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Calcareous sponges from São Paulo State, Brazil (Porifera: Calcarea: Calcinea) with the description of two new species

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Calcareous sponges (Calcarea: Calcinea) are being described, for the first time, from São Paulo State, Brazil. A total of five species are described, two of which are new to science (*Clathrina alcatraziensis* sp. nov. and *Leucascus roseus* sp. nov.). The remaining three species have their distribution widened (*Clathrina aurea*, *C. conifera* and *C. tetractina*).

INTRODUCTION

Calcarea is the sole class of Porifera whose skeleton is entirely formed of calcium carbonate (Manuel et al., 2002). All calcareous sponges are marine, and the class is monophyletic (Borchiellini et al., 2001; Manuel et al., 2003, 2004). Two subclasses comprise the Calcarea: Calcinea and Calcaronea. This division was proposed by Bidder (1898) based on the position of the nucleus in the choanocytes, which is basal in Calcinea and apical in Calcaronea. Later on, other characteristics supported this division, such as embryological differences, the arising point of the choanocyte flagellum, and the ontogeny, secretion and angle of the spicules. More recently, molecular data confirmed the monophyly of the Calcarea subclasses (Manuel et al., 2003; Dohrmann et al., 2006; Manuel, 2006).

Currently, there are 662 known species of calcareous sponges, which correspond to 9.5% of all described sponges (van Soest et al., 2005). Although this number is larger than the 5% previously calculated (Manuel et al., 2002), the number of calcareous species is still probably much higher. Recent works on calcareous sponges show an increasing number of species in areas previously poorly studied (e.g. Solé-Cava et al., 1991; Klautau et al., 1994; Wörheide & Hooper, 1999, 2003; Borojevic & Klautau, 2000; Klautau & Borojevic, 2001; Rapp et al., 2001; Klautau & Valentine, 2003; Rapp, 2006). The apparent low diversity of calcareous sponges may probably be a consequence of the low number of specialists actively working on the taxonomy of the class, rather than a true biological phenomenon.

In Brazil, studies on calcareous sponges have been concentrated mainly in the north-eastern (Borojevic & Peixinho, 1976; Muricy & Moraes, 1998; Moraes et al., 2003) and south-eastern regions (Solé-Cava et al., 1991; Klautau et al., 1994; Klautau & Borojevic, 2001; Klautau et al., 2004; Monteiro & Muricy, 2004; Rossi et al., 2006). Notwithstanding these works, Brazilian calcareous sponge biodiversity is still underestimated, even in these regions.

The present study is the first on calcareous sponges from the State of São Paulo, in Brazil's south-east, and is dedicated to the subclass Calcinea. Five species are described, two of which are new to science: *Clathrina aurea* Solé-Cava et al., 1991, *C. conifera* Klautau & Borojevic, 2001, *C. tetractina* Klautau & Borojevic, 2001, *C. alcatraziensis* sp. nov., and *Leucascus roseus* sp. nov.

MATERIALS AND METHODS

Sponges were collected by SCUBA diving during a few sampling campaigns in 2000 and 2002, on four different stations of the northern sector of São Paulo State's coast (south-eastern Brazil): one on the continent [Centro de Biologia Marinha, Universidade de São Paulo (CEBIMar)], two on the São Sebastião Island (between São Pedro and Veloso, and on Celada) and one on Alcatrazes Archipelago (Saco do Oratório) (Figure 1).

Specimens were fixed and preserved in 70% ethanol. For taxonomic identification, spicule and section preparations followed standard procedures (Wörheide & Hooper, 1999; Klautau & Valentine, 2003).

For the micrometry analyses, the width at the base of each actine and its length from tip to base were measured. Measurements were made using an ocular micrometer. The results are presented in tabular form, featuring length (minimum, mean, standard deviation [SD] and maximum), width (mean and SD) and the sample size (N).

Photomicrographs were taken with a digital camera mounted on a Zeiss Axioscop microscope at the Laboratório de Captura de Imagens of the Instituto de Biologia (Universidade Federal do Rio de Janeiro).

All the specimens are deposited in the sponge collection of the Museu Nacional/UFRJ, Brazil (MNRJ).

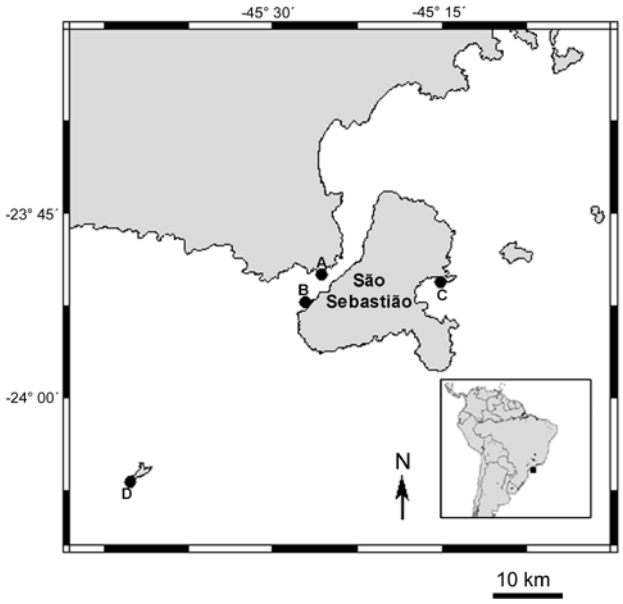

Figure 1. Collection sites in São Paulo State, Brazil. (A) CEBIMar; (B) between São Pedro and Veloso; (C) Celada; (D) Ponta do Oratório, Alcatrazes Archipelago.

SYSTEMATICS

Class CALCAREA Bowerbank, 1864
Subclass CALCINEA Bidder, 1898
Order CLATHRINIDA Hartman, 1958
Family CLATHRINIDAE Minchin, 1900
Genus *Clathrina* Gray, 1867

Diagnosis

'Clathrinidae in which the choanoderm is flat or rarely raised up into conules by the apical actines of the tetractines, but never forms true folds (at least when the sponge is in the normal physiological extended state). The full-grown cormus is composed of anastomosed tubes. The skeleton is composed of regular equiangular and equiradiate triactines and/or tetractines, to which diactines, tripods or tetrapods may be added' (Borojevic et al., 2002 modified by Klautau & Valentine, 2003).

Clathrina aurea Solé-Cava, Klautau, Boury-Esnault, Borojevic & Thorpe, 1991
(Figure 2A–C; Table 1)

Clathrina aurea: Solé-Cava et al., 1991: 382; Muricy & Moraes, 1998: 215; Klautau & Borojevic, 2001: 401; Klautau & Valentine, 2003: 9; Monteiro & Muricy, 2004: 683; Vilanova et al., 2004: 651.

Material examined (three specimens)

MNRJ 2995—between São Pedro and Veloso, São Sebastião Island, São Paulo State, Brazil (23°52.863'S 45°26.930'W; depth 8 m), coll. by E. Hajdu, 6 January 2000. MNRJ 10408; MNRJ 5911—Alcatrazes Archipelago, São Sebastião, São Paulo State, Brazil (24°06'S 45°41'W; depth 12 m), coll. by M. Custódio and C. Santos, 23 May 2002.

Type locality

Arraial do Cabo (Rio de Janeiro State), Brazil.

Description

Cormus formed of large, irregular and loosely anastomosed tubes with many oscula (Figure 2A). Water-collecting tubes are absent. Living specimens have a yellow cormus, which becomes white after preservation in ethanol.

The skeleton has no special organization and it is composed of only equi-angular and equi-radiate triactines (Figure 2B). Actines are cylindrical and slightly undulated near the tip, which is rounded (Figure 2C).

Ecology

Specimens were collected in scyaphilous habitats, sometimes attached to polychaete and bryozoan tubes.

Remarks

Clathrina aurea was originally described in 1991 from Arraial do Cabo in the north-east of Rio de Janeiro State, Brazil. It is a common species of the Brazilian coast, having been sighted in several other localities, such as Fernando de Noronha Archipelago (Pernambuco State) (Muricy & Moraes, 1998), Cagarras Archipelago (Rio de Janeiro State) (Monteiro & Muricy, 2004), and Ilha Grande Bay (Rio de Janeiro State) (Vilanova et al., 2004).

Clathrina conifera Klautau & Borojevic, 2001
(Figure 2D–F; Table 2)

Clathrina primordialis: Mothes-de-Moraes, 1985: 228; Klautau et al., 1994: 372.
Clathrina conifera: Klautau & Borojevic, 2001: 404; Klautau & Valentine, 2003: 18; Monteiro & Muricy, 2004: 683.

Material examined

MNRJ 10409—Alcatrazes Archipelago, São Sebastião, São Paulo State, Brazil (~24°06'S–45°41'W; depth 12 m), coll. by M. Custódio and C. Santos, 23 May 2002.

Type locality

Arraial do Cabo (Rio de Janeiro State), Brazil.

Table 1. *Measurements of the spicules of* Clathrina aurea *(MNRJ 2995).*

Spicule	Length (μm)				Width (μm)		
	Min	Mean	SD	Max	Mean	SD	N
Triactine	45.6	63.2	8.3	74.1	6.8	1.3	30

Table 2. *Measurements of the spicules of* Clathrina conifera *(MNRJ 10409).*

Spicule	Length (μm)				Width (μm)		
	Min	Mean	SD	Max	Mean	SD	N
Triactine	41.8	74.9	10.1	91.2	8.6	1.6	30

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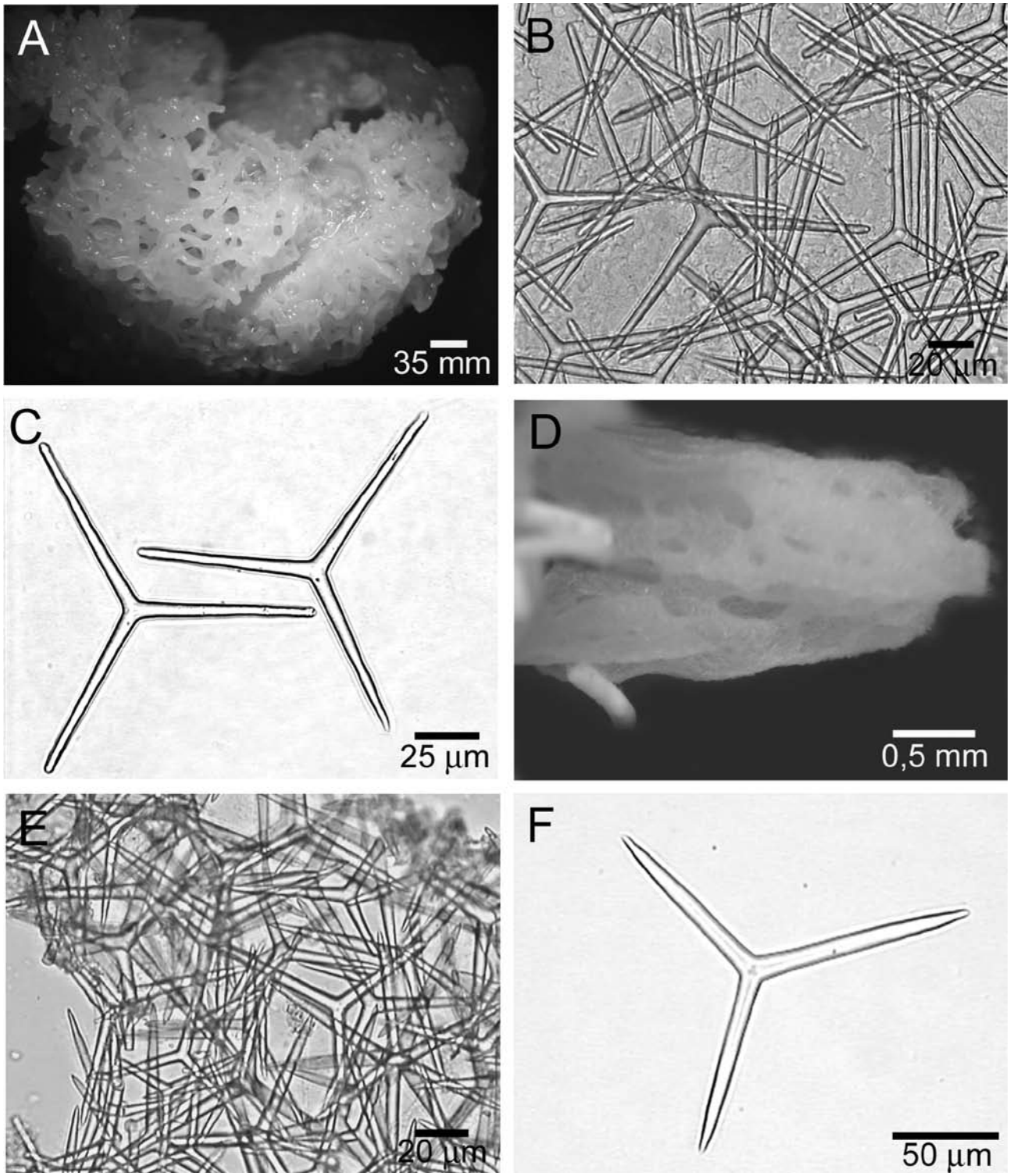

Figure 2. *Clathrina aurea* and *C. conifera*. (A) Preserved specimen of *C. aurea*; (B) section of tube wall of *C. aurea*; (C) triactines of *C. aurea*; (D) preserved specimen of *C. conifera*; (E) section of tube wall of *C. conifera*; (F) triactine of *C. conifera*.

Description

Cormus formed of large, irregular and loosely anastomosed tubes (Figure 2D), white in life and beige when preserved. Water-collecting tubes are absent.

The skeleton is composed only of triactines without any special organization (Figure 2E). They are equi-radiate and equi-angular. Actines are conical and straight with blunt tips (Figure 2F).

Ecology

The specimen was found attached to small hard corals.

Remarks

Clathrina conifera was first described from Arraial do Cabo (Rio de Janeiro State, Brazil). Since then, this species has been sighted only in one other locality also in Rio de Janeiro State, the Cagarras Archipelago (Monteiro & Muricy, 2004).

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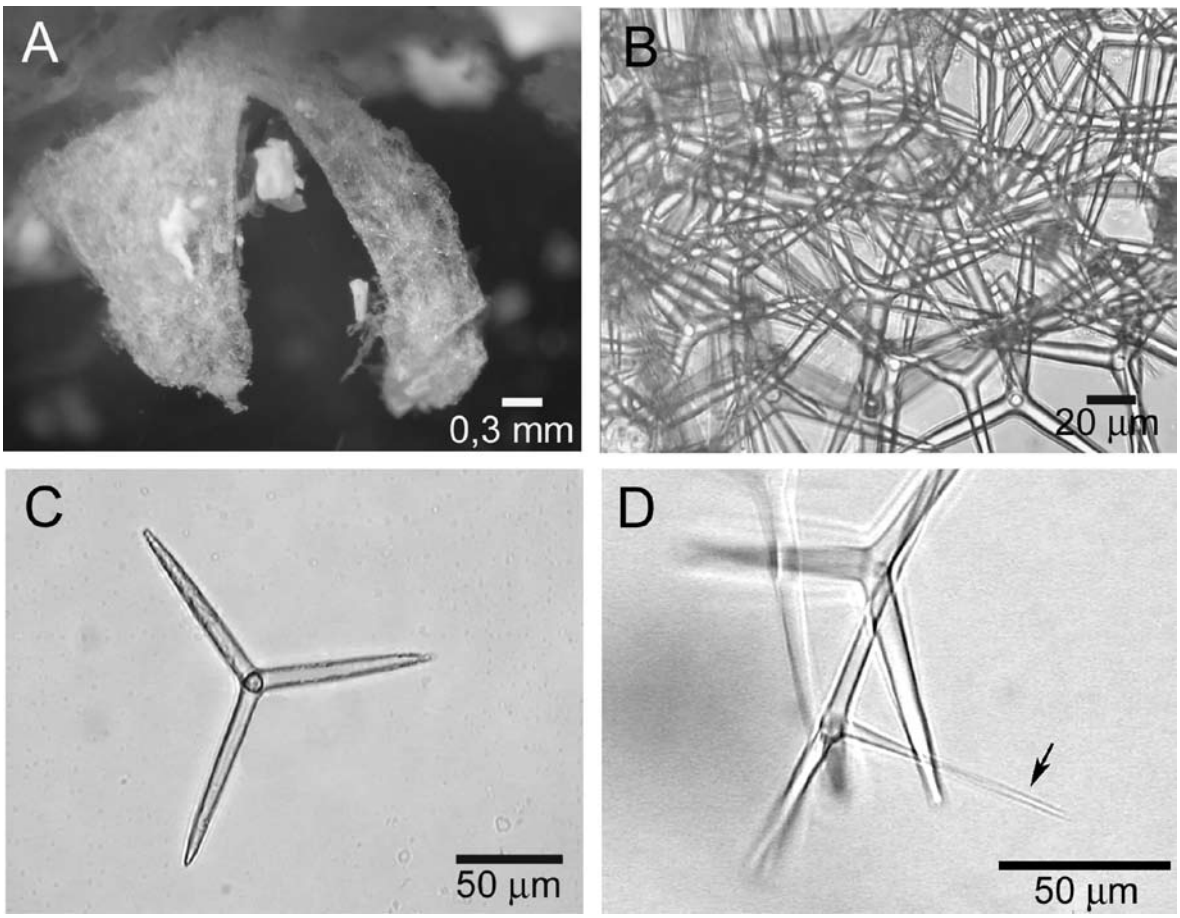

Figure 3. *Clathrina tetractina*. (A) Preserved specimen; (B) section of tube wall; (C) tetractine; (D) apical actine of a tetractine (arrow).

Clathrina tetractina Klautau & Borojevic, 2001
(Figure 3A–D; Table 3)

Clathrina tetractina: Klautau & Borojevic, 2001: 408; Klautau & Valentine, 2003: 42.

Material examined

MNRJ 5855—Celada, Castelhanos Bay, São Sebastião Island, Ilhabela, São Paulo State (23°50.563'S–45°14.402'W; depth 8 m), coll. by E. Hajdu and M. Carvalho, 1 May 2002.

Type locality

Arraial do Cabo (Rio de Janeiro State), Brazil.

Description

Cormus formed of large, irregular and loosely anastomosed tubes (Figure 3A). Colour is white alive and beige when preserved. Oscula are spread throughout the cormus.

The skeleton has no special organization (Figure 3B). It is composed mainly of tetractines, but few triactines are also present. Spicules are equi-angular and equi-radiate. Actines are conical, straight and sharp (Figure 3C). The apical actine of the tetractines is very thin, long, smooth, cylindrical, straight and sharp (Figure 3D).

Ecology

The specimen was found hidden in a coralline structure.

Table 3. *Measurements of the spicules of* Clathrina tetractina *(MNRJ 5855).*

Spicule	Actine	Length (µm)				Width (µm)		
		Min	Mean	SD	Max	Mean	SD	N
Tetractine		64.6	78.3	9.0	95.0	8.1	1.0	30
	Apical	28.0	52.0	10.6	72.0	4.0	1.1	30
Triactine		38.0	74.2	14.0	95.0	8.4	1.2	30

Remarks

This species seems to be rare. Since the original description, this is the first time that it has been found again.

Clathrina alcatraziensis sp. nov.
(Figure 4E,F; Tables 4 & 5)

Type material

Holotype: MNRJ 5859—Alcatrazes Archipelago, São Sebastião, São Paulo State, Brazil (24°06'S–45°41"W; depth 8 m), coll. by E. Hajdu and J. Rocha, 2 May 2002.

Paratype: MNRJ 10410—Alcatrazes Archipelago, São Sebastião, São Paulo State, Brazil (24°06'S–45°41'W; depth 12 m), coll. by M. Custódio and C. Santos, 03 May 2002.

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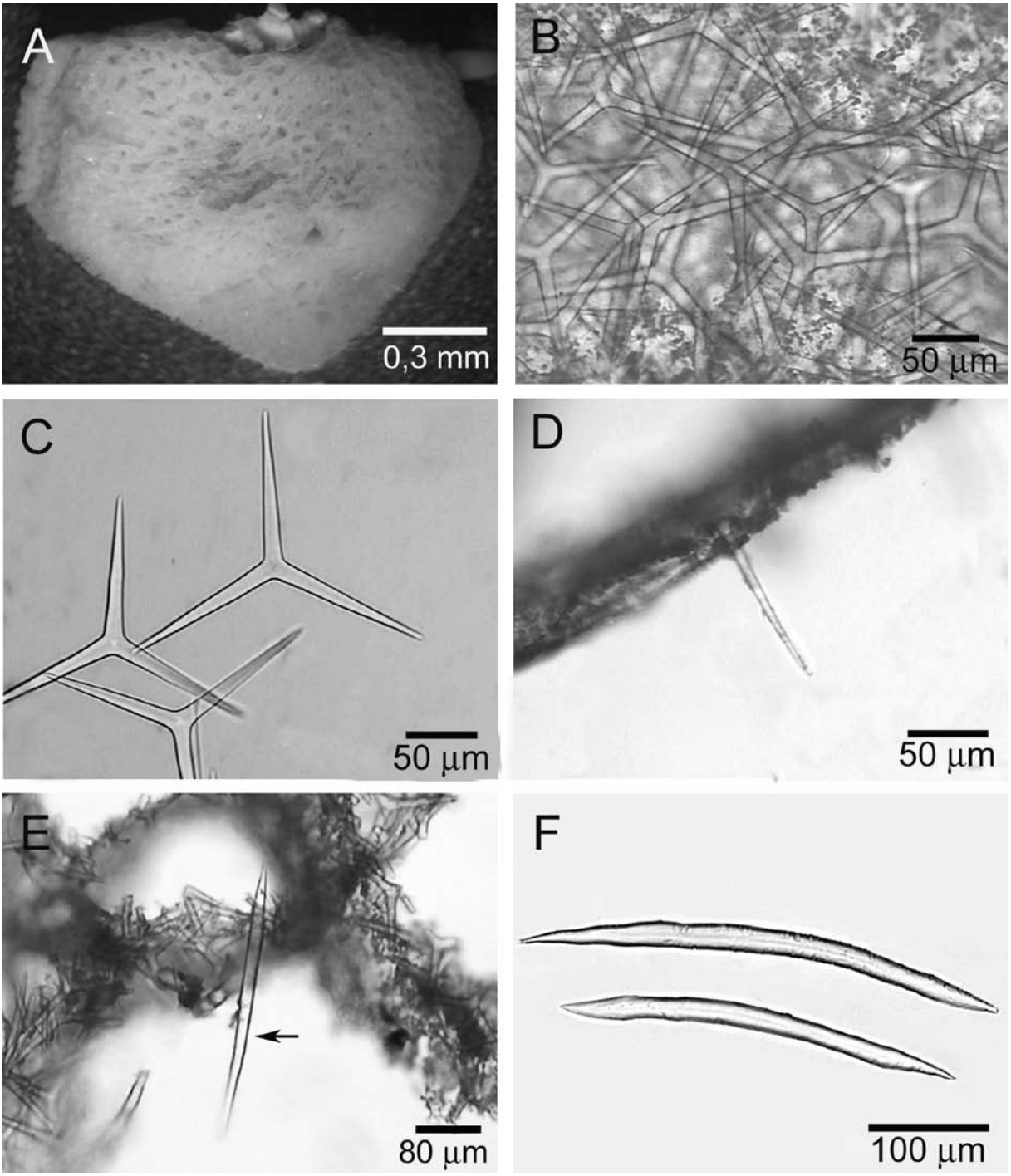

Figure 4. *Clathrina alcatraziensis* sp. nov. (A) Holotype after fixation; (B) section of tube wall; (C) triactines; (D) cross section of a tube showing the apical actine of a tetractine; (E) section of tube wall with a diactine perpendicular to the surface (arrow); (F) diactines.

Table 4. *Measurements of the spicules of the holotype of* Clathrina alcatraziensis *sp. nov. (MNRJ 5859).*

Spicule	Actine	Length (µm)				Width (µm)		
		Min	Mean	SD	Max	Mean	SD	N
Triactine		76.0	97.2	9.8	117.8	12.5	1.5	30
Tetractine		108.3	127.8	14.4	155.8	14.8	2.0	30
	Apical	48.0	96.0	16.9	120.0	8.0	1.6	30
Diactine		163.4	358.9	106.3	596.6	20.8	4.8	30

Table 5. *Measurements of the spicules of the paratype of* Clathrina alcatraziensis *sp. nov. (MNRJ 5818).*

Spicule	Actine	Length (µm)				Width (µm)		
		Min	Mean	SD	Max	Mean	SD	N
Triactine		83.4	100.0	9.7	118.1	13.9	2.2	30
Tetractine		88.0	96.0	7.5	120.0	8.0	1.9	30
	Apical	40.0	60.0	12.5	80.0	7.0	1.8	12
Diactine		144.0	328.0	135.2	736.0	16.0	7.0	26

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Etymology

From the type locality.

Type locality

Alcatrazes Archipelago, São Sebastião, São Paulo State, Brazil.

Description

The cormus is spherical, composed of thin, regular and tightly anastomosed tubes (Figure 4A). The anastomosis of the external tubes is tighter than that of the internal ones. Surface is hispid because of a large amount of diactines. Water-collecting tubes are present. Colour is white alive and beige when preserved.

The skeleton is composed of triactines, diactines and rare tetractines. The triactines and the tetractines have no special organization (Figure 4B). They are equi-angular and equi-radiate. Actines are straight, conical and sharp (Figure 4C). The apical actine of the tetractines is projected inside the tubes (Figure 4D). It is straight or undulated, sometimes slightly curved near the tip, smooth, slightly conical to cylindrical and sharp. Diactines are perpendicular to the surface (Figure 4E). They are slightly arrow shaped, almost fusiform. The tip that penetrates the cormus is larger than the distal one. Both tips are sharp. The size of the diactines is very variable (Figure 4F). On the surface, several trichoxeas are also present.

Remarks

Only six known species of *Clathrina* have diactines: *C. atlantica* (Thacker, 1908); *C. contorta* Minchin, 1905; *C. dubia* (Dendy, 1891); *C. hirsuta* Klautau & Valentine, 2003; *C. panis* (Haeckel, 1872); and *C. reticulum* (Schmidt, 1862). *Clathrina alcatraziensis* sp. nov. can be distinguished from *C. atlantica* mainly by the presence of two categories of tetractines in the latter. Comparing our species to *C. contorta*, it can also be easily distinguished because the main spicule type in *C. alcatraziensis* sp. nov. is the triactine, while in *C. contorta* it is the tetractine.

The skeleton of the new species is very similar to that of *C. dubia* and *C. hirsuta*. Nonetheless, the shape of the diactines in *C. dubia* is club-shaped and in *C. hirsuta* it is fusiform, while in *C. alcatraziensis* sp. nov. it is almost fusiform, but one of the tips is slightly arrow-shaped. Besides these differences in the skeleton, the cormus of *C. dubia* and *C. hirsuta* is formed of tubes irregular and loosely anastomosed, while *C. alcatraziensis* sp. nov. has regular and tightly anastomosed tubes.

The north-western Atlantic species *C. panis* also differs from *C. alcatraziensis* sp. nov. because it has an irregular and loosely anastomosed cormus and, additionally, it shows a pseudoatrium. The most similar species to *C. alcatrazienis* sp. nov. is *C. reticulum*, however, *C. reticulum* bears a pseudoatrium.

Family LEUCASCIDAE Dendy, 1892
Genus *Leucascus* Dendy, 1892

Type species

Leucascus simplex Dendy, 1892 by subsequent designation (Dendy & Row 1913).

Diagnosis

'Leucascidae with copiously branched and anastomosed choanocyte tubes. The exhalant aquiferous system is represented by a well-developed atrium delimited by a specific wall with no choanoderm' (Borojevic et al., 2002).

Leucascus roseus sp. nov.
(Figure 5A–F;, Table 6)

Type material

Holotype: MNRJ 5827—Alcatrazes Archipelago, São Sebastião, São Paulo State, Brazil (24°06'S–45°41'W; depth 14 m), coll. by E. Hajdu and M. Custódio, 2 May 2002.

Etymology

From Latin *roseus*: rosy. Describing the colour of the body.

Type locality

Alcatrazes Archipelago, São Sebastião, São Paulo State, Brazil.

Description

The holotype has a large massive and lobate body, with apical oscula surrounded by a delicate membrane (Figure 5A). This membrane covers the entire cormus, which is composed of regular and tightly anastomosed tubes. Below each osculum there is an atrium without choanoderm, perforated by several apertures of exhalant canals. Colour is light pink in life and white after preservation.

The skeleton is composed of equiangular and equiradiate triactines and few tetractines. Actines are cylindrical and sharp (Figures 5B,C). The apical actine of the tetractines is thinner than the basal ones, smooth, straight, cylindrical and sharp at the end (Figure 5D).

The membrane that surrounds the cormus is composed mainly of triactines (Figure 5E), while the membrane of the atrium is composed mainly of tetractines (Figure 5F). The few atrial triactines are similar to those of the cortical membrane and of the tubes. Few tetractines are also present in the tubes.

Remarks

The number of species of *Leucascus* is uncertain, since some of the large calcareous sponges described under the name *Leucosolenia* in the Indo-Pacific region are probably *Leucascus* (Borojevic & Klautau, 2000). However, if we consider only the species formally described as *Leucascus* or which were formally transferred to this genus, there will be six species: *L. simplex* Dendy, 1892; *L. clavatus* Dendy, 1892; *L. neocaledonicus*

Table 6. *Measurements of the spicules of the holotype of* Leucascus roseus *sp. nov. (MNRJ 5827).*

Spicule	Actine	Length (μm)				Width (μm)		
		Min	Mean	SD	Max	Mean	SD	N
Triactine		72.2	92.5	11.6	114.0	7.3	1.5	30
Tetractine		72.2	92.7	8.14	106.4	7.3	0.9	30
	Apical	26.4	51.2	14.2	85.8	3.3	0.9	30

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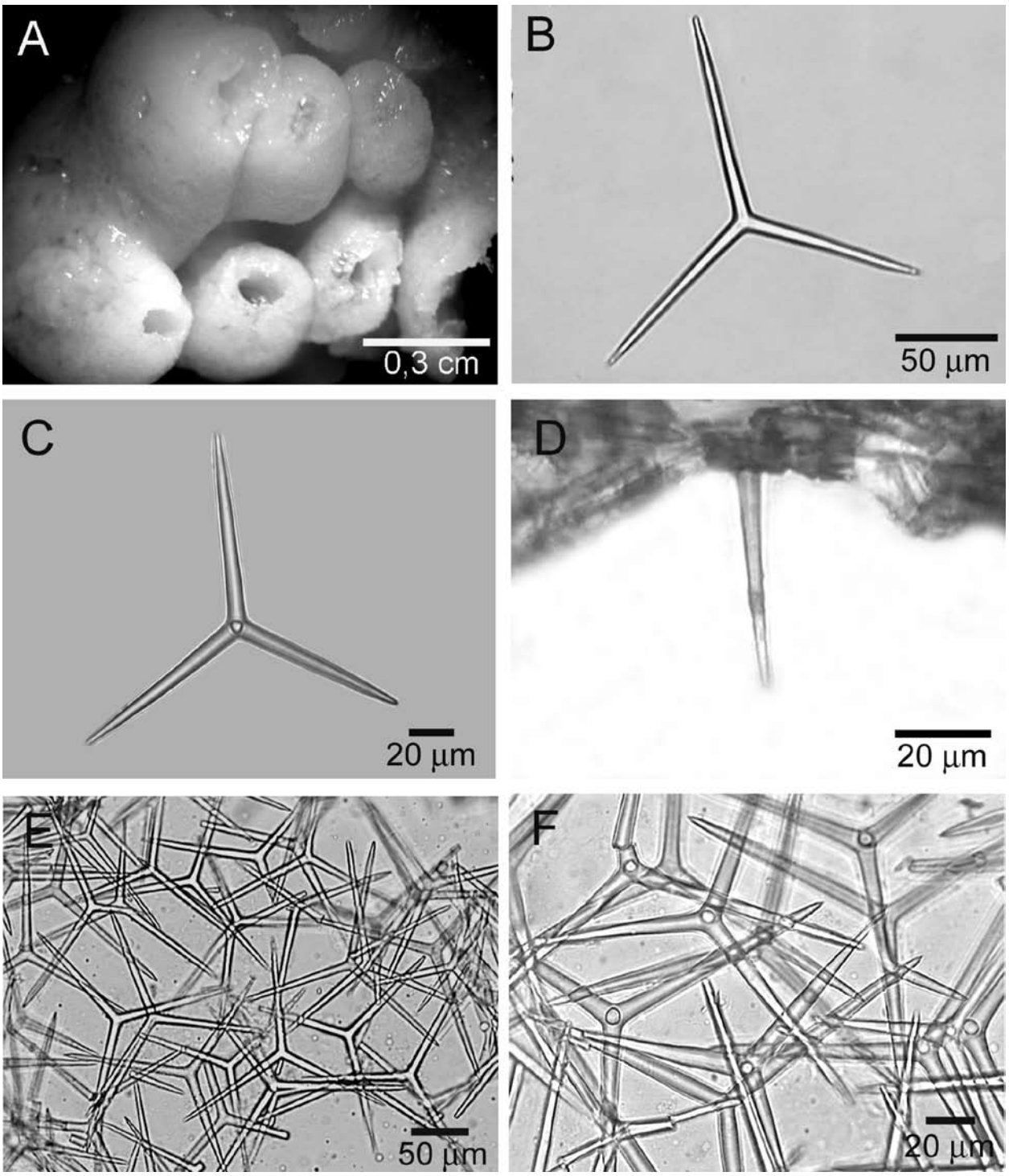

Figure 5. *Leucascus roseus* sp. nov. A, Holotype after fixation; B, triactine; C, tetractine; D, apical actine of a tetractine; E, cortical membrane; F, atrial membrane.

Borojevic & Klautau, 2000; *L. lobatus* Rapp, 2004; *L. compressa* (Dendy & Frederick, 1924), originally described as *Ascoleucetta compressa* but placed in the genus *Leucascus* by Borojevic & Klautau (2000); and *L. ventricosa* (Carter, 1886), originally described as a *Clathrina* but considered as *Leucascus* by Klautau & Valentine (2003) and by Rapp (2004).

Leucascus roseus sp. nov. differs from all the other species (including those identified as *Leucosolenia*) by its pink colour. Other characters, however, also differentiate this species from the others. *Leucascus simplex* has triactines with conical actines, while *L. roseus* sp. nov. has spicules with cylindrical actines. Moreover, our species has triactines and tetractines, while Dendy (1892) said that in *L. simplex* 'All the spicules are alike except that some exhibit an incipient apical ray'. We understand by this sentence that tetractines are rare in *L. simplex* and that, when present, they do not have a well formed apical actine as in the tetractines of *L. roseus* sp. nov. In relation to *L. clavatus*, *L. roseus* sp. nov. is different because it has no diactines, while *L. clavatus* has club-shaped diactines protruding through the cortex. *Leucascus neocaledonicus* is very similar to *L. roseus* sp. nov., though the former has two different categories of triactines, one in the cortex

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[130.0 (±27.0)/12.0 (±2.5) μm] and another in the tubes [100 (±14.0)/10 (±1.5) μm], while *L. roseus* sp. nov. has only one category of triactines. In addition, the tetractines are more abundant in *L. neocaledonicus* than in *L. roseus* sp. nov. *Leucascus lobatus* has also two categories of triactines, which differentiate it from *L. roseus* sp. nov. *Leucascus lobatus* also has larger spicules: cortical triactines [181 (±21.1)/10.9 (±1.3) μm] and choanosomal triactines [148.0 (±13.2)/6.9 (±0.9) μm].

Other species of *Leucosolenia* that Rapp (2004) indicated to be included in *Leucascus* are: *Leucosolenia amitsbo* Hôzawa, 1929 and *L. soyo* Hôzawa, 1933, both from Japan. The large triactines on the cortex of *L. amitsbo* (220–500/20–30 μm) and *L. soyo* (160–190/14–18 μm) differentiate them from *L. roseus* sp. nov. Another species that Rapp (2004) indicated to be included in *Leucascus* is *Leucettusa mariae* Brondsted, 1926. This species differs from ours by the presence of two categories of triactines and two of tetractines found by Rapp (2004) during his analyses of the holotype. The last species we would like to comment on is *Leucascus insignis* (Row & Hôzawa, 1931). Dendy & Row (1913) had assigned this species to the genus *Leucascus* saying that it was a new species that would be soon published by Row. However, it took several years for this species to be published, and it was named by Row & Hôzawa (1931) *Leucetta insignis*. To our knowledge, nobody has analysed the type of this species and transferred it to *Leucascus* until now, however, there is a suspicion that this sponge can be a *Leucascus* (Rapp, 2004). Therefore, we compared our species with the original description of *L. insignis*. This species differs from ours by its large tripods on the cortex, triactines inside the cormus and two categories of tetractines. *Leucascus roseus* sp. nov. is the second species of *Leucascus* described for the Atlantic Ocean.

DISCUSSION

From a biogeographical perspective, the five species reported here represent at least three different stocks. *Clathrina aurea* is a Brazilian endemic. *Clathrina conifera* and *C. tetractina* are Paulista Province endemics. And the two new species reported here are provisional endemics of the Alcatrazes Archipelago. Nevertheless, some field observations conducted in the 1980s by E. Hajdu revealed the occurrence of a clathroid, light-pink sponge at Arraial do Cabo (Rio de Janeiro State) and the Abrolhos Marine National Park (Bahia State), which are suggestive of *Leucascus roseus* sp. nov. widespread occurrence along the coast of Brazil.

The Alcatrazes Archipelago proved to be a rich ground for the collection of sponges, especially of the Class Calcarea. The large number of Calcaronea encountered will be reported upon elsewhere. As this material originated from a few days of field trip to this area in 2000 and 2002, it is likely that further collecting efforts will raise these findings considerably.

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REFERENCES

Bidder, G.P., 1898. The skeleton and classification of calcareous sponges. *Proceedings of the Royal Society of London*, **64**(403), 61–76.

Borchiellini, C., Manuel, M., Boury-Esnault, N., Vacelet, J. & Le Parco, Y., 2001. Sponge paraphyly and the origin of Metazoa. *Journal of Evolutionary Biology*, **14**, 171–179.

Borojevic, R., Boury-Esnault, N., Manuel, M. & Vacelet, J., 2002. Order Clathrinida Hartman, 1958. In *Systema Porifera. A guide to the classification of sponges* (ed. J.N.A. Hooper and R.W.M. van Soest), pp. 1141–1152. New York: Kluwer Academic/Plenum Publishers.

Borojevic, R. & Klautau, M., 2000. Calcareous sponges from New Caledonia. *Zoosystema*, **22**, 187–201.

Borojevic, R. & Peixinho, S., 1976. Éponges calcaires du nord-nord-est du Brésil. *Bulletin du Muséum National d'Histoire Naturelle (Paris, Zoologie)*, **3**(402), 988–1036.

Brondsted, H.V., 1926. Papers from Dr. Th. Mortensen's Pacific Expedition 1914–16. XXXV. Sponges from New Zealand. Part II. *Meddelelser fra Dansk natur-historisk Forening*, **81**, 295–331.

Carter, H.J., 1886. Descriptions of sponges from the neighbourhood of Port Phillip Heads. *Annals and Magazine of Natural History*, **17**, 502–516.

Dendy, A., 1891. A Monograph of the Victorian Sponges. I—The organisation and classification of the Calcarea Homocoela, with descriptions of the Victorian species. *Transactions of the Royal Society of Victoria*, **3**, 1–81.

Dendy, A., 1892. Synopsis of the Australian Calcarea Heterocoela; with a proposed classification of the group and descriptions of some new genera and species. *Proceedings of the Royal Society of Victoria*, **5**, 69–116.

Dendy, A. & Frederick, L.M., 1924. On a collection of sponges from the Abrolhos Islands, Western Australia. *Journal of the Linnean Society of London, Zoology*, **35**, 477–519.

Dendy, A. & Row, R.W.H., 1913. The classification and phylogeny of the Calcareous sponges, with a reference list of all the described species, systematically arranged. *Proceedings of the Zoological Society of London*, **47**, 704–813.

Dohrmann, M., Voigt, O., Erpenbeck, D. & Wörheide, G., 2006. Non-monophyly of most supraspecific taxa of calcareous sponges (Porifera, Calcarea) revealed by increased taxon sampling and partitioned Bayesian analysis of ribosomal DNA. *Molecular Phylogenetics and Evolution*, **40**, 830–843.

Gray, J., 1867. Notes on the arrangement of sponges with the description of some new genera. *Proceedings of the Zoological Society of London*, **2**, 492–558.

Haeckel, E., 1872. *Die Kalkschwämme, eine Monographie*, vols 1–3. Berlin: Verlag von Georg Reimer.

Hôzawa, S., 1929. Studies on the calcareous sponges of Japan. *Journal of the Faculty of Science of the University of Tokyo, Zoology*, **1**, 277–389.

Hôzawa, S., 1933. Report on the calcareous sponges obtained by the survey of the Continental Shelf bordering on Japan. *Science Reports of the Tohoku Imperial University*, **8**, 1–20.

Klautau, M. & Borojevic, R., 2001. Sponges of the genus *Clathrina* Gray, 1867 from Arraial do Cabo, Brazil. *Zoosystema*, **23**, 395–410.

Klautau, M., Monteiro, L. & Borojevic, R., 2004. First occurrence of the genus *Paraleucilla* (Calcarea, Porifera) in the Atlantic Ocean: *P. magna* sp. nov. *Zootaxa*, **710**, 1–8.

Klautau, M., Solé-Cava, A.M. & Borojevic, R., 1994. Biochemical systematics of sibling sympatric species of *Clathrina* (Porifera: Calcarea). *Biochemical Systematics and Ecology*, **22**, 367–375.

Klautau, M. & Valentine, C., 2003. Revision of the genus *Clathrina* (Porifera, Calcarea). *Zoological Journal of the Linnean Society*, **139**, 1–62.

Manuel, M., 2006. Phylogeny and evolution of calcareous sponges. *Canadian Journal of Zoology*, **84**, 225–241.

Manuel, M., Borchiellini, C., Alivon, E. & Boury-Esnault, N., 2004. Molecular phylogeny of calcareous sponges using 18S rRNA and 28S rRNA sequences. *Bollettino dei Musei e degli Istituti Biologici dell'Università di Genova*, **68**, 449–461.

Manuel, M., Borchiellini, C., Alivon, E., Le Parco, Y., Vacelet, J. & Boury-Esnault, N., 2003. Phylogeny and evolution of calcareous sponges: monophyly of Calcinea and Calcaronea, high level of morphological homoplasy, and the primitive nature of axial symmetry. *Systematic Biology*, **52**, 311–333.

Manuel, M., Borojevic, R., Boury-Esnault, N. & Vacelet, J., 2002. Class Calcarea Bowerbank, 1864. In *Systema Porifera. A guide to the classification of sponges* (ed. J.N.A. Hooper and R.W.M. van Soest), pp. 1103–1110. New York: Kluwer Academic/Plenum Publishers.

Minchin, E.A., 1900. Sponges. In *A treatise on zoology*. Part II. *The Porifera and Coelenterata* (ed. E.R. Lankester), pp. 1–178. London: Adam & Charles Black.

Minchin, E.A., 1905. The characters and synonymy of the British species of sponges of the genus *Leucosolenia*. *Proceedings of the Zoological Society of London*, **2**, 306–349.

Monteiro, L. & Muricy, G., 2004. Patterns of sponge distribution in Cagarras Archipelago, Rio de Janeiro, Brazil. *Journal of the Marine Biological Association of the United Kingdom*, **84**, 681–687.

Moraes, F.C., Vilanova, E.P. & Muricy, G., 2003. Distribuição das esponjas (Porifera) na reserva biológica do Atol das Rocas, nordeste do Brasil. *Arquivos do Museu Nacional, Rio de Janeiro*, **61**, 13–22.

Mothes-de-Moraes, B., 1985. Sponges collected by the Oxford diving expedition, to the Cabo Frio upwelling area (Rio de Janeiro, Brasil). *Studies on Neotropical Fauna and Environment, Lisse*, **20**, 227–237.

Muricy, G. & Moraes, F.C., 1998. Marine sponges of Pernambuco State, NE Brazil. *Revista Brasileira de Oceanografia*, **46**, 213–217.

Rapp, H.T., 2004. The first record of the genus *Leucascus* Dendy, 1892 from the Atlantic Ocean, with description of *Leucascus lobatus* sp. nov. (Porifera, Calcarea, Calcinea) from Greenland. *Steenstrupia*, **28**, 119–127.

Rapp, H.T., 2006. Calcareous sponge of the genera *Clathrina* and *Guancha* (Calcinea, Calcarea, Porifera) of Norway (north-east Atlantic) with the description of five new species. *Zoological Journal of the Linnean Society*, **147**, 331–365.

Rapp, H.T., Valentine, C. & Klautau, M., 2001. Two new species of *Clathrina* (Porifera, Calcarea) from the Norwegian coast. *Sarsia*, **86**, 69–74.

Rossi, A.L., Farina, M., Borojevic, R. & Klautau, M., 2006. Occurrence of five-rayed spicules in a calcareous sponge: *Sycon pentactinalis* n. sp. (Calcarea, Porifera). *Cahiers de Biologie Marine*, **47**, 261–270.

Row, R.W.H. & Hôzawa, S., 1931. Report on the Calcarea obtained by the Hamburg South-West Australian Expedition of 1905. *Science Reports of the Tôhoku University*, **6**, 727–809.

Schmidt, O., 1862. *Die Spongien des adriatischen meeres*. Leipizig: Wilhelm Engelmann.

Soest, R. van, Boury-Esnault, N., Janussen, D. & Hooper, J., 2005. *World Porifera Database*. Available online at http://www.vliz.be/vmdcdata/porifera. Consulted on 2006-12-01.

Solé-Cava, A.M., Klautau, M., Boury-Esnault, N., Borojevic, R. & Thorpe J.P., 1991. Genetic evidence for cryptic speciation in allopatric populations of two cosmopolitan species of the calcareous sponge *Clathrina*. *Marine Biology*, **111**, 381–386.

Thacker, A.G., 1908. On collections of the Cape Verde Islands fauna made by Cyril Crossland, M.A. The Calcareous Sponges. *Proceedings of the Zoological Society of London*, **49**, 757–782.

Vilanova, E., Mayer-Pinto, M., Curbelo-Fernandez, M.P. & Silva, S.H.G., 2004. The impact of the nuclear power plant discharge on the sponge community of a tropical bay (SE Brazil). *Bolletino dei Musei e degli Istituti Biologici dell'Università di Genova*, **68**, 647–654.

Wörheide, G. & Hooper, J.N.A., 1999. Calcarea from the Great Barrier Reef. I. Cryptic Calcinea from Heron Island and Wistari Reef (Capricorn-Bunker group). *Memoirs of the Queensland Museum*, **3**, 859–891.

Wörheide, G. & Hooper, J.N.A., 2003. New species of Calcaronea (Porifera: Calcarea) from cryptic habitats of the southern Great Barrier Reef (Heron Island and Wistari Reef, Capricorn–Bunker Group, Australia). *Journal of Natural History*, **37**, 1–47.

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