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Strontium/lithium ratios in shells of *Cerastoderma edule* – A potential temperature proxy for brackish environments

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Bivalve shells provide high-resolution records of climate variability. However, the number of suitable proxies to quantify environmental variables is still limited. The most frequently used and well-accepted tool for environmental reconstructions from shell carbonate, $\delta^{18}O_{shell}$, is a dual proxy that simultaneously informs about water temperature and the oxygen isotope signature of the water. Reconstruction of water temperature requires knowledge of $\delta^{18}O_{water}$ and reconstruction of the latter requires knowledge of salinity. Element-to-calcium ratios that are frequently used in other biological carbonates as tools for temperature reconstructions such as Sr/Ca_{shell} or Mg/Ca_{shell} are strongly biologically controlled in bivalves and show only a weak correlation to temperature.

Here, we present Sr/Li_{shell} ratios as a new temperature proxy that can complement $\delta^{18}O_{shell}$-based environmental reconstructions. In seawater, strontium and lithium have long residence times of 1.5Ma and 2Ma, respectively. Furthermore, salinity changes do not appear to affect the incorporation of Sr^{2+} and Li^{+} into the shells. Sr and Li concentrations were determined via LA-ICP-MS (line-scan method) in aragonitic shells of four *Cerastoderma edule* specimens collected alive from the intertidal zone of the North Sea. Geochemical data from the ontogenetic year three (growing season: April – September) were placed in precise temporal context by using tidal growth patterns and then compared to instrumental water temperature and water chemistry data. Sr/Li_{shell} values (15 to 287 mmol/mmol) are significantly above Sr/Li_{water} (1.9 to 3.3 mmol/mmol) suggesting the presence of vital effects. However, all shells revealed similar Sr/Li_{shell} patterns that are strongly negatively correlated to water temperature ($r^2 = 0.65 to 0.74$;p <0.01; $T = -0.056(\pm$0.005) * (Sr/Li_{shell}) [mmol/mmol] + 23.188 ($\pm$0.92)). To test the robustness of the presented proxy, we applied the new paleothermometry equation (Sr/Li_{shell} vs. temperature) to a fourth specimen of *C. edule*. Instrumental temperatures were perfectly resembled with an average absolute difference of 1.9°C. Considering that Sr^{2+} and Li^{+} can substitute Ca^{2+} in the crystal lattice of aragonite, the Sr/Li_{shell} ratio is a measure of which of the two elements is preferably incorporated into the shell. For currently unknown reasons, this ratio seems to be temperature-dependent. At higher water temperature, an increased amount of Li^{+} in incorporated into the shells. Sr/Li_{shell} values may function as a new temperature proxy in bivalves from brackish environments. Future studies are required to test if the Sr/Li_{shell} vs. temperature-relationship remains unchanged through lifetime and if this proxy can be applied to other environments and species.