Morphological and Chemical Characterization of Mineral Concretions in the Freshwater Bivalve *Anodonta cygnea* (Unionidae)

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ABSTRACT The freshwater mussel *Anodonta cygnea* is commonly used as a model organism for biomineralization studies, its peculiar morphofunctional properties also make it an excellent environmental biomonitor. The first detailed on the calcareous concretions from gill and mantle tissue, as well as fluids of the freshwater bivalve *A. cygnea*, supported by histological, scanning, spectrometry, and spectroscopy analyses. Through these analyses, the morphology, structure, and chemical characterization of these biomineral concretions were accomplished. The concretions represent a high percentage of the dry weight of these organisms. In gill tissue, it can reach up to 50% of dry weight prior to reproductive maturity. Analysis of elemental composition of the tissue concretions showed the presence of calcium and phosphate, as main components, associated with other residual elements like iron, manganese, magnesium, and zinc. Concretions are arranged in concentric alternated layers of organic and inorganic matrix. The shape and size of the concretions vary substantially, from very small, less than 1 μm diameter with very regular round structure, found mainly in the mantle tissue, to more than 50 μm length with irregular globular clusters, found predominantly in the gills. The microstructural organization is of a hydroxyapatite polymorphism in the mantle, in contrast to the gills, which exhibit irregular structure and carbonated hydroxyapatite polymorphism. These differences are supported by higher contents of dinitrogen pentoxide, magnesium, and iron in the mantle concretions, but higher contents of manganese and zinc in the gills. Furthermore, the results indicate that the mineral concretion formation in *A. cygnea* is a hemocytes reaction to particle or toxic invasions. A second relevant role, concerns the close involvement of these microspherules on the adult and larval shell calcification. J. Morphol. 000:000–000, 2014.

KEY WORDS: microspherules; immune system; calcification

INTRODUCTION

The mechanisms of solid inorganic mineral formation in living organisms are usually designated as biomineralization phenomenons. A large number of biogenic minerals are known; the most widespread biominerals are: calcium carbonate, calcium phosphate, and silicon dioxide (Lowenstam and Weiner, 1989; Epple, 2003; Bäuerlein, 2004). The highest diversity of functions for calcium carbonate and phosphate deposits are found in invertebrates, such as molluscs and crustaceans (Istin and Kirschner, 1968; Coimbra et al., 1988; Pratoomchat et al., 2002; Ziegler et al., 2007; Lopes-Lima et al., 2010). The first major function of this process is the hardening of a skeleton, as a structure to support muscles and protect against environmental pressures (shell, cuticle; Lowenstam and Weiner, 1989, Simkiss and Wilbur, 1989). Some other skeletal functions are associated with sensing (otoliths, auditory ossicles), and grinding of the food (teeth, grinding apparatus),

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