

Boring Sponges from Ha Long Bay, Tonkin Gulf, Vietnam

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Barbara Calcinai, Francesca Azzini, Giorgio Bavestrello, Carlo Cerrano, Maurizio Pansini, and Do-Cong Thung (2006) Boring sponges from the Ha Long Bay, Tonkin Gulf, Vietnam. *Zoological Studies* 45(2): 201-212. During 4 surveys performed from 2002 to 2004, 9 species of boring sponges were recorded from Ha Long Bay, on the northern coast of Vietnam: *Cliona aurivilli* (Lindgren 1897), *C. celata* Grant, 1826, *C. orientalis* Thiele, 1900, *Cliothosa hancocki* (Topsent 1888), *Pione carpenteri* (Hancock 1826), *Spirastrella decumbens* Ridley, 1884, *S. solida* Ridley and Dendy, 1886, *S. tentorioides* Dendy, 1905, and *Aka mucosa* (Bergquist 1965). *Cliona orientalis*, *P. carpenteri*, *S. decumbens*, *S. tentorioides* Dendy 1905, and *A. mucosa* are new records from the Tonkin Gulf, whereas all the other species are already known from Vietnam. <http://zoolstud.sinica.edu.tw/Journals/45.2/201.pdf>

Key words: *Cliona*, *Pione*, *Spirastrella*, *Aka*, Porifera.

Sponges of Vietnam are poorly known (Lévi 1961) particularly excavating sponges. In 1898, Lindgren recorded 20 species from Nha Trang (southern Vietnam), none of them excavating. The only paper entirely devoted to the sponge fauna of Vietnam was written by Lévi (1961), who recorded 28 species from Nha Trang, but included no excavating sponges.

Excavating sponges from Vietnam were reported by Dawydoff (1952) in a paper on the Indo-Chinese marine benthic fauna, but the most complete reference regarding the area is a checklist of sponges recorded from the South China Sea by (Hooper et al. 2000).

In this paper the following excavating species are reported: *Cliona celata* Grant, 1826, *C. mucronata* (Sollas 1888), *C. cf. viridis* Schmidt, 1862, *C. aurivilli* (Lindgren 1897), *Cliona* sp., *Pione carpenteri* (Hancock 1826), *Cliothosa hancocki* (Topsent 1888), and *Spirastrella solida* Ridley and Dendy 1886. For 2 other species

included in the list, *S. areolata* Lindgren, 1897 and *Spirastrella* sp., it was not possible to verify their excavating ability.

The aim of this paper was to make an initial contribution to the knowledge of the Vietnamese excavating sponges in the Tonkin Gulf, northern Vietnam, based on a series of samples taken from 2002 to 2004.

MATERIALS AND METHODS

Four surveys on several small islands of Ha Long Bay, Bai Tu Long Bay, and Cat Ba I., in the northern part of the Tonkin Gulf, northern Vietnam, were performed in July 2002, Apr. and Sept. 2003, and Apr. 2004 as part of the Vietnamese-Italian program of Cooperation in Science and Technology (2002-2005): "Study on Biodiversity Conservation in Coastal Areas of Vietnam".

Portions of dead coral, shells, and limestone

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infested by boring sponges were collected by divers using a hammer and chisel; photos were taken in situ or of fresh material for each sample.

Surveys were performed both on the reef areas surrounding the islands and in marine lakes on the islands. These lakes show different degrees of isolation from the sea (Cerrano et al. in press). For this reason, we use the term, "enclosed" for lakes where no connection with the open sea was evident and "semi-enclosed" for lakes showing an evident connection.

Specimens were preserved in either 4% formalin-seawater or 70% ethanol, or by drying.

Spicule preparations, for optical and electron microscopic scanning, were made by heat-digesting the sponge in nitric acid. Ectosome and choanosome samples were always treated separately. Details of the microscopic erosion were studied by digesting portions of the eroded substrata in boiling hydrogen peroxide (120 volumes). Spicules and cleaned fragments were mounted on stubs, sputtered with gold and observed with a Philips XL 20 scanning electron microscope (SEM).

The collected specimens were compared to the following material kindly provided by Dr. Clare Valentine of the British Museum of Natural History: *Spirastrella decumbens* BMNH 82.2.23.278-CR04/26T type material Coll. Do. Coppinger; *S. tentorioides* BMNH 07.2.1.24-CR04/26T type material, Herdman Coll; and *S. solida* BMNH 187.5.2.103-CR04/26T and BM.26 87.5.2.103.a type material.

Karin Sindemark of the Swedish Museum of Natural History kindly provided the type material of *Cliona aurivilli* (Lindgren 1897), SMNH 1190-1189-1187-23.

RESULTS

Nine species of boring sponges were recorded during the 4 surveys: *Cliona aurivilli*, *C. celata*, *C. orientalis*, *Cliothosa hancocki*, *Pione carpenteri*, *Spirastrella decumbens*, *S. solida*, *S. tentorioides*, and *Aka mucosa*.

Cliona aurivilli, *C. celata*, *Cliothosa hancocki*, and *S. solida* were already known from Vietnam, but all the other species are new records for the Tonkin Gulf and Vietnam.

Family Clionaidae

Genus *Cliona* Grant 1826

Cliona aurivilli (Lindgren 1897) (Fig. 1a-i)

Material examined: BTL 2, July 2002, Bai Tu Long Bay, dried specimen; HL 30, 4 Apr. 2003, Hang Du I Lake (Hang Trai I.), dried and alcohol-preserved specimens; HL 152, 24 Apr. 2004, Bui Xam Lake (Bo Hon I.), alcohol-preserved specimens.

Habitus and color: This species only recorded in α boring stage. Papillae digitiform, cylindrical, fleshy and slightly prominent on substrate (Fig. 1a). Inhalant papillae 0.8-3.1 mm high and 0.6-0.8 mm in diameter; exhalant ones are 1.5-2.1 mm high and 0.8-1.2 mm in diameter. Some fused papilla observed. Surface minutely hispid, and consistency firm and tough, but elastic. Exposed ectosome always covered by sand that was also incorporated into sponge body. Inhalant and exhalant papillae and upper part of papillar canals pink to orange; formalin-preserved and dried material lighter orange. Lower parts of channels connecting excavated chambers light-orange to yellow. In chambers, choanosome brownish to brick-red. Sponge bores rocks and dead stony coral present in both enclosed and semi-enclosed marine lakes and in Bai Tu Long Bay, from tidal zone to depth of 3 m. At low tide, sponges may be completely out of the water.

Erosion traces: This species excavates in a very peculiar way, creating single, wide chambers with maximum size of 3.5 x 1.1 cm (Fig. 1b). As many as 5 long papillar canals, with maximum size of 2 cm, 1.25 cm long, and 0.63 cm across on average, converging in single excavating chamber (Fig. 1a).

Scars that sponge leaves on substrate irregularly rounded with a smooth surface, devoid of particular marks. Scar size 21-102 (avg., 55.4) μ m.

Skeletal organization: Tylostyles organized in tracts in choanosome, in papillae, and in papillar canals with pointed tips toward surface. Spirasters dispersed.

Spicules: Megascleres. Tylostyles thick and curved in middle of their shaft. Measuring 535-665 x 18-35 (avg., 601.6 x 27.1) μ m (HL 152), and 510-790 x 50-30 (avg., 702.4 x 43.4) μ m (BTL 2). Thickness is minimal close to the head, increasing in middle, where spicule curves and gradually decreasing toward tip (Fig. 1c). Annular outgrowths frequent along shaft. Straight, thinner tylostyles also present (Fig. 1d) 290-670 x 10-30 (avg., 455.6 x 18.1) μ m.

Numerous tylostyles modified into tylo-

strongyles (Fig. 1e), showing rounded tips 340-645 x 22-45 (avg., 531.6 x 28.6) μm , and globoid or subterminal heads 22-50 (avg., 30.3) μm . Frequent lateral, conical tips are present on shaft.

Tylostyle heads discrete and generally spherical (Fig. 1f) 20-30 (avg., 24.9) μm (HL152); and 30-45 (avg., 39.1) μm (BTL 2). Pointed tips has-tate, sometimes blunt or bifidous.

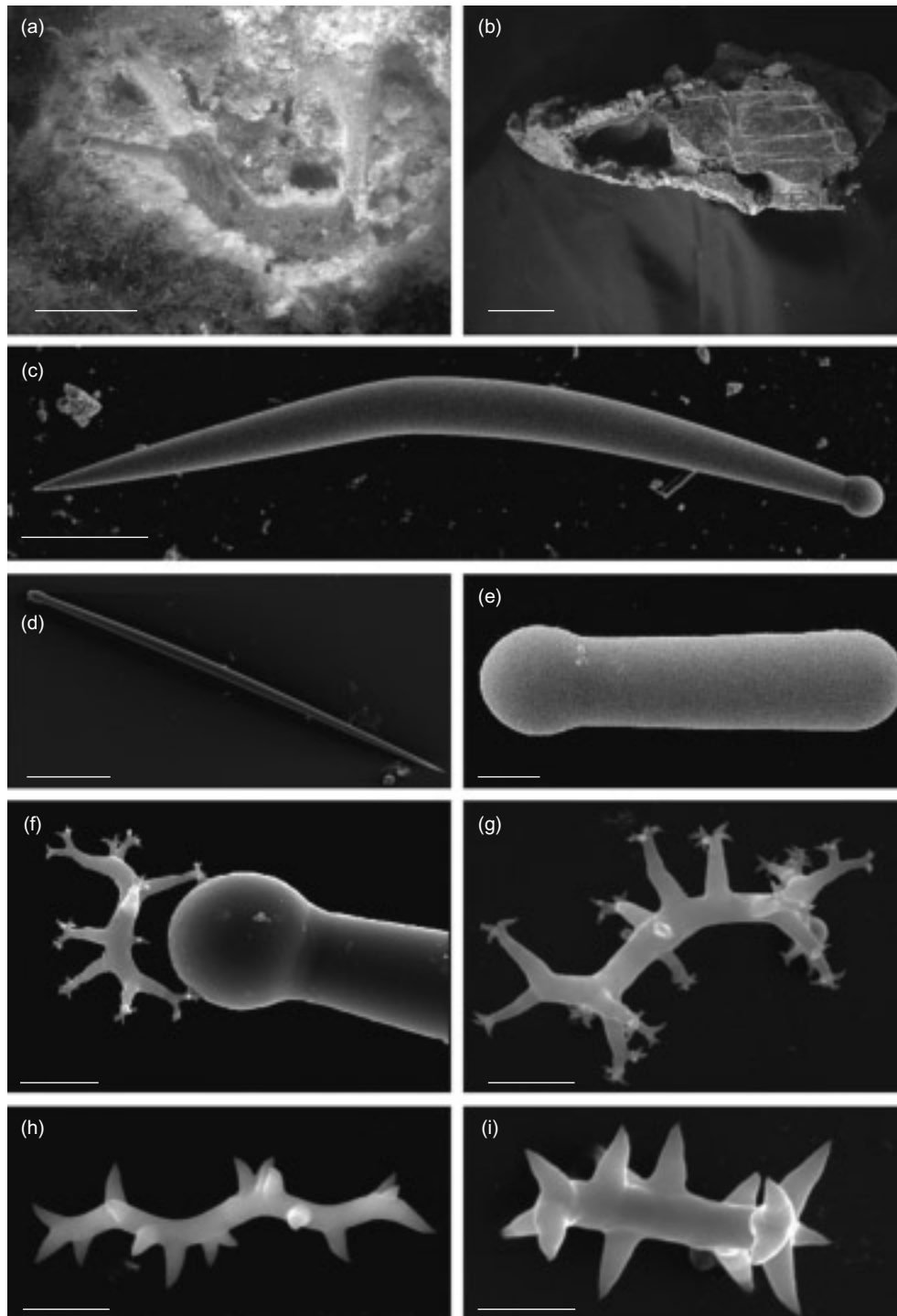


Fig. 1. *Cliona aurivilli*. (a) field image of the sponge showing papillae converging in a single excavating chamber; (b) dried preserved specimen showing a large excavating chamber; (c) thick tylostyle; (d) thinner tylostyle; (e) tylostyle modified into tylo-strongyle; (f) head of tylostyle and contort spiraster ending with tufts of spines; (g) spiraster with tufts of spines; (h-i) regular spirasters with triangular spines. Scale bars: (a) 2.5 cm; (b) 3 cm; (c) 90 μm ; (d) 100 μm ; (e-f) 20 μm ; (g-i) 10 μm .

Microscleres. Spirasters with a contorted and bent axis and robust and triangular rays ending with tufts of spines; measuring 38-62 x 8-12 (avg., 49.6 x 10.2) μm , and present in choanosome and papillar canals (Fig. 1f, g).

Normal spirasters with simple triangular spines on spiralate axis, 27-50 (avg., 36.8) μm long and 3.5-5.0 (avg., 4.8) μm thick (Fig. 1h). Straight spirasters also found (Fig. 1i). Rare spirasters with sparse, short spines 18-22 x 2-3.5 (avg., 18.7 x 3.2) μm .

Remarks and geographical distribution: A third category of spirasters described by Lindgren (1898; table 19, fig. 22c) was not detected. The species is already known to exist in Vietnam (Dawidoff 1952), in the Palau Archipelago (Bergquist 1965), in Indonesia (Java, Lindgren 1897 and Sulawesi, author's collections), in the region of Australia, the Gulf of Manaar, Palk Bay (Indian Ocean), and in the Pacific Ocean (Thomas 1972).

***Cliona celata* Grant 1826**
(Fig. 2a)

Material examined: HL 37, 4 Apr. 2003, Hang Du I Lake (Hang Trai I.), dried and alcohol-preserved specimens; HL 171, 26 Apr. 2004, Hang Du

II Lake (Hang Trai I.), alcohol-preserved specimen.

Habitus and color: Sponge, brilliant lemon-yellow, observed only in the α stage. Inhalant papillae small, cylindrical, about 1-2 mm in diameter; exhalant papillae larger, 4-5 mm in diameter (Fig. 2a). Boring into rocks in enclosed and semi-enclosed marine lakes at 1 m depth.

Erosion traces: This species producing small circular, very closely spaced chambers, about 2-4 mm wide.

Skeleton organization: In papillae, tylostyles organized in a palisade, with their tips directed outwards; in choanosome, being scattered and irregularly arranged.

Spicules: Megascleres. Tylostyles generally straight, 250-376 x 7-12 (avg., 339.5 x 9.6) μm , with variable oval or trilobate heads with vesicles 10-16 (avg., 11.8) μm across. Microscleres absent.

Remarks and geographical distribution: Chamber size and shape represent useful characters that can be used to discriminate this excavating species in the field. *Cliona celata* and *Cliothisa hancocki* can be confused in the field, since their color and ectosomal organization are similar. To distinguish them, it is necessary to break the rock: in *C. celata*, the excavating chambers are porous areas, separated by small pieces

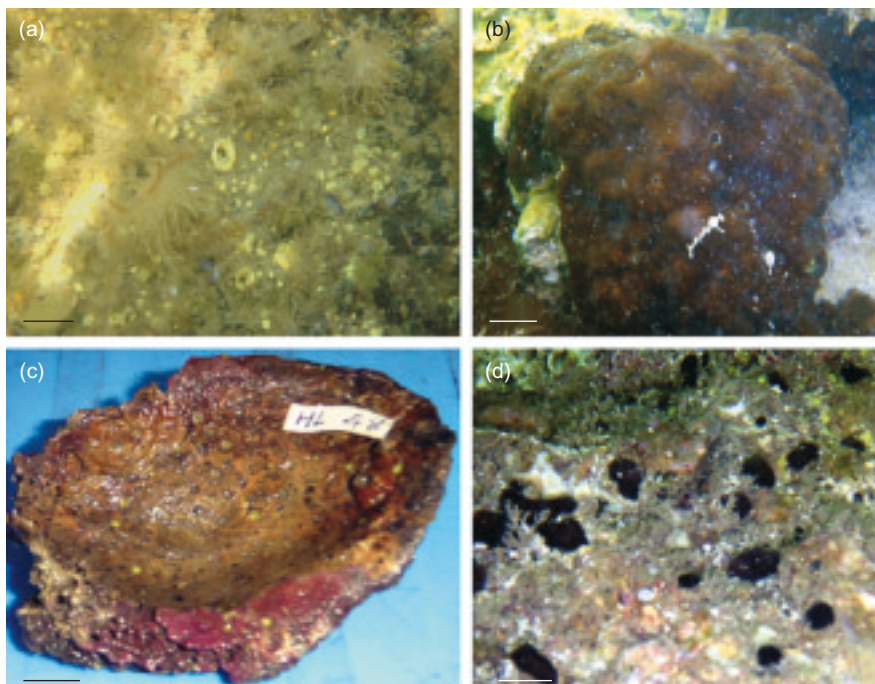


Fig. 2. Field images of (a) *Cliona celata*; (b) *Cliona orientalis*; (c) *Cliothisa hancocki* and (d) *Aka mucosa*. Scale bars: (a) 1 cm; (b) 2 cm; (c) 1.5 cm; (d) 2.5 cm.

of substrate, whereas in *Cliothosa hancocki* they are larger, flat, and generally separated. *Cliothosa celata* is considered a cosmopolitan species, even though dubious records need to be confirmed (Rützler 2002).

***Cliothosa orientalis* Thiele 1900**

(Fig. 2b)

Material examined: HL 25, 4 Apr. 2003, Hang Trai I., dried specimen; HL 172, 26 Apr. 2004, Hang Du II Lake (Hang Trai I.), alcohol-preserved specimen.

Habitus and color: In studied area, this species observed exclusively in β stage. In this stage, papillae encrusting substrate (Fig. 2b) connected by a thin layer of ectosome. Sponge over substrate beige-brown to yellow; papillae highly variable in size, and lighter in color, being pale yellow. Choanosome deep yellow. It bores dead stony corals at 1-4 meters depth, both in and out of the lakes.

Erosion traces: The sponge penetrates as deep as 2-3 centimeters into the substrate, exploiting original porosity of coral. Sometimes porous structure of coral disrupted by very rare, small, rounded chambers 0.5-1.9 (avg., 0.9) mm in diameter.

Skeletal organization: In ectosome, megascleres organized as usual in a palisade with pointed ends outwards. Tylostyles irregularly arranged in choanosome. Microscleres abundant in sponge body (both in choanosome and ectosome) and in papillar skeleton.

Spicules: Megascleres. Tylostyles 227-367 x 8-12 (avg., 302.4 x 10.6) μm , with well-developed spherical heads, 10-16 (avg., 13.5) μm across. Heads may be elongated and sometimes subterminal.

Microscleres. Delicate, thin, curved spirasters 17-25 x 1.5-2.5 (avg., 21.1 x 2.1) μm . Spines short and organized in bouquets. Some C-shaped spirasters present; in these spicules, spines arranged along convex side.

Remarks and geographical distribution: *Cliothosa orientalis* is known to exist in the Indian and Pacific Oceans: it was recorded in the Mergui and Malay Archipelagos, the Red Sea, the Gulf of Manaar, Palk Bay (Thomas 1979a), the Maldives (Calcinai et al. 2000), Australia (Schonberg 2000), and New Caledonia (Kelly-Borges and Vacelet 1998). This is the first record for Vietnam. Schönberg (2000 and 2002) provides a detailed description of this species.

Genus *Cliothosa* Topsent 1905 ***Cliothosa hancocki* (Topsent 1888)**

(Fig. 2c)

Material examined: BTL 3, June 2002, Bai Tu Long Bay, dried specimen; BTL 8, June 2002, Bai Tu Long Bay, dried specimen; BTL 9a, June 2002, Bai Tu Long Bay, dried specimen; BTL 10, June 2002, Bai Tu Long Bay, dried specimen; HL 48a, 5 Apr. 2003, Conf I., Ha Long Bay, dried and alcohol-preserved specimens; HL 48b, 5 Apr. 2003, Conf I., Ha Long Bay, dried specimen; HL 130, 17 Sept. 2003, Me Cung Lake, dried and alcohol-preserved specimens.

Habitus and color: All collected specimens in α stage, except HL 48a, in β stage. Specimen HL 48b, boring a dead mollusc shell, showing a particular arrangement of aquiferous system: exhalant papillae open on convex side of shell, while inhalant ones occupying concave side in contact with bottom. Inhalant papillae cylindrical, 1.5 mm in diameter; exhalant papillae conical, 2.1 mm in diameter. Papillae and choanosome intensely brilliant yellow or orange when alive. Dried specimens dark yellow or ochre (Fig. 2c). Sponge boring into dead stony coral and mollusc shells (*Spondylus* sp.) in enclosed marine lake of Me Cung Lake and in Bai Tu Long Bay, at 2-5 m deep.

Erosion traces: HL 48b and BTL 9a showing large erosion chambers that may occupy entire thickness of substrate. In HL 48b, chambers 0.7 cm wide and 0.3 cm high on average. Chambers irregularly ovoid and rarely fused. In BTL 3, excavating a *Fungia* sp. specimen, chambers very small, 4 mm in diameter. Erosion chambers showing typical scars on walls; irregularly rounded, ovoid 68.5 μm on average, with a smooth surface.

Skeletal organization: In ectosome, megascleres packed, with pointed tips directed outwards. Nodular amphisters only present in the papillae. In choanosome, tylostyles irregularly arranged with abundant interposed ramose amphisters.

Spicules: Megascleres. Stout, slightly curved tylostyles measuring 192-460 x 3-22 (avg., 316.4 x 13.8) μm (HL 48b); usually with rounded, well-formed, sometimes trilobate heads, 8-25 (avg., 16.75) μm across (HL 48b).

Microscleres of 2 kinds. Ramose amphisters, 25-30 x 5-10 (avg., 29 x 6.7) μm (HL 48b). At each extremity short rays with 4 or 5 curved spines. Nodular amphisters, with short and large axes, bearing 4 nodular outgrowths at each extremity, measuring 12-18 x 7-10 (avg., 15 x 9.5) μm (HL 48b).

Remarks and geographical distribution: *Cliothesa hancocki* is already known to exist in Vietnam (Hooper et al. 2000). It has a wide distribution and is recorded from the Mediterranean Sea, the Indian and Pacific Oceans (Rützler 1973), and Australia (Schönberg 2000). The species is very common in Ha Long Bay.

Cliothesa hancocki may produce different erosion patterns: large continuous chambers and single bag-pipe chambers have been observed in Australian (Schönberg 2000) and Indonesian specimens (Calcinai et al. 2005), whereas the chambers appear minute, separated, and densely spaced in the Ha Long Bay and in Mediterranean specimens (Rützler 1973).

Genus *Pione* Gray 1867
***Pione carpenteri* (Hancock 1826)**

Material examined: HL 81, 14 Sept. 2003, Hang Du I Lake (Hang Trai I.), dried specimen; HL 92, 15 Sept. 2003, Bui Xam Lake (Bo Hon I.), dried specimen.

Habitus and color: In α stage (HL 81), inhalant papillae irregularly circular, 8.6 mm in diameter; in HL 92 (β stage) papillae merged with one another forming a thin ectosomal crust above substrate. Ectosome reddish-orange in live specimens, while choanosome ivory-colored. Sponge becoming grey when dried. It is present both in enclosed and semi-enclosed marine lakes at 1.5-4 m deep, where it bores into rocks and mollusc shells.

Erosion traces: Species producing small, circular, very closely spaced chambers, about 1-2 (avg., 1.7) mm in diameter. Chambers directly connected to papillae, without a papillar canal.

Skeletal organization: Papillar skeleton made up of tylostyles organized in parallel tracts, with tips directed outwards, and dispersed micro-rhabds. Skeleton of chambers made up of tangential and disarranged oxeas that tend to be organized in parallel concentric tracts towards foramina connecting 2 chambers.

Spicules: Megascleres. Slender sinuous tylostyles with a well-developed rounded head, 247-348 x 5-8 (avg., 299.6 x 6.2) μm . Head diameter 8.75 μm on average.

Microscleres. Straight microrhabds tending to sharpen at extremities, measuring 11-16 x 2.5-3.5 (avg., 13.8 x 2.9) μm . Microxeas covered by minute spines not easily detectable with optical microscope, 95-147 x 2.2-4.7 (avg., 117.7 x 3.4) μm . In numerous oxeas, a central, annular swelling visible.

Remarks and geographical distribution: *Pione carpenteri* has a wide distribution: it is known from Mergui (Annandale 1915), Sri Lanka (Topsent 1891), the Seychelles (Thomas 1981, Calcinai et al. 2000), the Maldives (Calcinai et al. 2000), the Atlantic and Pacific Oceans (Topsent 1888; Carballo et al. 2004), and the Australia region (Thomas 1979a). This is the first record for the Tonkin Gulf.

Family Spirastrellidae
Genus *Spirastrella* Schmidt 1868
***Spirastrella decumbens* Ridley 1884**
(Fig. 3a-f)

Material examined: HL 89, 15 Sept. 2003, Bui Xam Lake (Bo Hon I.); alcohol-preserved specimen.

Habitus and Color: Thin encrusting sponge in β stage, with soft consistency and smooth surface. Living specimens salmon-pink; becoming beige when preserved in alcohol. Sponge boring into stony corals in enclosed marine lake of Bui Xam, at 1-1.5 m deep.

Erosion traces: Sponge not making proper chambers, but excavating as deep as 1 cm into superficial layer of coral, exploiting its porosity. Scars on substrate irregularly rounded or polygonal, 19-35 (avg., 25.8) μm across with signs of secondary erosion.

Skeletal organization: Microscleres abundant in ectosome, where they form a tangential crust, typical of the genus. Tylostyles irregularly arranged in choanosome.

Spicules: Megascleres. Straight tylostyles with long hastate tips 311-445 x 7.5-11.2 (avg., 370.9 x 9.1) μm . Heads well-formed (Fig. 3a), generally spherical, 9-12 μm (avg., 10.8) across.

Microsclere. Spirasters so variable in size and shape that 4 categories are distinguishable: stout and large spirasters with long and triangular spines, 39-60 x 5-11 μm (Fig. 3b, c); short bent spirasters with spines located on convex side (Fig. 3d); straight, amphiaster-like spirasters (5.5-10 μm) (Fig. 3e, f); long, thin, curved forms with spines located at extremities and on curved part of spicules.

Remarks and geographical distribution: *Spirastrella decumbens* is present in the Australian region and New Caledonia (Hooper and Wiedenmayer 1994), the Philippines (Ridley and Dendy 1887), and Indonesia (Hooper et al. 2000). This is the first record for Vietnam.

***Spirastrella solida* Ridley and Dendy 1886**

(Fig. 4a-k)

Material examined: HL 24, 4 Apr. 2003, Hang Trai I., dried specimen; HL 58, 14 Sept. 2003, Hang Toi, Ha Long Bay, dried specimen.

Habitus and color: Thickly encrusting sponge, with lobate and digitate osculiferous processes erected over substrate (Fig. 4a). Inhalant pores organized in cribrate areas. When alive, with a tough consistency and smooth surface. When dry, becoming hard and uncompressible, and its surface appearing slightly velvety. Choanosome of oscular processes not dense, and in dried state,

characterized by cavernous spaces. Living specimens olive, brown, and white; becoming ochreous-beige when dried. Sponge boring into stony coral in Ha Long Bay, at 1-3 m deep.

Erosion traces: Sponge insinuating into substrate, pervading it without making organized or well-defined erosion chambers, but only long, cylindrical excavating canals. Scars on substrate irregularly rounded or polygonal, 28-63 (avg., 46.6) μm across, with evident signs of secondary erosion.

Skeletal organization: Tylostyles arranged in parallel tracts forming a dense, more or less tidy skeleton. In ectosome, tylostyles grouped in bouquets. Their pointed tips protruding out of surface,

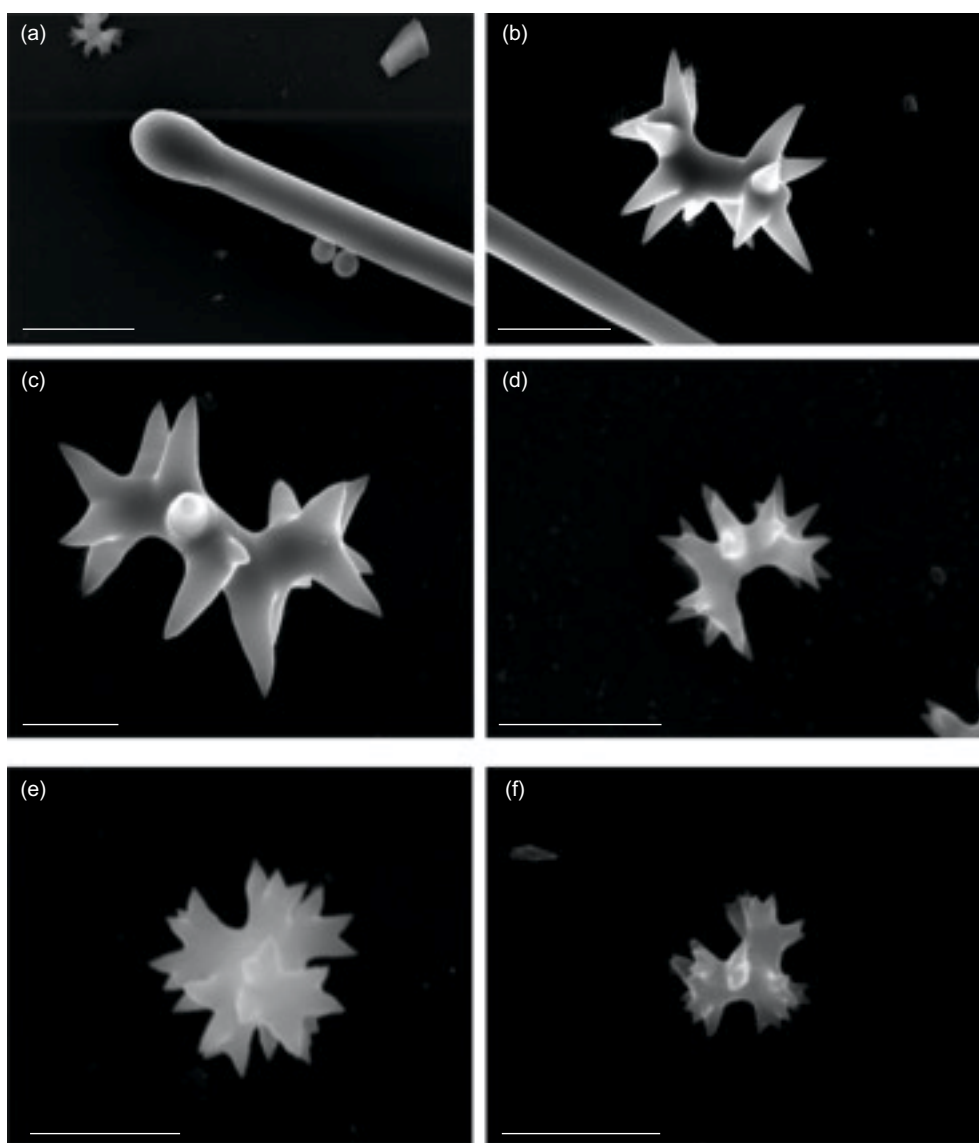


Fig. 3. *Spirastrella decumbens*. (a) head of tylostyle, (b, c) stout and large spirasters with long and triangular spines; (d-f) short, bent spirasters. Scale bars: (a, b) 20 μm ; (c-f) 10 μm .

making it slightly velvety. Microscleres abundant and located in different regions of sponge. Small spirasters forming a thin tangential crust, while

larger ones dispersed in choanosome.

Spicules: Megascleres. Straight tylostyles with a constant thickness along axis and gradually

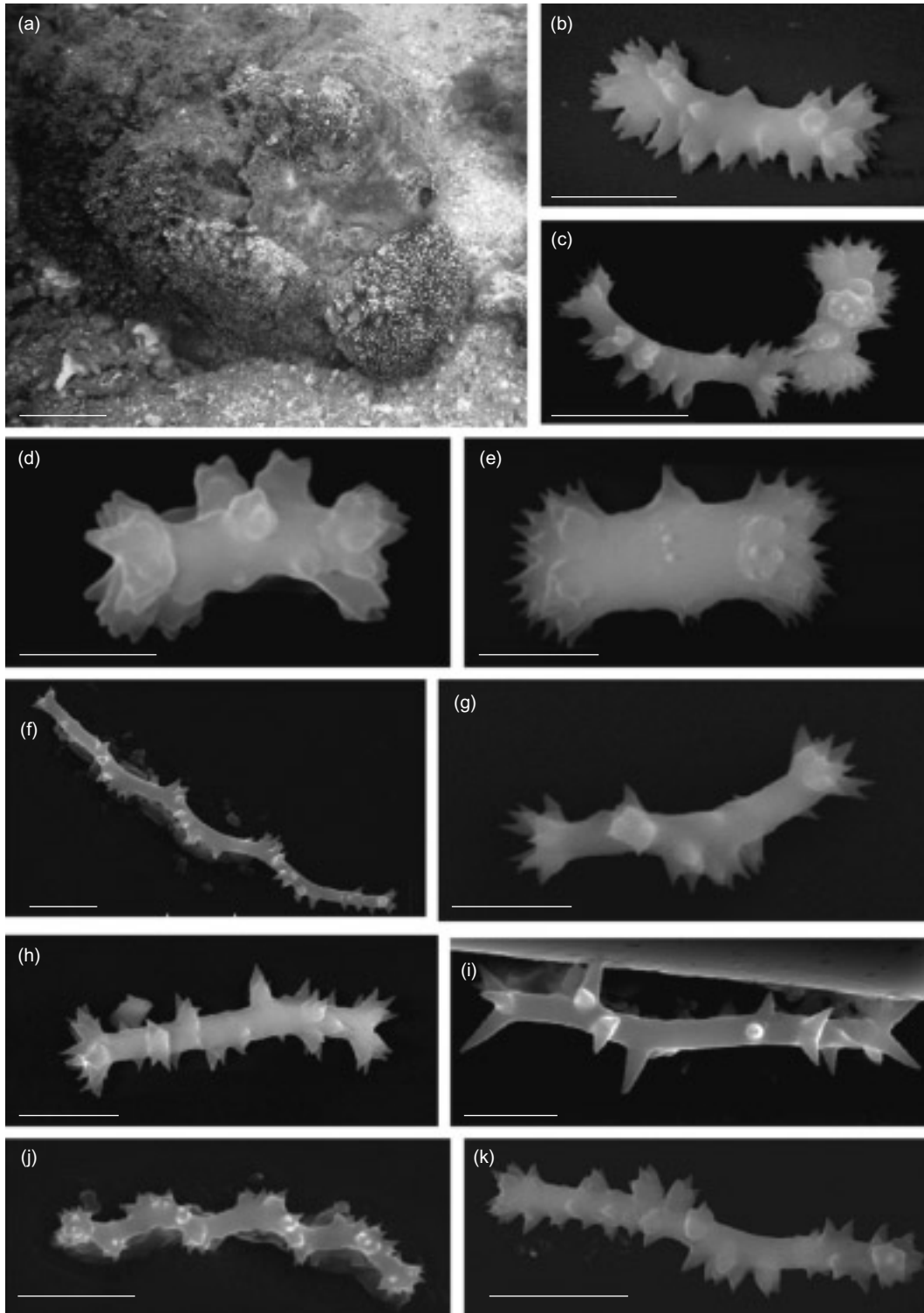


Fig. 4. *Spirastrella solida*. (a) field image; (b-e) small amphistars with verrucose spines; (f-k) slender, curved spirasters. Scale bars: (a) 5 cm; (b, d, e) 5 μ m; (c, f-k) 10 μ m.

sharpening towards hastate tips. Measuring 212-715 x 8-20 (avg., 647.5 x 15.3) μm . Heads generally ovoid and not well formed, 8-22 (avg., 16.4) μm .

Microscleres. Spirasters extremely variable in shape and size: being small, amphiaster-like and short, sometimes curved with verrucose spines, 6-21 x 4.5-8 (avg., 12.8 x 5.7) μm (Fig. 4b-e); located at surface of sponge. Other spirasters may be slender, straight, or curved, with thin or more-robust spines (Fig. 4f-k), and dispersed in the choanosome. Measuring 16-52 x 2-5 (avg., 27.9 x 3.4) μm .

Remarks and geographical distribution: This species is already known from Vietnam (Hooper et al. 2000). It is also reported from Tasmania (Hooper and Wiedenmayer 1994), San Thomé (Topsent 1918), Amboine (Desqueyroux-Faundez 1981), the Philippines (Ridley and Dendy 1887), the Gaspar Straits, the Java Sea, and Indonesia (Hooper et al. 2000, Calcinai et al. 2005).

***Spirastrella tentorioides* Dendy 1905**

(Fig. 5a-i)

Material examined: BTL 7, June 2002, Bai Tu Long Bay, dried specimen; HL 45, 5 Apr. 2003, Ha Long Bay, (Conf I.), dried specimen; HL 91, 15 Sept. 2003, Bui Xam Lake (Bo Hon I.), alcohol-preserved specimen; HL 119, 16 Sept. 2003, Hang Luong Lake, alcohol-preserved specimen.

Habitus and color: Massive body of sponge overgrowing dead corals. Its surface smooth or wrinkled. Papillae few, large, conical, and bearing rounded oscula at top (Fig. 5a). Sponge hard and coriaceous when alive; in dried state, being hard but fragile. Surface smooth. Dark olive to brown; dried specimens ochreous-beige. Boring into stony coral, at 2-5 m deep, both inside and outside of marine lakes.

Erosion traces: Sponge invading substrate, filling its cavities. It perforates coral without making well-organized chambers, but only rarely excavating canals, leaving original porous aspect of organic substrate almost unaltered. Scars on substrate irregularly polygonal. Their surface not completely smooth, but some light erosion lines detectable. Measuring 33-56 (avg., 43.9) μm .

Skeletal organization: Microscleres abundant

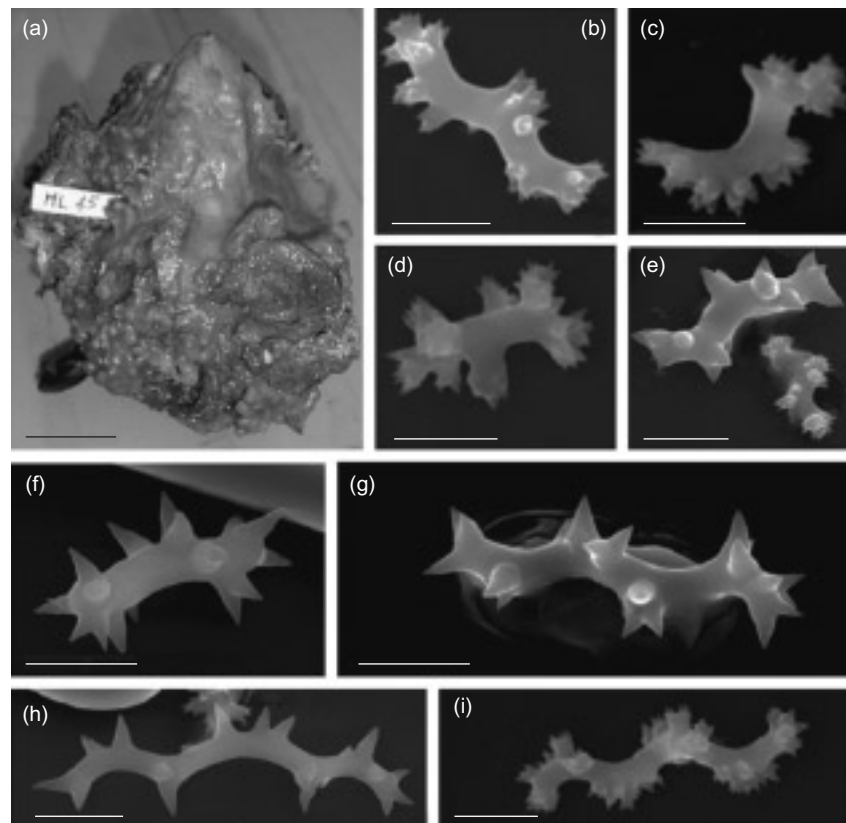


Fig. 5. *Spirastrella tentorioides*. (a) field image, (b-e) short spirasters with rounded spines; (f-g) stout and short spirasters with conical spines; (h, i) curved and thin spirasters with short and thin spines. Scale bars: (a) 3 cm; (b, e-h) 10 μm ; (c, d, i) 5 μm .

in ectosome, where they form a tangential crust typical of genus and consisting of short nodular and long, thin spirasters. Tylostyles irregularly arranged in choanosomal skeleton. In peripheral part of sponge, forming tracts that protrude from surface. In basal zone, in contact with eroded substrate, also numerous stout spirasters.

Spicules: Megascleres. Tylostyles curved, sometimes sinuous, 212-715 x 8-20 (avg., 647.5 x 15.3) μm . Their heads subterminal, not well formed, 8-22 (avg., 12.9) μm across. Smaller tylostyles more abundant in ectosome.

Microscleres. Spirasters with highly variable shapes: short with rather blunt spines (Fig. 5b-e); stout and short with conical spines (Fig. 5f, g); and curved and thin with short, thin spines (Fig. 5h, i). Size also variable, ranging 6-47 μm long and 2.5-8 μm wide.

Remarks and geographical distribution: *Spirastrella tentorioides* was previously recorded from Sri Lanka, Australia, and the Indian Ocean (Hooper and Wiedenmayer 1994). This is the first record for Vietnam. In the stations studied, this species was very abundant.

Family Phloeodictyidae

Genus Aka de Laubenfels 1936

Aka mucosa (Bergquist 1965)

(Fig. 2d)

Material examined: HL 28, 4 Apr. 2003, Hang Trai I., dried specimen; HL 87, 15 Sept. 2003, Bui Xam Lake (Bo Hon I.); dried specimen; HL 103, 15 Sept. 2003, Bui Xam Lake (Bo Hon I.); dried specimen; HL 153, 24 Apr. 2004, Bui Xam Lake (Bo Hon I.); alcohol-preserved specimen; HL 181, 27 Apr. 2004, Dau Be Lake; alcohol-preserved specimen.

Habitus and color: Exhalant and inhalant papillae, emerging from coral substrate, with different shapes: exhalant short, hollow tubes 5-8 mm in diameter and about 3 mm high in dried sample. Inhalant part of sponge, in HL 28, 87, and 103 cushion-shaped, bearing numerous pores 4-9 mm in diameter and 4-10 mm high in dried sample while, in HL 153, inhalant part organized in papillae 3-4.5 mm in diameter and 1.7-4.3 cm high. Exposed parts dark brown to black (Fig. 2d). Choanosome beige in living sponge, brown in dried state. Epilithic parts elastic in living specimens, hard and fragile in dried state. Choanosome is pulpy and dense. When collected, sponge exuding a large amount of mucus. Boring stony

Table 1. Distribution of the boring species found in Vietnam, in the Indian Ocean, Central Pacific area and Australia. Numbers refer to unpublished data and to the selected papers listed below

	Central Indian Ocean	Western Indian Ocean	Red Sea	Indonesia	Vietnam	Central Pacific and New Caledonia	Australia
<i>Cliona aurivilli</i>	1	-	-	2	3/t	-	4
<i>Cliona celata</i>	5	6/12	7/10/17	8	3/t	-	8/10/17
<i>Cliona mucronata</i>	1/5/9/10	11	-	12/13/14	13	-	1/10
<i>Cliona orientalis</i>	1/5/10	-	1	13/14	t	8	1
<i>Cliona viridis</i>	1/5/10/16	15	15	7/13/14	3	-	1/8
<i>Cliothisa hancocki</i>	1/9	11	17	7/13/14	3/t	18	8/17
<i>Pione carpenteri</i>	19/20	19/20	-	14	t	-	1
<i>Pione vastifica</i>	1/5/7	19	10	9	3	18	10
<i>Spirastrella areolata</i>	-	-	-	13	3	-	21
<i>Spirastrella decumbens</i>	-	-	-	13/21	t	21	21
<i>Spirastrella solida</i>	-	-	-	13/14/22	3/t	-	21
<i>Spirastrella tentorioides</i>	-	-	-	14/22	t	-	21
<i>Aka mucosa</i>	-	-	-	13/14/21	t	21	8/21

1.Thomas 1979a; 2.Lindgren 1898; 3.Dawydoff 1952; 4.Bergquist 1965; 5.Thomas 1985; 6.Thomas 1973; 7.Annandale 1915; 8.Schönberg 2000; 9.Pattanayak 1999; 10.Thomas 1972; 11.Vacelet et al. 1976; 12.Vacelet and Vasseur 1971; 13.Hooper et al. 2000; 14.Calcinai et al. 2005; 15.Thomas 1981; 16.Kumar 1925; 17.Thomas 1979b; 18.Topsent 1932; 19.Calcinai et al. 2000; 20.Topsent 1888; 21.Hooper and Wiedenmayer 1994; 22.Ridley and Dendy 1887; t.this paper.

coral and rock at depths of 3-4 m, both inside and outside of lakes.

Erosion traces: Erosion chambers almost circular, 1-2 cm across.

Skeletal organization: Oxeas of papillae tangentially arranged but not forming a regular skeleton. Long, stout tracts of spicules running along tubes, forming inner layer. Choanosomal skeleton formed by spicules without orientation.

Spicules: Megascleres. Two categories of stout oxeas, with central canal not clearly detectable: large oxeas with triangular, rarely mucronate tips and frequent modifications into styles and strongyles, 170-230 x 7-12 (avg., 207.3 x 9.8) μm ; thin oxeas gradually sharpening toward tips, 142-200 x 2.5-8 (avg., 168.4 x 5.6) μm .

Remarks and geographical distribution: *Aka mucosa*, a common species in the Indo-Pacific area, is known from Micronesia (Bergquist 1965), Indonesia (Rützler 1971), Thailand (Hooper et al. 2000), and Australia (Hooper and Wiedenmayer 1994, Schönberg, 2000). *Aka mucosa* was described in detail by Bergquist (1965) and Rützler (1971). This is the first record from Vietnam.

DISCUSSION

This paper highlights the status of the boring sponge fauna of the northern coast of Vietnam. About one half of the recorded species, *Cliona aurivilli*, *C. celata*, *Cliothosa hancocki*, and *Spirastrella solida*, were already known from this area (Hooper et al. 2000). Our paper adds 5 other species (*C. orientalis*, *P. carpenteri*, *S. decumbens*, *S. tentorioides*, and *A. mucosa*) to the list of Vietnamese boring sponges.

These species have a wide geographic range within the Indo-Pacific area (Table 1). All of them are present in Australia and Indonesia, and most of them extend their range to the central Indian Ocean.

The Vietnamese boring sponge fauna seems to be formed primarily by a pool of Indo-Pacific species with the absence of some taxa. This absence is probably due to the peculiar conditions in the northern part of the Tonkin Gulf: a shallow water, subtropical area affected by remarkable variations in water temperature and salinity during the annual cycle.

All the boring species we have recorded (except *Spirastrella solida*) were present in the enclosed and semi-enclosed marine lakes that are rather common inside the small karst peaks and

the larger islands scattered in Ha Long and Bai Tu Long Bays. Excavating sponge species can live both in and outside the lakes, but four of them (*C. aurivilli*, *C. celata*, *P. carpenteri*, and *S. decumbens*) were found only inside the lakes. Remarkable seasonal variations regulated by the monsoon rains affect the environmental conditions of these lakes, causing strong stratification of the water column. A superficial freshwater layer of variable thickness, preventing a regular mixing of the water body, and thus affecting its temperature, is present most of the year (Cerrano et al. in press). Since there are very few excavating sponge species known to be able to survive in brackish water (Corriero 1987, Carballo et al. 1994), and considering the peculiar conditions recorded in the lakes, the euryecious character of some of the sponge species reported herein is evident.

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