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SUBFOSSIL CHIRONOMIDS ALONG NUTRIENTS GRADIENT IN FIVE SHALLOW LAKES (POLESIE REGION, EASTERN POLAND)

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Summary. The studies were carried out in five shallow lakes representing different trophic status, from meso- to hypertrophy. Remains larger than 180 μm were analysed. The highest taxonomic richness of chironomids was found in mesotrophic lakes, and the least in a hypertrophic lake. The most fertile lakes were predominated by phytophilous taxa, especially by *Cricotopus*, a moderate eutrophic lake by benthic taxa, mainly by *Procladius* and *Cladopelma*, and mesotrophic lakes by eurytopic chironomids. The highest concentration of head capsules (HC) of the subfossil chironomids, amounting to 198 HC per one year of sedimentation, was found in the mesotrophic Lake Kleszczów. In the remaining lakes of the trophic gradient, starting from the mesotrophic Lake Rotcze, there was a gradual increase of the remains, until a sudden drop in the hypertrophic lake.

Key words: subfossil chironomids, shallow lakes, trophic status, paleolimnology

INTRODUCTION

Family *Chironomidae*, belonging to *Diptera*, are prominent as living larvae dwelling in bottom sediments and on the surface of macrophytes of almost all freshwater habitats. They are known to be sensitive to changes in lake productivity and the modern chironomid fauna has been used to classify lakes according to their nutrient conditions [e.g. Seather 1979]. The larvae of chironomids leave sclerotised chitinous head capsules which are identifiable, well preserved, and often very abundant in lake sediments. These subfossil remains have been used in paleolimnology to reconstruct and interpret past environmental conditions and also to trace recent environmental changes in lakes, as well as to classify lakes with relation to their trophic status [Brodersen and Lindegaard 1999].

The aim of the studies was to present subfossil assemblages of chironomids in five shallow lakes differing in trophic status (from meso- to hypertrophy). Although the limnology of these lakes is well recognized [e.g. Kornijów *et al*. 2002, Tarkowska-Kukuryk 2004, Smal *et al*. 2005] the study of subfossil remains of *Chironomidae* belong to pioneer research in this area [Halkiewicz 2005**,** Kornijów and Halkiewicz 2007, Halkiewicz 2008a, b].

STUDY SITE, MATERIAL AND METHODS

The studied lakes are located in Polesie Lubelskie Region (Eastern Poland). They are shallow (max. depth 2.3–7.1 m) and have small surface area (5.6–91.5 ha) (Tab. 1). The lakes represent different trophic status, from mesotrophy (lakes Kleszczów and Rotcze), through eutrophy (lakes Głębokie U. and Sumin), to hy-

Table 1. Chosen characteristics of studied lakes [acc. to Tarkowska-Kukuryk and Kornijów 2008]

Lake	Kleszczów	Rotcze	Sumin	Głębokie U.	Syczyńskie
Lake area, ha	53.9	42.7	91.5	20.5	5.6
Max. depth, m	2.3	4.3	6.5	7.1	2.9
PVI, %	29.3	34.5	3.3	0.75	0
SD, m	2.3	2.5	1.0	0.9	0.2
Chlorophyll *a*, mg dm^{-3}	5.8	12.4	31.4	58.6	330.8
Total P, µg dm^{-3}	32.0	50.5	107.0	204.0	369.5
Trophic status	mesotrphy	mesotrphy	eutrophy	eutrophy	hypertrophy

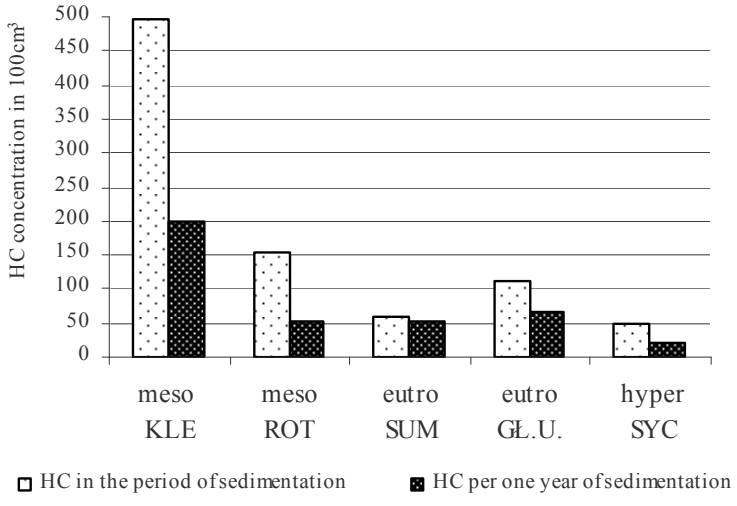

Fig. 1. Subfossil remains concentration of chironomids in sediments of studied lakes, HC – head capsules

pertrophy (Lake Syczyńskie). In March 2004 five 2-cm thick layers of surface sediments were collected from the centre of each lake using a UWITEC gravity corer (internal diameter of 6 cm). Before screening for chironomid head capsules, the samples were treated following the procedures of Hofmann [1986]. Remains larger than 180 µm were analysed. The head capsules were identified according to Wiederholm [1983]. Sediment samples were analysed for ^{210}Pb by Gąsiorowski [2008].

The concentration of subfossil remains of *Chironomidae* in examined layers were expressed as the abundance of head capsules (HC) per 100 cm^3 of sediments. Because of different age of the sediments collected in particular lakes, the HC concentration were also calculated per one year of sedimentation (Fig. 1).

RESULTS AND DISCUSSION

In surface sediment samples of subfossil remains usually only generic level or species group identification is possible for subfossil head capsules [Hoffmann 1988]. In the collected material 24 taxa of *Chironomidae* were found. The highest taxonomic richness of chironomids was found in the mesotrophic lakes (19–20 taxa), less in the eutrophic (13–16 taxa), and the least in the hypertrophic lake (11 taxa) (Fig. 2).

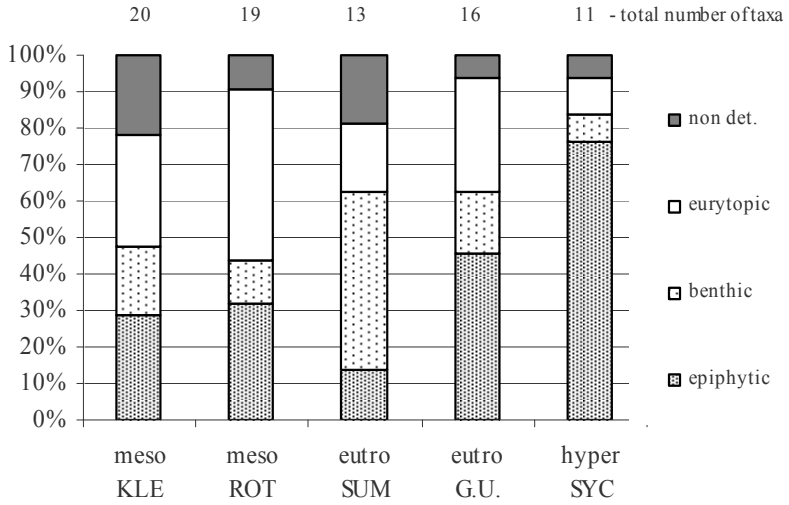

Fig. 2. Ecological assemblages and total number of taxa within subfossil chironomids in studied lakes

Different ecological assemblages dominated in the particular trophy-types of the lakes (Fig. 2). The richest (most fertile) lakes (hypertrophic Lake

Syczyńskie and strongly eutrophicated Lake Głębokie U.) were predominated by phytophilous taxa, especially by *Cricotopus* (Fig. 3), discriminator for shallow, highly productive and turbid lakes [Brodersen *et al*. 2001]. Moderate eutrophic Lake Sumin was dominated by benthic taxa, mainly by *Procladius* and *Cladopelma*, and mesotrophic lakes by eurytopic chironomids (Fig. 2, 3).

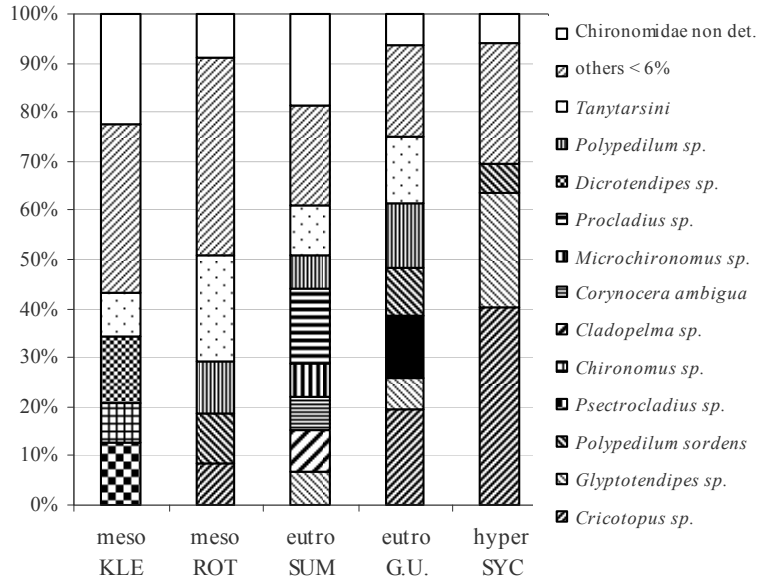

Fig. 3. Relative abundance of subfossil chironomids in sediments of studied lakes; others: *Anatopynia* sp., *Labrundinia* sp., *Parachironomus* sp., *Parakiefferiella* sp., *Phaenopsectra* sp., *Cryptochironomus* sp., *Einfeldia* sp., *Microchironomus* sp., *Microtendipes* sp., *Pseudochironomus* sp., *Ablabesmyia* sp., *Stempellina* sp.

In shallow non-stratified lakes mainly the littoral taxa formed the basis for chironomid paleoecology. The most frequently reported taxa in such lakes include *Procladius, Ablabesmyia, Endochironomus, Dicrotendipes, Microtendipes, Cricotopus, Microchironomus, Pseudochironomus* and *Chironomus*. A general pattern following increased lake productivity was a decline in the relative abundance of *Pseudochironomus, Psectrocladius, Cladopelma, Paratanytarsus and Ablabesmyia,* accompanied by an increase in *Procladius, Glyptotendipes, Chironomus* type plumosus, *Cricotopus* and *Microchironomus* [Brodersen and Quinlan 2006].

The concentration of subfossil chironomids in the analysed sediment layers ranged from 50 to 495 HC 100 cm^{-3}. The highest concentration of subfossil chironomids in the analysed sediment layers were found in the mesotrophic Lake Kleszczów, and the lowest in the hypertrophic Lake Syczyńskie (Fig. 1). There was a clear decline tendency of chironomid concentration with increase of fertility of the lakes (Fig. 1).

The number of head capsules in paleolimnological studies is usually a few hundred or less per sample, but the abundance can vary from zero to several thousand per cubic centimetre of sediment [Walker 1987]. It depends on lake sedimentation rate and hydrological conditions.

The concentration of remains per year of sedimentation increased together with the increase of trophy, and then plunged in the state of hypertrophy. The exception was the mesotrophic Lake Kleszczów in which the maximum concentration of subfossil chironomids was noted (Fig. 1). An identical pattern relating to the concentration of *Chironomidae* larvae was shown by Tarkowska-Kukuryk in her research [2008] concerning the analysis of contemporary assemblages of chironomids in the same five lakes.

CONCLUSION

The different character of the trophic status in the presentation of subfossil assemblages of chironomids is easily noted in the variety of taxons, different percentage of ecological assemblages (epiphytic, benthos, eurytopic chironomids), increased or decreased share of certain taxons, as well as in concentration values of remains deposited within one year of sedimentation. No presence of bioindicators significantly distinguishing individual trophic types of lakes was noted, as chironomids occurring in these lakes belong to typical littoral forms characterised by a wide scope of tolerance towards environmental conditions.

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SUBFOSYLNE SZCZĄTKI *CHIRONOMIDAE* W GRADIENCIE TROFICZNYM PIĘCIU PŁYTKICH JEZIOR (POLESIE LUBELSKIE, POLSKA WSCHODNIA)

Streszczenie. Badania subfosylnych szczątków *Chironomidae* prowadzono w pięciu płytkich jeziorach zróżnicowanych pod względem trofii (od mezo- do hipertroficznego). Analizie poddano szczątki wielkości powyżej 180 μm. Największe bogactwo taksonomiczne subfosylnych ochotek odnotowano w jeziorach mezotroficznych, a najmniejsze w jeziorze hipertroficznym. Jeziora najżyźniejsze zdominowane były przez taksony naroślinne, głównie przez *Cricotopus*, jezioro eutroficzne przez formy bentosowe, głównie *Procladius* i *Cladopelma,* natomiast w jeziorach mezotroficznych dominowały ochotki eurytopowe. Najwyższą koncentrację subfosylnych ochotek, wynoszącą 198 puszek głowowych (PG) przypadających na jeden rok sedymentacji, stwierdzono w jeziorze mezotroficznym (Kleszczów), a najniższą (20 PG) w jeziorze hipertroficznym. W pozostałych jeziorach w szeregu troficznym zaznaczył się począwszy od mezotroficznego jeziora Rotcze stopniowy wzrost koncentracji szczątków aż do gwałtownego załamania w jeziorze hipertroficznym.

Słowa kluczowe: subfosylne szczątki *Chironomidae*, płytki jeziora, szereg troficzny, paleolimnologia