Skeletal formation of scleractinian corals in response to Mg/Ca fluctuation

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Although coral skeletons generally comprise aragonite crystals, changes in the molar Mg/Ca ratio (*m*Mg/Ca) in seawater result in the incorporation of calcite crystals (Higuchi et al. 2014, Plos one). Also, we found temperature-dependent aragonite and calcite formation by scleractinian corals in low *m*Mg/Ca seawater (Higuchi et al. 2017, Geology). Corals produced more aragonite than formed in inorganic $CaCO_3$ precipitation experiments under the same conditions, except at 19 °C. Although the aragonite content reflected the results of the abiotic experiments at 19 °C, it is suggested that aragonitic scleractinian corals controlled skeletal formation biologically under low *m*Mg/Ca conditions at higher temperature. The mechanism of formation of aragonite and calcite crystals in coral skeletons was therefore investigated by RNA-seq analysis, using early growth stage calcite (*m*Mg/Ca=0.5) and aragonite (*m*Mg/Ca=5.2)-based corals (Yuyama and Higuchi, submitted). As a result, 1287 genes were up-regulated and 748 down-regulated in calcite-based corals. In particular, 91 skeletogenesis-related genes, such as Collagen alpha and Galaxin, were detected as up-regulated genes and 15, such as Hemicentin, were down-regulated, in low-Mg/Ca conditions. Since the number of down-regulated genes associated with the skeletal organic matrix of aragonite skeletons was much lower than that of up-regulated genes, it is thought that corals actively cause the skeletal organic matrix to construct an aragonite skeleton in low-Mg/Ca conditions. The results also indicated that different types of skeletal organic matrix proteins, extracellular matrix proteins and calcium ion binding proteins changed their expression in both calcite-formed corals and normal corals, suggesting that the composition of these proteins could be a key factor in the selective formation of aragonite or calcite $CaCO_3$.

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