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Disentangling controls on element impurities of bivalve shells

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Trace and minor elements of bivalve shells can potentially serve as proxies of past environmental change. However, retrieving environmental information from element impurities of bivalve shells remains an extremely challenging task. A central difficulty concerns the fact that extrinsic and intrinsic factors governing the element incorporation are poorly constrained. Within the framework of the ARAMACC project, we aim to decipher the complexity of the incorporation of trace and minor elements into bivalve shells and explore their full potential as proxies of environmental change. More specifically, the following questions were tackled. (1) How are trace and minor elements transported from the ambient environment to the calcifying front? (2) How is their incorporation into the shells affected by environmental and physiological variables?

Our findings lend support to the general assumption that divalent ions (e.g., Cu2+, Mn2+, Zn2+ and Pb2+) share the same transport pathways as Ca2+ because of similar ionic radii and electrochemical properties. However, results obtained for Mg2+, Sr2+ and Ba2+ are particularly interesting as they are at odds with existing hypotheses on the incorporation of these three elements, i.e. intracellular Ca2+ pathways (via Ca2+ channels and Ca2+-ATPase) are likely not responsible for their incorporation.

Despite the existence of strong physiological interference, some encouraging results were found, in particular (1) strong, positive relationships between the Sr, Ba and Mn contents of the shells and concentrations in the ambient water, (2) only minor effects of growth rate (which is closely linked to the rate of crystal growth and hence, kinetics) on the amounts of Na, Sr, Ba and Mn incorporation into the shells.

Overall, our findings demonstrate that environmental and physiological controls on the element incorporation do not have to be mutually exclusive, i.e. if environmental changes outweigh physiological influences, one could still expect that trace and minor elements of bivalve shells serve as promising environmental proxies.