Zoosymposia 2: 329–337 (2009)
www.mapress.com/zoosymposia/

ISSN 1178-9905 (print edition)
ZOOSYMPOSIA
ISSN 1178-9913 (online edition)

Surface analyses of biocements from *Pectinaria gouldii* (Polychaeta: Pectinariidae) and *Phragmatopoma lapidosa* (Polychaeta: Sabellariidae)

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Abstract

Pectinaria gouldii and *Phragmatopoma lapidosa* are marine polychaetes that reside in protective structures built from sand grains bound together using proteinaceous cement secreted from specialized glands. *P. gouldii* constructs a solitary, ice-cream-cone-like structure. The smaller, gregarious *P. lapidosa* forms a large, reef-like mound. This study investigates the physical features of these two polychaete biocements, linking structure and function in two marine environments.

The surface structures of hydrated biocement samples were analyzed using atomic force microscopy (AFM), and the surface structures and composition of dehydrated biocement samples were analyzed using scanning electron microscopy (SEM) and electron dispersive spectroscopy (EDS). Atomic force analyses indicate that (in their native states) the surface roughness, adhesion, and stiffness of *P. gouldii* biocement are greater than *P. lapidosa* biocement. The surface of *P. gouldii* resembled "cottage cheese," while the surface of *P. lapidosa* had smoother features. SEM revealed "popped bubble" features that indicated a solid foam-like material for both biocements. EDS confirmed the presence of calcium, magnesium, and phosphorous in both biocements, with varying amounts of these three elements at different locations on the same sample.

Key words: AFM, EDS, SEM, SPM, force curves, cement, surface roughness, solid foam

Introduction

Pectinaria gouldii (Verrill) and *Phragmatopoma lapidosa* (Kinberg) are small polychaetous annelids found in intertidal and subtidal regions along the Atlantic coastline. The benthic, solitary living *P. gouldii* is also known as a trumpet worm, or ice cream cone worm and can grow to be up to 5 cm in length (Remsen 2007). It uses sand grains to construct its tube, which has an ice cream cone-like structure that is open at both ends. Sand grains are selected by size, then fitted and cemented together in a single layer. The smaller, gregarious *P. lapidosa* form reef-like mounds that can vary in size from a softball to large boulder-like formations that can be part of a network that stretches for miles (Kirtley & Tanner 1968; U.S. Department of the Interior Fish and Wildlife Service 1989). These large structures form reefs that help shelter beaches by absorbing the force of the waves (U.S. Department of the Interior Fish and Wildlife Service 1989). Both polychaetes utilize a type of cement that is secreted from specialized glands to attach sand particles together in order to build their

Accepted by N. Maciolek: 20 Apr. 2009; published: 31 Aug. 2009