Calcareous nannoplankton evolution and the Paleocene/Eocene thermal maximum event

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Calcareous plankton are ideally suited to the assessment of evolutionary change through past rapid climate change events because they are abundant, widespread and cosmopolitan organisms. The study of these fossils has been integral to our recognition and emerging understanding of the Paleocene/Eocene thermal maximum (PETM), which is now a major focus of attention as an historic example of a carbon cycle event comparable to that predicted for the next century, *i.e.*, rapidly increasing atmospheric CO_2, global warming and possible ocean acidification. The PETM geological record has provided unambiguous evidence of disruption in the deep-sea environment, with acidification and large temperature rises accompanied by elevated extinction rates in benthic foraminifera. Evidence of similar disruption in the surface ocean plankton, however, currently comprises observations of poleward migration, short-lived 'excursion taxa' and elevated evolutionary turnover in calcareous phytoplankton. This is a somewhat muted evolutionary response, considering the temperature and acidification effects that have been proposed for this interval. Here we examine whether this evidence may be compromised by the quality of the stratigraphic and fossil record by analysing plankton from an expanded, hemipelagic PETM section in southern Tanzania (Tanzania Drilling Project Site 14) that, in background conditions at least, provides exceptionally preserved calcareous microfossils and therefore the optimal prospect of recovering reliable assemblage and diversity data. The calcareous nannoplankton are more diverse than any previously documented sections of the same age, and include small and fragile taxa that are not present in 'normal' preservation states. The PETM onset is marked by rapid and significant nannoplankton assemblage shifts, reduction in abundance and diversity, and synchronous extinctions representing around 10% of the total diversity. These changes clearly indicate severe disruption of the photic zone environment, but the disappearing taxa reveal no strong extinction selectivity bias and the assemblage shifts are not easily explained by the effects of dissolution, dilution, or productivity. Diagnostic nannoplankton components are observed throughout the carbon isotope excursion interval, but are replaced above this level by assemblages that are remarkably similar to those seen prior to the event. Despite synchronous extinctions at the PETM onset, and significantly perturbed assemblages for the duration of the PETM event, the plankton underwent only minor evolutionary changes in the longer term. Nevertheless, the event fell within the interval that saw the highest turnover rates in the history of the calcareous nannoplankton group.