

## Temporal change in morphological disparity relative to taxonomic diversity in ammonoids

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In the past decades, there has been an increasing interest in the relation of morphological disparity to taxonomic diversity in the fossil records. This relationship has been focused in the context of a particular mass extinction event and subsequent recovery. Recent improvement of the Paleobiology Database (PDBD) as well as development of analytical methods allows us to study change in the disparity-diversity relationship in a particular organic group throughout its macroevolutionary history. The present study focuses on the relationship between morphological and taxonomic richness in ammonoids. Morphological richness for each chronological bin was assessed using multi-dimensional kernel density estimation of measurement data in a morphospace and coverage-based rarefaction subsampling method. The Raup' s parameters were collected from more than 6000 ammonoid species figured in the literature and registered in the PDBD ranging in age from the Early Devonian to the end-Cretaceous. The abundance of each species was assessed by the collection-based occurrence data deposited in the PDBD. Taxonomic richness was also estimated for each bin from the examined data set using the Alroy' s shareholder quorum subsampling method. The results of the analyses reveal the pattern of change in taxonomic and morphological richness in ammonoids. Morphological richness relative to taxonomic richness was generally high mostly during the Devonian to Permian period. However, the results show relatively low morphological richness of ammonoids for their taxonomic richness during the Lopingian to Middle Triassic epoch. In contrast to the rapid recovery of taxonomic richness, post-crisis recovery of morphological richness was delayed after the double mass extinction at the end-Paleozoic. The morphological richness relative to taxonomic richness temporally increased in the Late Triassic, but remained at low level throughout the Jurassic and Cretaceous and never recovered to what it had been before the Guadalupian/Lopingian boundary. The results suggest phylogenetic constraints on conch geometries in the Mesozoic groups such as Phylloceratida and Ammonitida.

Keywords: morphological disparity, taxonomic diversity, ammonoids