UNIVERISTY OF CALIFORNIA, SAN DIEGO

Biomechanics, Biochemistry, and Molecular Biology of a Molluscan Scleroprotein Elastomer: Whelk Egg Capsules

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in

Marine Biology

by

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ABSTRACT OF THE DISSERTATION

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Whelk egg capsule biopolymer (WECB) is a well known, but previously ignored protein polymer that some marine snails (Class Gastropoda: Family Buccinidae, The whelks) use to construct their egg capsules. The present dissertation incorporates many fields of study in an attempt to amass an understanding of the potential of WECB as a model system with which to attain a better understanding of structure/function relationships in biopolymers.

Mechanically complex, WECB is a highly elastic material whose overall stress-strain behavior bears some resemblance to that of keratin—a initially high stiffness behavior at low strain followed by a fully-repeatable order of magnitude decrease in stiffness heralded by a region of apparent failure. Cycles of strain through the varying stiffness regimes are fully repeatable. During egg capsule formation by the snail, development of mechanical properties of the WECB occurs in stages, with the long range elasticity developing almost immediately upon entry into the ventral pedal

gland, followed by development of the initial high-stiffness low-strain behavior. In the material, the high-stiffness behavior could be reversibly removed by chemical/thermal treatments. This suggested two levels of stabilization in egg capsules: a covalent non-reducible stabilization and a labile non-covalent stabilization. Assembly of an extracted version of this polymer into a mechanically testable form demonstrated the potential of this material for further sclerotization studies.

Biochemically, it was determined that cysteine residues in the WECB play an important role as a possible ligand for metal ions. Extraction of proteins from sclerotized capsules corroborated partial sequence from a major gene product isoform responsible for the production of this material. Material including this partial signature sequence appears seasonally in their respective glands. In the ventral pedal gland, the location of egg capsule sclerotization, partial sequence was obtained from a potential mediator of egg capsule sclerotization. Further studies should address intra-/interspecific compositions of WECB and could alter cloned gene products to understand the effect on primary protein structure both on the mechanics and self-assembly of WECB.

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