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Holocene climatic changes in the Austrian Alps inferred from fossil chironomid assemblages

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Palaeoclimatic reconstructions derived from lacustrine sediment records are essential to understand natural climate variability and to determine the magnitude and trajectories of environmental change. This research is a part of multi-proxy investigation of Schwarzsee ob Sölden (46˚57'N, 10˚56'E), a high alpine lake (2796 m a.s.l.) located in western Austria, and focuses principally on the chironomid assemblages in the lake. The chironomid-based climatic inferences are compared with other proxy records from this lake and with other climate proxy archives available for the Alpine region. The lake is located well above the present tree line and the catchment area is mainly composed of fine-grained crystalline rock and scree. The modern July air temperature based on meteorological measurements in the region for the period of 1976-2006 yrs and calculated for the altitude of Schwarzsee ob Sölden is ca. 4˚C. A 159 cm sediment core from the deepest part of the lake spans the last 10,200 calibrated radiocarbon years BP (cal. yr BP). The chronology is based on nine calibrated AMS radiocarbon dates obtained from plant macrofossils as well as on ^{210}Pb and ^{241}Am profiles. The most important taxa comprising 60-100% of the specimens in all sediment layers are *Micropsectra radialis*-type and *Pseudodiamesa arctica*-type. Both these taxa are cold-stenothermic and typical of high latitude lakes and high mountain regions, where they often dominate together in lakes at an altitude greater than 2000 m. The appearance and abundance of *Pseudodiamesa arctica*-type along the

sediment core correlate well with previously described cold events of the Holocene in the Alpine region (e.g. the “8.2k” event, Hypsithermal/Neoglaciation transition ca. 5200 cal. yr BP, Middle Bronze Age cooling, and Little Ice Age) because this taxon, in comparison with *Micropsectra radialis*-type, is better adapted to harsh physical environment, including freezing, drying and successful emergence through cracks in the ice cover. A Principal Components Analysis (PCA) suggests that the changes in the chironomid assemblages were mainly driven by the temperature gradient during the Holocene. Mean July air temperature (Tjul) was reconstructed by weighted averaging (WA) regression based on a Swiss chironomid calibration data set. Smoothing of the inferred Tjul with a span of 0.15 was used to summarize the overall Holocene trend in the reconstructed temperatures. At the beginning of the Holocene, inferred temperatures rise rapidly from 5.0˚C to their maximum values of 7.5-8.0˚C between 10,200 and 8700 cal. yr BP. During the mid-Holocene (7500-4200 cal. yr BP), inferred temperatures remain relatively stable at 6.0˚C. An abrupt shift to a cooler late-Holocene climate occurs after 4200 cal. yr BP when air temperatures decrease to reach values of 4.0-4.5˚C. Major inferred temperature changes agree well with other central European climate reconstructions.