Bacterial ecosystem of bivalves at the hydrothermal vent inferred from carbon and hydrogen isotope ratios of biomarkers

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Various faunal activities have been observed around hydrothermal vents on the deep-sea floor. The faunal activities depend primarily on organic matter produced by chemoautotrophs such as sulfur-oxidizing bacteria or methane-oxidizing bacteria as primary producers. So far a lot of isotope studies including C, S and N have been carried out for the bulk tissues of fauna harboring symbionts to elucidate the bacterial metabolism and their ecosystems at hydrothermal vents. However, the bulk isotope studies have an overprint signal of fauna and bacteria. In this study, we determined carbon and hydrogen isotopic compositions of biomarkers including fatty acids and diploptene from mussels at three hydrothemal vent sites in the Pacific Ocean in order to clarify their bacterial ecosystems, as a part of the Archaean Park Project supported by the Special Coordination Fund.

Two Bathymodiolus platifrons and one Bathymodiolus septemdierum were examined from the Yonaguni No. 4 Seamount and the Hatoma Seamount hydrothermal vent sites in the western Okinawa, and from Suiyo Seamount hydrothermal vent site in the Ogasawara, respectively. Diploptene is found only from B. platifrons, but not detected at all from Suiyo Seamount. The presence or absence of diploptene clearly indicates that B. platifrons has methanotrophic bacterial endosymbiont in the tissue, while B. septemdierum harboring no methanotrophic bacteria. This result is consistent with a previous study (Fujiwara et al., 2000) that B. platifrons had methanotrophic bacterial endosymbiont in the tissue, while B. septemdierum harboring thiotrophic endosymbionts. The delta13C value of diploptene is -62.8 per mil (vs. PDB) for Yonaguni mussel and -34.7 per mil for Hatoma mussel, which values are inferred from carbon isotopic composition of CH4 assimilation.

On the other hand, molecular abundance of saturated fatty acids ranging from C16 to C20 is quite similar among the three Bathymodiolus, which suggest that these saturated fatty acids are from mussel itself. Unsaturated fatty acids are more abundant than saturated fatty acids. The molecular composition of unsaturated fatty acids is a little variable among the three mussels, although C16:1n9 is the most abundant in every specimen. The fatty acids of Hatoma and Suiyo mussels are more depleted in 13C by up to ~7 per mil than the corresponding bulk tissue. In contrast, all fatty acids from Yonaguni gill are enriched in 13C relative to the gill bulk tissue. The delta13C values of fatty acids indicate an incorporation of organic matter by the filter feeding of Yonaguni mussel.

A delta13C-deltaD two-dimensional plot shows a positive correlation between delta13C and deltaD values using all isotopic data except Yonaguni mussel. The isotopic covariance with the DeltaD/Delta13C slope ~12 may indicate a mass-dependent isotope fractionation during lipid synthesis in an ecosystem. Compound-specific carbon and hydrogen analyses are useful means to evaluate bacterial ecosystems at hydrothermal vents.