Phosphate Enrichment Hampers Development of Juvenile Acropora digitifera Coral by Inhibiting Skeleton Formation

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Coral reef degradation resulting from various types of local stress on corals such as excessive nutrient enrichment in and gravel inflow into coastal waters is of an increasing global concern. Because tropical and subtropical seawaters are generally poor in nutrients and thus oligotrophic, these stresses are thought to result in the decline of environments favorable to coral growth. Inorganic phosphates have been especially considered to possibly inhibit the formation of coral skeleton. Despite many studies available on the effects of nutrients on corals, a clear consensus for how nutrients exert deteriorative effects on the corals has not been established satisfactorily. Recently, we found that biogenic polyamines react with carbon dioxide (CO_2) and accelerate an aragonite formation of calcium carbonate ($CaCO_3$) in seawater. In this study, we examined the effects of phosphates and nitrates on *in vitro* aragonite formation of $CaCO_3$ by using biogenic polyamines and *in vivo* aragonite formation of juvenile coral *Acropora digitifera* skeletons, showing that phosphates clearly inhibited both *in vitro* and *in vivo* $CaCO_3$ formations at similar concentrations. In contrast, nitrates inhibited neither *in vitro* aragonite formation of $CaCO_3$ nor *in vivo* aragonite formation of juvenile coral skeletons. These findings indicate that phosphates have a detrimental effect on bioinorganic coral calcification. Furthermore, the findings that phosphate enrichment inhibits coral skeleton formation led us to conclude that enriched phosphate is adsorbed on juvenile coral skeleton surface and inhibits inorganically normal development of juvenile coral skeleton.

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