Calcareous nannoplankton in greenhouse world: examples of Jurassic & Cretaceous oceans

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The ocean, the oldest and largest ecosystem on Earth, best records global changes in climate and oceanic physical, chemical and trophic parameters. Within the oceanic biosphere, calcareous nannoplankton play a key-role as is abundant from coastal to open ocean settings, has a 220 My-long evolutionary history, is one the most effective calcite producers of the planet, and is extremely sensitive to environmental variations. Our research group has focused on Mesozoic calcareous nannofloras to quantify evolutionary changes, adaptations and reactions to times of greenhouse conditions, In particular, we explored cases of excess CO_2 derived from major volcanic episodes and marked by calcareous nannoplankton changes in evolutionary rates, species richness, abundance, and calcite production.

High-resolution stratigraphy and cyclochronology allow precise dating of biotic and environmental fluctuations, providing the precision necessary for understanding the role of global warming and ocean acidification on nannoplankton biocalcification and evolution. We analyzed the Toarcian OAE, the Aptian OAE1a and the latest Cenomanian OAE2, corresponding to episodes of greenhouse climate under excess pCO_2. The Late Aptian is an intriguing time interval, because although CO_2 was most probably very high, climate was cool.

Calcification decrease and crisis, dwarfism and short-lived abundance peaks of peculiar nannoliths, perhaps representing recurrent alkalinity recovery following CaCO3 dissolution maxima, are consequences of ocean acidification. As far as evolution is concerned, rising pCO_2 triggered false extinctions (Lazarus effect) among calcareous nannoplankton; conversely, major originations perhaps represent a biocalcification strategy to overcome ocean acidification. Calcareous nannoplankton show interesting changes in biodiversity and abundance also during times of apparently stable environmental conditions, such as the late Pliesnbachian, the Aalenian/Bajocian boundary interval, the late Tithonian, the late Albian.

Jurassic and Cretaceous case-histories provide examples of evolutionary patterns and abundance changes in calcareous nannoplankton. Although greenhouse climate and environmental changes have been instrumental for directing nannoplankton evolution, episodes of major innovation occurred during times of ecosystem stability suggesting very successful diversification and adaptations to steady conditions. Contrary to general models, extreme events, such as OAEs, caused calcification crises but no extinctions. Morphotypes associated with these episodes represent "excursion taxa", that is ephemeral adaptations to peculiar oceans.