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Mg/Ca within the shell of the bivalve Pecten maximus: A new palaeotemperature proxy and implications for bivalve shell geochemical proxies

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A strong seawater temperature control on marine bivalve shell calcite Mg/Ca has not yet been observed, with physiological effects thought to influence shell elemental composition. In the king scallop Pecten maximus substantial intra-shell small-scale heterogeneity of Mg/Ca has been observed within a single calcite layer, with high and variable Mg/Ca evident in the outermost shell and lower and invariant Mg/Ca in the mid and innermost shell regions. New Mg/Ca data obtained by milling the mid and innermost shell regions from P. maximus specimens grown in a laboratory aquaria under constant seawater temperatures between 10 to 20 °C exhibit a strong relationship between Mg/Ca and temperature: Mg/Ca = 2.56 ($\pm$0.42) + 0.17 ($\pm$0.03) * T, r2 = 0.77, $p < 0.001$, RMSE = 0.38, N = 54. A set of P. maximus specimens (N = 7) cultured in an independent experiment at the constant temperature of ca.18°C was used to evaluate the precision and accuracy of previous equation. Estimated temperatures were on average 0.48 $\pm$1.43°C lower than measured temperatures and the difference between measured and estimated temperatures range from -0.98 to +2.22°C. The incorporation of Mg in the mid and innermost shell regions of the P. maximus shell was primarily controlled by temperature and other physiological and environmental factors (i.e. shell growth rate, Sr/Ca, pH seawater Mg/Ca and salinity) only exerted minor influences on Mg/Ca in these shell regions of P. maximus. The mid and innermost shell regions of P. maximus is so far the most promising bivalve archive of Mg/Ca temperature proxy data. Nevertheless, a valid sclerochronological approach must be developed to circumvent the lack in such regions of the P. maximus shell of any internal bands or growth marks that are commonly used in sclerochronology studies to establish a chronology of shell growth. Furthermore, the use of specific shell regions within shells other than simply milling from the outermost shell surface should be considered when developing geochemical proxies in bivalves.