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Sub-fossil chironomid assemblages (*Diptera: Chironomidae*) from the Černé lake and Prášilské lake (Bohemian Forest, Czech Republic)

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Abstract

Chironomid thanatocenoses of the Černé Lake and Prášilské Lake were studied. Sub-fossil material (head capsules) was obtained from the 19.5 cm long sediment cores taken in 1991. 372 sub-fossil remains were found and 17 taxa were identified from the core taken from the Černé Lake. The sub-fossil record was dominated by *Heterotrissocladius marcidus*. Taxonomic composition indicates oligotrophic conditions without anoxic events in the profundal. Decrease of both the number of chironomid taxa and individuals from the bottom to the top of the core was observed. The most apparent changes were revealed at 6.5 – 8.0 cm. They corresponded with analysis of the sub-fossil diatoms and cladocerans. Acidification caused by air pollution is considered to be the most important force in the changes of the sub-fossil records. Not only low pH but high concentrations of Al and other trace metals might be responsible for the impoverishment of chironomid fauna.

315 head capsules were recovered and 22 chironomid taxa were identified from the sediment core of the Prášilské Lake. Taxonomic composition was indicative for warmer, more productive system in comparison with the Černé Lake. Number of taxa and specimens from the bottom to the top of the core displayed similar pattern as was recognised in the Černé Lake sediment record. Decrease of the head capsule numbers and disappearance of most taxa (including relatively acid sensitive *Corynoneura* and *Pagastiella orophila*) from 7.0 – 6.5 cm to the top of the core is probably a reflection of a progressive acidification stress.

Chironomid fauna of the older sediments consisted of some rheophilic and hygropetric taxa that might be flushed into the lake from tributaries. They may indicate more pronounced influence of the inflows in the past. *Pagastiella orophila* (Edwards, 1929) and *Heterotrissocladius grimshawi* (Edwards, 1929) from the sub-fossil record of the Prášilské Lake have never been found recently in Czech Republic yet.

Key words: Chironomidae, stratigraphy, sub-fossil, acidification, lakes, Bohemian Forest

Introduction

Remote lakes in the Bohemian Forest are the only natural lakes in the Czech Republic. As very valuable parts of nature they attracted interest of scientists since the second half of the 19th century. During recent years, the research works are focused above all on understanding of the acidification dynamics and responses of biota on an acidification stress.

The lake sediments and sub-fossil records of diatoms, cladocerans and chironomids provide usually valuable information not only on history of air pollution and acidification as an important force changing the lake biota but also on other human impacts.

Results of paleolimnological analyses of diatoms and cladocerans of three lakes in the Bohemian Forest have been already published (Arzet & al. 1992, Veselý & al. 1993, Pražáková & Fott 1994, Fott & al. 1994). Chironomid sub-fossil record taken from the Černé Lake has been interpreted partly (Fott & al. 1992).

In this paper, we report the results from an analysis of chironomid remains in two sediment cores taken from the Černé Lake and the Prášilské Lake in 1991. The objectives of the study are i) to find the taxonomic composition of the chironomid fauna during last period of the development of both lakes, ii) to compare the chironomid stratigraphy with stratigraphical profiles of diatoms and cladocerans, iii) to interpret the changes in the fauna in relation to acidification and other influences, as well.

Study sites

The lakes studied are situated in the Bohemian crystalline at altitude above 1000 m. The lake basins were shaped by small local glaciers during the last glaciation. The Černé Lake has a surface area of 18.4 ha, its maximum depth is 39.5 m (mean 15.6 m). The drainage basin has an area of 129 ha. The lake is the biggest natural lake in the Czech Republic. The Prášilské Lake is smaller one with a surface area of 3.7 ha and maximum depth 16 m (mean 7.4 m). Its drainage area is 54 ha. The geology are biotite-rich paragneiss with gneiss, quarzite and granite. The surroundings are coniferous mixed forests dominated by spruce. Each lake has only one perennial tributary. Values of pH of both lakes range between 4.5 and 4.7.

Methods

The cores for chironomid remains (CN II and PR II) were taken nearby with a Kajak corer in 1991. Samples of sediment slices were diluted by distilled water to a known volume between 50–100 ml. Subsamplings were carried out on volume basis after shaking. Subsamples were diluted to about 50 ml by 10 % KOH and stirred on a magnetic stirrer hotplate for half an hour. The digested portions corresponding to 4.7 ml of wet sediment were examined in Segdwick Rafter cells under stereomicroscope. The head capsules were picked out manually using capillary tube. Head capsules were mounted in the Berlese's medium following a standard procedure.

Chironomid remains were identified with reference principally to WIEDERHOLM (1983) and KOWALYK (1985).

The microscopic slides are deposited in the Department of Biology, Faculty of Ecology and Environmental Sciences, Technical University in Zvolen.

Results

Černé Lake

Thirteen samples were analysed. In total 372 chironomid remains were found, 17 taxa were determined (12 specimens = 3.7% were not identified). The most important taxon was *Heterotrissocladius marcidus* (43.3%). This species together with other four taxa: *Tanytarsus, Telmatopelopia, Procladius, Corynoneura* made up more than 70% of the specimens.

Stratigraphical profiles for the relative abundance of all chironomid taxa are very similar. The obvious change is connected with a decrease of both the number of taxa and the specimens. Relative abundance of taxa decreases between 8.0 and 6.5 cm. Some taxa disappear entirely (*Microtendipes, Dicrotendipes, Psectrocladius*) or occur irregularly (*Zavrelia, Tanytarsus, Telmatopelopia*). The dominant species *H. marcidus* declines considerably from 3.0–2.5 cm to the top of the core. Some species appear again (*Corynoneura*) or increase (*Tanytarsus, H. marcidus*) in the most recent sediment layers (Fig. 1).

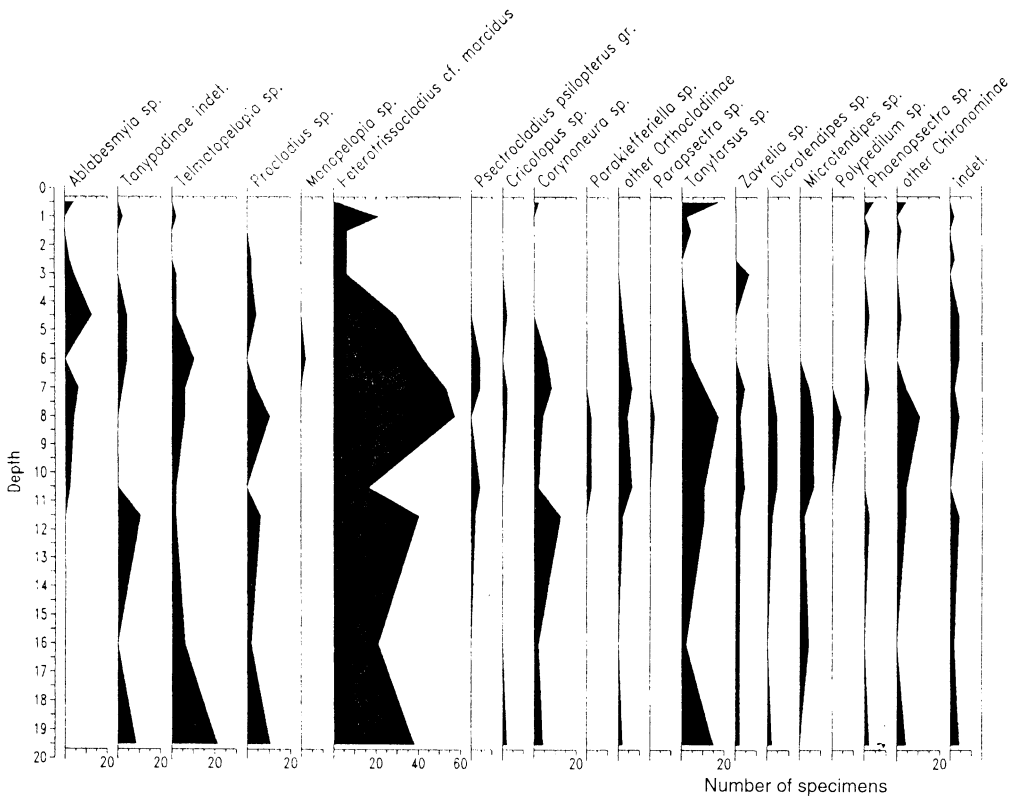

Fig. 1. – Černé Lake. Stratigraphical profiles of the chironomid taxa abundance (number of capsules per 10 ml of wet sediment) in the sub-fossil record.

Prášilské Lake

Fourteen samples from the 19.5 cm long core were analysed and 315 head capsules were recovered. Altogether 22 chironomid taxa were identified. In contrast to the Černé Lake core, the share of unidentified specimens is greater (27.8%). The whole sediment record is dominated by *Tanytarsus/Micropsectra* and *Tanytarsus* (21.6%). Because only two head capsules were identified with certainty as *Micropsectra*, the majority of the remains determined as *Tanytarsus/Micropsectra* (premandibles were missing) are likely to belong to *Tanytarsus*. More abundant taxa were *Corynoneura, Microtendipes, Procladius, Limnophyes* and *Heterotrissocladius marcidus*.

Number of taxa and specimens from the bottom to the top of the core displays similar pattern as was recognised in the Černé Lake sediment record. Both parameters decline obviously from 6.5–7.0 cm. Numbers of taxa and specimens remain low in the top of the core with the exception of 3.0–2.0 cm where slight increase can be shown. Most of taxa disappear mostly from 6.5–7.0 cm or from 4.0–4.5 cm definitively (*Phaenopsectra, Microtendipes, Pagastiella orophila, Paratanytarsus, Cricotopus*). Some taxa reappear again in the most recent sediments (*Limnophyes, Psectrocladius psilopterus* gr., *Dicrotendipes, Telmatopelopia*). Only *H. marcidus* and *E. devonica* gr. display a peak at 3.0–4.5 cm where other taxa are missing (Fig. 2).

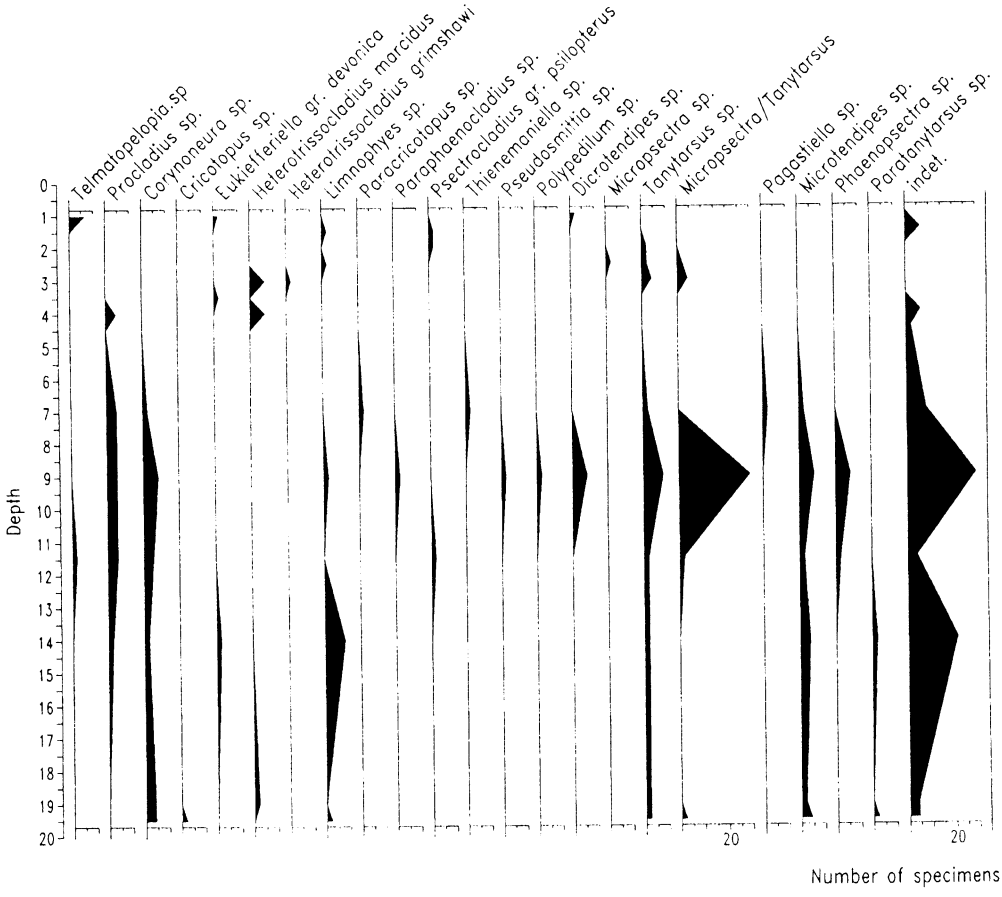

Fig. 2. – Prášilské Lake. Stratigraphical profiles of the chironomid taxa abundance (number of capsules per 10 ml of wet sediment) in the sub-fossil record.

Interesting taxa indentified in the cores

Pagastiella orophila (Edwards, 1929) and *Heterotrissocladius grimshawi* (Edwards, 1929) recorded in the core taken from the Prášilské Lake have never been found for any habitat in the Czech Republic.

Discussion

Černé Lake

Only *H. marcidus, Procladius* and *Ablabesmyia* can be considered to be potential inhabitants of the profundal zone. The dominance of *H. marcidus* as oligostenothermic and polyoxybiontic species indicates cold, oligotrophic conditions with well oxygenated hypolimnion. Sufficient amount of dissolved oxygen in the littoral zone is connected with the presence of *Corynoneura, Parakiefferiella* and *Parapsectra. Ablabesmyia* and *Procladius* are eurytopic

widespread taxa. *Microtendipes, Dicrotendipes, Polypedilum, Tanytarsus* and *Phaenopsectra* are common taxa for littoral and sublittoral zones of temperate lakes. Shallow littoral with plant debris may be indicated by *Telmatopelopia, Monopelopia, Parapsectra* and *Zavrelia.*

The major change in the chironomid stratigraphy takes place in the upper part of the core. Chironomid assemblages reflect some environmental change that influenced the lake in the last decades of the 20th century. Abundance of head capsules in the segment from 3.0 to 1.0 cm is very low and the decline involves all investigated taxa. Impoverishment of the chironomid fauna corresponds to the changes in stratigraphy of diatoms and cladocerans, as well (Fott & al. 1992). Diatom community of the younger sediment layers was poorer with dominance of acidobiontic species (Arzet & al. 1992). A transition between two zones recognised in diatom stratigraphic profile took place between 10.0 cm and 4.5 cm. The significant changes in the stratification of cladoceran remains occurred about 9.0 cm (Pražáková & Fott 1994). On the assumption that upper 10 cm of the sediments were deposited in the post Second World War period, sub-fossil chironomid fauna reflects an increase of air pollution in the region. Qualitatively and quantitatively poor chironomid thanatocenose in the top of core suggests an increase of acidification stress (Wiederholm & Ericsson 1977).

However, low pH itself cannot be responsible for the change in chironomid sub-fossil record. Thanatocenose of the pre-acidification era is consisted of taxa tolerant to low pH, perhaps with exception *Corynoneura.* Dominant *H. marcidus* is a common inhabitant of all mountain lakes in the High Tatras including strong acidified ones (Bitušík & Kubovčík 1999). Some taxa, e.g. *Telmatopelopia, Monopelopia, Parapsectra*, prefer acid waters in peat bogs. Fott & al. (1994) pointed out the high concentrations of total reactive aluminium in the lake as the most important factor influencing negatively zooplankton species. An evidence of toxic effects of Al on phytoplankton and zooplankton in acidified lakes has been presented by Hörnström & al. (1984). Veselý & al. (1989) have supposed that toxic effects of other metals, e.g. berrylium in the Černé Lake cannot be excluded. Concentrations of trace metals (e.g. Zn, Pb) in the sediments are good indicators of acid deposition (Rippey 1990). The stratigraphical profiles of trace metals in the acidified lake Store Hovvatn showed very similar patterns although clear chironomid community response has not been found (Schnell & Willassen 1996).

Increase of some taxa in the most recent sediments can be connected with rising pH measured in the surface sediments and distinct decline of the Al values (Arzet & al. 1992).

Prášilské Lake

The chironomid thanatocenose composition differs from the one taken from the Černé Lake. While Orthocladiinae accounted for 52% of the fauna in the sub-fossil record of the Černé Lake, the sub-fossil chironomids of the Prášilské Lake consisted largely of Chironominae with predominance of Tanytarsini (sub-fossil material retrieved from the core PR91-II was poorly preserved thus a considerable part of remains have not been determined).

Taxonomic composition is indicative for warmer, more productive system in comparison with the Černé Lake. Only *Procladius, H. marcidus* and perhaps *Micropsectra* were able to dwell the deepest part of the lake. Low proportion of *H. marcidus* could be connected with insufficient amount of dissolved oxygen in hypolimnion. However, the littoral zone was inhabited by relatively diverse chironomid community.

Analysis of the sub-fossil record reveals the up-core impoverishment of the chironomid fauna. The highest abundance of the head capsules between 14.0 and 7.0 cm would be explained by influx of terrestrial material as a result of deforestation after wind-fall in 1870. Provided that material contained enough of organic particles, the events might influenced favourably the chironomid community. In the High Tatra lakes a terrestrial sediment load

with high proportion of inorganic fraction have been found to be very important factor affecting negatively chironomid community (BITUŠÍK & KUBOVČÍK 1999).

Decrease of the head capsule numbers and disappearance of most taxa (including relatively acid sensitive *Corynoneura* and *Pagastiella orophila*) from 7.0–6.5 cm to the top of the core is probably a reflection of a progressive acidification stress as has been documented in diatom stratigraphy, too (ARZET & al. 1992).

Chironomid fauna of the older sediments consists of more rheophilic taxa (*Eukiefferiella devonica* gr., *Paracricotopus*) than the sub-fossil fauna of the Černé Lake. These taxa together with hygropetric *Limnophyes*, *Paraphaenocladius, Pseudosmittia* might be flushed into the lake from tributaries. It may indicate more pronounced influence of the inflows in the past.

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