Spatial and Temporal Distribution and Composition of Nutrients, Microalgae and CDOM in Shiraho Reef, Ishigaki Island

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Shiraho Reef (Ishigaki Island, Okinawa, Japan) has been subjected to various pressures including sedimentation and nutrient enrichment. These can have serious adverse effects on the coral ecosystem including decrease in coral cover, phase shift (i.e. algal dominance), and enhancement of coral diseases. Increased nutrient levels generally increase microalgal concentrations, which can potentially lead to further growth of macroalgae, thereby underscoring the need to investigate microalgal response to nutrient loadings in more detail. Moreover, little is known about the composition of phytoplankton in Shiraho Reef. In this study, the distribution of nutrients and microalgae was assessed in order to gain insights on the interplay of various biogeochemical processes occurring in the reef. The coupling between reef waters and open ocean waters in terms of exchange of nutrients and microalgae was elucidated as well. Field surveys were conducted in 2005 and 2006 to measure various nutrients forms and phytoplankton concentrations throughout the reef area. Class-differentiated phytoplankton distributions were obtained using a submersible spectrofluorometer (bbe FluoroProbe), which also measures relative amounts of colored dissolved organic matter (CDOM). Profiles of other water quality parameters (e.g. turbidity, salinity, pH, DO) were simultaneously obtained using an STD-type sensor. Sediment and nutrient discharge from Todoroki River were monitored using a turbidity meter and an in situ nutrient analyzer (MicroLAB) for nitrate and phosphate. Prior to typhoon, nutrient concentrations near the river mouth and southern part of the reef were comparable. Based on monitoring data, Todoroki River discharged significant amounts of nutrients, particularly phosphate and nitrate during strong rainfall events resulting in relatively higher nutrient levels in areas close to the river mouth. This resulted in a general increase in total chl-a level (e.g. up to 4 times) along with a noticeable increase in blue-green and cryptophyta contribution after the typhoon, particularly in areas where diatoms and green algae previously dominated and notable increase in nitrate and phosphate levels have been observed. The proportion of bluegreen microalgae further increased a few days later, accounting for as much as 80% of the total chl-a. Increased silicate concentration promotes increase in diatom contribution to total chl-a. In certain occasions, chl-a concentration is higher outside the reef flat, primarily due to low nutrient levels inside the reef and mixing in the outer reef as indicated by the uniform vertical profiles of phytoplankton and other water quality parameters. During periods of no mixing, chl-a increases at least until measurement depth of around 20 meters. In both cases, diatoms and green microalgae dominate outside the reef with bluegreen and cryptophyta at close to zero levels. CDOM concentration (in relative units) in the reef is considerably much higher than that outside the reef. CDOM levels generally increased throughout the reef after a typhoon or heavy rains due to river runoff. In conclusion, nutrient levels not only controls phytoplankton abundance but also influences its composition. At low nutrient conditions, green microalgae and diatoms dominate, however as nutrient levels increase, the contribution of bluegreen and cryptophyta becomes greater.