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Vegetation development influenced by grazing in the coastal dunes near The Hague, The Netherlands

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Abstract. In 1990, grazing was introduced in a section of Meijendel, a coastal sand dune system near The Hague, The Netherlands. After five years an evaluation was made of the effects of grazing on vegetation development. Three transects were established, two in grazed areas and one in an ungrazed area. Field survey data were classified by means of TWINSPAN, ordinated with Detrended Correspondence Analysis and the resulting vegetation types interpreted according to Westhoff & den Held (1969). All associations were found in both the grazed and the ungrazed areas, but at the subassociation and variant level some communities appeared to be restricted to the grazed area. These variants were five grassland variants characterized by disturbance indicators such as *Senecio sylvaticus* and *Cynoglossum officinale*.

The total number of plant species in the 19 permanent plots, which had been observed to have been decreasing since 1960, showed a considerable increase after the introduction of horses and cows in 1990. A marked decrease in the cover of *Calamagrostis epigejos* and *Carex arenaria* since 1990 was evident, while in some plots species such as *Ribes rubrum* and *Viburnum opulus* increased considerably.

A series of false-colour aerial photographs were used to compare vegetation structure in the three transects between 1990 and 1995. In the grazed area the tall grass vegetation had almost totally disappeared, whereas the areas of open sand, sand with moss and lichens, and low grass vegetation had increased and the pattern had become more fine-grained. In the ungrazed area the area covered by low grass vegetation had increased at the expense of the area of sand with moss and lichens and the pattern had become more coarse-grained.

Keywords: Cattle grazing; Detrended Correspondence Analysis; Horse grazing; Meijendel; Nature management; TWINSPAN; Vegetation pattern.

Nomenclature: van der Meijden (1990) for phanerogams; Rubers & Touw (1989) for mosses; Wirth (1987) for lichens; Westhoff & den Held (1969) for syntaxa.

Introduction

Meijendel is a coastal sand dune system of calcareous origin bordering the North Sea and situated north of the city of The Hague, The Netherlands (52° N, 4° E), covering a total area of ca. 2000 ha (ca. 3 km × 6.5 km). For more than 100 years most of Meijendel has been used as a catchment area for drinking water by the Dune Water Company of the province of South Holland (DZH). The DZH is also responsible for the management of nature conservation, recreation and scientific research of the area. Although situated in the most densely populated and most industrialized part of The Netherlands, Meijendel is still free from urban and industrial encroachment and it boasts a diverse plant species composition (cf. Adriani & van der Maarel 1968; van der Meulen & van der Maarel 1993).

Since the 1950s, however, the species-rich dune grassland has gradually declined (van der Meijden 1986; Vertegaal et al. 1991), mainly because of (1) atmospheric nitrogen deposition (Boorman & Fuller 1982; van Hecke et al. 1981; van der Meulen et al. 1996) and (2) decreased intensity of grazing by rabbits, as a result of the myxomatosis plague in 1956 (Wallage-Drees 1988). The living and dead biomass of the very competitive species *Calamagrostis epigejos* and *Carex arenaria* increased considerably (ten Harkel 1998; van der Meijden 1986). Light penetration to the soil level was reduced and resulted in a decrease of low-growing herbs and short-lived species (Bobbink & Willems 1991; Olff et al. 1993). Germination of various species is hampered by the accumulation of litter (van der Meulen et al. 1996).

To reduce the large proportion of *Calamagrostis epigejos* and *Carex arenaria*, horses and cows have been introduced in several dune systems in The Netherlands (van Dijk 1992; Taal 1989). Instead of other methods such as cutting sods and burning and mowing, grazing can easily take place on steep dune slopes and guarantees a more natural and gradual border between the various vegetation types (Bakker 1987). Grazing in coastal dunes is not a recent phenomenon; for centuries the dunes have been used by farmers as pasture for their cattle (Boerboom 1957; Coops 1953). This has resulted in a diverse pattern of open sand, grassland and scrub. Where the carrying capacity had been exceeded, overgrazing caused erosion of the dunes. Consequently, cattle grazing was forbidden, which partly contributed to the increase of *Calamagrostis epigejos*.

In 1990 grazing was introduced by the Dune Water Company in two valleys in Meijendel, Kijfhoek and Bierlap with the aim of (ten Haaf 1990):

- maintaining the present proportions of the different main structure types;
- developing a more fine-grained pattern of structural types;
- eliminating the increasing dominance of *Calamagrostis epigejos* and *Carex arenaria*; and
- stimulating the development of short dune grassland with herbs.

27 animals (15 horses and 12 cows) are kept in an area of 270 ha (Kijfhoek and Bierlap) all year round. This a low grazing density, because of the extremely low primary production of the coastal dunes (ten Haaf 1990). Horses are able to digest the rough and less nutritious material of grasses and sedges such as *Calamagrostis epigejos* and *Carex arenaria*, while the cows, being ruminants, eat the finer grasses and herbs. Hence, combined grazing will lead to a fine-grained pattern (van Soest 1982). Much research has been done on the effects of grazing on vegetation development (e.g. Hewitt 1985; Belsky 1992; Gibson & Brown 1992; Kooijman & de Haan 1995; Smit & Middelkoop 1992). In this study three hypotheses are put forward, all within the context of the already existing situation, i.e. that which arose in 1990 – when the decision was made as to the particular mixture of animals and grazing intensity. Clearly, this is an unsatisfactory context from the viewpoint of sampling design. The three hypotheses are:

- Grazing causes a decrease in the dominance of species;
- Grazing causes a shift in species composition of plant communities;
- Grazing causes a change in vegetation pattern from coarse-grained to fine-grained.

Five years after the introduction of grazing these hypotheses were tested as follows. The presence of plant communities and their development in the grazed area (Kijfhoek and Bierlap) were compared to those in an ungrazed area (Noorderpan): does grazing cause a decrease of dominant species and a shift in the species composition of plant communities?

The vegetation development in permanent plots was analysed: does a shift in the species composition and dominance of species occur?

False-colour aerial photography was used to compare the structure of the vegetation before, and five years after the introduction of the grazing animals: do coarse-grained patterns change into fine-grained patterns as a result of grazing?

In this study the term 'ungrazed' means no grazing by large herbivores, but light grazing by rabbits. The methods used were chosen to verify the above-mentioned hypotheses.

Methods

Vegetation analysis and classification

Three representative transects (each approximately 600 m × 125 m) were selected: two (Kijfhoek and Bierlap) in the grazed area and one (Noorderpan) in an ecologically comparable, but ungrazed area. All three transects are situated in the same landscape ecological zone between the foredunes and inner dunes (Doing 1974, 1995). Although the area covered, including both the grazed and ungrazed areas was large enough, i.e. ca. 450 ha, it was not possible to select a second comparable transect in the non-grazed area.

A total of 239 relevés were recorded according to the Braun-Blanquet-method (Westhoff & van der Maarel 1973). The plots selected were from evenly distributed sites across the different vegetation types in the three transects. The size of the sample plots was determined by the structure of the vegetation and varied from 2 m × 2 m in the grasslands to 10 m × 10 m in the woodlands. In each plot the cover/abundance of all plant species was estimated using the Braun-Blanquet scale as refined by Barkman et al. (1964). These values were again transformed according to the ordinal transformation of van der Maarel (1979) into a 0 - 9 scale.

The relevés were classified by means of the divisive clustering methods TWINSPAN (Hill 1979). For each plant community the percentage contribution of various syntaxonomic elements was calculated (Westhoff & den Held 1969).

Permanent plots

19 permanent plots, varying from 24 m^2 to 360 m^2, had been established earlier – only in the grazed section of the study area. The vegetation of these plots, most of which had been sampled since 1952 (usually once every three years), originally consisted of homogeneous woodland. Many of them have gradu-

ally become more or less heterogeneous, and have degenerated into phases of structurally lower and more open vegetation during the course of a cyclical succession (Randall 1978).

The permanent plot data from 1952 to 1995 were analysed by means of the ordination method Detrended Correspondence Analysis (DCA) from the program package CANOCO (ter Braak 1987). Relations were determined between the position of the relevés in the diagram of the first two axes of the DCA-ordination and (1) proportion of syntaxonomic elements, and (2) the mean indicator values (Ellenberg 1974) for nitrogen, moisture, acidity, temperature and light. These indicator values were used because no abiotic field data were available (Persson 1981; Diekmann & Dupré 1997). In addition, the average number of species in the 19 permanent plots was calculated for the years 1960, 1965, 1970, 1980, 1990 and 1995; these are the years in which all 19 plots were analysed. Furthermore a comparison was made between the years 1990 and 1995 on the basis of the average cover in the plots of *Calamagrostis epigejos* and *Carex arenaria*.

Structural comparison

A comparison of the vegetation structure was made in the three transects before the introduction of grazing and after five years of grazing. Both series of false-colour aerial photographs from 1990 and 1995 (scale 1 : 2500) were interpreted using a stereoscope. The series of 1990 had been taken just before the introduction of grazing. The following six structural types were distinguished: (1) bare sand; (2) sand with mosses and lichens; (3) short grass vegetation with mosses; (4) tall grass vegetation; (5) low shrubs; and (6) tall shrubs and trees.

The overlay sheets with the above-mentioned structural types were scanned and converted into a digital data file. In each transect, the area of each structural type and the length of their mutual borders in 1990 and again in 1995 were determined using a Geographical Information System. These (dimensionless) mutual border lengths were used as a measurement for the scale of the pattern in which the different structure types occur: the larger the border lengths per unit area, the more fine-grained the pattern.

Results

Vegetation classification

20 plant communities were distinguished in the three transects (Table 1). At the association level of classification there is no difference between the grazed and the ungrazed areas: all associations were found in both areas. To study the differences in greater detail, the comparison was extended to the units below the association level: subassociations and variants.

- In the ungrazed Noorderpan area dominated by *Calamagrostis epigejos,* most other plant species were still present, although with fewer and smaller populations (de Bonte & Boosten 1996).
- The impact of grazing was largest on the *Tortulo-Phleetum arenarii* and the *Taraxaco-Galietum maritimi* associations. Five grassland communities (Nos. 4, 6, 8, 12 and 13) were found only in the grazed area, characterized by *Cynoglossum officinale* and *Senecio sylvaticus*.
- An important impact of grazing is the destruction of trees and shrubs by horses and cows. The *Tortulo-Phleetum* communities 4 and 6 had developed by trampling and destruction at the edges of *Hippophae rhamnoides* shrubs.
- The *Taraxaco-Galietum maritimi* subassociation *cladonietosum* (no. 8) was also restricted to the grazed area. Here, the vegetation had been opened by the trampling of the animals.
- The communities 12 and 13, fragmentary *Taraxaco-Galietum*, were restricted to parts of the Bierlap, dominated by *Calamagrostis epigejos* before grazing was introduced five years ago. Severe grazing caused a major change in the vegetation, which now consists of a thick moss layer and of plant species such as *Agrostis capillaris, Rumex acetosella,* and *Senecio sylvaticus*.
- Community 12 was dominated by the moss *Campylopus introflexus*, an invasive species from the southern hemisphere (van der Meulen et al. 1987), and the lichen *Cladonia foliacea*, growing on the dense layer of *Campylopus introflexus*.
- Community 13 was restricted to parts of the Bierlap, which were shaded by trees of *Ulmus minor* five years ago.
- Two variants of the *Crataego-Betuletum*, communities 19 and 20, were also restricted to the grazed area. In community 19 the shrub layer of the forest was affected by the grazing. The absence of community 20 in the ungrazed area probably has no relation to grazing but may have resulted from the drier conditions in the Noorderpan valley.

Table 1. Survey of the plant communities distinguished, including subassociations and local variants. The table also gives the number of relevés involved and the average number of species per type.

	(Sub)association/variant	Comm. no.	No. of relevés	Mean no. of species	Grazed/ Ungrazed
Ammophiletea					
Elymetalia arenarii					
Ammophilion borealis					
	Elymo-Ammophiletum subass. *redivivum*	1	4	11	G/U
Koeleria-Corynephoretalia					
Festuco-Sedetalia					
Galio-Koelerion					
	Tortulo-Phleetum arenarii subass. *typicum* var. with *Cardamine hirsuta*	2	9	17	G/U
	Tortulo-Phleetum arenarii subass. *typicum* var. with *Erophila verna*	3	32	14	G/U
	Tortulo-Phleetum arenarii subass. *typicum* var. with × *Calammophila baltica* and *Senecio sylvaticus*	4	10	22	G
	Tortulo-Phleetum arenarii subass. *typicum* var. with *Cladonia foliacea* and *Cladonia furcata*	5	10	18	G/U
	Tortulo-Phleetum arenarii subass. *jasionetosum*	6	7	27	G
	Taraxaco-Galietum maritimi var. with *Ditrichum flexicaule* and *Ononis repens* ssp. *repens*	7	8	27	G/U
	Taraxaco-Galietum maritimi subass. *cladonietosum*	8	22	24	G
	Taraxaco-Galietum maritimi var. with *Thymus pulegioides* and *Veronica officinalis*	9	25	32	G/U
	Taraxaco-Galietum maritimi var. with *Vicia lathyroides* and *Vicia sativa* ssp. *nigra*	10	6	19	G/U
	Fragmentary *Taraxaco-Galietum maritimi* var. with *Hippophae rhamnoides* and *Erigeron canadensis*	11	6	18	G/U
	Fragmentary *Taraxaco-Galietum maritimi* var. with *Cladonia foliacea* and *Polytrichum juniperinum*	12	13	21	G
	Fragmentary *Taraxaco-Galietum maritimi* var. with *Holcus lanatus* and *Pseudoscleropodium purum*	13	14	23	G
Rhamno-Prunetea					
Prunetalia spinosae					
Berberidion					
	Hippophao-Ligustretum subass. *typicum* var. with *Salix repens* and *Dicranum scoparium*	14	10	26	G/U
	Hippophao-Ligustretum subass. *typicum* var. with *Ligustrum vulgare* and *Galium verum*	15	13	12	G/U
	Hippophao-Ligustretum subass. *typicum* var. with *Ligustrum vulgare* and *Moehringia trinervia*	16	8	14	G/U
	Hippophao-Ligustretum subass. *typicum* var. with *Hippophae rhamnoides* and *Cynoglossum officinale*	17	10	20	G/U
Querco-Fagetea					
Fagetalia sylvaticae					
Alno-Padion					
	Crataego-Betuletum variant with *Geum urbanum* and *Polygonatum odoratum*	18	9	31	G/U
	Crataego-Betuletum variant with *Sambucus nigra* and *Populus tremula*	19	12	24	G
	Crataego-Betuletum variant with *Teucrium scorodonia* and *Betula pubescens*	20	11	24	G

Table 2. Cover of *Calamagrostis epigejos* and *Carex arenaria* in the permanent plots in 1990 and 1995 (ordinal scale; van der Maarel 1979).

Plot number		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Calamagrostis epigejos																				
cover	1990	2	2	7	8	7	1	5	1	7	0	5	6	6	-	-	-	0	2	3
	1995	1	1	1	1	1	1	1	4	2	1	1	1	1	-	-	-	1	0	3
		decrease: 11 plots						increase: 3 plots						no difference: 2 plots						
Carex arenaria																				
cover	1990	1	1	7	6	5	2	6	-	4	2	0	5	9	-	-	-	-	2	-
	1995	0	0	4	2	6	2	4	-	1	1	1	1	4	-	-	-	-	0	-
		decrease: 10 plots						increase: 2 plots						no difference: 1 plot						

Permanent plots

No common pattern of vegetation development in relation to Ellenberg indicator values was discernible in the 19 permanent plots – which were mainly situated in afforested areas. Instead, the following four trends could be distinguished (detailed information is given in de Bonte & Boosten 1996):

1. Some plots showed no obvious effect of grazing, as far as cover percentage of the tree, shrub and herb layer, as well as overall species composition are concerned. Grazing intensity on the sites of these permanent plots was very low and the development had proceeded unrelated to grazing.
2. Several plots of woodland with shrub species in the understorey or in the herb layer, e.g. *Ribes rubrum* and *Viburnum opulus*, increased. This may be due to some trampling.
3. In some plots a decrease of trees and shrubs was evident. This might be due to a too high grazing intensity.
4. In a few plots the vegetation had been stabilized, may be due to grazing and no development could be detected; as a result the vegetation in 1995 was almost the same as it was in 1990.

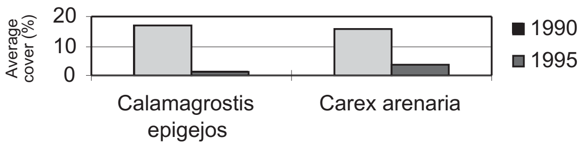

Fig. 1. Mean cover of *Calamagrostis epigejos* and *Carex arenaria* in the permanent plots in 1990 and 1995.

Most plots showed a decrease in cover of *Calamagrostis epigejos* and *Carex arenaria*: 11 and 10 plots out of 16 and 13 plots with *Calamagrostis epigejos* and *Carex arenaria* respectively (Table 2). The average cover of both species decreased as well (see Fig. 1). Since 1960 the number of species in the plots had decreased from 35 (± 6.2) to 24 (± 6.7) in 1990. After five years of grazing the number of species appears to increase again to 30 (± 6.8) (Fig. 2).

Change in structure

Comparison of the vegetation structure in the three transects before and after five years of grazing produced some important results. In the ungrazed area (the

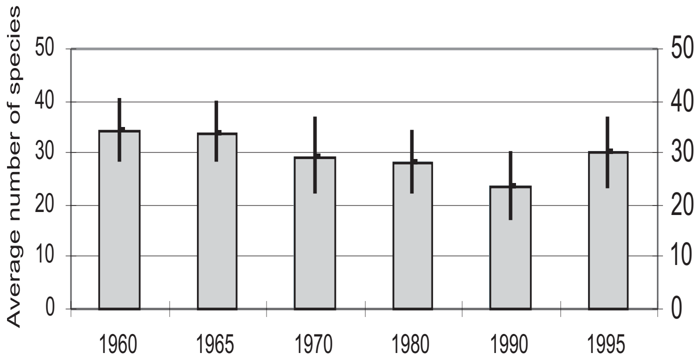

Fig. 2. Mean number (± S.D.) of plant species in all 19 permanent plots in different years.

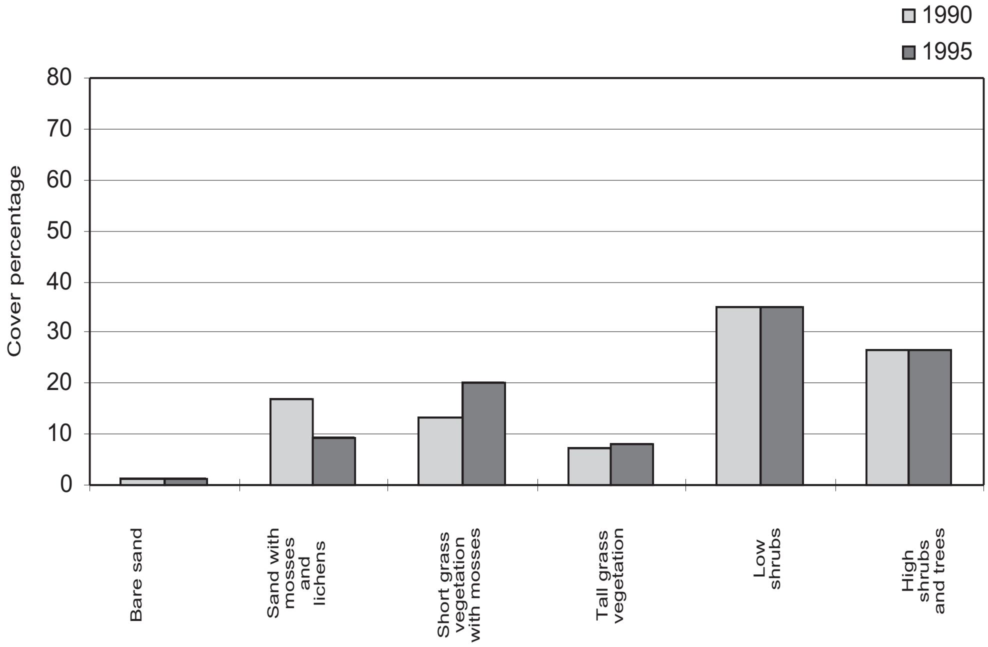

Fig. 3. Comparison of the percentages of the total surface covered by the six distinguished structural types in the Noorderpan (ungrazed area) in 1990 and in 1995.

Noorderpan transect), the surface covered by low grass vegetation had increased at the expense of sand with mosses and lichens (Fig. 3). The length of the mutual border of the structural types in the ungrazed situation has decreased by 14.1 % (Table 3). It is evident that the absence of grazing resulted in a more coarse-grained pattern, so the distribution of the structural types had grown larger in scale.

In the grazed area the development of the vegetation structure was totally different (Figs. 4 and 5). The areas of bare sand, sand with mosses and lichens, and short grass vegetation with mosses had increased, while those with tall grass vegetation have almost disappeared and the cover of high shrubs and trees had decreased (most obvious in the Bierlap transect, Fig. 5). The length of border shared by the different structural types increased (in the Bierlap transect by 13.4%, in the Kijfhoek transect by 10.6%, Table 3), revealing a more fine-grained pattern.

Table 3. Mutual border lengths of several structural types in the three transects.

	Kijfhoek	Bierlap	Noorderpan
1990	8632	13847	13520
1995	9547	15705	11609
Difference (%)	+ 10.6	+ 13.4	– 14.1

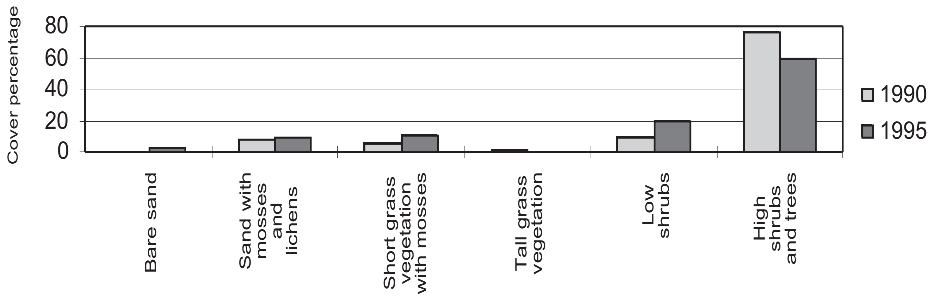

Fig. 4. Comparison of the percentage of the total surface covered by the six distinguished structural types in the Kijfhoek (grazed area) in 1990 and in 1995.

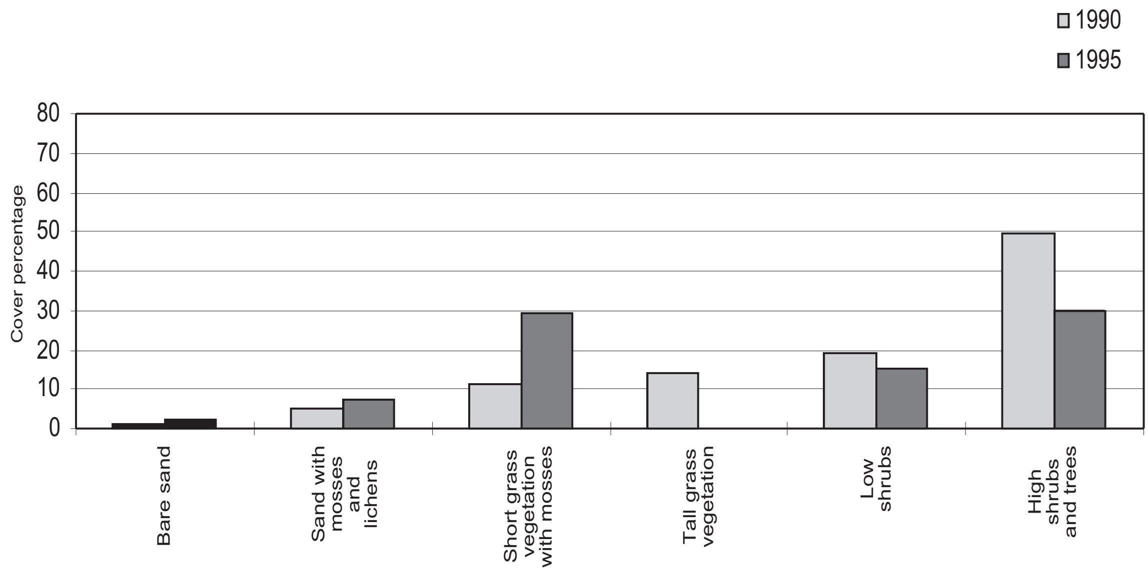

Fig. 5. Comparison of the percentage of the total surface covered by the six distinguished structural types in the Bierlap (grazed area) in 1990 and in 1995.

Discussion

The results of the vegetation classification for the transects, the analysis of the permanent plots and the investigation of changes in vegetation structure by means of aerial photographs, complement and support each other partly.

After five years of grazing no change in the vegetation types at the association level had occurred. All associations distinguished were present, both in the grazed and in the ungrazed area. However, when the vegetation was compared at the subassociation or variant level, five of the communities appeared to be restricted to the grazed area. These five variants were all grassland communities, probably the result of the preference of horses and cows for grass species (van Soest 1982). The variants are characterized by some disturbance indicators like *Senecio sylvaticus* and *Cynoglossum officinale*, which favour the opening of the soil caused by trampling. This indicates that, on average, all species were present also in the ungrazed situation and that only a shift in presence has taken place as a result of the grazing, apart from the presence of disturbance indicators.

The grazing animals not only show a preference for the grass species, but also for *Euonymus europaeus* (van der Hagen 1996); they even destroy surrounding shrubs in order to reach this species. The shrubland in the grazed area appeared to have a more open character than in the ungrazed area. In the case of the *Tortulo-Phleetum* communities 4 and 6, the destruction of *Hippophae* shrubs seemed to slightly eutrophicate the soil by mineralization of *Hippophae* leaves. Community 8, *Taraxaco-Galietum maritimi* subass. *cladonietosum*, had been opened by trampling, leaving sufficient space for the germination of low-productive species such as *Sedum acre* and annuals such as *Myosotis ramosissima*. The heavily grazed fragmentary *Taraxaco-Galietum* communities 12 and 13 in a section of the Bierlap were characterized by species such as *Rumex acetosella* and *Agrostis capillaris*, species indicating a relatively acidic soil (Ellenberg 1974). In community 12, the trampling by horses and cows has resulted in favourable conditions for the germination of species such as *Galium verum* and *Taraxacum laevigatum* by opening the thick moss layer as well as the top soil. The occurrence of many shade-preferring species in community 13, in particular the mosses *Eurhynchium praelongum* and *Pseudoscleropodium purum*, is related to the former shading by *Ulmus minor*, which had been ring-barked by the horses. The vegetation was in transition from being shade-tolerant to light-tolerant.

Because composition and structure of the vegetation just before the introduction of the grazing animals has not been recorded, this part of the research could only be based on a contemporary comparison between the grazed and ungrazed areas. Although the grazed area was situated in the same landscape-ecological zone as the ungrazed area, between the foredunes and the inner dunes, there may have been some minor differences in biotic and abiotic conditions. A different hydrological system in the three more or less ground-water-dependent transects led to differences in species composition.

This might have been the reason for the occurrence of community 20, i.e. only in the grazed area, under relative humid circumstances.

Differences in vegetation development were apparent among the various permanent plots. The reaction of vegetation to grazing is difficult to explain. Impact on vegetation dynamics differs according to the grazing intensity and the species of herbivore (Bakker 1987; Gibson & Brown 1992; Prins 1987). In some plots the grazing had no apparent influence on the development of the vegetation, probably due to the absence of palatable plant species. The animals visited these plots only incidentally. Here, it would appear that the vegetation development is governed rather by abiotic conditions. The vegetation canopy appeared to close, and shade-tolerant species thrived. When grazing intensity is moderate, the trampling of grazing animals provides better conditions for germination of shrubs and woodland species (van der Meulen et al. 1996). However, when the grazing intensity is very high, the vegetation is so intensively affected that the influence is even seen on trees and shrubs.

Tree browsing is found frequently causing bonsai-like growth forms of tall shrubs, e.g. *Crataegus monogyna*, and trees, e.g. *Quercus robur* (van der Hagen & Droesen in prep.). Also young plants are eaten; they have no chance to mature, except when surrounded by thorny shrubs (Vera 1997). On the contrary, in several permanent plots an increase in the presence of *Ribes rubrum* and *Viburnum opulus* has been found. More abiotic data should be collected and research on the exploratory behaviour and migration of the grazing animals in Kijfhoek and Bierlap is needed to explain the differences in vegetation development.

The total number of plant species in the permanent plots, which had been decreasing since 1960, showed an increase after the introduction of grazing in 1990. Although this increase is statistically not significant, it still indicates that grazing has a positive effect on species numbers. Species richness normally increases when the herbivores feed preferentially on the dominant plant species (Crawley 1983). The reason for the increase of species richness found in this survey was probably the result of the marked decrease of *Calamagrostis epigejos* and *Carex arenaria* from 1990 till 1995. The opening of the tall grassland canopy and the trampling of the horses and cows, opening the top soil, provides the opportunity for several plant species to occur. Because the increase is based on just one year of observations, we may not yet speak of colonization.

In the transects in the grazed area, the tall grass vegetation present in substantial quantities in 1990, disappeared almost totally. Contrastingly, the surfaces of bare sand, sand with moss and lichens and short grass vegetation increased. Furthermore, after five years of grazing, the pattern became more fine-grained. In the ungrazed Noorderpan the short grass vegetation had increased at the expense of sand with moss and lichens, as a result of succession caused by the increasing influence of atmospheric deposition and as an autonomic process. The growth of grasses caused the influence of interception deposition to increase substantially and the grass becomes less palatable for grazing by rabbits (ten Harkel 1998), resulting in a more coarse-grained pattern in the ungrazed transect.

After five years of grazing two aims have been realized, namely the development of a more fine-grained pattern of structural types and the curbing of the increasing dominance of *Calamagrostis epigejos* and *Carex arenaria*. The aim of maintaining the present proportions of the different structural types has not been realized, because grazing resulted in an increase of open vegetation. Similar increases were reported by Belsky (1992) and Kooijman & de Haan (1995). When we look at the hypotheses we can conclude that grazing causes a decrease of dominant species. This leads to a slight shift in species composition, but this only occurs below the association level. Grazing also causes a change in the vegetation pattern from coarse-grained to fine-grained.

It can be concluded that grazing is a suitable way of enhancing species-rich dune grasslands, to obtain a larger area of bare sand – which is important for the development of various groups of animals – and to obtain a more fine-grained pattern of vegetation types. However, the effect of the density of horses and cows should continue to be monitored; also research on the exploratory behaviour and migration of the animals should be started in order to be able to explain several results of this study.

Excessively high grazing pressure will destroy woodland and shrubland, especially where they border grasslands (ten Haaf 1990; van Soest 1982). Grazing is an excellent management tool in nature conservation but must be utilized with care.

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