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7. Ecological dune research
'Veevers' Duin'

7.1. Some demographic characteristics of Plantago species grown in experimental plots (C.W.P.M. Blom, J. van Heeswijk)

Introduction and methods
The floristic composition and development of the semi-natural grasslands of coastal sand dunes can be strongly influenced by trampling and soil compaction. This study was performed to obtain more insight into the effects of these two environmental factors on the various stages in the life cycle of plants. For this purpose, Plantago species were chosen. P. major ssp. major and, to a lesser degree, P. coronopus are found on trampled and compacted soils. P. lanceolata occurs on moderately compacted and loose soils. For purposes of comparison P. media, which occurs on loose or moderately trampled clay and loam soils, was also included in the study.

The part of the study described in this report was performed in three groups of experimental plots where the effects of light, moderate, and heavy trampling on the growth and development of the four Plantago species were investigated. The trampling treatments were carried out with a trampling machine (see Blom 1979). In this experiment, the effects of compaction on these species, planted in April 1976 as young seedlings, were also studied.

The experimental design and many of the results have already been described in Blom, 1979. Because this experiment was continued in 1979, the results on survival and daughter-rosette formation are given in this report.

Results and discussion
A. Survival (Fig. 7.1.1.)

P. lanceolata
For P. lanceolata, the chance of survival is greatest on loose and moderately compacted soils. After three years, 80% of the planted individuals were still alive. On an untrampled, strongly compacted soil, the survival of this species was also found to be relatively high (70%).

The chance of survival decreased strongly with increasing trampling intensity. In October of 1979, only 37% of the heavily trampled P. lanceolata plants were still alive. During the entire research period the number of moderately and heavily trampled plants decreased, whereas a decline of the number of lightly trampled plants was only observed in the beginning of the period.

P. coronopus
Of all the species under study, P. coronopus appeared to have the shortest life. In 1978 a strong decrease of P. coronopus was observed in all plots and in the severe winter of 1978-1979 all plants succumbed. This...
phenomenon was also observed in the field outside the experimental plots. Studies in the field indicate that plants of this species occurring on dune grasslands are short-lived (2-3 years). Thus, it is likely that the plants in the experimental plots (seed originating from a dune grassland population) would have died off even in the absence of extremely low temperatures.

The various treatments had a pronounced effect on the mortality rate. An increase in compaction of the soil led to an increasing number of surviving plants up to October, 1978. An increase of the trampling intensity led to a higher death risk. In 1978, the percentages of surviving plants were 42, 21, and 12, for the lightly, moderately, and heavily trampled plots, respectively. Compared with the untrampled plants on the loose soils, the chance of surviving was higher with light trampling.

**P. major ssp. major**

Comparison of the mortality rate of *P. major* plants in the untrampled and the trampled plots shows that under these conditions trampling strongly increases the chance of survival of this species. In 1979, the percentages of living plants lay between 37 and 54 in the untrampled plots, whereas for the trampled sites these values were 54 and 71. Remarkable were the relatively low numbers of living plants on the moderately compacted, trampled, and untrampled soils. The highest numbers of living plants were found on the heavily trampled plots (70.8% in 1979).

**P. media**

Between the treatments, no important differences in survival were observed for this species. Under these conditions, *P. media* had the longest life span of the *Plantago* species studied.

Comparison of the above results with the chances of survival of seedlings (Blom 1979) gives the following picture. The effects of soil compaction and trampling on the seedlings of *P. lanceolata* are similar to those on mature plants. *P. coronopus* seedlings are very vulnerable to trampling and occur mainly on loose and relatively dry soils; the mature plants are more resistant to trampling. In the untrampled series the two-year-old *P. coronopus* plants survived in higher numbers on the compacted than on the loose soils. Seedlings of *P. major* and *P. media* succumbed in higher numbers in loose and relatively dry soils than the mature plants did. Both species have a high resistance to trampling in all stages of the life cycle.

**Daughter rosette formation in *P. lanceolata* (Table 7.1.1.)**

*P. lanceolata* showed a strong tendency to vegetative reproduction, which is in accordance with the findings of Soekarjo (1979). Only a few individuals of the other species formed daughter rosettes. No correlation was found between the vegetative reproduction of *P. major*, *P. coronopus*, or *P. media* and the treatment. It was remarkable that 7 plants (50%) of *P. media* formed rosettes in one of the untrampled, strongly compacted plots. However, daughter rosettes rarely occurred in the other plots of the same treatment.

As the results in Table 7.1.1 show, the number of rosettes per *P. lanceolata* plant increases with age. No important differences as to the number of daughter rosettes were observed between the trampled and the corresponding untrampled series. In 1979 there was a significantly higher number of rosettes per plant on the loose soils and on the lightly trampled plots compared with the untrampled strongly compacted soils and the heavily trampled plots. An increase of compaction and trampling led to a decrease in the rate of daughter rosette formation. The highest percentages of plants with more than one rosette were also observed on loose soils or on lightly and moderately trampled plots.

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**Table 7.1.1. Rosette formation by *P. lanceolata* plants in experimental plots.**

<table>
<thead>
<tr>
<th></th>
<th>loose soil</th>
<th>moderately compacted soil</th>
<th>strongly compacted soil</th>
<th>lightly trampled</th>
<th>moderately trampled</th>
<th>heavily trampled</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1976</td>
<td>1.4 ± 0.2</td>
<td>1.0 ± 0</td>
<td>1.3 ± 0.1</td>
<td>1.2 ± 0.1</td>
<td>1.2 ± 0.1</td>
<td>1.1 ± 0.1</td>
</tr>
<tr>
<td>1977</td>
<td>5.6 ± 0.7</td>
<td>2.5 ± 0.5</td>
<td>1.8 ± 0.4</td>
<td>4.6 ± 0.5</td>
<td>3.0 ± 0.4</td>
<td>3.4 ± 0.5</td>
</tr>
<tr>
<td>1978</td>
<td>7.2 ± 0.8</td>
<td>4.1 ± 0.6</td>
<td>4.6 ± 0.6</td>
<td>6.8 ± 0.7</td>
<td>5.9 ± 0.8</td>
<td>4.5 ± 0.9</td>
</tr>
<tr>
<td>1979</td>
<td>12.4 ± 1.9</td>
<td>8.4 ± 1.0</td>
<td>9.5 ± 1.5</td>
<td>14.5 ± 1.7</td>
<td>8.7 ± 1.5</td>
<td>6.8 ± 1.8</td>
</tr>
<tr>
<td>B. October 1979</td>
<td>95</td>
<td>82</td>
<td>76.5</td>
<td>100</td>
<td>100</td>
<td>89</td>
</tr>
</tbody>
</table>
Fig. 7.2.1. Map of the coastal region of Voorne with indication of the inventoried area.
7.2. CHANGES IN THE FLORA OF THE VOORNE COASTAL AREA

(M. Boeken, D. van der Laan, P.A.I. Oremus)

Introduction

The coastal area of Voorne has always been of great biological value in many respects. Above all, this area could be considered outstandingly rich floristically. This richness was clearly demonstrated by an inventory of the vascular plants, which was started in 1962. The aim of this survey was to identify the species occurring and estimate their distribution in the area. For this purpose, van der Maarel suggested that the Voorne coastal area be subdivided into sections, each one homogeneous as to type of landscape and roughly equal in size (Adriani and van der Maarel, 1968). A hundred physiognomical sections were distinguished.

The main part of the inventory was executed between 1962 and 1964. Up to 1970, new localities of species were added. In 1979 part of the same area was inventoried again. This was done to make it possible to establish changes in the composition of the flora over these two periods, because a number of such changes might have taken place as a result of environmental changes in the area as well as in the surrounding area. This made it possible to detect the effects on the flora of such activities as the execution of the Delta Project; the construction of harbours, industrial plants, and roads; housing projects; increase of recreation pressure; and so on.

In this contribution the results of the second inventory of the flora (1979) are briefly reported and compared with the earlier results. More detailed information will be given elsewhere by the first author as part of his doctoral work at the University of Groningen.

During the period from April to August in 1979, the flora of part of the total area originally surveyed (31 of the 100 sections) in the dunes near the village Oostvoorne (Fig. 7.2.1) was inventoried. On the basis of the species list of the Dutch flora prepared by the Rijksherbarium in Leiden (Mennema 1976), all vascular plant species recorded in each section were checked off. To cover the seasonal variation, most of the sections were visited twice at different times of the year. The data of the first and the second inventories were put on tape for computer analysis.

For comparison of the two inventories, use was made of a method introduced by van der Maarel (1971) and elaborated by Arnolds and van der Meijden (1976). According to this method, the Dutch species of vascular plants are classified in 9 categories, subdivided into 37 ‘ecological groups’ and 10 frequency classes (0-9). The frequency values are based on the numbers of squares (5 x 5 km²) in which a particular species is present in the Netherlands. By subtracting the frequency value of a given species from 10, a notation is obtained indicating the degree of rareness of that species in The Netherlands (Mennema 1973; Arnold 1975). The rareness values of all taxa occurring in a particular section taken together, determine the rareness value assigned to that section. Once rareness values are available for the various sections, the difference between them can be determined.

Another interesting aspect of the method devised by van der Maarel is that it makes possible to determine the ecological groups by which the floristical composition of a section is principally characterized. Calculation of the rareness values for each ecological group in each section indicates which particular group is the most important for that section (van der Meijden 1977). This method, called floristic analysis, has proved to be useful for the comparison of inventories of different areas made at the same time but is equally applicable to compare flora inventories of the same area made at different times.

To detect changes, if any, in the rareness value and the number of species in each ecological group, these characters of the respective inventories are compared. The data of both the 1962 and 1979 inventories were analysed to determine the extent to which the ecological groups were represented in each section. The amount of change could then be determined, and was expressed as:

1. the increase or decrease of the number of species of a particular ecological group in all 31 sections;
2. the increase or decrease of the rareness value of a particular group in all 31 sections; and
3. the increase or decrease of the number of sections in which species of a particular ecological group were found.

Unlike the 1962 inventory, where quantity was not recorded, in 1979 the occurrence of the species was quantified according to the Tansley scale (Tansley 1946). Of the three possibilities – i.e., increase, decrease, or equality in number of species and floristic composition – the first two are left because the equals were taken as half decrease and half increase.

References
