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Deep-water sponges (Porifera) from Bonaire and Klein Curaçao, Southern Caribbean

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Abstract

Four submersible dives off the coast of Bonaire (Caribbean Netherlands) and Klein Curaçao (Curaçao) to depths of 99.5–242 m, covering lower mesophotic and upper dysphotic zones, yielded 52 sponge specimens belonging to 31 species. Among these we identified 13 species as new to science. These are *Plakinastrella stinapa* n. sp., *Pachastrella pacoi* n. sp., *Characella pachastrelloides* n. sp., *Geodia curacaoensis* n. sp., *Caminus carmabi* n. sp., *Discodermia adhaerens* n. sp., *Clathria (Microciona) acarnoides* n. sp., *Antho (Acaronia) pellita* n. sp., *Parahigginsia strongylifera* n. sp., *Calyx magnoculata* n. sp., *Neopetrosia dutchi* n. sp., *Neopetrosia ovata* n. sp. and *Neopetrosia eury stomata* n. sp. We also report an eurentid hexactinellid, which belongs to the rare genus *Verrucocoeloidea*, recently described (2014) as *V. liberatorii* Reiswig & Dohrmann. The remaining 18 already known species are all illustrated by photos of the habit, either in situ or ‘on deck’, but only briefly characterized in an annotated table to confirm their occurrence in the Southern Caribbean. The habitat investigated - steep limestone rocks, likely representing Pleistocene fossil reefs - is similar to deep-water fossil reefs at Barbados of which the sponges were sampled and studied by Van Soest and Stentoft (1988). A comparison is made between the two localities, showing a high degree of similarity in sponge composition: 53% of the present Bonaire-Klein Curaçao species were also retrieved at Barbados. At the level of higher taxa (genera, families) Bonaire-Klein Curaçao shared approximately 80% of its lower mesophotic and upper dysphotic sponge fauna with Barbados, despite a distance between them of 1000 km, indicating high faunal homogeneity. We also preliminarily compared the shallow-water (eu-photic) sponge fauna of Curaçao with the combined data available for the Barbados, Bonaire and Klein Curaçao meso-photic and upper dysphotic sponges, which resulted in the conclusion that the two faunas show only little overlap.

Key words: Sponge fauna, new species, mesophotic, dysphotic, Caribbean Netherlands, Curasub, manned submersible

Introduction

We report here results of the Bonaire Deep Reef Expedition 2013 (May 27–June 1, 2013) exploring the mesophotic and upper dysphotic zones surrounding the islands of Bonaire and Klein Curaçao with the aid of the manned submersible ‘Curasub’ of the Substation Curaçao (Becking & Meesters 2014). The shallow-water reefs of the Caribbean are considered a biodiversity hotspot, an area with exceptional diversity of animals, plants and ecosystems (e.g. Roberts *et al.* 2002). The shallow-water reef sponges of Curaçao and Bonaire are relatively well-known from multiple studies by Van Soest and others (e.g. Van Soest 1978, 1980, 1981, 1984a & b, 2009; De Weerd 2000), yet surprisingly little is known about the biota of the deep reef and the mesophotic and dysphotic zones. This represents a critical knowledge gap for developing future reef policies and management practices. The only previous deep water submarine research conducted on Bonaire and Curaçao took place in May 2000, during which 24 dives were conducted with the Johnson Sealink II submersible of Harbor Branch, FLA, USA, down to depths of 900 m (Reed & Pomponi 2001). The focus of that expedition was on the discovery of biomedically interesting taxa, especially sponges, and did not result in species descriptions, with one exception: a member of the rare hexactinellid genus *Verrucocoeloidea* Reid, 1969, *V. liberatorii* was recently described by Reiswig & Dohrmann (2014).

In order to adequately protect the ecosystem and construct sustainable management plans it is essential to document the biodiversity and to gain an understanding of which processes keep it in place. The Netherlands

Ministry of Economic Affairs commissioned the Institute for Marine Resources and Ecosystem Studies (IMARES) to study the deeper reef of Bonaire as part of the Exclusive Economic Zone management plan for the Caribbean Netherlands (Meesters *et al.* 2010; Becking & Meesters 2014). In this framework we describe below new sponges of the mesophotic and upper dysphotic zone of Bonaire and briefly characterize the already known species. In a preliminary attempt to place our results in perspective, we compared these with previously published sponge surveys, and some tentative conclusions about sponge biodiversity of the mesophotic and upper dysphotic zone of the Southern Caribbean are drawn.

This is Ocean Heritage Foundation/Curacao Sea Aquarium/Substation Curacao (OHF/CSA/SC) contribution number 12.

Study sites and methods

Dive locations and collection method. Dives were made with the ‘Curasub’ submarine to depths of 99.5–242 m at Klein Curaçao (one dive) and at the southwest coast of Bonaire (three dives, at Kralendijk, Cargill, and Statoil), cf. Fig.1, Table 1. The ‘Curasub’ was operated from the support vessel RV ‘Chapman’. All visible sponge species were collected at least once, excepting cryptic and thinly encrusting sponges. The dive locations were selected based on available piers where the support vessel could moor. At each station, video transects were made, from the shallow coral reef down to the maximum depth that could be reached within the available dive time (maximum 7 hours). During the dives digital in situ images were made of encountered species and specimens selected for collection. Data loggers on the hull of the submarine recorded depth and temperature while diving. Samples were collected using the operational arms of the submarine and stored on the basket in front of it during the dive, or were chiseled from the rock surface and collected by suction tube into a container to the side of the submarine. Upon arrival at the surface, samples were collected from basket and container by divers and transferred to buckets filled with seawater, and these were then transferred to a laboratory on board of the ‘Chapman’.

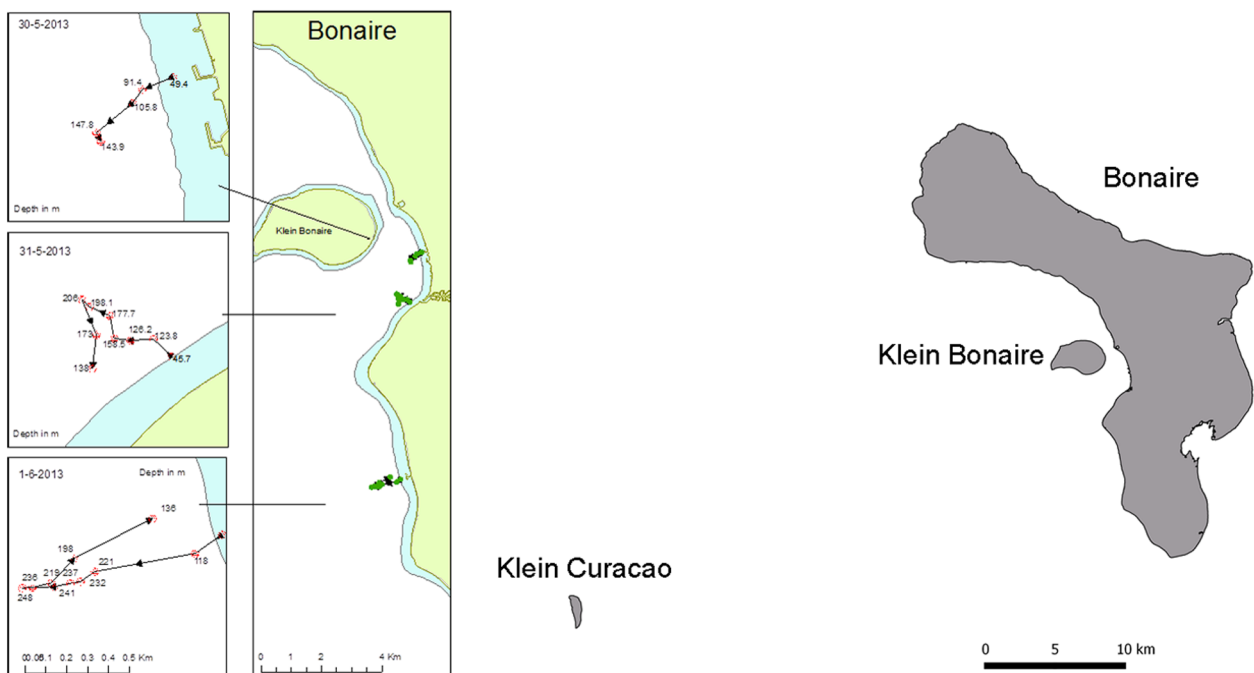


FIGURE 1. Map showing the positions of Bonaire and Klein Curaçao (Southern Caribbean), where the present collections were obtained. Insets show details of locations and course of dives 2–4 of the Curasub.

TABLE 1. Station information of four dives with the ‘Curasub’ submarine off the south west coast of Klein Curaçao and the south coast of Bonaire. Duration is indicated as hours: minutes and the maximum depth that the submarine traveled is provided.

Station	Date	Island	Location	Latitude	Longitude	Duration	Max. depth (m)
DIVE 1	27/5/2013	Klein Curacao	SW coast	11.982103	-68.645152	2:20	167
DIVE 2	30/5/2013	Bonaire	Kralendijk pier	12.14692	-68.2821	3:10	148
DIVE 3	31/5/2013	Bonaire	Curoil Dock	12.137	-68.286	5:11	207
DIVE 4	1/6/2013	Bonaire	Cargill pier	12.07996	-68.2938	5:30	248

Specimen processing. Collected specimens were processed as soon as the samples and researchers were on board of the ‘Chapman’. Voucher specimens were preserved in 70% ethanol and deposited in the collections of the Naturalis Biodiversity Center, Leiden, The Netherlands, registered as RMNH Por. XXXX. Observations were made on the external morphology, skeletal architecture and spicules of all specimens. Spicule dimensions were calculated based on 25 measurements (unless noted otherwise) and given in the text as minimum-average-maximum. Only fully developed spicules were measured. To study the skeletal architecture hand cut perpendicular and tangential sections were made. The sections were air-dried, mounted in Durcupan® ACM on a microscope slide, studied and photographed using a Leica DM5500 high power stacking microscope. Spicule preparations were made by dissolving the organic tissue of a small fragment of the specimen in commercial bleach, after which the spicules were washed 5 times with distilled water and once with 96% ethanol. The spicules were air-dried on microscope slides and mounted with Durcupan® ACM for light microscopy. The spicules were also mounted on aluminum stubs, coated with gold-palladium and studied with a JEOL Scanning Electron Microscope.

Observed habitat features at Bonaire. During the three dives at Bonaire a distinct depth zonation of substrate features was visible. Living coral reef was observed until approximately 45 m depth, and then followed a zone of sand mixed with varying amounts of dead coral. Here rubble mounds of tilefish nests were also observed. Subsequently from approximately 45–90 m depth there was an extended zone of sand covered by cyanobacterial mats. The only macrofauna observed in this zone were yellow gorgonians and small groups of garden eels in occasional patches of sand that were not covered by cyanobacteria. The depth from 90–100 m was dominated by sand with occasional small rocks on which fan corals and sponges resided. Between 100 and 150 m depth fossil barrier reef formations and rodolith beds (nodules created by coralline algae) were observed, either in long stretches or in patches within a barren sandscape. By providing hard substrate, these fossil reefs displayed a heightened biodiversity in a desert landscape of sand. Below 150 m the substrate was generally dominated by fine sand, with occasional rocks. The sponge assemblage below 100 m is dominated by rock sponges (lithistid Demospongiae) and glass sponges (Hexactinellida).

Comparison with previous deep-water sponge studies from the region. We compared the species and higher taxa composition of the present four submarine dives at Bonaire and Klein Curaçao with the results of dredge sampling at two nearby locations (Holetown and Paynes Bay) off the west coast of Barbados reported in Van Soest & Stentoft (1988). These dredge samples were taken at comparable depths between 100 and 325 m and the collection (housed at Naturalis Biodiversity Center) was available to us for direct comparison. This allowed us to establish how similar the deep-water sponge faunas are in the southeast Caribbean region.

A further comparison was made by adding up the results of the present collection, those of the Barbados collection and the recent (2000) deep-water sponge results of the Harbor Branch Oceanographic Institute’s Submersible and SCUBA cruise to Curaçao and Bonaire (Reed & Pomponi 2001), and comparing the ordinal composition of the deep-water sponge faunas with that of the shallow-water collections reported from Curaçao and Bonaire by Van Soest and others (Van Soest 1978, 1980, 1981, 1984a & b, 2009, Van Soest & De Weerd 2001; Van Soest *et al.* 2010; Díaz *et al.* 1987; Kobluk & Van Soest 1989; Meesters *et al.* 1991; De Weerd *et al.* 1999; De Weerd 2000; Parra-Velandia *et al.* 2014). We counted the deep-water species belonging to taxa of the ordinal level (removing double occurrences), determined the percentages of the total number of species reported from deep-water, and compared these with percentages obtained from ordinal groups reported from shallow-water. In this way we were able to obtain a preliminary view of the extent in which the photic zone sponge composition differs from that of the deep-water zones.

Results

The total sponge collection made during the four dives consisted of 52 sponge specimens attributed to 31 species, together belonging to three of the four classes of Porifera (the class Calcarea was not represented in our material). We determined that 13 of the 31 species are new to science and their full description is the main purpose of this publication. The remaining 18 species were described previously, but in view of the underexplored habitat and the relatively poorly known species, we construct below also a table containing brief characterizations of these species and present combined photo plates with images - often in situ - of a large number of these species to facilitate future in situ recognition of the sponges.

Systematic descriptions

The order in which the taxa are treated and their affiliation follows the Systema Porifera (Hooper & Van Soest 2002) and recent adaptations as represented in the World Porifera Database (Van Soest *et al.* 2014).

Geographical locations mentioned in the text all belong to the former Netherlands Antilles, which since 2010 have altered status and now either consist of independent countries under the Kingdom of the Netherlands (the islands of Aruba, Curaçao and Sint Maarten) or are special municipalities of the Netherlands (the islands of Bonaire, Sint Eustatius and Saba). We refer to these locations as Caribbean Netherlands.

Phylum Porifera Grant, 1836

Class Homoscleromorpha Bergquist, 1978

Order Homosclerophorida Dendy, 1905

Family Plakinidae Schulze, 1880

Genus *Plakinastrella* Schulze, 1880

Plakinastrella stinapa new species

Figures 2a–e, 3a–e

Material examined. Holotype: RMNH Por. 9252, Caribbean Netherlands, Bonaire, locality ‘Cargill’ (Dive 4), 12.08°N 68.2938°W, depth 242 m, on a limestone rockwall, coll. L.E. Becking & E. Meesters, field nr. BON4/BDR049, 31 May 2013.

Description. Encrusting (1–2 cm thick) with 30–35 slightly elevated oscules scattered over the smooth surface. In situ size approximately 15 x 10 cm, of which 7 small fragments were collected the largest of which is 5 x 2.5 x 1 cm (Figs. 2a,b). Color green-grey alive, chocolate-brown in preservation. Consistency firm and crumbly.

Skeleton. A dense mass of diods and triods arranged around the aquiferous system. At the surface the skeleton is alveolar consisting of rounded meshes of approximately 50–60 µm diameter surrounded by a dense mass of small diods (Fig. 2c). Choanosome densely packed with bundles of diods mixed with triods and calthrops, the latter of which carry the tangential crust. There are some small subdermal cavities. In the overall spiculation diods dominate, but there is a relatively large proportion of large calthrops (Fig. 2d).

Spicules. Calthrops, diods, triods.

Calthrops (Fig. 3a, b) are abundant and large, 200–457–700 µm in overall diameter of the cladome, with actines 110–299–500 x 15–35–50 µm, usually slightly inequiaxial.

Diods centrotylote, some crooked in the middle, arbitrarily divisible in two size classes (Fig. 3c, d): smaller, generally angularly curved, 20–36–72 x 1.5–2.65–3.5 µm, and larger, 75–123–170 x 3–8–10 µm.

Triods (Fig. 3e) 15–68–125 µm in overall diameter of the cladome, with conical actines 5–35–70 x 2.5–4.5–10 µm, either equiaxial or with one relatively long actine.

Ecology and distribution. One specimen collected on carbonate rock wall in the upper dysphotic zone at Bonaire.

Etymology. Named after STINAPA (**St**ichting **N**ationale **P**arken) Bonaire, a non-governmental not-for-profit organization that manages and actively conserves the Bonaire National Marine Park.

Remarks. Of the twelve accepted species of *Plakinastrella* listed in Van Soest *et al.* 2014, only three species are recorded from the whole of the Central West Atlantic, including the Greater Caribbean, Carolinian and Brazilian waters. These are *Plakinastrella onkodes* Uliczka, 1929, *P. microspiculifera* Moraes & Muricy, 2003, and *P. globularis* Domingos *et al.*, 2013. Our new species differs from all three by the relatively giant calthrops: actines up to 500 x 50 µm against up to 152 x 26 µm in *P. onkodes* (cf. Zea 1987) only up to 45 x 9 µm in *P. microspiculifera* and 24–53 µm in *P. globularis*. The latter species is from approximately the same depth (90–170 m, off the northeast coast of Brazil).

Elsewhere, only Mediterranean *P. copiosa* Schulze, 1880 has rather similar large calthrops, up to 320 x 30–35 µm (measurements by Topsent 1895). This species also has ‘giant’ diods up to 600–700 x 30–33 µm, which sets it clearly apart from our new species. Its colour is indicated as white or pale yellow. Another species with the combination of giant calthrops (200–400 x 20–30 µm) and giant diods (800–1100 x 15–40 µm) is Philippine *P. polysclera* Lévi & Lévi, 1989, but this has also giant triods with actines up to 900 x 50 µm. Its colour is described as rosy-ochraceous. Finally, *P. trunculifera* Topsent, 1927 has calthrops actines up to 190 x 23 µm and diods up to 455 x 15 µm, and thus differs clearly in these dimensions from our new species, while it is white-pale yellow in colour.

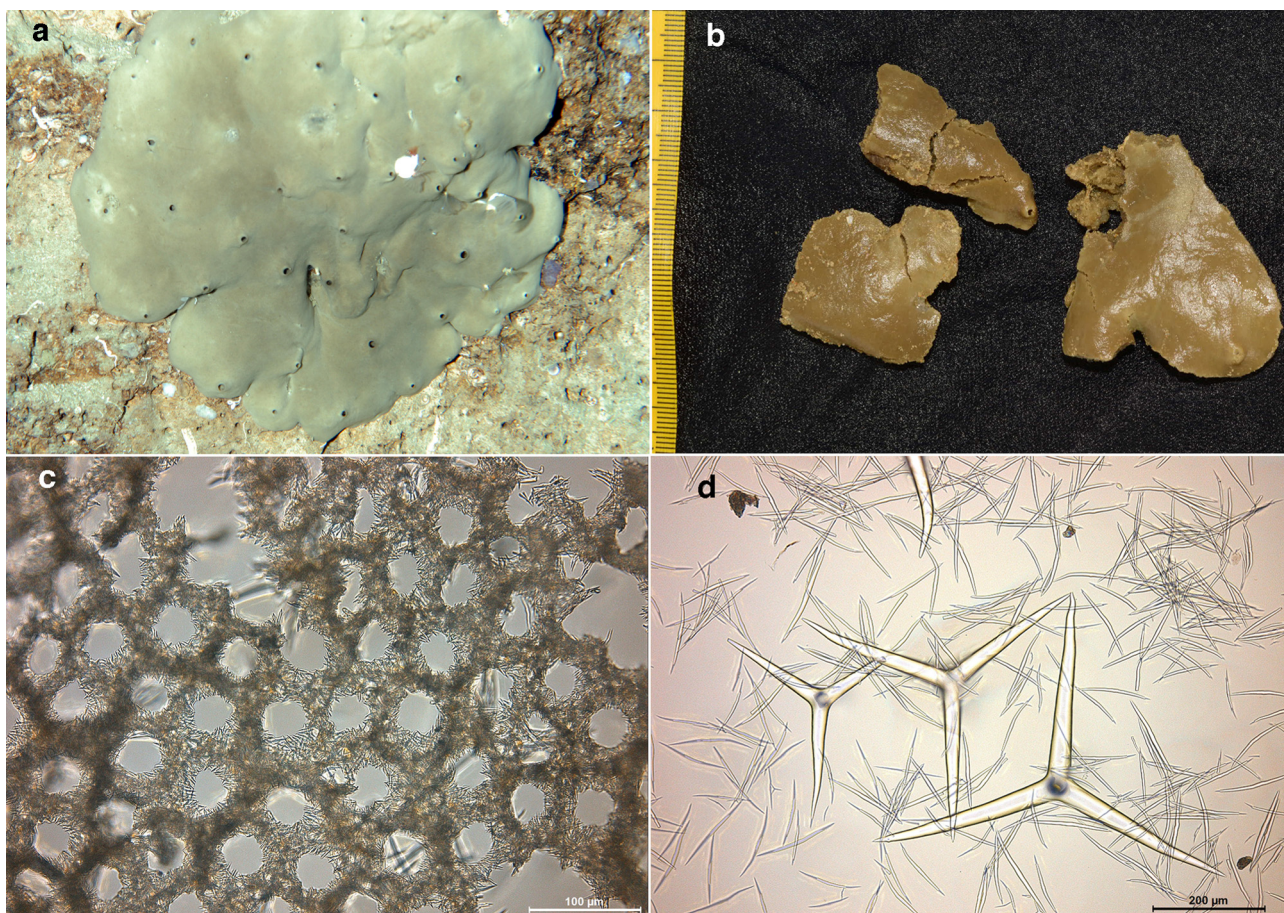


FIGURE 2. *Plakinastrella stinapa* n. sp., holotype RMNH Por. 9252, a. habit of holotype in situ on limestone rockwall W of Bonaire, b. preserved fragments, c. light microscope image of surface skeleton, d. light microscope overview of the spicule complement.

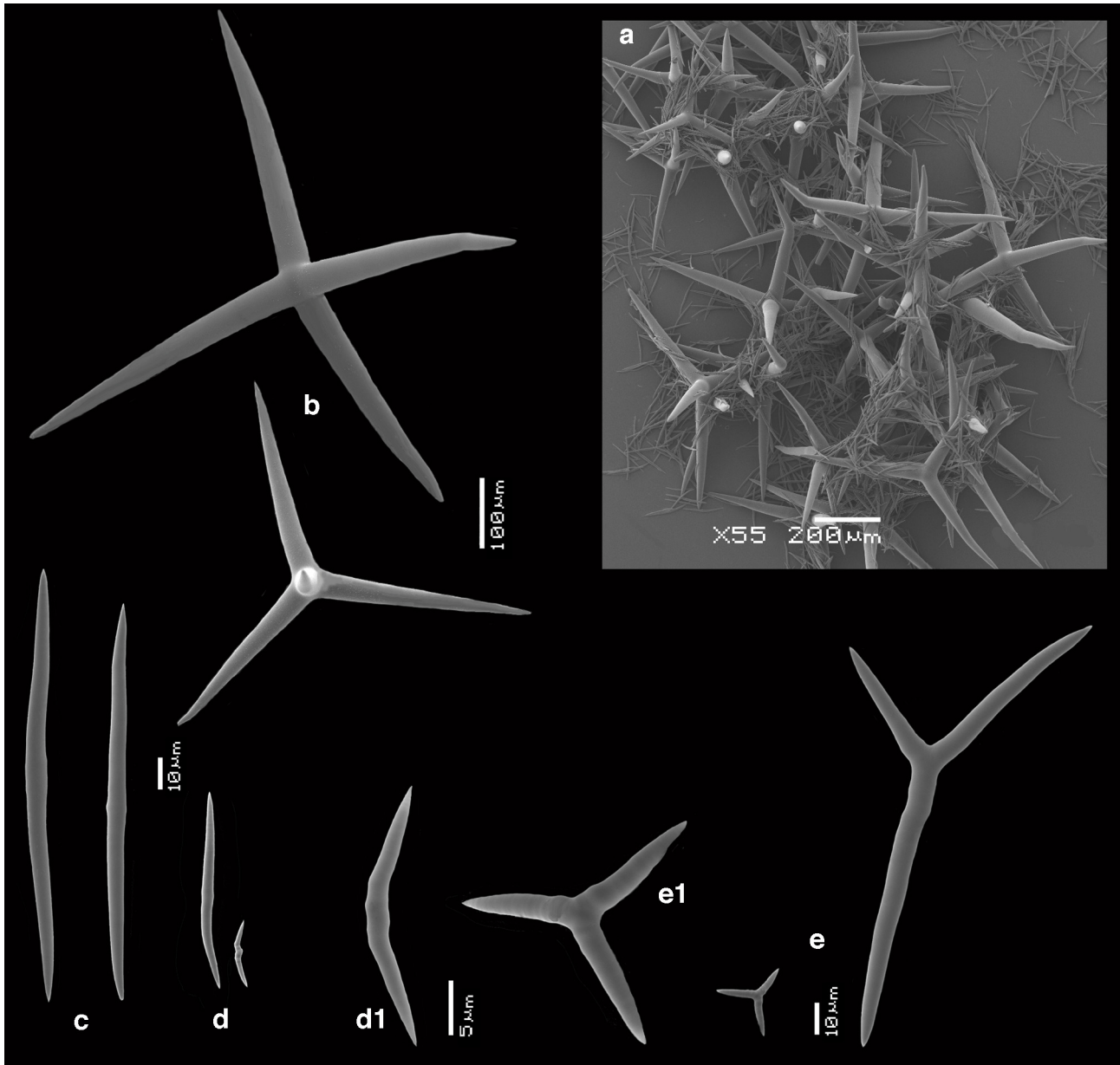


FIGURE 3. *Plakinastrella tinapa* n. sp., holotype RMNH Por. 9252, SEM images of the spicules, a. overview, b. calthrops, c. large diods, d. small diods, d1. enlarged small diod, e. triods, e1. enlarged triod.

Class Demospongiae Sollas, 1885

Order Astrophorida Schmidt, 1868

Family Pachastrellidae Carter, 1875

Genus *Pachastrella* Schmidt, 1868

***Pachastrella pacoi* new species**

Figures 4a–d, 5a–g

? *Pachastrella abyssis* sensu Van Soest & Stentoft, 1988: 34, pl. 5 figs. 3–6, text-fig. 15 (not: Schmidt, 1870, based on Cárdenas & Rapp, 2012: 18, Fig. 9)

Material examined. Holotype: RMNH Por. 9255, Caribbean Netherlands, Bonaire, locality Cargill (Dive 4), 112.08°N 68.2938°W, depth 232 m, on a limestone rockwall, coll. L.E. Becking & E. Meesters, field nr. BON4/BDR064, 1 June 2013. Paratype: RMNH Por. 9248, Caribbean Netherlands, Bonaire, locality Curoil Dock (Dive 3), 112.137°N 68.286°W, depth 159 m, in the sand at the base of a limestone rockwall, coll. L.E. Becking & E. Meesters, field nr. BON3/BDR033, 31 May 2013.

Additional fragment: RMNH Por. 9246 Caribbean Netherlands, Bonaire, locality Curoil Dock (Dive 3), 112.137°N 68.286°W, depth 203 m, coll. L.E. Becking & E. Meesters, field nr. BON3/BDR028, 31 May 2013.

For comparison: *Pachastrella abyssi* sensu Van Soest & Stentoft, 1988, ZMA Por. 05301, 05312, Barbados, off Paynes Bay, 153 m, 1978.

Description. Variable in shape (Figs. 4a–d), but rather persistently shallow cup-shaped, bumpy-irregular outside, optically smooth inside. Largest size in situ (the paratype, Figs. 4c–d) up to 16 cm in diameter, 15 cm high, of which a fragment of 4 x 2.5 x 2.5 cm was retrieved. The holotype (Figs. 4a–b) is about half the size of the paratype, and two fragments were preserved, each of which is 2 x 2 x 2 cm in size. If the Barbados material is indeed conspecific then size may be up to 20 cm high. Surface rough to the touch, consistency hard, incompressible, somewhat crumbly. Oscules not apparent, but in the cup-bottom of the paratype a cluster of small openings is visible. Colour alive greyish white, on deck and in preservation light beige.

Skeleton. Ectosome consisting of a dense layer of oval microrhabds, pierced here and there by the cladi of subectosomal calthrops. Choanosomal skeleton thoroughly confused, without radiate architecture. Calthrops of all sizes are strewn randomly in the interior, separated by few canals and open spaces. Microscleres abundantly present throughout the choanosome.

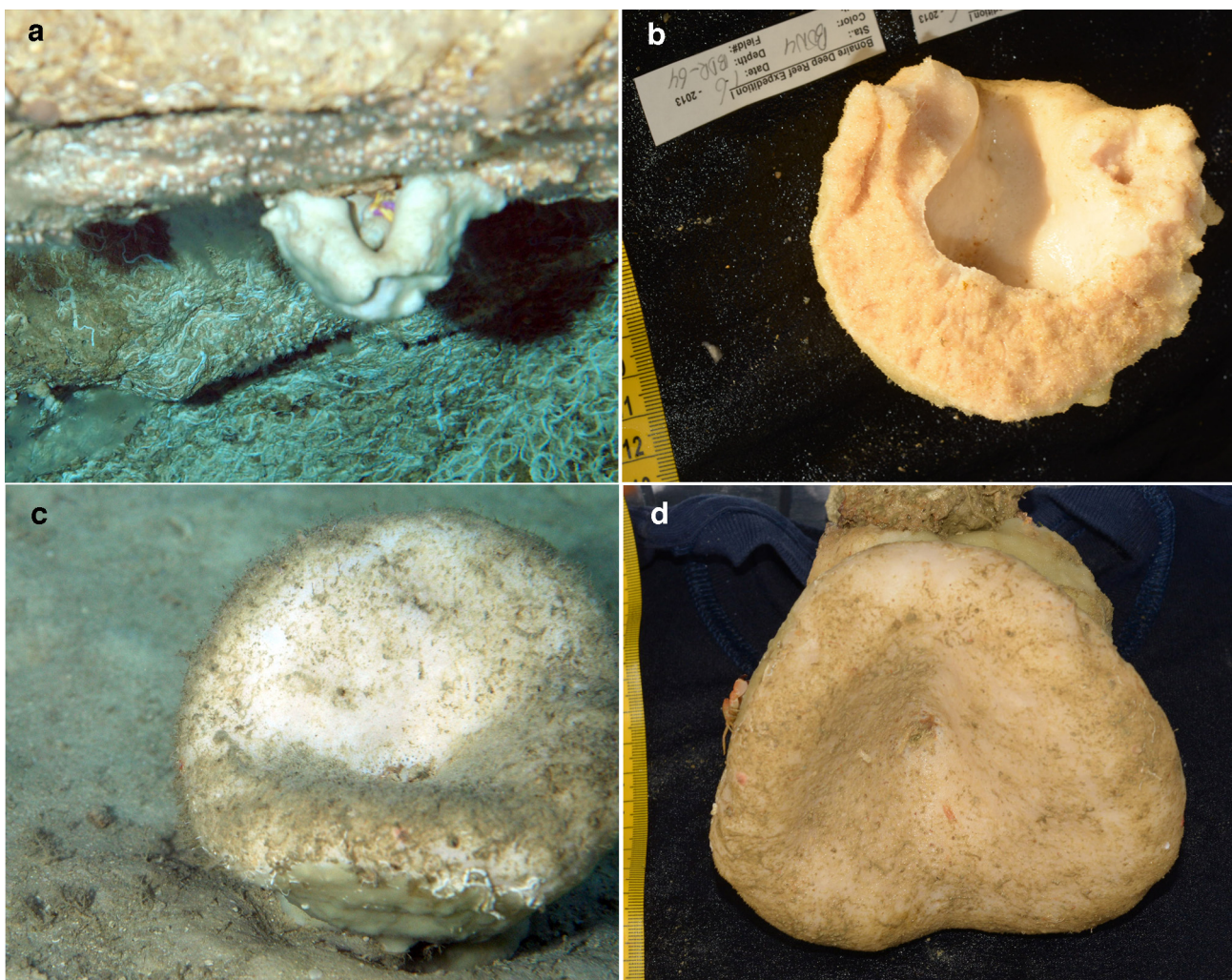


FIGURE 4. *Pachastrella pacoi* n. sp., habits in situ and on deck, a–b. Holotype RMNH Por. 9255, c–d. Paratype RMNH Por. 9246.

Spicules (Fig. 5a) Calthrops/short-shafted triaenes, oxeas, amphiasters, microrhabds.

Short shafted calthrops-like triaenes (Fig. 5a–b) in an extreme size range, with smooth, conical cladi, often slight curved at the apices, rarely bifid at one of the cladi, but no dichotriaenes were detected, size range extreme, perhaps divisible arbitrarily in a larger size, cladi $348\text{--}825\text{--}1260 \times 50\text{--}143\text{--}204 \mu\text{m}$, and a smaller size, $66\text{--}168\text{--}252 \times 10\text{--}23\text{--}32 \mu\text{m}$; overall range $66\text{--}1260 \times 10\text{--}204 \mu\text{m}$.

Oxeas (Fig. 5c), long, straight, relatively thin, sharply pointed, invariably broken in the slides, reconstructed to be up to 3 mm long, $24\text{--}30 \mu\text{m}$ in diameter; short, probably foreign oxeas present in most slides, $150\text{--}200 \times 5\text{--}6 \mu\text{m}$.

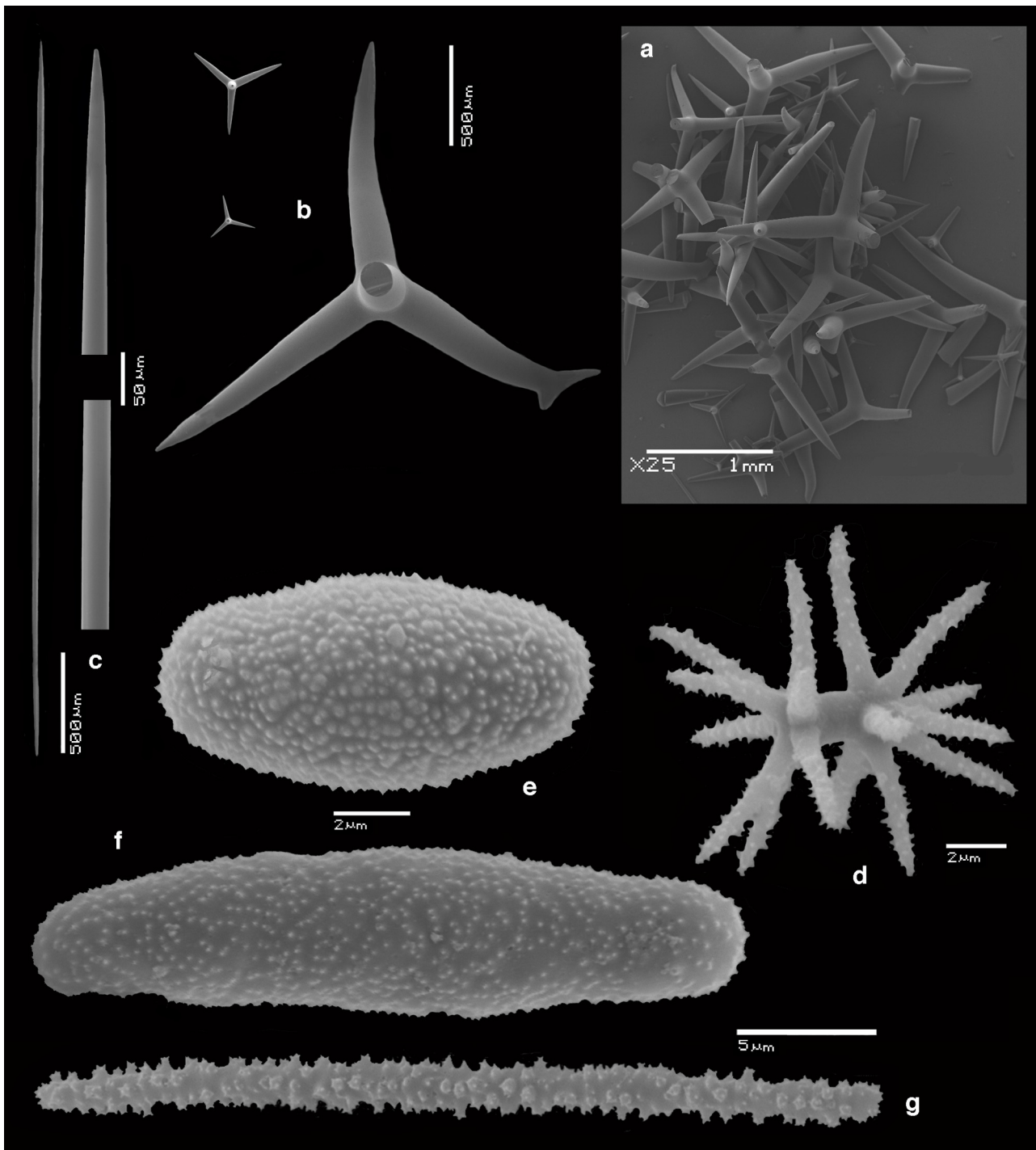


FIGURE 5. *Pachastrella pacoi* s.p., SEM images of spicules of the holotype RMNH Por. 9255, a. overview of spicules, b. calthrops of various sizes, c. oxea, d. amphiaster, e. oval microrhabd, f. elongate oval microrhabd, g. thin long microrhabd with complicated spines.

Amphiasters (Fig. 5d) in a single uniform size and shape, 14–15–17 μm , with 10–18 rays.

Microrhabds/microstrongyles in three distinct categories, (1) short fat oval rhabds (Fig. 5e), rather coarsely spined, vaguely centrotylote, forming a thick layer at the surface and abundantly present throughout the choanosome, 9–13–15 x 5.5–6–7 μm , (2) rather rare longer (Fig. 5f), more finely spined rhabds, 18–24 x 5–6 μm , (3) thin, long, somewhat curved, occasionally wavy rhabds (Fig. 5g), with spines frequently bearing secondary spines (named microrhabdose streptaster by Cardenas & Rapp, 2012), 28–34–42 μm .

Ecology and distribution. On limestone rockwalls and in the sand at their base, depth range 153–232 m. Bonaire, Barbados.

Etymology. The name honors Dr Paco Cárdenas, in acknowledgement for his great efforts to make sense of the phylogeny and classification of tetractinellid sponges.

Remarks. Our material is close to but apparently not the same species as the holotype of *P. abyssi* Schmidt, 1870, redescribed recently by Cárdenas & Rapp (2012). Aside from the usual *Pachastrella* complement, this has rare dichotriaenes and more robust amphiasters and also spiraster-like amphiasters, unlike our specimens. Furthermore, the diversity of microrhabds in *P. abyssi* is larger with fat curved and elongate microstrongylote forms added to the oval ones. It is likely but not entirely certain that our material is the same species as the Barbados material of Van Soest & Stentoft (1988). In the Barbados specimens the microrhabdose streptasters, which were only rarely observed in our specimens, are quite common and thicker. The oval microrhabds/microstrongyles of the Barbados specimens are thinner and more centrotylote, and the largest calthroproths have smaller cladi than in the present material. According to Cárdenas & Rapp (2012) the variability of specimens of *Pachastrella* is unusually large making delimitation of closely similar species difficult, so for the time being we assume the Bonaire and Barbados specimens to be conspecific. Molecular research may be helpful in determining species diversity in the Caribbean *Pachastrella*. Cárdenas & Rapp (2012) insist that *Pachastrella abyssi* has a complement of small smooth oxeas, suggested to have been overlooked by Van Soest & Stentoft (1988). However, many of such oxeas are likely foreign as they appear typically haplosclerid in shape and size. Part of our present material also possessed lots of such small oxeas, 150–200 x 6–10 μm , but this is attributed to a green-yellow thin crust seen to grow over part of the specimens in photos made of them on deck.

Genus *Characella* Sollas, 1886

Characella poecillastroides new species

Figures 6a–d, 7a–e

Material examined. Holotype: RMNH Por. 9247, Caribbean Netherlands, Bonaire, Curoil Dock (Dive 3), 112.137°N 68.286°W, on a coral rock wall at 168 m, coll. L.E. Becking & E. Meesters, field nr. BON3/BDR031, 31 May 2013.

Description. Thickly massive, folded plate (Figs. 6a–c) of 2–4 cm thick and approximately 20–40 cm in lateral expansion. A fragment of 8 x 2 x 2.5 cm was preserved. Rough/hispid surface due to protruding spicules, which cause strong accumulation of sediment. No oscules visible. Color beige alive underneath greyish sediment layer, white-beige after preservation. Consistency hard, rough, but can be torn rather easily.

Skeleton. Radiate skeleton of long oxeas (Fig. 6d), with a relatively low presence of calthroproth-like short-shafted triaenes. Microxeas form a rather dense cover at the surface and are abundantly strewn in the choanosome.

Spicules. Calthroproths, oxeas, amphiasters, microxeas,

Calthroproth-like short shafted triaenes (Fig. 7a), cladi straight or curved, in a large size range, cladomes 400–598–800 μm , cladi 200–345–500 x 20–27–30 μm .

Oxeas (Fig. 7b), smooth, usually somewhat curved, 2600–3120–3800 x 35–46.5–62.5 μm .

Amphiasters (Fig. 7c), rugose/spined all over, 10–17–25 μm , with 10–16 rays of 2.5–6–10 μm long.

Microxeas, microspined/rugose, in two size classes, larger ones (1, Fig. 7d, 7d1), gently curved and with tapering sharp ends, 170–232–275 x 4–7–10 μm , and short ones (2, Fig. 7e, 7e1), abruptly curved and/or centrotylote, 25–37–45 x 2–3 μm .

Ecology and distribution. The holotype was collected on a carbonate rock wall just below the mesophotic zone off Bonaire.

Etymology. The name refers to the plate-like shape which is unusual in the genus *Characella*, but is characteristic for the related genus *Poecillastra*.

Remarks. The new species is assigned to *Characella* because of the occurrence of two microxea categories and the predominance of amphiaster microscleres (cf. Cárdenas & Rapp 2012). The habit resembles that of a *Poecillastra*, but that genus has a single microxea category and diverse streptasters including spirasters. Barbados *Poecillastra sollasi* sensu Van Soest & Stentoft, 1988: 36 (not sensu Topsent 1890) also has this habit, but differs in having metasters and spirasters, next to amphiasters. This Barbados material was discussed by Cárdenas & Rapp (2012), who pointed out that the species appears intermediate between *Poecillastra* and *Characella* in having two sizes of microxeas next to diverse streptasters. Apparently, habit is not a good marker for the two genera, which have been demonstrated to be distinct genetically (Cárdenas *et al.* 2011). *Characella aspera* Sollas, 1886 as reported by Van Soest & Stentoft (1988: 38) from Barbados appears close in spiculation to *C. poecillastroides* n. sp., but is radically different in habit (see Table 2 and Figs 21a1, 21a2). Several specimens were collected during the present submarine dives (BDR027 and 036).

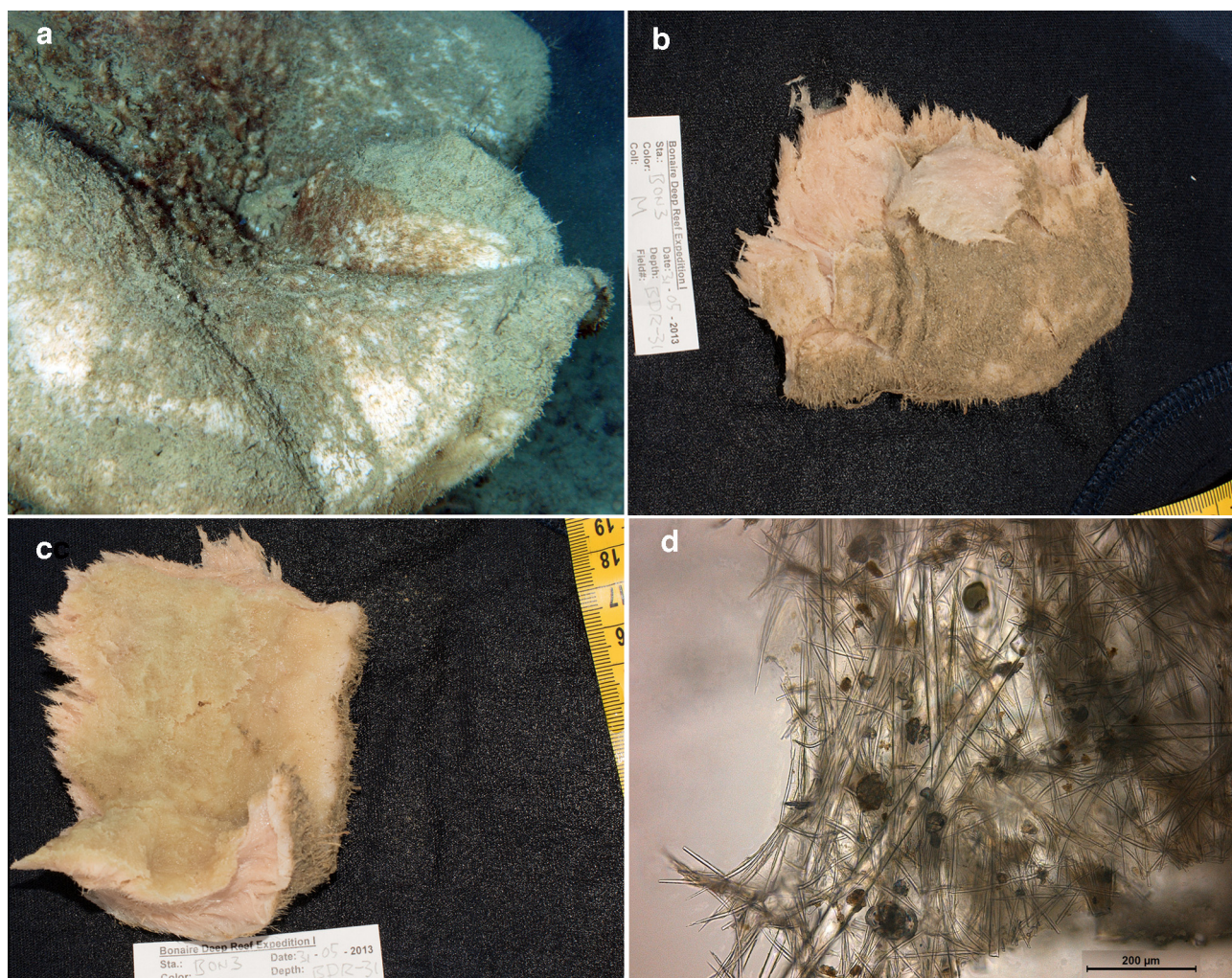


FIGURE 6. *Characella poecillastroides* n. sp., holotype RMNH Por. 9247, a. in situ off the SW coast of Bonaire, b. on deck, upper surface, c. on deck, lower surface, d. cross section of skeleton showing dominance of long oxeas and microxeas.

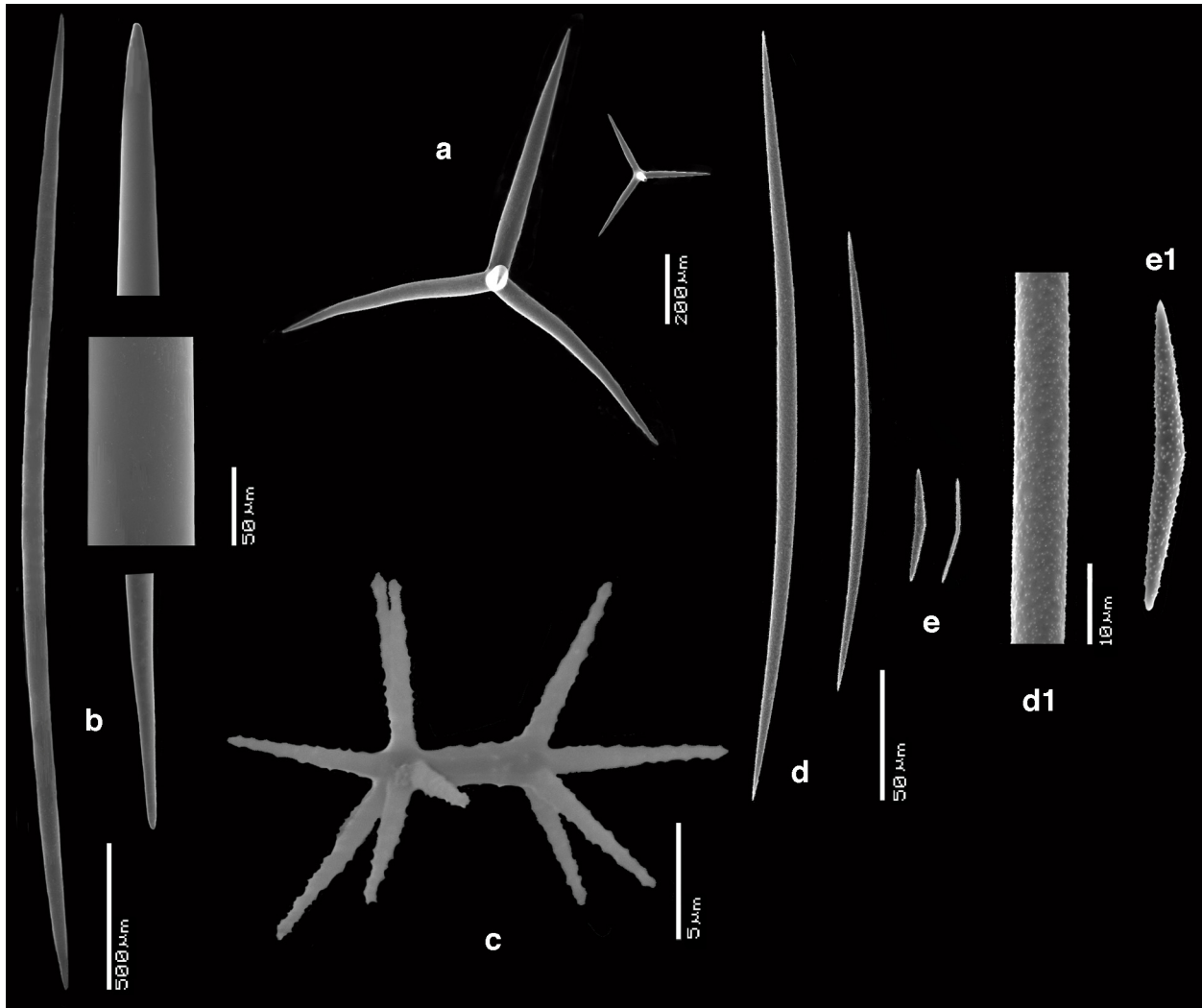


FIGURE 7. *Characella poecillastroides* n. sp., SEM images of spicules of the holotype RMNH Por. 9247, a. calthrops, b. oxea, c. amphiaster, d. large microxea, d1. detail of surface of large microxea showing microspination, e. small microxea, e1. detail of small microxea.

Family Geodiidae Gray, 1867

Genus *Geodia* Lamarck, 1815

Geodia curacaoensis new species

Figures 8a–k

Geodia aff. *megastrella* sensu Van Soest & Stentoft, 1988: 14, pl. 11 figs 1–4, text-fig. 4 (not: Carter, 1876, nec sensu Topsent, 1911, 1928)

Material examined. Holotype: RMNH Por. 9260, Caribbean Netherlands, Klein Curacao, off SW coast (Dive 1), 11.9821°N 68.6452°W, on a coral rock wall at 156 m, coll. L.E. Becking & E. Meesters, field nr. CURASUB13-09/BDR005, 27 May 2013.

For comparison: *Geodia* cf. *megastrella* sensu Van Soest & Stentoft, 1988, ZMA Por. 05272, Barbados, off Paynes Bay, 144–153 m, 11 August 1978.

Description. Small sphere (Fig. 8a) of 5.5 cm diameter (two fragments were preserved, one of 5 x 2.5 x 2 cm, a second of 4 x 2.5 x 2 cm). Surface generally smooth but with patches of long hair-like spicules distributed over

the entire surface. Oscules crowded on top in a sieve plate. Color white grey around, but with upper half and sieve-plate dark red. Cortex can crack easily, and choanosome is pulpy.

Skeleton. Cortex (Fig. 8b) consisting of a layer of sterrasters 300–500 µm in thickness, carried by the cladi of radially arranged ortho/plagiotriaenes, anatriaenes and oxeas. Small short oxeotes and abundant small asters are distributed in the peripheral regions of the cortex among the cladi of the triaenes. Choanosomal skeleton a confused mass of oxeas and small aster microscleres.

Spicules. Ortho/plagiotriaenes, anatriaenes, oxeas, cortical oxeotes, sterrasters, oxyasters, strongylasters.

Ortho/plagiotriaenes (Fig. 8c), (cladi curved downwards, so technically they are closer to orthotriaenes than to plagiotriaenes, but the cladi are not exactly at right angles to the shaft). They are not very common and were invariably broken in the slides. From measurements from thick sections it appeared that the shaft length is up to approximately 4200 µm (usually smaller), shaft width 50–90 µm, cladomes 320–550 µm, cladi 160–270 x 60 µm.

Anatriaenes (Figs. 8d, 8d1), shaft length 1500–2000 µm, shaft width 20–25–30 µm, cladomes 120–152–180 µm, cladi 70–93–120 µm x 20–28–50 µm.

Oxeas (Fig. 8e, 8e1), usually broken in the slides, they are mostly around 4000 µm x 30 µm (thick section measurements).

Cortical oxeotes (Fig. 8f, 8f1), slightly different at both ends, 320–380–480 x 7.5–10–12.5.

Sterrasters (Fig. 8g), slightly oval, 70–94–110 x 70–78–85, individual rosettes approximately 5 µm in diameter with larger spines numbering 4–6.

Large oxyasters (Figs. 8h–i), diameter 15–22–28 µm, number of rays 6–8.

Small oxyasters (Figs. 8h, 8j), diameter 10–12–18 µm, number of rays 6–12.

Strongylasters (Figs. 8h, 8k), diameter 5–6.7–10 µm.

Ecology and distribution. One specimen collected on carbonate rock wall just below the mesophotic zone at Klein Curaçao.

Etymology. Named after the type locality, (Klein) Curaçao.

Remarks. It is likely that this species was recorded from Barbados by Van Soest & Stentoft (1988: 14) as *Geodia* cf. *megastrella* Carter, 1876. We reexamined this material. It differs from Carter's Portuguese material in the presence of short cortical oxeas and the size of the oxyasters, which are only half the size in the Barbados specimen (and in our new species). The shape of the Barbados material differs from that of the holotype of our new species in being more elaborate and irregular, but its size is also larger (10 x 10 x 7 cm) and it is not unusual for geodiid species to have a globular shape when young and more irregular when older. In the spiculation of the Barbados specimens only one feature seemed to differ, the length of the cortical oxeotes, given as 150 x 3–4 µm in Van Soest & Stentoft (1988: 14). When we reexamined this, we found that variation is large and many of the cortical oxeotes were in the range of 200–300 x 5–6 µm and only few were as small as 150 µm. We assume that the Barbados material and the present specimen are conspecific as all other features match closely.

On paper our new species appears rather close to *Geodia gibberosa* Lamarck, 1814 as extensively redescribed by Cárdenas *et al.* 2009, but habit, length of the oxeas and the form, ray number and ornamentation of the oxyasters are clearly different in the two species. *G. gibberosa* was also reported from deep water (Barbados, cf. Van Soest & Stentoft 1988).

Of the *Geodia* species recorded from the Central West Atlantic, *G. tumulosa* Bowerbank, 1872 appears close to our new species, but it differs in overall shape and in having prototriaenes in addition to ortho- and anatriaenes. Furthermore the sterrasters are about half the size of those of our new species, and the largest oxyasters are twice as large as those of our new species. Most other species reported from the region differ more clearly by lacking cortical oxeas (*G. australis* Da Silva & Mothes, 2000, *G. riograndensis* Da Silva & Mothes, 2000, *G. splendida* Da Silva & Mothes, 2000, *G. pachydermata* (Sollas, 1886), *G. thomsonii* Schmidt, 1870, *G. apiarium* (Schmidt, 1870) and *G. tylastra* Boury-Esnault, 1973), having dichotriaenes (*G. spherastrea* Lévi, 1964), or having much shorter structural oxeas (*G. gibberosa*, *G. papyracea* Hechtel, 1965, *G. corticostylifera* Hajdu *et al.* 1996, *G. neptuni* Sollas, 1886, and *G. vosmaeri* Sollas, 1886). Deep water species from the opposite side of the Atlantic differ likewise from our new species: *G. divaricans* Topsent, 1928 has dichotriaenes, *G. glariosa* (Sollas, 1886) has oxeas less than 2 mm in length, and *G. ramosa* (Topsent, 1928) and *G. globus* Schmidt, 1870 lack cortical oxeas.

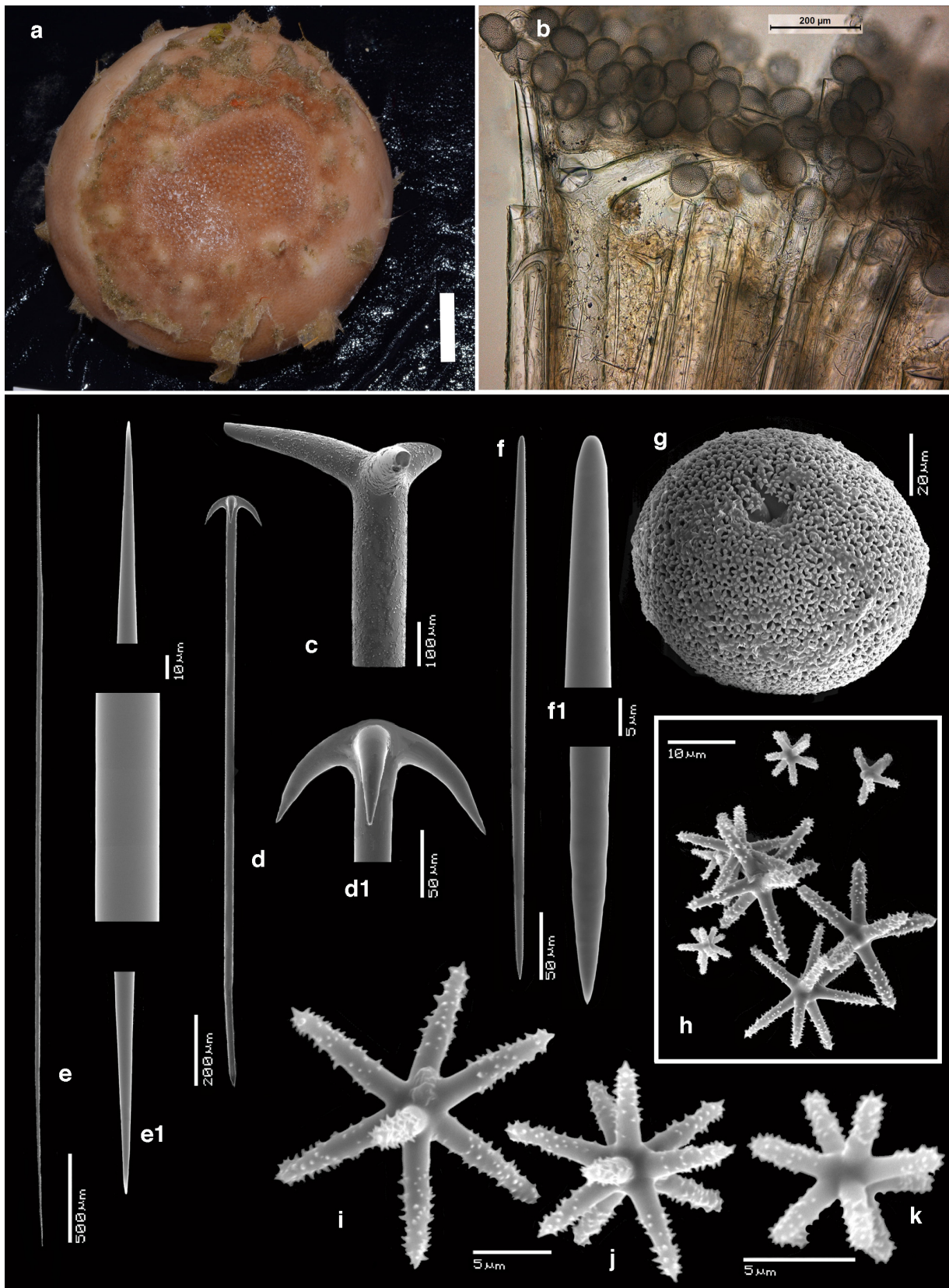


FIGURE 8. *Geodia curacaoensis* n. sp., holotype RMNH Por. 9260, a. habit on deck (scale bar = 1 cm), b. cross section of cortex showing layer of sterrasters carried by ortho/plagiotriaenes, oxeas and anatriaenes, c–k. SEM images of the spicules, c. ortho/plagiotriaene, d. anatriaene, d1. detail of cladi, e. oxea, e1. details of oxea, f. cortical oxeote, f1. details of endings of cortical oxeote, g. sterraster, h. overview of aster microscleres, i. large oxyaster, j. small oxyaster, k. strongylaster.

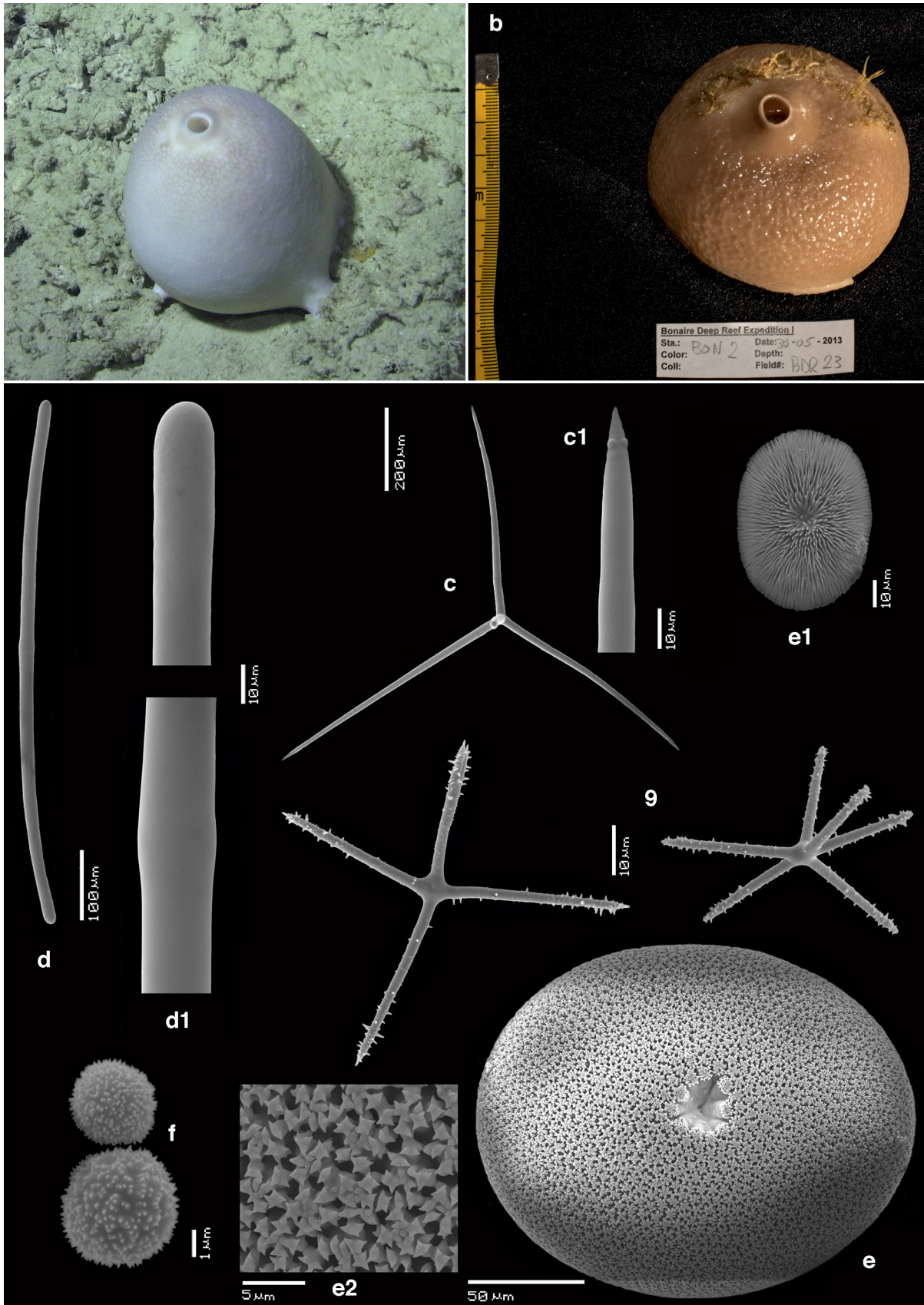


FIGURE 9. *Caminus carmabi* n. sp., a. habit in situ of the paratype RMNH Por. 9249, b. habit on deck of holotype RMNH Por. 9245, c–g. SEM images of the spicules of the holotype RMNH Por. 9245, c. calthrops, c1. detail of cladus of calthrops, d. strongyle, d1. details of strongyle, e. sterraster, e1. juvenile sterraster, e2. detail of surface of sterraster, f. spherules, g. oxyasters.

Genus *Caminus* Schmidt, 1862

Caminus carmabi new species

Figures 9a–g

Material examined. Holotype: RMNH Por. 9245, Caribbean Netherlands, Bonaire, Kralendijk Pier (Dive 2), 12.1469°N 68.2821°W, in the sand and on rock walls, at 120–137 m, coll. L.E. Becking & E. Meesters, field nr. BON1/BDR023, 30 May 2013.

Paratype: RMNH Por. 9249, Caribbean Netherlands, Bonaire, Curoil Dock, (Dive 3), 12.137°N 68.286°W, on a coral rock wall at 198 m, coll. L.E. Becking & E. Meesters, field nr. BON1/BDR035, 31 May 2013.

Description. Spherical pink-colored sponge (Figs. 9a–b) with central oscule with raised rim, supported at lower parts by small side projections ('feet'). Surface smooth, with mosaical pattern, with lighter polygons separated by darker pink grooves. Size of both specimens approximately 15 cm in diameter, oscule 1 cm. Of the holotype three fragments were preserved, the largest of which measured 7 x 4 x 4 cm, of the paratype two fragments were preserved the largest being 5 x 2 x 2 cm. Consistency hard, inside pulpy but likewise hard.

Skeleton. Cortical skeleton a dense layer of sterrasters carried by subcortical calthrops-like short-shafted triaenes. Choanosomal skeleton a confused mass of strongyles and microscleres.

Spicules. Calthrops, strongyles, sterrasters, spherules, oxyasters.

Calthrops-like short-shafted triaenes (Fig. 9c, 9c1), with cladome 820–1050–1250 µm, cladi 250–650–1020 x 18–24–30 µm.

Strongyles, (Figs. 9d, 9d1), curved, faintly polytylote, 600–860–936 x 14–21–25 µm.

Sterrasters (Figs. 9e, 9e2), large, oval, 140–190–210 x 125–144–162 µm, juvenile forms small and spined (Fig. 9e1).

Spherules (Fig. 9f), microspined, somewhat variable in size, 3.5–5–6.5 µm.

Oxyasters (Fig. 9g), rays spined especially at the apices, diameter 51–65–81 µm, with 4–8 rays.

Ecology and distribution. On rockwalls and rubble at the edge of or below the mesophotic zone off the southwest coast of Bonaire.

Etymology. Named after the **Caraibisch Marien Biologisch Instituut** at Piscadera Baai, Curaçao, center for biological investigations of the Caribbean Netherlands.

Remarks. The only other species of *Caminus* in the Central West Atlantic is *C. sphaeroconia* Sollas, 1886, originally reported from Brazil, but subsequently also found in Puerto Rico (Wilson 1902), the Virgin Islands (Uliczka 1929) and Barbados (Van Soest & Stentoft 1988). This differs clearly from our new species in the size and shape of the sterrasters, which are rounded and only 45–90 µm in diameter, and by the absence of oxyasters. Our material is most similar to Mediterranean *Caminus vulcani* Schmidt, 1862, but in that species sterrasters are smaller (105–115 x 85–88) and calthrops have also shorter and thinner cladi. Elsewhere, several species of *Caminus* occur in East and South East Asia (*C. chinensis* Lindgren, 1898, *C. awashimensis* Tanita, 1969, *C. strongyla* (Hoshino, 1981) and *C. albus* Pulitzer-Finali, 1996) (Van Soest *et al.* 2014), but these also have smaller sterrasters and smaller oxyasters.

Family Theonellidae Lendenfeld, 1903

Genus *Discodermia* Du Bocage, 1869

Discodermia adhaerens new species

Figures 10a–e, 11a–f

Material examined. Holotype: RMNH Por. 9241, Caribbean Netherlands, Bonaire, Kralendijk Pier (Dive 2), 12.1469°N 68.2821°W, on a coral rock wall at 146m, coll. L.E. Becking & E. Meesters, field nr. BON1/BDR012, 30 May 2013.

Description. Bright orange sponge, thinly to massively encrusting limestone rockwalls (Fig. 10a). Size several dm² in lateral expansion, about 2–3 mm in thickness. The holotype consists of a dozen small fragments (Fig. 10b),

each approximately 1 cm² or less, sucked off from the rock. Surface smooth. No apparent oscules visible in situ nor in the fragments. Consistency hard.

Skeleton. An ectosomal skeleton of closely packed discotriaenes (Fig. 10c) with margins of neighbouring spicules overlapping. Desma skeleton strongly zygoed (Fig. 11e) with thick, strong tubercles. Smaller discotriaenes and subdermal desmas show occasional zygois (Fig. 11a1). Auxiliary spicules long thin oxeas (Fig. 11c, 11c1), not prominent.

Spicules. Discotriaenes, desmas, oxeas, microrhabds.

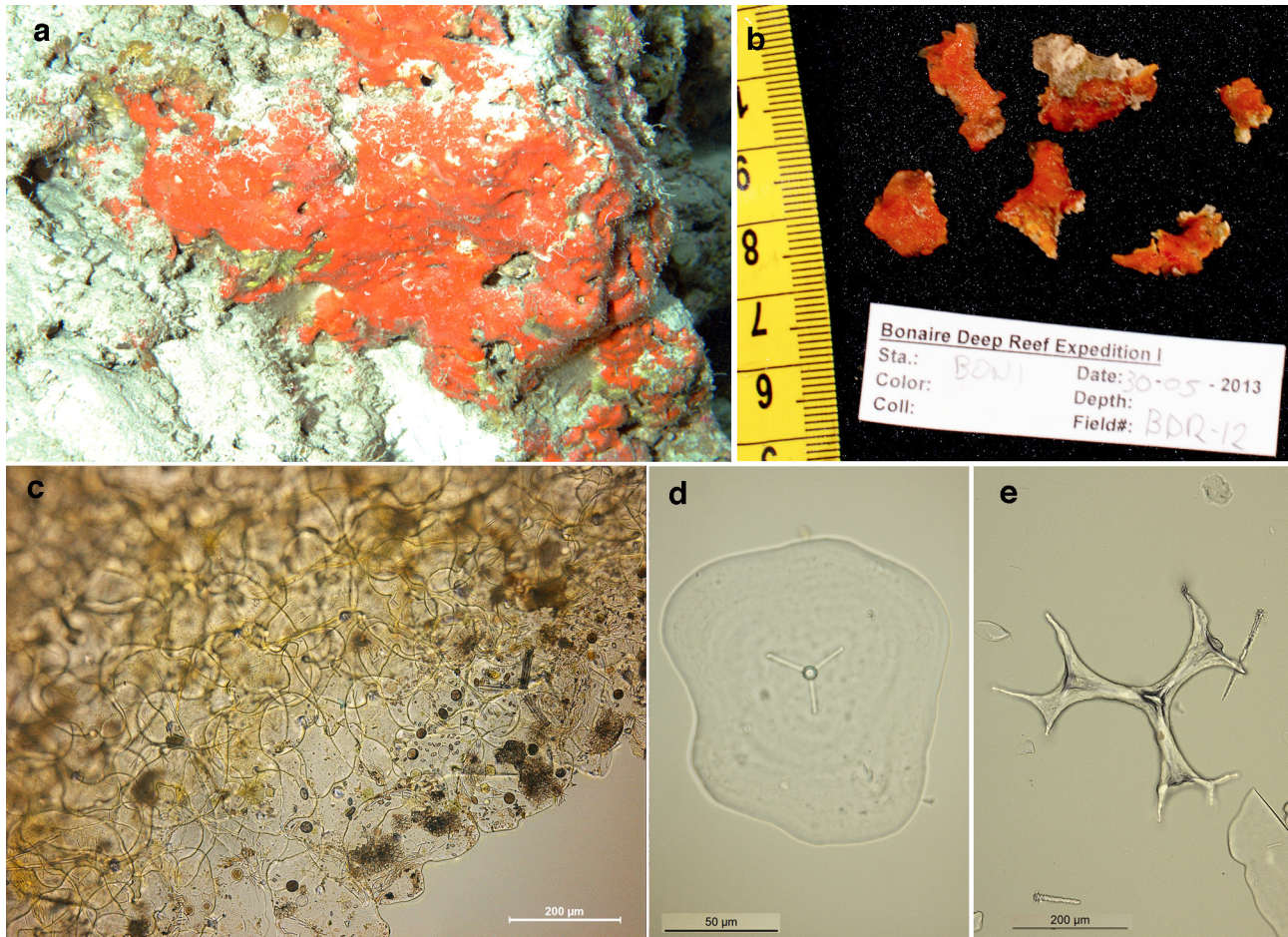


FIGURE 10. *Discodermia adhaerens* n. sp., holotype RMNH Por. 9241, a. habit in situ, b. preserved holotype fragments, c. ectosomal discotriaenes, d. small discotriaene, showing triaxial canals, e. juvenile desma.

Discotriaenes (Figs. 10b, 10d, 11a) showing an extreme variation in shape and outline, from an almost perfectly rounded shape (rare) to a deeply notched irregular form. The outer surface is usually smooth, but may bear a group of central warts (verrucose condition). The discs vary also considerably in size, 130–202–350 x 100–155–280 µm. The rhabds are conical and relatively short 24–34–41 µm, and equally wide at the base.

Desmas (Figs. 10e, 11b) are large and robust, cladomes 320–428–520 µm, shafts smooth, varying between 40 and 66 in thickness, and the arms are heavily tuberculated; juvenile desmas are tetraclones (Fig. 10e, 11f).

Oxeas (Figs. 11c, 11c1), thin, curved, with wispy thin endings, relatively rare and often broken in the preparations, 670–795–910 x 5–6.3–7 µm.

Acanthomicrorhabds (Fig. 11d), densely distributed on the surface of the discotriaenes and strewn in the interior, in a single rather uniform size range, 15–20–25 µm.

Ecology and distribution. On vertical walls, in the upper dysphotic zone, at Bonaire.

Etymology. adhaereo (L.) = to cling to, referring to the habit thinly encrusting on rocks, which is so far unknown in the genus.

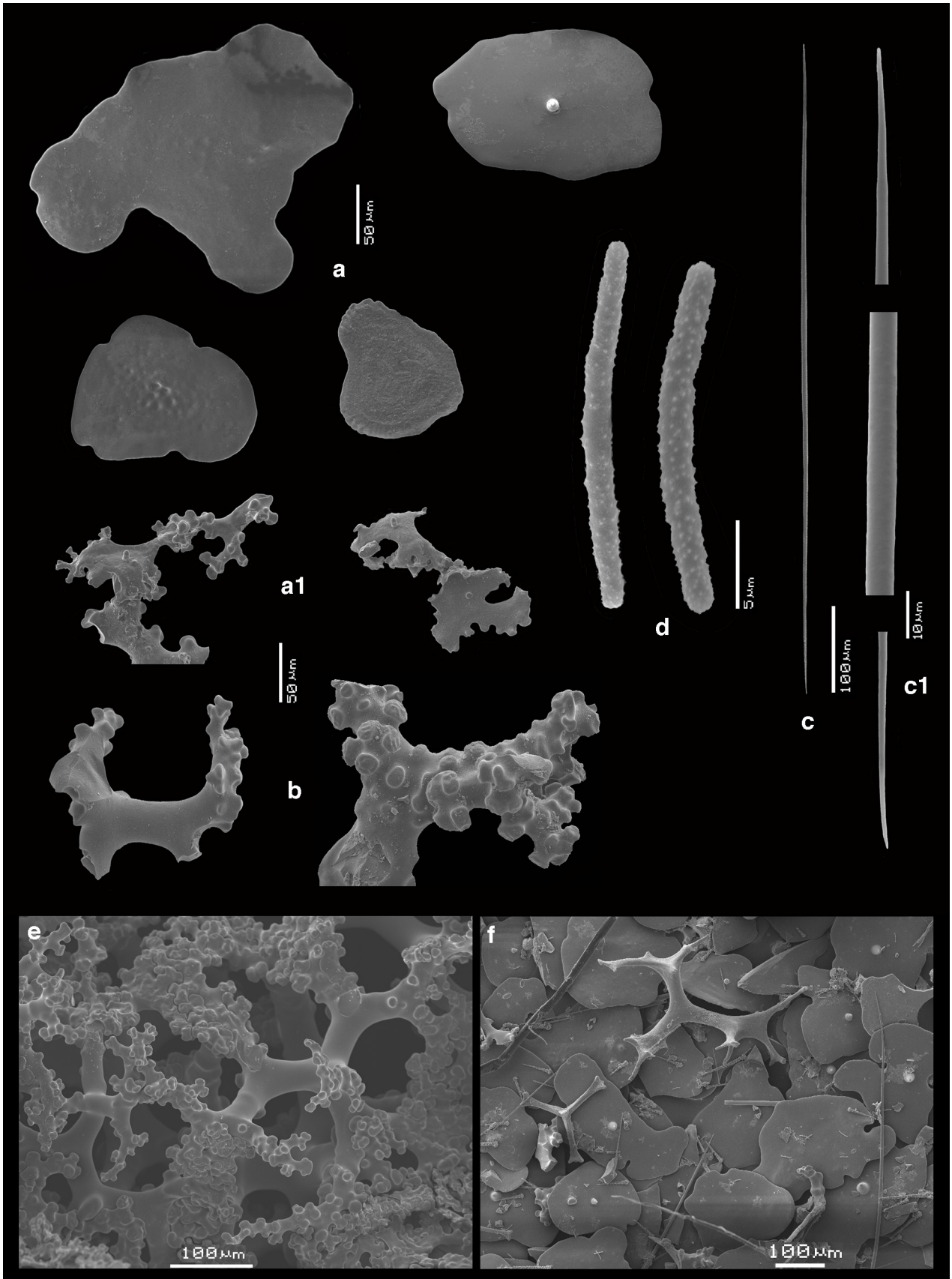


FIGURE 11. *Discodermia adhaerens* n. sp., holotype RMNH Por. 9241, SEM images of the spicules, a. various discotriaene shapes, a1. subdermal discotriaenes zygosing with other discotriaenes and with desmas, b. desma, c. oxea, c1. details oxea endings and middle part, d. acanthomicrohabds, e. desma skeleton, f. overview of discotriaenes and juvenile desmas.

Remarks. From the Western Atlantic several *Discodermia* species have been reported, but only two species are currently considered accepted unequivocal species of *Discodermia*, viz. the type species of the genus, *D. polydiscus* (Bowerbank, 1869), originally from Saint Vincent, subsequently reported from Barbados (Van Soest & Stentoft 1988), and *D. dissoluta* Schmidt, 1880 from Cuba, subsequently reported from various localities across the Caribbean, and also herein (see Table 2 and Fig. 21c). Our new species differs from these two species by the encrusting growth form, whereas *D. polydiscus* is cup-shaped and *D. dissoluta* a group of cylinders. Further clear differences are the single category of microstrongylote microscleres, whereas the two other species have separate categories of microxeas and microstrongyles, and the very short rhabds of the discotriaenes which are only about 40 µm, while those of the other two species are always over 100 µm, even up to 170 µm in *D. polydiscus*. An interesting feature of our new species is the presence of proliferated discotriaenes, which appear to form a link with the underlying desma-skeleton, providing zygosid margins locking into the peripheral desma skeleton. No such zygosid discotriaenes have been reported in the literature so far, but possibly these have gone unnoticed in other species.

A fourth Caribbean *Discodermia* species might be *D. inscripta* (Schmidt, 1879 as *Collinella*), but the type material is deciduous and no discotriaenes or microscleres have been found in it (Pisera & Levi 2002), making the species incertae sedis. On the eastern side of the Atlantic, several further species have been reported, *D. ramifera* Topsent, 1892, *D. verrucosa* Topsent, 1928, and *D. polymorpha* Pisera & Vacelet, 2011. None of these species conforms closely to our new species in shape and spiculation.

Order Poecilosclerida Topsent, 1928

Family Microcionidae Carter, 1875

Subfamily Microcioninae Carter, 1875

Genus *Clathria* Schmidt, 1862

Subgenus *Microciona* Bowerbank, 1862

Clathria (Microciona) acarnoides new species

Figs. 12a–i

Material examined. Holotype: RMNH Por. 9243, Caribbean Netherlands, Bonaire, Curoil Dock, (Dive 3), 12.137°N 68.286°W, on a coral rock wall at 152 m, coll. L.E. Becking & E. Meesters, field nr. BON2/BDR0020, 30 May 2013.

Description. Orange hispid encrustation (Figs. 12 a1–a4) on a vermetid gastropod shell, lodged in a specimen of *Spongosorites ruetzleri*. The sponge specimen was detected only when on deck. The holotype consists of four fragments, on vermetids and on *Spongosorites ruetzleri* specimens. Size of fragments 1–2 cm².

Skeleton. Microcionid (i.e. choanosomal styles and echinating acanthostyles are grouped) or hymedesmioid (i.e. choanosomal styles and echinating acanthostyles are arranged singly erect with heads embedded in the spongin plate adhering to the substratum) (Figs. 12a, 12b). Ectosomal subtylostyles are strewn in the dermal membrane and also form bouquets.

Spicules. Choanosomal principal styles, ectosomal subtylostyles, acanthostyles/cladostyles, toxas in two shape categories, palmate isochelae.

Choanosomal styles (Figs. 12 c–d), smooth, slightly curved, apparently occurring in two size classes, (1) larger styles (Fig. 12c, 12c1) with predominantly smooth heads, 550–895–1110 x 20–22–25 µm and (2) smaller styles (Figs. 12d, 12d2) predominantly with rugose heads (Figs. 12d1, 12d3), 150–344–640 x 10–14–15 µm.

Ectosomal subtylostyles (Figs. 12e, 12e1), with faint microspination on the head, 380–512–620 x 5.

Acanthostyles/cladostyles (Fig. 12f), unique spicule type shaped like a ‘normal’ echinating acanthostyle, but provided with four sharp hooks at the pointed end, 60–70–75 x 5 µm. The hooked ends are pointed outwards, the heads are embedded in the basal spongin plate.

Oxhorn toxas (Fig. 12g), 30–77–115 x 2.5–4.7–5 µm.

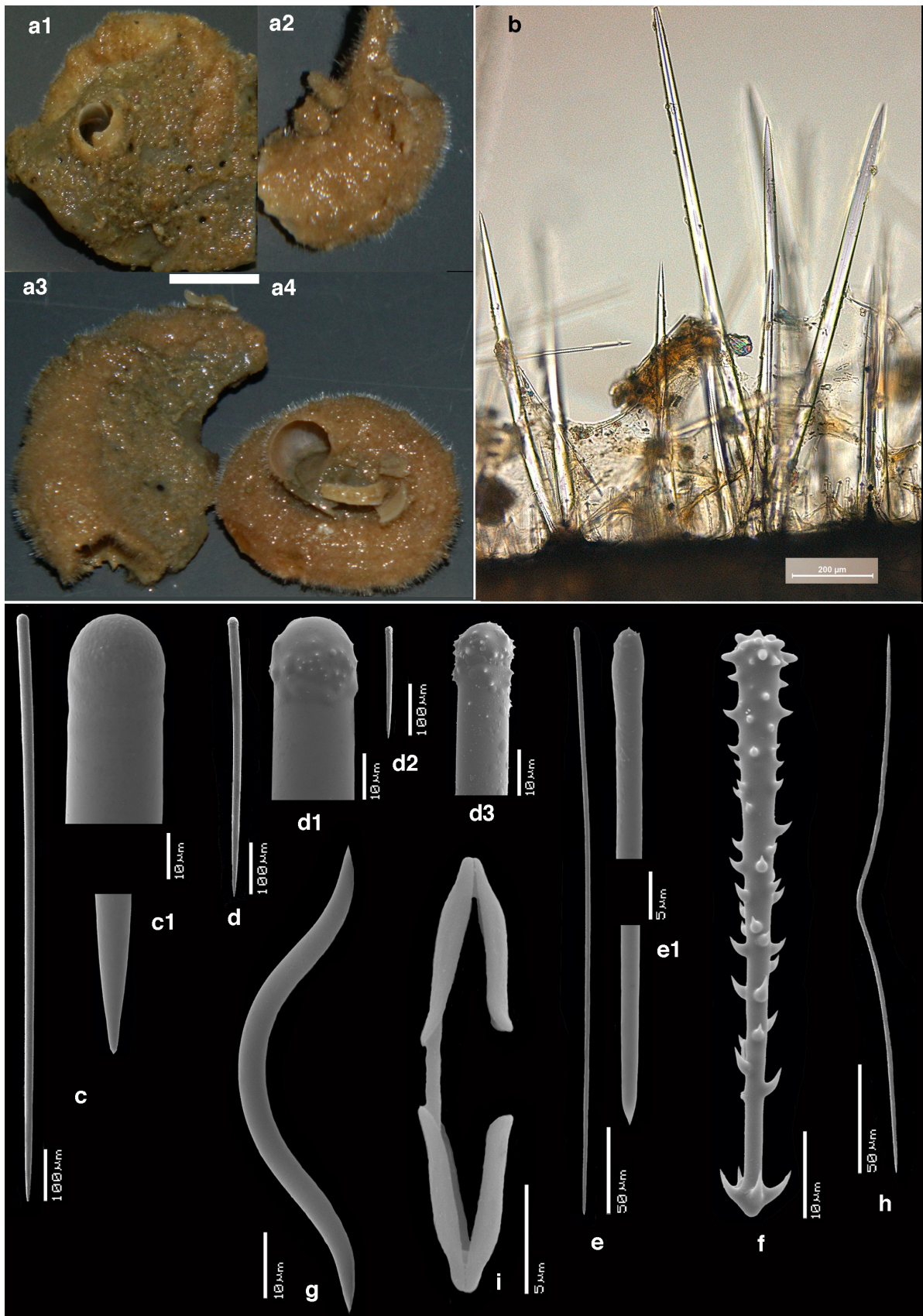


FIGURE 12. *Clathria (Microcionia) acarnoides* n. sp., holotype RMNH Por. 9243, a1–a4. habit of the four holotype fragments (scale bar = 1 cm), b. cross section of hymedesmioid skeleton, c–i. SEM images of the spicules, c. style, c1. details of smooth style, d. smaller style with rugose head, d1. detail of head of d, d2. even smaller style, d3. detail of head of d2, e. subtylostyle, e1. details of subtylostyle, f. cladotylole acanthostyle, g. oxhorn toxa, h. long thin shallow-curved toxa, i. palmate isochela.

Long thin shallow-curved toxa (Fig. 12h) 190–331–450 µm.

Palmate isochelae (Fig. 12i), rather narrow, but normal-shaped, 15–20.4–25 µm.

Ecology and distribution. Known only from the type locality, encrusting a mollusk, at a depth of 152 m off the SW coast of Bonaire.

Etymology. The name refers to the presence of acanthocladotylole-shaped acanthostyles, which so far were known only from members of the genus *Acarinus* Gray, 1867 (family Acarnidae Dendy, 1922).

Remarks. The new species is unique among *Clathria* species by the modification of its echinating acanthostyles to resemble the acanthocladotyloles of the genus *Acarinus*, more in particular those of the species *Acarinus primigenius* (Hiemstra & Hooper, 1991 (see also Van Soest *et al.* 1991)). For that reason, we assigned the new species at first to *Acarinus*, but a major feature does not match: the presence of unmistakable ectosomal subtylostyles, in all its aspects thoroughly representative of the genus *Clathria*, whereas all *Acarinus* species, including *A. primigenius* have microspined tyloles as ectosomal spicules. Furthermore, most *Acarinus* species have two categories of cladotyloles, one of which appears derived of the principal styles (cf. Van Soest *et al.* 1991). An exception is *A. primigenius*, which has only the acanthocladotylole type, but significantly, this species also has normal echinating acanthostyles, without the hooks at the pointed end. We conclude that the combination of ectosomal subtylostyles with the acanthostyle-like cladotyloles, makes the new species morphologically more similar to many *Clathria* (*Microcionia*) than to *Acarinus* and that this constitutes a remarkable case of parallel development in these two genera. There are more overlapping features between the two: several *Clathria* (*Microcionia*) species are known to have the feature of (partial) modification of their ectosomal microspined subtylostyles to quastyloles, often provided with microspines at both ends (see e.g. Van Soest *et al.* 2013). It indicates that the two groups (*Acarinus* and *Clathria*) are likely closely related and their assignment to different families may be unjustified.

Genus *Antho* Gray, 1867

Subgenus *Acarinia* Gray, 1867

Antho (*Acarinia*) *pellita* new species

Figures 13a–i

Material examined. Holotype: RMNH Por. 9240, Caribbean Netherlands, Bonaire, Kralendijk Pier (Dive 2), 12.1469°N 68.2821°W, on a large sponge at 108 m, coll. L.E. Becking & E. Meesters, field nr. BON1/BDR009, 30 May 2013.

Description. Red, optically smooth, but microhispid encrustation (Fig. 13a) on *Neopetrosia eurytomata* n. sp. (see below). Lateral expansion of the encrustation is 11 x 6 cm, the fragment preserved measures 3 x 2 x 0.2 cm. Consistency soft.

Skeleton. Choanosomal skeleton (Fig. 13b) a renieroid reticulation of acanthostrongyles, echinating at the nodes by longer acanthostyles. Subectosomal skeleton single long smooth styles, heads embedded in the choanosomal reticulation. Ectosomal skeleton bouquets of subtylostyles or single strewn subtylostyles.

Spicules. Principal styles, subtylostyles, acanthostyles, acanthostrongyles, toxa, palmate isochelae.

Styles (Fig. 13c, 13c1), usually smooth, but occasionally with a few spines on the head, curved, 300–394–498 x 6–13–16 µm.

Subtylostyles (Figs. 13d, 13d1, 13e, 13e1), with microspined heads, in a large size range, possibly divisible in two groups (165–298 and 310–470 µm), overall range 165–306–470 x 1.5–2.5–4 µm.

Acanthostrongyles (Fig. 13f), heavily spined at both rounded ends, less densely spined on the shaft, 90–101–110 x 7.5–9–10.

Acanthostyles (Figs. 13g, 13g1), longer than the acanthostrongyles, spined densely and uniformly along the shaft, more densely spined on the head, 130–151–180 x 7.5–9–10.

Toxa (Figs. 13h, 13h1), with a shallow curve, ends microspined or rugose, in a large size range, 66–142–272 µm.

Palmate isochelae (Fig. 13i), normal shaped, symmetrical, 13–14–15.5 µm.

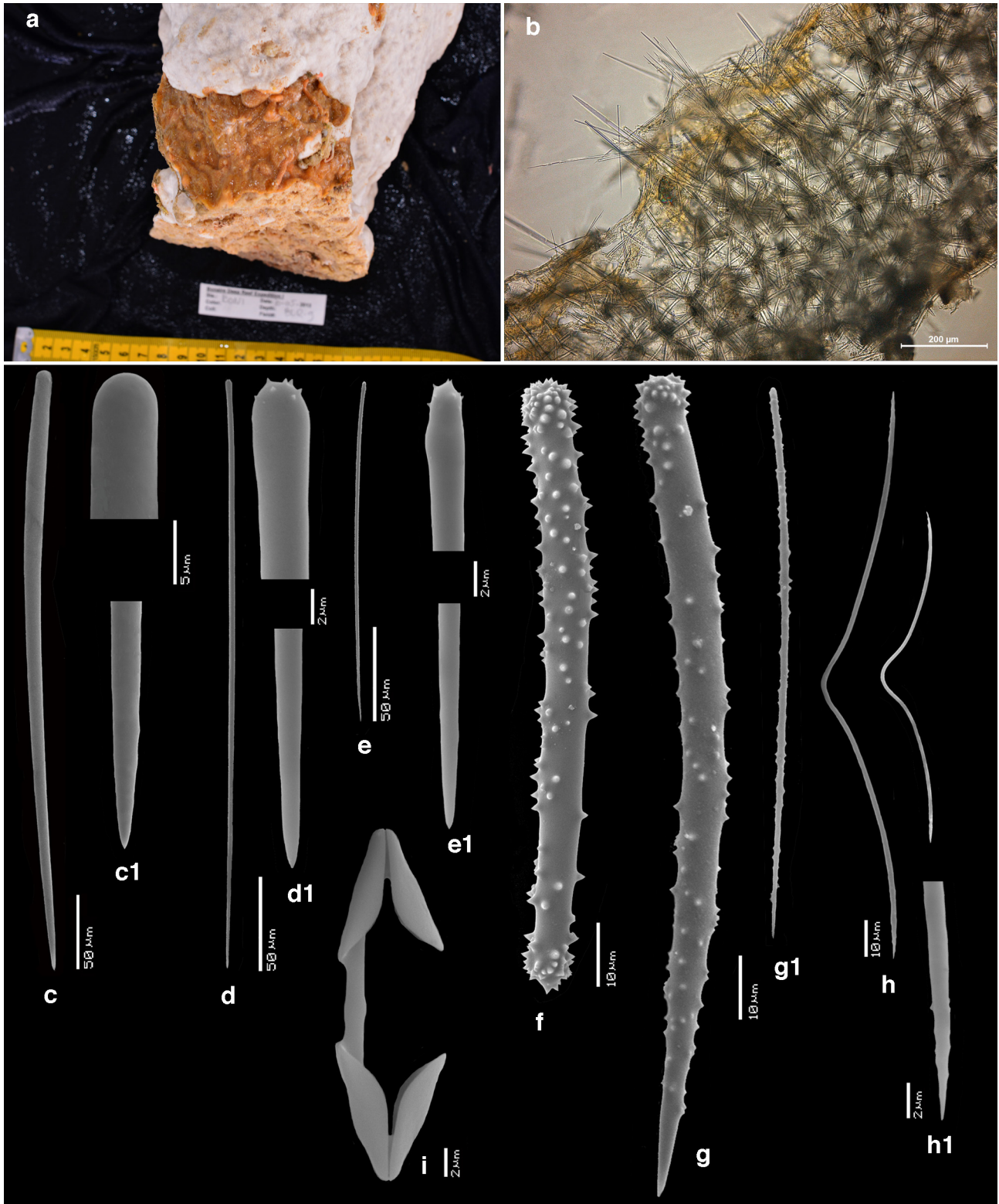


FIGURE 13. *Antho (Acarinia) pellita* n. sp., holotype RMNH Por. 9240, a. habit encrusting on the base of the holotype of *Neopetrosia eury stomata* n. sp., b. cross section of the skeleton, c–i. SEM images of the spicules, c. style, c1. details of style, d. long subtylostyle, d1. details of long subtylostyle, e. short subtylostyle, e1. details of short subtylostyle, f. acanthostrongyle, g. acanthostyle, g1. thin growth stage of acanthostyle, h. toxa, h1. microspined apex of toxa, i. palmate isochela.

Ecology and distribution. Known only from the type locality at the lower edge of the mesophotic zone.

Etymology. *pellita* (L.) means ‘forming a skin’, referring to the encrustation on another sponge.

Remarks. The new species belongs to the subgenus *Acarinia* because of its combination of acanthostrongyles

making up the basal reticulation and acanthostyles, echinating the nodes of this reticulation. The species is closest to *Antho (Acarnia) penneyi* (De Laubenfels, 1936 as *Holoplocamia*) from 70 m depth off Florida, likewise encrusting and basically with the same spicule complement. Differences are the smaller acanthostyles (only up to 97 μm) and toxas (only up to 80 μm), and the shape of the chelae which are contort unlike those of our new species. Other Central West Atlantic *Antho* species are encrusting *Antho (Antho) barbadensis* Van Soest & Stentoft, 1988 from Barbados, differing a.o. in the absence of acanthostrongyles, encrusting *Antho (Acarnia) delaubenfelsi* (Little, 1963 as *Holoplocamia*) from the Gulf of Mexico, differing a.o. by its lack of acanthostyles, and lamellate *Antho (Plocamia) gymnazusa* (Schmidt, 1870) from Florida, which differs by its habit and its possession of dumbbell-shaped spicules.

Order Halichondrida Gray, 1867

Family Heteroxyidae Dendy, 1905

Genus Parahigginsia Dendy, 1924

Parahigginsia strongylifera new species

Figures 14a–d, 15a–f

Material examined. Holotype: RMNH Por. 9251, Caribbean Netherlands, Bonaire (Dive 4), 112.08°N 68.2938°W, depth 238 m, on a limestone rockwall, coll. L.E. Becking & E. Meesters, field nr. BON4/BDR048, 1 June 2013.

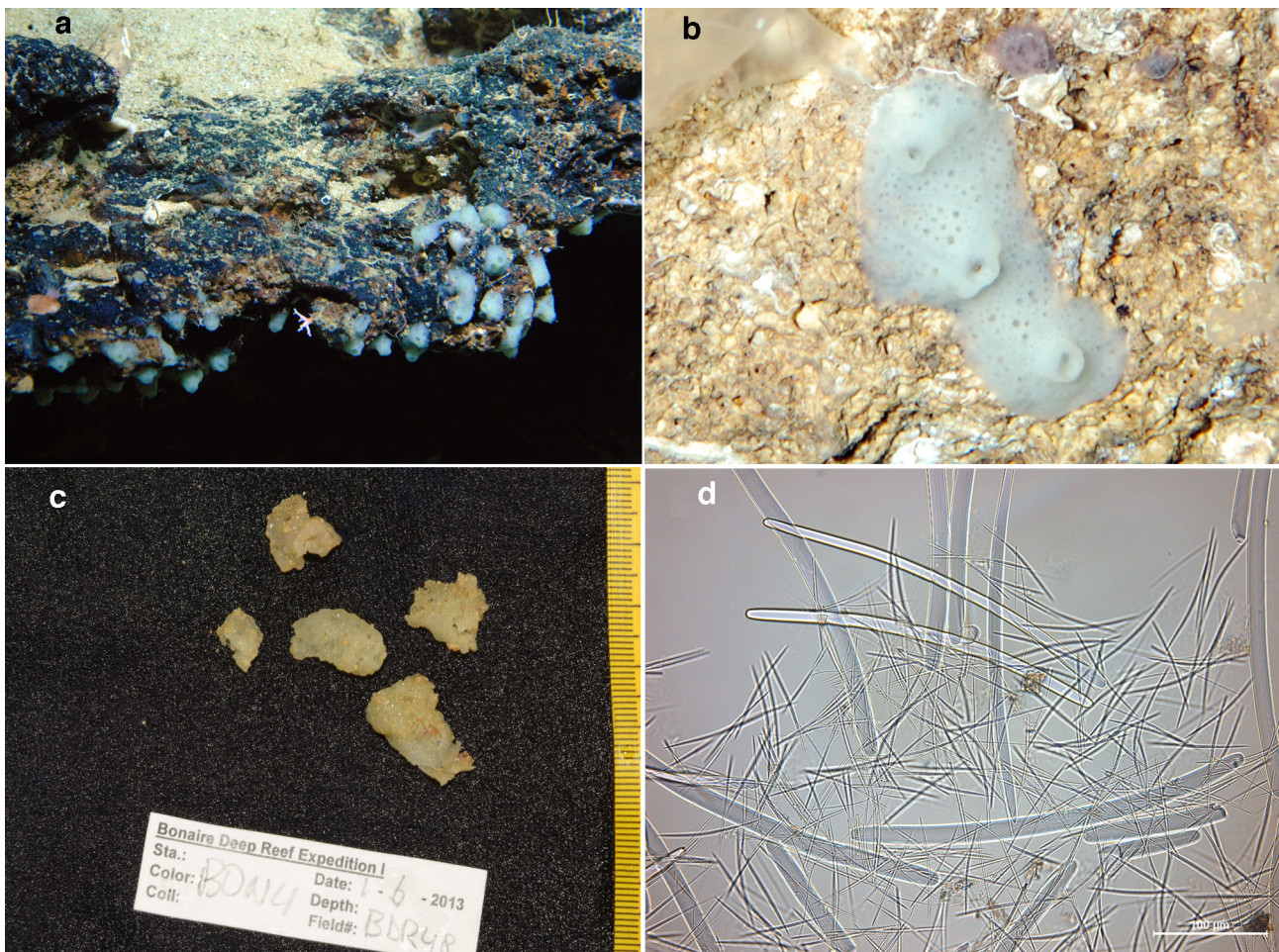


FIGURE 14. *Parahigginsia strongylifera* n. sp., habit in situ, b. detail of habit in situ, c. preserved holotype RMNH Por. 9251, d. spicules of holotype.

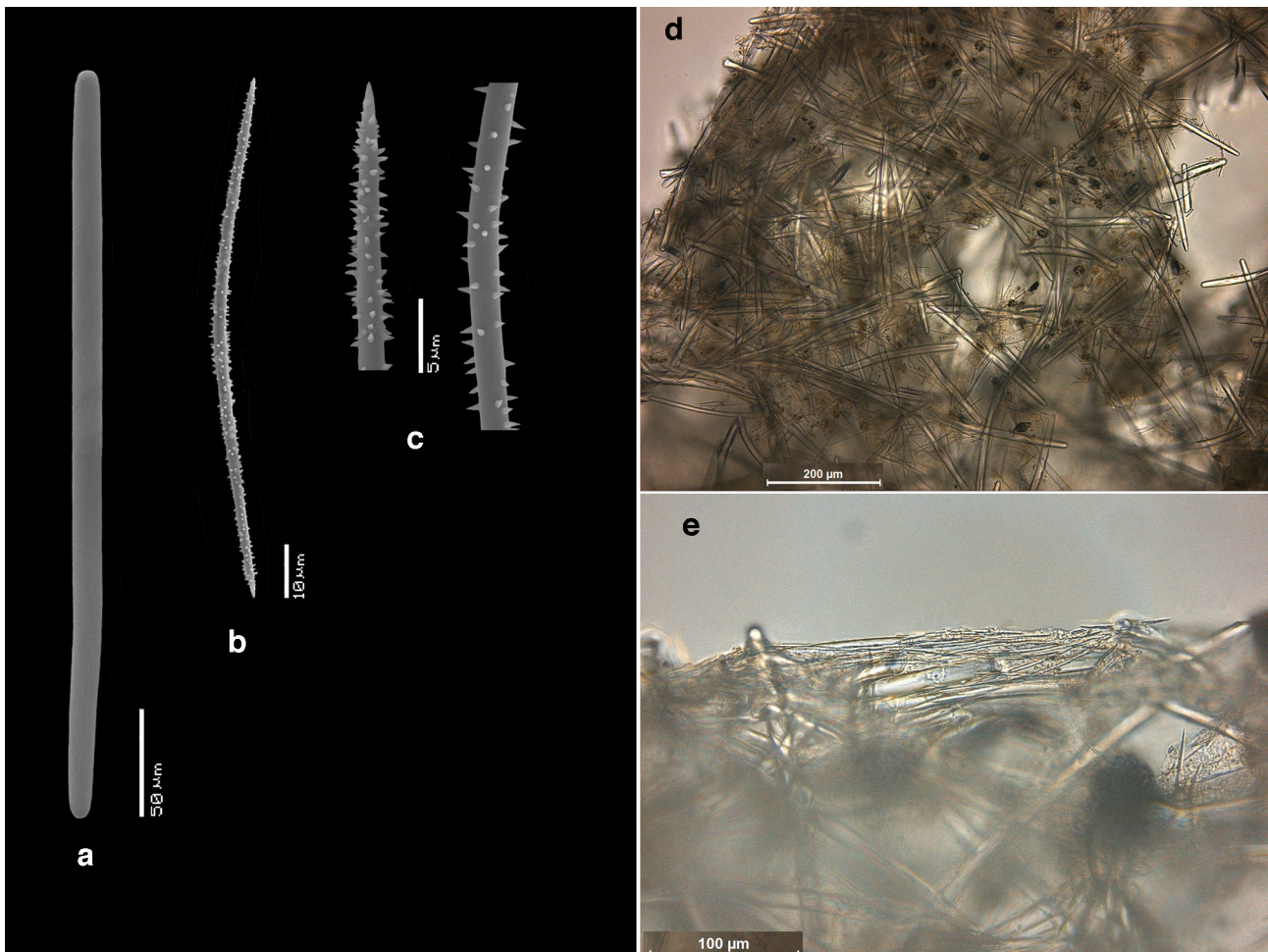


FIGURE 15. *Parahigginsia strongylifera* n. sp., holotype RMNH Por. 9251, a–c. SEM images of the spicules, a. strongyle, b. acanthomicroxea, c. details of apex and middle part of acanthomicroxea, d–e. light microscopy images of skeleton, d. cross section of skeleton, e. detailed view of peripheral skeleton showing ectosomal cover of acanthomicroxeas.

Description. Pale blue, encrusting sponges (Fig. 14a) forming small lobes with raised oscules (Fig. 14b), individual lobes approximately 2 x 1 x 1 cm in size. The preserved holotype material consists of fragments of approximately 1–2 cm in size (Fig. 14c). Individual lobes may coalesce with nearby lobes, and may be connected by thin tissue strands on the substratum. Consistency soft, easily damaged.

Skeleton. The ectosomal skeleton consists of a thin layer of spined microxeas (Fig. 15e) covering a confused choanosomal reticulation (Fig. 15d), constructed from individual strongyles or vaguely aligned bundles of two or three. No clearly developed meshes or tracts. Microxeas are also profusely present in the choanosome.

Spicules (Figs. 14d). Strongyles, acanthomicroxeas.

Strongyles (Fig. 15a), curved, often with slightly asymmetrical ends, 290–341–370 x 10–15–18 µm

Acanthomicroxeas (Figs. 15b–c1), curved gently, not abruptly, with thin somewhat irregularly distributed spines (denser at the apices and in the center), 75–93–120 x 1–1.8–2.5 µm.

Ecology and distribution. Deep water (238 m) off the coast of SW Bonaire, on volcanic outcrops.

Etymology. The name refers to the strongyle megascleres.

Remarks. The genus *Parahigginsia* is so far monotypical, erected for the New Zealand deep water species *P. phakelloides* Dendy, 1924, subsequently reported also from New Caledonia by Lévi & Lévi (1983). The assignment of our specimen to this genus is based on the combination of a dense isotropic skeleton of smooth diactines arranged in vague bundles and an ectosomal cover of thin curved acanthomicroxeas. *P. phakelloides* has a similar skeleton, but the megascleres are more definitely curved oxaeas, whereas *P. strongylifera* n. sp. predominantly has (aniso-)strongyles. The megascleres and microscleres of both species are in the same size range. *P. phakelloides* has a lamellate growth form, up to 14 cm high, 8 cm wide and 2.5 mm thick, quite different from

the encrusting-lobate *P. strongylifera* n. sp. Both species occur at comparable depths (*P. phakelloides* was collected from 126 m).

Hooper (2002) assigned the genus *Parahigginsia* to the family Desmoxyidae, for priority reasons renamed as Heteroxyidae in Van Soest & Hooper (2005). This family is likely polyphyletic (Morrow *et al.* 2012). *Parahigginsia* was reassigned to a family Stelligeridae, along with several other heteroxyid genera. Since only limited evidence of mostly molecular nature was presented to justify the proposed reassignment, we prefer to retain *Parahigginsia* in the family Heteroxyidae until a comprehensive integrative classification of these genera and families has been published.

Order Haplosclerida Topsent, 1928

Family Phloeodictyidae Carter, 1882

Genus *Calyx* Vosmaer, 1885

Calyx magnoculata new species

Figures 16a–e

? *Pachypellina podatypa*; sensu Van Soest, 1980: 91, pl. XIV fig. 3, text-fig. 34.

? *Calyx* cf. *podatypa* sensu Van Soest & Stentoft, 1988: 133, text-fig. 65 (not De Laubenfels, 1934: 23)

Material examined. Holotype: RMNH Por. 9254, Caribbean Netherlands, Bonaire (Dive 4), 112.08°N 68.2938°W, depth 232 m, on a limestone rockwall, coll. L.E. Becking & E. Meesters, field nr. BON4/BDR060, 1 June 2013.

Description. Massively encrusting sponge (Fig. 16a), 11 x 16 cm in lateral expansion, 2 cm thick, provided with two conspicuous flush oscules with thin rims, approximately 1 cm in diameter. Preserved holotype consists of three fragments, the largest of which is 4 x 2 x 2 cm. Surface smooth, but bumpy, irregular with occasional small hillocks. Consistency firm, crumbly. Colour light beige.

Skeleton. Surface skeleton a dense multilayered crust of spicules (Fig. 16b) lacking orientation or organization. The layer is approximately 100–150 µm in thickness and on average is 8 spicules thick. It overlies an irregular zone of subdermal spaces (Fig. 16c), which are traversed by occasional more or less perpendicularly oriented spicule bundles, which follow an indistinct course in the underlying choanosomal skeleton. The latter is barely reticulate, mostly an isotropic–confused spicule mass, with few larger open spaces.

Spicules. Oxeas.

Oxeas, relatively sharply pointed, slightly curved, apparently in two slightly overlapping size categories, which are, however, not localized in the skeleton and distinguished only in size, (1, Fig. 16d, 16d1) 225–242–264 x 10–11–13 µm, and (2, Fig. 16e) 141–170–195 x 6–8–10.5 µm.

Ecology and distribution. Known only from the type locality, a vertical limestone wall at 232 m off SW Bonaire.

Etymology. The name reflects the large conspicuous oscules.

Remarks. The species is assigned to the genus *Calyx* on account of the thick crust of intercrossing oxeas at the surface, making a characteristic, dense armor. The only other known Western Atlantic *Calyx* species is *C. podatypa* (De Laubenfels, 1934 as *Haliclona*). It is largely similar to our new species, but has distinctly smaller spicules, 90–119 x 2–4 µm in the type and its oscules are of the key-hole type, not rounded; color is pinkish beige, not tan like our new species. *C. podatypa* has also been hesitatingly reported from deep water off Puerto Rico (Van Soest 1980: 91 as *Pachypellina*) and from deep water off Barbados (van Soest & Stentoft 1988: 133). Both records might possibly belong to the present new species, as the upper size of the spicules nears that of our material and is up to twice the length of those of the type of *C. podatypa*. The type of the latter has been found between 36 and 72 m depth, but most subsequent specimens originate from shallow water (e.g. Rützler *et al.* 2014).

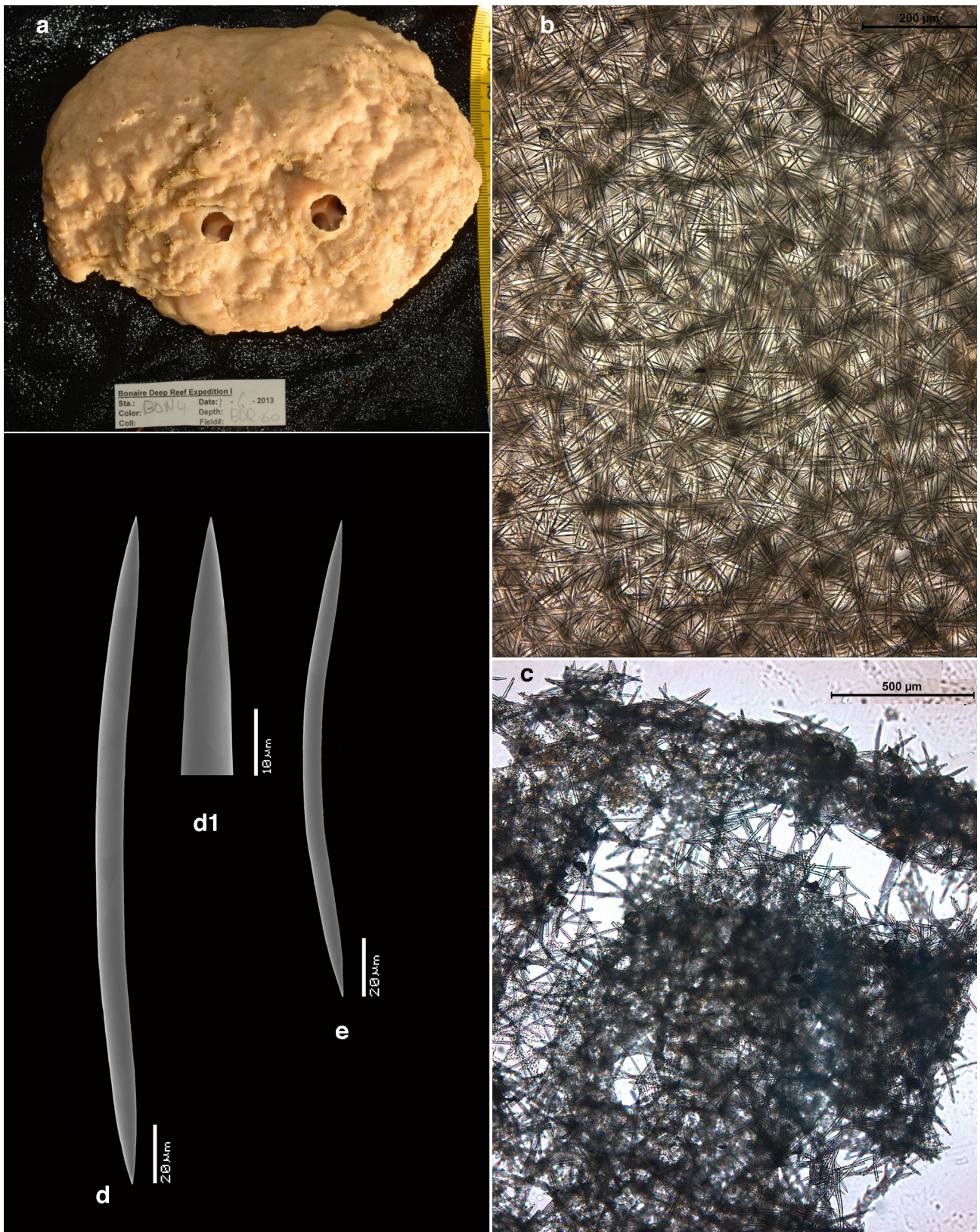


FIGURE 16. *Calyx magnoculata* n. sp., holotype RMNH Por. 9254, a. habit shortly after collection, b. dense ectosomal skeleton, d–e. SEM images of spicules, d. larger oxea, d1. detail of apex of larger oxea, e. smaller oxea.

Family Petrosiidae Van Soest, 1980

Genus *Neopetrosia* De Laubenfels, 1949

Neopetrosia dutchi new species

Figures 17a–h

Xestospongia cf. *rosariensis* sensu Van Soest & Stentoft, 1988: 130, pl. 12 fig. 3, text-fig. 63 (not Zea & Rützler, 1983)

Material examined. Holotype: RMNH Por. 9253, Caribbean Netherlands, Bonaire (Dive 4), 112.08°N 68.2938°W, depth 217 m, in the sand, coll. L.E. Becking & E. Meesters, field nr. BON4/BDR058, 1 June 2013.

Description. Thick clump of large lobes (Figs. 17a–c), each with prominent central oscule of 0.8–1.5 cm in diameter; color pale beige alive and in preserved state. Size 35 x 35 x 30 cm, with individual lobes up to 14 cm high and 9 cm in diameter. Preserved holotype consists of two fragments, one small lobe of 3 cm diameter and 2 cm high, and one fragment of a lobe of 1.5 x 1.5 x 1.5 cm. Surface optically smooth, provided with starshaped subdermal spaces (Fig. 17d) connected by thin subdermal grooves into a characteristic subsurface network.

Skeleton (Figs. 17e–f). No special ectosomal skeleton; the choanosome is dominated by a heavily spiculated anisotropic skeleton forming squarish meshes, on average 200–250 µm in diameter, with 3–8 spicules on the sides (mostly 3 or 4 spicules in the cross connections and up to 8 in the ascending tracts).

Spicules. Oxeas.

Oxeas (Figs. 17g–h), smooth, relatively robust, usually curved, with abruptly pointed or mucronate ends, rather uniform in shape, but with a large size range 165–235–264 x 11–14–18 µm.

Ecology and distribution. In the sand at 217 m off the SW coast of Bonaire; at 90–153 m off Barbados.

Etymology. The name is given to acknowledge Adriaan ('Dutch') Schriers, the owner of the 'Curasub' for making it available for our scientific sponge studies.

Remarks. This species was previously reported from Barbados as *Xestospongia* cf. *rosariensis* Zea & Rützler, 1983 by Van Soest & Stentoft (1988). We compared that material with our new species and concluded that this is not *Neopetrosia rosariensis*. That species has a dark brown colour and is tube-shaped, unlike the pale beige color and lobate shape of the present species. Besides *N. rosariensis* four additional species of *Neopetrosia* have been reported from the Western Atlantic, viz. *N. carbonaria* (Lamarek, 1814 as *Spongia*), *N. dominicana* (Pulitzer-Finali, 1986 as *Xestospongia*), *N. proxima* (Duchassaing & Michelotti, 1864 as *Thalysias*, with junior synonym *Densa araminta* De Laubenfels, 1934), and *N. subtriangularis* (Duchassaing, 1850 as *Spongia*, with junior synonyms *Haliclona doria* De Laubenfels, 1936, *H. longleyi* De Laubenfels, 1932, *Thalysias rugosa* Duchassaing & Michelotti, 1864 and *Schmidtia aulopora* Schmidt, 1870) (Van Soest *et al.* 2014). *N. carbonaria* is a black massive species, whereas *N. subtriangularis* is brown ramose; both are common shallow-water species, clearly different from our new species in habit and color. *N. dominicana* differs from our new species in the shape of the spicules, which are strongyles. *N. proxima* is encrusting, orange-brown, and has a much denser skeleton (see also below in the comparison with *Neopetrosia ovata* n. sp. and *Neopetrosia eurytomata* n. sp.).

Neopetrosia ovata new species

Figures 18a–f

Material examined. Holotype: RMNH Por. 9257, Caribbean Netherlands, Klein Curacao, off SW coast (Dive 1), 11.9821°N 68.6452°W, in the sand at 149 m, coll. L.E. Becking & E. Meesters, field nr. CURASUB13-09/BDR002, 27 May 2013.

Description. Pinkish beige, ovate sponge (Figs. 18a–b), size 10 cm high, 8 cm in diameter, with a central oscule of 1.4 cm in diameter. The preserved holotype consists of three fragments the largest of which is 3.5 x 3 x 2 cm. Surface smooth, punctate in life, covered with tiny zoanths. Oscule rim thin, slightly raised. Inner side of atrial lumen ridged lengthwise. Consistency firm to hard.

Skeleton (Figs. 18e–f). Dense mass of oxeas forming vague rounded meshes, which are largely obscured by the thick tracts. Compared to the skeleton of *N. dutchi* n. sp. described above, the present skeleton is much less organized and much more confused.

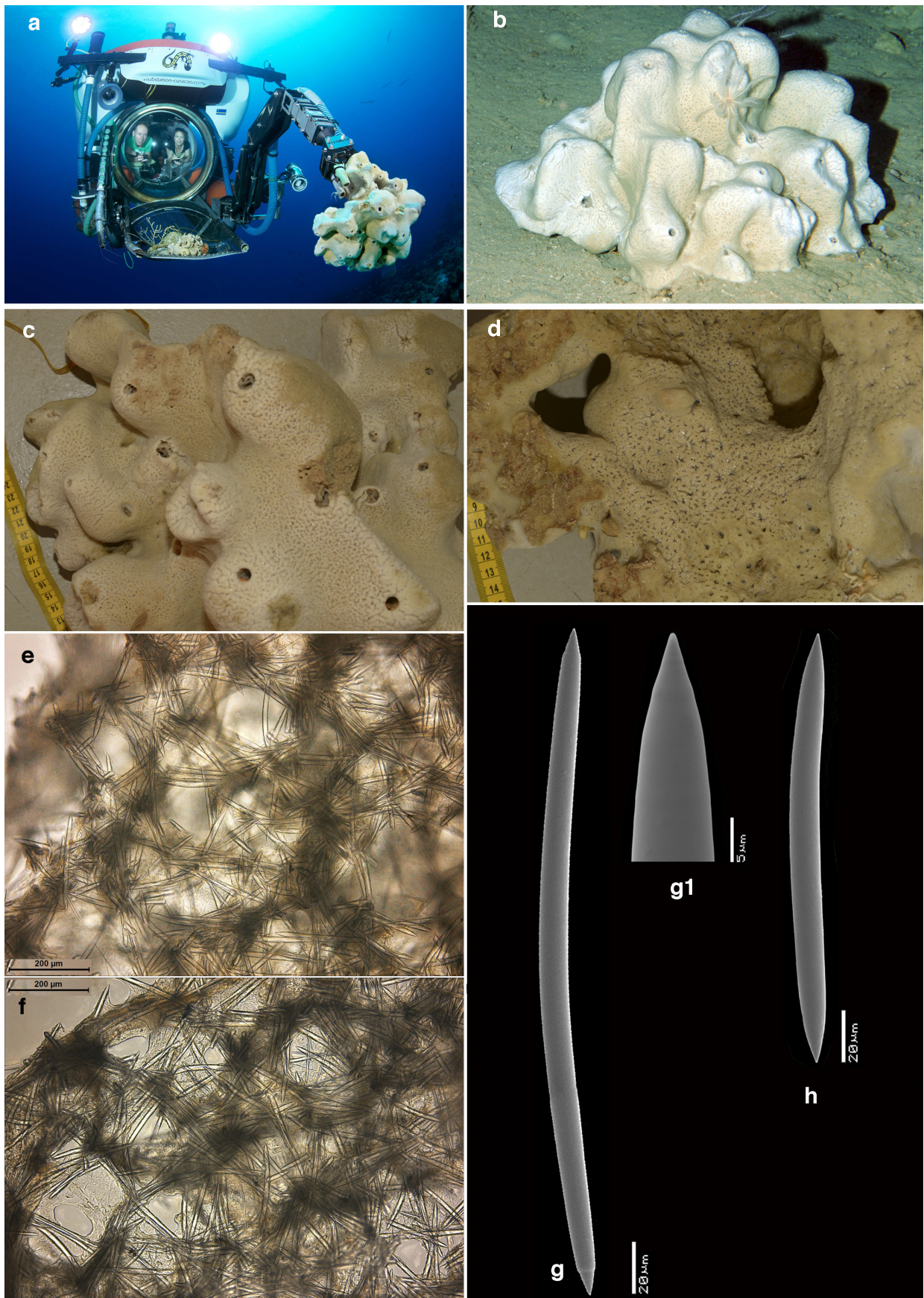


FIGURE 17. *Neopetrosia dutchi* n. sp., holotype RMNH Por. 9253, a. view of submarine with collected holotype, b. habit in situ, c. habit shortly after collection, d. detail of surface, e. tangential view of ectosomal skeleton, f. cross section of peripheral skeleton, g–h. SEM images of spicules, g. larger oxea, g1. detail of apex of larger oxea, h. smaller oxea.

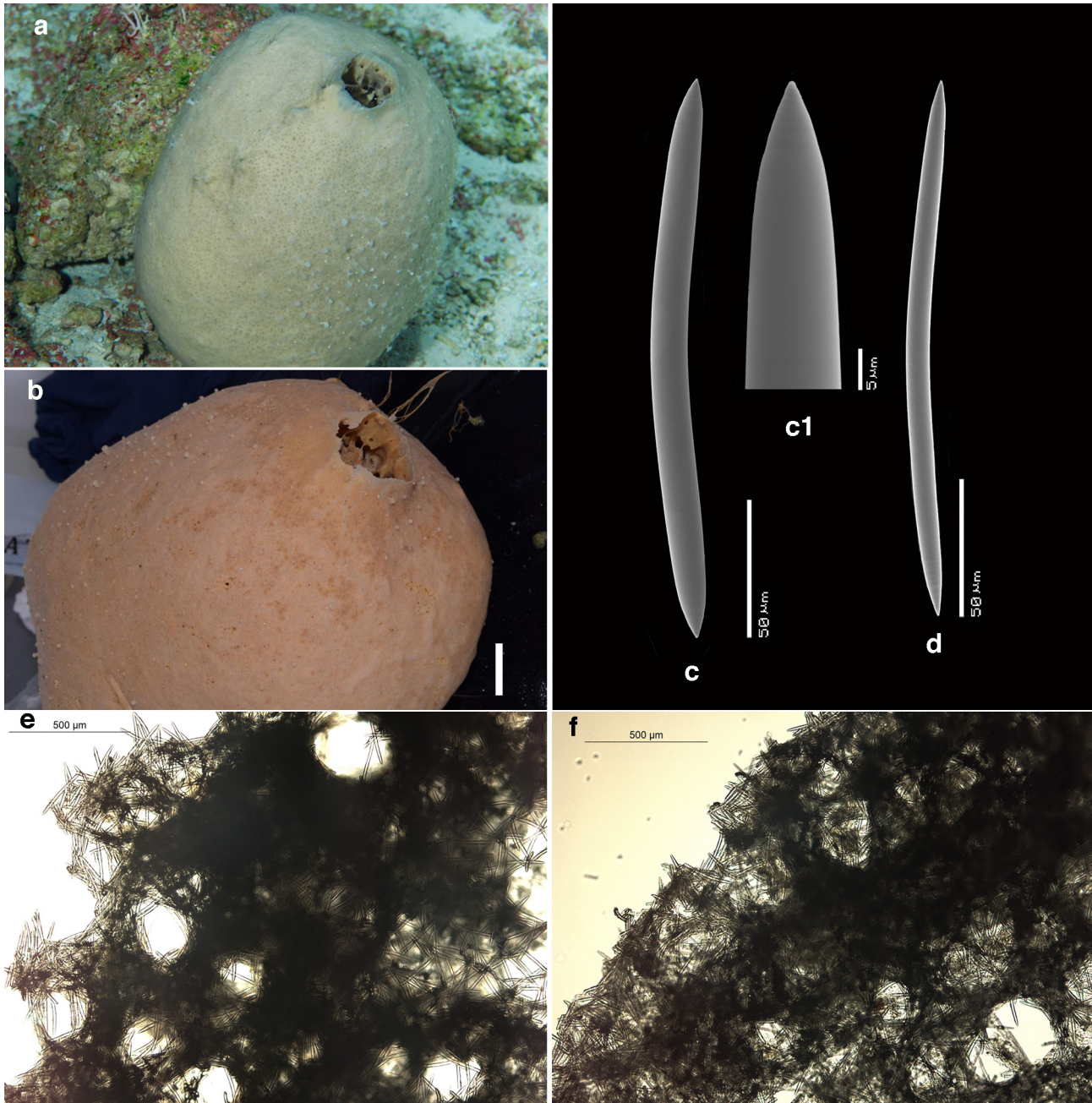


FIGURE 18. *Neopetrosia ovata* n. sp., holotype RMNH Por. 9257, a. habit in situ, b. habit shortly after collecting, c–d. SEM images of the spicules, c. robust oxea, c1. detail of apex of robust oxea, d. thinner oxea, e. tangential view of ectosome, f. cross section of peripheral skeleton.

Spicules. Oxeas.

Oxeas (Figs. 18c–d), smooth, robust, slightly curved, uniform in length, but variable in thickness, 200–235–270 x 10.5–14.5–15 μm .

Ecology and distribution. In the sand at 149 m depth, at Klein Curaçao.

Etymology. The name refers to the characteristic shape of the sponge.

Remarks. Although spicule sizes and shapes are essentially the same as the above *N. dutchi* n. sp. the present new species differs clearly from it in the habit (a single upright globular mass vs. a mass of coalescing lobes in *N. dutchi* n. sp.) and especially also the structure of the skeleton which is much denser and irregular with barely distinguishable meshes. In that respect it somewhat resembles *Neopetrosia proxima* (Duchassaing & Michelotti, 1864) but in that species all the spicules are smaller than 200 μm , and its habit is encrusting with oscules raised on small lobes (see redescription in Zea 1987).

Neopetrosia eurystomata new species

Figures 19a–f, 20a–c

Xestospongia cf. *proxima* sensu Van Soest & Stentoft, 1988: 132, pl. 12 fig. 4, text-fig. 64 (not: *Thalysias proxima* Duchassaing & Michelotti, 1864).

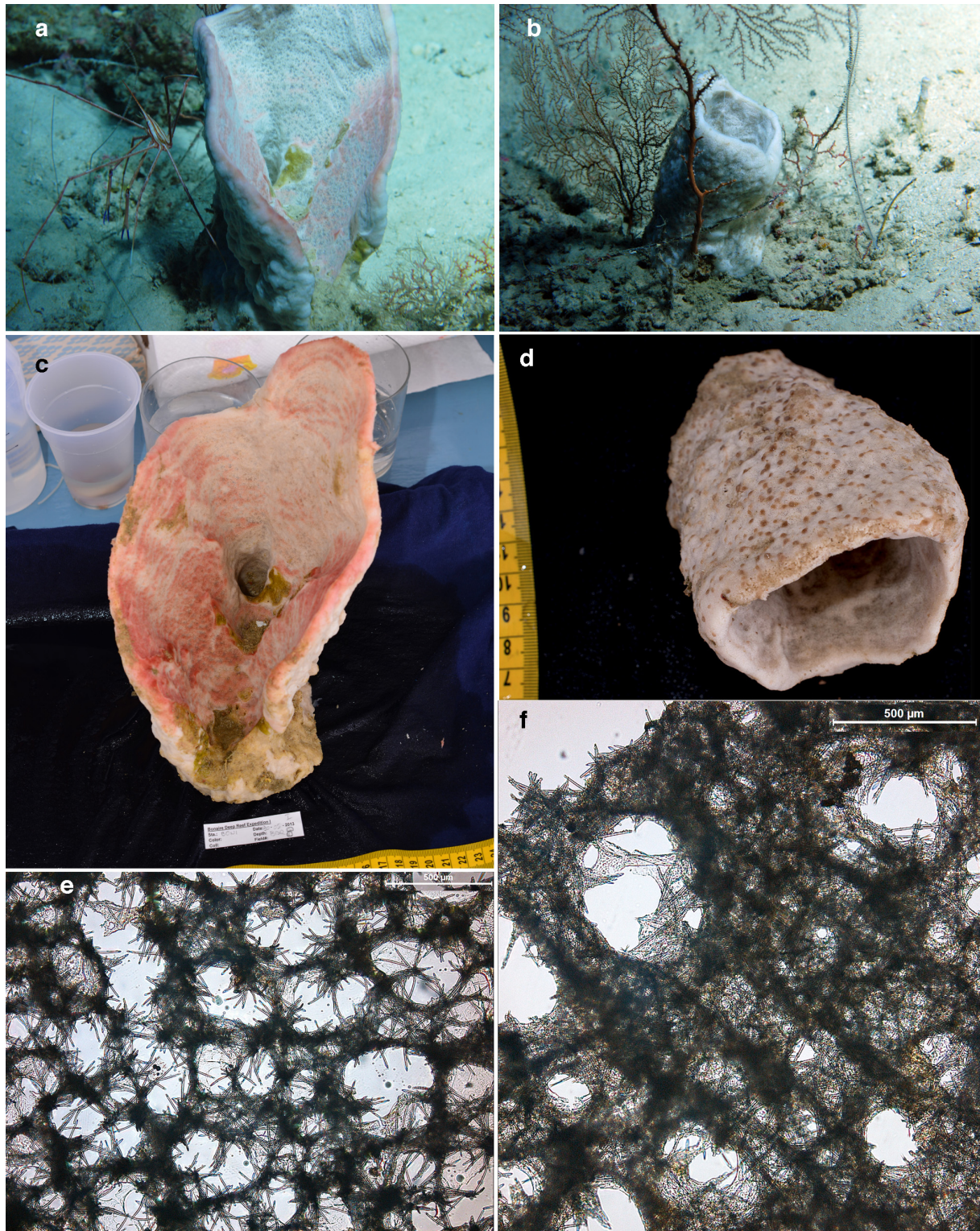


FIGURE 19. *Neopetrosia eurystomata* n. sp., a, holotype RMNH Por. 9239 in situ, b, paratype RMNH Por. 9242 in situ, c, holotype after collection, d, paratype RMNH Por. 9242, after collection, e, tangential view of ectosomal skeleton of holotype, f, cross section of peripheral skeleton of holotype.



FIGURE 20. *Neopetrosia eurystomata* n. sp., a. fragment of paratype RMNH Por. 9250 after collection, b–c. SEM images of spicules of holotype RMNH 9239, b. larger oxea, b1. details of apex of larger oxea, c. smaller oxea.

Material examined. Holotype: RMNH Por. 9239, Caribbean Netherlands, Bonaire, Kralendijk Pier (Dive 2), 12.1469°N 68.2821°W, on sandy rubble at 108 m, coll. L.E. Becking & E. Meesters, field nr. BON1/BDR008, 30 May 2013.

Paratypes: RMNH Por. 9242, Caribbean Netherlands, Bonaire, Kralendijk Pier (Dive 2), 12.1469°N 68.2821°W, on sandy rubble at 111 m, coll. L.E. Becking & E. Meesters, field nr. BON1/BDR013, 30 May 2013. RMNH Por. 9250, Caribbean Netherlands, Bonaire, Curoil Dock, (Dive 3), 12.137°N 68.286°W, in the sand at 88 m, coll. L.E. Becking & E. Meesters, field nr. BON3/BDR037, 31 May 2013.

Description. Vase shaped (Figs. 19a–d), larger specimens with wide, flaring walls, some specimens may look similar to barrel sponges [*Xestospongia muta* (Schmidt, 1870)]. Size of largest specimen 30 cm high, 18 cm wide, wall thickness 1.5–2 cm. The preserved holotype consist of two fragments, one 4.5 x 2.5 x 1 cm, the other 3 x 2 x 1.5 cm. The paratypes consists of two (RMNH 9242) and one (RMNH 9250) fragments, each approximately 4 x 2 x 2 cm. External color of live specimen is pink and white, inner color dark red or brownish (Fig. 20a). Consistency firm and crumbly, but slightly compressible. Surface (Fig. 20a) with vague stellar sunken groups of pores on both the outer and the inner surface. Outer surface often infested with red zoanthids.

Skeleton. The surface skeleton (Fig. 19e) is a vague tangential reticulation of single spicules or two or three aligned spicules. Underneath there are regularly distributed subdermal spaces of 200–400 µm diameter. The choanosomal skeleton (Fig. 19f) is isotropic but with a superimposed anisotropic orientation as is typical for many *Neopetrosia* species. There is little or no visible spongin.

Spicules. Oxeas.

Oxeas (Fig. 20b–c), smooth, robust, sharply pointed, lightly curved, in a fairly large size range, but not divisible in size categories, 160–187–200 x 5–9–10 µm.

Ecology and distribution. In the mesophotic zone at or around the 100 m mark, off the SW coast of Bonaire; at 120 m off Barbados.

Etymology. Eury- (Gr.) means wide, -stoma (G.) means mouth, referring to the wide, often flaring, opening of the vase-like sponge.

Remarks. The species was reported by Van Soest & Stentoft (1988: 132) as *Xestospongia* cf. *proxima*. It is not the encrusting *Neopetrosia proxima* (see above). At first glance it appears close to the common shallow-water sponge *Xestospongia muta* in habit. However, the spicules of our new species are definitely significantly shorter and thinner than those of *X. muta*. Van Soest (1980: 68) compared spicule sizes of shallow-water populations of *X. muta* in several Greater Caribbean localities: Curaçao specimens measured 360–345 x 11–16 µm, Puerto Rico specimens 303–412 x 14–23 µm, and Bahamas specimens 290–430 x 3.5–12 µm. The spicules of our deep-water specimens do not exceed 200 µm in length. Although the shallow-water specimens of *X. muta* have predominantly oxea spicules, there is always a good proportion of strongyle forms. In the present deep-water material there are no strongyles, all spicules are sharply pointed oxeas. Finally, the skeletal structure of *X. muta* specimens is more loosely organized, and does not have the superimposed anisotropic arrangement of spicules and meshes. No other *Neopetrosia* species in the Central West Atlantic have a vase-shaped habit.

The niphatid *Cribrochalina vasculum* (Lamarck, 1814) shares the vase-shaped habit with *N. eurystomata* n. sp., but it is different in color (brown) and the spicules include forms as small as 50 µm and up to 300 µm or more. The skeleton is also radically different with an emphasis on ascending spicule tracts separated by large spaces in which only loose spicules occur, with few interconnecting tracts (Wiedenmayer 1977: 119; Zea 1987: 91).

Additional species collected

We refrain from describing a further 18 species, which were also collected in the four Curasub dives, as they belong to already known species and do not appear different from the original (and subsequent) descriptions. However, since many of these species have been reported rarely or even only once, a summary characterization is presented here in the form of an annotated table (see Table 2), names, brief description of habit, brief description of skeleton and spicules including size range, depth of occurrence and RMNH Por. registration numbers. In addition we present one or more small in situ or on deck images of all species (Figures 21–22). With these data we provide proof for the validity of these recorded occurrences and in some cases in situ images and live colors of rare species.

A few species need to be highlighted:

Daedalopelta nodosa Schmidt, 1879 (Fig. 21g) appears to be the third record ever, as it was originally described from Florida and subsequently only once, from Jamaica or the Bahamas (authors discussing this HBOI material give different localities, see Kelly 2000: 279; Pisera & Lévi 2002: 346). Oxeas in our specimen were up to 380 µm long exceeding those of the previous reports.

Neopelta perfecta Schmidt, 1880b (Fig. 21h) has been also reported only twice before, from Barbados and Grenada (see Pisera & Lévi 2002: 350). Our specimen conforms to Schmidt's description in having distinct oscular papillae, unlike the HBOI specimen from Grenada depicted by Pisera & Lévi 2002: Fig. 10.

Siphonodictyon viridescens (Schmidt, 1880 as *Siphonochalina*) (Fig. 22d) is here newly reassigned to the genus *Siphonodictyon* Bergquist, 1985 on account of its habit, long whitish tubes with a greenish tinge issuing from a limestone substratum. We were able to verify its identity from a slide of the type MCZ Por. C-119 from 180 m off Barbados. This shows a dense skeleton of robust oxeas typical for the genus and unlike the skeleton of *Oceanapia* to which it was previously assigned.

Verrucocoeloidea liberatorii Reiswig & Dohrmann, 2014 (Figs. 22g, 22g1, 22g2), recently described from various localities in the Caribbean including Curaçao was also found by us, off the SW coast of Bonaire.

Comparison with regional deep-water sponge faunas (mesophotic and upper dysphotic zones)

Our investigation is not the first attempt to obtain data on the faunal diversity of sponges from Bonaire, as the biomedical division of the Harbor Branch Oceanographic Institute made a submersible and SCUBA cruise to Curaçao and Bonaire in 2000 (Reed & Pomponi 2001). Although it is obvious from the taxonomy report that many sponges collected during this cruise were likely similar, a direct comparison of our results with the results from the HBOI cruise is difficult because (1) identification was made usually only to family or genus level, (2) depth data were only presented in very broad strata (e.g. 45–150 m) and exceeded our limits at the upper depths (0–45 m) and lower depths (300–600 m). Below we do use these data along with other data to examine photic and deep-water faunas.

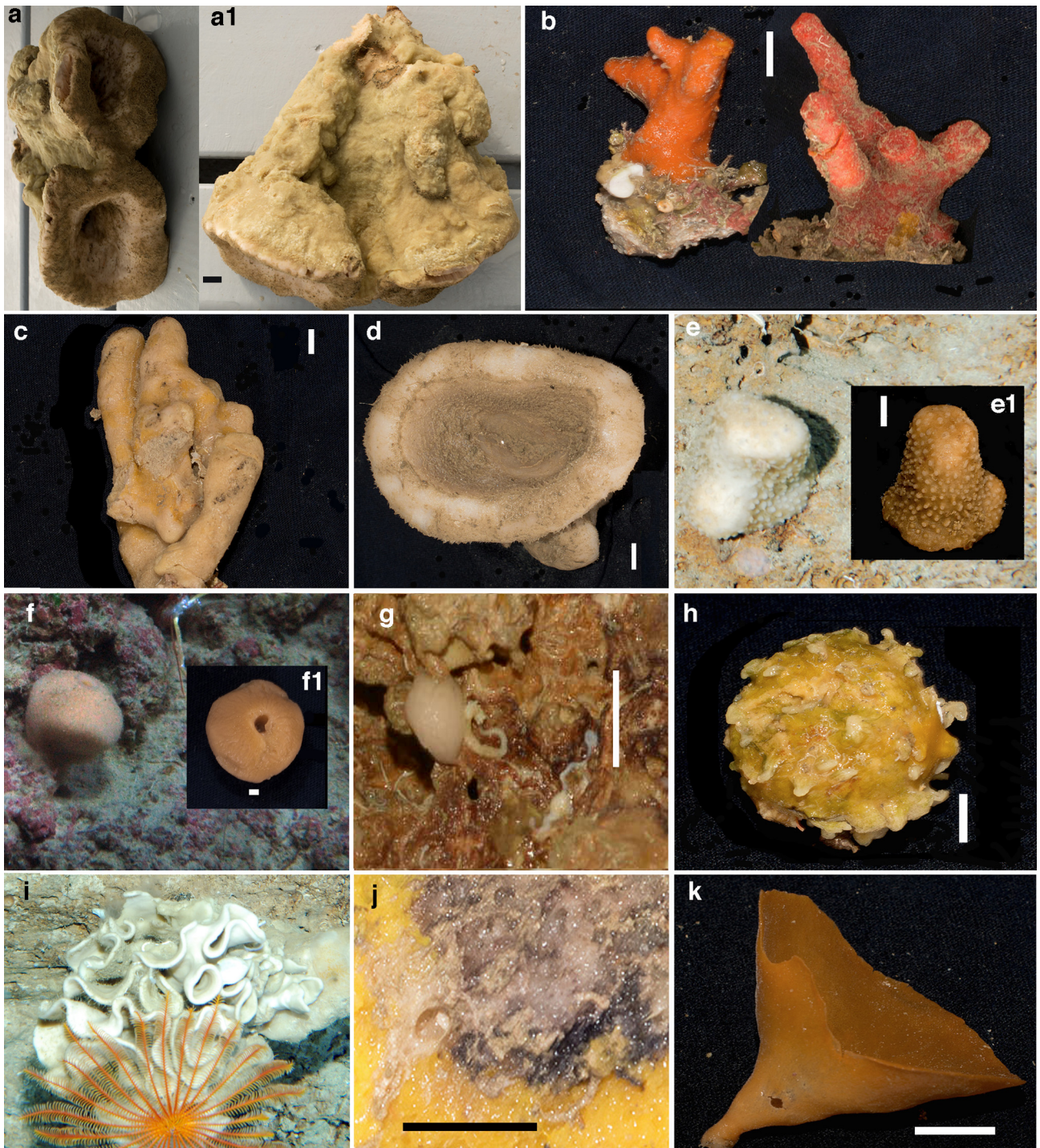


FIGURE 21. Images of specimens belonging to already known species, briefly characterized in Table 2. All scale bars 1 cm, a. *Characella aspera* (Sollas, 1886) photographed after collection, from the front, a1. ditto photographed from the side, b. *Theonella atlantica* Van Soest & Stentoft, 1988, two specimens after collection, c. *Discodermia dissoluta* Schmidt, 1880, after collection, d. *Corallistes typus* Schmidt, 1870, after collection, e. *Aciculites cribrophora* (Schmidt, 1880), in situ, e1. ditto, after collection, f. *Gastrophanella implexa* Schmidt, 1870, in situ, f1. ditto, after collection, g. *Daedalopelta nodosa* (Schmidt, 1879), after collection, h. *Neopelta perfecta* Schmidt, 1880, after collection, i. *Leiodermatium lynceus* Schmidt, 1870, in situ, j. *Hamacantha* sp. after collection, k. *Phakellia folium* Schmidt, 1870, after collection.

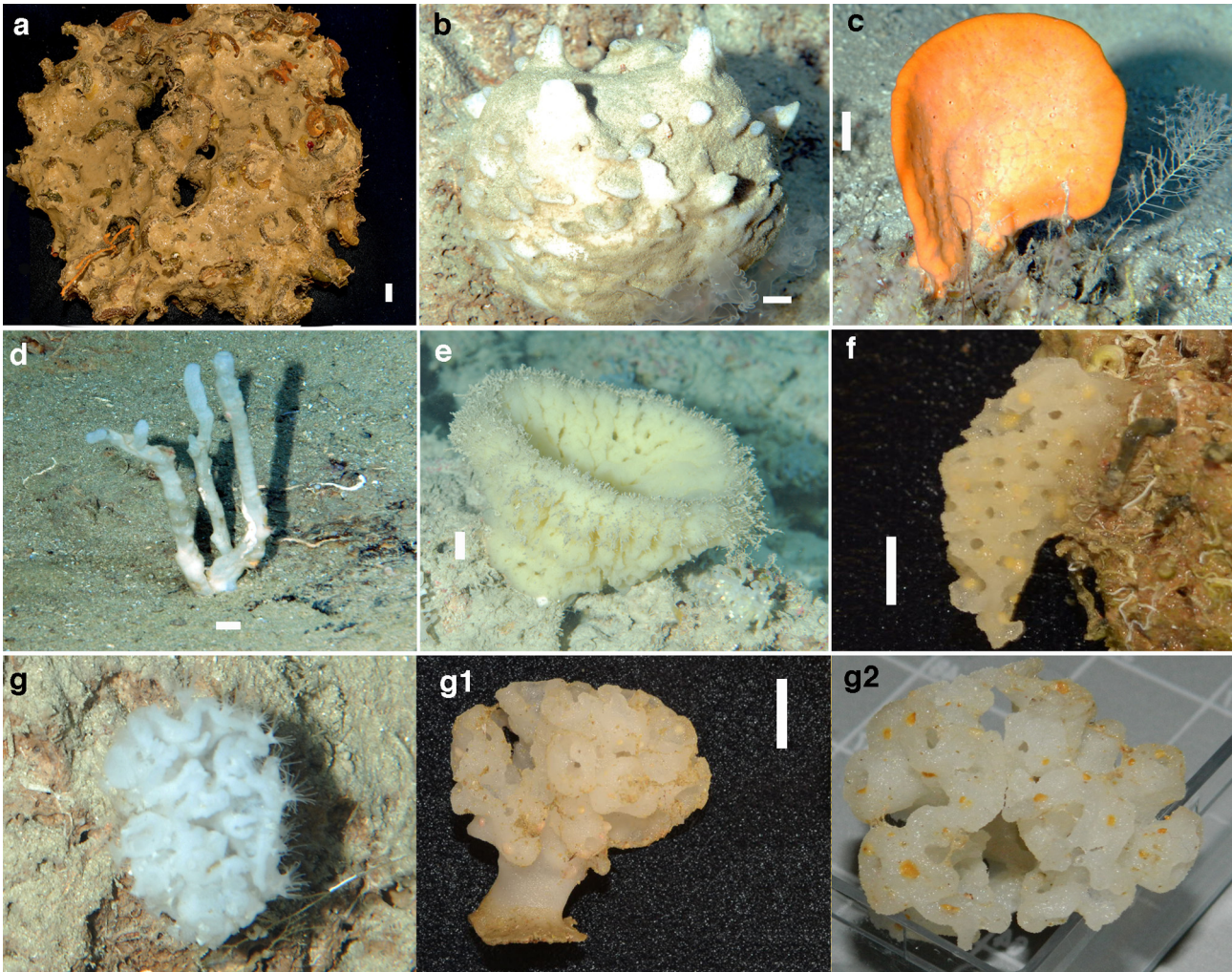


FIGURE 22. Images of specimens belonging to already known species, briefly characterized in Table 2. All scale bars 1 cm, a. *Spongosorites ruetzleri* (Van Soest & Stentoft, 1988), photographed after collection, b. *Topsentia pseudoporrecta* Díaz *et al.* 1993, in situ, c. *Agelas flabelliformis* (Carter, 1883), in situ, d. *Siphonodictyon viridescens* (Schmidt, 1880 as *Siphonochalina*), in situ, e. *Dactylocalyx pumiceus* Stutchbury, 1841, in situ, f. *Cyrtaulon sigsbeeii* (Schmidt, 1880), after collection (scale bar = 1 cm), g. *Verrucocoeloidea liberatorii* Reiswg & Dohrmann, 2014, in situ, g1. ditto after collection, g2. ditto, photographed from above to show funnel.

Our results were obtained from similar depths and habitats as those reported from the west coast of Barbados by Van Soest & Stentoft (1988). This locality is approximately 600 miles ((950 km) E of our Klein Curaçao - Bonaire localities, as part of the chain of Leeward Islands off the north coast of South America. Van Soest & Stentoft (1988) report the occurrence of 69 species between depths of 100–325 m. Like our smaller yield of 32 species from Bonaire, the composition of the Barbados fauna was distinctly biased towards lithistid, astrophorid and halichondrid sponges, with a small complement of hexactinellids. Taking the larger Barbados sample as the basis (Fig. 23), 53% of the Bonaire species (17 of the 32 species) also occurred at Barbados. For higher taxa the shared percentage is 75% (order level) or 84 % (genus and family level), indicating a strong similarity in faunal composition between these two localities.

Shallow-water (photic zone) vs. deep-water sponge faunas (mesophotic and upper dysphotic zones)

The deep-water sponge data available (present Klein Curaçao - Bonaire samples, Curacao - Bonaire HBOI samples, Barbados samples) allow a comparison with shallow-water sponge data reported from Curaçao and Bonaire by Van Soest (1981), based on SCUBA sampling, with additional data presented in 1984b and 2009. We compared (Fig. 24) the deep-water data expressed as a count of the number of species reported from below 100 m

depth with Van Soest's shallow-water numbers of species above 100 m depth, summarized at the ordinal level as an appropriate level of differentiation for such a comparison. To remove low values obscuring the overview several of the Systema Porifera orders were further combined (Astrophorida + Spirophorida, Halichondrida + Agelasida, and Dictyoceratida + Dendroceratida + Verongida + Halisarcida + Chondrosida, together dubbed 'Kerato-Verongida' for the occasion). The striking trend, already noted above and previously noted by Reed & Pomponi (2001), of dominance of lithistid Demospongiae, Tetractinellida and Halichondrids (and Hexactinellida) in the deep-water zone is confirmed (see also e.g. Maldonado & Young 1996). Dominant taxa in the photic zone groups are typically the Keratosa and related sponges as well as the poecilosclerids. Many members of these groups possess photosynthetic symbionts.

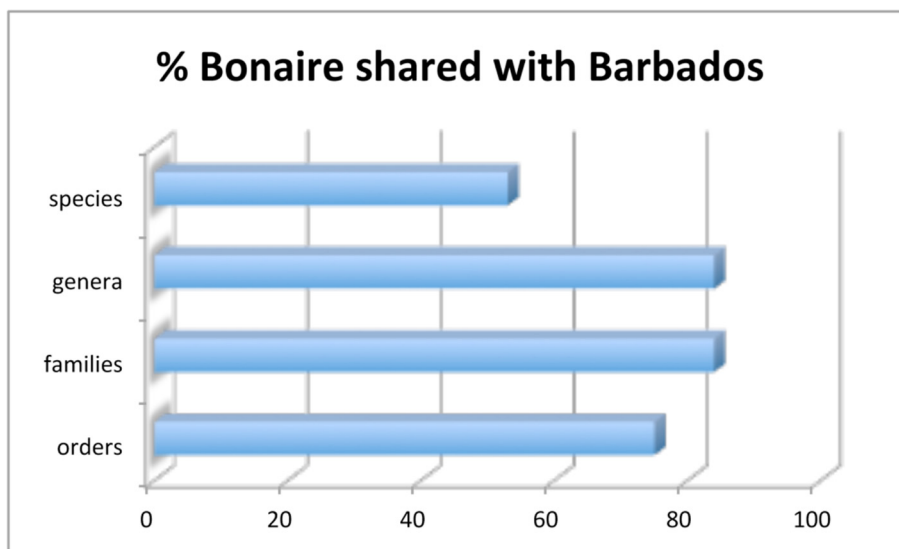


FIGURE 23. Faunal comparison of deep-water sponge species and their higher taxa affiliations (genera, families, orders) of present collections with those of Barbados (from Van Soest & Stentoft 1988), expressed as percentage of Bonaire and Klein Curaçao taxa shared with Barbados.

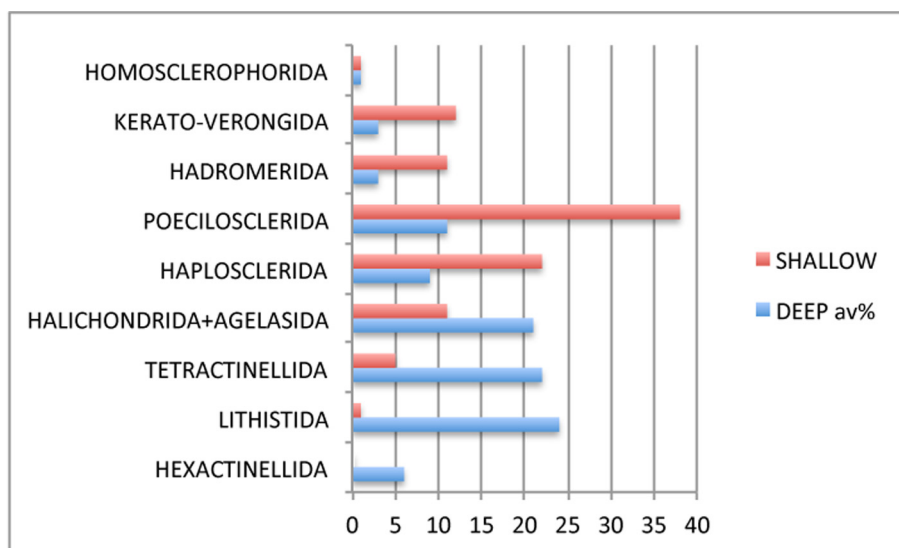


FIGURE 24. Higher taxa (ordinal and supraordinal) composition of South East Caribbean deep-water sponges (100 m and deeper) compared with that of shallow-water sponges (above 100 m) reported from Curaçao and Bonaire, expressed as percentage of total number of sponge species of deep-water (145 spp.) and shallow-water fauna (209 spp.). Several small ordinal taxa have been combined to allow visual comparison of the results: Halichondrida + Agelasida, Dictyoceratida + Dendroceratida + Halisarcida + Chondrosida (dubbed Kerato-Verongida). The deep-water sponge data are the combined data of Bonaire, Klein Curaçao (from present study), Curaçao (from Reed & Pomponi 2001) and Barbados (from Van Soest & Stentoft 1988). The shallow-water data were obtained from Van Soest 1978, 1980, 1981, 1984a & b, 2009; Díaz *et al.* 1987; Kobluk & Van Soest 1989; Meesters *et al.* 1991; De Weerd 2000; Reed & Pomponi 2001; Van Soest & De Weerd 2001; Van Soest *et al.* 2010; Parra-Velandia *et al.* 2014.

TABLE 2. Additional species collected during Dives 1–4 of the ‘Curasub’ submarine at Klein Curaçao and Bonaire, not described in the text. Information is given in four columns: (1) ‘Species, specimens, figures’ presenting taxonomic names, author, collection numbers, and figure numbers, (2) ‘Shape, color and size’, (3) ‘skeletal data’, including spicule size range, (4) ‘depth’ of collection.

<u>orders, species, specimens, figures</u>	<u>shape, color and size</u>	<u>skeletal data (measurements um)</u>	<u>depth (m)</u>
Astrophorida			
<i>Characella aspera</i> (Sollas, 1886)	folded cup-shaped masses	calthrops with cladi 250–400 x 30, oxeas up to 4.5 mm x 100–130	159
RMNH Por. 9250 (field nr. 27), Por. 9231 (36), Por. 9259 (04) Figures 21a, a1		amphiasters up to 20, abundant microxeas 225 x 5, rare centrotolote microxeas 20–30 x 1–2	
Lithistida			
<i>Theonella atlantica</i> Van Soest & Stentoft, 1988	arborescent, with rounded blunt branches, orange,	desma skeleton, layer of ectosomal phyllotriaeans, carried by bundles of oxeotes,	120–130
RMNH Por. 9223 (field nr. 24), Por. 9224 (25) Figure 21b	height 4–6cm, stalk 1.5cm diameter, branches 1cm	phyllotriaeans with cladomes 380–475, rhabdomes 120–180x20–25	
		oxeotes (strongyle-, style-, oxea-like) up to 700x6, in bundles of 3–5	
		desmas with smooth shaft and arms, 350x50, ectosomal microhabds 8–15	
<i>Discodermia dissoluta</i> Schmidt, 1880			
RMNH Por. 9225 (field nr. 26) Figure 21c	coalescent group of tubes, beige-white, height 11–12cm, tube diameter 1 cm	desma skeleton, layer of ectosomal discotriaeans, carried by bundles of oxeotes,	120
		discotriaeans with cladomes 175–200, rhabdomes 45–150x15–20,	
		oxeotes up to 420x8, in bundles of up to 15,	
		desmas with smooth shaft, up to 550x40, microhabds (1) 14–18 (2) 40–45	
<i>Corallistes typus</i> Schmidt, 1870			
RMNH Por. 9228 (field nr. 30), Por. 9229 (34) Figure 21d	cup-shaped, dirty white to pale brown, height up to 10cm, diameter 11cm, thickness 1 cm	desma skeleton, layer of ectosomal dichotriaeans,	166–195
		dichotriaeans with cladomes 260–300x30, rhabdomes 300x30	
		oxeotes up to 1200x5, spirasters 15–30, tuberculate desmas 500x90	
<i>Aciculites cribrophora</i> (Schmidt, 1880)			
RMNH Por. 9226 (field nr. 29), Por. 9227 (52) Figures 21e, e1	lumpy mass with covered by papillae, pale brown, height 6cm, diameter 3–4cm, papillae 2–3mm	desma skeleton with ectosomal cover of acanthostrogyles, acanthostrogyles 200–270x10–12,	233
		desmas with smooth shaft, up to 300x35	

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TABLE 2. (Continued)

orders, species, specimens, figures	shape, color and size	skeletal data (measurements μm)	depth (m)
<i>Gastrophanelia implexa</i> Schmidt, 1870	club-shaped with central oscules, beige, 3cm high, 3cm diameter	desmas, cladome 250–300 x 30–40, monactines with spined apices 360–400 x 4.5–7.5	140–141
RMNH Por. 9211 (field nr. 7), Por. 9212 (15) Figures 21f, fl			
<i>Daedalopelta nodosa</i> (Schmidt, 1879)	small lobe, beige, 1 cm	desma skeleton, layer of ectosomal pseudophyllotriaenes, with cladome 300 μm , rhabdome 65–85x5–8	142
RMNH Por. 9218 (field nr. 17) Figure 21g		oxeas 380 x 2, smooth shafted desmas 350x18, amphiasters 20	
<i>Neopelta perfecta</i> Schmidt, 1880	globular, papillate, orange, 4x4x4cm	desma skeleton, layer of ectosomal pseudodiscotriaenes, 119	
RMNH Por. 9232 (field nr. 43) Figure 21h		pseudodiscotriaenes 270–350, desmas 600x40, smooth shafts, spined fusiform microhabds 60x2, amphiasters 6–10	
<i>Leidoerematium lynceus</i> Schmidt, 1870	cup-shaped, strongly folded walls in larger specimens	desma skeleton, thin wispy oxeotes at surface, 177–242	
RMNH Por. 9258 (field nr. 3), Por. 9236 (56), Por. 9237 (63) Figure 21i	height 6–10cm, width 5–20cm, walls 0.5cm thick	desmas 200x20–25, with shaft and arms provided with sharp tubercles	
Poecilosclerida			
<i>Hamacantha</i> (H.) sp.	pink crust on <i>Aplysilla</i>	tangential surface membrane, 150	
RMNH Por. 9222a (field nr. 21) Figure 21j		oxeas 180–220 x 5, diancistras 80–90, sigmas 18–20	
Halichondrida			
<i>Phakellia folium</i> Schmidt, 1870	orange thin-walled cup, 5cm high, 5cm diameter	reticulation of styles and sinuous strongyles, 99	
RMNH Por. 9233 (field nr.45) Figure 21k		styles 130–400x4–6, strongyles 420–480x4–9	
<i>Spongosorites ruetzleri</i> (Van Soest & Stentoft, 1988)	massive, smooth surface, pale brown, 10x8x4 cm	oxeas in confusion, surface crust, 148–152	
RMNH Por. 9220 (field nr. 19), Por. 9244 (22), Por. 9221 (38) Figure 22a		three size categories 70x2, 200x8, 500x13	

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TABLE 2. (Continued)

orders, species, specimens, figures	shape, color and size	skeletal data (measurements μm)	depth (m)
<i>Topsetia pseudoporrecta</i> Diaz et al. 1993	turnip-shaped, with fistules, pale brown,	oxeas in confusion,	243
RMNH Por. 9235 (field nr. 50)	20 cm high, 20 cm diameter	three size categories, 1300–1400x66, 800x35, 500x20	
Figure 22b			
Agelasida			
<i>Agelas flabelliformis</i> (Carter, 1883)	thin bladed form, orange, 8x7x0.5cm	primary fibers cored 1-3 spicules, 50 μm ,	110
RMNH Por. 9217 (field nr. 14)		secondary fibers uncored, 35 μm , meshes 100-150 μm ,	
Figure 22c		verticillated acanthostyles 110-170x5-8 μm (11-15 verticils)	
Haplosclerida			
<i>Siphonodictyon viridescens</i> (Schmidt, 1880)	group of long thin fistules sticking out from bottom,	tight-meshed reticulation of spicule bundles	247
RMNH Por. 9238 (field nr. 61)	whitish turquoise, up to 16 cm high, 1 cm diameter	with meshes 120–200, bundles 3–8 spicules,	
Figure 22d		spicules thick abruptly pointed oxeas, 225–245x18–19	
Dendroceratida			
<i>Aphysilla</i> sp.	conulose crust	pixhed dendritic fibers, rising up from dead bryozoan substratum,	150
RMNH Por. 9222b (field nr. 21)		1200-3500 x 40–70	
Figure 21j			
Hexactinellida			
<i>Dactylocalyx pumiceus</i> Stutchbury, 1841	cup-shaped, with fringed rim and fenestrated sides,	dietyonine skeleton, tuberculate fused hexactines,	134–170
RMNH Por. 9213 (field nr. 10), Por. 9214 (11)	diameter 8-15cm, height up to 14 cm	with meshes 150–350,	
Por. 9215 (16), Por. 9216 (32), Por. 9256 (01)		dermal and atrial hexactines and pentactines, rays 150-300 x 2-3,	
Figure 22e		giant pentactines and hexactines, shaft invariably broken, 2–8 mm x 30–60, large intermediate pentactines, ray 750x10, discohexasters (rare onychhexasters) 30-65	

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<u>orders, species, specimens, figures</u>	<u>shape, color and size</u>	<u>skeletal data (measurements μm)</u>	<u>depth (m)</u>
<i>Cyrtaulon sigsbeeii</i> (Schmidt, 1880) RMNH Por. 9219 (field nr. 18) Figure 22f	irregular-cylindrical, clathrate structure, dirty white, 3x2x2 cm	dietyonine skeleton, tuberculated fused hexactines, globular nodes with meshes 50-300, beams 250-300x35-50, pentaactines with pointed rays 200x2, sixth distal ray knobbed uncinates with central swelling, 390-500x2 cyrtaulon spicules (tylodiscohexaster), aster radius 90-100, shaft up to 250, discohexasters 35-40	140
<i>Verrucocoeloides liberatorii</i> Reiswig & Dohrmann, 2014 RMNH Por. 9234 (field nr. 46) Figures 22g, g1, g2	mushroom shape, dirty white, white zoanthids, 6 cm high, 4 cm diameter, stalk 2 x 1.5 cm	dietyonine skeleton, tuberculated fused hexactines, globular nodes with meshes 120-250 μm , beams 20-60 μm , pentaactinal rays 130-225 x 5-9, hexactinal rays 140-155 x 5-7 μm , uncinates 1160-2280 x 7-14 μm tyloscopules in two sizes 370-570 x 4-7 and 190-315 x 2-4 μm , discohexasters 35-50 μm , oxyhexasters 45-65 μm	223

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References

- Barboza Du Bocage, J.V. (1869) Éponges siliceuses nouvelles du Portugal et de l’île Saint-Iago (Archipel de Cap-Vert). *Jornal de Sciencias mathematicas, physicas e naturaes*, 2, 159–162.
- Becking, L.E. & Meesters, E.H.W.G. (2014) *Bonaire Deep Reef Expedition I. Report number C006/14*. IMARES, Wageningen, 50 pp.
- Bergquist, P.R. (1965) The Sponges of Micronesia, Part I. The Palau Archipelago. *Pacific Science*, 19 (2), 123–204.
- Bergquist, P.R. (1978) *Sponges*. Hutchinson, London, 268 pp.
- Boury-Esnault, N. (1973) Résultats scientifiques des campagnes de la ‘Calypso’. Campagne de la ‘Calypso’ au large des côtes atlantiques de l’Amérique du Sud (1961–1962). I. 29. Spongiaires. *Annales de l’Institut océanographique*, 49 (Supplement 10), 263–295.
- Bowerbank, J.S. (1862) On the anatomy and physiology of the Spongiadae. Part II. *Philosophical Transactions of the Royal Society*, 152 (2), 747–829.
- Bowerbank, J.S. (1869) A monograph of the siliceo-fibrous sponges. Part I. *Proceedings of the Zoological Society of London*, 1869 (1), 66–100.
- Bowerbank, J.S. (1872) Contributions to a general history of the Spongiadae. Part III. *Proceedings of the Zoological Society of London*, 1872, 626–635.
- Cárdenas, P., Menegola, C., Rapp, H.T. & Díaz, M.C. (2009) Morphological description and DNA barcodes of shallow-water Tetractinellida (Porifera: Demospongiae) from Bocas del Toro, Panama, with description of a new species. *Zootaxa*, 2276, 1–39.
- Cárdenas, P., Xavier, J.R., Reveillaud, J., Schander, C. & Rapp, H.T. (2011) Molecular Phylogeny of the Astrophorida (Porifera, Demospongiae) reveals an unexpected high level of spicule homoplasy. *PLoS ONE*, 6 (4), e18318. <http://dx.doi.org/10.1371/journal.pone.0018318>
- Cárdenas, P. & Rapp, H.T. (2012) A review of Norwegian streptaster-bearing Astrophorida (Porifera: Demospongiae: Tetractinellida), new records and a new species. *Zootaxa*, 3253, 1–52.
- Carter, H.J. (1875) Notes Introductory to the study and classification of the Spongida. Part II. Proposed classification of the Spongida. *Annals and Magazine of Natural History*, Series 4, 16 (92), 126–145, 177–200.
- Carter, H.J. (1876) Descriptions and figures of deep-sea sponges and their spicules, from the Atlantic Ocean, dredged up on board H.M.S. ‘Porcupine’, chiefly in 1869 (concluded). *Annals and Magazine of Natural History*, Series 4, 18, (105) 226–240, (106) 307–324, (107) 388–410, (108) 458–479.
- Carter, H.J. (1882) New sponges, observations on old ones, and a proposed new group. *Annals and Magazine of Natural History*, Series 5, 10 (55), 106–125.
- Carter, H.J. (1883) Contributions to our knowledge of the Spongida. *Annals and Magazine of Natural History*, Series 5, 12 (71), 308–329.
- Da Silva, C.M.M. & Mothes, B. (2000) Three new species of *Geodia* Lamarck, 1815 (Porifera, Demospongiae) from the bathyal depths off Brazilian coast, Southwestern Atlantic. *Revue Suisse de Zoologie*, 107 (1), 31–48.
- De Laubenfels, M.W. (1932) Physiology and morphology of Porifera exemplified by *Iotrochota birotulata* Higgin. *Carnegie Institute of Washington Publication*, 435 (*Papers Tortugas Laboratory* 28), 37–66.
- De Laubenfels, M.W. (1934) New sponges from the Puerto Rican deep. *Smithsonian Miscellaneous Collections*, 91 (17), 1–28.
- De Laubenfels, M.W. (1936) A discussion of the sponge fauna of the Dry Tortugas in particular and the West Indies in general, with material for a revision of the families and orders of the Porifera. *Carnegie Institute of Washington Publication*, 467 (*Tortugas Laboratory Paper*, 30), 1–225.
- De Laubenfels, M.W. (1949) Sponges of the western Bahamas. *American Museum Novitates*, 1431, 1–25.
- De Weerdt, W.H. (2000) A monograph of the shallow-water Chalinidae (Porifera, Haplosclerida) of the Caribbean. *Beaufortia*, 50 (1), 1–67.

- De Weerd, W.H., De Kluijver, M.J. & Gómez, R. (1999) *Haliclona (Halichoelona) vansoesti* n. sp., a new chalinid sponge species (Porifera, Demospongiae, Haplosclerida) from the Caribbean. *Beaufortia*, 49 (6), 47–54.
- Dendy, A. (1905) Report on the sponges collected by Professor Herdman, at Ceylon, in 1902. In: Herdman, W.A. (Ed.), *Report to the Government of Ceylon on the Pearl Oyster Fisheries of the Gulf of Manaar*. 3 (Supplement 18). Royal Society, London, pp. 57–246.
- Dendy, A. (1924) Porifera. Part I. Non-Antarctic sponges. *Natural History Report. British Antarctic (Terra Nova) Expedition, 1910 (Zoology)*, 6 (3), 269–392.
- Díaz, M.C., Alvarez, B. & Van Soest, R.W.M. (1987) New species of Demospongiae (Porifera) from the national park 'Archipiélago de Los Roques', Venezuela. *Bijdragen tot de Dierkunde*, 57 (1), 31–41.
- Díaz, M.C., Pomponi, S.A. & Van Soest, R.W.M. (1993) A systematic revision of the central West Atlantic Halichondrida (Demospongiae, Porifera). Part III: Description of valid species. *Scientia Marina*, 57 (4), 283–306.
- Domingos, C., Moraes, F. & Muricy, G. (2013) Four new species of Plakinidae (Porifera: Homoscleromorpha) from Brazil. *Zootaxa*, 3718 (6), 530–544.
<http://dx.doi.org/10.11646/zootaxa.3718.6.2>
- Duchassaing De Fonbressin, P. (1850) *Animaux radiaires des Antilles*. Plon Frères, Paris, 35 pp.
- Duchassaing De Fonbressin, P. & Michelotti, G. (1864) Spongiaires de la mer Caraïbe. *Natuurkundige verhandelingen van de Hollandsche maatschappij der wetenschappen te Haarlem*, 21 (2), 1–124.
<http://dx.doi.org/10.5962/bhl.title.11943>
- Grant, R.E. (1836) Animal Kingdom. In: Todd, R.B. (Ed.), *The Cyclopaedia of Anatomy and Physiology*. Vol. 1. Sherwood, Gilbert, and Piper, London, pp. 107–118.
- Gray, J.E. (1867) Notes on the arrangement of sponges, with the descriptions of some new genera. *Proceedings of the Zoological Society of London*, 1867 (2), 492–558.
- Hajdu, E., Muricy, G., Custodio, M., Russo, C. & Peixinho, S. (1992) *Geodia corticostylifera* (Demospongiae, Porifera) new astrophorid from the Brazilian coast (Southwestern Atlantic). *Bulletin of Marine Science*, 51 (2), 204–217.
- Hechtel, G.J. (1965) A systematic study of the Demospongiae of Port Royal, Jamaica. *Bulletin of the Peabody Museum of Natural History*, 20, 1–103.
- Hiemstra, F. & Hooper, J.N.A. (1991) Additions to the Indo-Australian representatives of *Acarinus* Gray (Porifera: Demospongiae: Poecilosclerida), with description of a new species. *Memoirs of the Queensland Museum*, 30 (3), 431–442.
- Hooper, J.N.A. (2002) Family Desmoxiidae Hallmann, 1916. In: Hooper, J.N.A. & Van Soest, R.W.M. (Eds.) *Systema Porifera. A guide to the classification of sponges. 1*. Kluwer Academic/Plenum Publishers, New York, Boston, Dordrecht, London, Moscow, pp. 755–772.
- Hooper, J.N.A. & Van Soest, R.W.M. (Eds.) (2000) *Systema Porifera. A guide to the classification of sponges. Vol. 1. & 2*. Kluwer Academic/Plenum Publishers, New York, Boston, Dordrecht, London, Moscow, xix + 1101 pp. & 604 pp. [pp. 1–1101 & pp. 1103–1706]
- Hoshino, T. (1981) Shallow-Water Demosponges of Western Japan 2. *Journal of Science of the Hiroshima University*, (B), 29 (2), 207–289.
- Kelly, M. (2000) Description of a new lithistid sponge from northeastern New Zealand, and consideration of the phylogenetic affinities of families Corallistidae and Neopeltidae. *Zoosystema*, 22 (2), 265–283.
- Kobluk, D.R. & Van Soest, R.W.M. (1989) Cavity dwelling sponges in a southern Caribbean coral reef and their paleontological implications. *Bulletin of Marine Science*, 44 (3), 1207–1235.
- Lamarck, J.B.P. De Monet, Comte De (1813–1814) Sur les polypiers empâtés. Suite du mémoire intitulé: Sur les Polypiers empâtés. Suite des éponges. *Annales du Muséum national d'histoire naturelle, Paris*, 20 (6), 294–312 (published 1813), 370–386, 432–458 (published 1814).
- Lamarck, J.B.P. & De Monet, C. De (1815) Suite des polypiers empâtés. *Mémoires du Muséum d'Histoire naturelle, Paris*, 1, 69–80, 162–168, 331–340.
- Lendenfeld, R. Von (1894) Eine neue *Pachastrella*. *Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften. Mathematisch-Naturwissenschaftliche Classe*, 103, 439–442.
- Lendenfeld, R. Von (1903) Porifera. Tetraxonia. In: Schulze, F.E. (Ed.), *Das Tierreich. Vol. 19*. Friedländer, Berlin, pp. vi–xv, 1–168.
- Lévi, C. (1964) Spongiaires des zones bathyale, abyssale et hadale. *Galathea Report. Scientific Results of The Danish Deep-Sea Expedition Round the World, 1950–52*, 7, 63–112.
- Lévi, C. & Lévi, P. (1983) Démosponges bathyales récoltées par le N/O 'Vauban' au sud de la Nouvelle Calédonie. *Bulletin de la Musée nationale d'Histoire naturelle Paris, Series 4*, 5, 931–997.
- Lévi, C. & Lévi, P. (1989) Spongiaires (MUSORSTOM 1 & 2). *Mémoires du Muséum national d'Histoire naturelle (A, Zoologie)*, 143, 25–103.
- Lindgren, N.G. (1898) Beitrag zur Kenntniss der Spongienfauna des Malayischen Archipels und der chinesischen Meere. *Zoologische Jahrbücher. Abteilung für Systematik, Geographie und Biologie der Thiere*, 11, 283–378.
- Little, F.J. (1963) The sponge fauna of the St. George's Sound, Apalache Bay, and Panama City Regions of the Florida Gulf Coast. *Tulane Studies in Zoology*, 11 (2), 31–71.
- Maldonado, M. & Young, C.M. (1996) Bathymetric patterns of sponge distribution on the Bahamian slope. *Deep-Sea Research* 1, 43 (6), 897–915.

- Meesters, E., Knijn, R. Willemsen, P., Pennartz, R., Roebers, G.J. & Van Soest, R.W.M. (1991) Sub-rubble communities of Curaçao and Bonaire coral reefs. *Coral Reefs*, 10, 189–197.
<http://dx.doi.org/10.1007/bf00336773>
- Meesters, E.H.W.G., Slijkerman, D.M.E., De Graaf, M. & Debrot, A.O. (2010) *Management plan for the natural resources of the EEZ of the Dutch Caribbean. IMARES Technical Report C100/10*, p. 1–79.
- Moraes, F.C. & Muricy, G. (2003) Taxonomy of *Plakortis* and *Plakinastrella* (Demospongiae: Plakinidae) from oceanic islands off north-eastern Brazil, with description of three new species. *Journal of the Marine Biological Association of the United Kingdom*, 83 (2), 385–397.
- Morrow, C.C., Picton, B.E., Erpenbeck, D., Boury-Esnault, N., Maggs, C.A. & Allcock, A.L. (2012) Congruence between nuclear and mitochondrial genes in Demospongiae: A new hypothesis for relationships within the G4 clade (Porifera: Demospongiae). *Molecular Phylogenetics and Evolution*, 62, 174–190.
- Parra-Velandia, F.J., Zea, S. & Van Soest, R.W.M. (2014) Reef sponges of the genus *Agelas* (Porifera: Demospongiae) from the Greater Caribbean. *Zootaxa*, 3794 (3), 301–343.
<http://dx.doi.org/10.11646/zootaxa.3794.3.1>
- Pisera, A. & Lévi, C. (2002) Family Neopeltidae Sollas, 1888. In: Hooper, J.N.A. & Van Soest, R.W.M. (Eds.), *Systema Porifera. A guide to the classification of sponges*. 1. Kluwer Academic/Plenum Publishers, New York, Boston, Dordrecht, London, Moscow, pp. 344–351.
- Pisera, A. & Vacelet, J. (2011) Lithistid sponges from submarine caves in the Mediterranean: taxonomy and affinities. *Scientia Marina*, 75 (1), 17–40.
- Pulitzer-Finali, G. (1986) A collection of West Indian Demospongiae (Porifera). In appendix, a list of the Demospongiae hitherto recorded from the West Indies. *Annali del Museo civico di storia naturale Giacomo Doria*, 86, 65–216.
- Pulitzer-Finali, G. (1996) Sponges from the Bismarck Sea. *Bollettino dei Musei e degli Istituti Biologici della (R.) Università di Genova*, 60–61, 101–138.
- Reed, J. & Pomponi, S.A. (2001). *Final Cruise Report. Submersible and SCUBA collections in the coastal waters of the Netherlands Antilles (Curaçao, Bonaire) and Aruba: Biomedical and biodiversity research of the benthic communities with emphasis on the Porifera and Gorgonacea*. Harbor Branch Oceanographic Institution, Inc., Florida, 184 pp. [mimeographed]
- Reiswig, H.M. & Dohrmann, M. (2014) Three new species of glass sponges (Porifera: Hexactinellida) from the West Indies, and molecular phylogenetics of Euretidae and Auloplacidae (Sceptrulophora). *Zoological Journal of the Linnean Society*, 171, 233–253.
<http://dx.doi.org/10.1111/zoj.12138>
- Roberts, C.M., McClean, C.J., Veron, J.E., Hawkins, J.P., Allen, G.R., McAllister, D.E., Mittermeier, C.G., Schueler, F.W., Spalding, M., Wells, F., Vynne, C. & Werner, T.B. (2002) Marine biodiversity hotspots and conservation priorities for tropical reefs. *Science*, 295, 1280–1284.
- Rützler, K., Piantoni, C., Van Soest, R.W.M. & Díaz, M.C. (2014) Diversity of sponges (Porifera) from cryptic habitats on the Belize barrier reef near Carrie Bow Cay. *Zootaxa*, 3805 (1), 1–129.
<http://dx.doi.org/10.11646/zootaxa.3805.1.1>
- Schmidt, O. (1862) *Die Spongien des adriatischen Meeres*. Engelmann, Leipzig, viii + 88.
- Schmidt, O. (1868) *Die Spongien der Küste von Algier. Mit Nachträgen zu den Spongien des Adriatischen Meeres (Drittes Supplement)*. Engelmann, Leipzig, iv + 44 pp.
- Schmidt, O. (1870) *Grundzüge einer Spongien-Fauna des atlantischen Gebietes*. Engelmann, Leipzig, iii–iv, 88 pp.
- Schmidt, O. (1879) *Die Spongien des Meerbusen von Mexico (Und des caraibischen Meeres). Abtheilung I. Heft I. Reports on the dredging under the supervision of Alexander Agassiz, in the Gulf of Mexico, by the USCSS 'Blake'*. Gustav Fischer, Jena, 32 pp.
- Schmidt, O. (1880) *Die Spongien des Meerbusen von Mexico (Und des caraibischen Meeres). Heft II. Abtheilung II. Hexactinelliden. Abtheilung III. Tetractinelliden. Monactinelliden und Anhang. Nachträge zu Abtheilung I (Lithistiden). Reports on the dredging under the supervision of Alexander Agassiz, in the Gulf of Mexico, by the USCSS 'Blake'*. Gustav Fischer, Jena, 58 pp. [pp. 33–90]
- Schulze, F.E. (1880) Untersuchungen über den Bau und die Entwicklung der Spongien. Neunte Mittheilung. Die Plakiniden. *Zeitschrift für wissenschaftliche Zoologie*, 34 (2), 407–451.
- Sollas, W.J. (1885) A classification of the sponges. *Annals and Magazine of Natural History*, Series 5, 16 (95), 395.
- Sollas, W.J. (1886) Preliminary account of the tetractinellid sponges dredged by H.M.S. 'Challenger' 1872–76. Part I. The Choristida. *Scientific Proceedings of the Royal Dublin Society*, New Series, 5, 177–199.
- Stutchbury, S. (1841) Description of a new sponge from Barbados. *Proceedings of the Royal Society*, (B), 9, 86–87.
- Tanita, S. (1969) Further studies on the sponges obtained from the Sado Island and its adjacent waters. *Bulletin Japan Sea Regional Fisheries Laboratory*, 21, 67–88.
- Topsent, E. (1890) Notice préliminaire sur les spongiaires recueillis durant les campagnes de l'Hirondelle. *Bulletin de la Société zoologique de France*, 15, 26–32, 65–71.
- Topsent, E. (1892) Contribution à l'étude des spongiaires de l'Atlantique Nord (Golfe de Gascogne, Terre-Neuve, Açores). *Résultats des campagnes scientifiques accomplies par le Prince Albert I Monaco*, 2, 1–165
- Topsent, E. (1895) Étude monographique des spongiaires de France. II. Carnosa. *Archives de Zoologie expérimentale et*

générale, Series 3, 3, 493–590.

- Topsent, E. (1927) Diagnoses d'éponges nouvelles recueillies par le Prince Albert Ier de Monaco. *Bulletin de l'Institut océanographique Monaco*, 502, 1–19.
- Topsent, E. (1928) Spongiaires de l'Atlantique et de la Méditerranée provenant des croisières du Prince Albert Ier de Monaco. *Résultats des campagnes scientifiques accomplies par le Prince Albert I Monaco*, 74, 1–376.
- Uliczka, E. (1929) Die tetraxonen Schwämme Westindiens (auf Grund der Ergebnisse der Reise Kükenthal-Hartmeyer). *Zoologische Jahrbücher Abteilung für Systematik, Geographie und Biologie der Tiere*, Supplement 16, 35–62.
- Van Soest, R.W.M. (1978) Marine sponges from Curaçao and other Caribbean localities. Part I. Keratosa. *Studies on the Fauna of Curaçao and other Caribbean Islands*, 56 (179), 1–94.
- Van Soest, R.W.M. (1980) Marine sponges from Curaçao and other Caribbean localities. Part II. Haplosclerida. *Studies on the Fauna of Curaçao and other Caribbean Islands*, 62 (191), 1–173.
- Van Soest, R.W.M. (1981) A checklist of the Curaçao sponges (Porifera Demospongiae) including a pictorial key to the more common reef-forms. *Verslagen en Technische Gegevens Instituut voor Taxonomische Zoölogie (Zoölogisch Museum) Universiteit van Amsterdam*, 31, 1–39. [mimeographed]
- Van Soest, R.W.M. (1984a) Deficient *Merlia normani* Kirkpatrick, 1908, from the Curaçao reefs, with a discussion on the phylogenetic interpretation of sclerosponges. *Bijdragen tot de Dierkunde*, 54 (2), 211–219.
- Van Soest, R.W.M. (1984b) Marine sponges from Curaçao and other Caribbean localities. Part III. Poecilosclerida. *Studies on the Fauna of Curaçao and other Caribbean Islands*, 62 (191), 1–173.
- Van Soest, R.W.M. (2009) New sciophilous sponges from the Caribbean (Porifera: Demospongiae). *Zootaxa*, 2107, 1–40.
- Van Soest, R.W.M., Beglinger, E.J. & De Voogd, N.J. (2010) Skeletons in confusion: a review of astrophorid sponges with (dicho-)calthrope as structural megascleres (Porifera, Demospongiae, Astrophorida). *Zookeys*, 68, 1–88. <http://dx.doi.org/10.3897/zookeys.68.729>
- Van Soest, R.W.M., Beglinger, E.J. & De Voogd, N.J. (2013) Microcionid sponges from Northwest Africa and the Macaronesian Islands (Porifera, Demospongiae, Poecilosclerida). *Zoölogische Mededelingen Leiden*, 87 (4), 275–404.
- Van Soest, R.W.M., Boury-Esnault, N., Hooper, J.N.A., Rützler, K., De Voogd, N.J., Alvarez de Glasby, B., Hajdu, E., Pisera, A.B., Manconi, R., Schoenberg, C., Janussen, D., Tabachnick, K.R., Klautau, M., Picton, B., Kelly, M., Vacelet, J., Dohrmann, M., Díaz, M.C. & Cárdenas, P. (2014) *World Porifera database*. Accessed at <http://www.marinespecies.org/porifera> (accessed 27 June 2014).
- Van Soest R.W.M. & De Weerd, W.H. (2001) New records of *Xestospongia* species (Haplosclerida: Petrosiidae) from the Curaçao reefs, with a description of a new species. *Beaufortia*, 51 (7), 109–117.
- Van Soest, R.W.M. & Hooper, J.N.A. (2005) Resurrection of *Desmoxya* (Porifera: Halichondrida), with the description of a new species from Rockall Bank bathyal coral reefs, North Atlantic. *Journal of the Marine Biological Association of the United Kingdom*, 85, 1367–1371.
- Van Soest, R.W.M., Hooper, J.N.A. & Hiemstra, F. (1991) Taxonomy, phylogeny and biogeography of the marine sponge genus *Acarinus* (Porifera: Poecilosclerida). *Beaufortia*, 42 (3), 49–88.
- Van Soest R.W.M. & Stentoft, N. (1988) Barbados deep-water Sponges. *Studies on the Fauna of Curaçao and other Caribbean Islands*, 70 (215), 1–175.
- Vosmaer, G.C.J. (1885) Porifera, Parts VII–XI. In: Bronn, H.G. (Ed.), *Die Klassen und Ordnungen des Thier-Reichs. I.* C.F. Winter, Leipzig & Heidelberg, pp. 177–368.
- Wiedenmayer, F. (1977) Shallow-water sponges of the western Bahamas. *Experientia Supplementum*, 28, 1–287. <http://dx.doi.org/10.1007/978-3-0348-5797-0>
- Wilson, H.V. (1902) The sponges collected in Porto Rico in 1899 by the U.S. Fish Commission Steamer Fish Hawk. *Bulletin of the United States Fish Commission*, 2, 375–411.
- Zea, S. (1987) *Esponjas del Caribe Colombiano*. Catálogo Científico, Bogotá, Colombia, 286 pp.
- Zea, S. & Rützler, K. (1983) A new species of *Xestospongia* (Porifera, Demospongiae) from the Colombian Caribbean. *Caldasia*, 10, 817–831.