

Shell microstructures of vent and seep pectinodontid limpets exhibiting intraspecific variations in shell morphology

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Chemosynthesis-based ecosystems play a special role as the home to numerous unique molluscan taxa, and their evolutionary histories are intriguing research topics. In this context, it has always been problematic that there are insufficient data for revealing the true phyletic relationships between extant and extinct taxa. For example, gastropods often show intraspecific variation in phenotypes among different habitats. In limpets, the morphology has been shown to be determined by a variety of substrata, including rock, algae, and shells of other molluscs. In the light of this, special attention should be paid to the systematics of fossil gastropods with regards to the selection of reliable morphological characteristics. Molluscan shells are composed of complex structural units termed shell microstructures and demonstrate a great variety of microstructures which are similar among phylogenetically close taxa. Shell microstructure has long been studied, chiefly in paleontology, because it is potentially preserved in fossils and provides a clue for the inference of evolution and phylogeny of extinct taxa. Recently, the authors carried out molecular phylogenetic analyses of seven pectinodontid limpets species in two genera, *Bathyacmaea* and *Serradonta*, commonly associated with vent and seep environments in the west Pacific. Instead of revealing distinct lineages corresponding to morphological identification, the analyses showed that all individuals from both genera were mixed in a single nested monophyletic clade, except for one undescribed species from the South Chamorro Seamount. This result strongly implies that most previously recognized 'species' in fact belong to one species that is highly morphologically plastic in shell form, and thus a good example for testing the usefulness of shell microstructure as an alternative for their systematics. The same seven 'species' were used for scanning electron microscopy (SEM), which revealed that all but one 'species' share the irregular spherulitic prismatic structure type-A (ISP type-A) in the outermost layer, as well as having alternation layers of semi-foliated and crossed lamellar (CL) structures under the outermost layer. Only the population from the South Chamorro Seamount had a simple three-layered shell composition, consisting of ISP type-A, semi-foliated and CL structures. This result is consistent with the molecular analysis and suggests that microstructural composition is under phylogenetic constraints in pectinodontids. On the other hand, the number of alternation layers and the thickness of each layer varied among specimens, which implies that their shell microstructures also exhibit minor phenotype changes, probably related to habitat conditions. In this study, we will also investigate the systematic position of extinct species, using two fossil specimens from a Cretaceous cold-seep in northern Hokkaido.

Keywords: shell microstructure, chemosynthesis-based ecosystem, intraspecific variation