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Fossil invertebrates reveal major ecological turnovers during the recent centuries in a high altitude lake in the Austrian Alps

Tomi Luoto (1,2) and Liisa Nevalainen (2)

(1) Department of Geosciences and Geography, University of Helsinki, Helsinki, Finland (tomi.luoto@helsinki.fi), (2) Institute for Limnology, Austrian Academy of Sciences, Mondsee, Austria (liisa.nevalainen@oeaw.ac.at)

We examined fossil chironomid (Diptera: Chironomidae) and cladoceran (Crustacea: Cladocera) assemblages in a high-resolution sediment core covering the past approximately 500 years from a High Alpine Oberer Landschitzsee in the Niedere Tauern region, Austria. Our aim was to characterize late Holocene faunal dynamics and to detect possible major ecological turnovers related to late Holocene environmental variability. Numerical analysis of the chironomid and cladoceran data revealed clear faunal successions and distinct ecological turnovers. The chironomid communities in the lower part of the core were dominated by Micropsectra contracta-type and also Psectrocladius sordidellus-type, Procladius and Tanytarsus lugens-type were common, while the cladoceran assemblages were dominated by Alona affinis and A. quadrangularis. A major simultaneous change occurred in the chironomid and cladoceran communities at the middle part of the sediment core. The previously dominated taxa decreased or disappeared and the chironomid communities became dominated by Sergentia coracina-type and the cladocerans by Acroperus harpae. The almost complete species turnover in chironomids indicated a major ecological or environmental perturbation. The dominance of cold-indicating S. coracina-type suggests that the deep water oxygen conditions became poorer, because this taxon is able to tolerate temporary anoxia due to the ability to accumulate glycogen and degrade it from anaerobic metabolism. It is possible that the decreased oxygen conditions occurred during the 'Little Ice Age' when the long ice-covered period would have prevented the oxygenation. In the more recent sediment layers, the dominating chironomid and cladoceran taxa decreased, but the fauna did not return to a composition resembling the situation in the early part of the core. Although chironomids became again dominated by M. contracta-type, all the other taxa present in the early part of the core had permanently disappeared, such as the cold-indicating T. lugens-type. Furthermore, S. coracina-type remained as an important component of the macrobenthic community of the lake. Warm-indicating Bosmina longirostris, which also favours elevated nutrient conditions, colonized the lake in the latter part of the sediment profile and began to dominate in the most recent sediment layers. Based on the ecological characteristics of these taxa, the recent changes in invertebrate communities were likely caused by the coupling effects of climate warming and increased nutrient conditions. This would be in an agreement with the present climate warming and the expected climate-related increase in primary production. The present results show that the High Alpine Austrian lakes are potentially ecologically extremely sensitive to environmental changes and that regime shifts are currently occurring subsequent to the present climate warming.