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Crustose Coralline Algae as Bio-remediator for Coral Reef Ecosystem

Yeong-Shyan Yuen, Takashi Nakamura & Hideo Yamasaki
Graduate School of Engineering and Science, Faculty of Science. University of the Ryukyus

Crustose coralline algae (CCA; Rhodophyta, Corallinales) are ubiquitously found in coral reef ecosystems. Although their contribution to the construction and maintenance of coral reef ecosystems has been documented in many literatures, nutrient dynamics of CCA in oligotrophic environments yet remains as a subject to be explored.

Eutrophication due to runoffs, in general, increases concentrations of nitrate, nitrite and ammonium ions in seawater, a potential threat to corals that have evolved and adapted to oligotrophic environment. In contrast to frondose macroalgae and turf microalgae, CCA do not bloom or outgrow other benthic organisms in eutrophic conditions. In addition, CCA and its substrate provide an environment for a wide variety of endolithic communities that play a potential role in the uptake of nitrogen compounds. Thus, we hypothesized that CCA play a significant role as a bio-remediator to keep oligotrophic conditions in coral reef ecosystem.

Here, we report the uptake activity for ammonium ions (NH_4^+) and its uptake kinetics in CCA. Laboratory experiments showed that NH_4^+-uptake by CCA followed the first-order kinetics under both light and dark conditions. In a short term experiment (12 hours), the average half-decay time ($t_{1/2}$) of supplemental NH_4^+ was 8.48 ± 0.95 h under light conditions. In contrast, the value of $t_{1/2}$ was much higher under dark conditions (14.26 ± 3.65 h). We further examined the NH_4^+ removal capability of CCA by a consecutive supplementation of NH_4^+ into seawater at 0, 24 and 48 hours. The results showed no substantial difference in $t_{1/2}$ for the decay of NH_4^+concentration under light conditions. On the contrary, an increment of 1.5 fold in the $t_{1/2}$ was observed in every NH_4^+ supplementation under dark conditions. These discrepancies suggest that CCA employs different mechanisms of ammonium uptake under light and dark conditions. We consider that photosynthesis stimulates the NH_4^+-uptake due to nitrogen assimilation activity in CCA under light conditions.

These results suggest that CCA are capable of thriving under elevated nutrient conditions. Their abilities in ammonium uptake at high concentration, without outgrowing other organisms, offer us to consider them as a bio-remediator in eutrophication.