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Chr. C. van Leeuwen

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THE AFTER-EFFECTS ON THE FLORA  
AND VEGETATION OF MYXOMATOSIS  
IN THE NETHERLANDS

by Chr. C. van LEEUWEN \*  
Utrecht, Netherlands

*Introduction.*

A number of incidental observations have been made in the Netherlands with respect to changes in the flora of uncultivated areas, and it appears practically certain that they must be attributed to the fact that rabbits have suddenly disappeared. This applies primarily to the dunes of the North Sea Coast, the landscape which of all the uncultivated areas in the Netherlands where rabbits are found bears the clearest marks of the voracity of these rodents. Since the autumn of 1954 myxomatosis has spread rapidly in many places. So the observations refer to the changes that took place in the course of 1955, which, incidentally, was an extremely favourable year because of weather conditions for plant growth.

An investigation into the development of the vegetation in the dunes and on the shallows at the nature reserve « De Beer » near the Hook of Holland, which has been carried out since 1946 already on square plots of ground permanently used for purposes of scientific investigation, has produced some exact data on the after-effects of the epidemic. Moreover an experimental investigation into the influence of the damage caused by rabbits on the succession of plant associations, which was started in 1952, appeared to be particularly instructive in this connection.

The significance of the myxomatosis for forestry

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and agriculture cannot be discussed here. It can only be stated that as far as forestry is concerned the percentage of losses in afforestation appeared to be much lower than before in places where the disease has raged. Further the fact can be mentioned that according to information received from the Central Institute of Agricultural Research at Wageningen myxomatosis has had no great influence on the yield of the Netherlands grassland.

*The relation between vegetation on the dunes and rabbits.*

For many centuries the dunes on the sea coast have been an excellent biotope for rabbits. The presence of these animals has not only had a direct influence on the vegetation, but it has also affected the geomorphology and the composition of the soil, and thus, indirectly, the flora.

The often very complicated pattern of plant association in this area may therefore be largely looked upon as an unstable equilibrium between the rabbit population and its biotope.

The interaction between the rabbits and the dune landscape is probably one of the principal reasons why there is practically no high timber, while there are various grassy associations in addition to associations of woody pioneer plants and characteristic thorny brushwood (*Prunetalia spinosae* Tx 1952).

*After-effects of myxomatosis on the flora and vegetation of the dunes.*

The influence of rabbits on the dune landscape has many aspects (compare the publication by Mr. van der Kloot, 1937) :

1. A reduction in number as well as a less thick growth of the species selected by preference.
2. An increased growth of the species that are left alone.
3. Impeded succession.
4. Impeded settlement of new species.

In connection therefore with myxomatosis the following influences may be discussed in further detail :

1. After the rabbits had been exterminated, it appeared that the conditions of life of a number of plant species has suddenly become more favourable, a fact which was to be expected. The rich flowering and the

luxuriant growth of various grasses, which otherwise were eaten down very closely to the ground, especially in places frequented by the rabbits, are noticeable in the first place. A high inflorescence was observed generally in such species as *Avena pubescens* Huds. and *Agrostis stolonifera* L. The result was that in many places the general aspect of the landscape had undergone an appreciable change after only one year. Species important for building dunes because they prevent the sand from shifting, like *Ammophila arenaria* (L.) Link, had all the aerial parts severely damaged formerly, and *Carex arenaria* L., the rootstock of which particularly appealed to the rabbit, also remain undamaged now.

Other species which owing to myxomatosis could develop more favourably included : *Silene nutans* L., *Cerastium arvense* L., *Taraxacum* div. Spec., *Senecio jacobaea* L., *Antennaria dioica* L., Gaertn., *Juncus articulatus* L., *Juncus gerardi* Loist., *Carex distans* L., *Epipactus palustris* (Mill.), Crantz, *Epipactis helle borine* (L.) Crantz, *Listera ovata* (L.), R. Br. and *Gymnadenia conopaea* (L.), R. Br. The generative propagation of various orchid species particularly in the dunes was impeded by the rabbits eating the flower buds. The remarkably rich flowering and fruit setting of *Rosa pimpinellifolia* L. and *Rubus caesius* L., is especially attributed to the fact that the plants could now produce plenty of flowering shoots.

2. Experience as well as investigations have shown that certain species, as far as their relative numbers are concerned, are favourably influenced by the presence of rabbits. This applies to such species as *Parnassia palustris* L., *Gentiana amarella* L. ssp. *uliginosa* (Willd.) Hega, *Mentha aquatica* L. and others. These plants were not only left alone, but they benefitted by the elimination of competing species, which were eaten by the rabbits. The spread of such varieties as *Cirsium arvense* (L.) Scop. is promoted by the rabbits burrowing and thus providing favourable conditions for the seed to germinate. However, the investigation carried out at « De Beer » shows that after the rabbits have disappeared it may be a number of years before the decline of such species can be observed. So there are no definite observations here in connection with myxomatosis.

3. The investigation at « De Beer » shows that at least under the conditions prevailing there the succession to certain species of thorny brushwood (*Hippophaeto-Ligustrum* Meltzer) was only impeded or locally prevented, even when there was a very dense rabbit popu-

lation. Species that were hardly damaged if at all, such as *Calamagrostis epigeios* (L.) Roth and *Hippophae rhamnoides* L., could easily overrun the ground in many places. By very intensive grazing the rabbits only managed to form patches of grassland locally with more or less thick brushwood between them, while it is likely that edaphic factors also contributed towards this development.

Thus, the rabbits managed to keep only in check such a species as *Phragmites communis* Trin., even if the surroundings are unfavourable for this species. Similar mosaics of often very open « grassy plots » alternating with bush formations of *Salix repens* L. and *Hippophae rhamnoides* L. are also frequently found in other dune districts, for instance in the National Park « de Kennemer-duinen ». It can be observed now that owing to myxomatosis these plots, which were grazed down by the rabbits, are now being overrun from their boundaries of brushwood, especially by means of root-suckers of *Hippophae rhamnoides* L. The results of the experimental investigation into the succession carried out at « De Beer » confirm this observation. The further development in the square experimental plots there gives the impression that such accompanying symptoms as the formation of humus and the improvement of the conditions for micro-organisms promote the growth of thick brushwood.

Another important fact is the sudden appearance of sprouts of woody crops in the places that used to be grazed down. In various plots this year sprouts were found among others of *Rosa* spec., *Ligustrum vulgare* L. and *Salix* div. species, principally species of thorny brushwood. These observations are also confirmed by the experimental investigation. The present development indicates that unless the rabbits return soon the « rabbit fields » will presumably be overrun completely within a comparatively short time. It was also observed that in *Hippophaeto ligustretum* Meltzer in its later stage such a species as *Euonymus europaeus* L. which used to suffer much damage in winter, has now been able to develop long shoots. In open spots this bush grows in large numbers at present.

Long term changes are to be expected in respect of the formation of high timber. In the « Kennemerduinen », for instance, sprouts of *Quercus Robur* L. and *Betula pendula* Roth appear now.

4. One observation has been made in respect of the sudden appearance of a few adventives, the seeds of

which are introduced in the feed of pheasants. It is possible that formerly the sprouts of these species were eaten selectively. For the rest it is likely that the introduction of new species in a natural way, which is a slow process, is promoted by the absence of rabbits (Westhoff 1947).

#### *Summary.*

Myxomatosis has already had appreciable after-effects on the flora and vegetation in the Netherlands after one year. Remarkable changes in vegetation have occurred, especially in the dune district on the North Sea coast. The changes were particularly noticeable in the rich growth and flowering of a number of plant species and in symptoms relating to the disturbance of the equilibrium in the closely grazed parts of the places with thorny brushwoods, which had adapted themselves to damage caused by rabbits. With due regard to the facts, it may be expected that unless the rabbit population is restored soon, many places in the dunes will be short time.

One of the other things that can be mentioned is that the rather strongly dynamic character of the older dunes, which still prevails locally and is largely due to the activity of these animals, will become more static. If in the long run the rabbits should come back in large numbers, the dune districts with artificial or natural (salty) plots of grasslands will offer the best chances overrun by bush associations within a comparatively for a quick recovery of the rabbit population.

Those in charge of the management of dune land, particularly of the nature reserves there, have so far been greatly satisfied with the reduction in the rabbit population. On the other hand they realize that certain measures, including the cutting of the vegetation, will be necessary to preserve the variety of the landscape and to promote the survival of certain species.

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