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Reconstructing the climatic ultrastructure and aquatic biotic communities response to Heinrich stadials in the continental northern Neotropics

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Heinrich stadials (HS) are recognized as fast-acting "pulses" of global rapid environmental change that affect the climate and cause alterations in species composition and distribution. Past changes in aquatic ecosystems due to HSs may be an analog for future disruptions caused by climate change in the Neotropics. Our aim is to provide high resolution water temperature and conductivity records for HSs (HS1-HS6) in the northern Neotropics and identify their effects on aquatic communities. We analyzed the geochemical sediment composition (TIC and TOC) and quantified ostracode and diatom fossil abundances in cores PI-6 (73m long, from71m water depth) and PI-2 (84m long and from 54m water depth) from Lake Petén Itzá, Guatemala. Sediment cores were dated using a combination of radiocarbon and tephra chronology.
Taxonomical analysis revealed that the ostracode fauna through all HSs had an exclusive tropical composition, reflecting that water temperatures remained warm, likely within the current tolerant range (26-33°C) observed for modern species inhabiting Central American lakes. Because of these warm conditions on the lake ecosystem, we infer that there was not a large change in temperatures as suggested by Hodell et al. (2012), but a small on such at the 5°C suggested by Correa-Metrio et al. (2012).
Sediments during HSs are dominated by gypsum, suggesting variable water solute composition. Low TIC and TOC values during HSs indicate that these variations resulted from a decrease in precipitation and prevailing dry conditions. Bioproxy composition however, suggests sharp climatic transitions from humid to arid (HS5, HS3and H1) and from arid to humid (HS4, HS2).
HS6 (63.2-60.1 ka BP) was characterized by domination of benthic diatoms and nektobenthic Cypria petenensis, Paracythereis opesta and Pseudocandona sp. ostracode species, suggesting low lake levels with predominance of littoral conditions.
HS5 (50-47ka BP), HS3 (32.7-31.3ka BP) and HS1 (18-15.6ka BP) were characterized by rapid changes from planktonic to benthic diatoms, suggesting deepening of water. These transitions occurred at the onset of HS5, the middle-end of HS3 and the end of HS1. Lake ecosystem, thus had different response to these events. Ostracode community during HS5 was characterized by the nektobenthic and conductivity tolerant ostracodes Cypridopsis vidua, C. petenensis, P. opesta and Heterocypris putei suggesting low lake levels prevailing with high conductivity. During HS1 and HS3 ostracode assemblages was mostly dominated by nektobenthic species with the emergence of conductivity-tolerant H. putei at the end of the periods. Thus, humid conditions dominated during these HSs, but they ended with a rapid transition to a dry environment with increasing of conductivity.
HS4 (38.3-40.2ka BP) and HS2 (24.3-26.5ka BP) showed abrupt changes from benthic to planktonic diatoms suggesting increasing water depth due to increased precipitation rates. The HS4 ostracode assemblage was initially dominated by benthic species such as Pseudocandona sp and Darwinula stevensoni but later on only necktobenthic species were present. Similar patter occurred during HS2, but the dominance of littoral-related species lasted longer, suggesting predominant dry conditions and low lake levels. The occurrence of necktobenthic species at the end of the period suggests increase of humidity.
Our study highlights good agreement of the cores analyzed from different water depths and the applicability of multiproxy approach for a high resolution interpretation of past climate forces in northern Neotropics.