina*, *P. reptans*), *Plantago major*, *Lolium perenne*, *Poa annua*, *Agrostis stolonifera* var. *prorepens* Aschers., *Ranunculus sardous*.

Distribution : Euro-Siberian and North Mediterranean Regions.

Alliance 1 : *Agropyro-Rumicion crispi* (Nordhagen 1940) R. Tüxen 1950.

Communities of contact zones between contrasting regimes of environment as described under the order.

Faithful taxa : Doubtful, but probably o.a. (*Potentilla anserina*), *Leontodon autumnalis*, *Trifolium repens*, *Ranunculus repens*, *Festuca arundinacea*, *Agropyron repens*, *Agrostis stolonifera* var., *Carex hirta* and *Rumex crispus*.

Distribution : Euro-Siberian except the Arctic and Mediterranean Regions.

* **Note** : The vegetation in the zones of humid saline-fresh contact, where sometimes eutrophication in the top soil-layers takes place, is characterized by a special group of taxa (suballiance Loto-Trifolion Westhoff et Van Leeuwen 1961; cf. WESTHOFF c.s., 1962). It may be divided into three groups of communities without allotting them a rank in the classification :

- (1) Communities of *Elytrigia pungens*,
- (2) Communities of *Juncus maritimus* and
- (3) Communities with *Carex distans* var. *vikingensis*, *Lotus tenuifolius*, *Juncus ambiguus* Guss., *Eleocharis uniglumis* and *Trifolium fragiferum*.

Transitions between these groups frequently occur. Only two associations will be distinguished here, viz.: the *Atripliceto-Elytrigietum pungentis*, comprising a part of the *Elytrigia pungens* communities, and the *Festuca arundinacea-Potentilla anserina*-association which also occurs in zones representing other contrasts than that of saline-fresh.

Association 1: *Atripliceto-Elytrigietum pungentis* Beeftink et Westhoff ass. nov.

Syn.: *Atropidetum maritimae* sous-association à *Festuca rubra* subvar. *arenaria* (*Atropidetum Festucetosum arenariae*) facies à *Agropyrum repens* var. *littorale* De Litardière et Malcuit 1927; *Triticetum acuti* W. Christiansen 1927 p.p.; *Agropyrum littorale* community Br.-Bl. et De Leeuw 1936; *Artemisietum maritimae* facies of *Triticum littorale* Feekes 1950 (in BROUWER c.s., 1950), Westhoff et Beeftink 1950; *Agropyretum littorei* Corillion 1953 p.p.; *Agropyron littorale*-meadow VandenAbeelee 1955.

Differential species combination: *Elytrigia pungens* (Pers.) Tutin and *Atriplex hastata*.

Constant taxa: *Aster tripolium*, *Halimione portulacoides* and *Festuca rubra* f. *litoralis* Hackel.

Synecology: Within the reach of the tides optimal on creek banks composed of well-aerated sandy clay- to clay-soils and supplied with a moderate quantity of tidal drift giving at intervals an eutrophication in the top soil-layers; likewise on corresponding habitats at the foot of dikes. The association finds its optimum in the polyhaline zone, but extends into the α -mesohaliniacum. In the latter zone it may be replaced by the *Festuca arundinacea-Potentilla anserina*-association when no or moderate grazing takes place or by the *Plantaginetololietum* (vide p. 354) after heavy grazing. In the polyhaliniacum the association is the counterpart of the *Artemisietum maritimae*, although the salinity of the soil moisture may fluctuate more in the former association. On the landside of the dikes the *Atripliceto-Elytrigietum* occurs on higher terrains bordering polyhaline waters.

Distribution: Wadden Area: Locally, e.g. in the isles of Ameland (BRAUN-BLANQUET and DE LEEUW, 1936) and Griend (FEEKES, in BROUWER c.s., 1950), in the Dollard and on the Balgzand (DE VRIES, 1940).

Deltaic Area: Common, but mostly along the estuary of the river Scheldt from Flushing to the Boudewijn sluices near Antwerp (cf. also VANDENABEELE, 1955). Locally on the landside of the dikes, e.g. Inlaag 1887 near Ellewoutsdijk.

Association 2: **Festuca arundinacea-Potentilla anserina-association** (R. Tüxen 1937) Nordhagen 1940.

Syn.: *Lolium perenne*-*Matricaria suaveolens*-association, subassociation of *Festuca arundinacea* Tüxen 1937 prov.; *Armerietum maritimae*, subassociation of *Festuca arundinacea* Bückner 1954.

Faithful taxon: *Festuca arundinacea*.

Synecology: Develops on the highest parts of the marshes and at the foot and outer slope of the dikes; flooded by spring tides and storm floods only and receiving a minor quantity of tidal drift. Not too intense grazing promotes its development. Outside the dikes the association develops from the less saline part of the α -mesohaline zone upstream the rivers.

Distribution: Outside the dikes only known from the estuary of the river Scheldt (from Fort St. Philip upstream) and from the valleys of the Kwaden Hoek, isle of Goeree (vide WESTHOFF, VAN LEEUWEN and ADRIANI, 1962). Formerly probably also along the Zuiderzee. On the landside of the dikes probably common on suitable habitats but up to the present insufficiently investigated.

Alliance 2: *Polygonion avicularis* Br.-Bl. 1931.

Faithful taxa (on the authority of R. TüXEN, 1950): *Plantago major*, *Lolium perenne*, *Poa annua*, *Cynodon dactylon* and *Coronopus squamatus*.

Differential taxon: *Polygonum aviculare* var.

Synecology: Plant communities trodden by animal or man, developing on beaten paths, roadsides, yards, etc.

Distribution: As that of the order.

Association: **Plantagineto-Lolietum** (Beger 1930) Sissingh 1950.

Syn.: vide R. TüXEN (1950, p. 142-143).

Faithful taxa: *Plantago major*, *Lolium perenne*, *Coronopus squamatus*, *Matricaria matricarioides* and *Coronopus didymus*.

Synecology: Outside the dikes the association develops on creek banks and other higher parts of the salt marshes trodden by cattle or man. Confined to the least saline part of the polyhalinic and other less saline zones. The association shows affinity with and transitional stages to the *Puccinellietum distantis polygonetosum*.

Distribution: Outside the dikes only found along the Haringvliet, the Volkerak and in the estuary of the river Scheldt from the salt marsh east of Waarde to that near the former Fort Pijp Tabak.

Class: **SAGINETEA** Westhoff, Van Leeuwen et Adriani 1962 prov.

Order: **SAGINETALIA** Westhoff, Van Leeuwen et Adriani 1962 prov.

Alliance: *Saginion maritimae* Westhoff, Van Leeuwen et Adriani 1962 prov.



5. — Salt marsh along the Scheldt-estuary between the Forts De Perel and Ste Marie (beyond the river the Fort St. Philip). *Phragmites communis* communities with *Cochlearia officinalis* on the edge of the creek.

Communities of contact zones between contrasting saline-fresh (both dry) regimes of environment.

Faithful taxa : Not yet certain, but probably in the first place *Sagina maritima* (vide below).

Synecology : The contact between the above-mentioned contrasting regimes of environment results in strongly fluctuating salinity of the soil moisture and, by temporarily sharp superficial desiccation, in the formation of a stone-hard crust by luting of sand-grains in the top-layer. Some tidal drift may be deposited (developing of *Cochlearia danica*). Mainly at the foot of dunes and beach-banks where supply of wind blown sand is lacking (cf. WESTHOFF c.s., 1962).

Distribution : Wadden Area : Locally common in the Frisian Islands.

Deltaic Area : Locally, e.g. Groene Strand (Oostvoorne), Kwaden Hoek (isle of Goeree and Overflakkee), Verdrongen Zwarte Polder (Zeeuwsch-Vlaanderen). Also (temporarily) on the landside of the dikes e.g. in the nature reserve of the Braakmanpolder.

Note : The alliance will not be subdivided here. Communities composed of small, mainly annual species belong to it, e.g. those of *Parapholis strigosa*, *Sagina maritima*, *Plantago coronopus*, *Catapodium marinum*, *Cochlearia danica*, *Bupleurum tenuissimum*, *Sagina nodosa* var. *moniliformis* and *Centaureum vulgare*. Among the described associations, belonging to this alliance, must be named : the association of *Plantago coronopus* and *Carex distans* Tüxen 1937, the *Centaureto-Sagnetum moniliformis* Diemont, Sissingh et Westhoff 1940, the *Sagnetum maritimae* Westhoff 1947, the *Cochlearietum danicae* Westhoff 1947, the *Plantago coronopus* — *Sagina maritima* — association Br.-Bl. et R. Tüxen 1952 n.n. and the *Sagnetum maritimae* — *Cochlearietum danicae* R. Tüxen 1957.

Communities which have not been classified into higher vegetation units.

Association : *Scirpetum maritimi compacti* (Van Langendonck 1931) Beeftink 1957.

Syn. : *Scirpetum maritimi* Van Langendonck 1931; *Halo-Scirpetum maritimi* Dahl et Hadac 1941; ? *Scirpetum maritimi* auct. p.p.

Faithful taxon : *Scirpus maritimus* var. *compactus* (Hoffm.) G.F.W. Meyer.

Constant taxa : *Atriplex hastata* and *Aster tripolium*.

Synecology : Outside the dikes optimal in the eu-littoral region of the α -mesohalinicum. The association is very sensitive to erosion and will not stand any treading. On the landside of the dikes along mesohaline creeks, ditches and in other wet depressions.

Distribution : Wadden Area : Outside the dikes rather local, mostly in cattle-drinking pools; formerly locally common along the borders of the Zuiderzee.

Deltaic Area : Along the Haringvliet, Volkerak and in the estuary of the river Scheldt, from the salt marsh west of Bath up to the Galgeschoor, north of Lilloo (Belgium).

On the landside of the dikes common in all coastal provinces.

Consociations with *Phragmites communis*, *Calystegia sepium* and *Althaea officinalis*.

Dominant taxa : *Phragmites communis* resp. *Calystegia sepium* and *Althaea officinalis*.

Synecology : Optimal in the mesohalinicum of the estuaries. In the basins *Phragmites communis* mostly dominates; its undergrowth is

mainly formed by *Aster tripolium*, *Atriplex hastata*, *Agrostis stolonifera* var., *Cochlearia officinalis* (mainly on the edges of creeks) and/or *Scirpus maritimus* var. *compactus*. On the creek banks *Calystegia sepium* and *Althaea officinalis* mostly dominate, accompanied by *Elytrigia pungens*, *Rumex crispus*, *Solanum dulcamara*, *Sonchus arvensis*, *Oenanthe lachenalii*, *Apium graveolens* and other taxa characteristic of the alliance *Convolvulo-Archangelicicion litoralis* R. Tüxen 1950 prov. (order *Convolvuletalia sepii* R. Tüxen 1950). The latter communities resemble the association of *Althaea officinalis* and *Oenanthe lachenalii* Weevers 1940.

Distribution : Deltaic Area : Along the Haringvliet and the estuary of the river Scheldt upstream from the salt marsh near Ossendrecht.

On the landside of the dikes, locally common along brackish ditches and canals in the provinces of Noord-Holland and Zuid-Holland. Formerly in the river-mouths discharging into the former Zuiderzee (Eem, IJssel).

Summary.

In this survey the salt plant communities of the Netherlands are treated, viz. those of the classes of the *Zosteretea marinae*, the *Rupietea*, the *Thero-Salicornietea*, the *Spartinetea*, the *Asteretea tripolium*, the *Plantaginetea maioris*, the *Saginetea* as well as some unclassified vegetation units. The faithful taxa of each vegetation unit have been enumerated and the synecology and distribution shortly described. In some cases absence of faithful taxa made it necessary to introduce the concept of « Differential Species Combination », which concept is shortly discussed in the introduction.

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