Permian-Triassic evolution of the BIVALVIA: Extinction-recovery patterns linked to ECOLOGIC and taxonomic SELECTIVITY

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ABSTRACT

The Bivalvia is an important benthic clade that was relatively less affected than other benthos during the Permian-Triassic biotic crisis, reporting losses of 85%, 64% and 32% at the species, genus and family levels, respectively. Globally, bivalves in occurrence data demonstrate that the initial recovery started in the Griesbachian characterized by relatively high origination and low extinction rates. Thus, unlike other fossil groups, bivalves did not significantly engage in the survival interval. The initial Griesbachian recovery is followed by a stepwise recovery during the Dienerian to Spathian. This, in conjunction with rapid radiation occurred in the Anisian, indicated by extremely high proportional origination and extinction rates. Infraunalization has long been considered the most significant adaptation during the Mesozoic Marine Revolution (MMR), which was thought to have commenced in the Early-Middle Triassic. However, the proportion of infauna in communities remained virtually unchanged before and after the P-Tr biotic crisis; additionally, there was no significant difference in proportional extinction/origination rates between infraunal and epifaunal taxa at the genus and family levels through the entire P-Tr transition, implying the absence of ecological selectivity; a conclusion that differs from previous studies. Therefore, if escalating predation pressure indeed played a crucial role in driving the initial phases of the MMR, infraunalization was not marked prior to the Ladinian. Alternatively, Infaunalization may have played a minor role in facilitating the MMR during the entire era. If so, changes in the physical and chemical environment (‘Court Jester’ model) or amelioration of marine environments in late Triassic, rather than biotic processes (‘Red Queen’ model), may be crucial for the origination and initial phases of the MMR during the early Mesozoic.

THE PATTERNS OF EXTINCTION-RECOVERY

The newly updated global dataset suggests that bivalves suffered a lesser, typically moderate extinction during the PTME. The general picture of global biodiversity shows that bivalves underwent a stepwise decrease in biodiversity through the Changhsinian-Danian interval. The lowest biodiversity occurred in the Danian, implying that extinction might continuously occur through part or all of the Griesbachian, except of PTME. However, bivalves experienced relatively low extinction rates in the Griesbachian, which reduces the possibility of a short extinction event between the Griesbachian and Danian. The lowest biodiversity in the Danian is probably biased by Lazarus effect. The combination of a relatively high biodiversity, high origination rate, and low extinction rate indicates that an initial recovery of low biodiversity occurred in the Griesbachian. Then, this clade experienced a stepwise recovery from the Danian to Spathian. The radiation of bivalves occurred in the Anisian, evidenced by highest biodiversity and high origination rates, coupled with rapid speciation rates. In addition, the faunal compositions greatly change from the Spathian to Anisian.

ECOLOGIC SELECTIVITY

The Ostreida, Trigonida, and Mytilida responded well during the PTME and its aftermath; the richness of them rebounded in the Anisian. In contrast, the Pectinida, Myalini da, and Pholidomidae suffered from the biotic crisis. Bivalves also underwent a switch of dominance in communities from the Pectinida to the Ostreida between the Spathian to Anisian.

TAXONOMIC SELECTIVITY

Our study suggests that the infraunalization did not occur, at least before the Ladinian. Thus, the start of the MMR was probably not driven by biotic processes ('Red Queen' model). Instead, environmental changes (‘Court Jester’ model) may be responsible for the origination and initial evolution of the MMR.

MATERIALS AND METHODS

The Ostreida, Trigonida, and Mytilida responded well during the PTME and its aftermath; the richness of them rebounded in the Anisian. In contrast, the Pectinida, Myalindá, and Pholidomidae suffered from the biotic crisis. Bivalves also underwent a switch of dominance in communities from the Pectinida to the Ostreida between the Spathian to Anisian.

DRIVING FORCE OF THE MMR

The variations of taxonomic richness suggest that any changes in the ecological preferences of bivalves were not obvious before and after PTME. In terms of proportional extinction/origination rates, there is noteworthy that some life modes usually consist a very small number of species, which may bias the selectivity pattern.

Accordingly, all bivalves have been re-categorized into two simple lifestyles: the infauna and epifauna. Surprisingly, no significant difference (P>0.05) is observed between these two groups at the genus and family levels within any time bin from the Changhsinian to Anisian.