Species diversity of vesicomyid bivalves from the middle Miocene seep carbonates in the Bessho Formation, Nagano Prefecture, Japan

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Vesicomyid bivalves have been dominant animals in submarine cold seeps through the Cenozoic age. Although coexistence of two or more vesicomyid species in a modern single seep site is considered to be due to different preferences in sulfide flux, salinity, and water temperature among species (Barry et al., 1997; Watanabe et al., 2013), co-occurrence of two or more vesicomyid species and its cause have rarely been discussed for ancient seeps. The middle Miocene Bessho Formation in Nagano Prefecture, central Japan is composed of slope mudstone deposited at a back-arc basin and contains many seep carbonates in various sizes. Two fossil vesicomyid species, *Adulomya uchimuraensis* and "*Calyptogena*" *akanudaensis*, were previously recorded from the Bessho Formation. This study makes genus reassignment of "*C*". *akanudaensis* and newly reports two vesicomyid species, *Pliocardia* sp. and *Adulomya* sp. and notes that relative abundance of the four vesicomyid species depends on carbonate size. The large seep-carbonate mounds more than 20 m in diameter is characterized by abundant occurrence of *A. uchimuraensis* with rare occurrences of "*C*". *akanudaensis* and *Pliocardia* sp. From the smaller, about 1 m in diameter carbonate body, "*C*". *akanudaensis* dominantly occur in association with *A. uchimuraensis*. The siltstone containing several cm-sized small carbonate concretions yields abundant shells of *Adulomya* sp. in scattered occurrence. The difference of carbonate size suggests that of fluid flux and/or longevity, and the species diversity of vesicomyid clams in the Bessho Formation might be caused by variation of seep activities among sites.

Keywords: Pliocardia, Adulomya, Vesicomyidae, Middle Miocene, Cold seep

Reconstruction of seepage history in the Eocene Poronai Formation, Hokkaido, Japan

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The Eocene Poronai Formation, central Hokkaido, is known to mark the oldest fossil records of vesicomyid bivalves in Japan. This study made an outcrop mapping of lithology, mode of fossils occurrence, and stable isotopic analyses to make clear the seep-habitats in initial stages of vesicomyid diversification through the Cenozoic age.
A series of irregular-shaped seep-carbonate rocks, about 1-2 m in diameter, vertically piled up in the outcrop section of massive siltstone. The carbonate rocks and the surroundings yield abundant shells of chemosynthetic bivalves, *Hubertschenkia ezoensis* and *Conchocele bisecta*. Their modes of fossil occurrences are divided into two types, 1) shell-concentrated lens and 2) sporadic patches and scattering, which alternate each other in the vertical section. The shell-concentrated lenses are mainly recognized in siltstone, whereas the scattering type is encompassed in the carbonate bodies.
It is noteworthy that all the shell-concentrated lenses were associated with calcitic concretions partly containing fluidized texture just below them. The fluidized part consists of mixture of 1) white-colored detrital micrite depleted in $\delta^{13}C$ (–38.05 to -22.91‰), 2) gray-colored micrite not depleted in $\delta^{13}C$ (4.87 to 9.01‰) and 3) black-colored sparitic cements with widely ranging values of $\delta^{13}C$ (-42.09 to 1.88‰). Detail lithological mapping show that such fluidized texture tends to be formed avoiding shell-rich part. These suggest that the alternating pattern of two modes of fossil occurrences was controlled by intermittent fluidizing events as follows. Sporadic biofacies was formed under the diffusive phase resulting in gradual rise of pore-water pressure. Over the critical point of pore-water pressure, fluidization was triggered in unconsolidated parts not rich in buried shell remains, which acted as a nucleus of precursor concretions. Such local fluidization caused a focused flow fostering shell-concentrated mode.

Keywords: chemosynthetic, Vesicomyidae, methane seepage, Poronai Formation, Eocene

Succession of whale-fall ecosystems at shallow waters: mainly based on one year monitoring of deployed whale carcasses in aquarium tank and natural environments in Tsukumo Bay, Ishikawa, Japan

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A whale carcass which sank into the sea-floor supports unique ecosystem called "whale-fall community" (Smith, 1989, Nature). Some of the communities are supported by microbial activities during degradation of organic matter within the bones. The community is thought to be change in its community structure over time through degradation process of carcass (Smith and Baco, 2003). Those whale-fall communities are well known in deep-sea environments and such schematic faunal succession has been proposed based on research in the deep-sea. Because of technical limitation of observations in the deep-sea, changes of microbial mat hasn't been fully analyzed. In addition, whale-fall community in the shallow waters are also not well known so far.
So, we tried experiments on deployed whale bones in aquarium tank. Fresh sea water continuously flow into the tank. In addition, we put whale-bones at 11 m in depth in Tsukumo Bay, Ishikawa, Japan.
As a result, the whale bones floated within few days after deployment. Many bubbles of gas, probably hydrogen sulfides, gushed out from the bones. A week later, green algae and white giant bacteria appeared on the bones. Two to three weeks after the deployment, the chemosynthetic cilliate (*Zoothamnium niveum*) and Hyalogyrinidae gastropod (*Xenoskenea* sp.) iappearred in the tanks. *X.* sp. grazed on both microbial mats, white bacterial mat and green algal mat. After appearance of those biota, abundance of those changed through a year. The green algae and the gastropods decreased in the winter and flourished in summer. Whale bones deployed in the natural environments, ca. 11 m deep, more than 1.5 years had encrusting animals such as barnacles, and very few area of the bone surface were covered by microbial mats.
We succeed to make a whale-fall community from fresh bone in aquarium tank with continuous supply of fresh sea water. It allow more detailed observations. Based on the observations, the shallow water whale-fall communities including chemosynthetic biota have establish within few weeks.

Keywords: Whale-fall community, ecosystem, reduced environment

Population connectivity of benthic copepods in deep-sea chemosynthetic communities

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Meiobenthos are small (<1mm) benthic animals living on seafloor. Although their considerable diversity in marine environment, only less attention is paid for meiobenthos than macro- and mega-benthos. Copepod is the most abundant crustacean in meiobenthos in deep-sea hydrothermal vent environment, and a copepod family Dirivultidae is one of the most successful vent taxa. However, only little is known about ecology and evolution of dirivultids. In the present study, we examined efficiencies of several DNA extraction methods available for copepods, and estimate population connectivity of dirivultid copepods of the genus *Stygiopontius* in the western Pacific hydrothermal vent fields. DNA extraction efficiency was increased when the morphology of copepod was destructed. However, even the DNA extraction with the lowest concentration (~5ng/μL) was sufficient to obtain sequence data by Sanger sequencer. Genetic diversities of *Stygiopontius* copepods were different among oceanographic regions, higher in back-arc basins in the southern Pacific than in volcanic arc. In both regions, local populations were not significantly separated genetically based on partial mtCOI sequence. The present result contributes to our knowledge of ecology of meiobenthos, and establishment of environmental assessment tool using meiobenthos in deep-sea hydrothermal vent fields.

Keywords: hydrothermal vent, environmental assessment, meiobenthos

Evaluation of nutrient sources of the biological community in the Shinkai Seep Field, Southern Mariana Forearc using C, N and S stable isotopes

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The Shinkai Seep Field (SSF), located in the inner trench slope of the southern Mariana Trench, ~80 km northeast of the Challenger Deep, is a serpentinite-hosted chemosynthesis-based community composed mainly of *Calyptogena* bivalves. It has been considered that the community is supported by the following mechanism; serpentinization of mantle peridotite produces CH_4-rich fluids, and anaerobic oxidation of CH_4 by sulfate-reducing bacteria (SRB) generates H_2S. Then, sulfide-oxidizing bacteria (SOB) oxidize the H_2S in order to obtain energy and produce organic matter (Ohara et al., 2012). However, there have been no geochemical studies on the energy and nutrient sources supporting this community. Therefore, the purpose of this study is to elucidate nutrient sources of the community in SSF using C, N, and S isotope analyses.

Nine animal species and particulate organic matter (POM) obtained around the colony and sediments obtained beneath the colony by *Shinkai* 6500 during YK13-08 cruise were analyzed. The animal samples were used to measure C, N, and S isotopes of their soft tissues, and the POM and sediment samples were measured total organic carbon (TOC) and total nitrogen (TN) and their isotope ratios. Acid volatile sulfide (AVS) was extracted from the sediment samples to measure its concentration and sulfur isotopic ratio.

TOC and AVS concentration increased with decreases in their isotopic ratios, suggesting that SOB produces organic matter using H_2S derived from SRB activity in sediment beneath the colony. Because isotopic ratios of POM are within the range of the common marine phytoplankton, it is thought that the POM was produced within the phobic zone by photosynthesis.

$\delta^{13}C$ value of *Calyptogena* bivalves within the range of a typical chemosynthesis-based animals relying on SOB for a nutrient source, while $\delta^{34}S$ value is approximately equal to that of AVS in the sediment. Thus, the energy source supporting the bivalves is H_2S derived from SRB activity. Also, isotopic composition of the amphipod, polychaete, and anthozoan samples show intermediate values between the POM and sedimentary organic matter, suggesting that the nutrient sources of these organisms are organic matter derived from both photosynthetic and chemosynthetic productions. The sibogrinid has clearly different isotope composition, implying that this organism relies on SOB using the different carbon fixation pathway and/or methanotroph as nutrient sources.

Keywords: isotopic composition

