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Deep-sea serpulids (Annelida: Polychaeta) in tetragonal tubes: on a tube convergence path from the Mesozoic to Recent

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Abstract

Serpulids typically build cylindrical calcareous tubes attached to hard substrates. Until now, only three serpulid species inhabiting free-lying polygonal tubes were reported from the deep sea: *Spirodiscus grimaldii* Fauvel, 1909 with quadrangular spirally coiled tubes, *Bathyditrupa hovei* Kupriyanova, 1993a with quadrangular tusk-shaped tubes, and *Ditrupa groenlandica* McIntosh, 1877 with octagonal tusk-shaped tubes. Similar free-lying tubes with tetragonal cross-section, both coiled and tusk-shaped, are described from shallow-water Mesozoic deposits as *Nogrobs* de Montfort, 1808, *Tetraserpula* Parsch, 1956, *Tetraditrupa* Regenhardt, 1961, *Glandifera* Regenhardt, 1961 and *Tubulostium* Stoliczka, 1868. We have revised deep-sea serpulids with tetragonal (and secondary octagonal) tubes and compared their tube ultrastructures and mineralogies with those of morphologically similar fossils. Revision of the Recent material has revealed six species in five genera: *Spirodiscus grimaldii*, *S. groenlandicus* **comb. nov.**, *Bathyditrupa hovei, Bathyvermilia gregrousei* **sp. nov.**, *Hyalopomatus dieteri* **sp. nov.** and *Zibrovermilia zibrowii* **gen. et sp. nov.** Comparisons showed significant ultrastructural and mineralogical differences between Recent and Mesozoic species. Similar tetragonal tube morphology of the Recent forms appears to be a result of convergence due to adaptation to similar soft-sediment habitats of the deep sea. None of Recent genera should be synonymised with any fossil genus, and the genus *Spirodiscus* Fauvel, 1909*,* previously synonymised with fossil *Nogrobs,* should be re-instated. However, a huge stratigraphic gap (66 Myr) between the earliest known fossil tetragonal tubes and their Recent counterparts still allows the possibility that such essentially different structures is a result of ultrastructural evolution, a hypothesis that could be verified by discovery and further study of Caenozoic material.

Key words: Serpulidae, bathyal, abyssal, tube ultrastructures, taxonomy, mineralogy, Jurassic, Cretaceous

Introduction

The diversity of bathyal and abyssal marine organisms is still poorly known and this holds true also for calcareous tube-worms of the polychaete family Serpulidae, a group known as common inhabitants of shallower seas. The serpulid genus *Spirodiscus* Fauvel, 1909 is a good illustration of this statement. Fauvel (1909, 1914) described *Spirodiscus grimaldii* gen. et sp. nov. from lower bathyal depths off the Azores, based on the material from the Prince of Monaco expeditions. The generic name referred to the unusual for serpulids tube, quadrangular in cross-section, unattached, and coiled into a flat spiral (Fig. 1A). The species also had an unusual peduncle—thick, but with pinnules. The very few subsequent records of this mysterious species have been recently summarised by Kupriyanova & Nishi (2011). Simultaneously with *Spirodiscus*, also from lower bathyal depths in the Azores, Fauvel (1909, 1914) collected unnamed empty tubes ("tube de Serpulien") that "like the coiled tubes were quadrangular in cross-section but straight". Almost a century later, Kupriyanova (1993a) described from the abyssal depths of Kuril-Kamchatka Trench *Bathyditrupa hovei* gen. et sp. nov., the species characterised by quadrangular tusk-shaped tubes (Fig. 1B,C) similar to those mentioned by Fauvel (1909). Additional records of *Bathyditrupa hovei* were reported only recently (ten Hove & Kupriyanova 2009; Kupriyanova *et al.* 2011).

Kupriyanova (1993a) had not recognised the similarity between *Spirodiscus grimaldii* and *Bathyditrupa hovei*, however, ten Hove (pers. comm.) proposed that *Bathyditrupa* might be a synonym of *Spirodiscus* based on the characters used in serpulid taxonomy (chaetae, operculum, opercular peduncle) and suggested that tube coiling in

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