Endolithic algae affect modern coral morphology and chemistry

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The skeletons of tropical corals provide an unrivaled archive of the Sea Surface Temperatures (SSTs) prevailing during coral growth. As coral aragonite is a metastable phase, it is prone to undergo diagenetic processes, challenging the application of isotope and trace element proxy approaches. While burial diagenetic processes are in the focus of intensified research, current knowledge about pre-burial factors initiating early diagenesis remains scarce. In the current study we show that endolithic green algae may largely contribute to earliest diagenetic alteration of the primary aragonitic skeleton of tropical corals. Algae metabolic activity not only results in secondary coral porosity due to chemical etching activities into the primary skeleton, but on the contrary also initiates re-precipitation of considerable amounts of secondary aragonite on primary pore space surfaces. In our study, we quantified an average mass transfer from primary to secondary aragonite of 5% within algae bands of coral parts younger than 3 yrs. Bulk analyses in combination with high-resolution element mapping clearly show that the secondary aragonite appeared to be precipitating under abiotic systematics far off coralline proxy calibrations. This results in noticeably shifted Sr/Ca, U/Ca, Mg/Ca, and Li/Mg ratios causing considerable SST artifacts >3°C. In contrast, the $\delta^{18}O$ signal remained conservative and rather unaffected.

As a conceptual model we propose that secondary aragonite formation is potentially aggravated by an active intracellular calcium transport through the algal thallus from the location of dissolution into coral pore spaces. The combined high-resolution structural and multi-proxy approach applied in this study provides a versatile toolbox for detailed bio-signature and early diagenesis identification. This procedure has proven to be highly suitable also for corals growing in extreme environments as microatolls.

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