Skeleton microstructures of aposymbiotic scleractinian coral cultured in seawater with various Mg/Ca ratios

*Satoko Motai[1], Naotaka Tomioka[1], Jun Kawano[2], Saki Harii[3], Takaya Nagai[2], Tsuyoshi Watanabe[2], Yu Kodama[4], Motoo Ito[1]

1. Japan Agency for Marine-Earth and Technology, 2. Hokkaido University, 3. University of the Ryukyus, 4. Marine Works Japan

Skeletons of present-day reef-building scleractinian corals consist of aragonite which is one of polymorphs of calcium carbonate. Meanwhile, in the Late Cretaceous, scleractinian corals with two different skeletal mineralogies of aragonite and calcite have been identified (Stolarski et al., 2007; Janiszewska et al., 2017). Although a Cretaceous seawater Mg/Ca molar ratio (*m*Mg/Ca), which affects polymorph selection, of ~1 is a possible reason as to why corals formed calcitic skeletons, previous studies have shown that aragonite was still a major phase in modern symbiotic coral skeletons in a pseudo-Cretaceous sea (Reis et al., 2006; Higuchi et al., 2014). There should be other factors to explanation for the existence of calcite skeletons in such a sea. Our previous work (Motai et al., 2017) has reported that corals form calcite skeleton without a symbiotic relationship between the coral host and zooxanthellae in a pseudo-Cretaceous sea with *m*Mg/Ca ratios of ~1.

Juveniles of modern scleractinian corals (*Acropora* spp.) were cultured without symbionts (Motai et al., 2017). At approximately 26 °C, aposymbiotic corals formed entirely aragonite skeleton in the present sea with an *m*Mg/Ca ratio of ~5, whereas aposymbiotic corals formed entirely calcite skeleton in a pseudo-Cretaceous sea with an *m*Mg/Ca ratio of <1. Both aragonite and calcite skeletons have typical structures same as skeleton of symbiotic consisted of basal plates, septa, costae, and walls, in sub-millimeter scale under an optical microscope. To retrieve the effectiveness of different mineral phases on coral skeletal morphology in more fine scale, we have carried out textural observation utilizing a scanning electron microscopy for μm-scale area and a transmission electron microscopy for sub-μm scale area.

The aragonite skeleton consists of granular and needle-like grains less than ~1 μm. The needle-like grains are radially oriented from aggregates of granular grains. The similar microstructures are previously observed in skeletons of symbiotic coral. The components of granular and needle-like grains are called as centers of calcification (COCs) and fibers, respectively. On the other hand, calcite skeleton consists of needle-like grains with larger than ~2 μm in length and shows neither COCs nor fibers components. The difference in grain size and shape between aragonite and calcite skeletons affects their surface morphology: regular shingled thickening deposits with the width ~10 μm appear in aragonite skeletons, whereas no such morphologies are observed in calcite skeletons. Nevertheless, both of aragonite and calcite skeleton of aposymbiotic corals form similar skeletal structure to symbiotic coral skeletons. Therefore, scleractinian corals may control forming their typical skeletal structures despite of different textures and morphologies caused by different mineral phases.

Stolarski J., Meibom A., Przenioslo R., Mazur M., 2007, Science, 318:92–94
Janiszewska K., Mazur M., Escrig S., Meibom A., Stolarski J., 2017, Geology, 45:319–322
Reis J.B., Stanley S.M., Hardie L.A., 2006, Geology, 34:525–528
Higuchi T., Fujimura H., Yuyama I., Harii S., Agostini S., Oomori T., 2014, PLoS One 9014

Motai S., Kawano J., Harii S., Watanabe T., Nagai T., 2017, JpGU-AGU Joint Meeting

Keywords: reef-building coral, biomineralization, symbiotic algae, aragonite, calcite