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Taphonomy of fossil seepage assemblages for ethological study cruise linking between paleontologists and biologists

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Chemosynthetic communities changed its taxonomical composition during the late Cretaceous to early Cenozoic period, but its cause and background are not clear at present. Some paleontologists reviewed this issue, mainly paying attention to global-scale events (tectonics, eustacy, and climatic changes) controlling activities of hydrothermal vents and hydrocarbon seeps. However, such a community revolution needs to be also discussed from ecological and ethological viewpoints. This study presents a taphonomic topic to interpret ethology of seep-bivalves, and make proposals for a future cruise of co-working of paleontologists and biologists.

Significant contrast is recognized in mode of fossil occurrences between vesicomyids and bathymodiolins in the Mid-Miocene Bessho Formation, central Japan. The vesicomyids not only form shell clusters in seep carbonate mounds, but also occurs in the marginal siltstone. Almost all of the shells are large (over 15 cm long). The ratio of conjoined valve is ca. 60-70 %, but most of the shells are open. Some young shells show nesting position in gerontic open dead-valves. In contrast, the bathymodiolin shells form small-clusters restricted in the carbonate mounds. Almost all of the shells are small and immature-sized (less than 2 cm long). The ratio of conjoined valves is extremely high (ca. 90%), and almost all of the valves are closed. The bathymodiolin shells are randomly oriented in matrix-supported condition with muddy rip-up clasts. The immature mussels were transported and rapidly buried by habitat-collapses maybe due to hydraulic explosion. This taphonomic contrast suggests that mobile vesicomyds have advantages over sessile bathymodiolins not only effectively tracing temporal seepages, but also in escaping from small-scaled habitat collapse.

This ethological interpretation should be tested not only by comparison of taphonomic signatures between recent dead assemblages and fossil assemblages, but also by confirming mobility and escape-ability of both bivalves responding to seepage dry-up and rapid burial events. However, the latter is hard because of difficulty in catching animal-responses to such unexpectable events by natural observation.

In order to overcome this problem, keys will be found in the following two approaches. First is sedimentological analysis of recent rapid-burial sediments (mud-flow, small-scale mass sliding, and so on). Push-core sampling of known event-sediments will provide information on the timing and scale of rapid-burial, responses of seep-benthos, and fossilization processes of the alive-burial shells.

Second is in-situ disturbance experiment on living chemosynthetic communities. Artificial dislocation of chemosynthetic bivalves from seepage sites can examine recovery ability of the bivalves (burrowing and straightening of life position, moving and searching seepage), and artificial burial of living bivalves can test their escape-ability quantitatively. Quickness of such biological responses is unknown and expected to be too gradual for submersible observation. Therefore periodical observations will be needed after artificial disturbances as is the case with long-term deep-see observatory station off-Hatsushima Island site.

Findings through these approaches are useful not only for evaluation of mode of fossil occurrences, but also for conservation ecology of seep communities.

Keywords: chemosynthesis, taphonomy, methane seepage, ethology, vesicomyid bivalves, bathymodiolin bivalves