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Late Quaternary responses of neotropical aquatic and terrestrial communities to abrupt climate and environmental change archived in sediments of Lake Petén Itzá, northern Guatemala

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Lacustrine sedimentary sequences containing high resolution paleoclimate datasets spanning multiple glacial/interglacial cycles are relatively rare. One outstanding exception in the northern Neotropics, is the ∼400 ka-paleoenvironmental record of Lake Petén Itzá, northern Guatemala. It is a deep (165 m) and large (100 km2) closed-basin lake. This makes it especially sensitive to changes in the balance between evaporation and precipitation (E/P), therefore, lake levels have drastically fluctuated in the past, especially during Heinrich events (H) that have been characterized as cold and dry stadials in this region. Such abrupt environmental changes have great impact on aquatic and terrestrial communities, because these are highly sensitive and respond to climate and environmental changes rapidly. Only few studies, however, have compared the impact on both, aquatic and terrestrial ecosystems, especially in the northern Neotropics.

With this in mind, we combined aquatic and terrestrial paleobioindicators (ostracodes and pollen) preserved in sediments of a long core PI-6 (∼75.9 m long) from Lake Petén Itzá to evaluate the biotic responses to abrupt environmental change in the northern Neotropics during the last 85 ka. Most studies use changes in abundances of fossil species assemblages as an indirect information of the magnitude of climate impact, however, a more accurate quantification of the magnitude and velocity of ecological changes can be achieved by applying Detrended Correspondence Analysis (DCA) on fossil counts. Here, we calculated the ecological change, rate of ecological change and ecological distance of ostracode and pollen data (R package “paleoMAS”). Throughout the core, ostracodes display larger ecological changes (in SD) than pollen. For both bioindicators ecological change was greater during H (cold/dry) and the Last Glacial Maximum (LGM, cold/wet), indicating profound modifications in species communities. Ecological change in the lake environment was especially high during H6 and H5, while in the terrestrial environment it was low. Rates of ecological change (in SD/yr) for ostracodes were greater as well, but show similar trends to those inferred for the terrestrial environment. Rates of ecological change were larger during the transition of the H2 and the LGM, H1 as well as the Bølling/Allerød (BA).

This study is only the first step in exploring and understanding the response of freshwater aquatic and terrestrial communities to climate change in the northern lowland Neotropics. The combination of aquatic and terrestrial bioindicator and more neotropical lake archives will allow making inferences in a broader spatial scale (lake, catchment area, northern Neotropics). This will allow to determine timing, regions and triggers of increased magnitudes and velocities of ecological change.