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Carbon system recovery and planktonic foraminifera ecology after the end Cretaceous mass extinction

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The end Cretaceous mass extinction profoundly affected the marine ecosystem. Surface-to-deep-ocean carbon isotope ($\delta^{13}C$) gradients and carbonate accumulation records suggest that pelagic extinctions coincided with a breakdown in marine biological pumping, which was followed by a long (3Myr) delay in recovery, but the apparent lack of response by benthic foraminifera has questioned the extent of this perturbation. Existing reconstructions of K/Pg carbon pumping are based on the difference between $\delta^{13}C$ in the calcitic tests of benthic and surface living foraminifera. One problem with this however, is our limited understanding of $\delta^{13}C$ disequilibrium effects in fast evolving early Paleocene planktonic foraminifera that diversified rapidly after decimation (~90 % extinction) of late Cretaceous stocks at the K/Pg. Positive or negative $\delta^{13}C$ disequilibrium effects that are a known feature of fossil and planktonic foraminifera could significantly over or underestimate the measured planktonic-benthic $\delta^{13}C$ gradient.

To help address this problem we present new multispecies foraminiferal stable isotope data size trends from ODP Site 1262. Our results suggest that all small specimens < 150 µm, which includes typical post-K/Pg Danian opportunists and extinction survivors, as well as small/pre-adult forms of other species, likely underestimate water column DIC $\delta^{13}C$ by 0.3 – 0.5 ‰ because of a pronounced metabolic vital effect. Our results also lend support to the hypothesis that foraminiferal photosymbiosis evolved in the *Praemurica* lineage but the new data provide further constraints on the timing of development of this ecology, which is associated with a positive disequilibrium $\delta^{13}C$ effect, pin-pointing its appearance to the *Pr. pseudoinconstans*- *Pr. inconstans* morphogroup by 63.5 Ma. All photosymbiotic species should, therefore, be expected to have artificially enriched $\delta^{13}C$ (by up to 1.0 ‰), especially species above 200 µm. By applying these new constraints to our down core records we are able to produce revised estimates of K/Pg changes in surface-to-deep $\delta^{13}C$ gradients and carbon cycling.

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