J. Mar. Biol. Ass. U.K. (2007), **87**, 1539–1552
Printed in the United Kingdom

doi: 10.1017/S0025315407060687

Five new sponge species (Porifera: Demospongiae) of subtropical or tropical affinities from the coast of Lebanon (eastern Mediterranean)

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Five new species of sponges are described from the coast of Lebanon in the eastern Mediterranean, Levantine Basin. *Euryspongia raouchensis* (Dysideidae), *Liosina blastifera* (Dictyonellidae) and *Niphates toxifera* (Niphatidae) belong to genera that are new for the Mediterranean but widely distributed in the tropics. *Cinachyrella levantinensis* (Tetillidae) and *Ciocalypta carballoi* (Halichondriidae) are described in genera with a restricted distribution in the Mediterranean, which have affinities with species from the Atlantic West African coast. These species do not appear to be lessepsian migrants, but are interpreted as remnants of an ancient thermophilous fauna that survived in the easternmost part of the Mediterranean.

INTRODUCTION

The Levantine basin in the easternmost part of the Mediterranean is the warmest zone in the Mediterranean Sea (Brasseur et al., 1996; Abboud-Abi Saab et al., 2004). Its sponge fauna is relatively poor (Voultsiadou, 2005). A recent review (Pansini & Longo, 2003), recorded only 43 sponge species from this basin, to which two littoral species and three deep-sea species recently described may be added (Ilan et al., 2003; Perez et al., 2004). This apparent low sponge diversity could be due in part to a low research effort, as only seven articles have dealt with the sponge fauna of the area.

The Levantine basin is also particularly exposed to colonization by Red Sea species entering the Mediterranean Sea via the Suez Canal, the so-called lessepsian migrants (Por, 1989; Galil, 2000). Although sponges have low dispersal ability and are not expected to be highly successful lessepsian colonizers, five species of the Levantine basin with tropical or subtropical affinities had been assumed to be newcomers from the Red Sea (Burton, 1936; Lévi, 1957; Tsurnamal, 1969b). [The number is erroneously indicated as 30, which actually relates to tropical species s.l. living in the Mediterranean (Pronzato, 2003)]. However, the identification of the Mediterranean specimens as Red Sea species has not been firmly established, and these species could rather be thermophilous remnants from an ancient warm period, which survived cold episodes of the history of the Mediterranean only in the warmest zones of this sea (Taviani, 2002). This hypothesis also seems to apply to the case of two lithistid sponges with tropical affinities recently described from a submarine cave in Lebanon (Perez et al., 2004).

During diving surveys along the coast of Lebanon, we have found several undescribed species of sponges showing affinities with taxa generally found in subtropical or tropical areas. We describe them as new species, and discuss their possible biogeographical affinities.

MATERIALS AND METHODS

Most of the specimens of the five new species were collected by SCUBA diving at several locations along the Lebanese coast (Figure 1; Table 1) in September 2002 and July 2003 (G. Bitar, H. Zibrowius, T. Perez and J. Vacelet). Some specimens were also collected under the same conditions between 1993 and 2002 (G. Bitar, J.-G. Harmelin, H. Zibrowius). Among the five species, only one was found at a single locality. Most of the time, sponges were

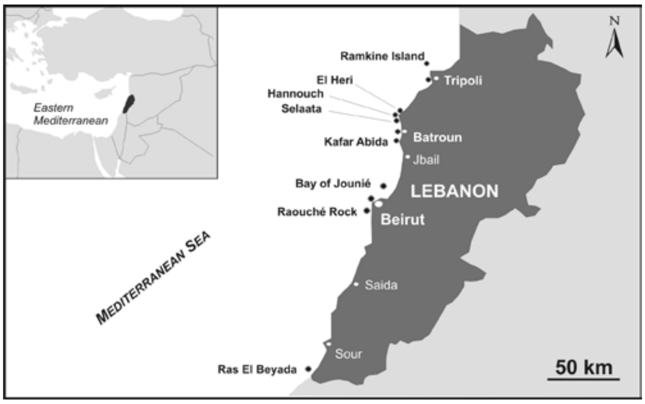

Figure 1. Location map of the main towns on the coast of Lebanon and collection sites.

Table 1. *Details of the collection sites in the study.*

Site	Coordinates	Sampling depth (m)	Comments
Batroun 1	34°15.22'N 35°39.35'E	10	In front of Phoenician wall
Batroun 2	34°15.06'N 35°39.43'E	0–14	Near the Marine Laboratory
Beirut harbour	33°54.27'N 35°30.94'E	2–11	Jetty
Raouché rock	33°53.323'N 35°28.163'E	1.5–5	'Corniche' of Beirut, 'Grotte aux Pigeons'. Semi-dark to dark tunnel
El Heri	34°19.395'N 35°41.793'E	3	Overhang
Hannouch	34°18.328'N 35°39.942'E	23	
Jounié	34°1.100'N 35°37.300'E	3–35	
Kafar Abida	34°13.581'N 35°38.864'E	8	3 km south of Batroun, tunnel
Ramkine Island	34°29.626'N 35°46.430'E	3–11	North-west of Tripoli, rocky bottom, semi-dark caves and vertical cliffs
Ras El Beyada	33°9.969'N 35°10.853'E	0–7	South Lebanon, sand and rocky bottom
Selaata	34°17.072'N 35°39.509'E	5–37	North of Batroun, rocky bottom, semi-dark caves and vertical cliffs
Tripoli Harbour	34°27.471'N 35°49.563'E	3–5	Pier and boulders

collected in shallow water (maximum depth 35 m) on rocky bottoms, sometimes under overhangs or in semi-dark caves. After collection, they were kept in seawater for a few hours before being preserved in ethanol or formalin upon return to the laboratory. Underwater photographs using Nikonos equipment were taken before collection whenever possible.

For the study of spicules, the sponge tissue was digested in boiling nitric acid. The dissociated spicules were separated by filtration on a 0.2 µm cyclopore membrane (Reiswig & Browman, 1987), sputter-coated with gold-palladium for observation under a Hitachi S570 scanning electron microscope (SEM) or mounted on glass slides for light microscopy. Alternatively, the tissue was digested directly on a microscope slide until dry; after rinsing with distilled water, the spicules were then either mounted in Araldite for light microscopy, or sputter-coated with gold-palladium for SEM (Vacelet, 2006). Spicule size was measured using light microscopy or on SEM photographs. A minimum of 30 spicules of each category were measured. Skeletal architecture and histology were studied by light microscopy on polished sections. These were obtained by cutting a piece of sponge embedded in Araldite with a low speed saw using a diamond-wafering blade. The sections were then wet-ground with abrasive paper or polishing discs, mounted on glass slides in Araldite and observed under a light microscope.

For cytology in light microscopy and transmission electron microscopy (TEM), the specimens were fixed in glutaraldehyde 2.5% in a mixture of 0.4 M cacodylate buffer and seawater (4:5 v/v). They were postfixed for 2 h in 2% osmium tetroxide in seawater, dehydrated through an alcohol series, and embedded in Araldite. Semi-thin sections were stained with toluidine blue. Thin sections for TEM were cut after local desilicification in 5% hydrofluoric acid applied on the free surface of the trimmed block (Borojevic & Lévi, 1967). They were then contrasted with uranyl acetate and lead citrate, and observed under a Zeiss EM 912 transmission electron microscope.

The type material has been deposited in the Muséum National d'Histoire Naturelle in Paris (MNHN). Comparative material has been examined in the British Museum of Natural History in London (BMNH).

SYSTEMATICS

Order SPIROPHORIDA Bergquist & Hogg, 1969
Family TETILLIDAE Sollas, 1886
Genus *Cinachyrella* Wilson, 1925
(Figures 2A–F & 7A)
Cinachyrella levantinensis sp. nov.
Chrotella cavernosa (Lamarck, 1815): (Tsurnamal, 1969b);
Cinachyra australiensis Carter, 1886: (Burton, 1936)

Type material

Holotype: MNHN-DJV 94. Selaata, 34°17.072'N 35°39.509'E, 24 September 2002 (53a), cliff, 35 m, fixation formalin, conservation in ethanol.

Paratype 1: MNHN-DJV 95. Selaata, 14 April 2002 (54a), 15 m, ethanol.

Paratype 2: MNHN-DJV 96. Jounié, 34°02.15'N 35°37.36'E, 11 July 2003 (1), 18 m.

Paratype 3: MNHN-DJV 97. Ras El Beyada, 33°9.969'N 35°10.853'E, 12 July 2003, 6 m.

Paratype 4: MNHN-DJV 98. Kafar Abida 3 km south of Batroun, 30 May 2000 (14a), tunnel, 8 m.

Other material examined

Selaata, 6 July 2003 (1), 20 m. Jounié, 11 July 2003 (1) and 11 July 2003 (2), 15 m, several specimens. (Specimens conserved at the Station Marine d'Endoume.)

Holotype of *Chrotella* ibis Row, 1911 (BMNH 1912.2.1.35).

Specimens of '*Cinachyra australiensis*' identified by Burton (1936) from Alexandria (Station 1001), BMNH YX1.

Etymology

From 'Levant', the countries bordering the eastern Mediterranean Sea from Turkey to Egypt.

Description

Subspherical sponge (Figure 7A), 2–3 cm in diameter, without root tuft. Surface somewhat wrinkled, wholly

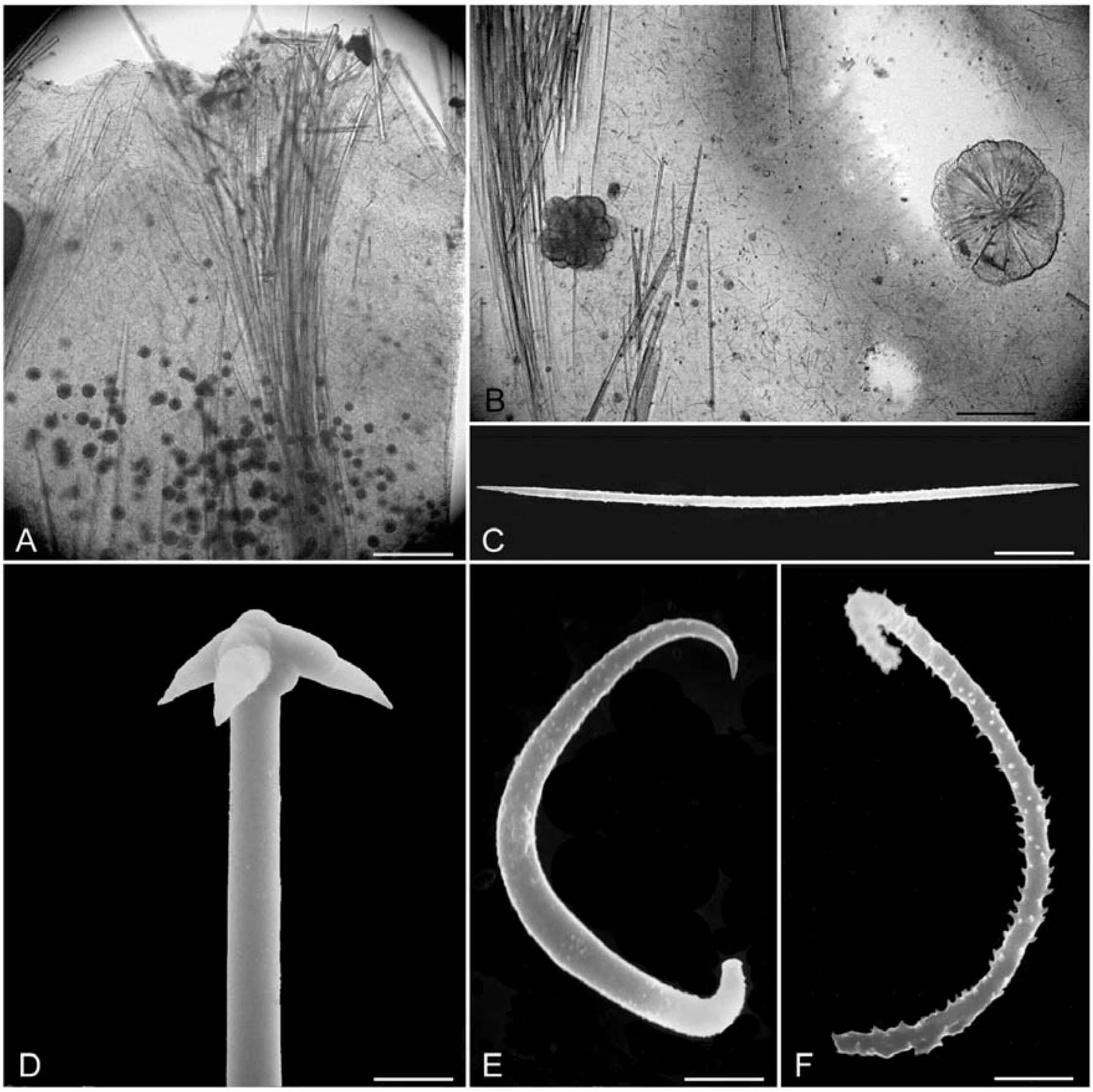

Figure 2. *Cinachyrella levantinensis* sp. nov. (A) Section perpendicular to surface, with numerous small crystalline spherules in the superficial choanosome; (B) section through choanosome with small and large crystalline spherules; (C) small oxea; (D) anatriaene; (E) sigmaspire; (F) sigmaspire. Scale bars: A, 315 µm; B, 266 µm; C, 12.7 µm; D, 12 µm; E,F, 2.1 µm.

covered with a sand layer 1–2 mm thick, or with some more or less extended areas without sand. Hispidation variable, sometimes entirely obscured by sand cover. Apertures and porocalices not visible in specimens with heavy sand cover, in others concentrated on lateral areas devoid of sand, where there are numerous adjacent circular depressions 1–2 mm in diameter. No special collagen condensation near the surface (Figure 2A). Outer part of choanosome containing crystalline spherules (Figure 2A,B), probably in calcium carbonate since disappearing in nitric acid, very variable in size and number according to the specimen, sometimes absent, from 2.5 to 55–65 µm in diameter, most often single and 30–60 µm in diameter with a darker centre and a fibrous, radiating structure, sometimes composite and larger (up to 425 µm). Colour of surface yellow in the area devoid of sand. Choanosome yellow in life, brown beige in alcohol.

Skeleton (Figure 2A,B): large oxeas forming strong fascicles radially arranged with a faint spiral arrangement, slightly diverging at the surface where they include protriaenes and anatriaenes. Small oxeas dispersed without order, less abundant or nearly absent in the most superficial layer of the ectosome, 200–300 µm thick. Sigmaspires abundant everywhere, although more concentrated around canals.

Spicules (Figure 2C–F): oxeas straight, fusiform, rarely styloid form, 1250–6250 × 2.5–42 µm. Protriaenes, sometimes prodiaenes, with a thin rhabdome often flexuous or hair-like, 1100–2000 × 2.5–4 µm, clads 10–100 × 2.5–6 µm often unequal, ill-formed or vestigial. Anatriaenes, rhabdome up to 6500 × 3.5–6 µm, cladome mostly vestigial, frequently reduced to a knob, clads 7–50 × 3–5 µm. Small oxeas, slightly rugose, 60–120 × 1–2 µm. Sigmaspires C shaped, very thin, with a slightly rugose shaft, 10–16 µm × 0.6–1 µm.

Ecology

A very common sponge on subhorizontal rocks between 6 and 35 m, often more or less covered by sediment.

Comment

The porocalices are often difficult to see on this sponge, even during underwater observations, due to the thick sand

Table 2. *Spicule and porocalice size (in µm) in the description of* Cinachyrella ibis *by Row (1911),* Cinachyrella cavernosa *by Tsurnamal (1969) and the new species.*

	Protriaenes	Anatriaenes	Oxeas	Microxeas	Sigma	Porocalices
Cinachyrella ibis	1500×5, clade 84 maximum	2100×40, clade 43×6 maximum	1600×25	150×2.1	10–15	750
Cinachyrella cavernosa	?, clades 8–96	?, clades 8–96	2000–4300/13–46	71–110 × 1.5–3	11–13	2000–7000
Cinachyrella levantinensis	1100–2000, clades 10–100 × 2.5–6	6500 × 3.5–6, clades 7–50 × 3–5	1250–6250 × 2.5–42	60–120 × 1–2	10–16	1000–1500

layer covering the surface and most often obscuring the surface coloration and structure. However, most specimens are undoubtedly provided with porocalices, and the sponge, also devoid of a well defined cortex, is accordingly referable to the genus *Cinachyrella* Wilson, 1925 (Rützler, 1987; Rützler & Smith, 1992). It differs from the other Mediterranean Tetillidae, *Craniella repens* Sarà, 1958 (which, having no cortex and auxiliary megascleres, should be transferred to *Tetilla*) and *Tetilla cranium* (Müller, 1776), by the presence of porocalices, small oxeas without cortical arrangement, presence of a sand cortex, and by the characters of the triaenes.

The genus *Cinachyrella* is known from the Mediterranean by two species, *C. tarentina* (Pulitzer-Finali, 1983) from southern Italy, which differs from the Lebanese species by the presence of plagiotriaenes, absence of small oxeas and very shallow water location, and a species from the Mediterranean coast of Israel identified as *Chrotella cavernosa* (Lamarck, 1815) by Tsurnamal (1969b). The latter species had already been recorded by Burton (1936) from Alexandria under the name *Cinachyra australiensis* Carter, 1886, but without description. Both Burton and Tsurnamal considered this sponge as a lessepsian migrant, referring to an excessive synonymy for *C. australiensis* and *C. cavernosa*. Our specimens from Lebanon closely agree in morphology, spiculation and habitat with the sponge recorded in Israel by Tsurnamal, who indicated that it was common on the floor of semi-shaded to shaded caves. It is likely that the *Tetilla* sp. recently studied by Meroz-Fine et al. (2005) on the Mediterranean coast of Israel also belongs to the same species. Meroz-Fine et al. did not describe that species, which is said to be common under the same ecological conditions as on the Lebanon coast, but indicated a size of 85 to 110 µm for the small oxeas, which is similar to that of the small oxeas of our specimens. We checked on two specimens from Alexandria identified by Burton (1936) as *Cinachyra australiensis* (Station 101, BMNH YX1-1933) that the morphology and the spicule complement were similar to those of *C. levantinensis* sp. nov.

The precise specific identification, which is crucial due to the possible lessepsian origin of this sponge, is rather problematic and we conclude that it is an undescribed species. The extensive synonymy for *C. australiensis* and *C. cavernosa* accepted by Burton and Tsurnamal and suggesting a recent Red Sea/Indian Ocean origin as a lessepsian migrant has been rejected by most subsequent authors. However, the Lebanese sponge somewhat resembles *Cinachyrella ibis* (Row, 1911) from the Red Sea, and its identification to this species would confirm a Red Sea origin. That identification is doubtful, and we prefer to describe it as a new species, possibly pending further study of the Red Sea species. *Cinachyrella ibis* has not been found again since its description, and there are no field observations for this species. Row's description and a re-examination of the holotype at the BMNH show that the Red Sea and the Lebanese specimens have the same size and general morphology, with a heavy superficial sand cover, and they share the presence of numerous malformed protriaene and anatriaene cladomes. Such characters, however, are frequent in diverse Tetillidae, for instance in two western Atlantic species, *C. alloclada* (Uliczka, 1929) and *C. kuekenthali* (Uliczka, 1929). The Red Sea species differs from the Lebanese specimens by smaller oxeas and triaene rhabdomes (Table 2), presence under the sand cover of a superficial hyaline zone devoid of small oxeas, and the absence of calcareous spherules. These spherules, which are dissolved by the usual methods of spicule preparation in nitric acid, were also overlooked by Tsurnamal in his specimens from Israel, but we checked that they are actually absent in the holotype of *C. ibis*. Similar spherules were described in a western Atlantic species, *C. alloclada* (Uliczka, 1929) (Rützler & Smith, 1992), which differs by general morphology, size and spiculation from the Lebanese *Cinachyrella*.

The presumably calcareous spherules closely resemble those described in *Hemimycale columella* Bowerbank, 1874 by Vacelet et al., 1987 and in *C. alloclada* by Rützler & Smith, 1992. They are highly variable in our specimens, sometimes absent, sometimes very abundant and of small size (Figure 2A), sometimes large and composite (Figure 2B). Their taxonomic value as a specific character has to be evaluated.

Order HALICHONDRIDA Gray, 1867
Family DICTYONELLIDAE van Soest, Diaz & Pomponi, 1990
Genus *Liosina* Thiele, 1899
Liosina blastifera sp. nov.
(Figures 3A–E & 7B,C)

Type material

Holotype: MNHN-DJV 109. Jounié, 11 July 2003 (2), 34°00.85'N 35°37.83'E, 20 m.

Paratype 1: MNHN-DJV 110. Jounié, 11 July 2003 (1-A), 34°01.45'N 35°37.19'E, 18 m.

Paratype 2: MNHN-DJV 111. Jounié, 11 July 2003 (1-2), 34°01.45'N 35°37.19'E, 18 m.

Other material examined

Batroun 2, near the Marine Laboratory (34°15.06'N 35°39.43'E), 4 July 2003 (4) under overhang, 8 m (dry), and

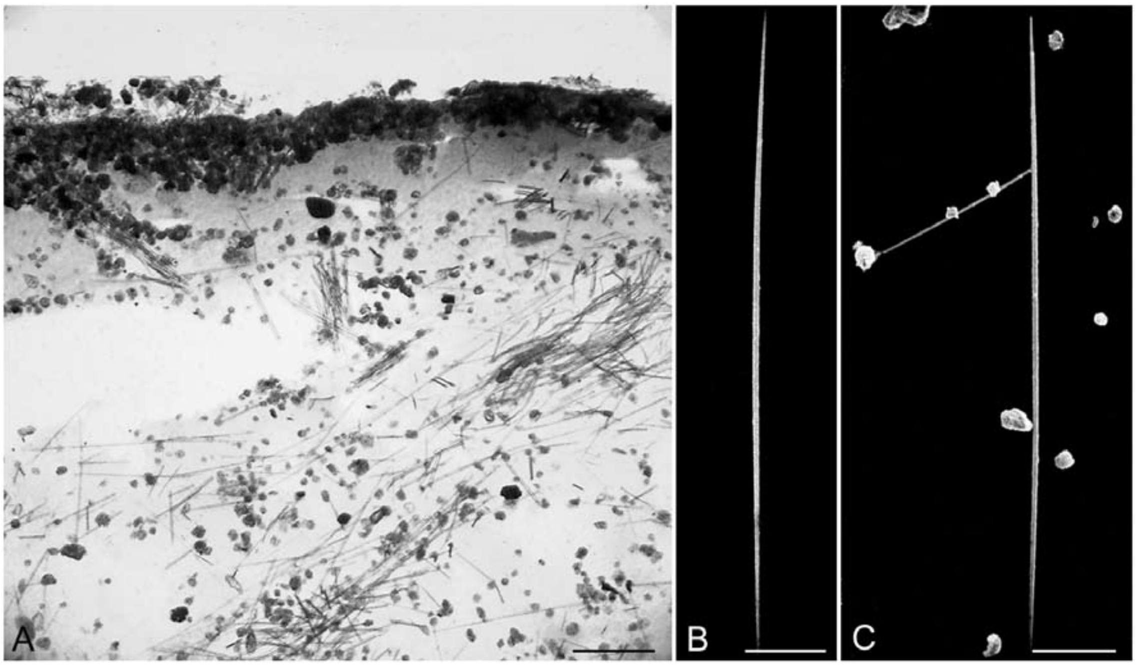

Figure 3. *Liosina blastifera* sp. nov. (A) Section perpendicular to the surface; (B) oxea; (C) oxeas and granules. Scale bars: A, 220 µm; B, 70 µm; C, 90 µm;

15 July 2003, 4–14 m. Jounié, 34°00.85'N, 35°37.83'E, 10 July 2003 (2-1,4), 15 and 24 m.

Etymology

blastifera From *blast*, Greek, bud, referring to the frequent presence of bud-like digitations.

Description

Massive or thickly encrusting, irregularly lobate, covering large surfaces. Some specimens in the deeper locations with short cylindrical digitations resembling small specimens of *Axinella* sp., up to 30 mm high and 5 mm in diameter, simple or dichotomous with enlarged ends, often curved (Figure 7B,C). Surface covered by sediment, with a very short and irregular hispidation, bearing groove-like depressions forming on the body an irregular surface pattern more or less visible *in situ* according to the thickness of the mud cover. Oscules on main body, never on digitations, with slightly raised margin, 1.5–2 mm in diameter in live specimens, non-visible after preservation. Consistency rather soft, fragile. Colour in life pale yellow inside, muddy grey with pale yellow grooves on surface, uniformly clear brown after preservation. Digitations uniformly yellow in life. Surface layer 80–120 µm thick, including numerous foreign particles mostly subspherical and 10 to 50 µm in diameter, less abundant in the buds. Foreign particles also present in the choanosome, although less frequent (Figure 3A).

Skeleton (Figure 3A): extremely confused reticulation of oxeas of variable size, with a few poorly defined ascending lines without visible spongin, 20–50 µm in diameter, made up of 5–10 spicules, slightly protruding from surface. No special ectosomal skeleton.

Spicules (Figure 3B,C): oxeas, most often straight, rarely feebly curved, with long acerate ends sometimes unequal, rarely styles, 150–940 × 2–10 µm.

Ecology

A common species between 4 and 25 m, under overhangs in the shallower locations, on subhorizontal surfaces in the deeper ones. The digitations are more frequent and more developed in deeper locations. When devoid of digitations, the sponge may be difficult to observe *in situ* due to its mud cover.

Comment

This sponge is allocated with some reservations to the Indo-Pacific genus *Liosina* Thiele, 1899. As typical in *Liosina*, the skeleton is made of oxeas with a wide size-range and a poorly defined arrangement but including loose bundles. The genus is also characterized by a muddy surface with shallow grooves determining a polygonal pattern (Kelly-Borges & Bergquist, 1988; van Soest et al., 2002), strongly reminiscent of the surface characters observed here. The Mediterranean sponge differs from the Indo-Pacific *Liosina* spp. by its shape, thickly incrusting rather than generally forming thick-walled tubes, by the presence of digitations, and by the irregularity of the surface pattern, but the general characters are similar. Furthermore, its surface layer contains subspherical inclusions of unknown nature that are likely equivalent to the 'pigmented cells' reported in *L. granularis* Kelly-Borges & Bergquist, 1988. The nature of these subspherical inclusions of the surface layer is undetermined. They are not pigmented cells, since they are observed on spicule slides after nitric acid treatment (Figure 3C). They are probably of sedimentary origin, but this implies a choice of sedimentary particles by the sponge, and only very few foreign spicules are present among them. We have observed similar particles in specimens of *L. granularis* from Mayotte (J.V., unpublished observations).

This is the first record in the Mediterranean of this tropical genus, which has not been reported from the Red Sea.

Order HALICHONDRIDA Gray, 1867
Family HALICHONDRIIDAE Gray, 1867
Genus *Ciocalypta* Bowerbank, 1862
Ciocalypta carballoi sp. nov.
(Figures 4A–E & 7D)

Type material

Holotype: MNHN-DJV 103. Jounié, 34°02.15'N 35°37.36'E, 10 July 2003 (1), 18–19 m. Fixed in formalin and preserved in ethanol.

Paratype 1: MNHN-DJV 104. Batroun 2, near the Marine Laboratory (34°15.06'N 35°39.43'E), 4 July 2003, 6 m.

Paratype 2: MNHN-DJV 105. Jounié, 34°00.85'N 35°37.83'E, 11 July 2003 (2), 15 m.

Paratype 3: Batroun 1, before Phoenician wall 34°15.22'N 35°39.35'E, 16 October 1999, 8 m.

Other material examined

Tyr, 25 October 1999, 12 m.

Etymology

Dedicated to Dr J.L. Carballo, who described a very similar sponge from Cadiz.

Description

Basal mass 1.5–2 cm thick, more or less buried in sediment, from which arise numerous conical papillae, 5–85 mm high for 3–10 mm basal in diameter (Figure 7D). Papillae sometimes coalescent or with a few poorly marked longitudinal ridges, not transparent, slightly hispid, closed at the apex, with two to five longitudinal internal canals up to 2 mm in diameter. No visible orifice. Consistency soft and crumbly for basal mass, more rigid for papillae. Colour deep yellow to orange yellow alive, basal incrustation between the papillae, when visible, yellow to yellow green, cream white in alcohol.

Skeleton (Figure 4A,B): in basal mass, irregular reticulation of vague tracts. In papillae, plumose ascendant fascicles intertwining in a poorly defined longitudinal axis, with obliquely diverging tracts ending in short irregular brushes perpendicular to the surface and palisade-like arrangement, without any superficial tangential skeleton. Spongin poorly developed, interconnecting spicules abundant.

Spicules (Figure 4C–E): oxeas, most often curved in the centre, sometimes curved along the whole length. Tips more or less equal, sometimes styles, thicker spicules having close successive narrowings. Size 300–750 × 2.5–15 µm. Styles of same size, rare or absent, with intermediates with true oxeas. A few thin spicules are present in some slides.

Ecology

A rather common sponge on subhorizontal surfaces of mixed sand and rock, 6–20 m depth. The basal mass is often covered by sediment, the conical papillae being the only visible parts of the sponge.

Comment

This sponge differs from *Ciocalypta penicillus* Bowerbank, 1864, the type species of *Ciocalypta* Bowerbank, 1862, which has a rather similar habit, by a dermal skeleton composed of brushes of perpendicular spicules instead of a tangential skeleton, a poorly differentiated axis made of anastomosing tracts instead of a dense central column, non-translucent papillae devoid of obtuse conules, clear predominance of oxeas with only a few styles, yellow colour alive instead of whitish. Some Mediterranean specimens of *C. penicillus* could have only oxeas (Topsent, 1922; Pulitzer-Finali, 1977;

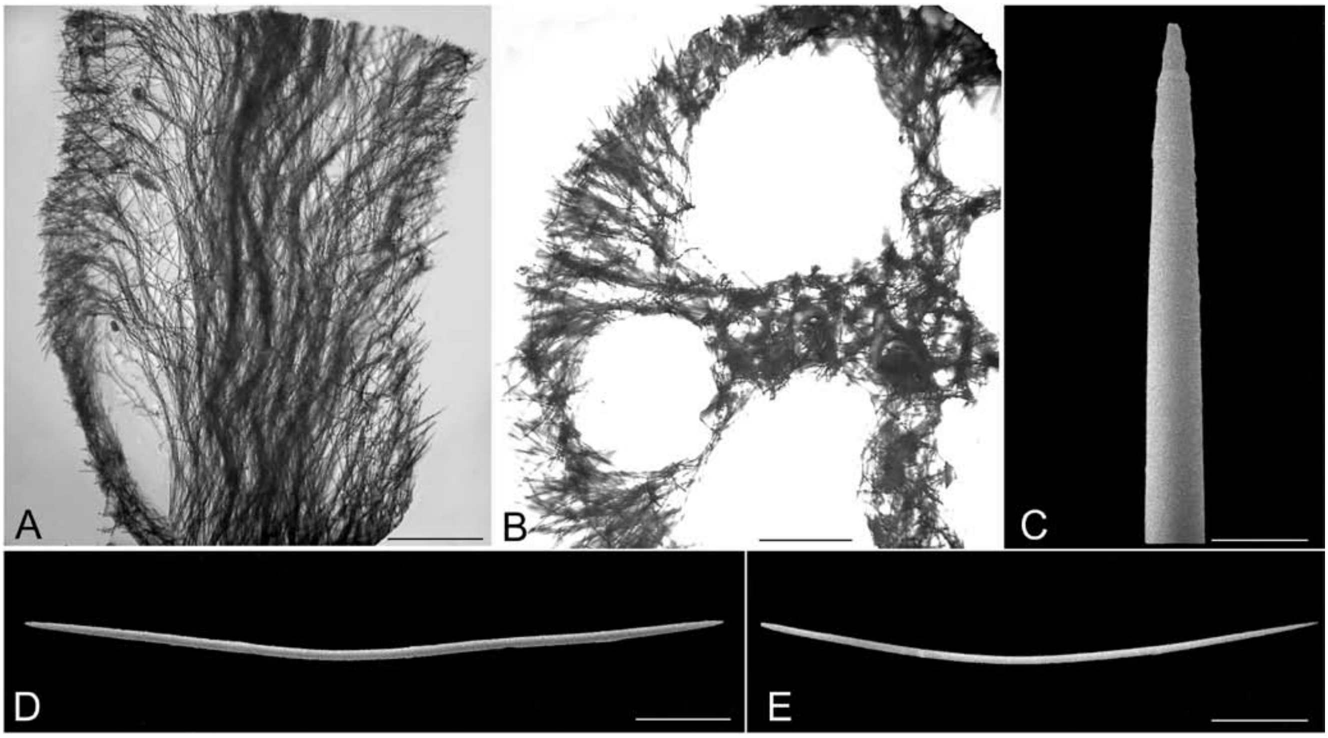

Figure 4. *Ciocalypta carballoi* sp. nov. (A) Longitudinal section through papilla; (B) transverse section through papilla; (C) end of an oxea; (D) oxea; (E) oxea. Scale bars: A,B, 0.7 mm; C, 11 µm; D, 80 µm

J.V., personal observation near Marseille); these specimens, however, are otherwise typical of *C. penicillus*. For the Lebanese specimens, the poorly defined skeletal axis of the papillae, the ectosomal skeleton, and the spicule complement of almost exclusively oxeas are in good agreement with the genus *Coelocalypta* Topsent, 1928. This genus was considered as valid by Carballo (2001), but has been synonymized with *Ciocalypta* in *Systema Porifera* on the ground of a similar overall morphology (Erpenbeck & van Soest, 2002). The Lebanese sponge also appears closely related to *Collocalypta* Dendy, 1905, also considered as a synonym of *Ciocalypta* by Erpenbeck & van Soest (2002), in spite of differences in the ectosomal skeleton. We follow this decision of extensive synonymy of *Ciocalypta* for the description of the present new species. However, the noteworthy differences in the skeletal architecture of the papillae suggest that there are two groups of species in *Ciocalypta* as presently construed.

Several species of *Ciocalypta* previously assigned to *Coelocalypta* have been already recorded from the Mediterranean. *Coelocalypta hyalina* Pulitzer-Finali, 1977, which is doubtfully assigned to the genus according to Carballo (2001) who re-examined the type-specimen, differs from *C. carballoi* by significantly larger oxeas. The type species of the genus, *Coelocalypta porrecta* Topsent, 1928, described from Madeira, possibly also present in Barbados, West Atlantic (van Soest & Zea, 1986), has been recorded by Carballo (2001) from the Gulf of Cadiz near the entrance of the Mediterranean. According to Carballo's description, this sponge appears very similar to the Lebanese specimens, with a basal mass and conical fistules, a pale orange colour in life, a non-tangential dermal skeleton and oxeas 213–690 × 0.9–19.4 µm. The specific identification to *C. porrecta*, however, appears doubtful, as the holotype of *C. porrecta* from Madeira has oxeas longer and significantly thicker (280–more than 1000 × 4–50 µm). Carballo (1994) had first considered it as a new species, *C. gaditana* (undescribed, *nomen nudum*), before finally referring it to *C. porrecta*. Considering the significant difference in spicule size compared to the species from Madeira, we propose a new species for the Lebanese sponge, possibly including the specimens identified as *C. porrecta* from the entrance of the Mediterranean.

Sponges of the same morphology and colour, most likely belonging to the new species have also be found in the Levantine basin in Datca peninsula and in Gokova Bay, Turkey, by Volkan Demyr (personal communication).

According to unpublished observations (Boury-Esnault, personal communication), a sponge with a similar habit, colour and spicule complement, possibly belonging to the same species, is common on the West African coast in Senegal. We have examined some specimens, which do not show significant differences. However, the spicule size of the Senegalese specimens appear rather variable, although always smaller than in *C. porrecta* from Madeira, and their specific identity either with *C. porrecta* or with *C. carballoi* sp. nov. needs to be confirmed. This sponge has also been recorded from Mauritania as *Topsentia porrecta* (van Soest, 1993). Whether the sponges from Lebanon, Cadiz, and Senegal belong to one species or represent twin species, they confirm interestingly some affinities between the West African and the easternmost Mediterranean sponge fauna.

The new species also remarkably resembles the sublithistid *Petromica* (*Chaladesma*) *ciocalyptoides* (van Soest & Zea, 1986) from the tropical Western Atlantic (van Soest & Zea, 1986; Muricy et al., 2001; List-Armitage & Hooper, 2002). The two sponges share the same habit, skeleton structure and spicule complement, but differ by the presence of desmas in *Petromica*. It can be hypothesized that they are closely related, but that *Ciocalypta* spp. lost the desmas. It has been shown that silicon limitation may modulate the secretion of some types of spicules, especially desmas (Maldonado et al., 1999). The desmas of *P. ciocalyptoides* do not present zygosis and are low in number, as compared to those of other *Petromica* spp. from deeper water (Muricy et al., 2001) where the concentration of silicic acid is higher. It would be interesting to investigate whether some *Ciocalypta* spp. do not correspond to species of *Petromica* (subgenus *Chaladesma*) that do not secrete desmas.

Previously known distribution

Possibly Gulf of Cadiz.

Order HAPLOSCLERIDA Topsent, 1928
Family NIPHATIDAE Van Soest, 1980
Genus *Niphates* Duchassaing & Michelotti, 1864
Niphates toxifera sp. nov.
(Figures 5H & 7E)

Type material

Holotype: MNHN DJV 99. Selaata, 34°17.072'N 35°39.509'E, 14 September 2002, 9 m, coll. G. Bitar & H. Zibrowius, one fragment fixed in formalin and preserved in alcohol, one fragment fixed and preserved in alcohol (50 b).

Paratype 1: MNHN-DJV 100. Selaata, 34°17.072'N 35°39.509'E, 2 May 2001, 15 m (Figure 7E), coll. J.-G. Harmelin, dry.

Paratype 2: MNHN-DJV 101. Tripoli Harbour, 34°27.471'N, 35°49.563'E, 19 September 2002, 5 m, coll. G. Bitar & H. Zibrowius, one fragment fixed in formalin and preserved in alcohol, one fragment fixed and preserved in alcohol (50 c).

Other material examined

Beirut harbour, 9 July 2003 (2-1), 3 m. El Heri 19 October 1999 (6a, 27a), overhang, 3 m. Hannouch, 18 March 1993, 23 m. Selaata, 2 May 2001 (47a, 50a), 15 m; 24 September 2002 (50d), 15 m; 6 July 2003 (1), 10 m. Ramkine Island, 14 July 2003 (2), 9 m. Tripoli harbour, 19 September 2002 (50c), 3–5 m, and 8 July 2003, 2 m. Syria (Latakié), 14 August 2002, 5 m.

Etymology

The specific name refers to the presence of toxa.

Description

Ramose sponge, irregularly branching and anastomosing, with repent branches attached to the substrate by several points forming low masses more than 50 cm wide, from which arise erect branches (Figure 7E). Branches irregular and flattened near the base, where they are up to 30 mm in diameter, more slender (5–12 mm in diameter) and regularly cylindrical in the upper parts, with a conical tip. Oscules

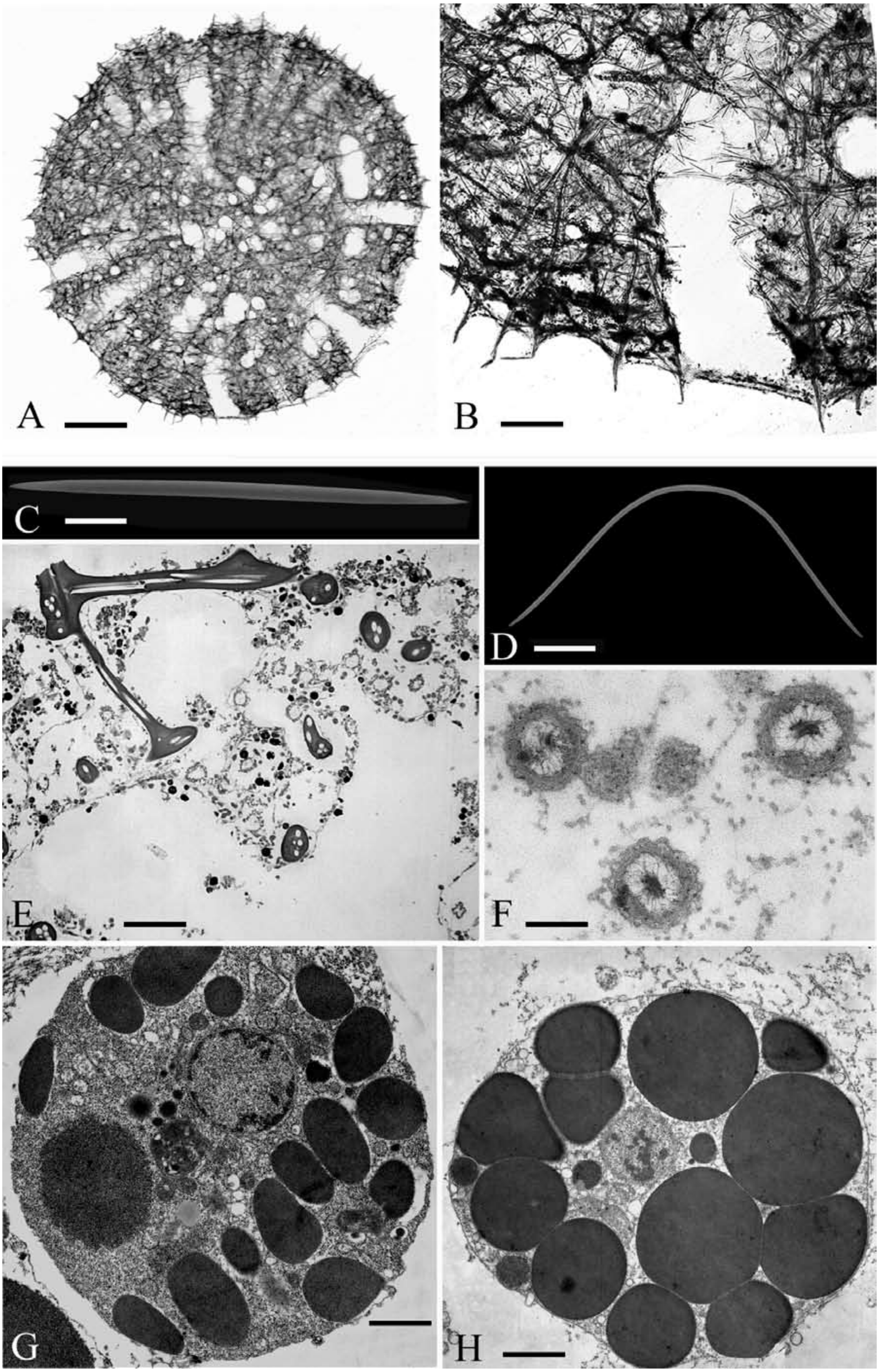

Figure 5. *Niphates toxifera* sp. nov. (A) Transverse section through a branch; (B) enlargement of a zone of A; (C) oxea; (D) toxa; (E) semithin section through the choanosome (desilicified), showing the fibre skeleton, traces of spicules, canals, choanocytes chambers and dark spherulous cells; (F) TEM view of symbiotic bacteria and collagen fibrils; (G) TEM view of a spherulous cell; (H) TEM view of a spherulous cell. Scale bars: A, 1.5 mm; B, 350 μm; C, 25 μm; D, 10 μm; E, 84 μm; F, 0.18 μm; G, 1 μm; H, 1.3 μm.

numerous, 1.5–3 mm in diameter, aligned in one row on the upper face of the branches, spaced from 7 to 20 mm, flush with the surface or with a slightly elevated margin, on the top of small lobes or on low crests near the basal parts. Surface covered by a delicate aspicular dermal membrane with ostia 30–50 µm in diameter, bearing a short, regular hispidation. Consistency firm, compressible. Colour reddish-brown alive, with clearer spots due to sand or mud deposition on the upper face, brown in alcohol, formalin and in dry state. Choanocyte chambers numerous, spherical, 25–30 µm in diameter (Figure 5E). Choanocytes very small, approximately 3 µm high with an anucleate nucleus 1.2–1.5 µm in diameter. Spherulous cells abundant, 7.5–12.5 µm in diameter, with cytoplasm more or less completely filled by homogeneous subspherical or ovoid spherules, up to 2.5 µm in diameter in mature cells (Figure 5G,H). Mesohyl containing a few short rod-like bacteria, 0.25–0.3 µm in diameter, with an irregularly wavy surface, belonging to a single morphotype (Figure 5F).

Skeleton (Figure 5A,B): regular reticulation of ascending, secondary and sometimes tertiary fibres. Ascending fibres multispicular, 250–400 µm apart near the end, 50–70 µm in diameter, with a clearly visible spongin sheath, ending at right angles to the surface in small conical projections 150–250 µm long, determining the short hispidation. Secondary fibres multispicular to paucispicular, often at right angles to the ascending fibres, 20–40 µm thick, frequently connected by a third system of unispicular to paucispicular fibres. No special dermal skeleton other than the protruding terminal parts of primary fibres. Toxas dispersed without order.

Spicules (Figure 5C,D): oxeas straight or very slightly bent, with long conical tips, 120–180 × 2–8 µm, smaller and thinner in specimens from El Heri (19 October 1999, 6a) and Tripoli harbour (19 September 2002, 50c, alcohol), where they do not exceed 140×4 µm. Toxas in variable abundance in most specimens, rarely absent or not observed, very thin, with a central flexion and nearly straight branches, the longer ones more open, 30–80 µm long.

Ecology

Very common on vertical or subvertical rock surfaces, from 2 m to 23 m on cliffs in relatively clean water. Obviously tolerant to pollution since also found in heavily polluted environments such as harbours. Sponge branches frequently bearing a thick mud cover on the upper face in polluted areas. The sponge is frequently associated with the holothurian *Synaptula*, a 'lessepsian species'.

Comment

This common haplosclerid is well characterized by its ramose branching habit, its colour and the presence of toxas. These characters do not agree with any described Mediterranean Niphatidae or Chalinidae and justify its description as a new species. The family and generic allocation, however, is rather difficult. Toxas may occur in Chalinidae (generally in association with sigmas) or in Callyspongiidae, but have not so far been reported in Niphatidae (Desqueyroux-Faúndez & Valentine, 2002; De Weerdt, 2002; van Soest & Hooper, 2002). However, the skeletal organization clearly differs from that of Chalinidae and Callyspongiidae, and is typical of Niphatidae (confirmed by W. de Weerdt, personal communication, 2002). The sponge is thus allocated to Niphatidae, in which it is a unique example of occurrence of toxas. In this family, the new species fits quite well with *Niphates* Duchassaing & Michelotti, 1864, although differing by the presence of toxas. It differs from *Pachychalina* Schmidt, 1868, which contrary to *Niphates* is already recorded from the Mediterranean, by a regular reticulation of multispicular fibres with abundant spongin and a relatively poor development of the aquiferous system. It also differs from *Amphimedon* Duchassaing & Michelotti, 1864 and from *Gelliodes* Ridley, 1884 by the absence of an ectosomal tangential skeleton, and by microscleres, absent in *Amphimedon* and being sigmas instead of toxas in *Gelliodes*.

The new Lebanese sponge appears different from any of the haplosclerids with only toxas as microscleres which have been described under various generic names in Callyspongiidae and Chalinidae (*Gellius*, *Toxiclona*, *Toxadocia*, *Toxochalina*). Among these, a few Indo-Pacific species with a similar spicule complement occurring or possibly occurring in the Red Sea need to be considered here because of the possibility that the Lebanese sponge could be a lessepsian migrant. This possibility has to be carefully examined especially as the sponge gives an intuitive feeling suggesting an Indo-Pacific haplosclerid rather than a Mediterranean one, and is a common member of the harbour fauna which is likely to include introduced species. *Gellius toxius* Topsent, 1897, from Ambon and also recorded in the Red Sea (Lévi, 1958, 1965), *Gellius toxotes* Hentschel, 1912, *Gellius toxophorus* Hentschel, 1912, all differ by shape, colour, spicule characters and in having a chalinid skeleton. There are some similarities in shape and in spicule characters to *Toxochalina ridleyi* Dendy, 1905, from the Gulf of Manaar, which however differs by its callyspongid skeletal organization. An apparently undescribed Niphatidae from the Red Sea studied by one of us (J.V., unpublished, collection Bourguet-Kondracki, 2002 DY-37) resembles the new species by its brown colour, a similar skeleton and the presence of toxas, but differs by an irregularly tubular shape, a softer consistency, and smaller toxas with a central swelling. We also compared this sponge to an apparently undescribed *Chalinula*, rather common in the Red Sea near Jeddah, which has toxas 27–44 µm similar in shape. This Red Sea sponge differs by a skeleton typical of *Chalinula*, a branching erect shape rather than ramose repent, a deeper brown colour, and a softer consistency. In conclusion, although this species displays some resemblances with a few haplosclerids from the Red Sea or the Indian Ocean, there is no exact correspondence with any known Indo-Pacific sponge, and the Red Sea origin of *N. toxifera* sp. nov. remains highly hypothetical. It must be noted, however, that the sponge fauna of the Red Sea has been described mostly from coral reef environments, whereas the fauna of harbours has been only poorly investigated. It would be interesting to check whether this species, which in Lebanon is able to live both in clear water environment and in polluted harbours, is not present in polluted areas of the Red Sea.

This appears to be the first Mediterranean record of the genus *Niphates*, previously recorded from the Caribbean and the Indo-West Pacific. However, given the problematic taxonomy of this group of sponges and the difficulty of

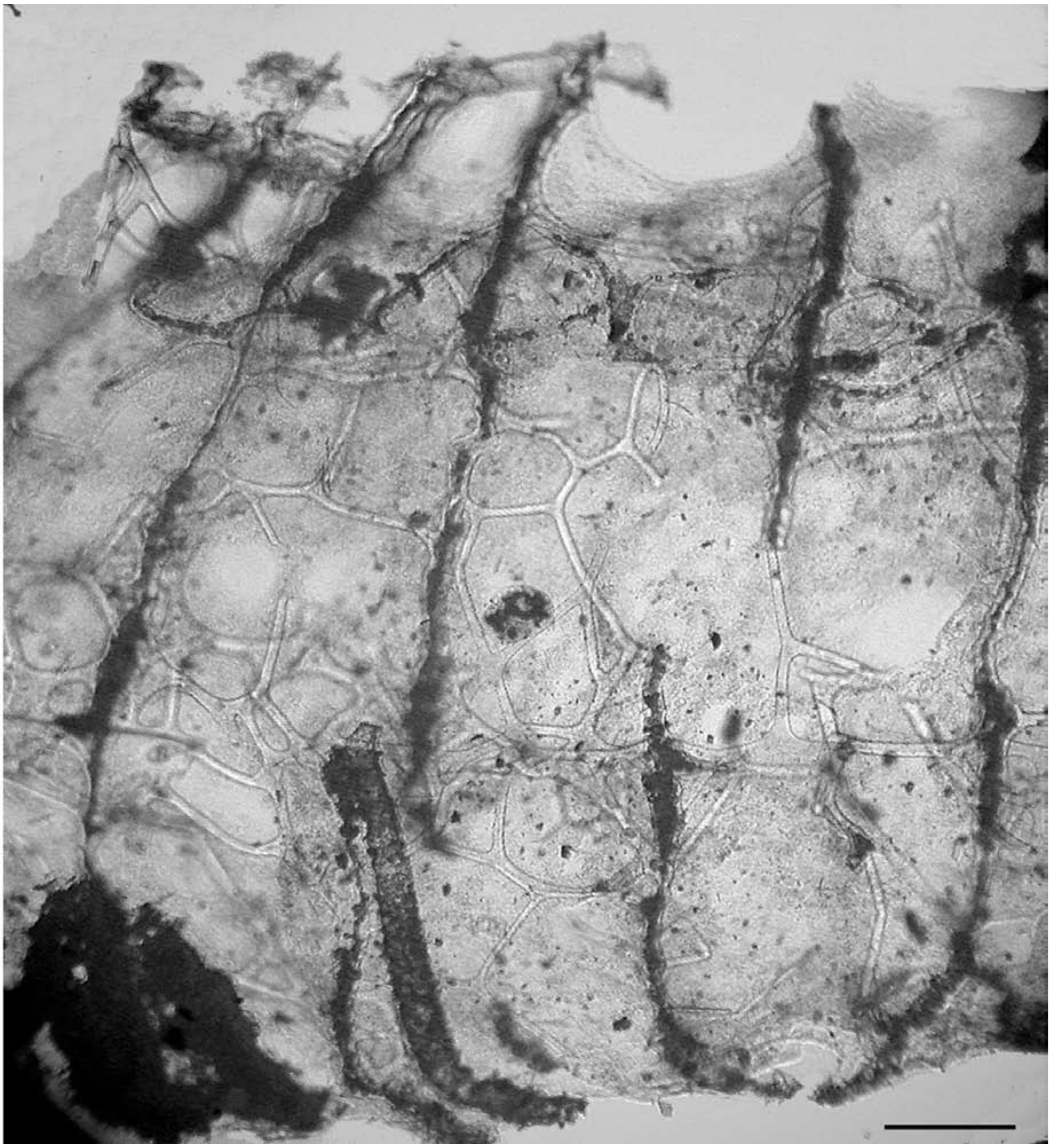

Figure 6. *Euryspongia raouchensis* sp. nov. Section perpendicular to surface, with a soft polychaete tube in the bottom centre. Scale bar: 0.5 mm.

appreciation of their diagnostic characters, it could not be ascertained that some Mediterranean haplosclerids are not referable to *Niphates* as recently redefined (Desqueyroux-Faúndez & Valentine, 2002).

Order DICTYOCERATIDA Minchin, 1900
Family DYSIDEIDAE Gray, 1867
Genus *Euryspongia* Row, 1911
Euryspongia raouchensis sp. nov.
(Figures 6 & 7F)

Type material

Holotype: MNHN DJV 107. Beirut (Raouché, 'Grotte aux Pigeons'), 33°53.323'N 35°28.163'E 16 July 2003 (1-B), 2 m.

Paratype: MNHN DJV 108. Beirut (Raouché, 'Grotte aux Pigeons'), 33°53.323'N 35°28.163'E 16 July 2003 (1-B), 2 m.

Etymology

Named from Raouché, a popular place in Beirut, where the cave in which the sponge was found is located.

Description

Thickly encrusting, approximately 3–5 mm thick. Holotype (Figure 7F) covering a surface of 6×4 cm, paratype smaller. Surface unarmoured, covered by small conules with a 0.8–1.2 mm spacing, each with a slightly protruding fibre. Ectosome non-armoured. Oscules irregularly scattered on the surface, rather numerous, circular, flush with surface, 0.8–1 mm in diameter. Colour in life cream with the end of conules whitish, clear brown in alcohol. Consistency fleshy, easily torn. Choanocyte chambers numerous, large, 75–90 µm in diameter. Presence of polychaete tubes in the flesh.

Skeleton (Figure 6): primary fibres ascending singly from substratum to surface, rather regular spaced, ending

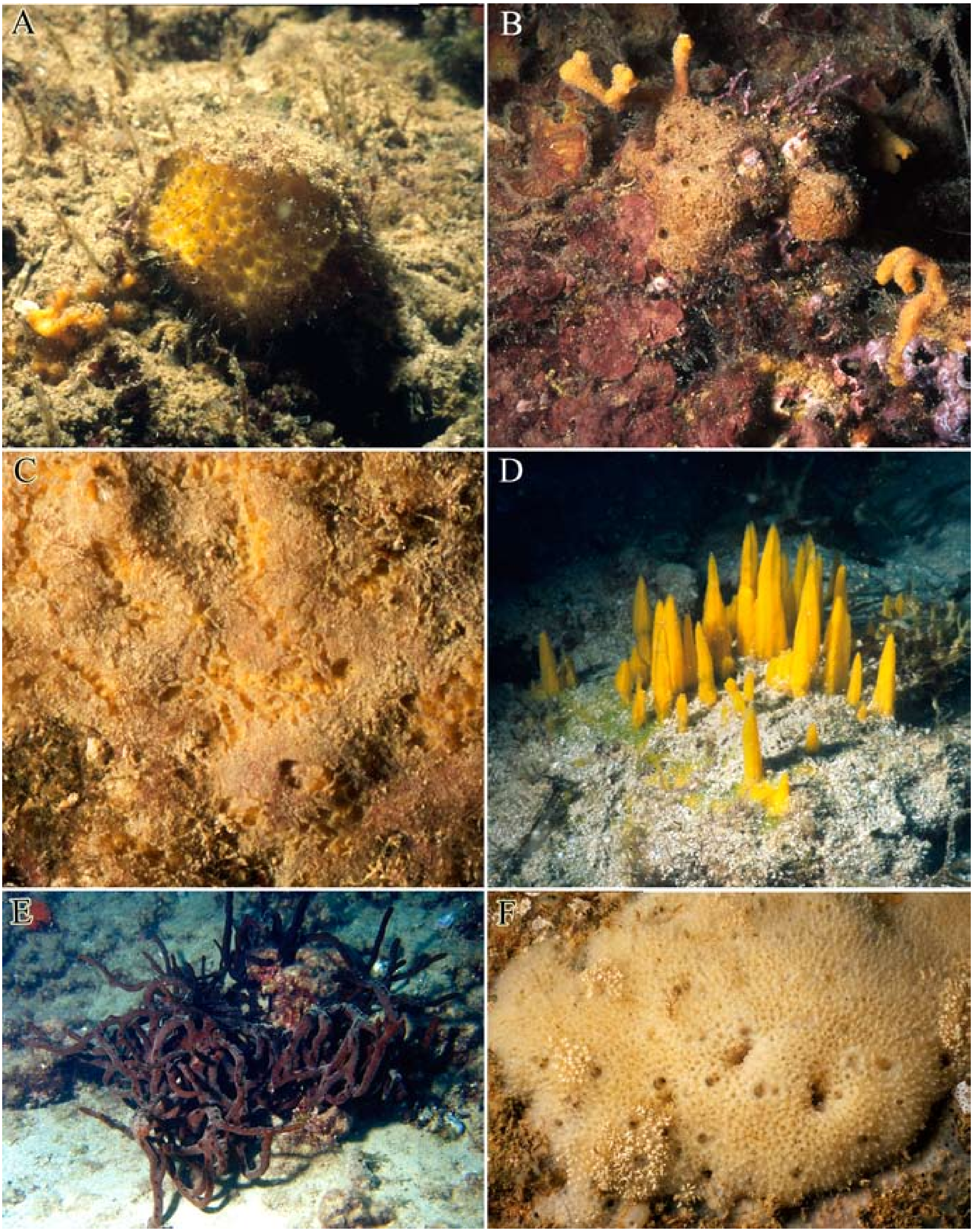

Figure 7. (A) *Cinachyrella levantinensis* sp.nov.; (B,C) *Liosina blastifera* sp.nov.; (B) general view of a specimen with buds, Jounié, 11 July 2003, 20 m; (C) close up of the surface, Jounié, 10 July 2003, 24 m; (D) *Ciocalypta carballoi* sp.nov. Batroun 2, 15 July 2003, 10 m; (E) *Niphates toxifera* sp.nov., paratype 1, Selaata, 2 May 2001, 15 m; (F) *Euryspongia raouchensis* sp.nov. Beirut (Raouché cave), 16 July 2003-1, 2 m. Photographs: A,D, T. Perez; B,C,F, J. Vacelet; E, J.-G. Harmelin;

at surface in a conule, heavily cored in their center by foreign material, 125–150 μm in diameter. Secondary fibres moderately developed, forming in places a roughly scalariform reticulation, without pith, non-cored although some fibres near the surface may have a poorly developed central core of foreign material, 40–70 μm in diameter.

Ecology

Only two specimens known from subvertical walls of Raouché cave, a superficial tunnel 2–5 m deep with strong water movements. A specimen most probably belonging to the same species, 15×10 cm in size, has been observed in a small cave near Raouché cave (G.B., 22 September 2005).

Comment

This sponge has large choanocyte chambers of the dysideid type, but differs from *Dysidea* by its general morphology and by the secondary fibres that are most generally clear of inclusions. The possibility that the sponge is an aberrant *Dysidea* with an encrusting habit and poorly cored secondary fibres due to the exposed habitat appears unlikely. Its colour also appears different from that of the common Mediterranean species of the genus. The characters agree quite well with those of the genus *Euryspongia* Row, 1911 (Cook & Bergquist, 2002) and we propose a new species in this genus, which has not been recorded from the Mediterranean.

The type species of *Euryspongia*, *E. lactea* Row, 1911 has been described from the Red Sea, and there is thus a possibility that the Mediterranean specimens are lessepsian migrants. According to the description by Row and by Cook & Bergquist (2002), and to a new examination of the type specimen (J.V., BMNH 1912.2.1.81), the new species differs by the encrusting shape, instead of subspherical, and by the poor development of the secondary fibres which in *E. lactea* are thinner and form a well developed reticulum. The genus *Euryspongia*, with seven nominal species (Cook & Bergquist, 2002), has a large Indo-Pacific distribution, and is also recorded from the West Indies.

DISCUSSION

The discovery of five new species that, with the exception of *Euryspongia raouchensis*, are in fact common on the Lebanese coast, suggests that the low diversity of the sponge fauna in the Levantine Basin is mainly apparent and due to the meagre number of studies for this area. This is confirmed by a more complete study of the Lebanese sponges that we have in preparation.

Three of these five new sponges belong to genera previously known from the tropics that are new for the Mediterranean. *Liosina*, with only two described species, has a wide Indo-Pacific distribution, whereas *Euryspongia* and *Niphates* are recorded from both the Indo-Pacific and the tropical Atlantic. The two others have an apparently restricted distribution in the Mediterranean and show intriguing resemblance, possibly similarities, to Atlantic species of the West African coast.

The presence of representatives of genera previously documented only in tropical areas, especially with Indo-Pacific affinities, in the easternmost, warmer area of the Mediterranean could suggest that their representatives are lessepsian migrants, recently introduced from the Red Sea by the Suez Canal. Sponges are considered as poor colonizers, but among the many species of invertebrates or algae that have been recorded as lessepsian migrants (Por, 1989; Galil, 2000), some have also apparently low colonization potential. The hypothesis of introduction from the Red Sea was already suggested for five species of sponges as early as 1936, when the potential for migration was still reduced due to salinity conditions (Burton, 1936; Tsurnamal, 1969b). The support, however, appears low. The specific identity of the Levantine specimens identified by Burton and Tsurnamal with those from the Red Sea is very doubtful. For instance, in the present study we have shown, as discussed above, that *Cinachyrella levantinensis* sp. nov. is more likely an undescribed species than referable to *Chrotella ibis* Row from the Red Sea. The case of *Didiscus placospongioides* Dendy, 1921, presented as another possible lessepsian migrant (Burton, 1936), has been contested by Lévi (1957), and Tsurnamal (1969a) convincingly argued that it was a different species, *Didiscus styliferus* Tsurnamal, 1969. The cases of *Dactylochalina viridis* Keller, 1889 (now *Amphimedon chloros* Ilan et al., 2004) identified by Burton (1936), of *Heteronema erecta* Keller, 1889 (now *Hyrtios erecta*) and of *Damiriana schmidti* Ridley, 1844 (now *Lissodendoryx schmidti*) remain very doubtful. However, the identity of a *Geodia* from the Mediterranean coast of Israel with the Red Sea *Geodia micropunctata* Row, 1911 is possible, as the sponge has been identified by the same author (Tsurnamal, 1969b) both from the Mediterranean and from Suez harbour.

As discussed above for each species, a Red Sea origin of the new species described here appears unlikely. Their identity with a known Red Sea or Indo-Pacific species can either be rejected or remains highly doubtful, and an exact correspondence cannot be observed for any of the species. The hypothesis, however, should not be definitively rejected. The sponge fauna of the Red Sea is still poorly known and certainly includes many undescribed species (see for instance Ilan et al., 2004). Furthermore, this fauna has been studied mostly in a coral reef environment, whereas the sponges of harbours and of the Suez Canal itself, i.e. those more likely to enter in the Mediterranean, are virtually unknown. The list given by Burton (1926) for the Suez Canal is difficult to interpret without a re-examination of the specimens due to the extensive synonymy accepted by the author. Future studies may lead to reconsideration of the question. Special attention should be paid to *Niphates toxifera*, which has been found in the polluted environments of the Beirut and Tripoli harbours and which should be looked for in Red Sea harbours. According to a brief examination of the Haplosclerida identified by Burton (1926) near the Suez Canal that we conducted in the BNHN, none has the same gross morphology as *N. toxifera*.

At present, it appears more likely that these sponges are remnants of a thermophilous fauna which thrived in the Mediterranean during warmer periods. These thermophilous species had a better chance of survival in the warmest parts of the Mediterranean during subsequent cooling episodes. They might represent remnants of a 'Senegalian fauna' that occurred in the Mediterranean in the late Pleistocene (Tyrrhenian) and generally disappeared during the Würmian cooling. Analogous events occurred also in the late Pliocene, with the subtropical Piacenzian conditions being followed by cooling episodes (Haywood et al., 2000). Similar examples of subtropical species trapped in the warmer parts of the Mediterranean have been found in other invertebrate taxa (Taviani, 2002 and references therein; Bianchi, 2007). This interpretation has already been accepted for two lithistid sponges recently described from the Lebanese coast (Perez et al., 2004). However, for the newly described species, if such an origin appears likely in the case of species having affinities with Atlantic species of the West African coast, it is less probable for those with Indo-Pacific distribution, especially the representative of *Liosina*. The genus has hitherto been known only from the Indo-Pacific area, which would indicate that it is a Tethyan relict in the Mediterranean. The actual presence of Tethyan relicts is very controversial (Taviani, 2002).

We gratefully acknowledge the assistance of Chantal Bézac and Christian Marschal, Centre d'Océanologie de Marseille, for their technical help. Field work in Lebanon has been carried out within the French–Lebanese cooperation programme CEDRE. Part of the study has been conducted within the framework of the programme of Agence Nationale de la Recherche ECIMAR. We especially thank Dr Gaby Khalaf, director of the Centre National des Sciences Marines of Batroun (Lebanon) for his kind hospitality and the facilities he offered for field work. We thank Dr W. de Weert, Dr J.-L. Carballo and Dr M. Ilan for useful information, J.G. Harmelin for access to his underwater photographs, and C. Valentine for consultation of type-specimens in the BMNH.

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Submitted 6 November 2007. Accepted 16 November 2007.