INLAND DUNE VEGETATION OF THE NETHERLANDS

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ABSTRACT - Drifting sands in the Netherlands are the result of human over-exploitation (sod-cutting, over-grazing) of woodlands and heathlands. The most important association of inland sand dune areas is the *Spergulo-Corynephoretum* (*Corynephorion canescentis*), which is poor in vascular plants, but in it older stager rich in mosses and especially lichens. In the Netherlands, the area of drifting sand is reduced dramatically in the last 70 years, mainly by afforestation and spontaneous succession.

KEY WORDS - *Spergulo-Corynephoretum*, *Corynephorion canescentis*, drifting sand, grassland, lichens, *Corynephorus canescens*, Netherlands, atlantic desert

INTRODUCTION

The large inland dune areas in the Netherlands and northern Germany might give the impression of extensive natural landscapes, where plants and animals meet extreme site conditions. But actually, they are the result of long-term human influences. In the past, especially since the middle-ages (Koster 1978), wood cutting and grazing (by sheep and cattle) did change the pleistocene forest landscape in a dwarfshrub heathland landscape, dominated by Heather (*Calluna vulgaris*) and Greenweed (*Genista pilosa* and *Genista anglica*) on dry soils, and Bog heather (*Erica tetralix*) and Purple moor grass (*Molinia coerulea*) on moist and wet soils. Subsequent overexploitation hy sod cutting and more intensive grazing resulted in a further degradation of the vegetation. Especially during the second half of the 19th century, large areas in the Netherlands were demonstrating an open, almost treeless landscape, where bare sand dunes alternated with lichen-rich dry grasslands and patches of heathlands. By some authors, these eolian drift sand regions are called 'atlantic deserts' (e.g. Schimmel 1975). This seems not to be an exaggeration, as the 19th century landscapes really must have been dramatic: not only forests and heathlands, but even complete villages were burried by the sand (Heidinga 1977). From the end of the 19th century onwards, however, the inland dune area has strongly diminished, especially by afforestation of pine forests (*Pinus sylvestris*). Generally, the remaining areas were too small for keeping up the characteristic vegetation

patterns with dominating bare sands, as wind activity could not counteract the stabilisation of the sands and consequent succession.

In the Netherlands, the vegetation of drift sands has been intensively studied by Daniëls (e.g. Biermann & Daniëls 1995, 1997; Daniëls & Krüger 1996), Ketner-Oostra (1993, 1994, 1995) and Masselink (1994). An overview has been presented in volume 3 of the Dutch national vegetation classification (Weeda *et al.* 1996).

PLANT COMMUNITIES

The characteristic pioneer grassland vegetation of the inland dunes in the Netherlands and northern Germany is considered to be a separate plant community, the Spergulo-Corynephoretum. This association belongs to the alliance Corynephorion canescentis (class Koelerio-Corynephoretea). The soils consist of nutrient poor sands with a rather uniform granular partition and a loose packing, often resulting in a strong parching in summer (Masselink 1994, Weeda *et al.* 1996). Due to this drought, in combination with wind erosion, soil acidity (pH 4-5), and nutrient poverty, soil building processes are minimal, and humus is hardly formed. Under favourable conditions, i.e. with strong insolation and low wind, surface temperatures of bare inland dunes rise to 30°C above the air temperature at 2 m. height. Daily temperature fluctuations on the surface are rather high: peaks of 50°C on a summers day are not rare, whereas night temperatures can go down to 10°C on the same day (Stoutjesdijk 1959). Due to these extreme conditions, vascular plants are rare and not very abundant; the vegetation is dominated by mosses and lichens, of which several species in the Netherlands are almost restricted to this biotope and highly endangered (Siebel et al. 1992). Therefore, inland dunes nowadays are considered of great importance for the protection of the national and international biodiversity (cf. Tüxen in Schimmel 1975).

Species composition. As mentioned already, the Spergulo-Corynephoretum is extremely poor in vascular plants. In the Netherlands, only six vascular plant species are showing a presence degree of more than 20%, and their abundance usually remains very low (see Table 1). In the whole overview of Dutch plant communities, there is no equivalent. Only three vascular plants, viz. *Corynephorus canescens*, *Agrostis vinealis* and *Spergula morisonii*, are constant species; of these, *Spergula morisonii* can be considered as a character species. By this circumstance, low-competitive cryptogams (acrocarpe mosses and lichens) are able to dominate the vegetation, particularly in the later succesion stages (Masselink 1994; Weeda et al. 1996; Biermann & Daniëls 1997). Among these cryptogams, there are several character species: *Polytrichum piliferum*, *Cetraria aculeata*, *Cladonia zopfii*, *Cladonia cervicornis* s.l., *Cladonia strepsilis*, and *Stereocaulon condensatum*. Alltogether, more than 40 lichen species were found in the Spergulo-Corynephoretum, most of them belonging to the genera *Cladonia* (incl. *Cladina*), *Peltigera*, and *Cetraria* (incl. *Coelocaulon*).

Distribution. The Spergulo-Corynephoretum is a Northwest-European community with a rather small distribution area from which the center lies in the Netherlands. Nowadays, large areas with this community are almost restricted to this country. Outside the Netherlands, the association can be found in Belgium and western Germany. In Germany, the association reaches southwarts to Bavaria (Hohenester 1967; Korneck

1978). From floristic descriptions of *Corynephorus* stands in eastern England by Trist (1977), the conclusion might be drawn that the association also occurs here, but only sporadically (confirmed by J.S. Rodwell). Vicariant associations are described by Passarge (1960; Spergulo-Festucetum psammophilae) for eastern Germany, by Olson (1974; Cladonio destrictae-Corynephoretum) for Denmark and southern Sweden and by Mucina and Kolbek for Austria (in Mucina *et al.* 1993; Thymo angustifolii-Corynephoretum canescentis Kripel 1954). Corynephorion canescentis stands in Czechia were also considered to belong to the last mentioned, but might possibly belong to the Spergulo-Corynephoretum (pers. comment M. Chytrý).

In the Netherlands, the Spergulo-Corynephoretum is almost restricted to the pleistocene districts; within this area it can be found in all sand dune regions from the north to the south. Outside the pleistocene districts, the association is only recorded from a small number of sites in old, completely leached coastal dunes (figure 1).

THREATS AND CONSERVATION

As mentioned before, the area with drift sand communities in the Netherlands is strongly decreased by plantation of large-scale pine forests. On the central pleistocene sand area "Veluwe", for example, the total area of open drift sands decreased from more than 14.000 hectares in 1850 to 1.500 hectares in 1975, a decline of almost 90%! In 1911, the "Kootwijkerzand"-area on the "Veluwe" was an open landscape, dominated by large sand surfaces. Due to afforestation, 1926 the landscape is almost irrecognizably chanced. In the remaining open sand areas, a significant change in species composition took place: a substantial part of the characteristic lichen vegetation disappeared in favour of dwarfshrub communities by spontaneous succession, induced by the immobilisation of the sand. Moreover, at many places, more or less dense grass carpets and algal communities came into development. Until now, it is unclear, to what extent this phemomenon is caused by nutrification by atmospheric deposition.

A rather recent threat for the inland dune vegetation in the Netherlands is the expansion of the acrocarpe moss *Campylopus introflexus*. Originally, this neotropical species was only widespread in the temperate zones of the southern hemisphere. In the Netherlands, it was found for the first time in 1961 (Sipman 1977). Since then, *Campylopus introflexus* expanded rapidly within 20 years on all kinds of open sites, with a leached, relatively acid, nutrient-poor and dry topsoil, covered by a sparse and short vegetation. Favourite sites include coastal dune areas, dry heathlands as well as inland dunes (Van der Meulen *et al.* 1987; Weeda *et al.* 1996). Once established, the species may develop dense and thick (2-10 cm) carpets, displacing the orginal heathland and dune vegetation almost completely, and reducing the richness in lichens (Biermann & Daniëls 1995). Sometimes the carpets are broken up into cushions, by the influence of fluctuations in moisture and temperature, and the activity of birds like pheasants and magpies, looking for worms and insects under the moss carpet. This invasion of *Campylopus introflexus* mainly occurs at sites where the sands are fixed (see Aptroot & Olff 1984). Therefore, one of the (few) possibilities to counteract this aggressive species is to favour the mobilisation of the sand. This can be reached by wood cutting and reintroduction of grazing, increasing the effects of wind activity.

Already from the 1960's, successfull attemps are made to regenerate and enlargc the existing inland dune areas. This is normally done by cutting the pine plantations and excavating the tree trunks, followed by removal of the humus. One of the problems

TABLE 1. SYNOPTIC TABLE OF THE SPERGULO-CORYNEPHORETUM IN THE NETHERLANDS. SPECIES WITH A FREQUENCY < 10% ARE EXCLUDED. COLUMN 1: SPERGULO-CORYNEPHORETUM INOPS; COLUMN 2: SPERGULO-CORYNEPHORETUM CLADONIETOSUM.

No. of column	1		2	
No. of relevées	247		480	
Spergulo-Corynephoretum				
Polytrichum piliferum	IV	8	V	7
Spergula morisonii	III	3	IV	3
Cladonia coccifera	I	3	IV	5
Cladonia floerkeana	r	3	IV	3
Cladina portentosa	r	6	IV	6
Cladonia gracilis	r	5	III	5
Cladonia glauca	r	2	III	3
Cladonia zopfii	r	2	III	6
Cladonia cervicornis	r	2	III	5
Cladonia uncialis subsp. *biuncialis*	r	3	II	5
Stereocaulon condensatum	r	2	+	2
Spergulo-Corynephoretum cladonietosum				
Cetraria aculeata	I	6	III	5
Cladonia grayi s.l.	r	3	III	3
Pohlia nutans	+	5	II	6
Cladonia furcata subsp. *furcata*	r	3	I	5
Cladonia macilenta	r	3	II	3
Campylopus introflexus	+	5	II	6
Cladonia ramulosa	r	3	II	4
Cladonia crispata	.		II	4
Cladonia subulata	r	4	II	3
Cetraria muricata	r	5	II	5
Dicranum scoparium	r	6	I	6
Cladina mitis	r	3	I	5
Cladina arbuscula	r	3	I	5
Cladonia foliacea	r	3	I	4
Trapeliopsis granulosa	r	7	I	4
Cladonia pyxidata	r	2	I	3
Placynthiella uliginosa	r	2	I	3
Cladonia strepsilis	.		I	6
Koelerio-Corynephoretea/Corynephorion				
Corynephorus canescens	V	6	IV	6
Rumex acetosella	II	3	III	3
Carex arenaria	II	5	II	3
Hypochaeris radicata	I	3	I	2
Ceratodon purpureus	I	6	I	5
Other species				
Agrostis vinealis	III	5	IV	5
Festuca filiformis	II	5	III	6
Calluna vulgaris	I	4	II	5
Deschampsia flexuosa	I	3	I	3
Pinus sylvestris	+	2	I	2
Algae	I	7	I	7
Cladonia spec.	+	4	I	6

dealt with, is the spreading of *Campylopus introflexus* in case of large scale restoration measurements (Daniëls & Krüger 1996); therefore, smale scaled measurements are recommended. On the resulting open sites, drift sand communities will develop and maintain, assuming that the influence of wind is strong enough to activate the sand permanently (Daniëls 1990; Ketner-Oostra 1995, 1996). This process can be stimulated by trampling, for example by recreation. However, this is a delicate matter, as the amount of human influence needs to be guided carefully. Especially the rare lichen communities prove to be susceptible for treading (Weeda *et al.* 1996).

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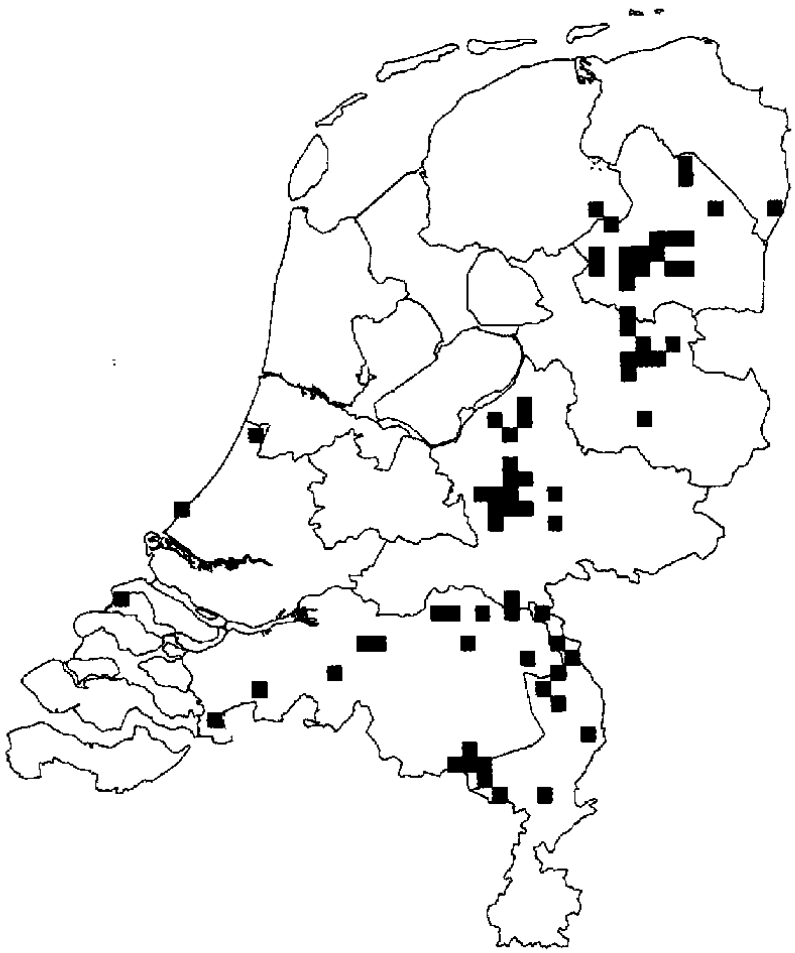

Fig. 1 - Distribution of relevées of the Spergulo-Corynephoretum in the Netherlands since 1975.