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Use of the isotope ratio of dissolved inorganic carbon for investigating the carbon cycle of coral reef ecosystems

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The isotopic composition of dissolved inorganic carbon ($d^{13}C_{DIC}$) has been determined for reef waters collected at subtropical coral reefs of Ishigaki Island, western North Pacific. Short-term (6 - 24 h) observation has been conducted several times at several different communities in summer (September) and winter (January). $d^{13}C_{DIC}$ varied between -0.2 and +3.2 per mil (vs. VPDB). Temporal pattern of $d^{13}C_{DIC}$ was significantly different between winter and summer, with the diurnal variation being much larger in summer. Both the concentration of DIC (c_{DIC}) and the alkalinity (A_T) decreased while the $d^{13}C_{DIC}$ increased during daytime due to active uptake by photosynthesis and calcification of reef primary producers. The opposite temporal pattern was observed at night. The gradient of the c_{DIC}-$d^{13}C_{DIC}$ regression line was almost same for different coral communities and seagrass beds. However, the gradient of the A_T-$d^{13}C_{DIC}$ regression line was somewhat larger for seagrass beds and *Heliopora*-dominated communities than for branching coral-dominated communities, possibly reflecting difference in the isotope fractionation by photosynthetic uptake of DIC. The $d^{13}C_{DIC}$ at a given c_{DIC} or A_T was constantly lower for the seagrass beds than the coral communities, which could be ascribed to the addition of groundwater DIC to the seawater of nearshore seagrass beds. The overall results suggested that, by carefully correcting for the difference in the isotope fractionation during uptake processes and incorporating into an appropriate numerical model, the c_{DIC}-A_T-$d^{13}C_{DIC}$ systematics can be used for simultaneous quantitative evaluation of the magnitudes of photosynthesis, calcification, respiration, and input of exogenous DIC such as groundwater DIC at coral reefs.

Keywords: coral, seagrass, carbon isotope, DIC, isotope fractionation, groundwater