The effect of carbonate chemistry on calcification and photosynthesis in the hermatypic coral Acropora eurystoma

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ABSTRACT: The rise in atmospheric CO_2 has caused significant decrease in sea surface pH and carbonate ion (CO_3^{-2}) concentration. This decrease has a negative effect on calcification in hermatypic corals and other calcifying organisms. We report the results of three laboratory experiments designed specifically to separate the effects of the different carbonate chemistry parameters (pH, CO_3^{-2}, CO_2 [aq], total alkalinity [AT], and total inorganic carbon [CT]) on the calcification, photosynthesis, and respiration of the hermatypic coral Acropora eurystoma. The carbonate system was varied to change pH (7.9-8.5), without changing CT; CT was changed keeping the pH constant, and CT was changed keeping the pCO_2 constant. In all of these experiments, calcification (both light and dark) was positively correlated with CO_3^{-2} concentration, suggesting that the corals are not sensitive to pH or CT but to the CO_3^{-2} concentration. A decrease of ~30% in the CO_3^{-2} concentration (which is equivalent to a decrease of about 0.2 pH units in seawater) caused a calcification decrease of about 50%. These results suggest that calcification in today[]s ocean (pCO_2 = 370 ppm) is lower by ~20% compared with preindustrial time (pCO_2 = 280 ppm). An additional decrease of ~35% is expected if atmospheric CO_2 concentration doubles (pCO_2 = 560 ppm). In all of these experiments, photosynthesis and respiration did not show any significant response to changes in the carbonate chemistry of seawater. Based on this observation, we propose a mechanism by which the photosynthesis of symbionts is enhanced by coral calcification at high pH when CO_2(aq) is low. Overall it seems that photosynthesis and calcification support each other mainly through internal pH regulation, which provides CO_3^{-2} ions for calcification and CO_2(aq) for photosynthesis.