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Planktic foraminiferal photosymbiont bleaching during the Early Eocene Climatic Optimum (Site 1051, northwestern Atlantic)

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The symbiotic relationship with algae is a key strategy adopted by many modern species and by early Paleogene shallow-dwelling planktic foraminifera. The endosymbionts play an important role in foraminiferal calcification, longevity and growth, allowing the host to succeed in oligotrophic environment. We have indirect evidence on the presence and loss of algae photosymbionts because symbionts modify the chemistry of the microenvironment where a foraminifer calcifies, resulting in a characteristic geochemical signature between test size and δ13C. We present here the result of a test on loss of algal photosymbiont (bleaching) in planktic foraminifera from the northwest Atlantic Ocean Drilling Program (ODP) Site 1051 across the Early Eocene Climatic Optimum (EECO), the interval ($\sim$49–53 Ma) when Earth surface temperatures and probably atmospheric pCO_2 reached their Cenozoic maximum. We select this interval because two symbiont-bearing planktic foraminiferal genera Morozovella and Acarinina, that were important calcifiers of the early Paleogene tropical-subtropical oceans, experienced a marked and permanent switch in abundance at the beginning of the EECO, close to the carbon isotope excursion known as J event. Specifically, the relative abundance of Morozovella permanently decreased by at least half, along with a progressive decrease in the number of species. Concomitantly, the genus Acarinina almost doubled its abundance and diversified within the EECO. Many stressors inducing loss of photosymbiosis may have occurred during the long-lasting environmental conditions relating to the EECO extreme warmth, such as high pCO_2 and possible decrease of the surface-water pH. The bleaching may therefore represent a potential mechanism to explain the rapid morozovellid decline at the start of the EECO.
Our geochemical data from Site 1051 demonstrate that there was indeed a reduction of algal-symbiosis in morozovellids at the EECO beginning. This bleaching event occurred at the time of the permanent low-latitude morozovellid collapse in abundance, but it affected also the acarininids that proliferated concomitantly. Foraminifera affected by bleaching are expected to reduce their test-size besides abundance, since endosymbiosis is advantageous in foraminiferal longevity and in providing energy to drive calcification. Our record on the species of Morozovella at Site 1051 shows a significant reduction of the maximum test diameter at the initiation of the EECO, thus supporting bleaching.
The postulated bleaching episode at the start of the EECO was transitory, as photo-symbiotic activity recovered for Morozovella and Acarinina species within the main EECO phase. However, species of Morozovella never recover their maximum diameter test-size, even after having restored the photo-symbiotic relationship. Decrease in planktic foraminiferal test-size can be related to different types of environmental stressors, in addition to the bleaching.
We cannot assign the loss of photo-symbionts to the main cause for morozovellid decline at the EECO onset. Changes in ocean chemistry or interaction with other microplankton groups may have contributed to induce favourable habitat for continued the Acarinina diversification and proliferation during the EECO whereas environmental conditions surpassed a critical threshold for morozovellids. A possible prolonged competition between Morozovella and Acarinina in the mixed-layer for life resources may have resulted in a reduced population for the former.