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Does environmental stability stimulate species renovation?

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The Tithonian-Berriasian time interval is characterized by a major calcareous nannoplankton speciation episode: several coccolith and nannolith genera and species first appear and rapidly evolve, reaching a high diversity, abundance, and calcification degree.
The history of calcareous nannoplankton indicates that times of accelerated rates of radiations (or extinctions) generally correlate with global changes in the geosphere, hydrosphere and atmosphere suggesting that evolutionary patterns are intimately linked to environmental modifications (Roth, 1989; Bown et al., 2004; Erba, 2006). Nevertheless, the Tithonian-Berriasian interval provides examples of intra- and intergeneric accelerated evolutionary rates (an origination event) during a time period of general environmental stability, in absence of coeval environmental change evidence. The Tithonian - Early Berriasian can be regarded as a "quiet" interval as far as the C cycle is concerned; the _13C curve shows a gradual minor decline after the Oxfordian anomalies and prior to the Valanginian event.
The Tithonian-Berriasian speciation episode provides an excellent opportunity to study modo and tempo of calcareous nannoplankton evolution relative to absent environmental change, which is believed to be instrumental for driving biological evolution. Nannofossils have been investigated in sections from the Tethys and Atlantic oceans in order to discriminate among local, regional or global causes, and to verify possible diachroneity in calcareous phytoplankton evolution and/or in response to global changes. Calcareous nannofossil species richness, first and last occurrences and relative abundance were achieved.

Different evolution modes have been proposed since Darwin's Evolutionary Theory: Phyletic Gradualism (Darwin, 1859), Punctuated Equilibrium (Gould & Eldredge, 1977) and Punctuated Gradualism (Malmgren et al., 1984). Phyletic gradualism holds that new species arise from slow, steady transformation of populations providing gradational fossil series linking separate phylogenetic species. Punctuated gradualism implies long-lasting evolutionary stasis interrupted by rapid, but gradual phyletic transformation without lineage splitting. Punctuated equilibrium explains the appearance of new species by rapid speciation occurring in small peripheral isolated populations, followed by migration to other areas where fossil sequence usually shows a series of sharp morphological breaks. The Tithonian-Berriasian nannoplankton speciation episode is characterized by the first occurrence of several new nannolith genera (Conusphaera, Polycostella, Pseudolithraphidites and Lithraphidites, Nannoconus, Assipetra, Braarudoaphaera and Micrantolithus), few new coccoliths genera (Umbria, Rhagodiscus, Cruciellipsis) and several coccoliths and nannolith new species. Most new species rapidly evolved generating related new species or subspecies, often in a time interval shorter than two millions of years, providing examples of all speciation modes.

The appearance of highly calcified nannoplankton and its evolution in the Tithonian-Berriasian interval were possibly controlled by abiotic factors, such as seawater chemistry (Mg/Ca ratio and pCO2) and temperature (cool climatic episode). On the other hand this speciation episode corresponds to an interval of environmental stability, probably favoring diversification and expansion of calcareous nannoplankton, adapted to oligotrophic oceans.
Nannoliths seem to have experienced all three evolutionary modes, while coccoliths provide examples for only two of them. Evolutionary patterns in the studied interval permit the following considerations: at specific level both nannoliths and coccoliths gradually evolve in time intervals of more that 1 Ma, while at generic level a rapid speciation is most common.

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