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Temperature proxy calibration on cultured cold-water coral *Balanophyllia elegans*

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Seawater temperature reconstructions are crucial for tracking climate change and ocean circulation patterns. Trace-element ratios in marine biogenic carbonates serve as important archives of past ocean temperatures, extending records beyond the limits of instrumental observations. However, the reliability of these proxies depends on understanding the environmental and biological mechanisms controlling elemental incorporation into biogenic carbonate, which differs across species. Laboratory culture experiments are a powerful tool for isolating the effect of individual environmental parameters on elemental partitioning, yet they remain rare for cold-water corals. Cold-water corals are particularly valuable as globally distributed and accurately dateable archives, which have potential to provide insight into seawater temperature changes for intermediate and deep water masses. We present the first culture experiment designed to directly assess the effect of temperature on trace-element incorporation in cold-water corals, filling a critical gap in proxy calibration.

Cold-water corals *B. elegans* were cultured for 6 months and 3 weeks under controlled environmental conditions, and with temperature range of 6–15°C. We measured coral extension and trace-element composition of the skeleton accreted during this time using femtosecond Laser Ablation ICP-MS. This high-resolution technique (20 µm spot size) allows for precise measurement of trace elements in the small new skeletal area produced during the culture experiment, and resolves elemental variability associated with skeletal ultrastructures. Notably, ratios of U/Ca, Li/Ca, and Mg/Ca exhibit systematic variability across microstructural domains, likely reflecting the influence of biologically mediated processes on elemental uptake. Of all ratios tested, Li/Mg shows the strongest significant correlation with temperature (R^2= 0.50), followed by Ba/Ca (R^2 = 0.46), Li/Ca (R^2 = 0.40), and Sr/Ca (R^2 = 0.28). Coral extension rate ranges from 0.9 to 1.8 µm/day and correlates with temperature (R^2 = 0.73), though with limited statistical significance (p = 0.15), consistent with the known coupling between temperature and aragonite growth rate. Calculating distribution coefficients and applying a biomineralization model reveal key controls on trace-element incorporation, investigating the interplay of temperature, solution composition, and growth rate. These findings provide the first experimentally constrained calibration of temperature proxies in *B. elegans*, advancing understanding of the Li/Mg proxy and coral biomineralization.