Assessing the roles of coral-algal symbiosis in coral calcification based on culture experiments using symbiont and aposymbiont primary polyps

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Scleractinian corals are well known for their vigorous calcification, enabled by their symbiotic relationship with photosynthesizing zooxanthellae. However, there is little evidence of a direct link between the presence of symbionts and the enhancement of calcification. In this study, we reared symbiotic and aposymbiotic primary polyps from the same coral colony (*Acropora digitifera*) in order to examine the role of symbionts for coral calcification. We cultured the polyps for 10 days at four temperatures (27, 29, 31 and 33˚C) and five salinities (34, 32, 30, 28, 26). Then U/Ca, Mg/Ca and $\delta^{44}Ca$ were analyzed in polyp skeletons as a proxy for pH, organic matrix (OM) and activity of Ca^{2+} channel.

In our experiment, we observed a clear decrease of skeletal U/Ca, but not Mg/Ca, in symbiotic compared with aposymbiotic polyps in both the culture expetiments. These results suggest that OM secretion, the precursor step to $CaCO_3$ precipitation, is controlled mainly by the coral host, without any contribution from zooxanthellae. In contrast, our results imply a higher pH of the calcifying fluid in symbiotic versus aposymbiotic polyps. Isotope fractionations of Ca showed no systematic differences between symbiotic and aposymbiotic polyps and environmental settings, suggesting activities of Ca^{2+} channel is not mainly controlled by the presense of zooxanthellae. Thus, our results demonstrate that the role of coral-algal symbiosis on coral calcification is predominantly to enhance the pH of the calcifying fluid rather than to promote OM secretion and/or activate Ca^{2+} channel.