

# Mechanisms to explain the elemental composition of the initial aragonite shell of larval oysters

## Abstract

Calcifying organisms face increasing stress from the changing carbonate chemistry of an acidifying ocean, particularly bivalve larvae that live in upwelling regions of the world, such as the coastal and estuarine waters of Oregon (USA). Arguably the first and most significant developmental hurdle faced by larval oysters is formation of their initial prodissoconch I (PDI) shell, upon which further ontological development depends. We measured the minor metal compositions (Sr/Ca, Mg/Ca) of this aragonitic PDI shell and of post-PDI larval *Crassostrea gigas* shell, as well as the water they were reared in, over ~20 days for a May and an August cohort in 2011, during which time there was no period of carbonate under-saturation. After testing various methods, we successfully isolated the shell from organic tissue using a 5% active chlorine bleach solution. Elemental compositions (Sr, Mg, C, N) of the shells post-treatment showed that shell Sr/Ca ranged from 1.55 to 1.82 mmol/mol; Mg/Ca from 0.60 to 1.11 mmol/mol, similar to the few comparable published data for larval oyster aragonite compositions. We compare these data in light of possible biomineralization mechanisms: an amorphous calcium carbonate (ACC) path, an intercellular path, and a direct-from-seawater path to shell formation via biologically induced inorganic precipitation of aragonite. The last option provides a mechanistic explanation for: (1) the accelerated precipitation rates of biogenic calcification in the absence of a calcifying fluid; (2) consistently elevated precipitation rates at varying ambient-water saturation states; and (3) the

high Ca-selectivity of the early larval calcification despite rapid precipitation rates.

### **Plain Language Summary**

Larval oysters are particularly susceptible to changes in ocean water chemistry thought to result from the increasing concentration of atmospheric carbon dioxide. Here, we use trace element concentrations measured in larval shells and the water in which the larvae were reared in order to investigate how and why the larvae are so sensitive to these small chemical changes in their environment. We suggest that the way in which larval oysters make their shells is inherently prone to these changes in water chemistry, but once past an initial phase of shell growth, the juvenile oysters may become more resilient.

Haley B. A., Hales B., Brunner E. L., Kovalchik K. & Waldbusser G. G., 2018. Mechanisms to explain the elemental composition of the initial aragonite shell of larval oysters. *Geochemistry, Geophysics, Geosystems* 19 (4): 1064–1079. [Article](#) (subscription required).

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