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Physiochemical controls on the rate of coral calcification

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Tropical coral reefs are the ocean's most biodiverse ecosystem, home to over a million species and providing trillions of dollars of ecosystem services each year. All these ecosystem services are dependent upon the 3D framework of the reef that is constructed by hermatypic scleractinian corals. Ocean warming and ocean acidification are causing a wide range of negative impacts on marine organisms and ecosystems, and reef-building corals are no exception. Yet exactly what the future holds for tropical corals and the reefs they support is unclear, in no small part, due to the uncertainty surrounding the mechanisms by which scleractinian corals make their skeletons. Two models of biomineralisation are currently in favour: (i) the biological model that suggests skeleton growth is under tight biological control via the production of amorphous phases and templating organic molecules; and (ii) the physiochemical model that suggests that skeleton growth is primarily controlled by the aragonite saturation state of the seawater-derived calcifying fluid, determined by the coral animal through a number of physiological processes. The two models have contrasting predictions about the future of coral biomineralisation.

Here we test the dominant control on coral calcification using laterally grown skeletons of *Stylophora pistillata* at 22, 26 and 30 ^{o}C. After acclimatisation we sequentially stained the corals with three fluorescent markers throughout a 24-hour period. By confocally imaging the stains in the skeleton in 3D we were able to determine calcification rate in terms of mmol/m^2/hour at each temperature treatment, allowing us to readily compare to inorganic aragonite growth rates. We find that the observed coral calcification rates are an exponential function of temperature in a way that is very similar to inorganic precipitation experiments. We therefore find strong support for the physiochemical model of coral calcification, or at least, that the saturation state of the calcifying fluid and water temperature exert a first order control on the rate of skeleton construction in tropical corals.