Derek Li
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Investigation of Differences in Ecological Impact of the Late Cretaceous and the Triassic-Jurassic Marine Mass Extinctions

Introduction:

There have been five major losses of biodiversity in Phanerozoic time (Raup and Sepkoski, 1982). Among these extinction events, the Late Triassic and Cretaceous extinctions shared similar levels of marine taxonomic loss, 20% and 15% familial loss respectively (Sepkoski, 1982). Despite the similarity in the marine taxonomic diversity loss, these two major extinctions resulted in different ecological effects on marine taxa. In this proposal, my objective is to investigate if the varying ecological impacts imposed by the Late Triassic and Cretaceous marine mass extinctions can be assessed in terms of feeding habits, how living organisms typically obtain food, across the extinction events. The feeding habits I will analyze include filter-feeding, deposit-feeding, and predatory. Here I hypothesize that through quantitative analysis of changes in feeding habits, which is commonly accompanied by extinction events (Hoekskra, 2004), the differences in ecological effect might be represented.

Justification:

Although the Late Cretaceous and Triassic marine extinctions exhibit similar levels of taxonomic extinction, they may have had different ecological effects in marine settings (Droser et al, 2000). If this conjecture is true, along with others' conclusions (McKinney et al, 1998), it would indicate that taxonomic evaluation alone is not enough to protect modern ecosystems because it only represents one of many aspects of a mass extinction. On the other hand, if this study fails to prove that the Late

Triassic and the Late Cretaceous marine mass extinctions imposed varying ecological effects, we cannot simply conclude that the difference did not exist. This result merely reveals that changes in feeding habits may not be appropriately assessed at class level. A higher taxonomic rank such as phylum should be used in future studies to analyze the differences in ecological effect of mass extinctions.

Moreover, this study may prove that analysis of feeding habits is a viable method for measuring differences in ecological impact that result from mass extinctions. Bush et al. (2007) states that functional morphology can usually provide a rather reliable indication of some ecologic properties of fossil taxa. As a result, feeding habits, as an essential variable for understanding how animals live and function in ecosystem, can possibly be a proper indicator that is able to provide some information regarding the ecological impact following a mass extinction event.

While some previous studies stated that survivorship was not linked to feeding mode across the Late Cretaceous extinction (Jablonski and Raup, 1995), other studies came to an opposite conclusion. Smith, Jeffrey (1998), and Hondt (2005) said that feeding habits are actually strongly correlated to survival of the extinction events. Unlike most of previous studies, drawing conclusion by using only one class of marine animals, this study will focus on multiple marine classes. This will not only allow scientists to solve the controversy that presented in the previous researches, but also provide a more overarching conclusion about the correlation between mass extinctions and change in feeding habits across these extinction events.

Research Plan:

Data will be drawn from the Paleobiology Database (www.paelobiodb.org) for all marine taxa by utilizing R. For the purpose of this project, we will mainly focus on three classes of marine animals, Bivalvia, Cephalopoda, and Gastropoda. The reason that these three classes are selected is that they were all present before and after the Late Triassic and the Late Cretaceous mass extinctions and they were relatively more thoroughly studied than other marine classes. This allows us to obtain a more accurate result without having to take into account the sampling bias.

Since the raw data will include information that I am not particularly interested in this project, a series of extra cleaning steps will be conducted until names of animals on species level and number of individuals within each species are only information that is remaining. By utilizing the culled up data, I will be able to investigate the feeding habit of each species via analyzing the trace fossil and functional morphology (Mangano et al., 1998). This investigation will be conducted individually on each species by utilizing literatures and scientific books.

I will then group species based on their feeding habits, such as filter-feeding, deposit-feeding, and predatory (Mangano et al., 1998; Carriker, 1981). After this, proportions of number of individuals within each species across each extinction event will be calculated for all feeding habits. In addition, a mean value of proportions will be calculated for each feeding habit and a cluster column graph for both geological intervals will be created in order to show the overarching trends that how each habit's proportion is influenced by the two major extinction events. Error bars will also be added to show how far from the reported value the true value might be. By doing this, we expect to observe if two error bars of the same feeding habit at different geological intervals overlap. If they do not overlap, it indicates that the difference between two means is statistically significant. In this case, we can conclude that difference in ecological effect of the Late Cretaceous and the Late Triassic marine extinctions caused varying levels of change in feeding habits across the extinction boundaries, and it is a genuine proof that feeding habits can be used to assess the difference in ecological impact resulted from mass extinctions.

References

Bush, A.M., Bambach, R.K., and Daley, G.M., 2007, Changes in theoretical ecospace utilization in marine fossil assemblages between the mid-Paleozoic and late Cenozoic: Paleobiology, 33(1), pp. 76-97.

Carriker, M.R., 1981. Shell penetration and feeding by naticacean and muricacean predatory gastropods: a synthesis: Malacologia 20(2): 403-422.

Droser, M.L., Bottjer, D.J., Sheehan, P.M., McGhee, G.R., 2000, Decoupling of taxonomic and ecologic severity of Phanerozoic marine mass extinctions: Geology, v. 28, pp. 675- 678.

Hoekstra, J.M., Boucher, T.M., Ricketts, T.H., and Roberts, C., 2005, Confronting a biome crisis: global disparities of habitat loss and protection: Ecology Letters, 8: pp. 23–29.

Hondt, S. D., Consequences of the Cretaceous/Paleogene mass extinction for marine ecosystem: Annu. Rev. Ecol. Evol. Syst., 36:295-317.

Jablonski D. and Raup D. M., 1995, Selectivity of End-Cretaceous marine bivalve extinction: Science, Vol. 268.

Mangano, M.J., Buatois, L.A., 1998, Contrasting Behavioral and Feeding Strategies Recorded by Tidal-flat Bivalve Trace Fossils from the Upper Carboniferous of Eastern Kansas; PALAIOS, V. 13, p. 335–351.

McKinney, F.K., Lidgard, S., Sepkoski, J.J., Jr., and Taylor, P.D., 1998, Decoupled temporal patterns of evolution and ecology in two post-Paleozoic clades: Science, v. 281, pp. 807- 809.

Raup, D.M., Sepkoski, J.J., 1982. Mass extinctions in the marine fossil record: Science, 215, pp. 1501–1503.

Sepkoski, J.J., 1982. Mass extinctions in the Phanerozoic oceans: a review: Special Paper - Geological Society of America, 190, pp. 283 – 289.

Smith, A. B. and Jeffery, C. H., 1998, Selectivity of extinction among sea urchins at the end of the Cretaceous period: Nature, Vol. 392.