始新世浮遊性有孔虫殻における安定同位体比の個体発生変化：現世光共生種との比較
Ontogenetic stable isotope records of Eocene planktic foraminifers: Comparison to modern symbiotic species observation

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Many planktic foraminiferal species in the Eocene epoch are thought to have symbiotic algae in their cytoplasm. Detection of photosymbiosis is achieved from ontogenetic isotopic signature; the $\delta^{13}C$ of symbiont-bearing species yields more ^{13}C-enriched values than the asymbiotic species, reflecting selective incorporation of ^{12}C by the symbiont photosynthesis. Because foraminiferal tests grow intermittently by adding a new chamber on the preformed test, each chamber holds information of the symbiont photosynthesis at the time of the chamber calcification. Recently, we have proposed chamber-by-chamber isotope analyses to investigate ontogenetic development of the photosymbiotic relationship. Here, we show the preliminary results of ontogenetic trends of isotopic values of Eocene species, and discuss the profiles from our observational results of cultured modern species.
Three Eocene species recovered by IODP Exp. 342 (U1407) were analyzed to examine ontogenetic isotopic profiles; *Morozovella*, *Acarinina* (symbiotic), and *Subbotina* (asymbiotic). Each individual test was dissected into chambers by using a micro-blade, then analyzed by the customized continuous-flow mass spectrometry system that can measure micro-volume carbonate as small as a single chamber.
The $\delta^{13}C$ values of *Morozovella* and *Acarinina* tended to show the ontogenetic positive shifts until the penultimate chamber. Then the final chamber showed more ^{13}C-depleted $\delta^{13}C$ value drastically by 0.5–1.0 ‰. In contrast to these species, *Subbotina* showed comparatively ^{13}C-depleted $\delta^{13}C$ values whole through its ontogeny. We can say that the progressive ^{13}C-enrichment of the chambers $\delta^{13}C$ with growth, excluding the last chamber, seen in *Morozovella* and *Acarinina* probably reflected the increase of the effect of symbiont photosynthesis. The contrasting relatively constant $\delta^{13}C$ values through ontogeny seen in *Subbotina* is in good agreement with the known asymbiotic nature of this species. The notable thing is that the last chamber of the two symbiotic species showed comparable $\delta^{13}C$ value to that of *Subbotina*. It indicates that the two symbiotic species had already lost their symbionts, or their photosynthesis was not active at the time of the last chamber calcification.
Our recent culture experiments of modern species (*Globigerinoides sacculifer* and *Globigerinella siphonifera*) to investigate symbiont photosynthesis through ontogeny showed that the chlorophyll content of the foraminifers, thus the symbiont content, drastically decreased to almost zero at the time or just before the gametogenesis. It sometimes occurred during the last chamber calcification. These modern observations indicate that the more ^{13}C-depleted $\delta^{13}C$ value in the final chamber in Eocene symbiotic species could reflect the digestion or lysis of symbionts. If so, it can be said that each individual had to acquire the symbionts from the environment at some time during the ontogeny as the modern obligate symbiotic species do.

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