

BECOMING A WINNER IN JUST A MILLION YEARS: EXAMINING THE FUNCTIONAL CONSEQUENCES OF AMMONOIDS ACROSS THE END-TRIASSIC

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Morphological shifts in animal lineages that survive global mass extinction are often interpreted as a direct biological response to environmental or ecological crises. A showcase for boom-bust diversity is presented by ammonoid cephalopods, particularly those with planispiral conchs. Ammonoids survived three of the “Big Five” mass extinctions before the clade’s total extinction with the Cretaceous-Paleogene mass extinction. Across these global Earth-life transitions, ammonoid lineages often produced an obvious shift in the morphology of their iconic shells. But these shifts can be difficult to interpret, because few specific functional advantages (or hardships) have yet been tied to distinct morphotypes. Whether post-extinction conch morphologies are attributed to intrinsic evolutionary-developmental constraints, or served as adaptations to extrinsic conditions, we can measure their apparent functional consequences

We consider the ammonoid response to end-Triassic mass extinction as a case study. Across this transition, ammonoids show a dramatic shift in conch morphospace occupancy. A Late Triassic wealth of shell shapes was abandoned by the paltry repertoire of the extinction-era ammonoids. For millions of years after the extinction, ammonoid clades produced great diversity and abundance, yet produced few conch shape varieties. Earliest Jurassic (Hettangian; Sinemurian) ammonoids chiefly grew serpenticonic (strongly coiled) or moderately oxyconic (wedge-like) morphs with low conch width. Moreover, many serpenticonic species reached large sizes. The apparent success of serpenticonic ammonites during the Early Jurassic has previously been troublesome to interpret; the simple conch shape should limit these animals to be poor swimmers relative to their oxyconic contemporaries. We present refined hydrodynamics simulations and trajectory analyses for ammonoids with conchs ranging from serpenticonic to oxyconic. Oxycones present distinct advantages in specific conditions – rapid acceleration at moderate sizes. Serpenticones appear to allow adequate performance across a much broader scope of sizes, musculature capacities, and jet propulsion tactics. Overall, we interpret the success of serpenticone ammonites in the Early Jurassic was fostered by this generalist capacity rather than a specific response or adaptation to extinction-related forces. This provides a straightforward explanation for the morphological shift as a consequence of the extinction without being a direct response.