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# *HIGGINSIA CICCARESEI* SP. NOV. (PORIFERA: DEMOSPONGIAE) FROM A MARINE CAVE ON THE APULIAN COAST (MEDITERRANEAN SEA)

MAURIZIO PANSINI* AND GIUSEPPE L. PESCE†

*Istituto di Zoologia, Università di Genova, via Balbi 5, I-16126 Genova, Italy.
†Dipartimento di Scienze Ambientali, Università di L'Aquila, via Vetoio – Coppito, I-67010 L'Aquila, Italy

A new species of sponge: *Higginsia ciccaresei* sp. nov. (Demospongiae: Desmoxyidae) is described from a marine cave of the Ionian Apulian coast (Mediterranean Sea). It lives in complete darkness, 250 m from the cave entrance, in a basin of anchialine waters of low salinity and relatively cool temperature. The spicule formation process seems to be affected by some of the peculiar characteristics of the ambient water, resulting in spicules of unusual shape and irregular surface. This is the second record of the genus *Higginsia* – which has a world-wide distribution – from the Mediterranean Sea. The hypothesis that *H. ciccaresei* could be considered as a tethyan relic which survived in the peculiar habitat of an anchialine cave is also suggested.

## INTRODUCTION

Some marine caves constitute peculiar habitats separated from the surrounding coastal ambient by sharp environmental gradients. Edaphic and hydrographic characteristics can create special ambient conditions which may persist over time, offering the opportunity to study sciaphilic and bathyphilous organisms, in a relatively accessible environment. An outstanding example of this occurs in a marine cave on the French Mediterranean coast where Vacelet & Boury-Esnault (1995, 1996), in a permanently cold environment, made the exceptional discovery of a carnivorous sponge devoid of an aquiferous system.

Zinzulusa cave is a partially submerged marine cave excavated in the calcareous rock of southern Apulian coast (Figure 1). The cave has been described by Bottazzi (1923), De Lorentiis (1924) and Lazzari (1958); Ruffo (1955) made a detailed examination of the stygofauna living inside the cave.

A few specimens of the studied sponge occur, at a depth of about 8 m, in the anchialine waters of the 'La Nicchia' room, which is located about 250 m from the cave entrance, in complete darkness. Since the only two discrete specimens have been collected, no data on the density or patchiness of the population are at present available. In this part of the cave a freshwater layer (~1·5 m thick) overlies a layer of brackish water about 11·5 m deep. In August 1996 during the sampling period the surface salinity was 18 psu and gradually increased to 21 psu at the bottom of the

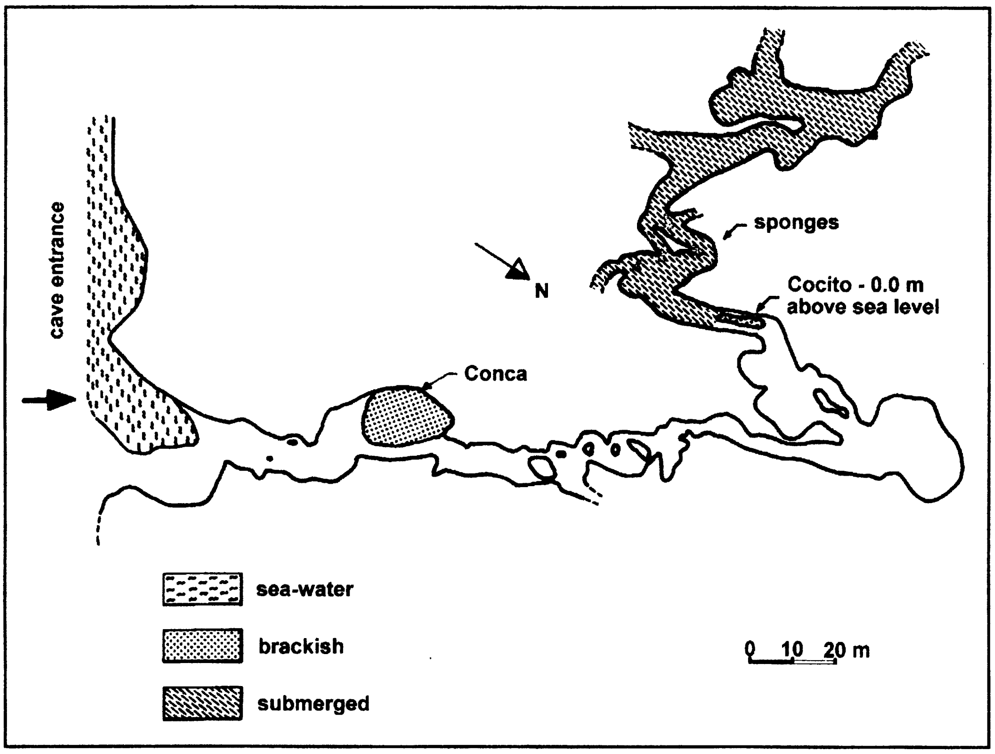


Figure 1. Map of the Zinzulusa cave showing the confined position of the sponge specimens.

basin. The surface water temperature was colder (16·5°C) than that of the underlying layer which rose to 18·9°C. Surface waters outside the cave are at least 6°C warmer in mid summer.

A number of stygobiotic taxa, some with tethyan affinities, have been collected from the same locality, viz annelids, water mites, decapods (*Typhlocaris salentina*, Caroli, 1924), mysids (*Spelaeomysis bottazzii*, Caroli, 1924; *Stygiomysis hydruntina*, Caroli, 1937) and amphipods (*Salentinella gracillima*, Ruffo, 1947); the two latter are new records from the cave. Sixteen demosponge species have been recorded out of the cave, from Zinzulusa Bay, by Pulitzer-Finali (1983). One of them, *Myrmekioderma spelaea* (Pulitzer-Finali, 1983), recorded in cavities under ledges at Zinzulusa Bay, and in other marine caves (Tremiti, Massalubrense) is a true stygobiotic species. No other sponge species have been identified so far from the inner part of the cave.

The present paper describes a new demosponge species from 'La Nicchia' room of Zinzulusa cave.

## MATERIALS AND METHODS

The studied specimens were collected by SCUBA diving by spelaelogists of the following groups: 'Gruppo Speleologico Salentino – P. De Laurentiis', 'Gruppo Speleologico Neretino' and 'Commissione Nazionale Soccorso Speleosub CNSAS'.

Spicule preparations were made by dissolving small fragments of the sponge in 65% nitric acid, both in test-tubes and directly on slides, rinsing with water, dehydrating with 90% ethanol and mounting in Eukitt resin. Tangential and transverse sections cut by hand from medium-dry specimens were mounted in the same resin to study the skeletal architecture. Dissociated spicules were dried directly on stubs, gold sputtered and examined by a Philips 515 SEM.

## SYSTEMATICS

Order HALICHONDRIDA

Family DESMOXYIDAE Hallmann, 1917

Genus *Higginsia* Higgin, 1877

*Higginsia ciccaresei* sp. nov.

### *Material examined*

(1) ZIN1, Zinzulusa Cave, Castro Marina, Ionian Sea, 8 m, 20 September 1996, leg. G. Contessa, holotype deposited at the Museo di Storia Naturale 'G. Doria' of Genova, MSNG 48877.

(2) IN2, same locality as above, 2 August 1996, leg. G. Casolaro, paratype, Porifera collection of the Istituto di Zoologia dell'Università di Genova.

### *Description*

The holotype and paratype are the whole material available for the species description. They are more or less globular in shape, slightly depressed. The holotype is less than 2 cm high and 2·8 cm across, the paratype slightly smaller. A single, roundish, flush oscule, 0·5 mm in diameter, opens at the top of each sponge. The colour *in vivo* is whitish and becomes light beige after fixation. The alcohol preserved specimens are compressible but consistent, not very elastic. They become fragile and very brittle when dry. The surface of the sponge *in vivo* is smooth, not hispid, scattered with conules united by ridges and separated by grooves (Figure 4B). The surface of a dry specimen is rough, due to the presence of the contracted conules (Figure 4A). It is regularly pierced, with remnants of the pore sieves.

*Skeletal arrangement*

Ectosome without specialized spiculation, containing oxeas and microxeas paratangential to the surface. Choanosomal skeleton typically halichondroid with most oxeas disorderly arranged and a few short tracts generally directed outwards (Figure 2). These ill-defined tracts may protrude through the surface. Spongin is

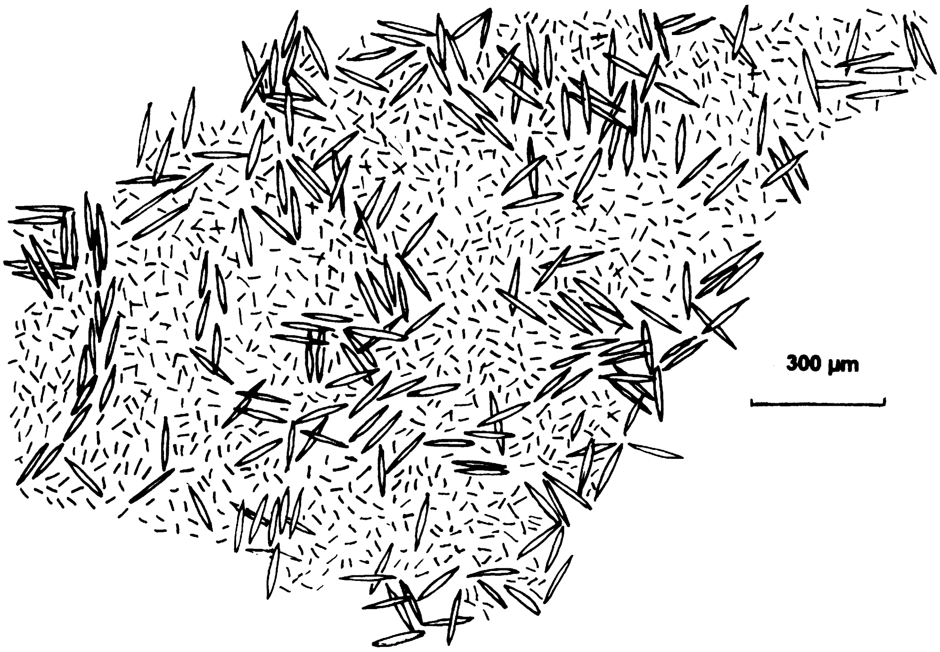


Figure 2. *Higginsia ciccaresei* sp. nov. Choanosomal skeletal arrangement, from a transversal section.

scarce while the interstitial spicules (spiny microxeas, strongyles and spherules) are very abundant. There is no trace of reticulation in the skeleton and any evidence of axial compression is also lacking.

*Spicules*

The megascleres are essentially fusiform oxeas (Figure 4C), mostly straight or gently curved, rarely bent or centrotylote. Ends are pointed and symmetrical, but mucronate and blunt ends are frequent (Figure 3A). Shape abnormalities often occur producing spicules with one or both spicule ends bifid, further divided or with polyaxonic malformations (Figure 3B). Oxeas measure 218–425 μm (mean 323·3 μm) by 22–35 μm (mean 26·9 μm).

Acanthomicroxeas are straight or gently curved, with long, sharp ends and a slightly fusiform shaft (Figure 4E). The short, conical spines are rather uniformly distributed on the spicules which are 45–70 μm long (mean 61·7 μm) and less than 2 μm thick (Figure 4F).

Short, thick strongyles, straight or reniform (Figure 4D), apparently not evolved from oxeas: 65–120×40–60 μm (mean 80·7×47·2 μm).

Spherules, sometimes fused by silica to one another (Figure 4C), measure 45–65 μm in diameter (mean 53·7 μm).

These spherules do not show the normal smooth surface of other spicules (compare the surface of an oxea with that of a sphere at the same magnification, Figure 4G,H), but show a rough, finely perforated surface, suggesting the occurrence of variable

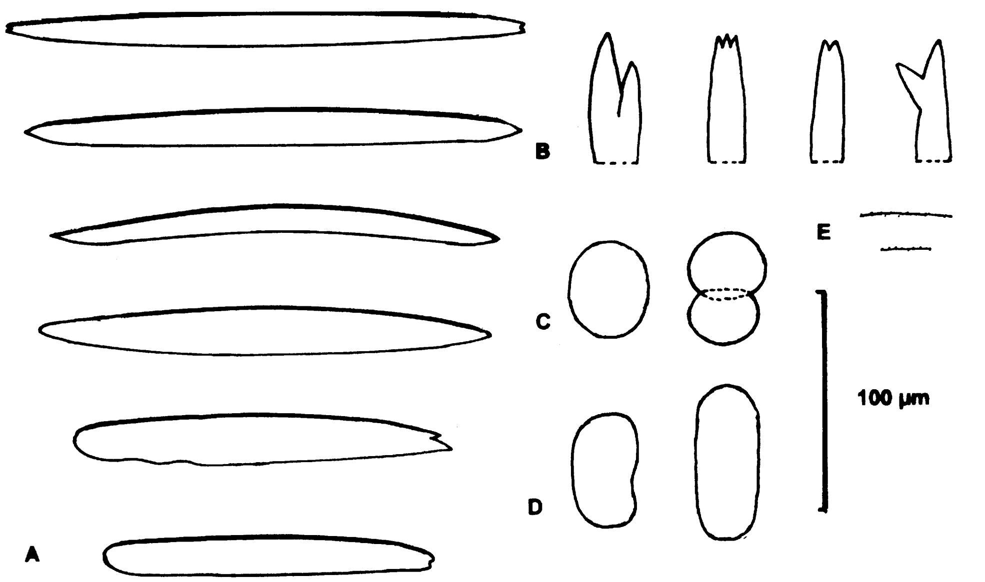


Figure 3. *Higginsia ciccaresei* sp. nov. Spicules: (A) oxeas; (B) oxea ends; (C) spherules; (D) strongyles; (E) acanthomicroxeas.

phases of silica deposition. Therefore these spherules should not be considered to be a permanent skeletal component of the species, but just as abortive spicules or malformed spicules.

*Etymology*

The new species is named after Gaetano Ciccarese in recognition of his valuable contribution to the biological research in the Zinzulusa cave.

## REMARKS

The new species is here attributed to the genus *Higginsia* Higgin, 1877 due to the presence of a halichondroid skeleton with loose, ill-defined and non-reticulated spicule tracts, of a single size category of megascleres protruding through the ectosome, and of typical spiny microxeas as only microscleres. According to Hooper & Lévi (1993), the skeletal pattern of *Higginsia* ranges from an halichondroid extra-axial region with a partially compressed, reticulate axis, to a lax, plumose, halichondroid skeleton without regional differentiation.

The new species described here appears to be close to the taxa having a simple halichondroid choanosomal skeleton with vestigial meandering choanosomal tracts (Hooper & Lévi, 1993). However, these taxa, e.g. *H. lunata* Carter, 1885 and *H. anfractuosa* Hooper & Lévi, 1993, have raphides as a second category of microscleres that *H. ciccaresei* sp. nov. lacks. Among the known species of the genus, erect forms are far more frequent than massive ones. The typical massive

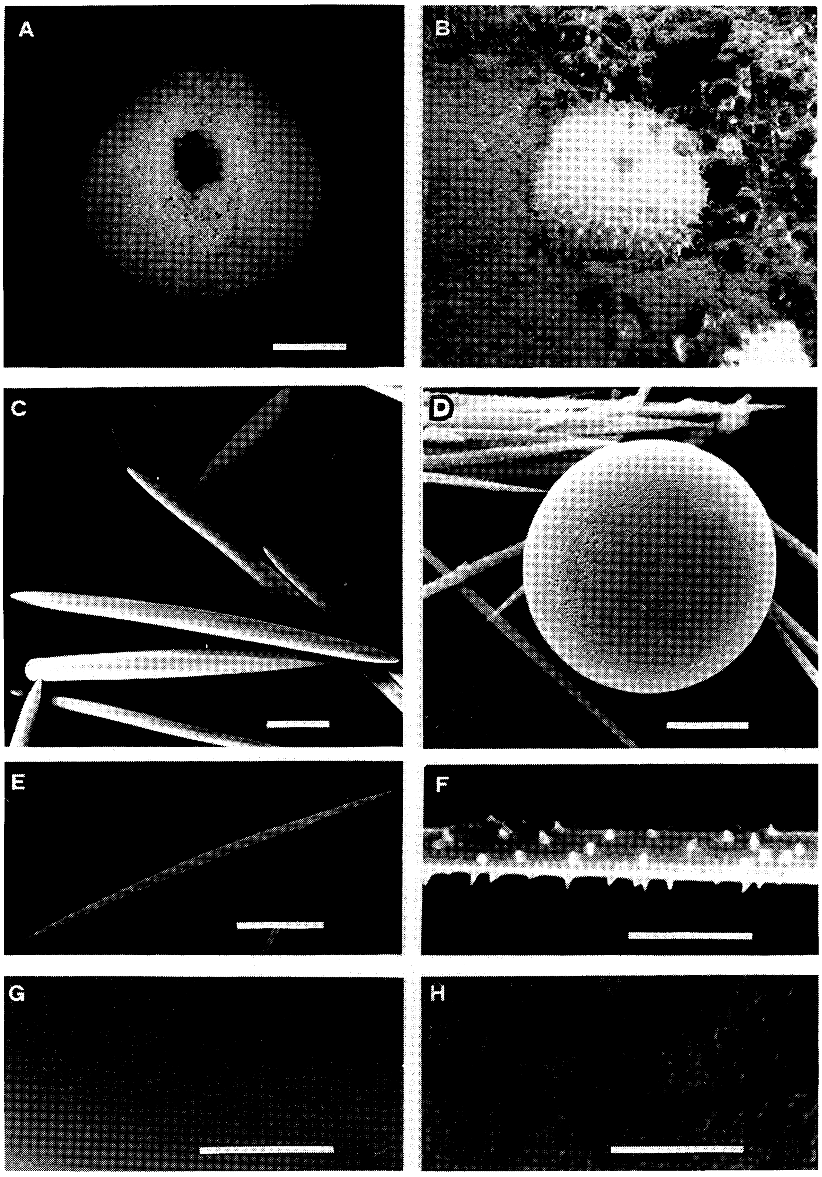


Figure 4. *Higginsia ciccaresei* sp. nov. (A) Holotype; (B) live specimens showing surface conules; (C) oxeas; (D) spherule; (E) acanthomicroxea; (F) detail of a microxea; (G) smooth surface of an oxea; (H) irregular surface of a spherule. Scale bars: A, 2 cm; C, 50 µm; D,E, 20 µm; F–H, 10 µm.

*Higginsia* is globular, slightly compressed, with a round apical oscule and a papillate surface. Among others this shape is shown by *Higginsia thielei* Topsent, 1898, from Ireland, Iceland and the Azores, and by *H. tethyoides* Lévi, 1960 from West Africa. Both differ from *H. ciccaresei* in having larger megascleres that are oxeas and styles instead of just oxeas. *Higginsia petrosioides* Dendy, 1921, recorded in cavities or on the underside of stones by Vacelet & Vasseur (1971) from the Indian Ocean and once from the Atlantic (Uriz, 1988) is the closest species to the new one. It differs from *H. ciccaresei* in having two categories of diactinal megascleres (oxeas), larger spiny microxeas and a tougher consistency. The skeleton, however, is alike, being formed by ill-defined spicule tracts which tend to be confused. Oxea ends may be denticulated, bifid or malformed as recorded for *H. ciccaresei* sp. nov.

As to the presence, in the studied material, of unusual spicules for the genus *Higginsia*, silica spheres in the same size order (50 μm) of those described here were observed by the authors in several specimens of the freshwater sponge *Ephydatia fluviatilis* from lakes of central Italy. They are not present in all specimens, but may occur in high frequency. Silicification should be affected by the peculiar features of the ambient water. In effect the important freshwater spill occurring in this confined space drastically reduces normal seawater salinity (37–38 psu in August), and seriously alters the environmental conditions.

Table 1. *Known species of* Higginsia *divided according to their geographic distribution.*

| | | |
|---|---|---|
| Atlantic Ocean | *Higginsia coralloides* Higgin, 1877 | Caribbean |
| | *Higginsia liberiensis* Higgin, 1877* | West Africa |
| | *Higginsia petrosioides* Dendy, 1921 | Indian Ocean, Namibia (Atlantic) |
| | *Higginsia strigilata* (Lamarck, 1814) | West Indies? |
| | *Higginsia tethyoides* Lévi, 1960* | West Africa |
| | *Higginsia thielei* Topsent, 1898 | Azores, Ireland, Iceland |
| Mediterranean Sea | *Higginsia mediterranea* Pulitzer-Finali, 1977* | Mediterranean |
| South Africa | *Higginsia bidentifera* (Ridley & Dendy, 1887) | South Africa (Cape of Good Hope) |
| | *Higginsia natalensis* Carter, 1885 | South Africa (Cape of Good Hope) |
| Western Indian Ocean | *Higginsia fragilis* Lévi, 1961* | Aldabra (Indian Ocean) |
| | *Higginsia higghini* Dendy, 1921 | Western Indian Ocean |
| | *Higginsia kenyensis* Pulitzer-Finali, 1993 | North Kenya Banks |
| | *Higginsia lamella* Pulitzer-Finali, 1993 | North Kenya Banks |
| | *Higginsia petrosioides* Dendy, 1921 | Indian Ocean, Namibia (Atlantic) |
| | *Higginsia pulcherrima* Pulitzer-Finali, 1993 | North Kenya Banks |
| | *Higginsia pumila* (Keller, 1889) | Red Sea |
| | *Higginsia robusta* Burton, 1959 | Gulf of Aden, Mozambique |
| Indonesia, West Pacific | *Higginsia anfractuosa* Hooper & Lévi, 1993 | New Caledonia |
| | *Higginsia massalis* Carter, 1885 | Australia, Indonesia, New Caledonia |
| | *Higginsia mixta* Hentschel, 1912 | Indonesia, Palau, Australia |
| | *Higginsia scabra* Whitelegge, 1907 | East, north-east, north-western Australia |
| | *Higginsia tanekea*, Hooper & Lévi, 1993 | New Caledonia |
| Eastern Pacific | *Higginsia higginissima* Dickinson, 1945* | Gulf of California |
| | *Higginsia papillosa* Thiele, 1905 | Calbuco (Chile) |
| Southern Australia | *Higginsia lunata* Carter, 1885 | Southern Australia, Bass Strait |

* taxa not thought to be valid in the list reported by Hooper & Lévi (1993).

The genus *Higginsia* has a world-wide distribution (Hooper & Wiedenmayer, 1994) and most of the known species come from tropical and temperate Indo-Pacific areas (Table 1). Some of them are known from the Atlantic as far north as Iceland (see Van Soest, 1987), but very few species were generally recorded from cold waters (e.g. *H. papillosa,* Thiele, 1905; *H. thielei,* Topsent, 1898). Only one species: *H. petrosioides* Dendy, 1921 was found in two different oceans (Table 1). There is but a single record of the genus from the Mediterranean Sea: *H. mediterranea* Pulitzer-Finali, 1977 from the Bay of Naples, whose skeletal architecture unfortunately was not described, which differs from *H. ciccaresei* by having bigger styles and oxeas, both with annular swellings. According to these swellings Van Soest (1987) suggested that *H. mediterranea* could possibly be material conspecific with *Halicnemia patera* Bowerbank. In our opinion such a view does not seem sufficiently supported.

From the above considerations it may be inferred that *Higginsia* could be a genus of tethyan origin with a remarkable species diversification in the Indo-Pacific area and some representatives reaching the Pacific coasts of North and South America and the Atlantic Ocean. Since the genus is quite rare in the Mediterranean Sea, the new species *H. ciccaresei* could be considered as a tethyan relic which survived the Mediterranean desiccation (Hsü et al., 1973) but in a cryptic, anchialine, cave confined habitat. Obviously, further data are needed to support such a hypothesis.

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