

Taxonomy of *Cladorhiza* in the deep SW Atlantic: *C. nicoleae* sp. nov. and redescription of *C. inversa* (Cladorhizidae, Poecilosclerida, Demospongiae)

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Until now only two species of Cladorhiza have been reported from the SW Atlantic, namely C. diminuta and C. inversa, despite a total of 39 species reported from various parts of the globe. Here we describe a new species, C. nicoleae sp. nov., dredged from 750 m depth on the continental slope off SE Brazil during the French RV 'Marion Dufresne' expedition in 1987. It is an erect, pedunculated and club-shaped sponge, 26 mm high and with 12 radially arranged whip-like projections (each up to 3 mm long). The new species differs from its closest relative, C. inversa (redescribed here), by its possession of sigmas and sigmancistras. The holotype of Cladorhiza inversa is also a pedunculated sponge, 1.9 cm tall, with a cup-shaped body with an apical spur-like continuation of the stem and a crown of 16 projections (up to 8 mm long) radiating from the rim of the body.

Keywords: MD55, deep sea, Porifera, H.M.S. Challenger, carnivorous sponges, Brazil

Submitted 5 November 2014; accepted 15 January 2015; first published online 17 April 2015

INTRODUCTION

Cladorhizid sponges are most frequently found in deep-water habitats, where the carnivorous feeding mode has been considered as a response to a nutrient-poor environment (Vacelet & Boury-Esnault, 1995). Given the currently accepted classification (Van Soest *et al.*, 2014), carnivory is distributed within the three families Cladorhizidae Dendy, 1922, Esperiopsidae Hentschel, 1923 and Guitarridae Dendy, 1924. Eight cladorhizids have so far been reported from the SW Atlantic (Lopes & Hajdu, 2014). Two of these belong to *Cladorhiza*, namely *C. diminuta* Lopes & Hajdu, 2014 and *C. inversa* Ridley & Dendy, 1886. Altogether 39 species of *Cladorhiza* have been reported from various parts of the world (Hestetun *et al.*, 2013; Lopes & Hajdu, 2014; Lundsten *et al.*, 2014).

The Franco-Brazilian MD-55 Vitória-Trindade Seamounts expedition was carried on board the RV 'Marion Dufresne' in 1987, and from a rich collection of sponges only the Hexactinellida have been described so far (Tabachnick *et al.*, 2009). In this paper we aim to give the first contribution into the study of the Demospongiae in this collection by describing a new species of carnivorous sponge as well as redescrbing the morphologically most similar species, *Cladorhiza inversa* Ridley & Dendy, 1886.

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MATERIALS AND METHODS

The holotype of the new species is deposited in the Porifera collection of the Museu Nacional/UFRJ. The material was studied and described following standard procedures for the group (Hajdu *et al.*, 2011; Lopes & Hajdu, 2014). The micro-metric data of spicules were obtained from 30 measures of each category. Figure 1 indicates the type locality of the new species, off SE Brazil. The redescription of *C. inversa* was based on re-examination of the holotype in the BMNH, Natural History Museum (London), followed by anatomical studies conducted in Bergen (Norway). Abbreviations used: MNRJ, Porifera Collection, Museu Nacional/UFRJ, Rio de Janeiro, Brazil; TAAF, Terres Australes et Antarctiques Françaises; MD55, 55th Oceanographic Campaign of RV 'Marion Dufresne'.

RESULTS

SYSTEMATICS

Phylum PORIFERA Grant, 1836
Class DEMOSPONGIAE Sollas, 1885
Order POECILOSLERIDA Topsent, 1928
Family CLADORHIZIDAE Dendy, 1922
Genus *Cladorhiza* Sars, 1872
Cladorhiza nicoleae sp. nov.
(Figure 2)

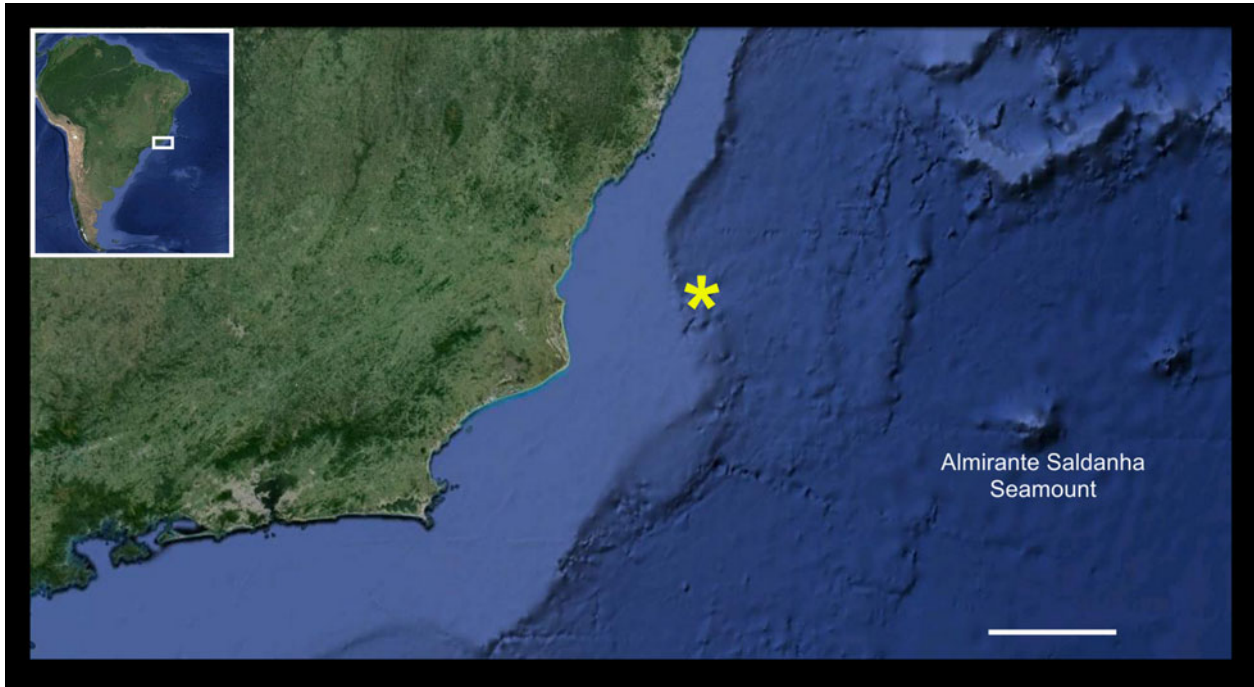


Fig. 1. Collecting locality of *Cladorhiza nicoleae* sp. nov. – continental slope off SE Brazil. Insert shows South America and the SE sector of the Brazilian coast shown in the expanded figure.

TYPE MATERIAL

Holotype. MNRJ 15991, continental slope off Quissamã (TAAF MD55, Stn 4 DSo8, 22°34.6'S – 40°05.4'W, SE Brazilian EEZ), 750 m depth, coll. N. Boury-Esnault, 10.V.1987.

DIAGNOSIS

Erect and pedunculated *Cladorhiza* with two categories of mycalostyles as megascleres, and microscleres comprising tridentate anchorate anisochelae up to 45 µm long, sigmas and sigmancistras up to 40 µm long.

DESCRIPTION

The single specimen is an erect, delicate and pedunculated sponge, 2.6 cm long, with a 2.0 cm long peduncle. Its globular body is slightly flattened sideways (diameter 0.45 cm), with radial projections up to 0.3 cm long, supported by a calyx-like thickening of the peduncle (Figure 2A, B). Surface slightly velvety and consistency very fragile. No oscule was observed. Colour yellowish-brown in ethanol.

SKELETON

Peduncle and body formed by an axis of longitudinally arranged mycalostyles. Microscleres abundant, distributed around the bundles of mycalostyles. Radial projections composed by similar longitudinal axes of mycalostyles surrounded by a layer of microscleres (Figure 2C–E).

SPICULES

Megascleres, mycalostyles in two size categories (Figure 2F–H); both straight or slightly curved mixed in different parts of the sponge. Microscleres, one category each of anchorate anisochelae, sigmas and sigmancistras (Figure 2I–K).

- Mycalostyles I, acerate, 939–1252.3–1618 µm long, 15–21.5–24 µm thick.
- Mycalostyles II, with short, acerate to conical point, 445–659.5–832 µm long, 4.8–9.1–9.7 µm thick.
- Anchorate anisochelae, 34–38.9–44 µm long, with tridentate head bearing spatuliferous alae, 9.7–14.4–17 µm tall, and tridentate unguiferate foot, 4.9–6.7–9.7 µm tall (Figure 2I).
- Sigmas, smooth, contorted, with relatively large hooks, 24–32.3–39 µm long (Figure 2J).
- Sigmancistras, contorted, concave side lined by long and large fimbriae (giving an overall flat appearance to the shaft), with very sharp, spur-like terminations, 19–29.8–39 µm long (Figure 2K).

DISTRIBUTION AND ECOLOGY

The species is known only from its type locality, off Quissamã (SE Brazilian EEZ).

ETYMOLOGY

The species is named in honour of Dr Nicole Boury-Esnault, the expert on sponges on board the RV 'Marion Dufresne' when the holotype was collected, and one of the greatest specialists on sponge taxonomy in recent times, with an important contribution to the taxonomic study of Brazilian species.

Remarks

Of the 39 species of *Cladorhiza* known worldwide, 11 have been reported from the Atlantic Ocean, and only two from the SW Atlantic, namely *C. diminuta* Lopes & Hajdu, 2014 and *C. inversa* Ridley & Dendy, 1886. *Cladorhiza nicoleae* sp. nov. differs from both mainly by its distinct set of spicules. *Cladorhiza diminuta* has only one category of much smaller mycalostyles (298–595/8–15 µm), smaller tridentate anisochelae (13–18 µm), and

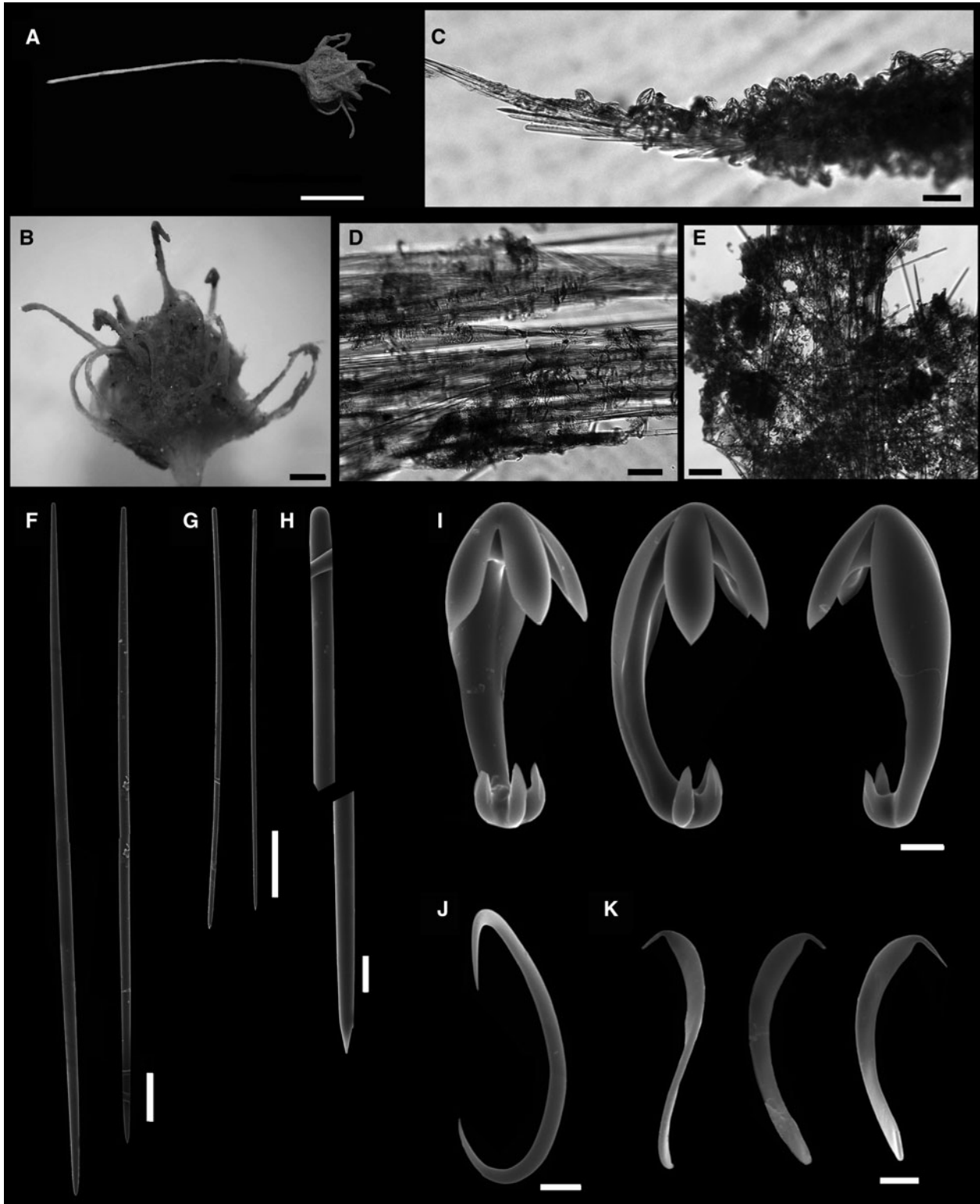


Fig. 2. External morphology, skeleton and spicules of *Cladorhiza nicoleae* sp. nov. (holotype, MNRJ 15991). (A) external morphology of holotype, (B) detail of external morphology of holotype, (C) appendages skeleton, (D) skeleton of peduncle, (E) skeleton of globular body, (F) mycalostyle I, (G) mycalostyle II, (H) detail of mycalostyle II, (I) anchorate anisochelae, (J) sigma, (K) sigmancistras. Scale bars: A = 0.5 cm; B = 0.10 cm; C–E = 100 μm; F–G = 100 μm; H = 10 μm; I–K = 5 μm.

somewhat larger sigmas (28–53 μm). *Cladorhiza inversa* can be distinguished from *C. nicoleae* sp. nov. by its larger category of styles (1496–2111/31–48 μm), the presence of tylostyles (270–365/8–13 μm), and by having smaller

tridentate anisochelae (30 μm) as its sole category of microscleres (see redescription below).

With respect to all *Cladorhiza* congeners a similar body shape (pedunculate with radial projections) can be found in

12 species (*C. arctica* Koltun, 1959, *C. bathyrcrinoides* Koltun, 1955, *C. diminuta* Lopes & Hajdu, 2014, *C. ephyrula* Lévi, 1964, *C. flosabyssi* Topsent, 1909, *C. grandis* Verrill, 1879, *C. inversa* Ridley & Dendy, 1886, *C. longipinna* Ridley & Dendy, 1886, *C. mirabilis* (Ridley & Dendy, 1886), *C. moruliformis* Ridley & Dendy, 1886, *C. nematophora* Lévi, 1964, *C. similis* Ridley & Dendy, 1886). However, none of these species have the same spicular set of the species described above.

Nineteen species of *Cladorhiza* have tridentate anisochelae (*C. arctica* Koltun, 1959, *C. bathyrcrinoides* Koltun, 1955, *C. corona* Lehnert, Watling & Stone, 2005, *C. diminuta* Lopes & Hajdu, 2014, *C. ephyrula* Lévi, 1964, *C. flosabyssi* Topsent, 1909, *C. inversa* Ridley & Dendy, 1886, *C. linearis* Ridley & Dendy, 1886, *C. longipinna* Ridley & Dendy, 1886, *C. mani* Koltun, 1964, *C. microchela* Lévi, 1964, *C. mirabilis* (Ridley & Dendy, 1886), *C. moruliformis* Ridley & Dendy, 1886, *C. nematophora* Lévi, 1964, *C. pentacrinus* Dendy, 1887, *C. pteron* Reischwig & Lee, 2007, *C. schistochela* Lévi, 1993, *C. similis* Ridley & Dendy, 1886, *C. tridentate* Ridley & Dendy, 1886) but these species all differ from *C. nicoleae* sp. nov. with respect to further important features of their spicular set.

The only species with a similar spicular set as *C. nicoleae* sp. nov. are *C. abyssicola* Sars, 1872 from the boreal Arctic and *C. segonzaci* Vacelet, 2006 and *C. septemdentalis* Koltun, 1970 both from the Pacific Ocean. Besides the body shape (these three species are pinnate or branching), *C. abyssicola* differs from *C. nicoleae* sp. nov. by the presence of megasclere styles (only one category), smaller anisochelae (20 µm) with five alae, larger sigmas (100 µm) and sigmancistras with 'C' to 'S' shape and both tips hastate; *Cladorhiza segonzaci* differs from *C. nicoleae* sp. nov. by the presence of one category of styles, smaller anisochelae (15–17.5 µm) with five alae, larger sigmas (50–80 µm) and sigmancistras with two hastate tips. *Cladorhiza septemdentalis* differs from *C. nicoleae* sp. nov. by the presence of styles (in two categories), anisochelae with seven alae and larger sigmas. Although *C. nicoleae* sp. nov. has the same spicule complement and spicule sizes as the species above, its tridentate chelae and body shape suggest that these species are more distantly related.

Thus *C. nicoleae* sp. nov. is well separated from any previously known *Cladorhiza* species. Based on a total assessment of body shape, chela shape and spicule complement, the closest relatives to *C. nicoleae* sp. nov. seem to be the other two SW Atlantic species *C. diminuta* and *C. inversa*. More generally, *C. nicoleae* sp. nov. could be seen as part of a larger assemblage of pedunculate *Cladorhiza*-species where the head of the chelae have three teeth rather than five or sometimes seven which is common for single-axis or branching *Cladorhiza*. Curiously, a similar division seems to occur also within genus *Chondrocladia* (Topsent, 1902, 1930). In addition to species mentioned above, the species *C. arctica* Koltun, 1959, *C. bathyrcrinoides* Koltun, 1955, *C. ephyrula* Lévi, 1964, *C. flosabyssi* Topsent, 1909, *C. inversa* Ridley & Dendy, 1886, *C. linearis* Ridley & Dendy, 1886, *C. longipinna* Ridley & Dendy, 1886, *C. mani* Koltun, 1964, *C. mirabilis* (Ridley & Dendy, 1886), *C. moruliformis* Ridley & Dendy, 1886, *C. nematophora* Lévi, 1964, *C. pentacrinus* Dendy, 1887, *C. similis* Ridley & Dendy, 1886 could be considered as part of this group.

Cladorhiza inversa Ridley & Dendy, 1886
(Figure 3)

EXAMINED MATERIAL

Holotype. BMNH 87.5.2.145, between Rio de la Plata and Tristan da Cunha, Challenger Expedition (Station 332, 37°29'S 27°31'W), 4023 m depth.

COMPARATIVE MATERIAL EXAMINED

Cladorhiza similis Ridley & Dendy, 1886, holotype (BMNH 87.5.2.142); *Cladorhiza longipinna* Ridley & Dendy, 1886, holotype (BMNH 87.5.2.143); *Cladorhiza mirabilis* (Ridley & Dendy, 1886), holotype (BMNH 87.5.2.141).

DIAGNOSIS

Erect and pedunculated *Cladorhiza* with a crown-shaped body, two categories of mycalostyles and one category of tylostyles as megascleres, and tridentate anchorate anisochelae up to 27 µm as microscleres.

DESCRIPTION

The holotype is a small, erect and pedunculated sponge 1.9 cm tall. The base of the sponge is missing. The peduncle is 1.5 cm long and supports a short, cup-shaped body with a fine central continuation of the stem and a crown of 16 up to 8 mm long projections pointing apically away from the sponge (Figure 3A, B). The sponge is fragile, partly damaged and with a slightly hispid surface. No oscules or any signs of an aquiferous system were observed. The colour is light brown in ethanol.

SKELETON

Peduncle and body formed by axis of longitudinally arranged mycalostyles. Projections composed of larger mycalostyles with a cover of microscleres. Chelae are abundant in body and projections but nearly absent in peduncle, possibly due to the condition of the specimen (Figure 3C–E).

SPICULES

Megascleres are straight and fusiform mycalostyles in two size categories (Figure 3C–E). Microscleres are anchorate anisochelae in a single size category (Figure 3G).

- Mycalostyles I in peduncle and body, with acerate point, 542–975.4–1500 µm long and 11.1–19.0–30 µm thick.
- Mycalostyles II in the projections only with acerate point, 1496–1799.6–2111 µm long and 31–35.9–48 µm thick.
- Tylostyles in the body, fusiform, straight or slightly bent 270–303.4–365 µm long and 7.9–10.8–12.6 µm thick (Figure 3F).
- Anchorate anisochelae 22.4–25.2–27.1 µm long with a tridentate spatuliferous head 9.6–12.6 µm long and tridentate unguiferate foot ~5 µm long (Figure 3G).

DISTRIBUTION AND ECOLOGY

The species is known only from its type locality, the South Atlantic abyssal plain between Rio de la Plata and Tristan da Cunha.

Remarks

In Ridley and Dendy's original measurements the mycalostyles are given as about 2000 µm long and 37 µm thick while tylostyles are given as 630 µm long and 19 µm thick (Ridley & Dendy, 1886, 1887). It is possible that the measurements given of the smaller mycalostyles and tylostyles by Ridley and Dendy were mixed up as the tylostyles are shorter (270–365 µm) in our measurements and the smaller type of

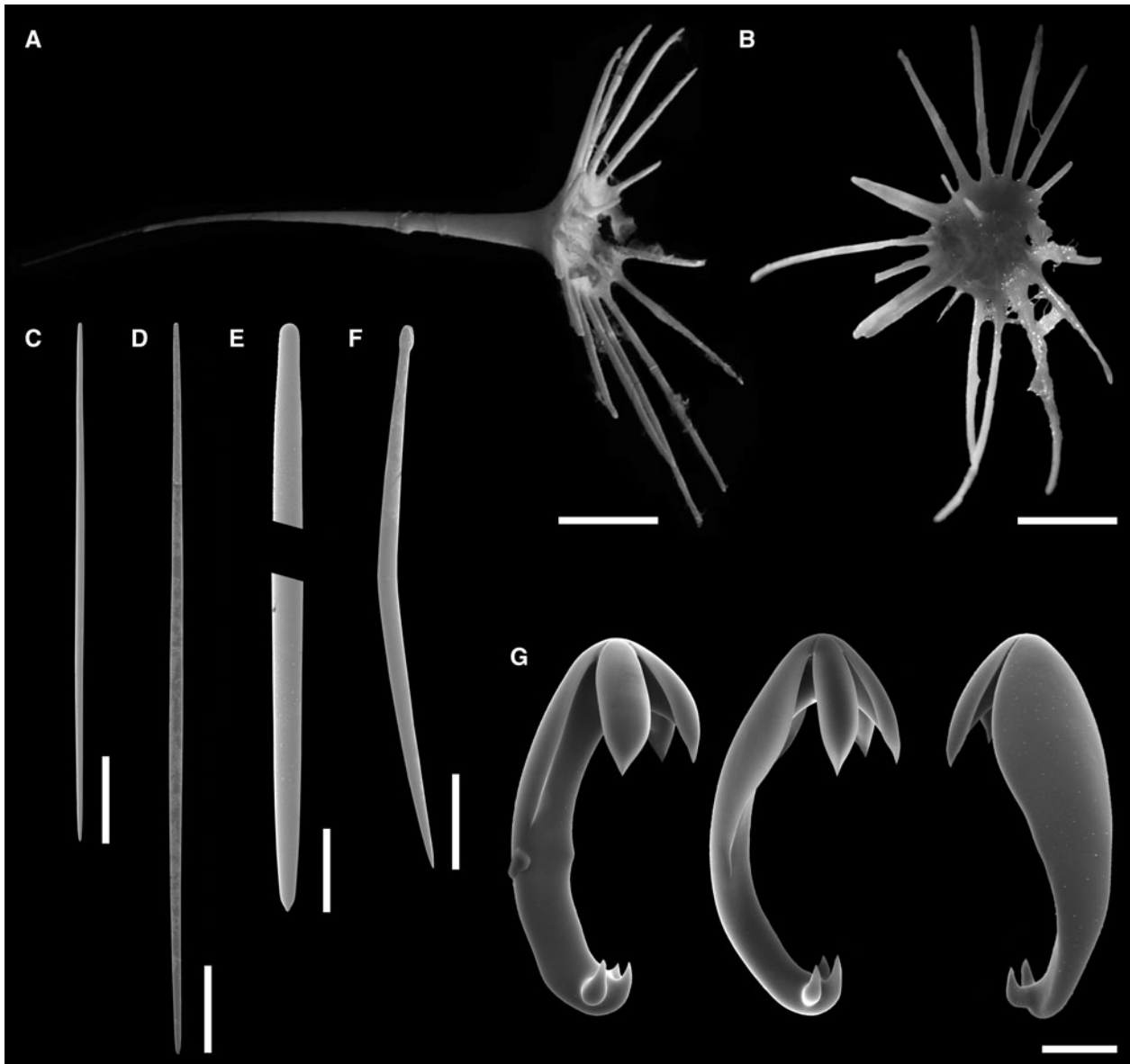


Fig. 3. *Cladorhiza inversa* Ridley & Dendy, 1886 (A–B) holotype (BMNH 87.5.2.145), (C) mycalostyle I of the stem and main body, (D) mycalostyle II from the projections with (E) detail, (F) tylostyle and (G) anchorate anisochelae. Scale bars: A, B = 3 mm; C, D = 250 μm ; E, F = 50 μm ; G = 5 μm .

mycalostyle is not mentioned in the original description. The cryptic statements ‘bihamates (?)’ (Ridley & Dendy, 1886) and ‘sigmata (?)’ (Ridley & Dendy, 1887) are given in Ridley and Dendy’s descriptions. Possibly they were expecting these spicules but were unable to find them. We did not find any trace of sigmas or sigmancistras in our examination of the holotype.

The name of the species derives from the original assumption by Ridley and Dendy that the body represents the basal part of the sponge with the projections acting as roots preventing the sponge from getting buried in the sediment (Ridley & Dendy, 1886, 1887). This interpretation was challenged by Topsent (1902) who correctly noted that the sponge is pedunculated with the body apical to the stem.

The spicule set and habit of *C. inversa* differs from that of the two other *Cladorhiza*-species known from the SW Atlantic, most significantly by its conical rather than clavate habit and by the lack of sigmas or sigmancistras in *C. inversa* (see remarks for *C. nicolae* sp. nov. above).

The Pacific species *C. similis* Ridley & Dendy, 1886 and *C. longipinna* Ridley & Dendy, 1886 are also close relatives but can be distinguished from *C. inversa* mainly by longer mycalostyles, slightly different chela sizes, the fact that projections point clearly downwards from the body as well as geographic distance. Two other species have a crown-shaped pedunculate body with apically oriented projections similar to *C. inversa*: *C. flosabyssi* Topsent, 1909 from the Azores, and *C. corona* Lehnert *et al.*, 2005 from the Aleutian Islands. *Cladorhiza inversa* can be distinguished from them by its smaller mycalostyles, the size of its chelae and the lack of sigmas or sigmancistras.

ACKNOWLEDGEMENTS

The authors are grateful to the Muséum National d’Histoire Naturelle and the ‘sponge team’ in Marseille (Station Marine

d'Endoume), namely Jean Vacelet, Nicole Boury-Esnault and Thierry Perez, for granting us access to the TAAF-MD55 collection of sponges. We would like to thank Norwegian Oil and Gas, The Norwegian Biodiversity Information Centre and Det Norske Veritas for sponsoring the 2nd International Workshop on Taxonomy of Atlanto-Mediterranean Deep-Sea Sponges (Bergen, Norway), where preliminary results leading to this publication were presented. M.Sc. Amanda G. da Veiga and Beatriz C.A. Cordeiro are thanked for help with SEM operation at the Center for Scanning Electron Microscopy of Museu Nacional/UFRJ. JTH is grateful to Emma Sherlock and Clare Valentine for granting access and assisting his visit to the Natural History Museum (London), when the type specimen of *C. inversa* was reexamined.

FINANCIAL SUPPORT

The Brazilian authors thank the National Counsel of Technological and Scientific Development (CNPq), Carlos Chagas Filho Research Support Foundation of Rio de Janeiro State (FAPERJ), and Coordination for Improvement of Higher Education Personnel (CAPES) for grants and/or fellowships.

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