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PRIMARY RESEARCH PAPER

Delineating the role of calcium in shell formation and elemental composition of *Corbicula fluminea* (Bivalvia)

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Abstract Calcium is one of the major constituents of bivalve shells. Other element impurities potentially record physical and chemical changes of the ambient environment during growth. It is commonly assumed that Ca^{2+} and other divalent ions may share the same transport mechanisms because of similar ionic radii and electrochemical properties. However, little effort has been devoted to bolstering this hypothesis. Here, we investigated the effects of Ca^{2+} on shell formation and element composition of the freshwater bivalve, *Corbicula fluminea*. Our results showed that increasing aqueous Ca^{2+} levels from 3 to 6 mM did not facilitate shell production. However, the amounts of Mn, Cu, and Pb incorporated into the shells significantly decreased, indicating the potential competition with Ca^{2+} in the same transport pathways. Furthermore, blocking the Ca^{2+} channels by lanthanum and Verapamil significantly reduced Mn, Cu, Zn, and Pb incorporation into the shells, and Mn/Ca_{shell} and Cu/Ca_{shell} decreased simultaneously when inhibiting the Ca^{2+}-ATPase by ruthenium red. However, the amounts of Mg, Sr, and Ba incorporated into the shells were virtually unaffected, implying that intracellular Ca^{2+} transport mechanisms are not responsible for their incorporation into the shells. These findings help decipher underlying mechanisms responsible for the element partitioning between the ambient water and the shells.

Keywords Bivalve shells · Calcium · Element-to-calcium ratio · Biomineralization

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Introduction

Bivalve shells contain ultra-high-resolution records of environmental change. During growth, physical and chemical changes of the ambient environment are preserved in the shells in the form of variable growth increment widths as well as geochemical and microstructural properties (Schöne, 2013). Using periodic shell growth patterns as a time gauge, environmental proxy data can be placed in a precise temporal context. Furthermore, bivalve mollusks have a broad biogeographic distribution and inhabit a variety of freshwater, brackish and marine habitats (Gosling, 2003), and fossil shells are abundant and often well preserved in sedimentary settings. Therefore, shells of bivalves can serve as an excellent archive of paleoenvironmental change. Since shell growth is highly synchronous among contemporaneous specimens, it is