Paleobiology and paleoecology of the Mesozoic marine bivalves of Kutch, Gujarat, India

Thesis Abstract

The Mesozoic rocks of Kutch, a fault-controlled pericratonic basin at the western margin of India, are characterized by nearly 3000 meters of sediment deposited during the Middle Jurassic (Bajocian-Bathonian) to the Early Cretaceous (Aptian). The varied lithology, from carbonates to siliciclastics to oolites, suggests repeated sea level change across the basin. These repeated transgressive–regressive cycles and the associated change in the depositional environments can potentially result in distinct paleobiological and paleoecological changes in the marine ecosystems. Although the Mesozoic marine invertebrates of Kutch have been investigated for over a century, most of the previous works focused on the taxonomic and biostratigraphic aspects of the faunal communities. The present work aims to investigate the long-term paleobiological and paleoecological change in the Mesozoic marine bivalve community of the Kutch basin in relation to the temporal changes in the depositional environments. While a few studies documented the evolutionary pathways in individual lineages, the lineage-level phyletic patterns can be hypothesized to lead to higher-order macroevolutionary trends or be independent of the community-level trends. The temporal change in bivalve body size can most easily manifest any disassociation between the trends in the lower and higher taxonomic orders. An organism's body size, an easily measurable phenotypic trait, is strongly associated with ecological and physiological parameters and has long been a topic of interest for decades for evaluating macroevolutionary trends. In the present study, a new database on the Middle Jurassic-Early Cretaceous bivalves of Kutch has been used to investigate the long-term evolutionary trends in bivalve body size, such as the Cope's rule (a tendency towards larger body size in descendants), across different taxonomic levels. The result suggests that the Unbiased Random Walk model (URW) best explains the class Bivalvia body size trend of the Kutch basin. A fluctuating pattern of body size change prevailed throughout the Middle Jurassic-Early Cretaceous period, and this pattern could be explained by the repetitive transgressive-regressive cycles in the Kutch basin that resulted in temporally volatile adaptive landscapes and adaptive optima. This oscillating pattern in body size is pervasive at higher (class and order) and lower taxonomic levels (family and genus) and also among the ecological groups (infaunal, epifaunal, semi-infaunal), suggesting that similar underlying processes are responsible for both lower-order and higher-order trends.

Sea level fluctuations may also significantly influence temporal changes in paleoecological interactions. Gastropod drilling predation is one of the few biotic interactions that provides evidence of predatory activity and can be preserved in the fossil record. Therefore, gastropod drillholes on prey shells provide a unique opportunity to test the importance of predation in an evolutionary context. Analyses of drilling predation in the Upper Jurassic records of Kutch suggest a small but significant increase in predation intensity from the Kimmeridgian to Tithonian. In addition to the drilling intensity, the diversity of the bivalve community also significantly increases from the Kimmeridgian to the Tithonian. While a high degree of disarticulation, fragmentation, size sorting, and convex-up orientation of shells in the Kimmeridgian assemblage reflects repeated reworking and transport within a high-energy environment in the Kimmeridgian, the Tithonian deposits represent a maximum flooding zone sequence with low-energy indicating deepening of the basin and a sediment-starved offshore depositional setting with a lesser degree of reworking. These results suggest a relationship between the depositional environment and drilling intensity in the Mesozoic. Repeated transgressive-regressive cycles may also govern the faunal distribution, as high sea level promotes faunal migration and mixing between different provinces, and low sea levels lead to endemism. The present study reports the oldest occurrence of *Seebachia bronni* Krauss, 1850, the type species of the genus *Seebachia*, from the oolitic bands of the upper Tithonian of Kutch. The oldest species of *Seebachia* (*Seebachia*), *Seebachia* aff. *bronni* was previously reported from the middle–upper Oxfordian of the Morondava Basin in Madagascar. Transgression in the late Tithonian may have enabled the the migration of *Seebachia* (*Seebachia*) from Madagascar to western India during the late Tithonian. Additionally, the range of *Seebachia* aff. *bronni* in the Oxfordian of Madagascar to *Seebachia bronni* sensu stricto in the Tithonian of India and the Early Cretaceous of South Africa may also reflect an evolutionary size increase following Cope's rule.

Keywords: Mesozoic, Bivalvia, Kutch, body size evolution, drilling predation, paleobiogeography, sea level change