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Coral calcification response to carbonate ion varies with temperature

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Coral reefs are globally under two major stresses, temperature and atmospheric CO_2 increase which lower the pH of the surface ocean. We studied the combined effect of temperature and carbonate chemistry in short ($\sim$1.5 hr.) laboratory experiments on the hermatypic coral *Acropora eurystoma*. The experiments were performed in sealed, temperature-controlled chambers equipped with a temperature probe, pH and Oxygen electrodes. First set of experiments tested the carbonate system variation in constant temperature (24 ºC) as follows: pH changed (7.9-8.5) without changing DIC (dissolved inorganic carbon), DIC was changed keeping pH constant, and DIC varied keeping pCO_2 constant. The rates of calcification (in light and dark incubations) displayed a positive linear dependence on pH and the carbonate ion concentration (CO_3^{2-}), with a slope of 25 percent increase for 0.1 pH unit. Unlike calcification, photosynthesis did not show any trend with pH, pCO_2 and DIC. Study of stable carbon isotopes of the DIC in these incubations suggests photosynthesis enhancement by calcification at high pH probably by proton supply that combines with bicarbonate to produce $CO_{2(aq)}$. A second set of experiments tested the effect of seawater temperature changes (18-30 ºC). In this set of experiments, in addition to *A. eurystoma* the coral *Stylophora pistillata* was also examined. The corals were cultured in continuous stirred flow cells for six weeks and were assayed once or twice a week for their photosynthesis, respiration, and calcification. Calcification and respiration showed an optimum rate in a temperature range of 22-26 ºC. Photosynthesis in *A. eurystoma* showed the same optimum as calcification and respiration, while in *S. pistillata* there were similar rates in the temperature range of 18-26 ºC and a decrease in 30 ºC. Gross photosynthesis to respiration ratio (P_G/R) was negatively correlated with temperature in both coral species. The CO_3^{2-} in the water reservoir was varied artificially during

the experiment and a general positive correlation with calcification was observed at all temperatures. The slope of the linear correlation was highest at the optimum temperatures (22-26 ºC). A third set of experiments tested the combined effect of seawater pH (7.9-8.5) at constant DIC and temperature changes (21-29ºC). Temperature increase caused a decrease in net photosynthesis and an increase in respiration, while pH changes had no affect on these processes. P_G/R decreased in response to increasing temperature in agreement with the previous experiment. Calcification in the light showed an optimum at 24 ºC, while dark calcification was practically not affected by temperature. Light and dark calcification showed a positive correlation with pH changes, and the response of calcification to CO_3^{2-}concentration was temperature dependent, with the maximum sensitivity in the optimal temperature (24 ºC). This result is again in agreement with the log term experiment described above. In conclusion, calcification is much more sensitive to CO_3^{2-} in the optimum temperatures than above or below it while photosynthesis and respiration are sensitive to temperature but not to pH, showing an optimum at 22-26 ºC.