

Stable carbon and oxygen isotope fractionation in bivalve (*Placopecten magellanicus*) larval aragonite

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Abstract

The relationship between stable isotope composition ($\delta^{13}\text{C}$ and $\delta^{18}\text{O}$) in seawater and in larval shell aragonite of the sea scallop, *Placopecten magellanicus*, was investigated in a controlled experiment to determine whether isotopes in larval shell aragonite can be used as a reliable proxy for environmental conditions. The linear relationship between $\delta^{13}\text{C}_{\text{DIC}}$ and $\delta^{13}\text{C}_{\text{aragonite}}$ ($r^2 = 0.97$, $p < 0.0001$, RMSE = 0.18) was:

$$\delta^{13}\text{C}_{\text{DIC}} = 1.15(\pm 0.05) * \delta^{13}\text{C}_{\text{aragonite}} - 0.85(\pm 0.04)$$

The relationship between $\delta^{13}\text{C}_{\text{DIC}}$ and $\delta^{13}\text{C}_{\text{aragonite}}$ described for *P. magellanicus* resulted in larval shell aragonite that was depleted on average by 1.82‰ (SD = 0.22‰, range = 1.1–2.1‰) from predicted equilibrium values based on the relationship calibrated for inorganic aragonite. The average contribution of metabolic carbon that resulted in this depletion was 5.4% (SD = 0.57%; range = 3.4–7.8%). Stable oxygen isotopes were deposited into the larval shell in equilibrium for most samples, and the linear relationship described by least squares regression between temperature and $\delta^{18}\text{O}_{\text{aragonite}} - \delta^{18}\text{O}_{\text{water}}$ ($r^2 = 0.90$, $p < 0.0001$, RMSE = 0.63) was:

$$T (^{\circ}\text{C}) = 20.0(\pm 0.4) - 4.6(\pm 0.3) * (\delta^{18}\text{O}_{\text{aragonite}} - \delta^{18}\text{O}_{\text{water}})$$

However, larvae reared under “stressful” conditions were depleted from oxygen isotope equilibrium. Further studies are necessary to determine the variable contribution of metabolic carbon to the larval shell in field conditions, the potential effects of growth rate on carbon isotope composition, and the factors influencing oxygen isotope depletion in *P. magellanicus* larval shell before the isotope composition of larval shells can be used to reconstruct $\delta^{13}\text{C}_{\text{DIC}}$ or temperature of the seawater in which the larvae developed.

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1. INTRODUCTION

Stable carbon and oxygen isotope signatures of biogenic calcium carbonate structures are indispensable tools to reconstruct the physical and chemical properties of ancient

and modern seawater. The carbon isotope composition of calcareous skeletons of invertebrates has been used to estimate ocean circulation patterns (Duplessy et al., 1988; Lynch-Steiglitz and Fairbanks, 1994), water column productivity (Woodruff and Savin, 1985), and anthropogenic CO_2 inputs (Beveridge and Shackleton, 1994), while the oxygen isotope composition of biogenic carbonates has been used to reconstruct seawater temperature (Epstein

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