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Lichen Mapping and Remapping in The Netherlands

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With 1 table and 8 figures

1. Introduction

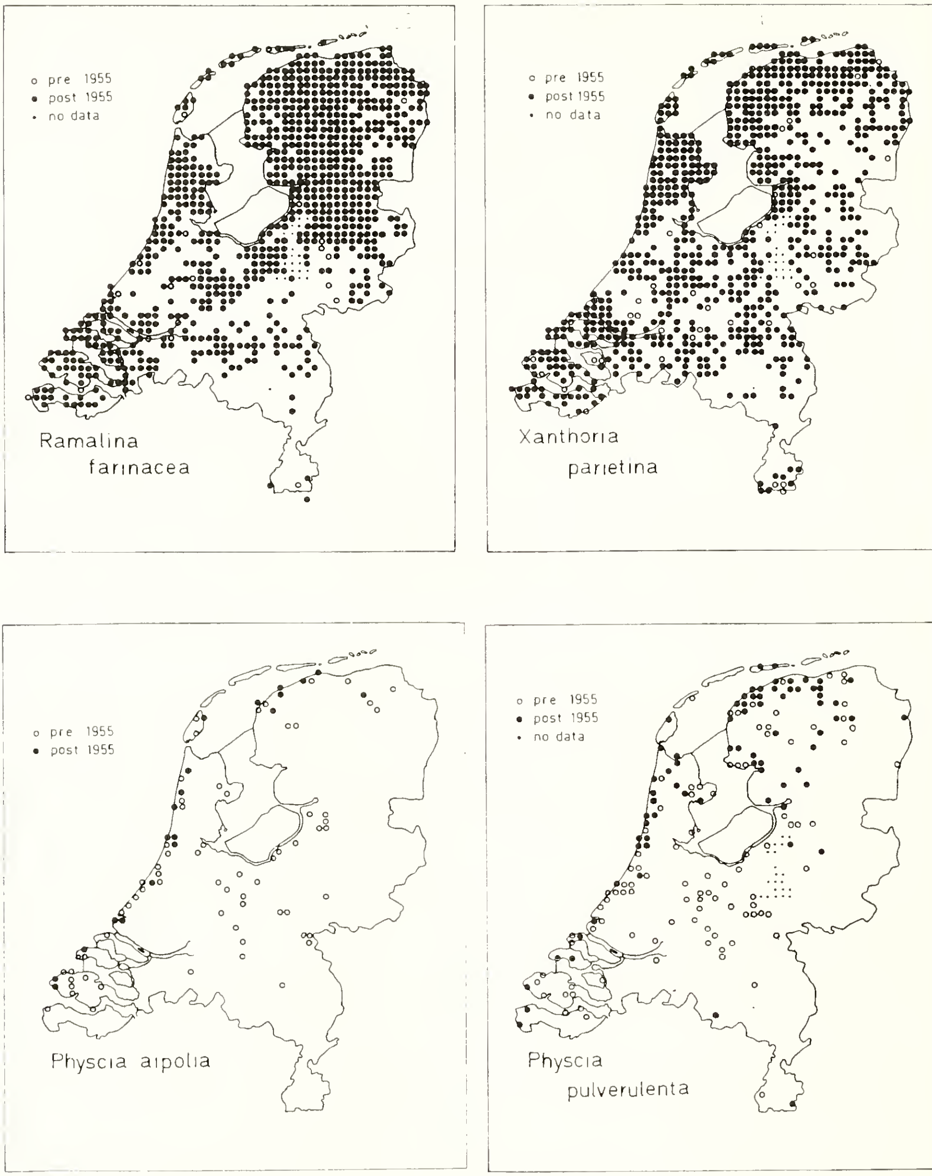
The Netherlands are a lichen-poor country. The poverty is caused by a lack of suitable substrates for epilithic species, especially the acidophytic ones, by a lack of old forest relics, and by a high level of air pollution. There is no systematic, nationwide mapping program of Dutch lichens. However, numerous data collected by various workers provide a fairly good picture of the Dutch lichen flora, and, with respect to epiphytes, of the changes during the past century. The present state of knowledge is summarized in the ‚Standaardlijst van de Nederlandse korstmossen' (Checklist of the Dutch Lichens; Brand et al. 1988), which states ecology and estimated frequency for all species. In this list a total of 665 species is recorded, of which 562 have been found after 1970.

2. The 'WHEN' project

More precise data are available on the epiphytic species. Barkman's (1958) work on the cryptogamic epiphytes of The Netherlands still stands as one of the most important works in descriptive ecology. He was also the first to investigate the effect of air pollution on epiphytic lichens in The Netherlands, and his map has been published many times since, e. g. in Barkman (1969). The relation between epiphytes and air pollution proved to be a great stimulus to the study of this group. Barkman's map was based on relatively few lichen data, and systematic air pollution data were unavailable at that time. However, between 1972 and 1974 the 'WHEN' project (Werkgroep Herkartering Epifytenwoestijnen Nederland; de Wit 1976) was undertaken, a nationwide mapping of epiphytic lichens on the basis of a 5 km x 5 km grid. This inventory was carried out at localities which were chosen randomly within each grid square (c. four per square, most of them wayside trees), by amateurs with a varying degree of experience. The results should be looked at with some caution because field identifications were accepted. Nevertheless, the observed pattern of species richness correlates well with measured SO_2 concentrations. Figure 1 shows the distribution maps of two easily recognizable species, Fig. 3 gives the generalized species richness per square, and Fig. 4 the mean SO_2 concentration measured in 1977.

3. Changes in the epiphytic flora before 1980

Valuable though incomplete information on species distribution in the 19th and early 20th century can be obtained from the material preserved in the Rijksherbarium at Leiden. When these data are compared to the situation after 1950, a strong decline of many species becomes apparent. Examples based on these data are given by Barkman (1958). A comparison of Barkman's data with the WHEN data shows that between 1950 and 1974 further decline took place; Fig. 2 gives two examples (more examples are given by de Wit 1976).



Figs. 1–2. Distribution of several lichen species in the Netherlands (from DE WIT 1976). – 1. (above) *Ramalina farinacea* (left) and *Xanthoria parietina* (right) in the WHEN inventory. – 2. *Physcia aipolia* (left) and *Physconia distorta* (right).

A detailed mapping study in the 's-Hertogenbosch area (c. 20 km x 20 km) by VAN DOBBEN (1983) showed a spectacular decline between 1900 (115 spp.) and 1974 (46 spp.), which could largely be ascribed to air pollution by SO_2 and resulting bark acidification. For most species (except *Lecanora conizaeoides*) naturally acid bark had become too acid, while some common species, e. g. *Parmelia sulcata* and *Evernia prunastri*, survived on naturally neutral, now acidified bark.

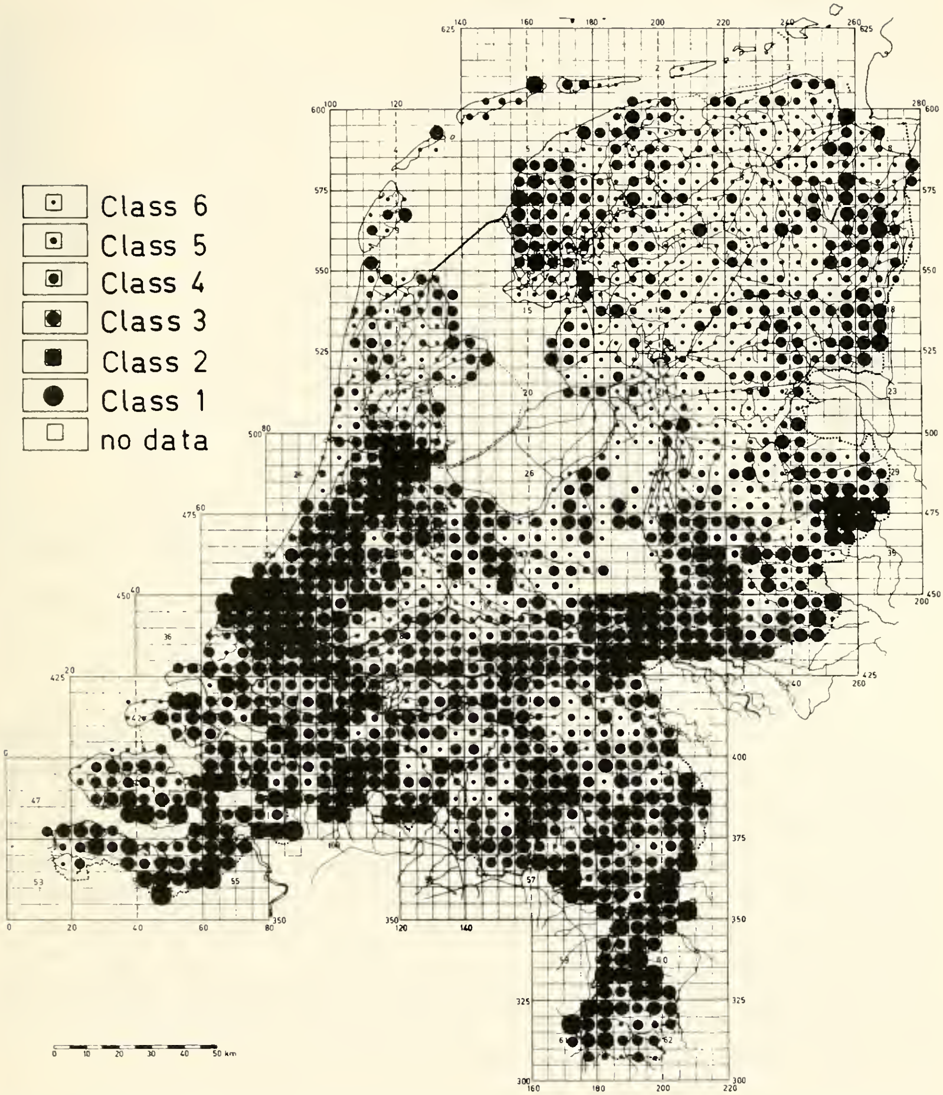
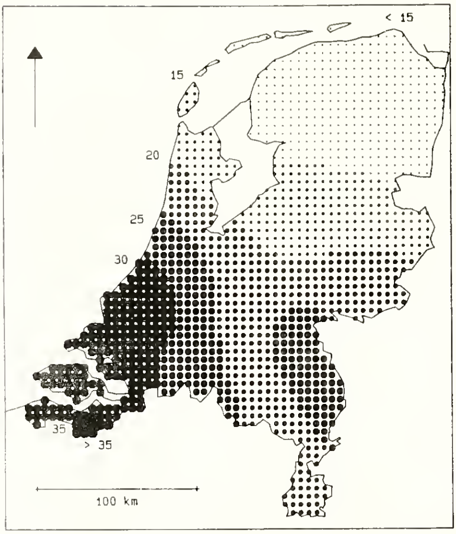


Fig. 3. Species richness per grid square in the WHEN inventory (from DE WIT 1976). – *Explanation* of class numbers:

class	approx. number of species per square	common species
1	0 – 3	*Lecanora conizaeoides, L. expallens*
2	4 – 7	*Buellia punctata, Physcia tenella*
3	8 – 11	*Parmelia sulcata, Evernia prunastri*
4	12 – 17	*Ramalina farinacea, Parmelia acetabulum*
5	17 – 20	*Ramalina fastigiata, Parmelia exasperatula*
6	> 20	*Parmelia caperata, Ramalina fraxinea*



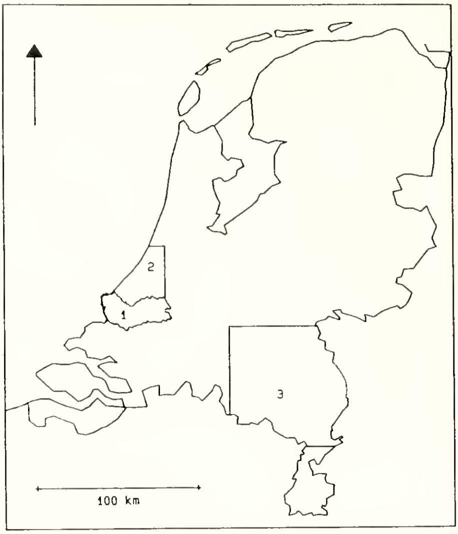


Fig. 4. (left) Mean SO_2-concentration in µg·m^{-3} in 1977 (data from National Institute of Public Health and Environmental Protection).

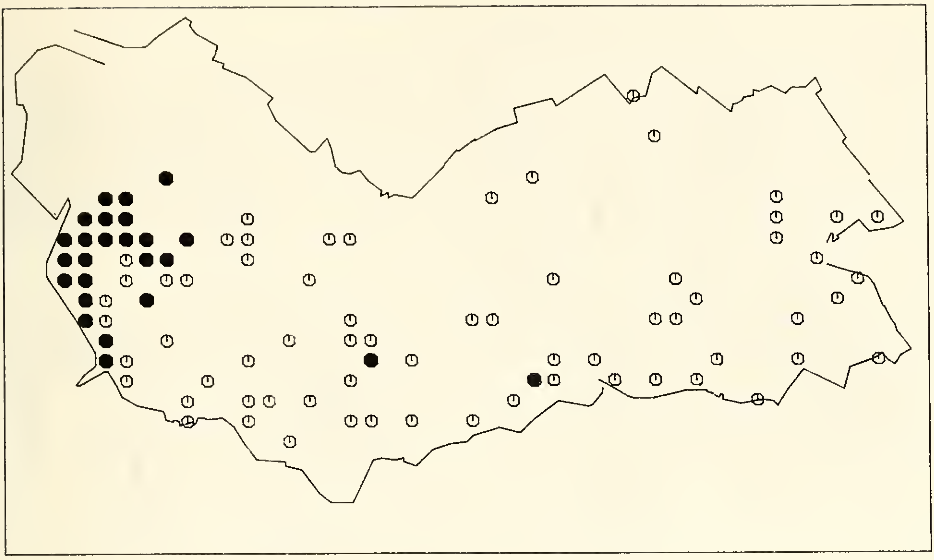
Fig. 5. (right) Location of re-mapped areas: *1* = Rijnmond (industrial), – *2* = Zuid-Holland (industrial and agricultural), – *3* = eastern Brabant (agricultural).

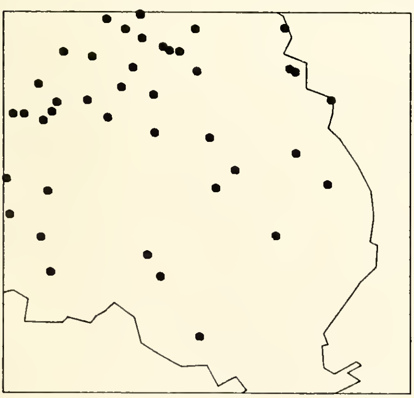
4. Remapping studies

From c. 1970 onward the SO_2-concentration had steadily decreased and it was thought that this might have had a positive effect on epiphyte vegetation. Therefore a number of local remapping studies were undertaken after 1980 (e. g. DE BAKKER 1985, VAN DER KNAAP & VAN DOBBEN 1987, VAN DIJK 1988). In these studies the localities visited in the WHEN project were revisited, and new localities were chosen when former ones could not be tracted. It appeared that many epiphyte species had become more common, in agricultural as well as in industrial areas (Fig. 5, 6, 7). However, nitrophytic species (*Physcia, Xanthoria* and *Candelariella* spp.) had increased much more than the other species (Table 1). This increase in nitrophytic species is now ascribed to an emission of NH_3 from intensive cattle husbandry, which has strongly increased over the past few decades (ASMAN et al. 1987).

Table 1. Mean frequency (= number of occurrences as a percentage of number of visited localities) of the nitrophytic species (*Physcia, Xanthoria* and *Candelariella* spp.) and the other species, in three re-mapped areas (Fig. 5) in 1973 and 1985. – The *areas* are: Rijnmond (*1*; industrial), Zuid-Holland (*2*; industrial and agricultural) and eastern Brabant (*3*; agricultural).

area →	1		2		3	
year →	1973	1984	1973	1984	1973	1984
no. of localities	565	689	680	902	1439	1202
mean freq. nitr. spp.	5.3	8.9	1.6	5.6	8.4	16.5
mean freq. other spp.	4.7	5.8	3.6	4.8	6.0	6.0





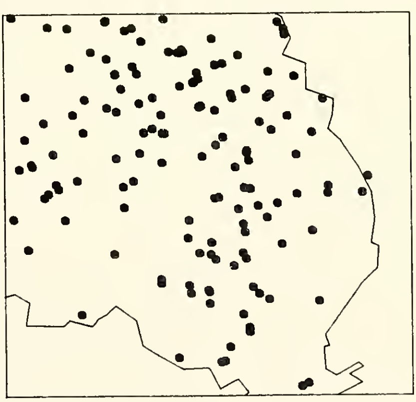
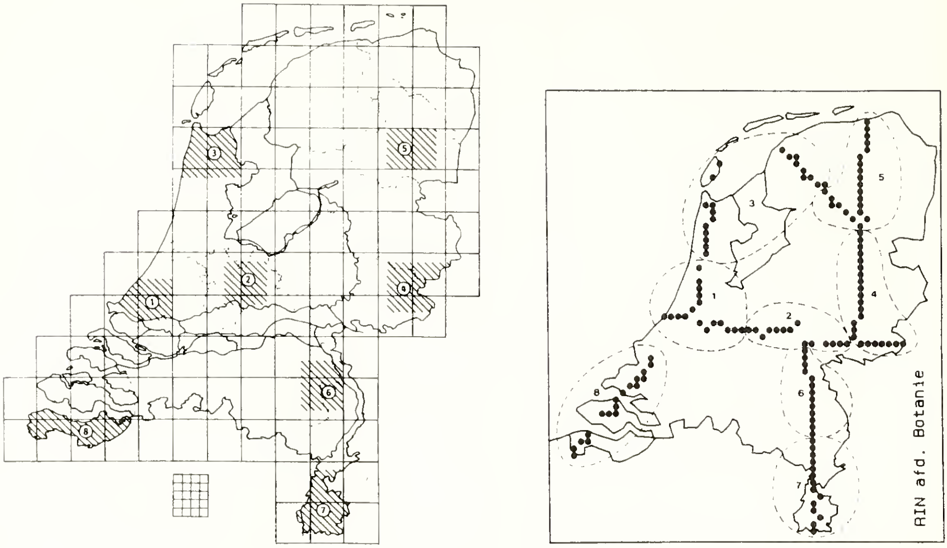


Fig. 6. (above) Distribution of *Evernia prunastri* in the Rijnmond area on a 1 x 1 km² grid basis. – *Closed* circles = 1973, *open circles* = 1984.
Fig. 7. Distribution of *Physcia adscendens* in eastern Brabant in 1973 (left) and 1986 (right).

In one of the local studies (DE BAKKER & VAN DOBBEN 1988) the pH and nitrogen content of bark samples were measured. Nitrophytic species appeared to be favoured by a high bark pH rather than a high nitrogen content. Therefore, the decrease in SO_2-concentration, leading to less bark acidification, is also favourable for nitrophytic species. As a result, species like *Physcia adscendens*, *Ph. dubia* and *Xanthoria polycarpa* have increased strongly, especially in areas where intensive cattle husbandry is common (Fig. 7). A phenomenon that is not quite understood yet is the appearance of species in these areas which are not notably nitrophytic and have always been rare in The Netherlands, like *Physcia stellaris* (DE BAKKER 1987).



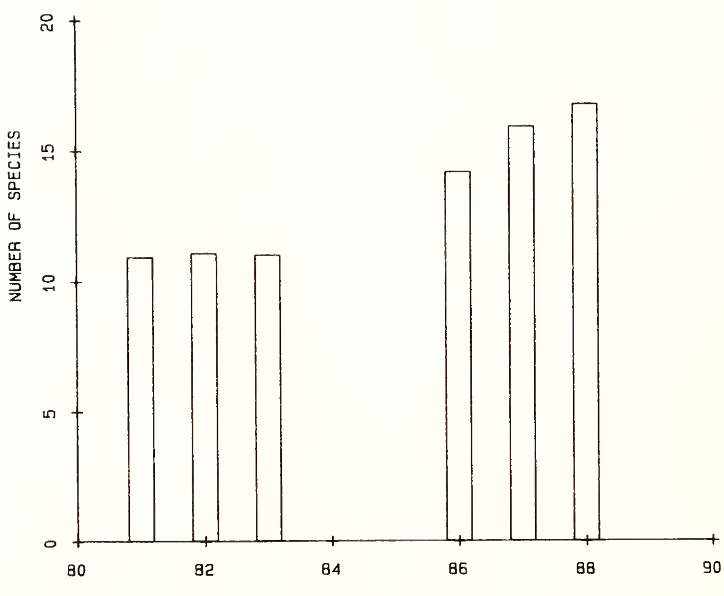


Fig. 8. (above) Epiphyte monitoring network; areas (left) and transects (right).
Fig. 9. (below) Number of species per row of 10 wayside trees as a function of time (2 transects, 104 rows in total).

5. Monitoring

Since 1981 monitoring of epiphytic lichens takes place at fixed stations (rows of 10 wayside trees, mostly *Quercus robur* and *Populus* spp.) as a part of the Dutch air quality monitoring program (DE BAKKER 1988). The monitoring stations (ca. 1350) are located in eight areas around chemical monitoring stations and in a number of transects through the country (Fig. 8). The time series that now exist for some of the transects clearly show the increase in species richness after 1980 (Fig. 9).

6. Summary and conclusions

The Netherlands are a lichen-poor country. Decreasing SO_2-concentrations and increasing NH_3-concentrations have caused an expansion of many of the more common epiphytes, especially the nitrophytic ones, during the past decade. Nevertheless, the epiphytic flora is still poor compared to the situation existing around 1900, and a return to that state cannot be expected in the near future, despite strong intentions of the government to further reduce both SO_2 and NH_3 emmission.

7. Literature

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