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A 260 000-year reconstruction of diatom community dynamics and photosynthetic pigments in Lake Chala, a tropical crater lake

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Lake Chala is a c. 90 m deep meromictic, oligotrophic crater lake near Mt. Kilimanjaro in equatorial East Africa. This sub-humid tropical region experiences two rainy seasons separated by a long dry season in June-August, when deep mixing fuels the epilimnion with nutrients resulting in increased phytoplankton primary production. Within the ICDP DeepCHALLA project, a 215-m long, continuous sediment sequence was obtained, which provides a unique opportunity to study long-term climate dynamics and aquatic ecosystem response during the past c. 260 000 years. Here we analyzed fossil pigments and diatom assemblages to reconstruct temporal dynamics in the lake's phytoplankton community structure with millennial-scale resolution. Fossil pigments were analyzed using high-performance liquid chromatography, and a minimum of 400 valves were counted and identified with best-possible taxonomic discrimination from sediment samples taken at c. 800-yr intervals throughout the last glacial cycle (back to c. 160 kyr BP) and at c. 1600-yr intervals throughout earlier lake history. The most abundant pigments were zeaxanthin and lutein, reflecting the presence of cyanobacteria and green algae. Despite the high diatom content of the sediments, the diatom marker pigment fucoxanthin was almost absent, which we attribute to its labile nature. A small cyclotelloid diatom resembling the tychoplanktonic species *Discostella stelligera* at the base of the sequence probably reflects open-water conditions with the proximity of littoral habitats during the early filling stages of lake ontogeny. High proportions (20-50%) of an *Encyonema* species at c. 240-230 kyr BP indicate increased availability of benthic habitats, possibly because of a marked low-stand at the time of early sediment infilling when the central ash cone on the basin floor was still exposed. A phase of abundant needle-like *Nitzschia* and generally higher, yet fluctuating, pigment concentrations suggest a relatively moist environment with deep water and a stable stratification at c. 220-140 kyr BP. After c. 140 kyr BP, *Afrocymbella barkeri* appears for the first time, and from then onwards until the modern times the diatom community is composed of fluctuating abundances of *Afrocymbella* and needle-like *Nitzschia* taxa. The highest diatom biovolumes yet pronounced low carotenoid concentrations occur during the *Afrocymbella*-dominated (up to 100 %) intervals between c. 110 and 90 kyr BP and between c. 22 and 17 kyr BP, which broadly coincide with the MIS5 African megadrought and the Last Glacial Maximum, respectively. This suggests that during those time periods, the lake experienced pronounced dry and windy climate conditions, which triggered relatively deep mixing. This probably enhanced internal nutrient cycling and the injecting of oxygen to the bottom waters,

which facilitated diatom growth in the epilimnion and resulted in pigment degradation in the hypolimnion. Superimposed on these long-term patterns, we found many short-term fluctuations in the appearance of different *Nitzschia* taxa, which may reflect stochastic colonization and extinction events, rather than actual climate-driven changes in the abiotic environment of Lake Chala.