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A giant foraminifer that converges to the feeding strategy of carnivorous sponges: *Spiculosiphon oceana* sp. nov. (Foraminifera, Astrorhizida)

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Abstract

The foraminifer *Spiculosiphon oceana* **sp. nov.** is a giant (>4 cm) agglutinated astrorhizid, which makes the second known species of this unusual genus and its first Mediterranean record. It has a peculiar stalked, capitate, monothalamous test. Bleach digestion and X-ray microanalysis indicated the test to be made exclusively of siliceous sponge spicules agglutinated in organic cement. The organism stands on a hollow, 4 cm long, 0.5 cm thick stalk built with highly selected, long and thin spicule fragments, tightly cemented together in parallel to the main axis of the stalk. The proximal end of the stalk is closed and slightly expanded into a bulb-like structure, designed to penetrate between the sand grains and maintaining the test upright while avoiding a permanent attachment to the substratum. The distal stalk end becomes a hollow, globe-like structure that contains the main protoplasm. The globelike region is built with loosely agglutinated and irregularly-shaped spicules, allowing extrusion of the pseudopodia through the cavities between the spicules. The globelike structure also serves as an anchoring basis, from which long and thin, solid tracts protrude radially to make a spherical crown that attains about 4 mm in total diameter. The radiating tracts are built with highly selected aciculate spicule fragments held together with a translucent organic cement. They provide skeletal support for the extension of a crown of pseudopodia into the water column. This arrangement is thought to enhance the chances of the pseudopodia to contact demersal planktonic prey. In summary, S*piculosiphon* species collect and arrange sponge spicules with high selectivity to recreate a body morphology that strongly converges to that of some carnivorous sponges, which allows these predatory foraminifera to exploit a prey capturing strategy similar to that of the carnivorous sponges. This idea is also consistent with our report of an additional, yet undetermined, *Spiculosiphon* species occurring in the same sublittoral Mediterranean cave where carnivorous sponges were first discovered.

Key words: adaptive test, astrorhizid, agglutinated, siliceous test, sponge spicule, benthic foraminifera, silica, tellurium, collagen-like cement, bioturbation

Introduction

Agglutinated foraminifera make a relatively diverse group of organisms, which is taxonomically defined as a subclass (Textulariia) and comprises four orders. The orders are based upon gross morphology, wall structure, and cement composition (Kaminski 2004). The cement that binds the test together may be organic (as in the Astrorhizida), calcareous and canaliculate (as in the Textulariida), or of mixed nature, containing organic, calcareous, and microgranular types (as in the Lituolida and Loftusiida). Some of the agglutinated foraminifera build their test collecting partially or exclusively siliceous sponge spicules from the sea bottom. Although the fossil record clearly indicates that test morphology in the agglutinated foraminifera is species specific and does not vary over large time scales, little is known about the adaptive advantages that select for a particular shape (Bowser *et al.* 1995; Hohenegger 2009; Marszalek *et al.* 1969). Here we report on a new, large astrorhizid species using exclusively organic cement and sponge spicules to build a distinctive test that appears to replicate not only the body shape of carnivorous sponges but also its functionality as feeding strategy.

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