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WHOLE SYSTEM RESPONSES OF A MOORLAND POOL TO EUTROPHICATION

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The biocommunities of the moorland pools near Oisterwijk in the southern part of The Netherlands are strongly affected by acidification and eutrophication. Therefore, measures (removal of sediments and addition of buffered groundwater) are planned to counteract these threats.

In order to retrieve the reference situation and assess 'background' conditions, the history of the pools and the surrounding landscape was investigated. Publications, maps, photos and other documents were searched in archives and replicate cores from the pool Kolkven were studied with palaeolimnological methods, including analysis of ^{210}Pb, diatoms, pollen, other microfossils and macrofossils from the same cores.

The full results are presented and discussed in the reports by Van Wayjen (1991) and Van Dam *et al.* (1994). Part of the results from a single core are presented in Figure 1. The data for the replicate core were rather similar. The pool is situated in a sandy, shallow depression, which was formed in the Late Glacial. Below a depth of 115 cm the sediment consisted of sand. From 110 to 115 cm remnants of the peat bog, which was formed during the early Holocene, were still present. During the Holocene the pool gradually filled up with a bog vegetation, which was removed from the middle ages until the 19th century, for use as a fuel. When the bog was removed a pioneer vegetation with charophytes developed. The increase of *Scenedesmus* indicates the onset of eutrophication.

It is known from maps and historical documentation that the pine forests around the pool were planted around 1860. Thus the presence of scale leafs of *Pinus* indicates that the sediments above 80 cm depth were deposited after *ca.* 1875.

The Kolkven received seepage water, that was relatively rich in calcium. A eutrophic ecosystem developed, with luxuriant growth of charophytes occurring around 1850 and of *Stratiotes* in the first decades of the 20th century. The influx of nutrients with agricultural drainage water and by recreational fishing caused a massive bloom of plankton algae (*Pediastrum, Cyclostephanus dubius* and Cyanobacteria, which leave no visible rests in the sediments) and the decrease of aquatic macrophytes. The phenomena of eutrophication of the Kolkven are in agreement with those described by Phillips *et al.* (1978) and many others.
Although the changes of the abundance of macrofossils of macrophytes do indicate changes of the trophic state of the pool it is not easy to calculate or infer these changes quantitatively, due to a lack of a suitable calibration set of aquatic macrophytes and differential preservation of many taxa. As the indicator values of diatom taxa for a number of environmental variable, including trophic state, were listed recently by Van Dam *et al.* (1994), the weighted average values for the sediment samples in the cores 1 and 2 from Kolkven were calculated and are presented in Figure 2.

The parallel increase of both T and R indicates an increase of trophic state and pH from the bottom to the top of the core. The dip in the middle of the curves T and R in core 1 is due to the high relative abundance of *Aulacoseira alpigena*, which has been rated as a species of water bodies with rather low nutrient concentrations in some standard reference works. Apparently there is some uncertainty in this assignment. For an exact determination of former phosphorus concentrations an adequate calibration set of modern diatom samples is necessary.

For dating we had the zonation of macrophytes from the sedimentary record and we could compare this with historical records. Also we could trace the development of the landscape from old topographical maps and data from archives, (e.g. the presence of pines). Dating of the cores with ^{210}Pb was troublesome and gave less satisfactory results than comparison of the sedimentary with the historical record.

In short, the succession in the Kolkven pool is:

A *Late Glacial*
Origin of hollow, transformed to bog during the Holocene.

B *Middle Ages to 19th century*
Peat digging (fuel use).

C *c. 1825 - ca 1875*
Input of relatively eutrophic and buffered water from a lowland stream. Mesotrophic pool with many charophytes.

D *c. 1875 - ca 1950*
Input of agricultural drainage water via ditches. Strong development of *Stratiotes*, later filamentous algae.

E *c. 1950 - 1990*
Until 1969 input of agricultural drainage water. Permanent hyper-eutrophic conditions by re-suspension of bottom material by Cyprinids. Disappearance of submerged macrophytes. Strong development of phytoplankton (green and blue-green algae).

Our multidisciplinary approach was necessary to obtain this information.

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Figure 1 Depth distribution of selected taxa in Kolkven core 1. The abundance of taxa with an asterisk should be multiplied by 10. A cross indicates the presence of scale leafs of *Pinus*. The presence of fish is indicated by fish scales or cocoons of the leech *Piscicola*.

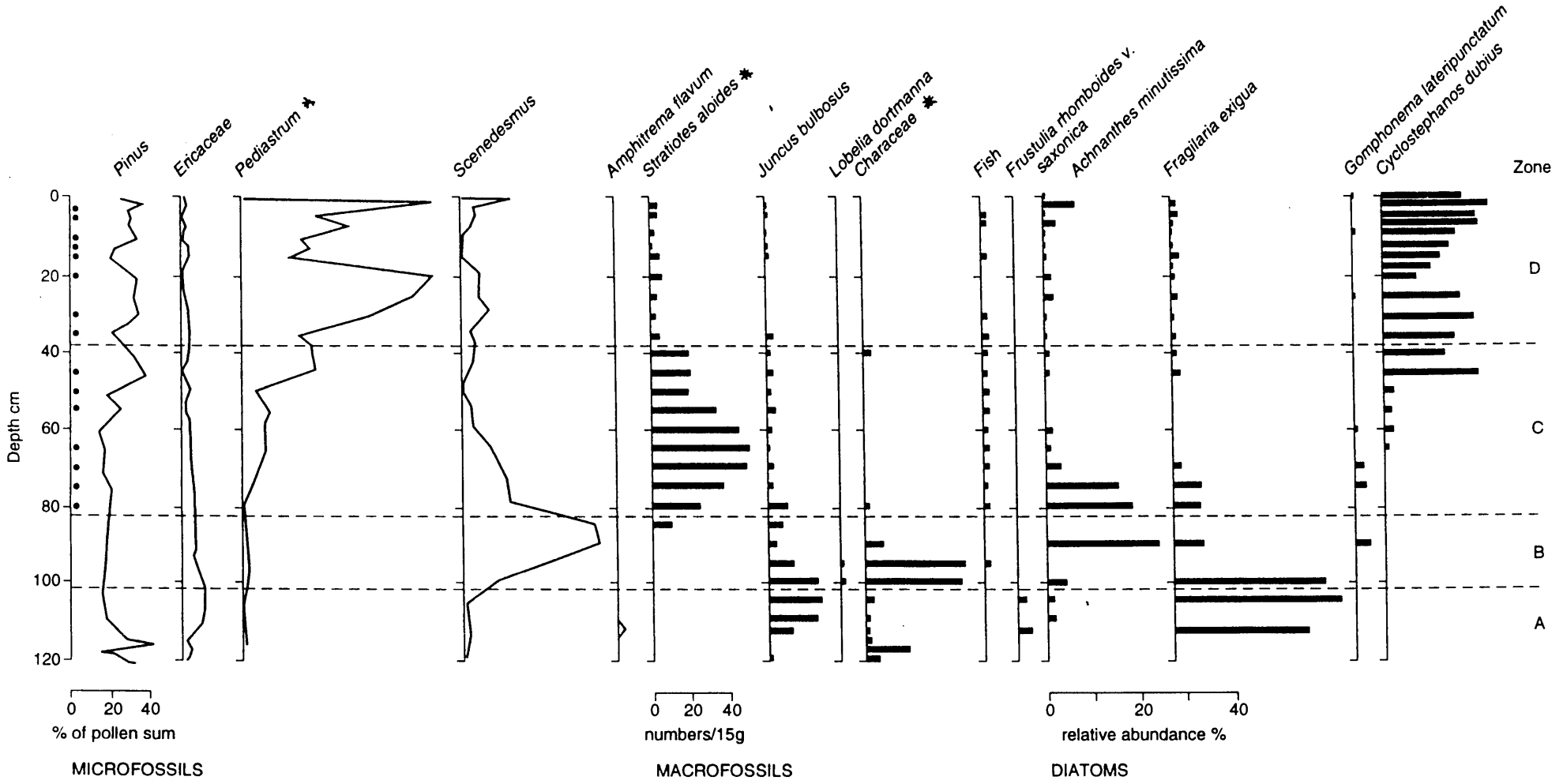

Figure 2 Mean indicator values of diatom assemblages for selected environmental variables according to the system of Van Dam *et al.* (1994) in the cores 1 (K1) and 2 (K2) from Kolkven.