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A CONCISE SURVEY OF TESTATE AMOEBAE ANALYSIS

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INTRODUCTION.

Testate amoebae, also called thecamoebae or rhizopoda, are protozoa with a shell that can be preserved in sediments (see plate 1). They give us information on certain aspects of the palaeoenvironments sometimes difficult to detect by other means e. g. soil moisture content. Around thirty papers have been published on fossil testate amoebae from European sites since LAGERHEIM in 1901 described the testate amoeba fauna from lacustrine sediments of Sweden and Finland. This is a rather small number compared with the amount of published work on pollen analysis, and palynologists are not yet fully aware of the valuable ecological information that rhizopod analysis can yield.

However, with the present increased interest in local palaeoenvironmental changes in bogs, more attention is now being paid to microfossils other than pollen and spores, and rhizopods in pollenslides are also counted (e. g. VAN GEEL, 1976). Nevertheless, integrated works in which testate amoebae have been prepared and counted separately remain scarce e. g. GROSPIETSCH with several works on bogs in Germany (i. e. 1953, 1976), TOLONEN (1966) on a core from an old raised bog in Finland, CASPARIE (1972) in his work on bog development in Drenthe (The Netherlands) and BEYENS (1982) on isolated peat bogs in the Belgian Campine.

The purpose of this paper is to demonstrate the use of testate amoebae in palaeoecological studies.

OUTLINE OF THE ECOLOGY OF TESTATE AMOEBAE IN PEAT BOGS.

Testate amoebae can be found in many habitats, ranging from lakes to soils. The integrated influence of several factors will probably determine the presence or absence of a certain species in a given habitat. However, the importance of the moisture content as a basic limiting parameter is generally accepted.

In a peat bog with a gradient from open waterpool to dry *Calluna* heath, the quantitative behaviour of the various species changes clearly with the degree of moisture content. This forms the basis of the rhizopod analysis (GROSPIETSCH, 1972). SCHÖNBORN (1962) distinguished four testate amoeba associations in the range from open water to dry moss hummocks living respectively in the moisture content classes I to II, III to IV, V to VII and VIII. These classes are based on the watercontent of the mosspolster (JUNG, 1936).

On the other hand there is also a vertical distribution within the mossplants, which is a function of the availability of food and particles for building the shell and of the moisture content (HEAL, 1962; SCHÖNBORN, 1963; BONNET, 1958). Si in the uppermost almost sterile layer only species with a self-produced shell and provided with *zoöchlorellae* (symbiosis) can survive, while in the dead mosslayer there are enough particles that can serve as food and for shell building as well.

Different kinds of bogs or even different sites within the same bog can show different ecological situations, resulting in distinct species composition. Based on these observations HARNISCH (1927) recognized the following associations, living in *Sphagnum*mosses :

1. The Waldmoos-type, occuring in peatfree bogs, smaller fens, even on humid, shaded woodland soils and inactive degenerate raised bogs.
2. The Hyalosphenia-type, mostly found in more closed peat bodies with a transitional character and locally in pieces of degenerate raised bogs. Characteristic is the continuous presence of *Hyalosphenia elegans* and *H. papilio*.

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3. The Flavum-type : when in the foregoing association the sphagnobiontic *Amphitrema flavum* becomes quantitatively more important. This type is widespread in active raised bogs.

4. The whrightianum-type represents the following step with *Amphitrema wrightianum* as markerspecies. This type is only found in old, well-developed raised bogs.

5. The Tyrphoxene-type is encountered at the margins of and disturbed areas in bogs. *Trigonopyxis arcula, Bullinularia indica* and *Cyclopyxis eurystoma* are typical of this association.

A possible morphological adaptation to the humidity of the environment can be found in the structure of the aperture and this lead BONNET (1964) to distinguish a few morphological groups; e. g. types with a well-hidden aperture (pseudostoma) are mainly restricted to drier habitats.

We can conclude that the possibility and the aim of rhizopod analysis will be the determination of the moisture content near the bog surface and the identification of the kind of bog.

METHODS.

A. Sampling, preparation and counting.

Sampling.

Sampling can be done in the same way as pollen-samples are taken. Since a pollendiagram will provide the overall reference, one should take care to sample exactly the same levels.

Preparation.

We used two cm^3 peat which we boiled for 10 minutes in 50 cm^3 water. After centrifugation and decantation of the liquid layer, the remainder is then poured into a tube with a glycerine solution. Some authors recommend passing the solution through a fine sieve (GROSPIETSCH, 1972; TOLONEN, 1966) in advance.

Counting and identification.

The analysis has to be done using a light microscope; for routine work a magnification of 250 x is sufficient. Since identification manuals are scarce, one is forced to refer to separate monographs, such as LEIDY, 1879; CHARDEZ, 1967, DEFLANDRE, 1928, 1929; DECLOITRE, 1976, 1977, 1978, 1979a, 1979b, 1981; GROSPIETSCH, 1972, HARNISCH (s. d.); OGDEN and HEDLEY, 1980. Several slides are usually necessary to count a statistically significant sum.

B. The presentation of the data.

The analysis can be presented like a pollendiagram (fig. 1). As it is the aim to determine the moisture degree one should also construct synoptic diagrams.

One can calculate the presence of the separate rhizopods in terms of the different categories of moisture classes e. g. the four classes distinguished by SCHÖNBORN. In Fig. 2 it is clear that at the base of the diagram rhizopods indicating drier situations (groups V-VII and VIII) prevail, while at 53 cm the presence of open water can be deduced (group I-II). It is also possible to construct a relative moisture contentcurve, reflecting the ratio between the wetter (I-IV) and drier (V-VIII) groups (fig. 3). This curve reflects the local changes in the moisture content as the bog surface.

On the basis of the relation morphology of the aperture-moisture content we can calculate the frequency of the different aperturetypes, and deduce from these morphological spectra the kind of habitat. We use as reference the known morphological spectra of recent habitats. This procedure has serious restrictions since some species do not obey this morphological rule. Yet, this method is complementary to the above and can be used to check the results.

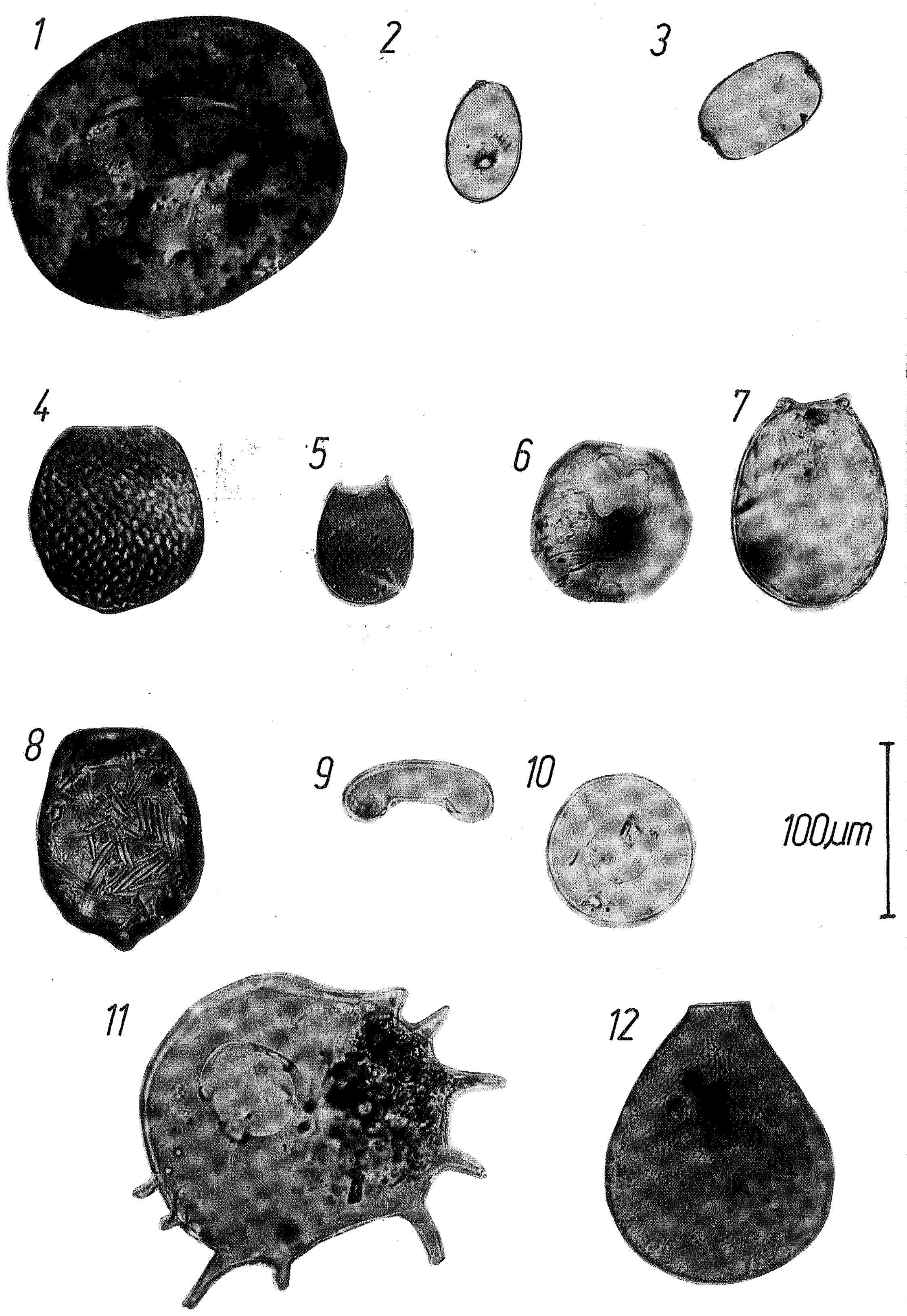
Should the fluctuations be shown to have a regional nature, it will prove possible to draw climatic conclusions from the results. However the kind of association will also give information regarding the climate. A thecamoeba fauna typical for e. g. an ombrotrophic raised bog is a strong indication for an oceanic climatic phase.

The preservation of the shells in sediments.

According to HOOGENRAAD (1935), no changes are to be expected in the transition from biocoenosis to necrocoenosis, but the composition of the latter may change. Differences in resistance of the shell (HARNISCH, 1927) and in rate of disintegration (HOOGENRAAD, 1935) are of paramount importance. LOUSIER and PARKINSON (1981) found two patterns in shell distruction : a linear pattern characteristic of species whose scales were composed of sedimentary particles, and an exponential one characteristic of species with platelets.

The nature of the sediment can also influence the necrocoenosis. Research done by Granlund (cited by HOOGENRAAD, 1935) suggested that the higher the degree of humification, the lower the number of shells. This is contradicted by TOLONEN (1966) regarding *Amphitrema flavum*. In experimental cultures temperature did not appear to significantly affect the number of shells disappearing through time, but higher moisture content and an increased biological activity stimulated their disappearance (LOUSIER and PARKINSON, 1981).

It is important to realise that those thecamoebae found in pollenslides represent that fraction of the fauna resistant to the corrosive acetolysis-treatment; other species are completely destroyed.



1. *Bullinularia indica* 2. *Hyalosphenia subflava* 3. *Amphitrema flavum*.

4. *Assulina seminulum* 5. *Assulina muscorum* 6-7. *Difflugia lobostoma*

7. *Heleopera petricola* 9-10. *Arcella rotundata var. aplanata*

11. *Centropyxis aculeata* 12. *Nebela collaris*

Plate 1. - Some thecamoebae found in the peat bog section from Inpenrooi-ven (Belgian Campine).

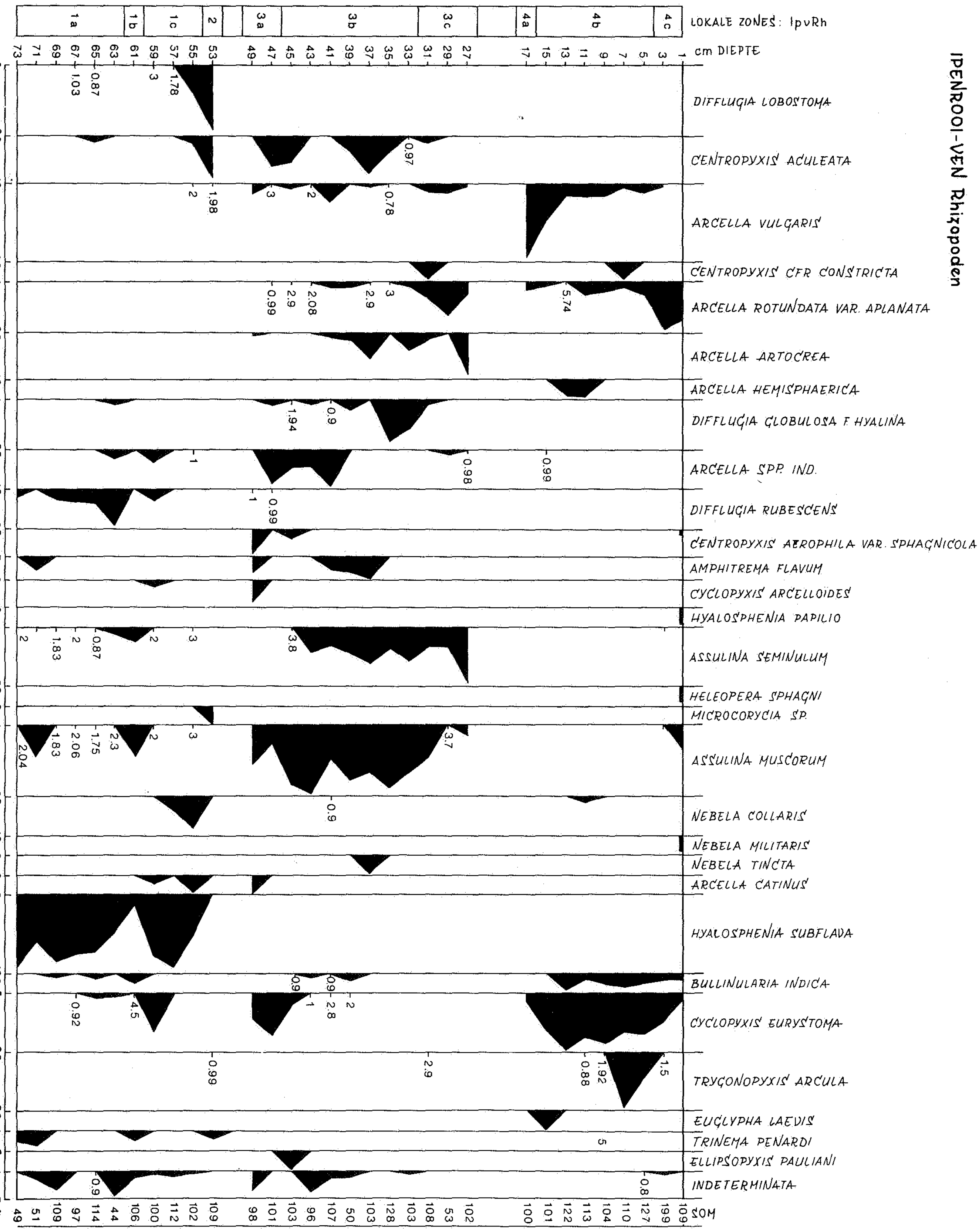


Fig. 1 - The testate amoebaediagram from the site Ipenrooi-ven.

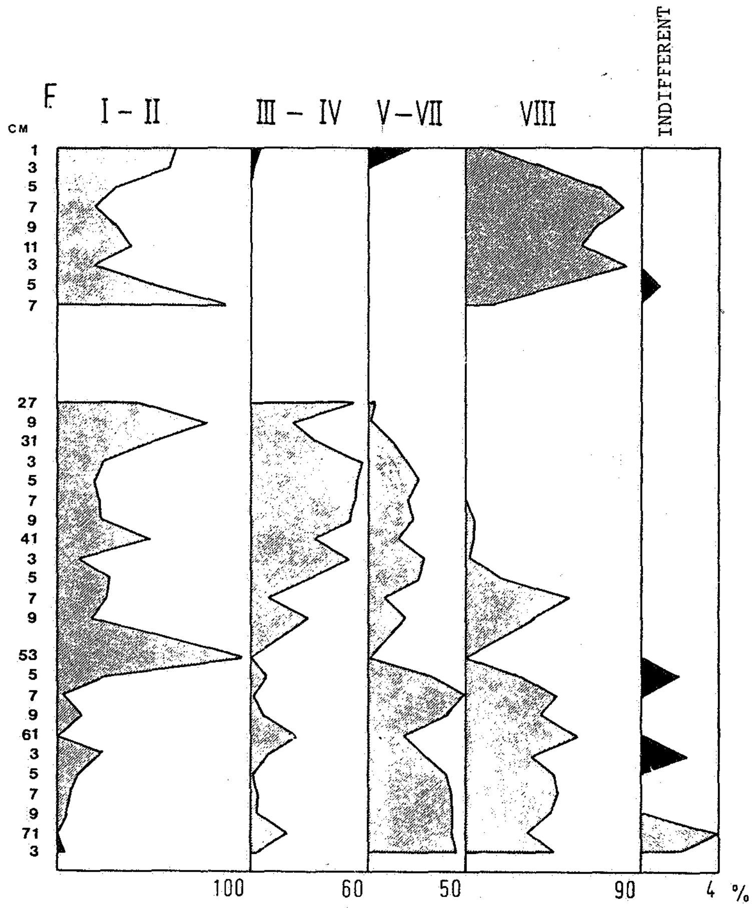


Fig. 2 - The relative presence of a number of moisture content classes (F) at the site Ipenrooi-ven.

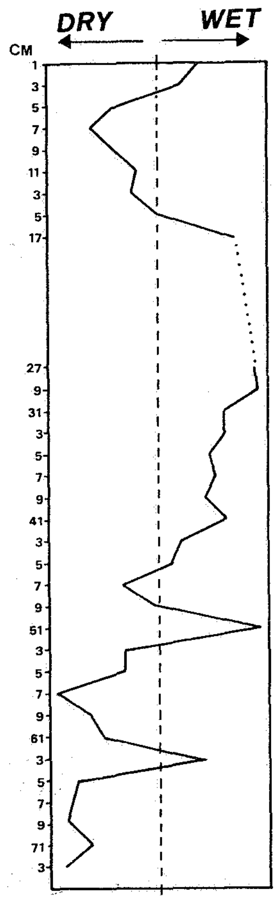


Fig. 3 - The evolution of moisture content at the bog surface as reflected by the ratio between the wetter and drier groups of thecamoebae.

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