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CLADOCERAN REMAINS ANALYSIS IN SEDIMENTS OF LAKE STRAŻYM (BRODNICA LAKE DISTRICT)

Analiza szczątków *Cladocera* w osadach jeziora Strażym (Pojezierze Brodnickie)

ABSTRACT. The work presents an analysis of Cladoceran remains from the Alleröd (when the lake had formed) to the Sub-Boreal period. There were 27 *Cladocera* species found and the changes of species diversity index are presented. On the basis of abundance of *Daphnidae* and *Bosminidae/Chydoridae* oscillations of lake water level have been reconstructed.

INTRODUCTION

Sediments depositing on the bottom of lake basin are the results of limnological processes taking place in the lake and in its catchment and deflation areas. *Cladocera* remains found in sediments are the indicator of ecological conditions in the lake throughout its development history. They are used for interpretation of paleolimnological changes (Alhonen 1970). They reflect, among other things, water level oscillations and degree of eutrophication (Mikulski 1978, Bilska & Mikulski 1979). Out of 10,000 present Polish lakes, *Cladocera* remains have been studied in sediments of only a few lakes in different lake districts.

The results presented in this work have a preliminary character and outline development of *Cladocera* during the lake history. One of the objectives of the present work was to discover changes significant for lake level oscillation index — ILL (Mikulski 1978).

STUDY AREA, MATERIAL AND METHODS

Strażym Lake is a transfluent lake situated on Brodnica Lake District. Its area is 73.4 ha, maximum depth 9 m, mean depth 3.5 m. The littoral zone takes up 4% of lake area (according to Inland Fisheries Institute). As shown by

zooplankton studies carried out in 1976—1978 (Błędzki et al., in press; Wyszyńska 1979) and benthos studies (Giziński, in press) this is an eutrophic lake. A noteworthy detail is occurrence of *Holopedium gibberum* in the lake, a species not found in neighboring lakes connected with Strażym Lake and other examined lakes of the district.

Material for analysis was collected from sediment core No. 3, every 5 cm. For that reason and also because of lack of analysis of upper part of core — not collected for technical reasons — the data are preliminary. Profile numbering follows Niewiarowski's description (this volume). Chronozone classification is quoted according to pollen diagram made by Noryśkiewicz (this volume).

The analysis was conducted according to Frey's method (1979) recommended by IGCP Project 158 B. Six to fifteen slides per sample were analysed and results were calculated per 1 cm³ of examined sediment. All *Cladocera* remains were counted, i.e. head shields, thorax shells, postabdomen and postabdominal claws.

Shannon-Weaver's diversity index was calculated with the formula $H' = -\sum p_i \lg_2 p_i$ on a microcomputer using the author's own program.

RESULTS

The presence of 27 *Cladocera* species was found in the analysed samples (Fig. 1). At the depths of 640 and 635 cm only the presence of *Daphnia* sp., *Bosmina longirostris* and *Chydoridae* non det. was discovered in minimal number, the important fact being that it was in the sand layer. The ILL index (Fig. 2)

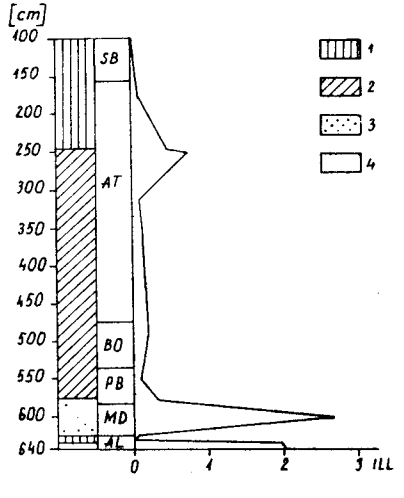

Fig. 2. Index of water level oscillations in lake Strażym. Legend as in Fig. 1

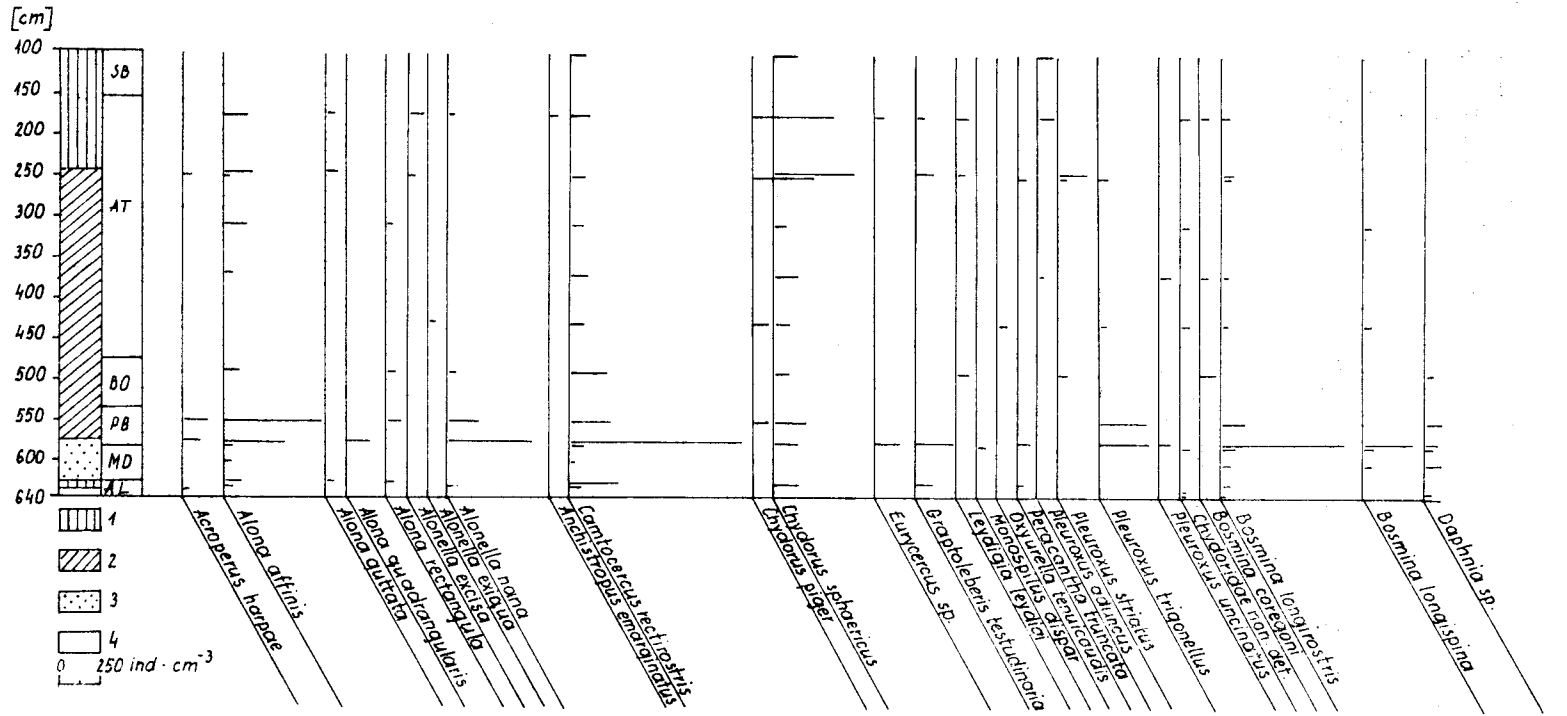

Fig. 1. Abundance of remains of particular *Cladocera* species in 1 cm³ bottom deposits. 1 — peat, 2 — gyttja, 3 — lake sand, SB — Sub-Boreal, AT — Atlantic, BO — Boreal, PB — Pre-Boreal, MD — Younger Dryas, AL — Alleröd

was high. In all samples examined, the remains of *Bosmina longirostris* and *B. longispina* sometimes outnumbered *B. coregoni* found rarely and in small quantity in the analysed samples.

In the peat layer, 630 cm, *Cladocera* remains were scarce, the ILL index falling to zero. The Alleröd was represented by several species in small amount. For that period also the species diversity index was the lowest $H' = 0.9$ (Table 1).

Table 1

Shannon-Weaver's species diversity index (H')

Depth in cm	H'
100	1.56
175	3.54
245	2.36
250	2.93
310	2.38
370	2.49
430	3.06
490	2.96
550	3.06
575	3.32
580	2.75
600	2.19
625	2.60
630	1.92
635	0.92
640	0.92

At the turn of Alleröd and Younger Dryas periods, when the number of species was higher (8) the species diversity index H' was 2.6, while the ILL index increased slightly. For that period *Chironomidae* remains were found in the sediments (*Einfeldia* or *Sergentia*, identification made by Dr A. Kentzer).

Later, during the Younger Dryas, *Cladocera* were again scarce, though pelagic species increased their dominance, which was reflected in ILL index increase reaching then its highest (Fig. 2).

During the Pre-Boreal period, the ILL index falls, while abundance ratio of *Camptocercus rectirostris*, *Alona affinis*, *Acroperus harpae* and *Chydorus sphaericus* remains divide the period into two parts. It is noteworthy that at the beginning of the period numerous presence of *Bosmina longirostris* was discovered.

During the Boreal period the number and abundance of particular species as well as species diversity index decreased.

The Atlantic period was characterized by a balanced number of species and

abundance of their remains. Slight changes were found only for the ILL index, and the H' — index was a little higher. The end of Atlantic period was marked by the highest number of species (15) and the highest diversity index $H' = 3.54$.

At the end of the Atlantic period and beginning of the Sub-Boreal, the ILL — index value drops down to zero, the number of species and abundance of their remains decreases remarkably.

DISCUSSION

The *Cladocera* remains found in bottom deposits of lake Strażym are species typical for Northern Poland's lakes (Adamska & Mikulski 1969, Szeroczyńska 1982). It is known that studies on *Cladocera* remains in lake deposits yields as a result a more complete list of species than zooplanktonic studies (Smirnov 1978). Failure to find *Holopedium gibberum* remains in lake deposits is one of those rare cases when species occurring in the zooplankton of lake were not found in lake deposits. Perhaps, the remains will be found in the analysis of the upper layer from neighboring profile, which was not analysed in this profile for technical reasons.

The presence of the remains and their composition at the depth of 640 cm where no pollen had been found was a surprise (Noryśkiewicz, this volume). However, an analysis of macrofossils (Boińska, this volume) proved very small amounts of aquatic vegetation which would be indicative of the lake existence during that period. However, *Cladocera* remains were very scarce, and dominance of *Daphnidae* and *Bosminidae* over *Chydoridae* could indicate poor development of littoral and littoral fauna at time of the lake formation.

Greater abundance of *Bosmina longirostris* in comparison to *B. coregoni*, which in many authors' view (Mikulski 1978) suggests eutrophication, may be a result of high lake trophy or predators pression (Pijanowska 1985) often disregarded in paleolimnological considerations. Also Nilssen (1976) mentioned the significance of predators pression.

High trophy of the lake in the past is evidenced by *Chironomidae* remains. According to Giziński (personal communication) *Einfeldia* presence would suggest a high trophy and shallow lake while presence of *Sergentia* — low trophy and deep lake, though if the species occurs in littoral then it loses its indicative value. Precise identification of the remains was not feasible for their incompleteness. It should be added that the ILL index was low for the period indicating shallowing of the lake.

Poorness of fauna during the Younger Dryas has been described in the literature (Frey 1964, Szeroczyńska 1982). The then present stenothermal *Camptocercus rectirostris* yielded to eurythermal *Alona affinis* and disappeared following its earlier expansion. Presence of *C. rectirostris* in that period was found by Hoffman (acc. to Szeroczyńska 1982) in German lakes. Discernible diversity of *Cladocera* fauna in the Pre-Boreal period was most probably related to tem-

perature rise followed by cool climate period. Great abundance of *Bosmina longirostris* during that time is further confirmed in the literature of the subject (Bilska & Mikulski 1979, Szeroczyńska 1982).

Subsequent development of *Cladocera* fauna during the examined Holocene period was similar to that described by Szeroczyńska (l.c.) and other authors.

Changes of species diversity index H' might indicate periods of *Cladocera* association stability (Margalef 1968, Mikulski 1978).

The data described above are likely to be more precise after a greater number of samples and upper layer of bottom deposits have been examined.

In conclusion, it should be emphasized that predators pression modifying the *Cladocera* association and totally disregarded problem of sloughing by particular species during their life cycle, may obscure the development of this animal group during the history of the lake. Therefore, one should be cautious in interpreting the obtained results especially as many opinions are based on mutual relation of the abundance of individual species remains. The problems mentioned above will be discussed in a separate work.

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