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Latest Cretaceous foraminiferal ecology and palaeoceanographic inferences from chamber-specific LA-ICPMS analysis.

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Our understanding of how atmospheric pCO₂ varied over the Cenozoic has been steadily improving, thanks in part to ever more numerous and more refined estimates from boron isotopes in foraminiferal calcite. However, the challenge of understanding how foraminiferal physiology and ecology might have influenced measured boron isotope-pH values becomes larger as we move towards older, extinct species that may be ever more different relative to well-studied modern descendants. For instance, shell morphology in itself may have effected differences in early Cenozoic foraminiferal carbon isotopes [1], while elsewhere some data suggest Eocene vital effects in boron isotopes may have been weaker than today [2]. To successfully extend boron isotope-derived pCO₂ estimates further back into the Cretaceous, where most clades have no Cenozoic descendants, necessitates a thorough approach to understanding symbiont and depth ecology in these foraminifera. Some such information can be gleaned from trends in oxygen and carbon isotopes with size [e.g. 3], but this alone cannot fully elucidate differences in physiology and biomineralisation pathways.

Here we present new insights into the physiology and palaeoecology of several key late Cretaceous planktic foraminiferal species from element/Ca ratios, measured as depth-profiles by laser ablation inductively-coupled plasma mass spectrometry (LA-ICPMS). While single-chamber Mg/Ca ratios support some depth migration patterns indicated from oxygen isotopes [3], our observed trends in boron incorporation with ontogeny often run counter to predictions based on carbon isotopes. Moreover, B/Ca ratios in Cretaceous foraminifera are strongly species-dependent, with studied trochospiral taxa recording far higher B/Ca ratios than co-habiting Heterohelicids, perhaps indicating fundamental differences in trace element incorporation mechanisms (and perhaps biomineralisation pathways) across different clades. We discuss the implications of these findings for proxy reconstructions in the Cretaceous, with a particular focus on expanding the horizons of palaeo-CO₂ and palaeotemperature reconstruction.

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