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Response of Subfossile Diatoms, Cladocera and Chironomidae in Sediments of Small Ponds to Changes in Wastewater Discharges from a Zn–Pb Mine

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Abstract : Mining of metal ores is one of the largest sources of heavy metals, which deteriorate aquatic systems. The response of organisms to environmental changes can be well recorded in sediments of the affected water bodies and may be reconstructed basing on analyses of organisms remains. The present study aimed at response of diatoms, Cladocera and Chronomidae communities to impact of Zn-Pb mine water discharge recorded in sediment cores of small subsidence ponds on the Chechło River floodplain (Silesia–Krakow Region, southern Poland). We hypothesis various response of the above groups to high metal concentrations (Cd, Pb, Zn, and Cu). The investigated ponds were formed either during the peak of the ore exploitation (DOWN) or after mining cessation (UP). Currently, the concentrations of dissolved metals (in µg g-1) in water reached up to 0.53 for Cd, 7.3 for Pb and up to 47.1 for Zn. All the sediment cores from subsidence ponds were heavily polluted with Cd 6.7–612 µg g−1, Pb 0.1–10.2 mg g−1, and Zn 0.5–23.1 mg g−1. Core sediments varied also in respect to pH 5.8-7.1 and concentrations of organic matter (5.7-39.8%). The impact of high metal concentrations was expressed by the occurrence of metal tolerant taxa like diatoms – Nitzschia amphibia, Sellaphora nigri, and Surirella brebisonii var. kuetzingii; Cladocera – Chydorus sphaericus (dominated in cores from all ponds), and Chironomidae – Chironomus and Cricotopus especially in the DOWN ponds. Statistical analysis exhibited a negative impact of metals on some taxa of diatoms and Cladocera, but only on Polypedilum sp. from Chironomidae. Abundance of such diatoms like Gomphonema utae, Staurosirella pinnata, Eunotia bilunaris, and Cladocera like Alona, Chydorus, Graptoleberis, and Pleuroxus decreased with increasing Pb concentration. However, the occurrence or dominance of more sensitive species of diatoms and Cladocera indicates their adaptation to higher metal loads, which was facilitated by neutral pH and slightly alkaline waters. Diatom assemblages were generally resistant to Zn, Pb, Cu, and Cd pollution as indicated by their large similarity to populations from non-contaminated waters. Comparison with reference objects clearly indicates the dominance of Achnanthidium minutissimum, Staurosira venter, and Fragilaria gracilis in very diverse assemblages of unpolluted waters. The distribution of the Cladocera and Chironomidae taxa depended on the habitat type. The DOWN ponds with stagnant water and overgrown with macrophytes were more suitable for Cladocerans (14 taxa, higher diversity) than the UP ponds with river water flowing through their centre and with a small share of macrophytes (8 taxa). The Chironominae, mainly Chironomus and Microspectra, were abundant in cores from the UP ponds with muddy bottom. Inversely, the density of Orthocladiinae, especially genus Cricotopus, were related to the organic matter content and dominated in cores from the DOWN ponds. The presence of diatoms like Nitzschia amphibia, Sellaphora nigri, and Surirella brebisonii var. kuetzingii, Cladocerans Bosmina longirostris, Chydorus sphaericus, littoral cladocerans, Alona affinis, A. rectangularis as well as Chironomidae Chironomus sp. (UP ponds) and Psecrotanypus varius (DOWN ponds) indicate the influence of the water trophy on their distribution.

Keywords : Chironomidae, cladocerans, diatoms, metals, Zn-Pb mine, sediment cores, subsidence ponds
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