Abiotic forcing on the Paleogene evolution of the marine protists

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The coccolithophores (calcareous nannoplankton) are marine unicellular protists, which secrete a complex, piece meal exoskeleton surrounding the cell. They are characterized by a complex life cycle in which the haploid and diploid stages represent distinct life strategies, including motile/non-motile capabilities and the production of utterly different coccoliths. The biology and ecology of the living coccolithophores remain poorly known, and the biological/physiological and/or ecological role of the coccoliths has not been resolved, which hampers a comprehensive interpretation of evolutionary dynamics of the group as a whole, and of its discrete lineages. A careful analysis of the structure of coccoliths in some living species has led to the hypothesis that coccoliths may be useful for collecting nutrients and preys, including bacteria and species of the eukaryotic picoplankton.

The role of coccoliths is even more difficult to determine in extinct species for which the coccosphere itself is rarely known. However, temporal analysis of the changes in shape in morphologically convergent lineages allows determination of significant physiological and ecological novelties in these lineages. For instance, it is possible to determine that high productivity associated with the earliest Oligocene ice-build up resulted in the appearance of lineages characterized by flagellate cells bearing hydro-dynamically shaped coccoliths, arising from ancestral lineages of non motile taxa. This strongly indicates the introduction or enhancement of mixotrophic physiology in these lineages. Morphostructural analysis strongly suggests that among the several roles that coccoliths may play, adaptation to food collecting/ active hunting may be prominent. In any case, strong morphological convergence implies major forcing on evolution.

Ecological models are based on the categorization of the coccolithophores as primary producers. On the other hand, the planktonic foraminifera, another prominent group of oceanic calcifiers, are classified as low-level consumers. Yet, inferences from structural and isotopic analysis of tests indicate that the physiology has changed during the Paleocene, from carnivory in all Danian taxa to mixotrophy in the shallow dwelling Thanetian taxa. Capable of harboring photosymbionts, the planktonic foraminifera behave as primary producers, at least temporally, whereas adapted to mixotrophy the coccolithophores behave as low-level consumers. Determination of the forcing agent on the evolutionary dynamics in these two groups must take into account their physiological requirements.