Stratigraphy of Cladocera and Chironomidae in a core from a shallow North German lake

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Abstract

In the subfossil assemblages of chironomids and cladocerans significant changes were found during the late-glacial and postglacial development of a small, shallow North German lake. The successions observed were obviously not related to eutrophication but to factors such as climatic conditions and lake siltation. The absence of species of the subgenus *Eubosmina* during postglacial times as well as the predominance of *Alonella* species among the chydorids was due to the small dimensions of the water body.

Introduction

There is a general view concerning postglacial changes in Chironomidae (Diptera) and Bosminidae (Cladocera) faunas of deep, stratified lakes in North Germany. For chironomids a *Tanytarsus-lugens* community was replaced by *Chironomus* and in the case of the subgenus *Eubosmina* a succession from *Bosmina longispina* to *B. coregoni* f. *kessleri* and then to *B. coregoni* f. *coregoni* occurred (Hofmann 1971a, 1977, 1978a, 1978b).

The question that arises whether this sequence is also applicable to the development of shallow, unstratified lakes. Hence, a comparative study was carried out on a core from Lake Poolsee, a small (diameter ca. 100 m) and shallow (2 m) lake about 10 km west of Kiel (North Germany).

A chemical analysis of the lake water in August 1975 showed the following values: temperature 21.4 °C, pH 7.5–8.0, conductivity 405 μS cm^{-1}, total dissolved phosphorus 10 μg P l^{-1}, PO$_4$–P was not detectable.

Material and methods

Coring, using a Livingstone piston sampler, and pollen analysis was carried out by Averdieck (1983). The core had a total length of about 14 m. The sediments below 12 m were from late-glacial times. In the postglacial section there was a disturbance at a sediment depth of 3.20 m indicated by the absence of sediments from Subboreal 2.

Results

The content of organic matter, measured by loss on ignition, showed that the late-glacial layers were minerogenic (range: 2–6% ash weight) and the postglacial sediments were organic (range: 59–94% ash weight). The sediments in the transitional periods (PB, B1, B2) had intermediate values (range: 14–46% ash weight) (cf. Ungemach 1960).

The intention of the study was to identify major faunal changes on the basis of the succession of the predominant species (percentage > 10%).

Subfossil remains of chironomids and cladocerans were analysed in 36 samples; sampling distances were closer in the late-glacial and early postglacial sediments than during the later postglacial period (Figs. 1 & 2).

For chironomids the residue collected from siev-

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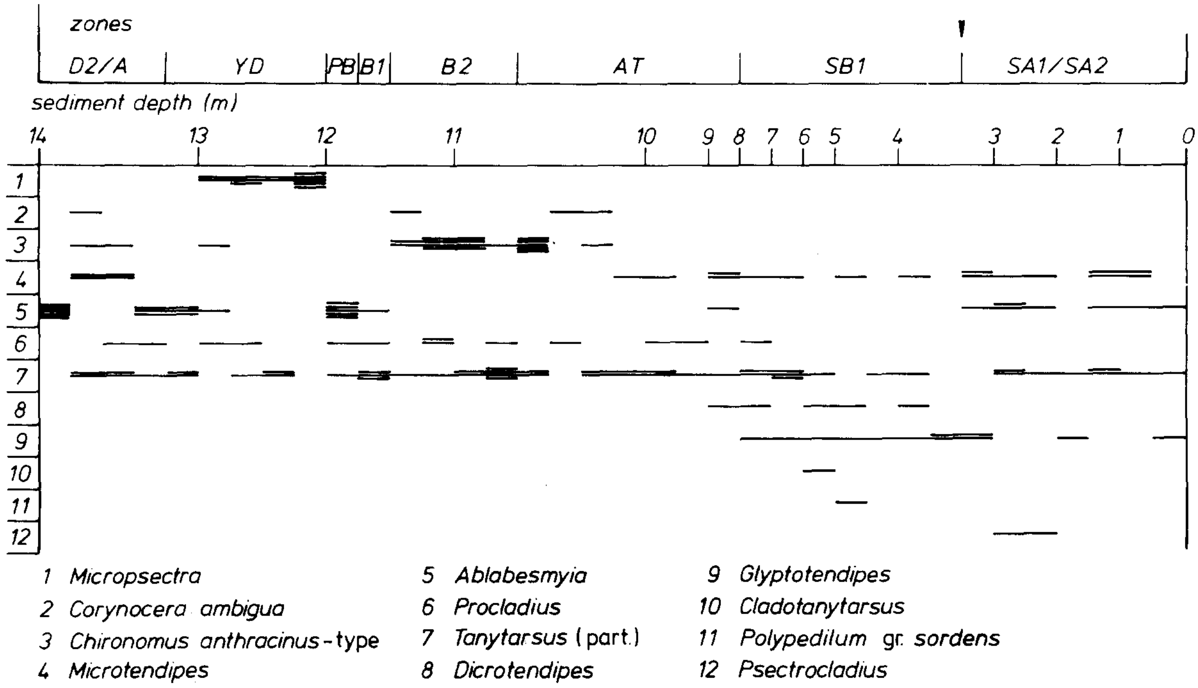

Fig. 1. Distribution of the predominant chironomids (>10% of the total); each line denotes a relative abundance ⩾10%; the arrow indicates a disturbance.

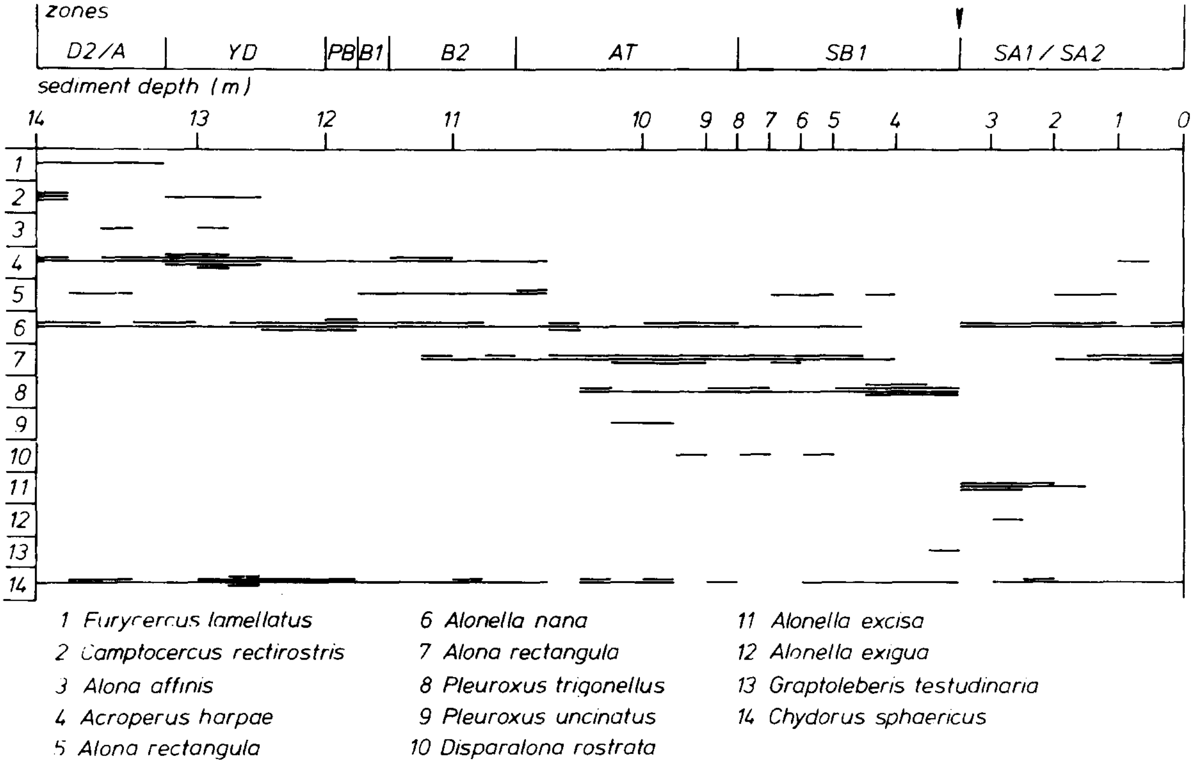

Fig. 2. Distribution of the predominant chydorids (>10% of the total); each line denotes a relative abundance ⩾10%; the arrow indicates a disturbance.

ing 10 g fresh sediment was examined (Hofmann 1978a). The number of head capsules varied from 14 to 500 specimens per 10 g of sediment.

Figure 1 shows the distribution of the chironomid taxa (Hofmann 1971b) accounting for more than 10% of the assemblage in any sample. Each line denotes a percentage of ⩾10%. In the lowermost layers *Ablabesmyia* and *Corynocera ambigua* were dominant but were replaced by *Micropsectra* during Younger Dryas. *Ablabesmyia* was again the most important form during the Pre-Boreal and Boreal 1 periods. In Boreal 2 the *Chironomus anthracinus* type was most abundant.

Since the Atlantic period the chironomid assemblage was characterized by the predominance of sublittoral-littoral taxa: *Microtendipes, Ablabesmyia, Procladius, Dicrotendipes, Cladotanytarsus, Tanytarsus, Polypedilum* gr. *sordens,* and *Psectrocladius.*

The following taxa were confined to the late-glacial period: *Micropsectra, Protanypus, Monodiamesa, Paracladius, Sergentia coracina, Heterotrissocladius.*

For cladoceran analysis subsamples of the sieved fraction >100 µm equivalent to 0.05 to 1 g fresh sediment were examined (Hofmann 1978a).

The genus *Bosmina* was represented by two species only: *B. longirostris* occurred throughout the core, whereas *B. longispina* was found in the late-glacial sediment only. It was always less abundant than *B. longirostris.*

As Fig. 1, Fig. 2 which is based on the percentage of the most common chydorids, illustrates the changes in the assemblage during lake development.

Eurycercus lamellatus, Camptocercus rectirostris, Alona affinis had percentages (>10%) during the late-glacial period only. This period was also characterized by high abundances of *Acroperus harpae* and *Alonella nana. Acroperus harpae* decreased in the Atlantic period but *Alonella nana* occurred throughout and was the most abundant chydorid species in almost all of the samples.

The species which decreased in late-glacial or early postglacial times were replaced by species such as *Alona rectangula, Pleuroxus uncinatus, Disparalona rostrata, Alonella excisa, Alonella exigua,* and *Graptoleberis testudinaria,* which predominated for longer or shorter intervals during the late postglacial period. In the uppermost samples *Alona rectangula* and *Alonella nana* were most abundant.

With the exception of one sample from the Younger Dryas *Chydorus sphaericus* was not very abundant and its distribution was rather uniform.

The disturbance of the sediment at 3.20 m (see arrow in Fig. 2) is clearly visible in the chydorid diagram, indicated by an abrupt change in the assemblage.

Discussion

The chironomid taxa which are restricted to late-glacial times (*Micropsectra, Heterotrissocladius, Protanypus, Sergentia coracina, Paracladius* (probably *alpicola*)) and the predominating chydorid species of the same period seem to be mainly influenced by climate: the chironomids are cold stenothermal species (Brundin 1949) and the chydorids are known as pioneer species occurring under late-glacial conditions (Goulden 1964; Whiteside 1970). These authors did not mention *Eurycercus lamellatus* in this connection but this species has been frequently found in late-glacial sediments from Wallensen (Frey 1958) and Grosser Segeberger See (Hofmann 1978a).

Most of the chironomids typical of this early phase of lake development are members of the *Tanytarsus lugens* community (Brundin 1956) and are used as indicators of oligotrophic conditions (Saether 1975). However, in late-glacial times they might have occurred in the littoral zone and would thus not be indicative of the oxygen conditions in the hypolimnion (Brundin 1956; Hofmann 1979). They must not be used as indicators of trophic state in such cases.

The abrupt and highly significant changes in the chironomid assemblage during late-glacial and early postglacial times *(Ablabesmyia – Micropsectra)* cannot be discussed on the basis of this restricted material.

During postglacial times taxa of the *Tanytarsus lugens* community were not found. However, their disappearance might have been caused by rising temperatures rather than by eutrophication.

For an evaluation of the importance of temperature, information on former water levels is required. The *Bosmina*/chydorid ratio gives little information on whether the lake was ever deep and

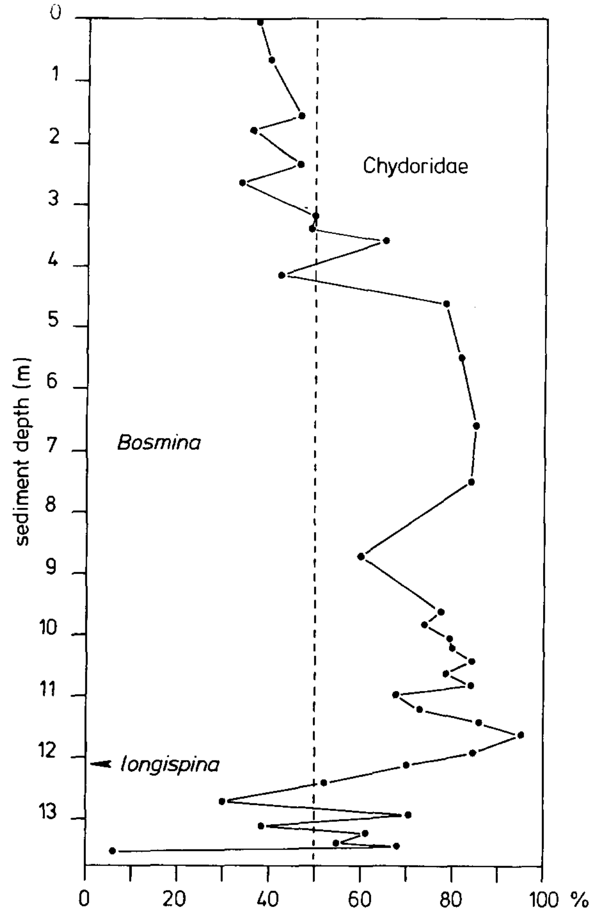

Fig. 3. Percentages of *Bosmina* and chydorids; the arrow indicates the upper limit of the occurrence of *Bosmina longispina*.

stratified but there is some significant variation in this ratio (Fig. 3). During postglacial times only *Bosmina longirostris* was involved. This species is very abundant in shallow waters and in the littoral zone (Flössner 1972) and is not a true indicator of the dimensions on the pelagic zone.

The predominance of the *Chironomus anthracinus* type during Boreal 2 is likely to indicate a deep, stratified *Chironomus*-lake with oxygen depletion in the hypolimnion. If the water level was as high as the present, the lake during the early postglacial periods would have been extremely deep relative to its surface area and a meromictic situation might have occurred. This is also suggested by the existence of varved sediments (Averdieck 1983).

Since the Atlantic period littoral chironomids have predominated. The interpretation of their distribution is difficult because the species involved are not known. *Tanytarsus* was abundant throughout the core, but its occurrence is not related to the trophic state of the lake (Hofmann 1979).

The low abundance of *Bosmina longispina* during late-glacial time and its disappearance at the end of this period as well as the complete absence of species of the subgenus *Eubosmina* during postglacial times is clearly related to the small dimensions of the water body.

The fossil assemblages of this shallow lake when compared with deeper lakes from the same region (Hofmann 1971a, 1977, 1978a, 1978b) are characterized by high percentages of littoral chironomids, the absence of species of the subgenus *Eubosmina* during postglacial times, and by the predominance of chydorid species typical of smaller water bodies such as *Alonella nana* and *Alonella excisa* (Whiteside 1970).

However, there were hardly any significant differences in the *Bosmina*/chydorid ratio between Poolsee and Grosser Segeberger See (178 ha, depth: 11.7 m). Only during the Subatlantic period was the ratio clearly lower in Poolsee (Hofmann 1978a).

The occurrence and high abundance of the *Alonella* species during late postglacial times indicate that pollution did not occur in Poolsee (Whiteside 1970) and this is in accordance with the present nutrient content of the water.

During lake development significant changes in chironomid and cladoceran assemblages were observed. These changes, however, do not reflect changing trophic conditions, but are related to factors such as climatic conditions and lake siltation. Recently, Whiteside (1983) has suggested that successions occurring during lake development are not only affected by nutrient conditions but by various other ecological factors, some of which were operative during the history of Poolsee.

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