Calcareous nannoplankton: a tool to understand the consequences of ocean acidification

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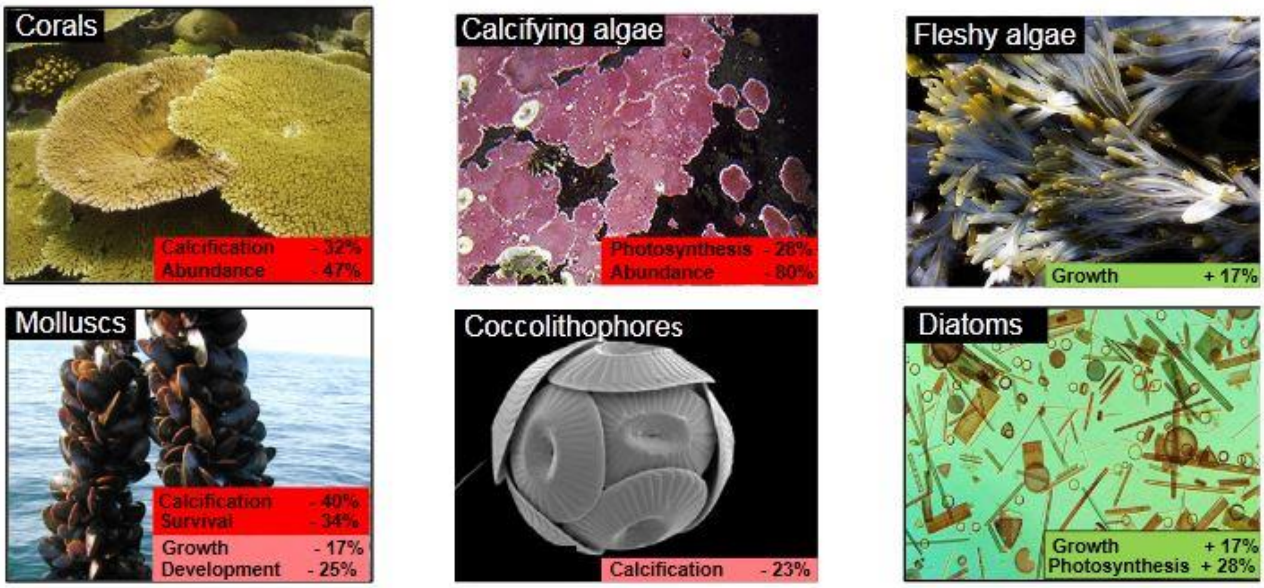
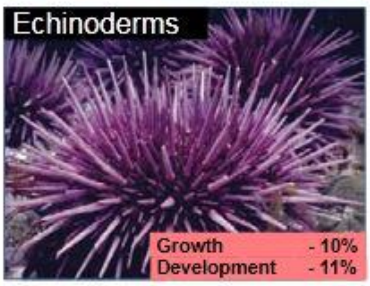
This project will focus on the paleoceanographic evolution of Paleogene oceans. The Paleogene is a time slice of the geological past which is often referred to as one of the most dynamic period of the entire Phanerozoic when the Earth's climate pass from super greenhouse conditions to the present icehouse regime through a series of relatively unknown steps (Zachos et al., 2001; 2008).

The early Paleogene is paved with remarkable climate changes which could have stimulated/forced biotic and abiotic perturbations. During the greenhouse regime, the climate displayed a long-term warming trend interrupted by a number of short-lived hyperthermals which ended with the so-called Early Eocene Climatic Optimum (EECO), a transitory phase characterized by the maximum temperatures of the entire Cenozoic (Zachos et al., 2001; 2008). Since these episodes of extreme warming has thought to be related to massive input of ^{12}C-enriched CO_2 into the ocean-atmosphere pool, they have served as a past analogue of the ongoing CO_2 anthropogenic emission.

At present, there is a considerable concern on physiology, fitness and survival of organisms secreting calcareous tests/skeletons that could in fact be severely affected by the increase in temperature, decrease in surface ocean pH and carbonate saturation (Figure 1). Past analogues recorded in the geological record have been the focus of much research because they are comparable in magnitude to predicted anthropogenic CO_2 release, but they differ significantly as they occurred over longer timescales, 10^5 years rather 10^3 years. This limit does not really change their extraordinary value in giving a much more comprehensive view on the impact and recovery path of the Earth system and biotic communities, as well as potential biotic sensitivity to abrupt climate change. (Aze et al., 2013).





<u>Global Acidification: A Thread to Ocean Life.</u>
Coccolithophores represent an important component of modern oceans and they have played this role since the Late Triassic thus being one of the most powerful tool to reconstruct analogous events occurred in the past and document their reaction/adaptation to pH decrease triggered by CO_2 input into the ocean-atmosphere pool.

Figure 1. (modified from Aze et al., 2013). Summary of the main effects of a decrease of 0.5 pH units on taxa showing greatest sensitivity, based on metadata analysis from 229 experimental studies on living organism. Data are from Kroeker et al. (2013).

Regrettably, the combined effect of multiple climate stressors, such as the increase of CO_2 and temperature or the decrease in oxygen availability, could in fact not result in a simple sum of each single factor, the Earth's dynamic is much more complicated and the final impact could be amplified or reduced as a consequence of complex interactions (e.g., synergism, antagonism). Our present understanding of the fragile equilibria among calcifying organisms in marine ecosystems is incomplete but the fossil record could add pieces of information on how calcareous phytoplankton community responded in the past and will likely react in the future to deep environmental stress.

In this project, we propose to investigate ocean sediments recovered at multiple DSDP/IODP sites covering the entire Eocene (56-34 Ma). We will concentrate on the study of calcareous nannoplankton, a group of algae secreting calcareous skeletons, which is routinely used to construct precise time framework and reconstruct past environmental conditions (2004). Calcareous nannoplankton are unicellular photosynthetic protists representing a major component of oceanic phytoplankton and have played a fundamental role in the inorganic and organic global carbon cycle since Late Triassic. Their fundamental role in the Cenozoic ocean and their response to extreme climate events occurred in the early Eocene could give us clues on the capability of the marine biotic component to react/adapt to stressed physical conditions especially those related carbon biogeochemical cycles.

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