Faunal dynamics of photosymbiotic planktic foraminifers in the Eocene thermal event

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Planktic foraminifers, which appeared in the middle Jurassic and have been flourished until Recent, have acquired photosymbiotic ecology in its evolutionary history. Some extant species also develop those symbiotic consortia with chrysophytes, dinoflagellates, etc. The photosynthates produced by symbiotic algae provide additional nutrition to host foraminifers, allowing foraminifers inhabit in the oligotrophic open ocean. Not only for the nutrition, but algal photosynthesis also enhances calcification of hosts, indicating that the photosymbiosis is critically important for the evolution of planktic foraminifers. Recently, it is reported from the investigation of modern corals that the symbiosis between algae and calcifiers can be damaged, or even destroyed by the global warming event. The deterioration of photosymbiosis has also been observed in the geological global warming events. Edgar et al. (2013) reported that significant decrease in relative abundance and test sizes of photosymbiotic planktic foraminifers at the hyperthermal event in the Middle Eocene Climatic Optimum (MECO; ~40Ma). While geological thermal events are thought to affect the diversity and abundance of photosymbiotic planktic foraminifers, mechanisms in assemblage dynamics and/or sensitivity to hyperthermal events in each species are still not well known.

In this study, we examined fossil assemblages and accumulation rates (specimens/cm^2/k.y.) of planktic foraminifers to discuss assemblage dynamics of photosymbiotic species in a hyperthermal event occurred in the early Eocene. The samples are recovered by Integrated Ocean Drilling Program Expedition 342, Site U1407 at Southeast Newfoundland Ridge, Atlantic Ocean, and dated at 45–50 Ma. Abrupt decrease in carbonate content from ~80 wt% to ~40 wt% is observed in the middle of the interval analyzed. The decrease in carbonate content is accompanies by sharp decrease in $\delta^{18}O$ of bulk carbonate by 0.6 ‰, indicating the decrease in this carbonate content occurred with warming . It is assumed that this decrease in carbonate content shows shoaling of the carbonate compensation depth (CCD). Additionally, two other warming events have been found prior to the decrease in carbonate content. There were three hyperthermal events within ~1.5 m.y., and the youngest one was accompanied by the shoaling of CCD. At the oldest event, accumulation rate of total planktic foraminifers, including both symbiotic and asymbiotic genera, decreased significantly. Since both mixed layer and thermocline/subthermocline dwellers were depressed, the oldest event represents changes in some sysmtems in the whole water column. The simultaneous decrease in $\delta^{13}C$ of bulk carbonate with $\delta^{18}O$ possibly indicates decrease in primary production. While the accumulation rates of total planktic foraminifers were small and unchanged at the second event, the accumulation rate of *Morozovella* and *Morozovelloides* further decreased down to almost zero (specimen/cm^2/k.y.) at the youngest event. On the other hand, asymbiotic species markedly increased. These observations indicate that photosymbiotic genera are selectively affected by the youngest event, which implies the collapse of photosymbiotic consortia caused by the global warming. In contrast to these two symbiotic genera, the accumulation rate of symbiotic *Acarinina* increased. Considering that *Acarinina* and *Morozovella* inhabited at the same depth within a mixed layer (Pearson et al., 2001), this difference against the hyperthermal event may indicate that *Acarinina* utilized different

algae from that in *Morozovella*, or was less dependent on the photosymbiosis than *Morozovella*.

Keywords: Planktic foraminifer, Photosymbiosis, Eocene, Thermal event, Faunal dynamics

