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Did microplankton „explosions“ trigger the Ordovician Biodiversification Event?

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The Ordovician fossil record shows evidence of the most rapid, long sustained burst of biotic diversification in the history of marine life on Earth (The Great Ordovician Biodiversification Event; Webby et al., 2004). Radiation events during Early and Middle Ordovician caused the tripling of marine biodiversity and the establishment of Palaeozoic and Mesozoic evolutionary faunas which have the greater relevance to present-day biotic communities. The Ordovician ended with a major climatic change, marked by the development of a glaciation centred on the Gondwana supercontinent. The above described ecological changes were associated, throughout the Ordovician, to intense tectonic and volcanic activity and major re-organization of the plate-tectonic global assembly.

Different authors have suggested a direct correlation between the tectonic evolution, volcanism and the Ordovician radiation events. However, as Sepkoski and Sheehan already pointed out in 1983, there it seems to be „no immediately obvious physical trigger for such a great burst of evolutionary activity“ that could have caused the Ordovician biodiversification.

We analyze the relationships between biodiversification patterns observed in marine invertebrates and oceanic microphytoplankton during Ordovician times, with the aim of a . better understanding of the role of primary production in the so-called „Great Ordovician Biodiversification Event“.

The fossil record of oceanic primary producers in the Palaeozoic is largely dominated by acritarchs. In spite of uncertainties regarding their precise biological alliances, acritarchs are currently considered to represent the resting cysts of algal protists; their

morphological and biogeochemical characteristics, and mode of occurrence in the marine sedimentary record are very close to those of the dinoflagellate cysts and to phycomata stages of various chlorophycean algae. However, it is not clear how palaeoecological information derivable from the fossil record of acritarchs can be related to oceanic productivity. The easiest parameter to be quantified, the diversity of the microphytoplankton cysts (acritarchs), cannot be taken directly as a proxy for palaeoproductivity. Abundance of microfossils in the sediments is a complex function of the variables: cyst production, hydrodynamic sorting, and preservation of the organic matter, and gives no direct information on microphytoplankton density in the water column.

However, evidence from the fossil record of consumers seems to indicate that primary production increased strikingly during the Ordovician. Increasing complexity in food webs during Ordovician times is suggested by the following facts: 1) the first appearance and radiation of graptolites, phyllocarids, several groups of echinoderms, of the chitinozoans, as well as the diversification of radiolarians; 2) innovation of planktotrophy in molluscs larvae; 3) the bursts in diversity observed in the great majority of the macroinvertebrate groups; 4) the innovations and increasing complexity within benthic and reef communities on the shelf including filtrating organisms such as sponges, corals, and stromatoporoids.

The observation of major diversification events in all fossil groups implies drastic changes in the basal food chain and a tremendous increase in primary production („plankton explosions“). This major change was presumably the main trigger for the „Great Ordovician Biodiversification Event“.

References

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