Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

BPT023-01 Room:201B Time:May 22 10:45-11:00

Shell microstructures of Japanese modan solemyids (Bivalvia)

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Molluscan shell is composed of carbonates and traces of organic matrix, and these compo nents make a unit of structure called shell microstructure that is classified according to the criteria such as their form and orientation. It is known that the shell microstructures are similar in the phylogenetically closed taxa (Uozumi and Suzuki, 1981) .

The Solemyidae is known as chemosynthetic bivalve (Fisher, 1990; Distel, 1998; Stewart & Cavanaugh, 2006) and classified into deep sea genus *Acharax* and shallow water genus *Solemya* (Coan et al., 2000). There is no study about shell microstructures of Japanese solemyids (*Solemya pusilla*, *Solemya tagiri*, *Solemya pervernicosa*, *Acharax japonica*, *Acharax johnsoni*). In this study, we describe shell microstructures of five solemyids from Japanese waters by scanning electron microscope (SEM). *S. pusilla*, *S. tagiri* and *S. pervernicosa* possess internal ligament that is the diagnostic character of the genus *Solemya*, and *A. japonica* and *A. johnsoni* possess external one characterizing the genus *Acharax*.

As a result of the SEM observations of each shell, the outer layer of *A. johnsoni* is composed of the unknown shell microstructure. The outer layer of *A. johnsoni* is composed of blocky units of structure (approximately 10um diameter) and units filling a gap between these blocks these consist of granular crystals (approximately 1um diameter). These units are enclosed by complex net-like organic matrix. The inner layer of this species consist of complex crossed lamellar structure (CCL). The other four species have radially elongated simple prismatic structure (RESP; Carter, 1990) that elliptic columns are elongated in a growth direction (i.e. radially) walled by organic matter. In *A.japonica*, granular prisms are arranged in the column that branched toward the outer shell surface. *S. pervernicosa* and *S. tagiri* have S-shaped structural units that consist of granules (approximately 1um diameter) in the outer layer. There are three sub-layers in the structural unit of RESP of *S. pusilla*: the thin layer that made of vertical acicular or granular crystals, the layer that acicular crystals are inclined to shell surface, and the layer of granular crystals. The inner layer of *A. japonica* is composed of lamellar structure and homogeneous structure. Homogeneous structure appears in the inner layer of *S. pusilla*. *S. pervernicosa* and *S. tagiri* have the same microstructure in the outer layer as described above and three layers in their shell. However, the combinations of the microstructures of the middle and inner layers are different. The middle shell layer of *S. pervernicosa* consists of CCL, and the inner layer of them was composed of irregular prismatic structure (ISP). *S. tagiri* has homogeneous structure in the middle layer, and ISP or CCL in the inner layer.

From the result of classification and observation of shell microstructure in five species, there was no consistency in two results. Our further observation of shell microstructure in other solemyid species and gene analysis may reveal this incompatibility.

Keywords: chemosynthetic bivalve, Solemyid, shell microstructure

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BPT023-02 Room:201B Time:May 22 11:00-11:15

Reevaluation of energy source of chemosynthesis-based animals in Okinawa Trough hydrothermal fields

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Hydrothermal activities in the Okinawa Trough maintain large biomass of chemosynthesis-based animals. Large part of such animals rely on thioautotrophic primary production, therefore, it is commonly believed that those animals are supported only by hydrogen sulfide provided from hydrothermal emission. However, the distribution of those animals are not limited nearby hydrothermal vents and are widely spreader around hydrothermal fields. We can not detect notable amount of hydrogen sulfide in the ambient seawater of those animal communities, it means that venting fluids are thoroughly diluted and possibly insufficient for sustaining those community.

The purpose of this study, therefore, is reevaluation of the energy source quantitatively for chemosynthetic primary production for understanding the extent of hydrothermal ecosystem in the Okinawa Trough.

We used isotope geochemical technique to achieve our goal. Seven animal species were collected at the two hydrothermal field, Iheya and Izena areas, using RV/Natsushima and ROV/HyperDolphin during NT10-17 cruise.

The isotopic signatures obtained from the soft body parts of the sample animals suggest that some animals (Solemyid clam, Alvinocaris shrimp, and galatheid crab) assimilate not only hydrothermal sulfide but also bacterial sulfide provided by sulfate-reducing activity. It may suggest importance of methane flux from the subsurface around the hydrothermal field because consortium of sulfate-reducing bacteria and methanotrophic archaea is potential source of hydrogen sulfide for thiotrophic animal community. On the other hand, methanotrophic *Bathymodiolus* mussel obtained from the Izena area have low sulfur isotopic signature, suggesting significant contribution of thioautotrophic production. It may imply that the mussel rely on not only symbiotic production but also suspended organic matter, which mainly produced by thioautotrophic bacteria.

Hydrothermal activity in the Okinawa Trough is characterized by high methane flux because thick sediment cover the area and interaction between the sediment and hydrothermal fluid generate significant amount of methane. The gaseous methane can spread widely rather than hydrogen sulfide dissolved in the hydrothermal fluid, therefore, large flux of methane may be a key factor for extent of chemosysthesis-based animal community in the Okinawa Trough.

Keywords: Okinawa Trough, hydrothermal system, chemosynthesis-based animal, energy source, stable isotope

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BPT023-03 Room:201B Time:May 22 11:15-11:30

Cold-seep ecosystem including deep-sea subsurface infaunal world

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Infaunal animals in the cold-seep environment have not received enough attention so far. The fossil record strongly suggests that the infaunal animals are much more abundant than the epifaunal ones in the cold-seep environments. To reveal more information on the Recent chemosynthesis-based ecosystem concealed beneath the water/sediment interface, a joint cruise of paleontologists, biologists and geochemists using R/V Natsushima and ROV Hyperdolphin has been performed. The cruise, NT10-19 Leg 2, was operated during 24th to 29th, October, 2010, around off Hatsushima Island in the Sagami Bay. We carefully observed surface of the seafloor, took sediment cores (ca. 30 cm for maximum length) by MBARI-corer and sediments by scoop. Furthermore, we obtained biological samples from those sediments by sieving on board, and measured the concentration of total sulfides in pore water squeezed from the sediments. In addition, we produced resin cast of burrows in situ.

The direct observations have shown that the white bacteria mat areas are densely populated by mobile epifaunal provannid gastropods while there are no living mollusc animals in the sediment underlying the mat. The measured concentrations of the sulfides at this location show 6.6 mg-S/l. On the other hand, we found the living infaunal solemyid and thyasirid bivalves in the sediment samples obtained from areas directly adjoining the Calyptogena colony where no living animals on the seafloor were observed. The solemyid and the thyasird bivalves are known to host symbiotic sulfur-oxidizing bacteria. Total sulfide concentrations at this sampling site is 0.8 mg-S/l so basically the same value as observed at the reference site. Detailed observations of the seafloor revealed many burrow holes produced by organisms surrounding the Calyptogena colony. We succeeded to get two resin casts of these burrows. One cast displayed Y-shaped burrow with a living solemyid bivalve, Acharax johnsoni, at its end. No significant change of sulfide concentrations between the site inhabited by solemyids and the reference site strongly suggests that the solemyids obtain the sulfides necessary for their symbiotic bacteria through the burrows which may connect the much deeper, anoxic zone. These preliminary observations have shown a necessity of further investigations of the cold seep subsurface.

Keywords: methane seep ecosystems, infauna, fossil cold-seep assemblages

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In situ burrow casting on the deep sea: an example from the Off Hatsushima cold seep site

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Burrows produced by marine invertebrate animals are quite important for our understanding of benthic ecology. Burrows also affect significant impact on geochemical properties of the marine sediments where their producers live, because they provide seawater into sediments. However, burrow morphology on the deep sea had been unknown to date, although numerous burrows occur on the seafloor. Here we document an experimental in situ burrow casting on the Off Hatsushima cold seep site (1173 m deep) for the first time. Casts were made with polyester resin using the ROV *Hyperdolphin* and the casting device *Anagattinger*. Anastomosing network of the small burrows and Y-shaped burrow of *Acharax johnsoni* were observed. This result indicates that complex and abundant burrow system occur under the deep seafloor. In addition, the burrows might affect subsurface geochemical properties of the sediments in the seep site. Our technique can contribute to deep sea ecology, microbiology, and geology.

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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