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ORIGINAL ARTICLE

Taxonomy of Euretidae (Porifera, Hexactinellida, Hexactinosida) of Campos Basin, southwestern Atlantic, with a description of a new species

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Abstract

Fourteen species of hexactinellid sponges have been known from the southwestern Atlantic, 11 of which belong to the subclass Hexasterophora. Among these, only two belong to Hexactinosida Schrammen, 1903, namely *Aphrocallistes beatrix* Gray, 1858, *Dactylocalyx pumiceus* Stutchbury, 1841. The present study increases the number of southwestern Atlantic Hexasterophora to 13 species, adding two additional Hexactinosida, namely *Chonelasma choanoides* Schulze & Kirkpatrick, 1910 and *Eurete atlantica* sp. nov. The latter species is the first record of *Eurete* for the Atlantic Ocean, differing from the remaining 11 known species most conspicuously by the heavy spination of its pentactines.

Key words: *Brazil, Hexasterophora, slope, sponges, taxonomy*

Introduction

Knowledge of southwestern Atlantic Hexactinellid biodiversity remains scarce. The taxonomy of these has been dealt with in only seven papers, namely Schulze (1887, 1899), Burton (1932, 1940), Mothes-de-Moraes (1977), Tabachnick (1990) and Lopes et al. (2005), which recorded only 14 species in total.

An increased effort towards a better understanding of deep-sea sponge biodiversity off the Brazilian coast is slowly changing this scenario, by permitting the study of old specimens as well as the collection of new materials through intensive dredging, trawling and grabbing by remotely operated vehicles (Lopes 2006). This effort has mostly been concentrated in Campos Basin, southeast Brazil.

Campos Basin occupies the sector between Vitória High (20.5°S) and Cabo Frio High (24°S) in the Brazilian continental margin, covering over 100,000 km^2. Over 70% of this basin is located in depths greater than 200 m (Carminatti & Scarton 1991). The continental shelf in the area has a mean width of approximately 100 km, and the shelf break varies from 80 to 130 m depth. The slope is 40 km wide in general, with a mean declivity of 2.5°, and a shallower base in the northern sector (1500 m versus 2000 m in the south) due to the presence of the Paraíba do Sul river submarine fan associated with the Almirante Câmara canyon (Brehme 1984). The intermediary slope (550–1200 m depth), where the samples reported here were collected, is characterized by fine-grained sand, coral banks and patches of sandy-mud and soft mud. This depth zone is under the influence of the Antarctic Intermediate Water (2–6°C, 34.2–34.6‰ salinity), which runs to the north (Viana et al. 1998; Amaral et al. 2004; Bentz et al. 2005).

Over 85% of the Brazilian crude oil and gas production originates from Campos Basin (off southeastern Brazil). In the face of the necessity of evaluating the environmental assets on exploration areas or potential exploration areas, Centro de Pesquisas e Desenvolvimento Leopoldo Américo Miguez de Mello/Petróleo Brasileiro S.A.(CENPES/PETROBRAS) has elaborated and co-ordinated

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the execution (ongoing) of Campos Basin Deep-waters Environmental Assessment Project (OCEAN-PROF). OCEANPROF's aim is the environmental characterization of northern and southern Campos Basin, between the isobaths of 700 and 2000 m.

The present study reports on two Euretidae collected in the deep waters of Campos Basin (off southeastern Brazil), including the first record of *Eurete* Semper, 1868 for the Atlantic Ocean.

Material and methods

R/V *Astro Garoupa* made two cruises in 2003, using a small otter-trawl semi-balloon (OTSB) net (5.5×1.0 m) with the same dimensions as the OTSB no. 14 shrimp-trawl net. The demersal trawlings executed lasted 1.5 h each. Sponge samples analysed here came from 1059–1152 m depth.

The OCEANPROF collection deposited at Museu Nacional comprises 47 samples belonging to the Hexasterophora, only 17 of which are in a good enough state of preservation to permit their full identification and description.

The preparation of dissociated spicule and thick section mounts followed the procedures described by Lopes et al. (2005). The scanning electron microscopes used were a JEOL JSM-6460LV and a ZEISS DSM-940A, made available by CENPES/PETROBRAS.

Figure 1 shows the southeastern Brazilian coastline and indicates the collecting station at Campos Basin. This map was elaborated with the aid of the website ONLINE MAP CREATION (http://www.aquarius.geomar.de/omc/).

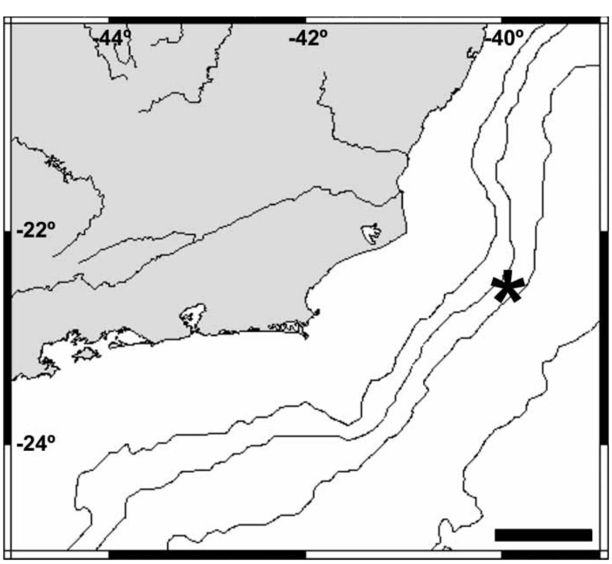

Figure 1. Map of the southeastern Brazilian coastline, with the collecting area (Campos Basin) indicated by an asterisk. The 200, 1000, 2000 and 3000 m deep isobaths are shown (scale = 100 km).

The following abbreviations have been used: CENPES, Centro de Pesquisas e Desenvolvimento Leopoldo Américo Miguez de Mello; CNPq, Conselho Nacional de Desenvolvimento Científico e Tecnológico; MNRJ, Porifera Collection, Museu Nacional/UFRJ; OCEANPROF, Campos Basin Deep-waters Environmental Assessment Project; PETROBRAS, Petróleo Brasileiro S.A.; REVIZEE, Evaluation of the Sustainable Potential of Life Resources in the Economic Exclusive Zone; UFRJ, Universidade Federal do Rio de Janeiro; ZEE, Economic Exclusive Zone.

Systematic results

Phylum Porifera Grant, 1836
Class Hexactinellida Schmidt, 1870
Order Hexactinosida Schrammen, 1903
Family Euretidae Zittel, 1877 *sensu* Reiswig & Wheeler, 2002

Genus *Eurete* Semper, 1868 *sensu* Reiswig & Wheeler, 2002

Eurete atlantica sp. nov. (Figure 2, Tables I, II)

Holotype. MNRJ 7330A, OCEANPROF 1, CENPES/UFRJ, stn. 4 (Campos Basin, RJ, start: 22°24.449′S 39°55.280′W, end: 22°21.936′S 39°53.602′W), 1128–1135 m deep, col. R/V *Astro Garoupa*, demersal fisheries net, 07 February 2003.

Diagnosis. Only species of *Eurete* with irregular, mainly triangular dictyonal meshes, microtuberculated beams with inconspicuous nodes and without spines, heavily acanthose pentactines, rare scopules and onychexasters.

Description. The holotype is composed of a single erect, tubular fragment $127 \times 66 \times 58$ mm (height $\times$ body width $\times$ base width), formed by a network of ramifying and anastomosing tubules in a tree-like pattern. The specimen is macerated and tubules are broken (Figure 2A). The body wall is thin, 1–3 mm wide and channelized with narrow, short epirhyses (Figure 2B, C) and aporhyses.

Skeleton. The dictyonal architecture is formed by irregular, mainly triangular meshes, 120–360 μm in diameter – quadrangular and ovoid meshes also occur (Figure 2B, C); elongated and microspined spurs; microtuberculated beams 20–30 μm thick; inconspicuous nodes without spines. Shallow cortical epirhyses and aporhyses may occur

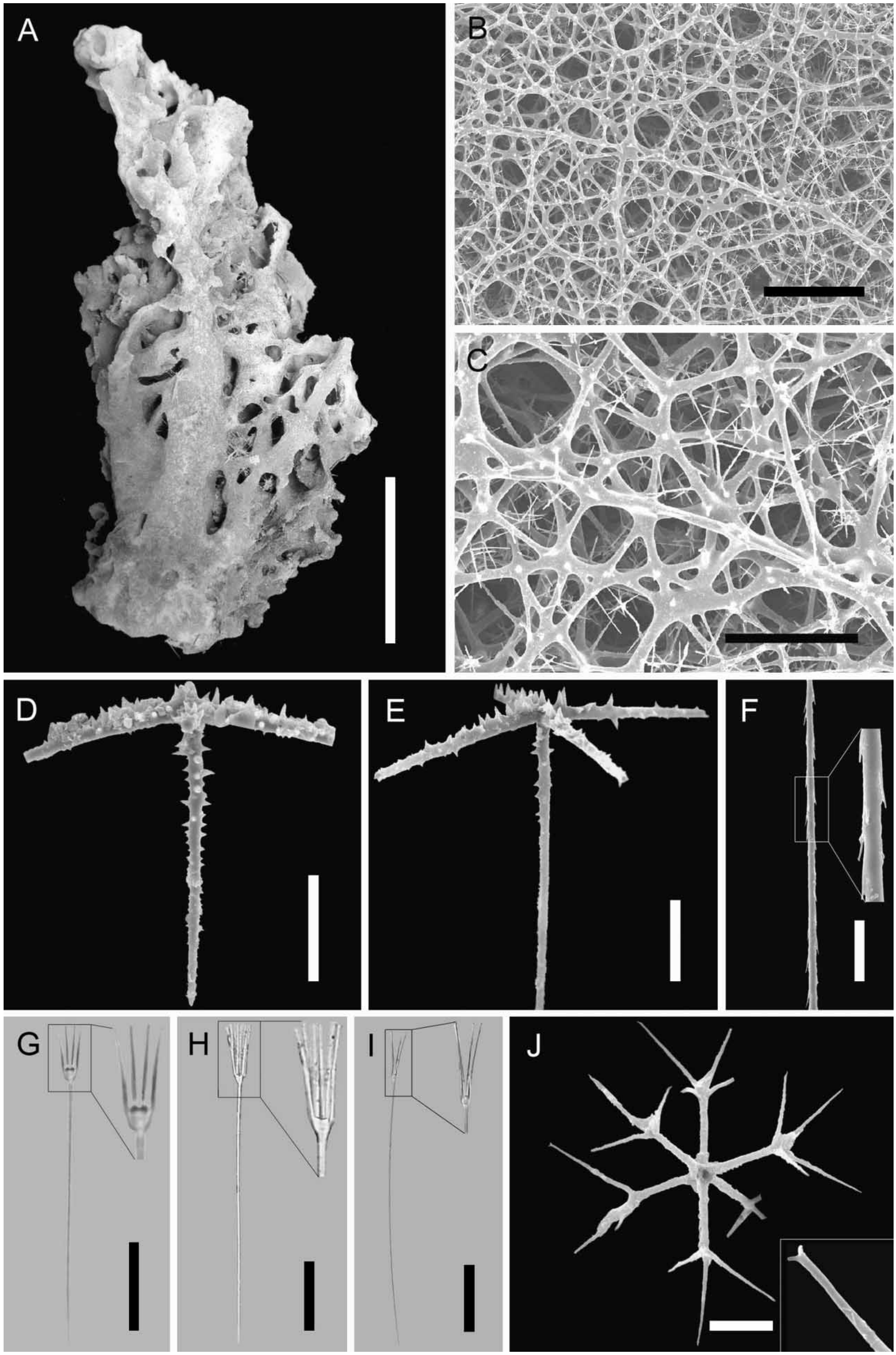

Figure 2. *Eurete atlantica* sp. nov., holotype. (A) Preserved specimen. (B, C). Scanning electron micrographs of dictyonal framework. (D–F, J). Scanning electron micrographs of spicules. (G–I) Optical microscopy of spicules: (D, E) pentactin; (F) uncinate; (G–I) scopule; (J) onychexaster (scales: A = 50 mm, B = 1 mm, C = 500 μm, D–H = 50 μm, I = 100 μm, J = 20 μm).

Table I. *Eurete atlantica* sp. nov. Dimensions of the spicules in μm: means ± standard error$_n$ (smallest–largest).

Holotype	MNRJ 7330A
Pentactines	
Tangential ray length	$168.0 \pm 36.4_{15}$ (115–240)
Tangential ray width	$17.0 \pm 3.7_{10}$ (10–23)
Proximal ray length	$185.0 \pm 27.4_{7}$ (160–240)
Proximal ray width	$13.6 \pm 2.8_{7}$ (10–18)
Uncinate length	$501.8 \pm 120.3_{14}$ (225–650)
Uncinate width	$11.3 \pm 6.5_{10}$ (3–23)
Scopule length (total)	$366.0 \pm 121.8_{5}$ (200–490)
Scopule length (head)	$58.3 \pm 22.4_{5}$ (33–73)
Scopule width (head)	$20.8 \pm 5.2_{5}$ (15–25)
Microscleres	
Onychexaster diameter	$85.2 \pm 18.2_{25}$ (50–113)
Primary ray length	$25.3 \pm 4.6_{25}$ (15–33)
Secondary ray length	$21.3 \pm 7.0_{25}$ (8–33)

(Figure 2C). Dermalia and atrialia are acanthose pentactines.

Spicules. Heavily spined pentactines (Figure 2D, E) with slightly arched tangential rays, conical spines are reduced in size towards the ray tips; proximal ray similar to tangential ones, but less spined. Dermal and atrial pentactines similar, but the latter appear more abundant. Uncinates (Figure 2F) vary considerably in length and width, but usually possess long, thin barbs. Scopules (Figure 2G–I) rare, three to six slightly divergent terminations, apparently smooth, with a small tyle at the tine tips; straight or slightly curved axis, apparently smooth, tapering gradually. Only one kind of microsclere: onychexasters (Figure 2J), with long primary rays, two to three secondary rays and very undeveloped terminations (Table I).

Etymology. The proposed name, *atlantica*, derives from this being the sole known species of *Eurete* to occur in the Atlantic Ocean.

Observations. Currently *Eurete* contains 11 species and two subspecies (*E. schmidti kampeni* Ijima, 1927 and *E. schmidti treubi* Ijima, 1927; Table II), all from the Pacific Ocean, mainly from the western Pacific, from Japan to Indonesia. A single record has been made from the eastern Pacific, from off northern Peru (Lendenfeld 1915). *Eurete atlantica* sp. nov. is distinguished from other species of *Eurete* by its pentactins bearing large spines. Only two other species of *Eurete* possess acanthose pentactines, namely *E. lamellina* Tabachnick, 1988 and *E. spinosum* Lendenfeld, 1915. Nevertheless, the former differs from the new species by its regular spines distributed along the rays of the pentactines (as seen in Tabachnick 1988: plate 3, Figure 7). Additionally, the uncinates and the scopules of *E. lamellina* are much larger than those seen in the new species (1600–4000 μm versus 225–650 μm long and 1180–1800/240–300 μm versus 200–490/33–73 μm total length/head length, respectively). Microscleres in *E. lamellina* are oxyhexasters, oxyhexactins and derivatives, with short primary and long secondary rays.

Eurete spinosum differs from the new species through its possession of differentiated dictyonal meshes, where the atrial ones are considerably more regular. Additionally, the former species has microspined scopules and abundant oxyhexasters with long secondary rays. Lendenfeld (1915) distinguished his new species *E. spinosum* from *E. bowerbanki* Schulze, 1886 and *E. marshalli* Schulze, 1886 mainly by the presence of acanthose pentactines, reported as being much more spined than those found in the latter two species.

Genus *Chonelasma* Schulze, 1886 *sensu* Reiswig & Wheeler, 2002

Chonelasma choanoides Schulze & Kirkpatrick, 1910 (Figures 3–7, Tables III, IV)

Synonymy. Chonelasma lamella choanoides Schulze & Kirkpatrick, 1910: 302; Schulze & Kirkpatrick, 1911: 48; Ijima, 1927: 369. *Chonelasma lamella* Schulze, 1886: 76 (in part); Schulze, 1887: 321 (in part); Barthel & Tendal, 1994: 61 (in part). *Chonelasma choanoides* Reid, 1963: 226; Reid, 1964: xcix; Janussen et al., 2004: 1860. *Chonelasma* sp. Schulze, 1887: 326. *Hexactinella grimaldii* Burton, 1928: 16 (in part).

Studied material. MNRJ 7317, 7318, 7319, OCEANPROF 1, CENPES/UFRJ, stn. 4 (Campos Basin, RJ, start: 22°24.449′S 39°55.280′W, end: 22°21.936′S 39°53.602′W), 1128–1135 m deep, col. R/V *Astro Garoupa*, demersal fisheries net, 07 February 2003. MNRJ 7994, 7995, OCEANPROF 2, CENPES/UFRJ, stn. A16 (Campos Basin, RJ, start: 22°16.304′S 39°53.360′W, end: 22°13.124′S 39°52.223′W), 1059–1110 m deep, col. R/V *Astro*

Table II. Comparative morphological and distributional data for all known species of *Eurete* Semper, 1868.

Species	Meshes	Beams/nodes	Pentactins	Microscleres	Observations	Locality/depth range
Eurete atlantica sp. nov.	Irregular, triangular, quadrangular and oval	Microtuberculated/slender	With large spines	Onychexasters microacanthose)	Rare scopules, with unbarbed terminations	Brazil/1128–1135 m
E. bowerbanki Schulze, 1886 (Schulze, 1887)	Irregular	Slightly tuberculated/slender or stoutish	Smooth?	Oxyhexactins and oxyhexasters	Scopules with barbed terminations	Japan/146–366 m
E. freelandi Ijima, 1927 (original description)	Irregular	Irregularly tuberculated and smooth in parts/more or less stout	Rugose extremities	Oxyhexaster, with hemihexasterose derivations	Scopules with finger-like or slightly thick terminations	Indonesia/275 m
E. irregularis Okada, 1932 (original description)	Regular and elongated, quadrangular	Smooth/?	Microacanthose	Onychexasters (smooth)	Uncinates absent	Southern Sea of Okhotsk/3240 m
E. lamellina Tabachnick, 1988(original description)	Irregular	Smooth or acanthose/?	With regular thorns along rays	Oxyhexactins and derivates, oxyhexasters	Scopules with small terminations	Western Central Pacific/1570 m
E. marshalli Schulze, 1886 (Schulze, 1887)	Mainly quadrangular	Smooth or slightly acanthose/ stout and acanthose	Rugose	Oxyhexasters	Scopules with pear-shaped terminations bearing barbs	Western Central Pacific/256 m
E. nipponica Okada, 1932 (original description)	Regular to irregular, triangular or quadrangular	Microtuberculated/stout	Microtuberculated	Onychexasters and oxyhexasters	Scopules with simple shafts, smooth with rugose extremity and terminations as marginally spined clubs	Japan/191 m
E. schmidtii Schulze, 1886 (Schulze, 1887)	Regular, mainly quadrangular	Smooth or slightly acanthose/ thick, moderately acanthose	Rugose	Oxyhexasters (rugose)	Scopules with sharp terminations, smooth or barbed	Japan, Philippines/ 187 m
E. sacculiformes Okada, 1932 (original description)	Irregular, triangular or quadrangular	Microtuberculated/thick	Nearly smooth	Onychexasters (smooth)	Scopules microacanthose	Japan/247 m
E. simplicissima Semper, 1868 (Schulze, 1887)	Quadrangular and triangular	Smooth or slightly acanthose/ slender	–	Oxyhexasters	Without free spicules, apart from oxyhexasters	Philippines?
E. spinosum Lendenfeld, 1915 (original description)	Irregular, triangular or quadrangular (dermal face) and regular (atrial face)	Acanthose/?	With large thorns	Oxyhexasters	Scopules microacanthose; uncinates absent?	Peru/4062 m
E. trachydocus Ijima, 1927 (original description)	Irregular, triangular or quadrangular	Tuberculated/slender, microtuberculated	Microtuberculated or nearly smooth	Oxyhexasters	Scopules with barbed terminations	Indonesia/204 m

?, information lacking.

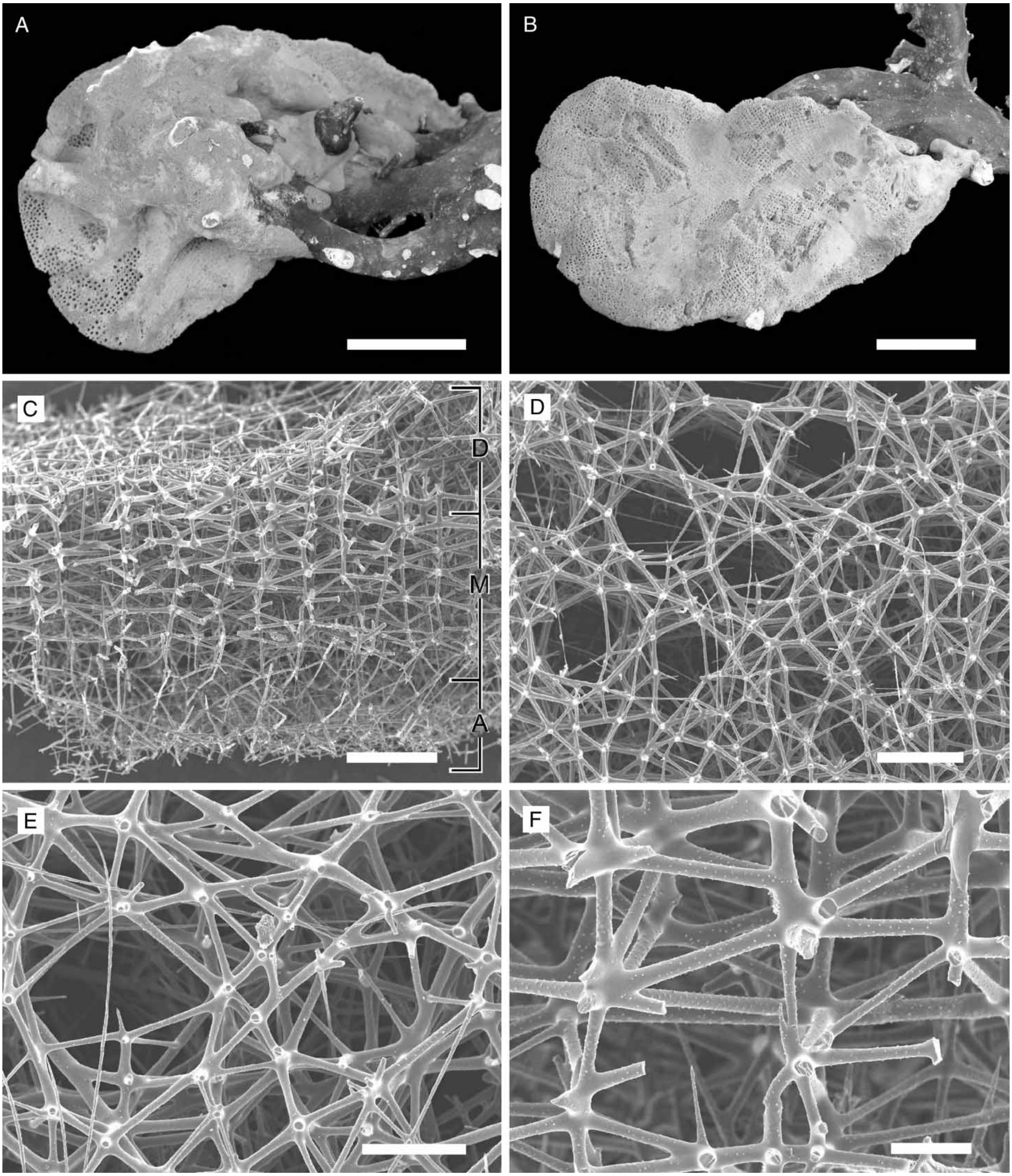

Figure 3. *Chonelasma choanoides* Schulze & Kirkpatrick, 1910. Preserved specimen (MNRJ 8009A). (A) Dermal surface. (B) Atrial surface. (C–F) Scanning electron micrographs of dictyonal framework of MNRJ 7995: (C) oblique view (D = dermal layer, M = middle layer, A = atrial layer); (D, E) dermal skeleton; (F) middle lamella (scales: A, B = 50 mm, C, D = 1 mm, E = 500 μm, F = 200 μm).

Garoupa, demersal fisheries net, 22 August 2003. MNRJ 7999, OCEANPROF 2, CENPES/UFRJ, stn. A4-2 (Campos Basin, RJ, start: 22°24.419′S 39°55.556′W, end: 22°21.438′S 39°53.559′W), 1105–1127 m deep, col. R/V *Astro Garoupa*, demersal fisheries net, 29 August 2003. MNRJ 8009A, OCEANPROF 2, CENPES/UFRJ, stn. A4-1 (Campos Basin, RJ, start: 22°23.943′S 39°54.679′W, end:

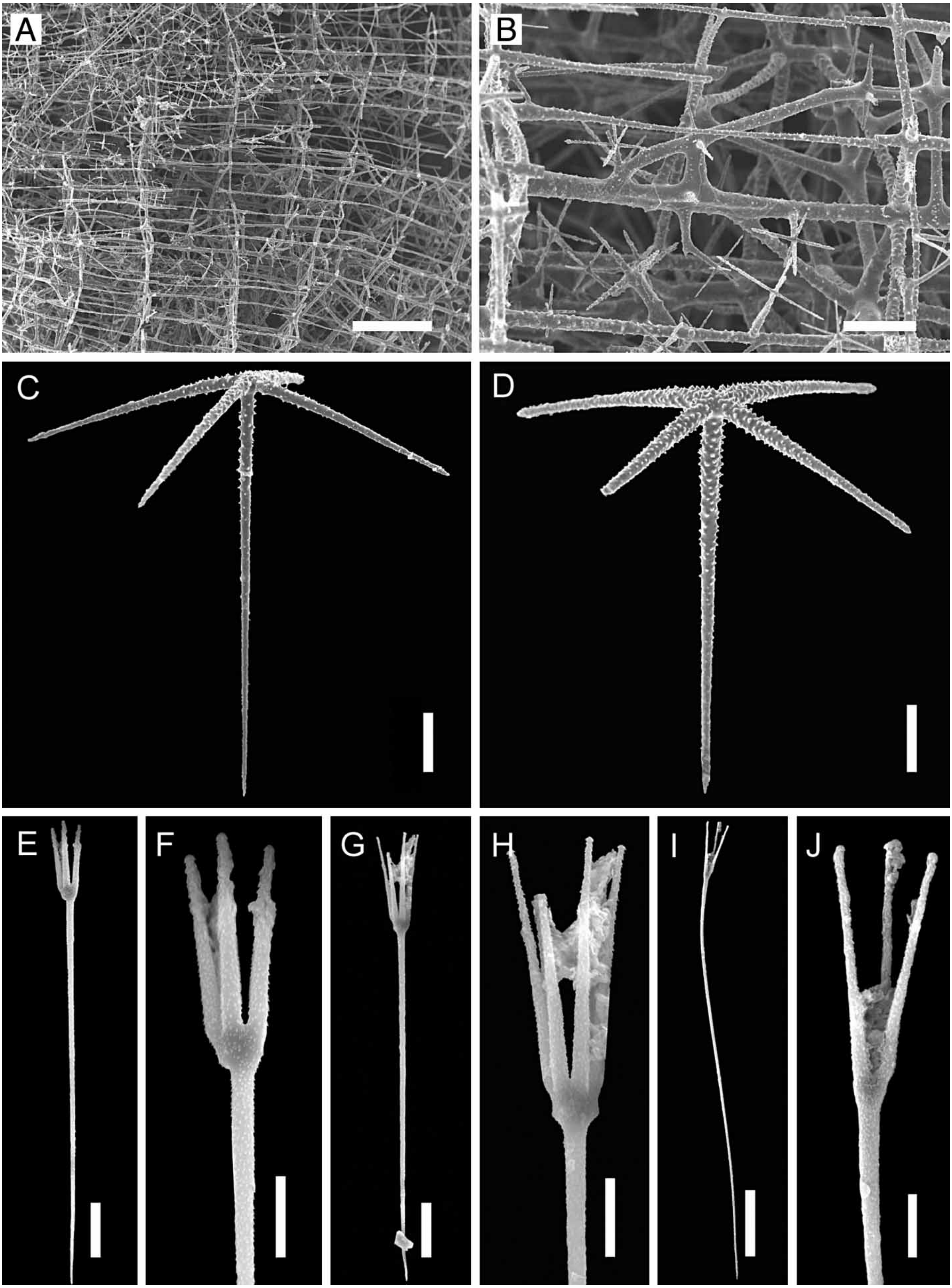

Figure 4. *Chonelasma choanoides* Schulze & Kirkpatrick, 1910. Scanning electron micrographs (A, B: MNRJ 7995; C, D: MNRJ 7319; E, F, I, J: MNRJ 8009A; G, H; MNRJ 7318). (A, B) Atrial skeleton. (C) Dermal pentactin. (D) Atrial pentactin. (E–J) Scopule (scales: A = 1 mm, B = 200 μm, C, D = 100 μm, E, G = 20 μm, F, H, J = 10 μm, I = 50 μm).

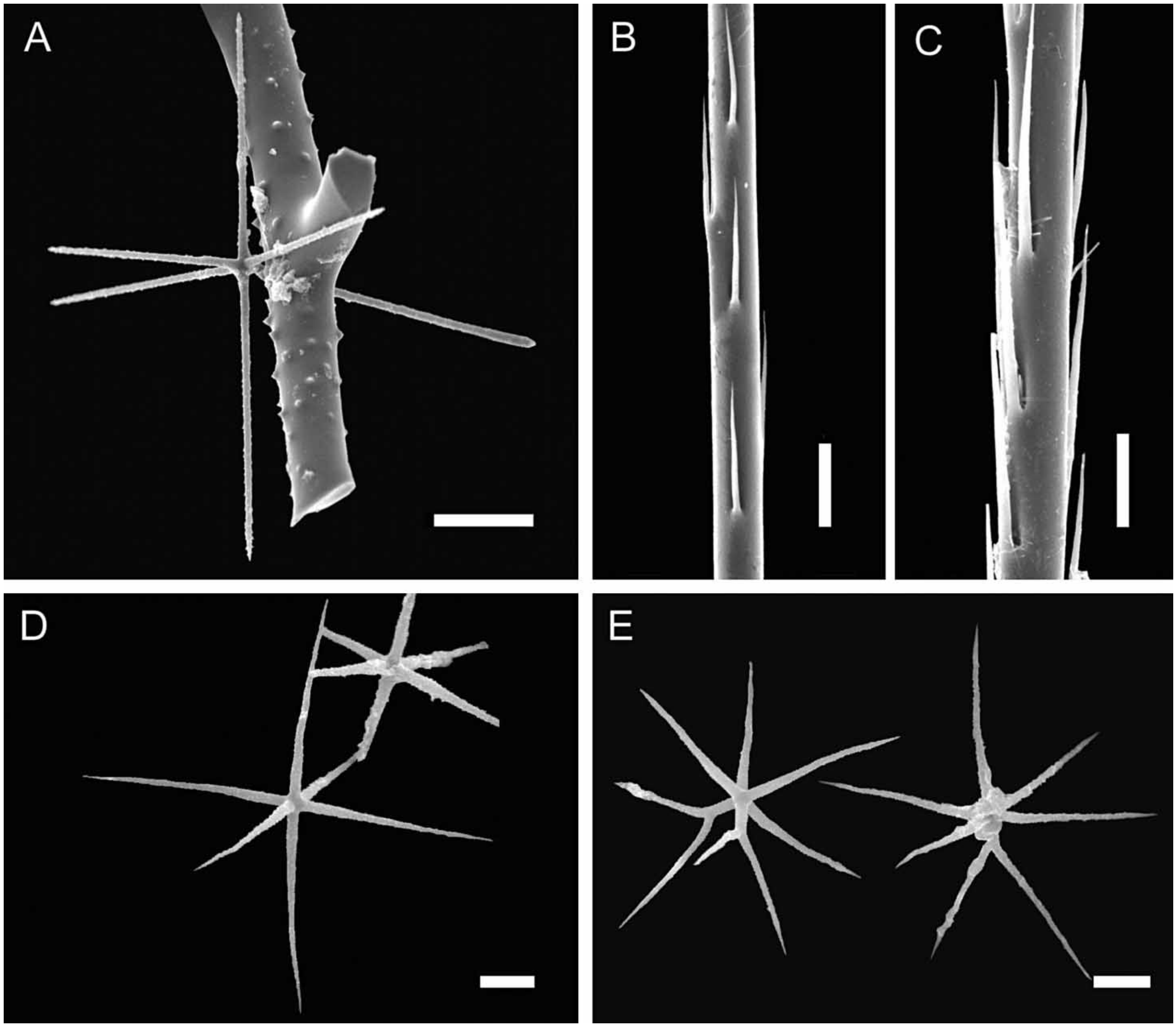

Figure 5. *Chonelasma choanoides* Schulze & Kirkpatrick, 1910. Scanning electron micrographs (A, B, D: MNRJ 7994; C: MNRJ 7995; E: MNRJ 7319). (A) Hexactine. (B, C) Uncinate. (D) Oxyhexactin. (E) Hemioxyhexasters (scales: A = 50 μm, B, C = 20 μm, D, E = 10 μm).

22°20.922′S 39°52.915′W), 1150–1152 m deep, col. R/V *Astro Garoupa*, demersal fisheries net, 25 August 2003.

Diagnosis. Chonelasma with a dictyonal framework divided into three layers, only the dermal one bearing channels; dictyonal beams acanthose in varied degrees. Microscleres are hexactines, hexasters and hemihexasters, which can have oxy-, onycho- and disco-tips.

Description. The specimens are fragmented, and the majority of them are attached to corals. Only two of the studied specimens appear as vaseform (MNRJ 7318 and 7995); the largest fragment/specimen is 190 × 110 mm (length × width; Figure 3A, B). The thickness of the walls vary between 4 and 17 mm. Consistency is rigid and breakable, and the surface is rough. The dermal surface (Figure 3A) is quite distinct from the atrial one, the latter exhibiting a conspicuous quadrangular meshed pattern (Figure 3B). Both the dermal and atrial surfaces have a layer of acanthose pentactines.

Skeleton. The dictyonal framework is divided into three distinct layers (Figure 3C), only the dermal one being channelized. The dermal layer (Figure 3D, E) consists of a network of acanthose dictyonal beams forming regular meshes 625–2250 μm in diameter; this layer is completely perforated by a system of channels (epirhyses), distributed without any clear arrangement (Figure 3E). The intermediary layer is dense and unchannelized (Figure 3F). The thin atrial layer (Figure 4A, B)

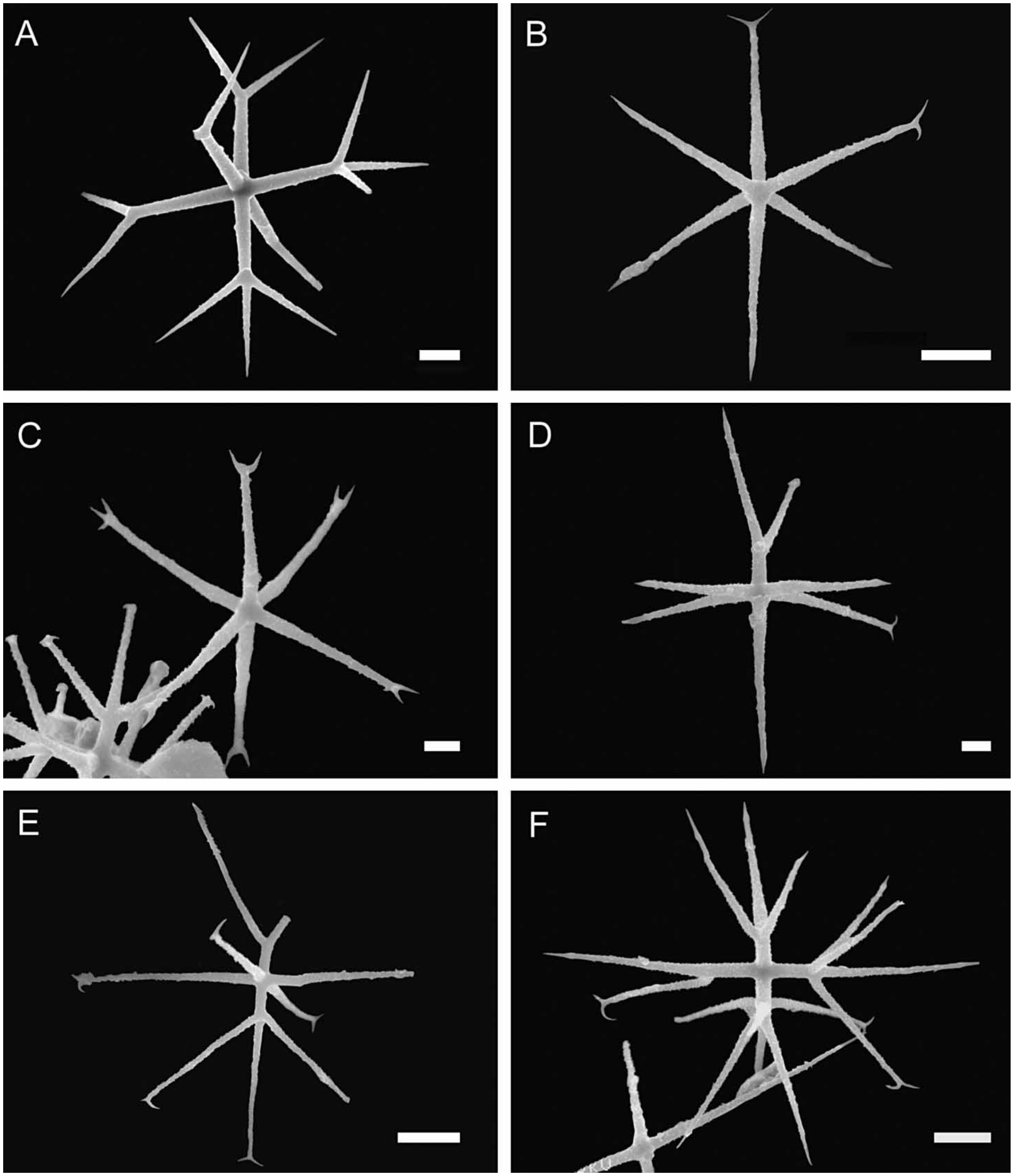

Figure 6. *Chonelasma choanoides* Schulze & Kirkpatrick, 1910. Scanning electron micrographs (A–D, F: MNRJ 7319; E: 7318). (A) Oxyhexaster. (B, C) Onychexactin. (D, E) Hemionychohexasters. (F) Onychexaster (scales = 10 μm).

is formed by an irregular network of fused, medium to small-sized hexactins; the free rays of these hexactines make the atrial surface dense and markedly hispid; polygonal meshes are not clearly seen in this layer. In specimens that are more macerated, only a vestigial atrial layer can be found. The spination on dictyonal beams is highly variable among specimens. These can be completely smooth, moderately acanthose, or completely spined (Table III).

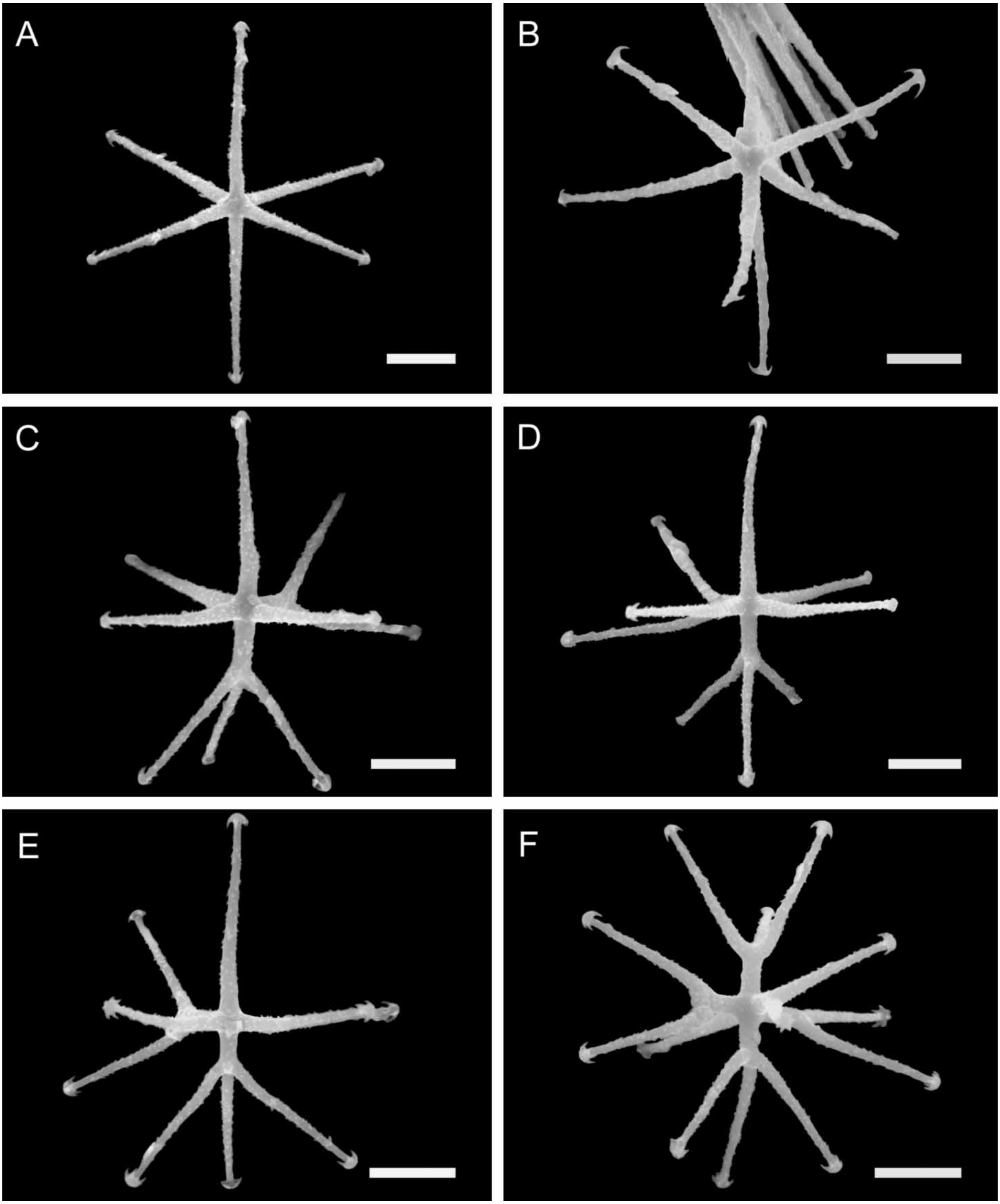

Figure 7. *Chonelasma choanoides* Schulze & Kirkpatrick, 1910. Scanning electron micrographs (A, C–F: MNRJ 7994; B: MNRJ 7319). (A, B) Discohexactin. (C–E) Hemidiscohexasters. (F) Discohexaster (scales = 10 μm).

Spicules. Pentactines of both surfaces are similar, although less abundant on the atrial side. Dermal pentactines (Figure 4C) may be more slender and less acanthose than atrial ones (Figure 4D). The tangential, as well as the proximal rays of these spicules are long and taper gradually; the latter can be larger. Spines on the rays of the pentactines are smaller towards the tips. Scopules (Figure 4E–J)

Table III. *Chonelasma choanoides* Schulze & Kirkpatrick, 1910. Skeletal data in μm: means±standard error$_n$ (smallest–largest).

Dictyonal framework	MNRJ 7317	MNRJ 7318	MNRJ 7319	MNRJ 7994	MNRJ 7995	MNRJ 7999	MNRJ 8009A
Epirhysis diameter	$1100.0 \pm 192.7_8$ (875–1500)	–	$1460.0 \pm 493.9_6$ (1050–2250)	$1487.5 \pm 446.9_6$ (1050–2250)	$1117.5 \pm 232.8_{10}$ (725–1425)	$1137.5 \pm 165.9_{10}$ (825–1400)	$943.8 \pm 198.1_8$ (625–1250)
Epirhysis centre–centre distance width	$2070.0 \pm 290.6_{10}$ (1500–2500)	–	$1775.0 \pm 382.3_8$ (1425–2250)	$1787.5 \pm 357.8_8$ (1425–2250)	$1725.0 \pm 455.2_{10}$ (1125–2500)	$1440.0 \pm 218.6_{10}$ (1125–1825)	$1667.5 \pm 200.4_{10}$ (1400–2000)
Epirhysis septum (margin–margin) width	$840.0 \pm 249.5_{10}$ (500–1325)	–	$655.0 \pm 255.2_8$ (300–900)	$615.6 \pm 212.1_8$ (300–900)	$800.0 \pm 254.1_{10}$ (375–1150)	$465.0 \pm 120.9_{10}$ (250–625)	$712.5 \pm 228.9_{10}$ (450–1125)
Lamella spacing width	– (600–1100)	$790.6 \pm 151.2_8$ –	–	(825–1475)	$1135.0 \pm 193.0_{10}$ (1175–1750)	$1410.0 \pm 242.8_{10}$	$1325–1500_2$

are localized under the surface; dermal and atrial ones are similar, with three to seven slightly divergent terminations bearing microacanthose heads and shafts. Mesohexactines are regular (Figure 5A), with small thorns along the rays. Uncinates (Figure 5B, C) have barb-like thorns along the shaft. Microscleres are oxyhexactins (Figure 5D), hemioxyhexasters (Figure 5E), oxyhexasters (Figure 6A), onychexactins (Figure 6B, C), hemionychexasters (Figure 6D, E), onychexasters (Figure 6F), discohexactins (Figure 7A, B), hemidiscohexasters (Figure 7C–E), discohexasters (Figure 7F), and irregular forms of these microscleres. The ratio of the different microsclere categories varies considerably among specimens, and a clear characterization of the microsclere component can only be achieved under scanning electron microscope due to the minute terminations shown by some of these (Table IV).

Distribution and ecology. The species is known from the North Atlantic, Antarctic and the southern Indian Ocean (Crozet Island; Schulze 1887), between 823 and 3397 m (Reiswig & Mehl 1994). This is the first record of the species for the South Atlantic. Specimens MNRJ 7317, 7318, 7994, 7995 and 8009A are attached to the coral *Lophelia pertusa* (Linnaeus, 1758).

Observations. Chonelasma currently contains four valid species, namely *C. lamella* Schulze, 1886 (New Zealand), *C. doederleini* Schulze, 1886 (Japan), *C. ijimai* Topsent, 1901 (Azores) and *C. choanoides* Schulze & Kirkpatrick, 1910. Among these, *C. lamella* is the closest species to *C. choanoides*, due to a considerable similarity in spicules and the dictyonal framework. The main difference between both species is in the atrial layer – unchannelized in *C. choanoides* and channelized in *C. lamella*. Additionally, pentactines and scopules differ in shape in the two species, as do the dimensions of the microscleres and other less conspicuous traits (Reiswig & Mehl 1994).

The fragmentary state of a considerable portion of the MNRJ material and the occurrence of specimens bearing no free spicules hampered the full identification of some samples of *Chonelasma* collected during REVIZEE (MNRJ 3346 and 3349) and by OCEANPROF (MNRJ 7320, 7321, 7341 and 8022). These specimens have markedly differentiated surfaces – with a clearly discernible quadrangular arrangement on the atrial surface and channelization on the dermal side only. They probably all belong to *C. choanoides*, but the lack of free spicules prevents their full, confident identification.

Table IV. *Chonelasma choanoides* Schulze & Kirkpatrick, 1910. Skeletal data in μm: means $\pm$ standard error$_n$ (smallest–largest).

Spicules	MNRJ 7317	MNRJ 7318	MNRJ 7319	MNRJ 7994	MNRJ 7995	MNRJ 7999	MNRJ 8009A
Dermal pentactin							
Tangential ray length	$267.5 \pm 121.6_{6}$ (145–420)	$258.8 \pm 68.2_{4}$ (185–350)	$266.9 \pm 90.0_{8}$ (155–405)	$323.9 \pm 72.0_{14}$ (205–480)	$280.0 \pm 48.7_{6}$ (230–340)	$286.4 \pm 54.6_{25}$ (155–425)	$263.8 \pm 62.6_{25}$ (160–370)
Tangential ray width	$36.5 \pm 19.8_{5}$ (15–60)	$17.5 \pm 10.1_{4}$ (15–20)	$28.1 \pm 10.3_{9}$ (18–48)	$23.0 \pm 7.3_{10}$ (13–38)	$18.8 \pm 3.5_{6}$ (15–23)	$31.5 \pm 7.4_{10}$ (20–43)	$22.3 \pm 6.4_{10}$ (13–33)
Proximal ray length	$417.0 \pm 280.6_{5}$ (165–745)	$211.7 \pm 40.4_{3}$ (165–235)	$330.0 \pm 115.5_{6}$ (245–550)	$381.7 \pm 219.6_{6}$ (165–710)	$318.0 \pm 69.8_{5}$ (240–400)	$195–395_{2}$	$332.0 \pm 95.9_{23}$ (150–540)
Proximal ray width	$31.0 \pm 18.7_{5}$ (13–55)	$17.5 \pm 5.0_{3}$ (13–23)	$22.9 \pm 5.8_{6}$ (18–33)	$22.5 \pm 4.9_{6}$ (10–23)	$13.5 \pm 1.4_{5}$ (13–15)	$21.7 \pm 8.2_{6}$ (15–38)	$18.8 \pm 8.8_{10}$ (10–40)
Mesohexactine ray length	$139.6 \pm 27.5_{6}$ (105–173)	$143.6 \pm 35.6_{25}$ (93–228)	$181.3 \pm 72.9_{8}$ (95–285)	$110.3 \pm 39.0_{25}$ (45–198)	$132.5 \pm 36.8_{25}$ (80–218)	$114.3 \pm 30.2_{25}$ (50–173)	$122.4 \pm 25.4_{25}$ (80–193)
Ray width	$6.0 \pm 1.4_{5}$ (5–8)	$6.3 \pm 1.8_{10}$ (5–10)	$11.3 \pm 4.4_{8}$ (5–18)	$7.0 \pm 2.8_{10}$ (5–13)	$7.0 \pm 4.2_{10}$ (3–18)	$5.8 \pm 1.7_{10}$ (5–10)	$6.8 \pm 2.1_{10}$ (5–10)
Microscleres							
Oxyhexaster diameter	$71.5 \pm 9.6_{25}$ (53–90)	$75.9 \pm 13.0_{25}$ (50–98)	$74.8 \pm 14.6_{25}$ (58–108)	$50–53_{2}$	$46.5 \pm 4.9_{5}$ (40–53)	$76.1 \pm 21.0_{25}$ (43–138)	$73.8 \pm 12.5_{25}$ (53–98)
Discohexaster diameter	$59.9 \pm 9.5_{25}$ (43–75)	$60.6 \pm 9.2_{25}$ (48–78)	$53.3 \pm 10.0_{25}$ (38–73)	$48.1 \pm 9.6_{25}$ (35–73)	$45.2 \pm 5.8_{25}$ (35–63)	$56.1 \pm 9.5_{25}$ (40–78)	$56.9 \pm 3.8_{4}$ (53–60)
Onychexaster diameter	$62.6 \pm 12.3_{25}$ (35–88)	$68.1 \pm 10.9_{25}$ (43–88)	$59.0 \pm 9.7_{25}$ (35–75)	43_{1}	$50.2 \pm 8.4_{21}$ (40–70)	$63.0 \pm 10.0_{25}$ (48–83)	$65.1 \pm 11.0_{25}$ (48–90)
Scopule length (total)	$279.6 \pm 144.4_{25}$ (150–585)	$188.4 \pm 30.4_{25}$ (130–285)	$290.6 \pm 214.5_{25}$ (140–1015)	$147.8 \pm 13.2_{25}$ (120–175)	$154.8 \pm 14.3_{25}$ (125–185)	$150.0 \pm 10.0_{6}$ (135–165)	$184.6 \pm 70.9_{25}$ (120–445)
Length (head)	$50.5 \pm 17.5_{25}$ (28–93)	$38.3 \pm 5.3_{25}$ (28–53)	$46.7 \pm 16.7_{25}$ (30–80)	$34.3 \pm 3.3_{25}$ (28–40)	$33.2 \pm 2.8_{25}$ (28–38)	$34.6 \pm 1.9_{6}$ (33–38)	$34.0 \pm 7.8_{25}$ (28–55)
Width (head)	$20.1 \pm 8.3_{25}$ (10–40)	$16.4 \pm 2.3_{25}$ (13–20)	$18.6 \pm 6.8_{25}$ (13–38)	$12.5 \pm 1.9_{25}$ (10–18)	$13.4 \pm 1.9_{25}$ (10–18)	$14.6 \pm 1.0_{6}$ (13–15)	$13.4 \pm 2.3_{25}$ (10–20)
Uncinate length	$1935.0 \pm 816.2_{5}$ (1175–3300)	$1325–2250_{2}$	$2212.5 \pm 925_{4}$ (1450–3550)	2717_{1}	–	1125_{1}	–
Width	$14.5 \pm 2.8_{10}$ (10–20)	$14.3 \pm 3.3_{10}$ (10–20)	$16.0 \pm 2.1_{10}$ (13–18)	$19.0 \pm 2.9_{10}$ (15–23)	$15.8 \pm 1.7_{10}$ (13–18)	$14.8 \pm 1.8_{10}$ (13–18)	$14.3 \pm 2.9_{10}$ (10–18)

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