

“Paradise Lost” for the Belemnites: New Insights using Clumped Isotopes from Cretaceous Trichinopoly, Southern India

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Physiological stresses induced by environmental factors are detrimental to the survival of marine mollusc populations. The Cretaceous was one of the most adverse time periods in Earth history, marked by a major extinction event that wiped out a significant fraction of the global biosphere, including the belemnites, an ascendant order in Phanerozoic oceans. Although belemnites finally became extinct in the Late Cretaceous, recent studies (1) indicate that these cephalopods were imperilled far earlier than the extinction event, i.e. during the Early Cretaceous greenhouse world, consistent with observations from India. Palaeotemperature reconstructions based on clumped isotope analyses of the last growth chambers of belemnites from the Cretaceous Cauvery basin, southern India, suggest factors responsible for their demise. The Δ_{47} of well-preserved carbonate guard shells (screened using EBSD and elemental concentration) indicates precipitation from water with a maximum temperature range of 15–30°C. The salinity reconstructed from the clumped isotope derived $\delta^{18}\text{O}_{\text{water}}$ and using the $\delta^{18}\text{O}$ -S relationship of LeGrande and Schmidt (2) shows that most of the belemnites lived in water with salinity > 40 p.s.u. This level is lethal for the hatchlings and embryonic population of squid, their closest modern relatives. Inverse Rayleigh modelling suggests that highly saline evaporative conditions would explain the observed sea water isotopic values. Our conclusion is further supported by high precision SIMS analyses of the $\delta^{18}\text{O}_{\text{carb}}$ across the growth bands of one belemnite rostrum.

Refs: (1) Iba et al., *Geology* 39, 483-6. (2) LeGrande and Schmidt, *Geophys. Res. Lett.*, 33, L12604.