Milankovitch Modulation of the Ecosystem Dynamics of Fossil Great Lakes

Details

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Abstract

Triassic and Early Jurassic lacustrine deposits of eastern North American rift basins preserve a spectacular record of precession-related Milankovitch forcing in the Pangean tropics. The abundant and well-preserved fossil fish assemblages from these great lakes demonstrate a sequence of cyclical changes that track the permeating hierarchy of climatic cycles. To detail ecosystem processes correlating with succession of fish communities, we measured bulk $\delta^{13}C_{org}$ through a 100 ky series of Early Jurassic climatic precession-forced lake level cycles in the lower Shuttle Meadow Formation of the Hartford rift basin, CT. The deep-water phase of one of these cycles, the Bluff Head bed, has produced thousands of articulated fish. We observe fluctuations in the bulk $\delta^{13}C_{org}$ of the cyclical strata that reflect differing degrees of lake water stratification, nutrient levels, and relative proportion of algal vs. plant derived organic matter that trace fish community changes. We can exclude extrinsic changes in the global exchangeable reservoirs as an origin of this variability because molecule-level $\delta^{13}C$ of n-alkanes of plant leaf waxes from the same strata show no such variability. While at higher taxonomic levels the fish communities responded largely by sorting of taxa by environmental forcing, at the species level the holostean genus *Semionotus* responded by in situ evolution, and ultimately extinction, of a species flock. Fluctuations at the higher frequency, climatic precessional scale are mirrored at lower frequency, eccentricity modulated, scales, all following the lake-level hierarchical pattern. Thus, lacustrine isotopic ratios amplify the Milankovitch climate signal that was already intensified by sequelae of the end-Triassic extinctions. The degree to which the ecological structure of modern lakes responds to similar environmental cyclicity is largely unknown, but we suspect similar patterns and processes within the Neogene history of the East African great lakes, which may be modified in the future by anthropogenic CO_2-driven intensification of the hydrological cycle.

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