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Diversity history of Cenozoic marine siliceous plankton

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Marine planktonic diatoms and polycystine radiolarians, both with shells of opaline silica, make up a large part of the deep-sea sediment fossil record. Diatom export of organic material to the deep ocean and sediments strongly affects the global carbon cycle; while both groups compete for, and are regulated by the availability of, dissolved silica derived from global weathering. Diatoms and radiolarians also both have a relatively (compared to foraminifera or coccolithophores) complex biogeography, with diverse, endemic polar and tropical assemblages. Changes in past diatom and radiolarian diversity can be used to understand how the ocean's biologic pump has evolved, how co-evolution between groups occurs, and how nutrient availability controls evolutionary change.

Lazarus et al. (2014) recently showed that diatom diversity increased by a factor of ca 3.5X over the Cenozoic, with a temporary peak in the latest Eocene, a late Oligocene-early Miocene low interval, very strong diversification in the late Miocene-early Pliocene, and minor decline in the late Pliocene-Recent. Only Phanerozoic scale radiolarian diversity estimates have been available until now, and these are strongly biased by sample size. We employed similar data (NSB database) and methods (1 my bins, 'sqs' subsampling, outlier removal using Pacman trims) as Lazarus et al. (2014) to calculate, for the first time, a detailed estimate of radiolarian diversity history, and origination and extinction rates over the last 50 my, the period for which sufficient NSB data is available. Radiolarian diversity increases almost monotonically by a factor of 5, with relatively rapid increases in the mid Eocene (high relative origination) and early Miocene (due to low extinction rates), and a moderate decline in the Plio-Pleistocene due to high extinction rates. Combined high rates of both extinction and origination, with little diversity change, are seen at the Eocene-Oligocene boundary. Most of these events can be related to changing global paleoceanographic conditions.

Radiolarians show a major decrease in Cenozoic silica usage, apparently due to the rise of diatoms and consequent reduction of surface water silica concentrations (Lazarus et al. 2009). This inference based on diatom diversity has been confirmed (Renaudie et al., this meeting) with new estimates showing Cenozoic increasing rates of global diatom silica deposition. Our new radiolarian results show this did not negatively impact radiolarian diversity. Presumably increasing diversity from increasing faunal provinciality dominated Cenozoic radiolarian diversity dynamics, similar to the diversity controls on diatoms (Lazarus et al. 2014).

Lazarus et al. (2009). PNAS 106:9333-9338.
Lazarus et al. (2014). PLOS One (in press).