

Mycale species (Porifera: Poecilosclerida) of Northwest Africa and the Macaronesian Islands

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Zool. Meded. Leiden 88 (4), 31.xii.2014: 59-109, figs 1-20, table 1. — ISSN 0024-0672.

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Key words: Porifera; sponges; new species; *Mycale*; Saharan Upwelling; Sahelian Upwelling; Macaronesia.

Based on collections assembled by Dutch expeditions to the Northwest African region, including the offshore islands in the neighbouring Atlantic, a taxonomic monograph of sponges of the genus *Mycale* is presented. Additional material from the region borrowed from the Zoologisk Museum of the University of Copenhagen and incidental samples made by individual collectors were also included. The combined collections contained sixteen species, nine of which are new to science: *Mycale* (*Aegogropila*) *syringosimilis* spec. nov., *Mycale* (*Aegogropila*) *tenerifensis* spec. nov., *Mycale* (*Arenochalina*) *africamucosa* spec. nov., *Mycale* (*Carmia*) *atrophia* spec. nov., *Mycale* (*Carmia*) *guineensis* spec. nov., *Mycale* (*Naviculina*) *cruzi* spec. nov., *Mycale* (*Paresperella*) *janvermeuleni* spec. nov., *Mycale* (*Rhaphidotheca*) *verdensis* spec. nov. and *Mycale* (*Zygomycale*) *sierraleonensis* spec. nov. We briefly reviewed six *Mycale* species known from the region, but not represented in our material, making the faunal diversity twenty-two species. We present a key to all species of Northwest Africa and the neighbouring offshore Atlantic islands. The regional diversity of *Mycale* species is discussed in comparison to those of other regions.

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Introduction

We present here a monographic treatment of sponges of the genus *Mycale* Gray, 1867 (Mycalidae, Mycalina, Poecilosclerida, Demospongiae) occurring in the area of the North-east Atlantic comprised by the coastal regions of Morocco, Mauritania, Senegal, Guinea, Sierra Leone, and the offshore island archipelagoes of the Azores, Madeira, Canaries and Cape Verde Islands. A few incidental specimens from Ascension and St. Helena in the Mid-South Atlantic are also included. Sponges of the genus *Mycale* are easily recognized by the possession of smooth, subterminally constricted, style megascleres ('mycalostyles') in combination with anisochelate microscleres. *Mycale* species occur in all sea regions of the globe, in most habitats and in a considerable depth range from intertidal to abyssal depth. This wide geo-ecological range has led to the description of more than 250 *Mycale* species, currently accepted from a pool of more than 500 nominal species (Van Soest et al. 2014). Based on the structure of the skeleton and the presence or absence of various types and size categories of microscleres, this large genus is subdivided into eleven subgenera (see Van Soest & Hajdu, 2002). Not all of these subgenera are certainly monophyletic, but they facilitate recognition of species among the vast amount of *Mycale* s.l. Molecular research into the phylogeny of the subgenera is still in its initial stages (Hajdu et al. 2013), so we will here employ them as defined in the Systema Porifera (Hooper & Van Soest, 2002; Van Soest & Hajdu, 2002). Most subgenera were found in the present Northwest African collection or in the literature of the region, with the exception of *Mycale* (*Grapelia*) Gray, 1867 and *Mycale* (*Oxymycal*) Hentschel, 1929.

This present contribution follows into the footsteps of previous studies on sponges collected by Dutch expeditions in the Northwest African region. See for expedition details Van der Land (1987, 1988); for sponges: De Weerd & Van Soest (1986); Van Soest (1993a and b); Van Soest et al. (2012, 2013). Previous descriptions on *Mycale* species from Northwest Africa were made by Topsent (1892, 1904, 1924 and 1928), Burton (1956), Lévi (1952, 1959, 1960), Boury-Esnault & Lopes (1985), and Cruz (2002). Species

from one or more of these studies not represented in our material are briefly characterized at the end of our text to complete the geographic monograph.

Materials and Methods

Specimens were collected by wading, snorkeling, SCUBA, Van Veen grab, 1.2, 2.4 and 3.5 m Agassiz trawl and rectangular dredge during the CANCAP 1 (March 1976, Madeira), 2 (August-September 1977, Canary Islands and Morocco), 6 (June 1982, Cape Verde Islands and Senegal) and 7 Expeditions (August 1986, Cape Verde Islands), on board of H.M.S. 'Onversaagd' and 'Tydemann', and Mauritania II Expedition (June 1988), on board of RV 'Tyro'. Refer to Van der Land (1987, 1988) for details of stations. We also included material from the Gulf of Cadiz collected by box cores during the Moundforce 2004 Expedition (organized by the Royal Netherlands Institute for Sea Research at Texel). Next to the material of these institutional expeditions, we studied additional specimens obtained by various individual researchers, J.H. Stock & J.J. Vermeulen (St. Helena and Cape Verde Islands), T. Cruz and R.W.M. van Soest (Canary Islands), D. Moss (Azores), and R. Irving (Ascension). Marine Ecoregions (Spalding et al. 2007) in which the collecting activities of all treated samples were located are presented in fig. 1. All material is kept in the Naturalis Biodiversity Center at Leiden. Precise collection data are provided with each treatment of the species below.

In addition to our own specimens, we borrowed *Mycale* material collected by the 'Atlantide' Expedition (1933-34) from the Zoological Museum of Copenhagen.



Fig. 1. Map of the North East Atlantic showing the Marine Ecoregions (blue-green) (from Spalding et al. 2007) in which studied sponge samples were obtained by various expeditions. Details of each collected sample are provided in the 'Material' section preceding each species description.

To study the skeletal structure of the sponges, thick sections were made by hand, air-dried on a hotplate and mounted in Canada Balsam. Stacked (automontage) light microscopy images of these thick sections were made using a Leica DM5500 microscope. For measurements of the spicules and SEM examination dissolved spicule suspensions were made with concentrated NaOHCl, washed five times in distilled water and mounted on light microscopic slides and SEM stubs. Spicule measurements (minimum-mean-maximum) are based on 25 spicules of each category or type for each individual specimen, unless otherwise indicated. SEM photos of spicules were combined in plates, aligned, and cleaned using Photoshop CS3 licensed to R.W.M. van Soest.

Deposition of type material.— Holotypes and paratypes of the new species described below have been deposited either in the collections of the Naturalis Biodiversity Center, at Leiden, The Netherlands, indicated by the abbreviations ZMA Por. or RMNH Por. and followed by a five or four digit number, or in the collections of the Zoological Museum of the University of Copenhagen, Denmark, indicated by the abbreviation ZMUC followed by DEM and a six digit number. Non-type material may bear similar abbreviations and numbers.

Higher taxa classification (subgenera) follows the Systema Porifera (Hooper & Van Soest, 2002). Definitions of subgenera are to be taken as conforming to those in the Systema Porifera, and are not repeated here. The order in which the species are treated is alphabetical within the respective subgenera.

Results

Systematic Descriptions

Phylum Porifera
Class Demospongiae
Order Poecilosclerida
Suborder Mycalina
Family Mycalidae

Genus *Mycale* Gray, 1867
Subgenus *Mycale* Gray, 1867

Mycale (Mycale) massa (Schmidt, 1862) (figs 2a-i)

Esperia massa Schmidt, 1862: 56, pl. V fig. 8; Vosmaer, 1880: 141.

Esperella lingua sensu Topsent, 1904: 200 (not: *M. lingua* (Bowerbank, 1866)).

Mycale (Mycale) massa; Topsent, 1924: 88, fig. 2a-f; Cruz, 2002: 147.

Mycale (Mycale) massa var. *oceanica* Topsent, 1924: 89, fig. 2m-n.

Mycale massa; Lévi, 1960: 755, fig. 16; Boury-Esnault & Lopes, 1985: 174, fig. 19; Boury-Esnault et al. 1994: 97, fig. 71.

Material.— ZMA Por. 06819, Mauritania, off Banc d'Arguin, 19.7667°N 17.1°W, 100-400 m, rectangular dredge, coll. R.W.M. van Soest & J.J. Vermeulen, Mauritania II Expedition, stat. 103/05, 16 June 1988; ZMA Por. 07307, Cape Verde Islands, Maio, off SW coast, Ponta Inglez / Ponta Preta, 15.1°N 23.2167°W, 67-79 m, coll. R.W.M. van Soest, 1.2 m Agassiz trawl, CANCAP 7 Expedition stat. 047/02, 25 August

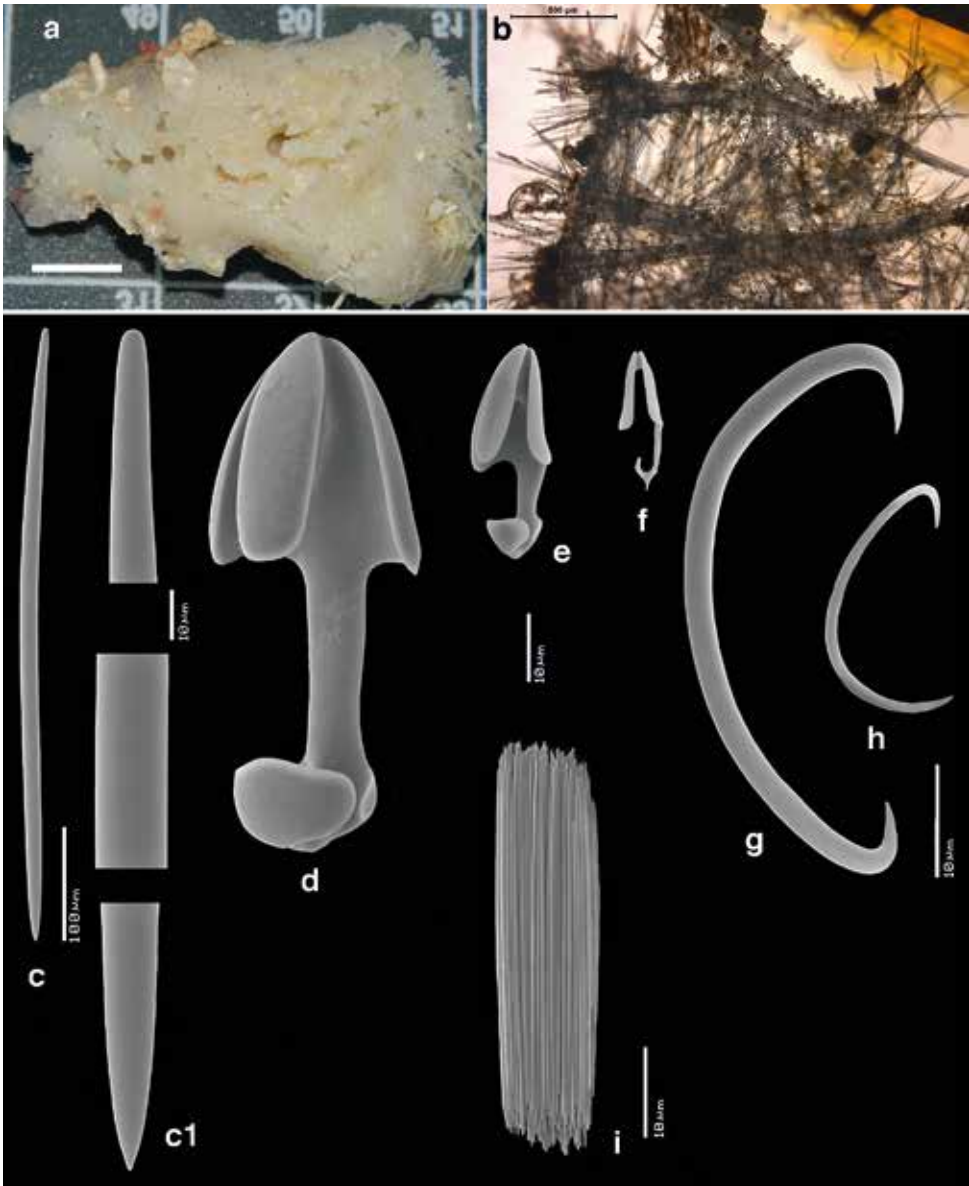


Fig. 2. *Mycale (Mycale) massa* (Schmidt, 1862), a, habit of ZMA Por. 07519 from the Cape Verde Islands (scale bar = 1 cm), b, tangential view of surface skeleton of ZMA Por. 06819 from Mauritania (scale bar = 500 µm). c-i, SEM images of spicules of ZMA Por. 07330 from the Cape Verde Islands, c, style, c1, details of style, d, anisochele 1, e, anisochele 2, f, anisochele 3, g, sigma 1, h, sigma 2, i, trichodragma.

1986; ZMA Por. 07319, Cape Verde Islands, Maio, off SW coast, Ponta Inglez / Ponta Preta, 15.1167°N 23.2333°W, 57-64 m, bottom calcareous nodules, coll. R.W.M. van Soest, rectangular dredge, CANCAP 7 Expedition stat. 059/08, 26 August 1986; ZMA Por. 07329, Cape Verde Islands, Maio, off SW coast, Ponta Inglez / Ponta Preta, 15.1167°N 23.2333°W, 57-64 m, bottom calcareous nodules, coll. R.W.M. van Soest, rectangular dredge, CANCAP 7 Expedition stat. 059/18, 26 August 1986; ZMA Por. 07330, Cape Verde Islands, Maio, off SW coast, Ponta Inglez / Ponta Preta, 15.1167°N 23.2333°W, 57-64 m, bottom calcareous nodules, coll. R.W.M. van Soest, rectangular dredge, CANCAP 7 Expedition stat. 059/19, 26 August 1986; ZMA Por. 07331, Cape Verde Islands, Maio, off SW coast, Ponta Inglez / Ponta Preta, 15.1167°N 23.2333°W, 57-64 m, bottom calcareous nodules, coll. R.W.M. van Soest, rectangular dredge, CANCAP 7 Expedition stat. 059/20, 26 August 1986; ZMA Por. 07519, Cape Verde Islands, São Nicolau, Branco, 16.6667°N 24.7167°W, 98 m, coll. R.W.M. van Soest, rectangular dredge, CANCAP 7 Expedition stat. 156/02, 5 September 1986; ZMA Por. 18039, Morocco, Gulf of Cadiz, 35.8°N 7.8°W, on dead corals in mud, 742 m, coll. R.W.M. van Soest, box core, Moundforce 2004 Expedition stat. 13/01, 26 August 2004; RMNH Por. 9130, Spain, Canary Islands, Gran Canaria, E coast, Puerto de Arinaga, rocky littoral pool, 27.8667°N 15.3833°W, snorkeling, CANCAP 2 Expedition stat. K07, 18 August 1977. Examined for comparison ZMA Por. 15056, Italy, Gulf of Naples, coll. H. Engel, 1939.

Description.— Thickly encrusting to massive, colours range from white to light- or yellow-brown or pale orange. Sizes of individuals vary from several mm up to 5×3×3 cm (ZMA Por. 07519, fig. 2a). Surface in larger specimens provided with sulcated grooves of 2 mm wide (preserved condition, see fig. 2a) widening in several places to oscules of 3-4 mm in diameter. Consistency firm, compressible but easily torn or crumbled.

Skeleton.— Surface skeleton (fig. 2b) a thick tangential crust of confusedly intercrossing spicules, forming vague bundles. In between, a dense mass of trichodragmas and rosettes of the large anisochelae is usually present. The choanosomal skeleton consists of thick spicule tracts subdividing dendritically and fanning out near the surface to carry the tangential ectosomal skeleton.

Spicules.— Styles, anisochelae in three size categories, sigmas in two size categories, trichodragmas. Sizes quoted here are combined from measurements of the nine specimens quoted above.

Styles (fig. 2c, c1), with a characteristically strongly fusiform shaft, at one end tapering into a blunt end variously rounded and subterminally constricted to bluntly pointed, at the opposite end mucronately pointed, sizes variable among specimens, 489-582.4-810 × 10-14.8-22 μm.

Anisochelae 1 (fig. 2d), common, robust, with relatively narrow alae, the naked shaft measuring about half the total length of the spicule, sizes variable among specimens, 61-89.9-123 μm.

Anisochelae 2 (fig. 2e), relatively rare, robust, similar in shape to the anisochelae 1, but with naked shaft measuring less than a third of the total length of the spicule, 30-36.8-48 μm.

Anisochelae 3 (fig. 2f), with narrow upper alae, with barely developed lower alae, showing just a thin front ala and lacking any side alae, shaft ending in a sharp spur, 16-20.2-24 μm (not found in RMNH 9130).

Sigmas 1 (fig. 2g), longer and thick, 30-49.3-63 μm.

Sigmas 2 (fig. 2h), smaller and thin, 13-20.3-27 μm.

Trichodragmas (fig. 2i), very common, variable in length, 33-62.6-75 × 7-12.1-18 μm.

Ecology. — Deep water, generally below 50 m depth, range of our specimens 57–742 μm . Apparently also in shallow-water (under boulders in littoral zone and caves), but see below.

Distribution. — Mauritania (including the type material of var. *oceanica* described by Topsent, 1924), Gulf of Cadiz, Cape Verde Islands, Canary Islands; Azores (Topsent, 1904 as *Esperella lingua*; Boury-Esnault & Lopes, 1985); possibly off the coast of Senegal (Lévi, 1960).

Remarks. — According to Topsent (1924), Atlantic members of *Mycale* (*Mycale*) *massa* supposedly would differ from the typical Mediterranean members in the fusiform oxete shape of the styles. We were able to compare the present material from Mauritania and the Cape Verde Islands with a Gulf of Naples specimen of *M. massa* in the ZMA collection (ZMA Por. 15056). Shape and size of all spicules are variable among Northwest African specimens and overlap with the Mediterranean material. Possibly, the oxete condition of the styles and the size of the largest chelae are correlated, as two specimens with oxete styles have anisochelae over 100 μm . Still, there is large variation in all specimens in these features, and Topsent (1924: 91) did not provide similar spicular differences between *massa* and *oceanica*. Thus, we conclude that the variety *oceanica* is too vaguely delimited from the typical variety to be maintained. Accordingly it is here merged with *M. (M.) massa*.

Lévi (1960) reported specimens from an undefined locality ('large, 100 m') off the Northwest African coast, possibly Senegal.

Cruz (2002) reports the lack of a third category of anisochelae in his shallow-water (?) Tenerife specimens, citing only anisochelae of 40–68 and 22–28 μm . Further characters described by him match those of *M. (M.) massa* convincingly. It is striking to note that in our shallow-water specimen from Gran Canaria (RMNH 9130) we also could not find a third category of anisochelae. as only larger chelae, 54–66 and smaller chelae, 24–31 μm are present. The smaller chelae have a spur and as such may be homologues of the smallest chelae category. For the time being we refrain from erecting a new taxon for these specimens, because we could not find any additional differences with normal *M. (M.) massa* specimens.

Mycale (Mycale) laevis (Carter, 1882 as *Esperia*), as redescribed by Hechtel (1965), Van Soest (1984), and Hajdu & Rützler (1998), shows considerable similarity to our material in shape as well as in spicule sizes and categories. It is obviously closely related to *M. (M.) massa*. Differences are the lack of a third chela category, bluntly rounded pointed ends of the styles, and on average smaller sigmas 1 and larger trichodragmas in *M. (M.) laevis*.

If we disregard the presence of exotyles, there is also a striking similarity in spicule sizes and shapes with *Mycale (Rhaphidotheca) verdensis* spec. nov. (see below), particularly the shape of the oxete styles and the smallest category of anisochelae are virtually the same.

Subgenus *Aegogropila* Gray, 1867***Mycale (Aegogropila) contarenii* (Lieberkühn, 1869)**
(figs 3a-h)

Restricted synonymy:

Esperia typus Nardo, 1833: 521.

Spongia contarenii Lieberkühn, 1859: 525.

Halichondria contarenii; Lieberkühn, 1859: pl. XI fig. 11.

Esperia contarenii; Schmidt, 1862: 54, pl. V fig. 2; Vosmaer, 1880: 139.

Mycale (Aegogropila) contarenii; Topsent, 1924: 91, fig. 3; Van Soest et al. 2000 and online at http://species-identification.org/species.php?species_group=sponges&menuentry=soorten&id=330 (with additional synonyms).

Mycale (Aegogropila) syrinx sensu Cruz, 2002: 148 (not: Schmidt, 1862).

Material. — ZMA Por. 05164a, Canary Islands, Tenerife, Playa San Andres (Playa de las Teresitas), 28.505°N 16.188°W, 2-4 m, under stones, coll. R.W.M. van Soest, snorkeling, 26 May 1983.

Examined for comparison. — ZMA Por. E44 (slide only), Tenerife, don. T. Cruz.

Description. — Thin pale orange encrustation (fig. 3a) under stones in shallow water. Size approximately 1.5 × 1.5 cm. Surface smooth, no apparent oscules.

Skeleton. — The detachable surface skeleton is of the ‘aegogropila’ type, with intercrossing spicule tracts. Choanosomal skeleton consists of spongin enforced spicule tracts fanning out at the surface, carrying the ectosomal skeleton.

Spicules. — Styles, three size categories of anisochelae, two size categories of sigmas, toxas.

Styles (fig. 3b, b1), relatively slim, with elongate heads and elongately constricted necks, 231-253.9-276 × 3-3.6-6 μm.

Anisochelae 1 (fig. 3c), rather narrow-shaped, with relatively long naked shaft, 33-37.9-41 μm

Anisochelae 2 (fig. 3d), rare, narrow-shaped, with thin alae, 18-21.4-25 μm.

Anisochelae 3 (fig. 3e), narrow, with thin alae, 11-14.3-16 μm.

Sigmas 1 (fig. 3f), narrow, robust, 75-86.2-102 μm.

Sigmas 2 (fig. 3g), rare, normal-shaped, 18-21.0-23 μm.

Toxas (fig. 3h), rather deeply curved, of widely variable size, but not readily divisible in smaller and larger, 27-101.5-242 μm.

Ecology. — Shallow-water, under stones.

Distribution. — Tenerife; elsewhere reported along most Eastern Atlantic and Mediterranean coasts.

Remarks. — The ZMA Tenerife specimen conforms to published descriptions of *M. (Ae.) contarenii*, but the upper length of the toxas (242 μm) is unusual, since most descriptions do not report sizes above 75-100 μm. Cruz’ slide (E44) also from Tenerife shows a toxa range of 15-100, and styles up to 310 × 6 μm. Cruz’ (2002) description of *M. (Ae.) syrinx*, likely represented by the same slide E44 mentions toxas of 8-100 μm. Other measurements are closely similar to the ZMA specimen. It is proposed here that the present material and Cruz’ *M. (Ae.) syrinx* are assigned to *M. (Ae.) contarenii*. Together these represent the most southern occurrence of the species, as Burton’s (1956) record of *M. contarenii* from Sierra Leone belongs to an undescribed *Mycale (Zygomycale)* species (cf. below).

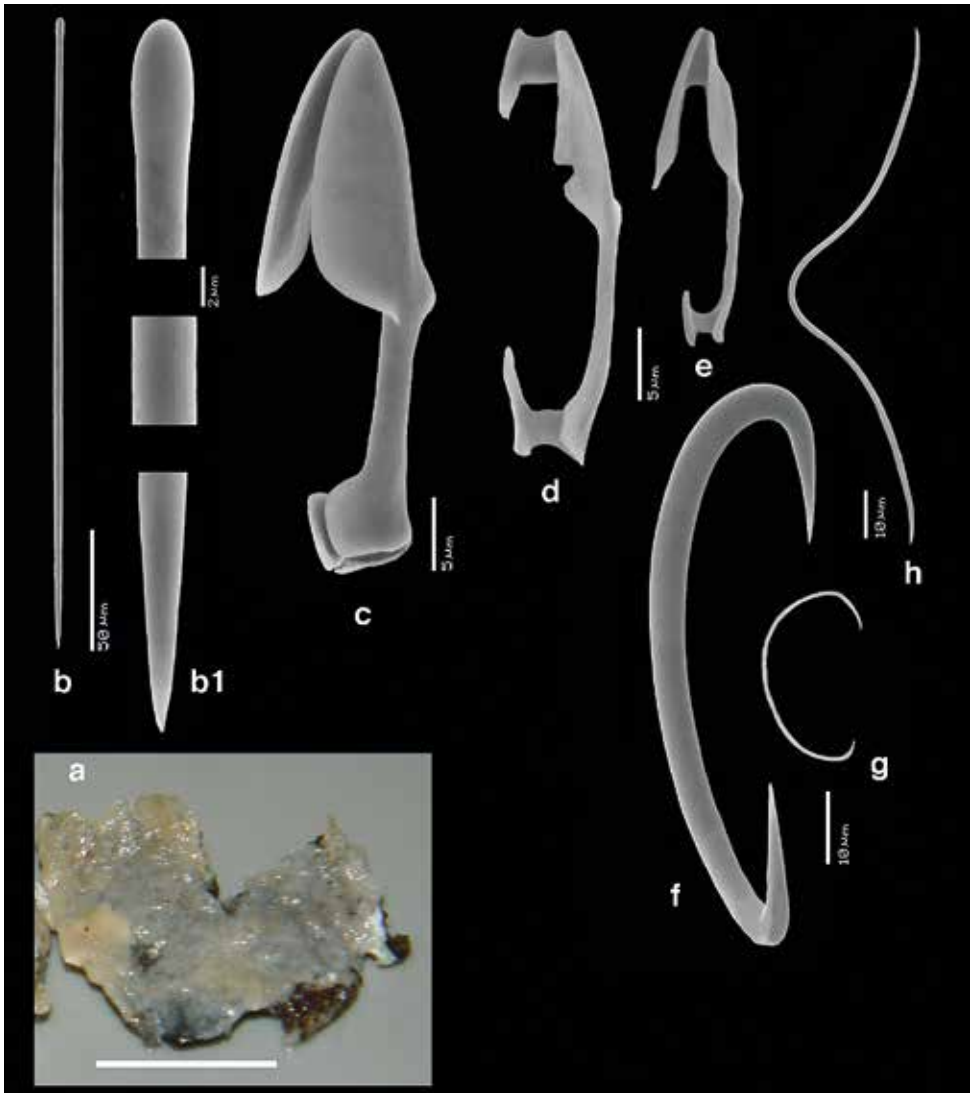


Fig. 3. *Mycale* (*Aegogropila*) *contarenii* (Lieberkühn, 1859), ZMA Por. 05164a from Tenerife, a, habit (scale bar = 1 cm), b-h, SEM images of the spicules, b, style, b1, details of style, c, anisochele 1, d, anisochele 2, e, anisochele 3, f, sigma 1, g, sigma 2, h, toxa.

***Mycale (Aegogropila) rotalis* (Bowerbank, 1874)**
(figs 4a-h)

Desmacidon rotalis Bowerbank, 1874: 327, pl. XC figs 8-14.

Mycale rotalis; Stephens, 1912: 34; Stephens, 1921: 22; Boury-Esnault & Lopes, 1985: 175, fig. 20.

Mycale (Aegogropila) rotalis; Topsent, 1924: 100, figs 8-9; Van Soest et al. 2000 and online: http://species-identification.org/species.php?species_group=sponges&id=337&menuentry=soorten (with further synonyms).

Material. — ZMA Por. 06781, Mauritania, off Banc d'Arguin, 20.0°N 17.4°W, 48-52 m, coll. R.W.M. van Soest & J.J. Vermeulen, 3.5 m Agassiz trawl, Mauritania II Expedition stat. 072/20, 13 June 1988; ZMA Por. 13361, Azores, Faial, 38.5333°N 28.6333°W, 8 m, coll. D. Moss, Scuba, field nr. 110, 1989; ZMA Por. 13362, Azores, Faial, 38.5333°N 28.6333°W, 1 m, coll. D. Moss, Scuba, field nr. 124, 1989; ZMA Por. 13363, Azores, Faial, Horta shore, on large boulders, 38.5333°N 28.6333°W, 1 m, coll. D. Moss, field nr. 14, 1989.

Description. — The Mauritanian specimen was reported as a thin red crust on a *Dy-sidea*; other parts of this sponge were thickly encrusting rocks and were provided with short irregular digitations. The Azores specimens were cited as orange or yellow and encrusted rocks with occasional outgrowths. Size of typical patches (fig. 4a) 3 × 2 × 1 cm. Surface smooth. Consistency soft, but stringy internally.

Skeleton. — Ectosomal tangential reticulation of spicule bundles (fig. 4b), 25-40 µm in diameter (6-8 spicules thick), meshes 300-450 µm. Choanosomal skeleton consisting of thick spicule tracts dividing and anastomosing, carrying the ectosomal skeleton. Fibers 100-150 µm (25 or more spicules thick).

Spicules. — Styles, anisochelae in three size categories, sigmas in two size categories. One of the Azores specimens (ZMA Por. 13362) has its spicules fortified and thicker, a sign of environmentally induced silicification.

Styles (fig. 4c, c1), fusiform, subterminally constricted, sizes vary over the regions: Mauritanian styles are predominantly over 300 µm, those of the Azores usually less than 300 µm long (confirmed also by measurements of Boury-Esnault & Lopes, 1985), overall size 276-303.8-331 × 5.5-9.4-13 µm.

Anisochelae 1 (fig. 4d), robust, with a short naked shaft and prominent upper frontal alae, 33-35.6-39 µm (Azores specimen ZMA Por. 13362 has peculiar heavily silicified chelae up to 50 µm in length)

Anisochelae 2 (fig. 4e), thin, with upper frontal alae still prominent but sharp edged and thin, 21-22.9-28 µm

Anisochelae 3 (fig. 4f), open, thin, sharp edged (similar in shape to anisochelae 2), 14-17.5-20 µm.

Sigmas 1 (fig. 4g), fairly robust especially in the Azores material, elongately curved, 54-66.5-81 µm.

Sigmas 2 (fig. 4h), very thin, open, 21-25.4-30 µm.

Ecology. — Shallow water down to 52 m.

Distribution. — Mauritania, Azores; elsewhere Celtic Seas and Mediterranean (Topsent, 1924; Van Soest et al. 2000 and online).

Remarks. — This species is easily recognizable by the 'aegogropila'-ectosome, the sturdy choanosomal skeleton, in combination with lack of toxas and trichodragmas. It is not reported south of Mauritania, nor is it known from the Canary Islands or

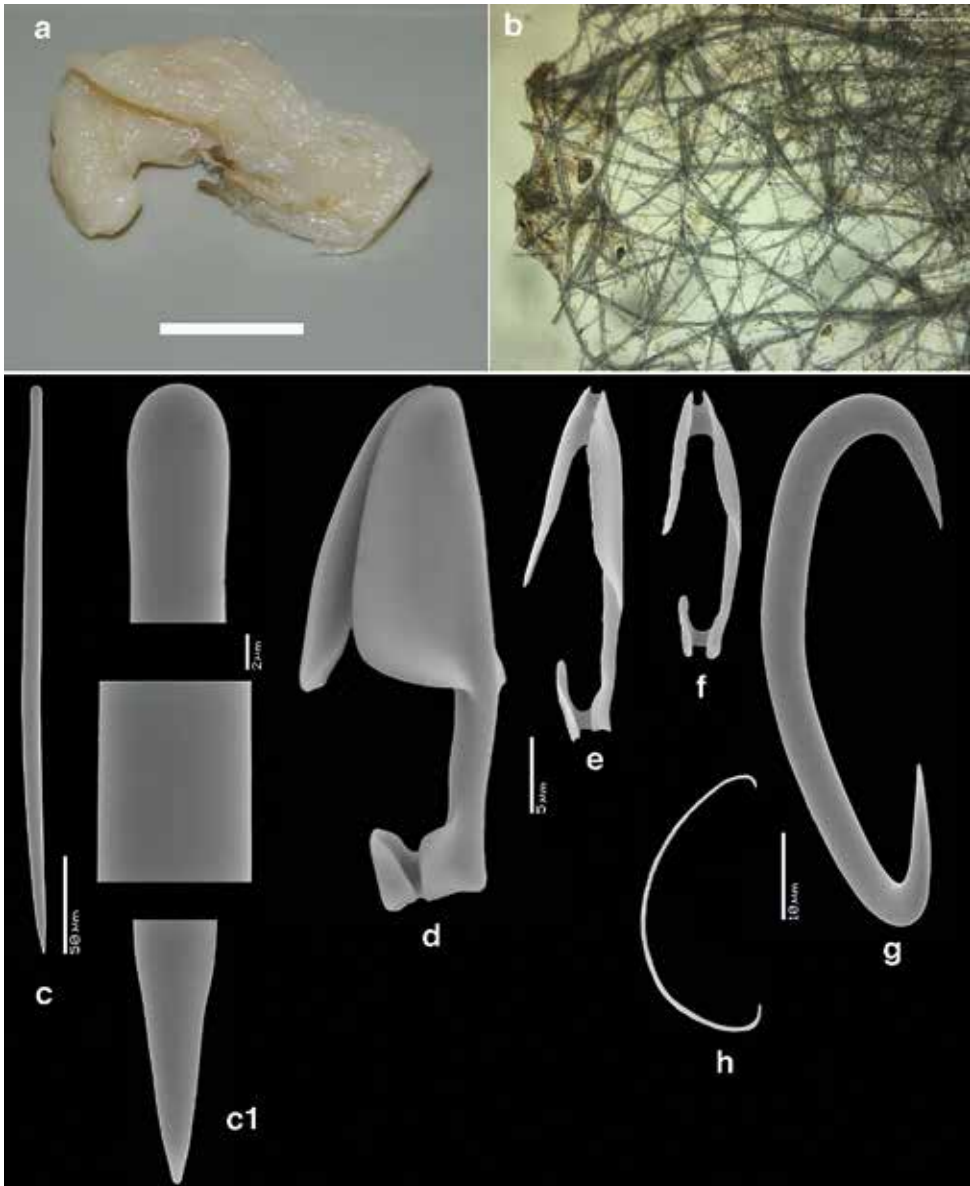


Fig. 4. *Mycale* (*Aegogropila*) *rotalis* (Bowerbank, 1874), a-b, ZMA Por. 13361 from Faial, Azores, a, habit (scale bar = 1 cm), b, tangential view of surface (scale bar = 500 μ m), c-h, SEM images of ZMA Por. 06781 from Mauritania, c, style, c1, details of style, d, anisochele 1, e, anisochele 2, f, anisochele 3, g, sigma 1, h, sigma 2.

Madeira, but apparently is fairly common in the Azores. Live colour appears rather variable: the present Mauritanian specimen was red, as were specimens collected by Topsent near Roscoff (Topsent, 1924: 101, although there were also rosy coloured specimens there) and Celtic Seas specimens (Ackers et al. 1992), but the Azores specimens were orange or yellow (see above), and specimens from Normandy collected by Topsent were pale yellowish (Topsent, 1924: 101).

***Mycale (Aegogropila) syringosimilis* spec. nov.**
(figs 5a-c, 6a-g)

Material.— Holotype: ZMA Por. 06644, Mauritania, S of Cape Timiris, 18.6°N 16.7167°W, 260-280 m, coll. R.W.M. van Soest & J.J. Vermeulen, 3.5 m Agassiz trawl, muddy bottom, Mauritania II Expedition stat. 039/10, 10 June 1988.

Paratypes: ZMA Por. 21302b and 21309, Cape Verde Islands, São Tiago, SE of Cima, 14.95°N 24.6333°W, 650-720 m, coll. R.W.M. van Soest, 1.2 m Agassiz trawl, CANCAP 7 Expedition, stat. 040, 24 August 1986.

Description.— The holotype (fig. 5a) consists of a group of soft, limp, brown bushes, each on a narrow stalk, which issue from a thin sprawling base. Branches undivided, surface irregular, conulose-spinose, without apparent oscules. Length of largest branch

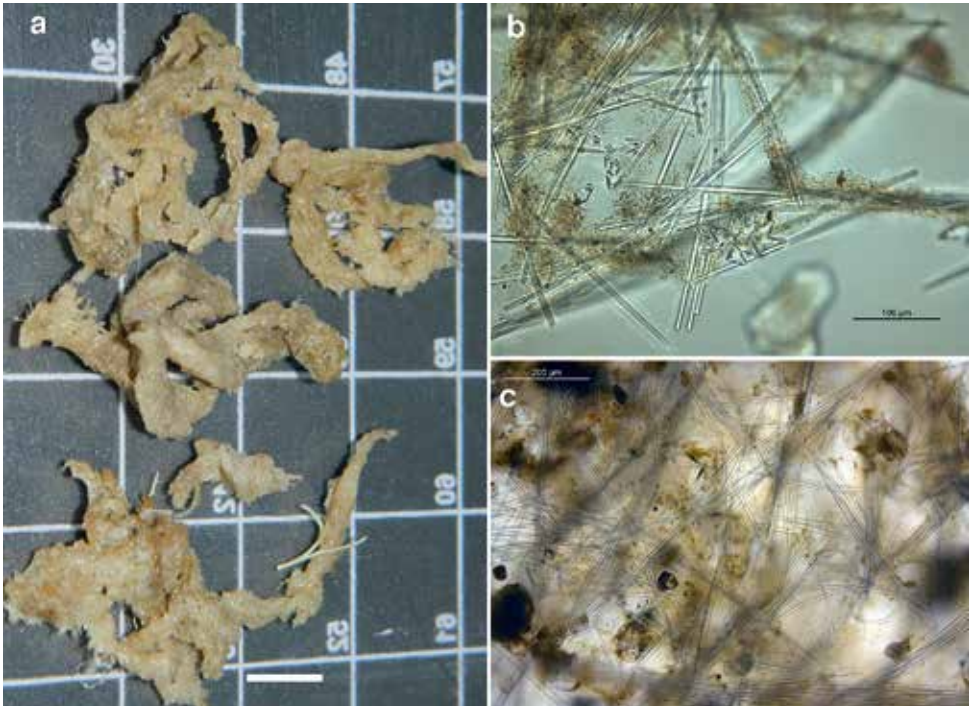


Fig. 5. *Mycale (Aegogropila) syringosimilis* spec. nov., holotype ZMA Por. 06644 from Mauritania, a, habit (scale bar = 1 cm), b, detail of surface skeleton (scale bar = 100 μ m), c, overview of tangential surface skeleton (scale bar = 200 μ m).

3 cm, thickness up to 1 cm. The paratypes are similar but smaller bushes with thinner branches, looking somewhat macerated.

Skeleton.— The ectosomal skeleton (figs 5b-c) is a system of intercrossing spicule tracts (fig. 5c), as is typical for the subgenus, with tracts 30-40 μm in diameter (3-8 spicules thick). There are rosettes of anisochelae 1 in the surface membrane (fig. 5b). The choanosomal skeleton is coarse, with fibers measuring 50-80 μm in diameter (8-10 spicules in thickness) dividing dendritically towards the surface where they carry the ectosomal tangential reticulation.

Spicules.— Styles, three size categories of anisochelae, two size categories of sigmas, toxas.

Styles (figs 6a, a1), with slight subterminal constriction, fusiform, slightly but distinctly polytylote, with thickly tapering sharp point, rather uniform in size, 306-328.1-345 \times 6.5-7.6-8.5 μm .

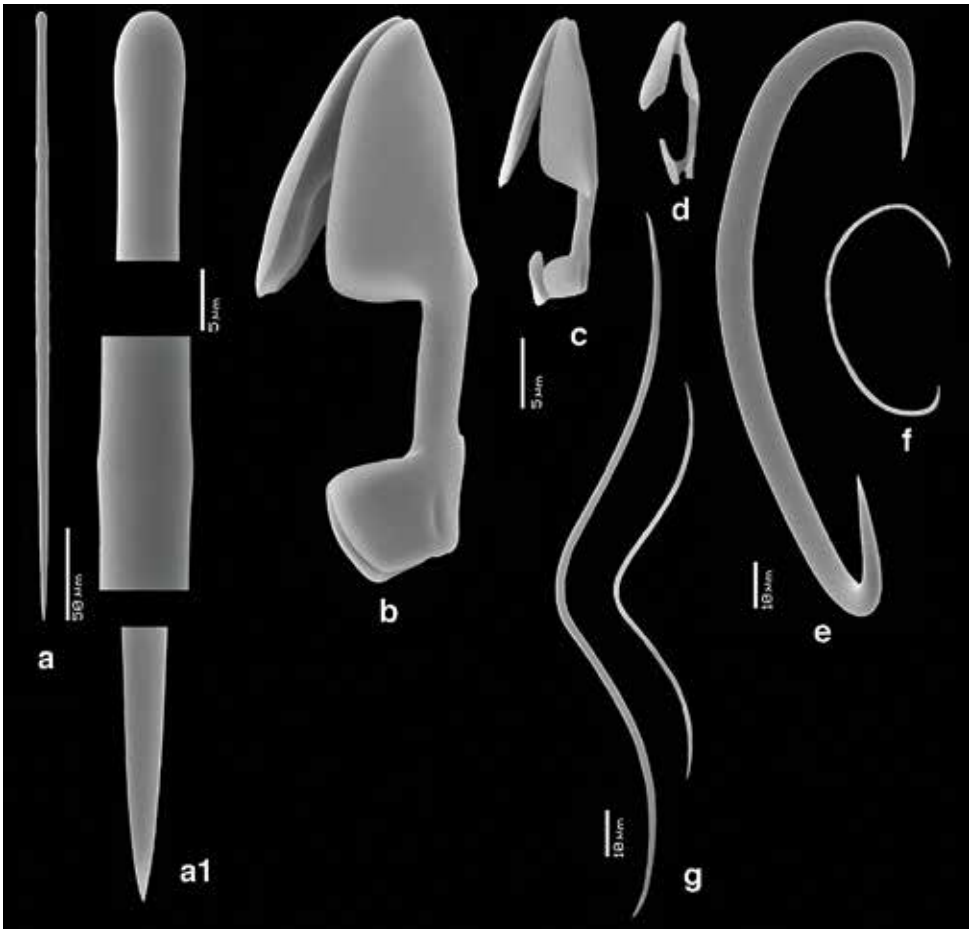
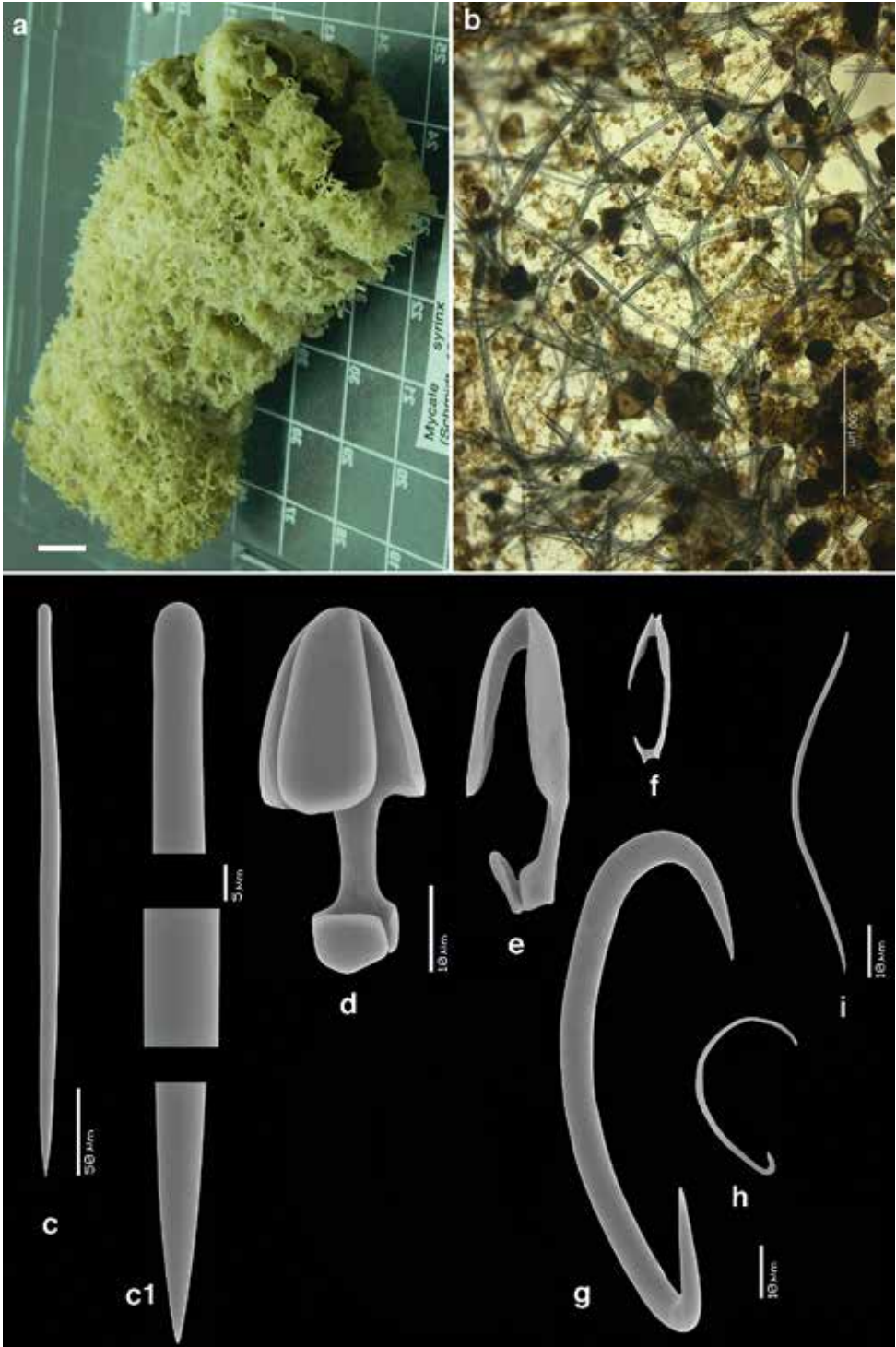


Fig. 6. *Mycale* (*Aegogropila*) *syringosimilis* spec. nov., holotype ZMA Por. 06644 from Mauritania, SEM images of spicules, a, style, a1, details of style, b, anisochela 1, c, anisochela 2, d, anisochela 3, e, sigma 1, f, sigma 2, g, toxas.



Anisochelae 1 (fig. 6b), robust, with naked shaft about $\frac{1}{3}$ of the length, 43-47.2-51 μm .

Anisochelae 2 (fig. 6c), similar to anisochelae 1, but with naked shaft only about $\frac{1}{4}$ of the total length, and with relatively large upper alae, 21-23.0-26 μm .

Anisochelae 3 (fig. 6d), 'open' with thinner upper and lower alae, with sharp rims, 11-12.1-13.5 μm .

Sigma 1 (fig. 6e), common, robust, strongly curved, sharp-pointed, 114-126.6-138 μm .

Sigma 2 (fig. 6f), less common, thin, strongly curved, 19-22.4-27 μm .

Toxas (fig. 6g), widely curved, with upturned apices, 60-107.8-126 μm .

Ecology.— Deep water, 260-720 m, soft bottom.

Distribution.— Mauritania, Cape Verde Islands.

Etymology.— *syringosimilis* = similar to *syrinx*, referring to the overall similarity of the spicule complement with *Mycale* (*Aegogropila*) *syrinx*.

Remarks.— Using Topsent's (1924) spicule key the specimens described here key out as *Mycale* (*Ae.*) *syrinx*. However, that species forms large spiny tubes (see below), its styles are not polytylote, its sigma I category does not exceed 114 μm (our new species has them as large as 138 μm), and the toxas do not exceed 61 μm (against 126 in our new species). Nevertheless, the spicule complement is closely similar. Lévi's (1960) record of *M.* (*Ae.*) *syrinx* may include specimens of our new species as some of his specimens were described as being branched. The tubular specimen and the spicule size data provided by Lévi (l.c.) do appear to belong to *M.* (*Ae.*) *syrinx* (see below).

Mycale (*Carmia*) *fusifformis* Lévi, 1960 from Senegal shows some similarity in shape (it is a single stalked branch), but spicule sizes and categories differ significantly. There is no surface skeleton in that species and it lacks toxas, while the large anisochelae are almost double the size of those of the present new species.

Mycale (*Aegogropila*) *syrinx* (Schmidt, 1862)

(figs 7a-i)

Esperia tubulosa Nardo, 1833: 522 (nomen nudum).

Esperia syrinx Schmidt, 1862: 56, pl. V fig. 6; Vosmaer, 1880: 140.

Esperia lorenzii Schmidt, 1862: 56, pl. V fig. 7.

Mycale syrinx; Babić, 1922: 268, textfig. K; Lévi, 1960: 756, fig. 11.

Mycale (*Aegogropila*) *syrinx*; Topsent, 1924: 95, figs 4-5.

Not: *Mycale* (*Aegogropila*) *syrinx*; Cruz, 2002: 148.

Material.— ZMA Por. 06815, Mauritania, off Banc d'Arguin, 100-400 m, 19.7667°N 17.1°W, coll. R.W.M. van Soest & J.J. Vermeulen, rectangular dredge, Mauritania II Expedition stat. 103/01, 16 June 1988; ZMA Por. 06856, Mauritania, off Banc d'Arguin, 400-450 m, 20.65°N 17.8°W, coll. R.W.M. van Soest & J.J. Vermeulen, 3.5 m Agassiz trawl, Mauritania II Expedition stat. 133/01, 20 June 1988.

◀ Fig. 7. *Mycale* (*Aegogropila*) *syrinx* (Schmidt, 1862), a-b, ZMA Por. 06815 from Mauritania, a, habit (scale bar = 1 cm), b, tangential view of surface skeleton (scale bar = 500 μm), c-i, ZMA Por. 06856 from Mauritania, SEM images of spicules, c, style, c1, details style, d, anisochela 1, e, anisochela 2, f, anisochela 3, g, sigma 1, h, sigma 2, i, toxa.

Examined for comparison. — ZMA Por. 02438, France, Banyuls, 12 miles off St. Cyprien, 42.7°N 3.0333°E, 80-90 m, trawl, bottom muddy sand, coll. J.H. Stock, 9 September 1964.

Description. — Large erect tubes (fig. 7a) with shaggy surface. Largest specimen 11 cm high, 6 cm diameter, with an internal lumen of 4 cm diameter. On deck colour was orange-brown; preserved it is light beige. Surface irregularly conulose-spinose due to projecting fiber reticulation, with 'skin' retracted between the conules-spines. Consistency firmly compressible, easily damaged, tendency to fragment.

Skeleton. — At the surface, between projecting fibers, the skeleton consists of intercrossing spicule tracts (fig. 7b), 40-60 μm in diameter each formed by 3-5 aligned spicules, making triangular meshes of 200-300 μm in diameter. Choanosomal skeleton consisting of coarse fibers, 300-500 μm in diameter, consolidated by spongin and cored by up to 50 spicules or more, dividing dendritically and anastomosing irregularly. Peripheral fibers project beyond the surface reticulation. Microscleres common in the ectosomal region. Anisochelae 1 occur in rosettes.

Spicules. — Styles, three categories of anisochelae, two categories of sigmas, and a single category of toxas.

Styles (figs 7c, c1), relatively short and thick, subterminally slightly constricted, fusiform, not polytylote, 344-364.0-388 \times 11-12.6-14 μm .

Anisochelae 1 (fig. 7d), robust, with upper frontal alae prominent and curved outward, naked shaft relatively short (less than half the length), 40-45.9-51 μm .

Anisochelae 2 (fig. 7e), size not strongly different from anisochelae 1, but frontal alae more incurved, not outward, naked shaft quite short, 29-35.9-39 μm .

Anisochelae 3 (fig. 7f), with thin alae, 14-16.3-18 μm .

Sigmas 1 (fig. 7g), robust, incurved, common, 91-103.5-114 μm .

Sigmas 2 (fig. 7h), thin, rather open, fairly rare (mostly confined to the surface membrane), 16-22.4-30 μm .

Toxas (fig. 7i), widely curved, thin, small, rather rare (also confined to the surface membrane), 45-52.8-61 μm .

Ecology. — Deep water, down to 450 m.

Distribution. — Mauritania; Senegal (Lévi, 1960). Elsewhere throughout the Mediterranean.

Remarks. — Our specimens conform to the original description of the species by forming large tubes. We were able to compare our material with a tubular specimen of *M. (Ae.) syrinx* from Banyuls, S of France (ZMA Por. 02438), and found shape and spicule data conforming closely with our specimens. Only the styles of our specimens exceeded those of the Mediterranean specimen (294-330 \times 7-10 μm , against our 344-388 \times 11-14 μm), all other spicules were similar in shape and size.

Several records of this species concern specimens with different habit from the typical *M. (Ae.) syrinx*: Lévi (1960) reported that species from Senegal as arborescent, 5 cm high and 1.5 cm diameter, with a larger branch apparently tubular. Above we described a branching species with slightly different spicule size data as a new species, *M. (Ae.) syringosomilis* spec. nov. close to *M. (Ae.) syrinx*. Possibly, some of Lévi's material belongs to the new species, rather than to *M. (Ae.) syrinx*. Cruz (2002) reported *M. (Ae.) syrinx* from the Canary Islands as a thin encrustation under shallow-water stones, with generally similar spiculation to ours, but with toxas as small as 8 μm and also the styles

(280-340 μm) were smaller than those of our material. Cruz himself suggested that the material could be assigned to *M. (Ae.) contarenii* (q.v.). Of course the species has to start out as a small sponge and such specimens probably do not immediately show the typical tubular shape, so there is a possibility that small encrustations or erect digitations may still belong to *M. (Ae.) syrinx*.

***Mycale (Aegogropila) tenerifensis* spec. nov.**
(figs 8a-h)

Mycale (Carmia) sp. 2 sensu Cruz, 2002: 153.

Material. — Holotype: ZMA Por. 05164, Canary Islands, Tenerife, Playa San Andres (Playa de las Teresitas), 28.505°N 16.188°W, 2-4 m, under stones, coll. R.W.M. van Soest, snorkeling, 26 May 1983.
Paratype: ZMA Por. 07218, Cape Verde Islands, São Nicolau, Preguiça, 16.5883°N 24.2667°W, 0-4 m, coll. R.W.M. van Soest, snorkeling, CANCAP 7 Expedition stat. K22/05, 2 September 1986.

Description. — Orange-brown encrustations with thickly massive or erect digitations (fig. 8a), growing under stones in front of beach. Holotype material fragmented into about a dozen pieces. Size of preserved patches averaging $2 \times 2 \times 0.5$ cm. Surface punctate, smooth, but faintly microhispid. Consistency soft.

Skeleton. — Ectosomal skeleton tangential, with intercrossing tracts (fig. 8b) of 2-5 spicules in cross section, carried by choanosomal bundles (fig. 8c) of 30-70 μm diameter.

Spicules. — Styles, anisochelae in a single small category, two size categories of sigmas, toxas.

Styles (fig. 8d, d1), straight, with elongated barely swollen heads, slightly terminally constricted, 238-253.1-267 \times 3-3.6-4.5 μm .

Anisochelae (fig. 8e), small and thin, 11-12.8-15 μm .

Sigmas 1 (fig. 8f), robust, relatively elongated, 39-44.2-60 μm .

Sigmas 2 (fig. 8g), small, open, very thin, 18-21.6-26 μm .

Toxas (fig. 8h), thin, with wide, shallow curve, 60-100.1-135 μm .

Ecology. — Shallow-water, under stones.

Distribution. — Tenerife, Cape Verde Islands.

Etymology. — The name refers to the type locality.

Remarks. — Cruz (2002) reports a similar specimen as *Mycale (Carmia)* spec. 2 from Tenerife and it is very likely that this concerns the same species. It has a spicule complement which by its possession of small anisochelae, large and small sigmas and open-curved toxas reminds of *Mycale (Carmia) macilenta* (Bowerbank, 1866), however the skeletal structure of the ectosomal region is clearly that of the subgenus *Aegogropila*, with its intercrossing tangential spicule bundles (*Carmia* lacks a proper ectosomal skeleton). From *M. (C.) macilenta* the present material further differs in having only a single anisochelae size, while *macilenta* has three size categories. This latter species moreover has trichodragmas, which are lacking in our material, and differently shaped toxas (see below).

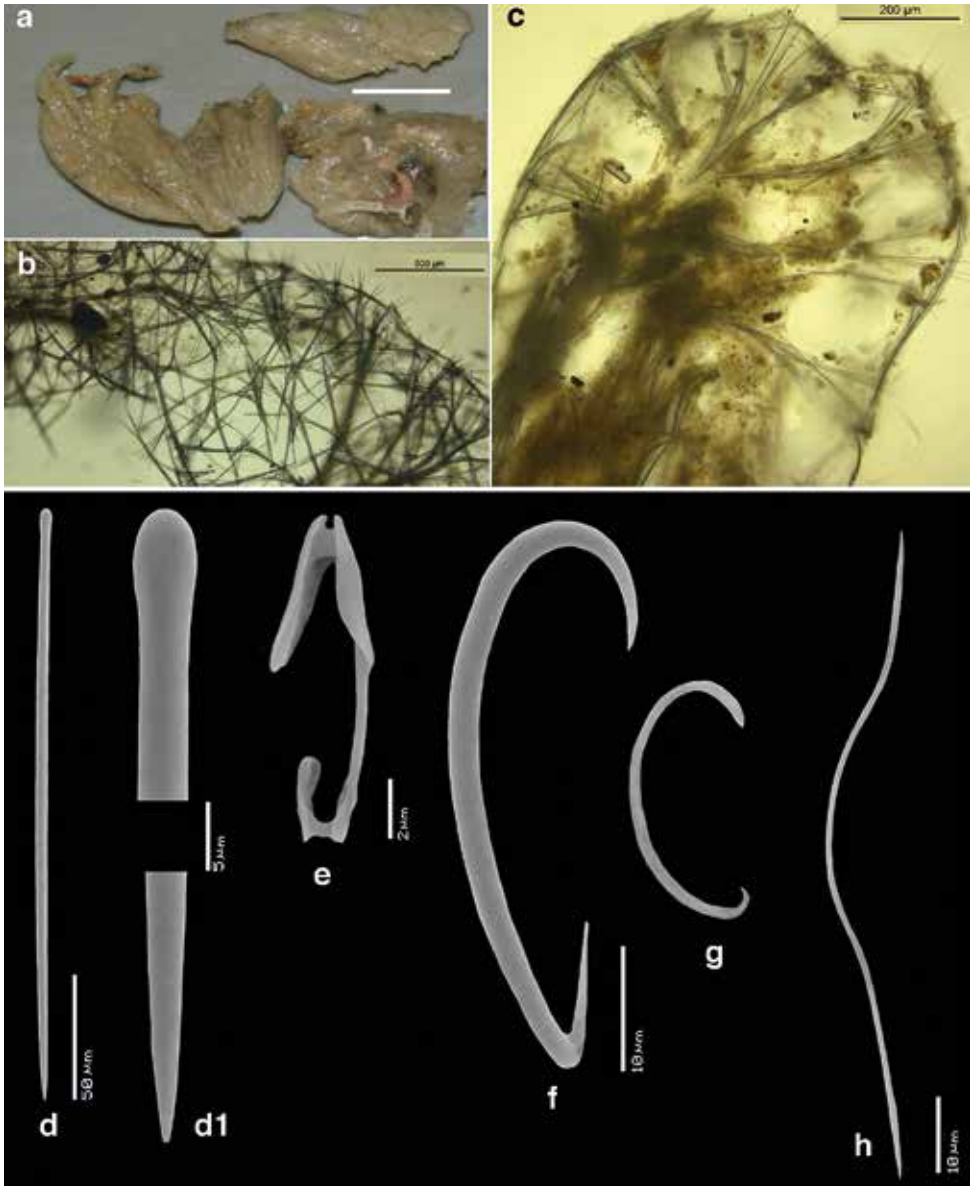


Fig. 8. *Mycale* (*Aegogropila*) *tenerifensis* spec. nov., holotype ZMA Por. 05164, a, habit of holotype fragments (scale bar = 1 cm), b, tangential view of surface skeleton (scale bar = 500 μ m), c, cross section of skeleton of digitate fragment (scale bar = 200 μ m), d-h, SEM images of the spicules, d, style, d1, details of style, e, anisochela, f, sigma 1, g, sigma 2, h, toxa.

Subgenus *Arenochalina* Lendenfeld, 1887*Mycale (Arenochalina) africamucosa* spec. nov.
(figs 9a-d, 10a-c)

Mycale laxissima; Van Soest, 1993: Table 3 (not: *Acamas laxissima* Duchassaing & Michelotti, 1864)
? *Mycale angulosa*; Lévi, 1959: 129, pl. 6 fig. 5, text fig. 6 (not: *Pandaros angulosa* Duchassaing & Michelotti, 1864; nec *Mycale angulosa* sensu Burton, 1956, cf. below).

Material. — Holotype: RMNH 9037, Cape Verde Islands, SW of Santa Luzia, 16.7333°N 24.7667°W, 25-33 m, rectangular dredge, coll. CANCAP 6 Expedition stat. 102, 16 June 1982.

Paratypes: ZMA Por. 05082, Cape Verde Islands, CANCAP 6 Expedition (no further data); ZMA Por. 06963, Cape Verde Islands, São Tiago, Ilhéus Rombos, Cima, 14.95°N 24.65°W, 5-15 m, coll. R.W.M. van

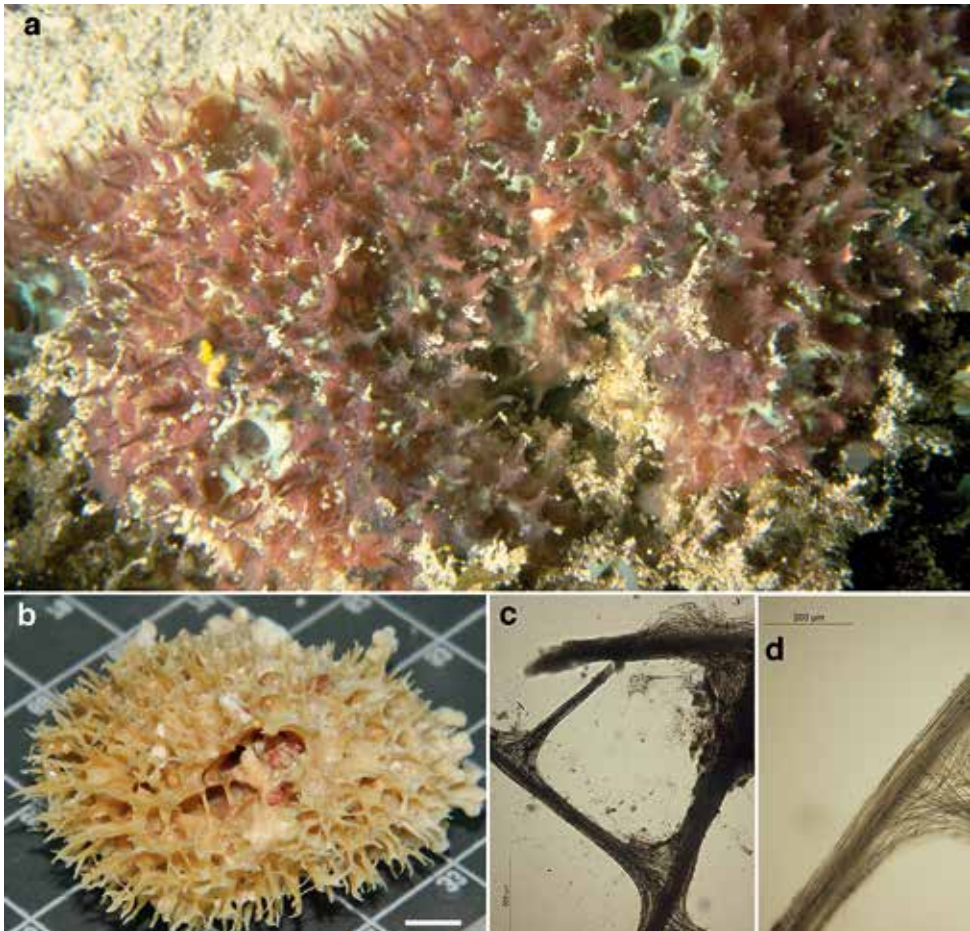


Fig. 9. *Mycale (Arenochalina) africamucosa* spec. nov. from the Cape Verde Islands, a, habit in situ of paratype ZMA Por. 06972, b, preserved habit of holotype RMNH 9037 (scale bar = 1 cm), c, cross section of skeleton of holotype (scale bar = 500 µm), d, detail of skeleton (scale bar = 200 µm).

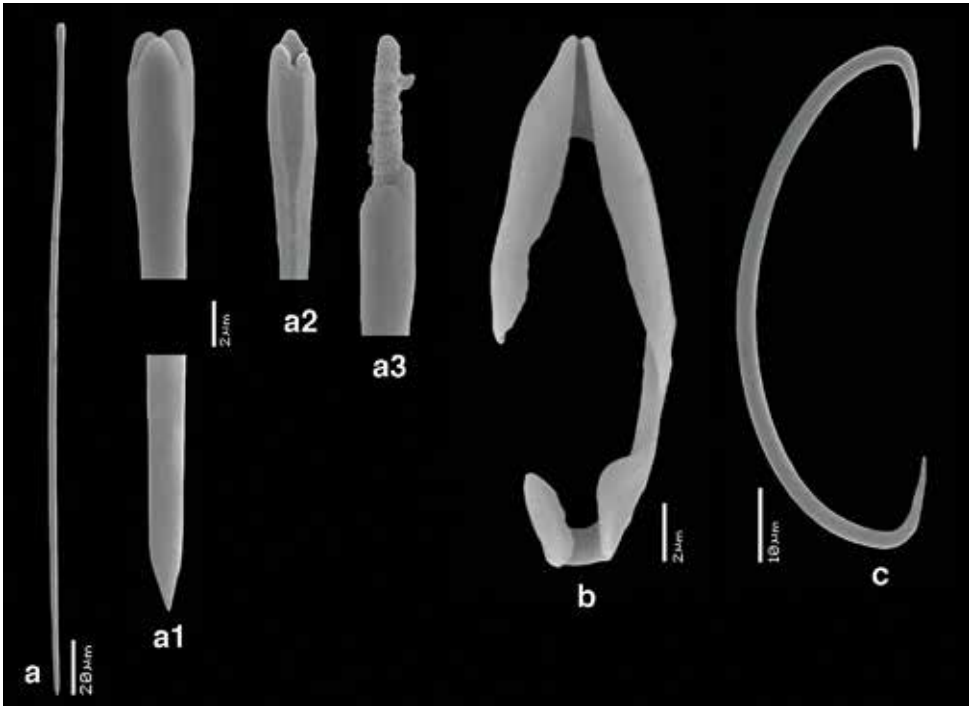


Fig. 10. *Mycale (Arenochalina) africamucosa* spec. nov. from the Cape Verde Islands, SEM images of the spicules, a, style, a1, detail of trifold head, a2, detail of trifold head with open connection to axial canal, a3, detail of irregular head, b, anisochela, c, sigma.

Soest, Scuba, CANCAP 7 Expedition stat. D03/24, 23 August 1986; ZMA Por. 06972, Cape Verde Islands, Maio, SW coast of Ponta Preta, 15.1167°N 23.3°W, 5-8 m, coll. R.W.M. van Soest, Scuba, CANCAP 7 Expedition stat. D05/04, 25 August 1986; ZMA Por. 07025, Cape Verde Islands, Boa Vista, W coast, NW coast of Ilhéu de Sal Rei, 16.1667°N 22.95°W, 5-15 m, Scuba, coll. R.W.M. van Soest, CANCAP 7 Expedition stat. D06/20, 27 August 1986; ZMA Por. 07109, Cape Verde Islands, Branco, S coast near Ponta da Parede, 16.65°N 24.6833°W, 14-16 m, coll. W. Prudhomme van Reine, Scuba, CANCAP 7 Expedition stat. D14/09, 4 September 1986; ZMA Por. 07112, Cape Verde Islands, São Vicente, W coast near Ponta do Manellino, 16.8667°N 25.0667°W, 10-12 m, coll. R.W.M. van Soest, Scuba, CANCAP 7 Expedition stat. D16/02, 7 September 1986; ZMA Por. 07125 and 07136, Cape Verde Islands, São Vicente, W coast near Ponta do Manellino, 16.8667°N 25.0667°W, 15 m, coll. R.W.M. van Soest, Scuba, CANCAP 7 Expedition stat. D16A5/02, 8 September 1986; RMNH 6323, Cape Verde Islands, S of São Vicente, 16.7833°N 25.0333°W, 50-60 m, 1.2 m Agassiz trawl, coll. CANCAP 6 Expedition stat. 133, 19 June 1982; RMNH 9036, Cape Verde Islands, S of São Tiago, 14.9°N 23.5°W, 15-21 m, Van Veen grab, coll. CANCAP 6 Expedition stat. 003, 5 June 1982; RMNH 9038, Cape Verde Islands, S of São Vicente, 16.7833°N 25.0333°W, 50-60 m, 1.2 m Agassiz trawl, coll. CANCAP 6 Expedition stat. 133, 19 June 1982; RMNH 9039, Cape Verde Islands, S coast of São Tiago, 14.9167°N 23.5°W, 0-20 m, Scuba, coll. CANCAP 6 Expedition stat. D.01, 4 June 1982.

Not type material.— ZMA Por. 11015, United Kingdom, St. Helena, Jamestown Bay, Needle's Eye, 15.92°S 5.71°W, 7-10 m, coll. J.H. Stock & J.J. Vermeulen, Scuba, 5 May 1995; ZMA Por. 16297, United Kingdom, Ascension Island, 7.92°S 14.41°W, coll. R. Irving, field number 21-109, 8 November 1985.

Examined for comparison.— *Mycale (Arenochalina) laxissima*, ZMA Por. 14262, Dutch Caribbean, Curaçao, Slangebaai, 12.134°N 68.997°W, 33 m, coll. M.J. de Kluijver, SYMBIOSPONGE nr. 98/CU/MAY19/MK123, 19 May 1998.

Description.— Reddish purple-brown, rounded masses developing into tubes in larger specimens (figs 9a, b). Surface coarsely spined, clathrate. When lifted out of the water it produces copious masses of mucous, after which specimens become macerated skeletons of spongin-encased fibers. Consistency toughly compressible.

Skeleton.— A rectangular reticulation (figs 9c-d) of coarse fibers enclosing large numbers of thin styles and thin filamentous algae. Main fibers up to 0.5-3 mm in thickness, connecting fibers up to 1 mm. Meshes very variable in size, from less than 0.5 to several mm. Coring spicules may be up to 100 or more in the thickest fibers.

Spicules.— A full complement comprises styles, one size category of anisochelae, and one size category of sigmas, but very often one or both of the microsclere types are lacking, presumably lost by the extreme mucous production.

Styles (figs 10a, a1, a2, a3), thin, straight, with wide axial canal, with faintly swollen elongate heads, which are crowned by peculiar trifold (figs 10a1, a2) or irregular (fig. 10a3) upper surface; heads frequently open on the upper surface leading into the hollow axial canal, 168-249.5-271 × 2-2.3-3.5 μm.

Anisochelae (fig. 10b), open, with thin alae and short naked shaft, 17-19.4-22 μm.

Sigmas (fig. 10c), thin, mostly elongately C-shaped, 66-79.2-89 μm.

Ecology.— Shallow-water down to 60 m.

Distribution.— Cape Verde Islands, Ascension, St. Helena, possibly Gulf of Guinean islands (Principe and Annobon, cf. Lévi, 1959).

Etymology.— The name is a combination of the continent Africa and the word *mucosa* (L.), meaning slimy, referring to the extreme mucous-production of this species when taken out of the water.

Remarks.— So far this species had been identified provisionally as belonging to the Caribbean *Mycale* (*Arenochalina*) *laxissima* (Duchassaing & Michelotti, 1864 as *Acamas*) (see also Van Soest, 1993b). We were able to compare the Cape Verde Islands specimens with Caribbean specimens in the ZMA collection (e.g. ZMA Por. 14262 from Curaçao), and could find almost no differences: shape, colour, mucous production, sizes of all spicules, including rarity of microscleres match closely (see also descriptions in Van Soest (1984: 29), Zea (1987: 143) and Hajdu & Rützler (1998: 748). Occurrence of the species on mid-Atlantic islands (Ascension and St. Helena) would support an eventual conspecificity of populations across the tropical Atlantic. Nevertheless, we found a difference in the style heads: those of the Caribbean specimens have all rounded heads, whereas the present specimens and also those of Ascension and St. Helena show the peculiar trifold heads, often also with open access to the axial canal. Such peculiarities of the style heads are also reported in *Mycale* (*Arenochalina*) *euplectelloides* (Row, 1911) (unpublished research), indicating that this is a character of several species in subgenus *Arenochalina*. We predict that future genetic studies will confirm that ampho-Atlantic populations of the subgenus are isolated since long and should be considered separate species, *M. (Ar.) laxissima* (Western Atlantic) and *M. (Ar.) africanucosa* spec. nov. (Eastern Atlantic). They are members of a circumtropical species group showing similar shapes, skeletons, mucous production and spicule dimensions. Such species are reported from the Red Sea: *M. (Ar.) setosa* (Keller, 1889) and *M. (Ar.) euplectelloides* (Row, 1911), Philippines: *M. (Ar.) euplectelloides* var. *regularis* Wilson, 1925, and Australia: *M. (Ar.) mirabilis* (Von Lendenfeld, 1887, see Wiedenmayer, 1989 with additional synonyms).

Lévi's (1959) record of *Mycale angulosa* from the Gulf of Guinea islands (Principe and Annobon) likely represents a further occurrence to the south of *M. (Ar.) africanucosa* spec. nov. The description and habit, as well as the overall spicule sizes match, but no details of style heads were provided.

Subgenus Carmia Gray, 1867

***Mycale (Carmia) atropha* spec. nov.**
(figs 11a-e)

Mycale cf. *angulosa* sensu Burton, 1956: 129 (not: *Pandaros angulosa* Duchassaing & Michelotti, 1864).

Material.— Holotype ZMUC-DEM-000324 (ZMK 19j), Guinea, off Conakry, 9.3333°N 14.25°W, 32 m depth, bottom shells, foraminifera, Atlantide Exped. stat. 145, 13 April 1946.

Description.— Massively encrusting (fig. 11a) on shells and overgrowing bryozoans, with folded surface and tendency to form erect lobes. Size 4 × 3 × 0.5 cm. Surface optically smooth, but microhispid. No apparent oscules. Colour beige in alcohol.

Skeleton.— Thick strong spicule tracks run from the substratum to the surface, dividing sparingly (fig. 11b). They are 30-100 µm in diameter (10-25 spicules in cross section), approximately 200 µm apart; in between there are numerous loose megascleres arranged without order. Surface membrane charged with microscleres.

Spicules.— Styles, anisochelae, sigmas.

Styles (figs 11c, c1), with prominent globular heads and constricted necks, shaft only very slightly fusiform, 228-245.2-267 × 4-5.5-6.5 µm.

Anisochelae (figs 11d, d1, d2), in a single category, uniform in size and shape, reduced, with peculiar short alae, relatively strongly silicified, 12.5-14.7-16 µm.

Sigmas (fig. 11e), normal-shaped, in a single uniform category, 31-33.6-37 µm.

Ecology.— Sandy bottom at 30 m.

Distribution.— Known only from the type locality off the coast of Guinea, West Africa.

Etymology.— *Atrophus* (L.) means reduced, referring to the reduced condition of the upper and lower alae of the anisochelae.

Remarks.— The reduced, strongly silicified, shape of the chelae of this new species appears to be unique among the *Mycale* species of the Central Atlantic. No other species has been described with similar chelae.

Burton's (1956) tentative identification of this material as *Mycale angulosa* was probably influenced by De Laubenfels' (1936) erroneous concept of that species, now recognized as *Mycale (Arenochalina) laxissima*. The Caribbean *Mycale (Zygomycale) angulosa* (Duchassaing & Michelotti, 1864 as *Pandaros*) is very different in structure (e.g. an 'aegogropila' ectosome) and spiculation (a full complement including two anisochelae and one isochelae categories, two sigma categories, toxas and trichodragmas), see also below under remarks on *Mycale (Zygomycale) sierraleonensis* spec. nov.



Fig. 11. *Mycale (Carmia) atropha* spec. nov., holotype ZMUC DEM000324, ZMK 19j from Guinea, a, habit (scale bar = 1 cm), b, cross section of skeleton (scale bar = 100 µm), c-e, SEM images of the spicules, c, style, c1, details of style, d, anisochela, d1, variation of anisochela, d2, another variation of anisochela, e, sigma.

***Mycale (Carmia) guineensis* spec. nov.**
(figs 12a-j)

Mycale macilenta; Burton, 1956: 129 (not: Bowerbank, 1866).

Material.— Holotype: ZMUC-DEM-000325 (ZMK 19d¹), Guinea, off Conakry, 9.3333°N 14.25°W, 32 m depth, bottom shells, foraminifera, Atlantide Exped. stat. 145, 13 April 1946.

Description.— Encrusting base, with stringy, probably digitate, projections (fig. 12a) which have collapsed because of their limp consistency. Colour in alcohol dark yellow brown. Size approximately 4 × 3 × 0.5 cm, with individual digitations 1 cm long and 0.3 cm in diameter.

Skeleton.— ‘Carmia’ structure with thick spicule tracts of 30–80 µm diameter (up to 12 or more spicules in cross section) rising up from the substratum to subdivide peripherally. No special ectosomal skeleton. Prominent presence of rosettes (fig. 12b) of the largest anisochela category.

Spicules.— Styles, four anisochela categories, two sigma categories, toxas.

Styles (figs 12c, c1), rather short and thin, but with distinct centrotylote swelling, 207–227.6–244 × 3–4.6–6 µm.

Anisochelae 1 (fig. 12d), normal shaped, robust, 30–34.5–37 µm.

Anisochelae 1a (fig. 12e), rare, about equal in length as anisochela 1, but with peculiar shape, having barely differentiated lateral alae, and thin, pointed frontal alae at both ends, 27–30.2–33 µm.

Anisochelae 2 (fig. 12f), rather rare, narrow, thin-bladed, 21–23.3–25 µm.

Anisochelae 3 (figs 12g, g1, g2), distinct by having the upper alae well-developed, but with an inversed spur on the lower frontal alae, 11–12.8–15 µm.

Sigmas 1 (fig. 12h), robust, but narrow, 75–82.3–91 µm.

Sigmas 2 (fig. 12i), quite thin and small, 15–24.3–28 µm.

Toxas (fig. 12j), with medium curve, smaller with shallow curve, in a wide size range, 42–124.5–225 µm.

Ecology.— Shell bottom at 32 m.

Distribution.— So far only know from the type locality off Conakry, Guinea.

Etymology.— Named after the type locality.

Remarks.— The present material is admittedly close to *M. (C.) macilenta* (cf. also below), but three features appear to be different, (1) centrotylote styles, (2) the presence of a peculiar additional anisochelae 1 which appear to have reduced lateral alae, and (3) the tooth-like extension of the lower central alae of the anisochelae 3. Less outspoken differences are the length of the styles, which is distinctly smaller in the new species. Also the habit with its stringy appearance differs from that of the thinly encrusting specimens of *M. (C.) macilenta* we obtained from the Canary Islands (cf. below), and more generally, from specimens reported from the coasts of Europe.

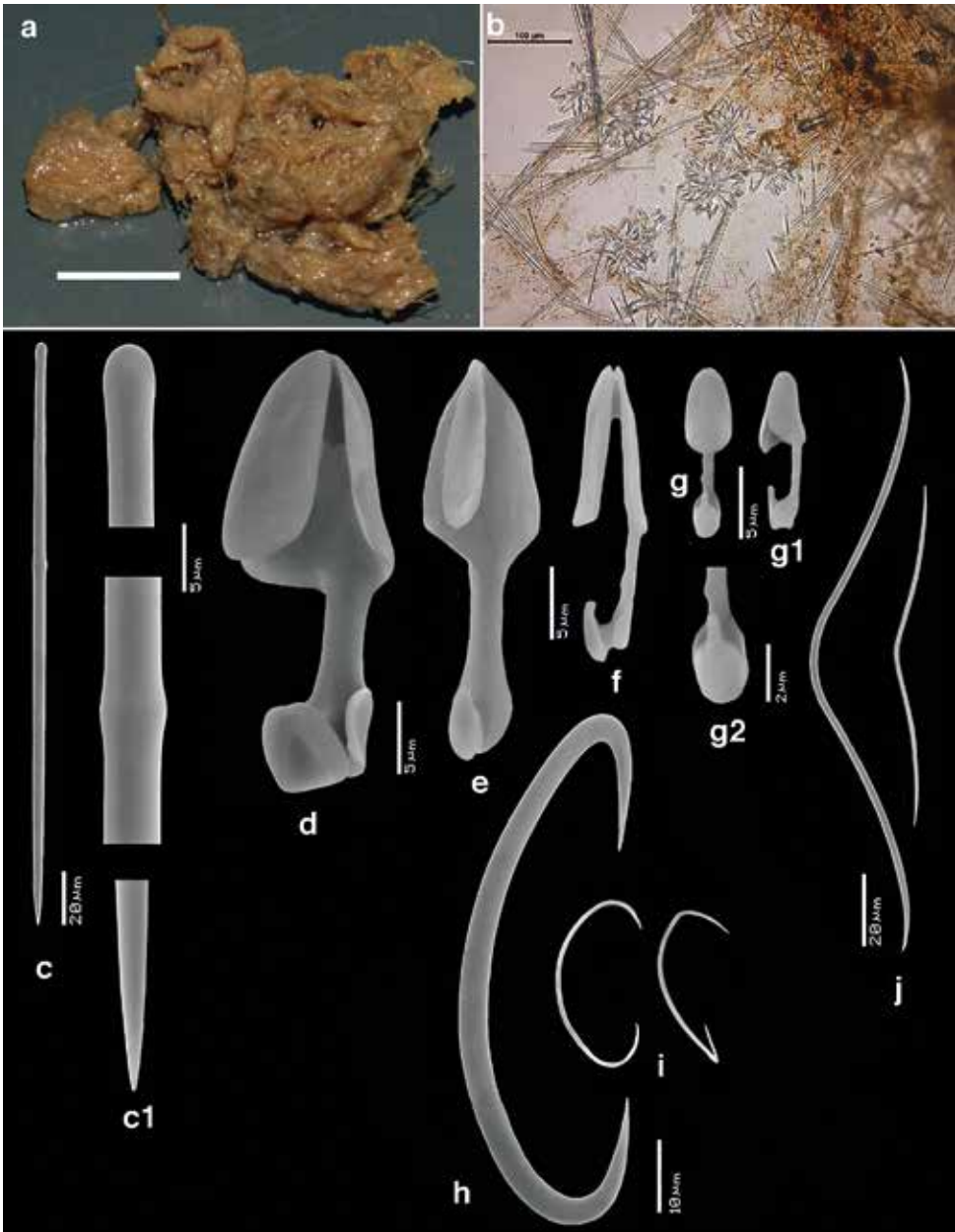


Fig. 12. *Mycale (Carmia) guineensis* spec. nov., holotype ZMUC DEM000325, ZMK 19d¹, a, habit (scale bar = 1 cm), b, tangential view of surface to show prominent rosettes of anisochelae 1, c-j, SEM images of the spicules, c, style, c1, details of style, d, anisochela 1, e, anisochela 1a with reduced lateral and frontal alae, f, anisochela 2, g, anisochela 3 in frontal view, g1, anisochela 3 in side view, g2, detail of lower frontal ala with spur, h, sigma 1, i, sigmas 2, j, toxas.

***Mycale (Carmia) macilenta* (Bowerbank, 1866)**
(figs 13a-i)

Restricted synonymy:

Hymeniacidon macilenta Bowerbank, 1866: 176.

Esperia macilenta; Vosmaer, 1880: 143.

Esperella macilenta; Topsent, 1894: 20.

Mycale macilenta; Stephens, 1912: 33 (not: Burton, 1956 = *M. (C.) guineensis* spec. nov.).

Mycale (Carmia) macilenta; Topsent, 1924: 105, figs 11-12; Van Soest et al. 2000 and online at http://species-identification.org/species.php?species_group=sponges&menuentry=soorten&id=332&tab=synoniemen (with further synonyms); Cruz, 2002: 150.

Material. — ZMA Por. 05694, Spain, Canary Islands, Tenerife, Banco Hondo, 28.27°N 16.14°W, coll. T. Cruz, field nr. E43, 9 April 1979; RMNH Por. unnumbered (slide only), Spain, Canary Islands, Hierro, SW coast, Puerto Orchilla, 0-7 m, 27.7°N 18.1167°W, snorkeling, coll. CANCAP 2 stat. K15, 5-8 September 1977.

Description. — Small patches (fig. 13a) encrusting worm tubes, undersides of stones and other hard surfaces. Largest fragment is 1.5 × 1 cm. Colour pale orange or yellow, grey in alcohol. Consistency soft.

Skeleton. — Wispy choanosomal spicule tracts (fig. 13b), 30-45 µm in diameter, consisting of up to 5-15 spicules in cross section, fan out at the surface; no special ectosomal spicule cover or skeleton. No rosettes of anisochelae were observed.

Spicules. — Styles, three size categories of anisochelae, two of sigmas, toxas.

Styles (figs 13c, c1), straight, sharply pointed with prominent rounded head and slight subterminal constriction, 249-277.5-297 × 2.5-4.7-6.5 µm.

Anisochelae 1 (fig. 13d), normal shaped, 28-37.8-44 µm.

Anisochelae 2 (fig. 13e), similar to anisochelae 1, but distinctly smaller, 17-22.7-27 µm.

Anisochelae 3 (fig. 13f), small, thin, with frontal alae pointed towards each other, 12-14.3-18 µm (overlapping slightly with anisochelae 2, but shaped differently).

Sigmas 1 (fig. 13g), robust, normal-shaped, 78-91.6-105 µm.

Sigmas 2 (fig. 13h), thin open, rather rare, 18-25.8-36 µm.

Toxas (fig. 13i), shallow-curved, with upturned apices, in an extreme size range, but not divisible into clearly demarcated categories, 7-81.2-204 µm.

Ecology. — Shallow-water.

Distribution. — Canary Islands; elsewhere common along the coasts of Europe and the Mediterranean.

Remarks. — Our material is considered to be conspecific with *Mycale (Carmia) macilenta* s.l. It seems to appear most similar to Topsent's (1924: 107) 'éponge de Banyuls'. The species is notoriously variable and may have one or more categories of chelae and sigmas rare or possibly absent. Several varieties have been proposed in the past (e.g. var. *hamata*, var. *florea*) but none of these appear distinguishable after thorough scrutiny.

Burton's (1956) record of this species from Guinea is referred above to a new species on account of its possession of a peculiar narrow anisochelae, next to normal-shaped anisochelae. In other respects it is similar to *M. (C.) macilenta*.

Lévi (1963: 12, fig. 6) reported the species from the Atlantic coast of South Africa, but his description differs considerably from that of our material and European records, including the presence of raphides of 10-11 µm. It is unlikely to be conspecific with the present species.

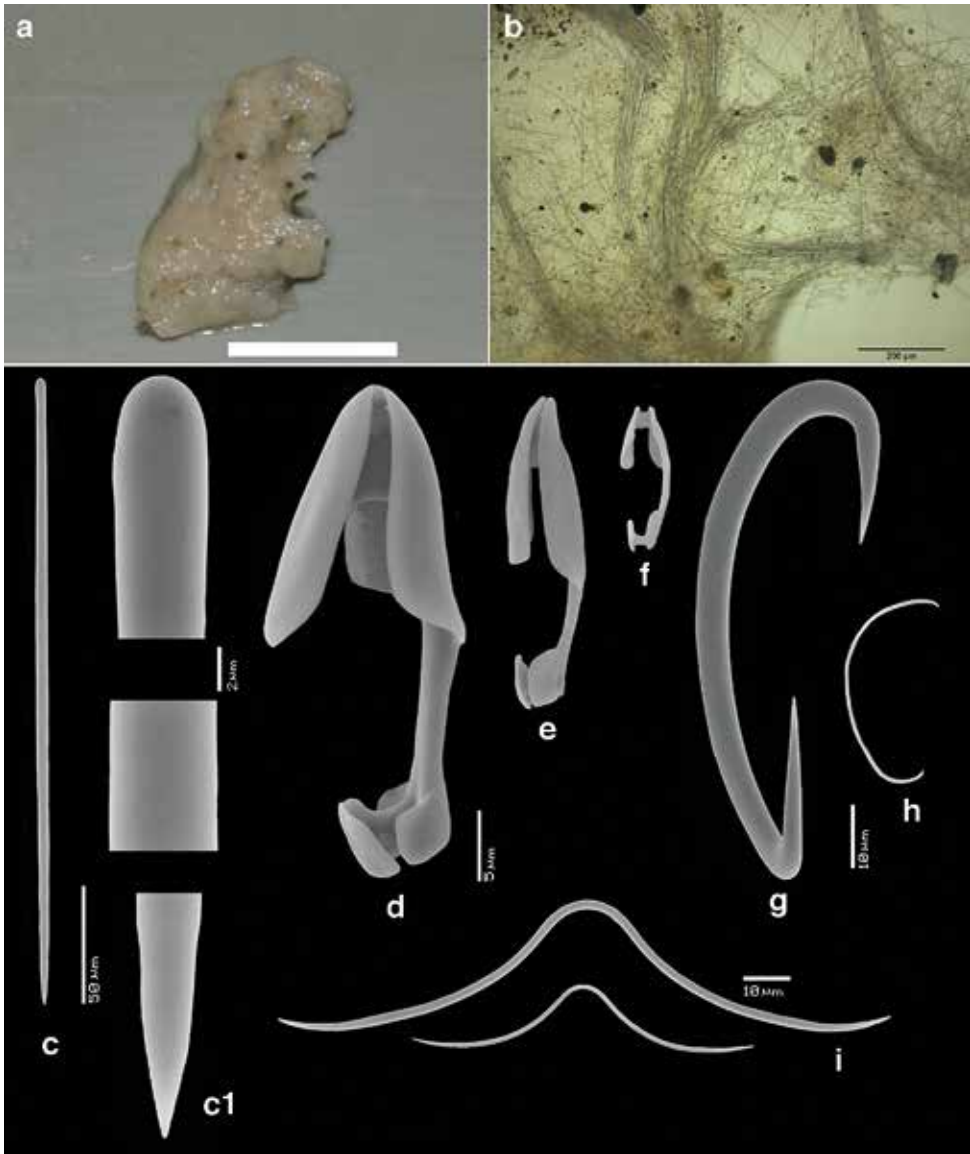


Fig. 13. *Mycale (Carmia) macilentata* (Bowerbank, 1866), ZMA Por. 05694 from the Canary Islands, a, preserved fragment (scale bar = 1 cm), b, cross section of skeleton (scale bar = 200 μ m), c-i, SEM images of the spicules, c, style, c1, details of style, d, anischela 1, e, anischela 2, f, anischela 3, g, sigma 1, h, sigma 2, i, toxas.

***Mycale (Carmia) senegalensis* Lévi, 1952**
(figs 14a-e)

Mycale senegalense Lévi, 1952: 46, fig. 11.

Mycale (Carmia) microsigmatosa sensu Cruz, 2002: 151 (? not: *Mycale fistulata* var. *microsigmatosa* Arndt, 1927: 144, pl. I fig. 9, textfig. 7a-d, see also Van Soest, 1984: 24).

?*Mycale sanguinea* Tsurumal, 1969: 349, figs 17-19.

Material. — ZMA Por. 20835, Ascension, coll. R. Irving, field nr. 310, 1985 (no further data).

Description. — Thin crust (fig. 14a) on volcanic rock and limestone concretion, beige in alcohol. Lateral size approximately 2 × 1 cm. Surface optically smooth, no apparent oscules. Consistency soft.

Skeleton. — Thin bundles of styles (fig. 14b), 20-30 µm in diameter (5-8 spicules in cross section), are erected perpendicularly on the substratum and run parallelly to the surface where they fan out to carry the organic surface membrane. No ectosomal skeleton. Overall spicular density low.

Spicules. — Styles, one size category of anisochelae, one size category of sigmas.

Styles (figs 14c, c1), straight, with elongate heads and wide axial canal, 213-225.5-249 × 2-2.7-3.5 µm.

Anisochelae (fig. 14d), open, with thin alae, 16-18.3-21 µm.

Sigmas (fig. 14e), elongate, 28-30.3-39 µm.

Ecology. — Shallow-water.

Distribution. — Ascension, Senegal, Tenerife (Cruz, 2002 as *M. (C.) microsigmatosa*); possibly Eastern Mediterranean (Tsurumal, 1969 as *M. sanguinea*).

Remarks. — The present material conforms closely to the original description of Lévi, 1952, and indeed appears almost indistinguishable from the Central West Atlantic species *M. (C.) microsigmatosa* Arndt, 1927. These species are likely members of a circumtropical species group which also includes Indian Ocean *M. (C.) tenuispiculata* (Dendy, 1905 as *Esperella*) and East Pacific *M. (C.) cecilia* De Laubenfels, 1936 (see also Desqueyroux-Faúndez & Van Soest, 1997; Carballo & Cruz-Barraza, 2010).

***Mycale (Carmia) subclavata* (Bowerbank, 1866)**
(figs 15a-j)

Hymeniacion subclavata Bowerbank, 1866: 209; Bowerbank, 1874: 93, pl. XXXVII figs 9-13.

Desmacidon similis Bowerbank, 1874: 312, pl. LXXXIX figs 14-20.

Mycale (Carmia) similis; Topsent, 1924: 109, fig. 13.

Mycale (Carmia) subclavata; Van Soest et al. 2000 and online at http://species-identification.org/species.php?species_group=sponges&menuentry=soorten&id=338&tab=synoniemen (with additional synonyms).

Material. — ZMA Por. 13351, Azores, Faial, Horta harbor, 38.5333°N 28.6333°W, 9 m, coll. D. Moss, Scuba, field nr. 150, 1989.

Description. — Orange encrustation (fig. 15a), lateral size 2 × 2 cm, thickness 2 mm. Surface smooth, no visible openings.

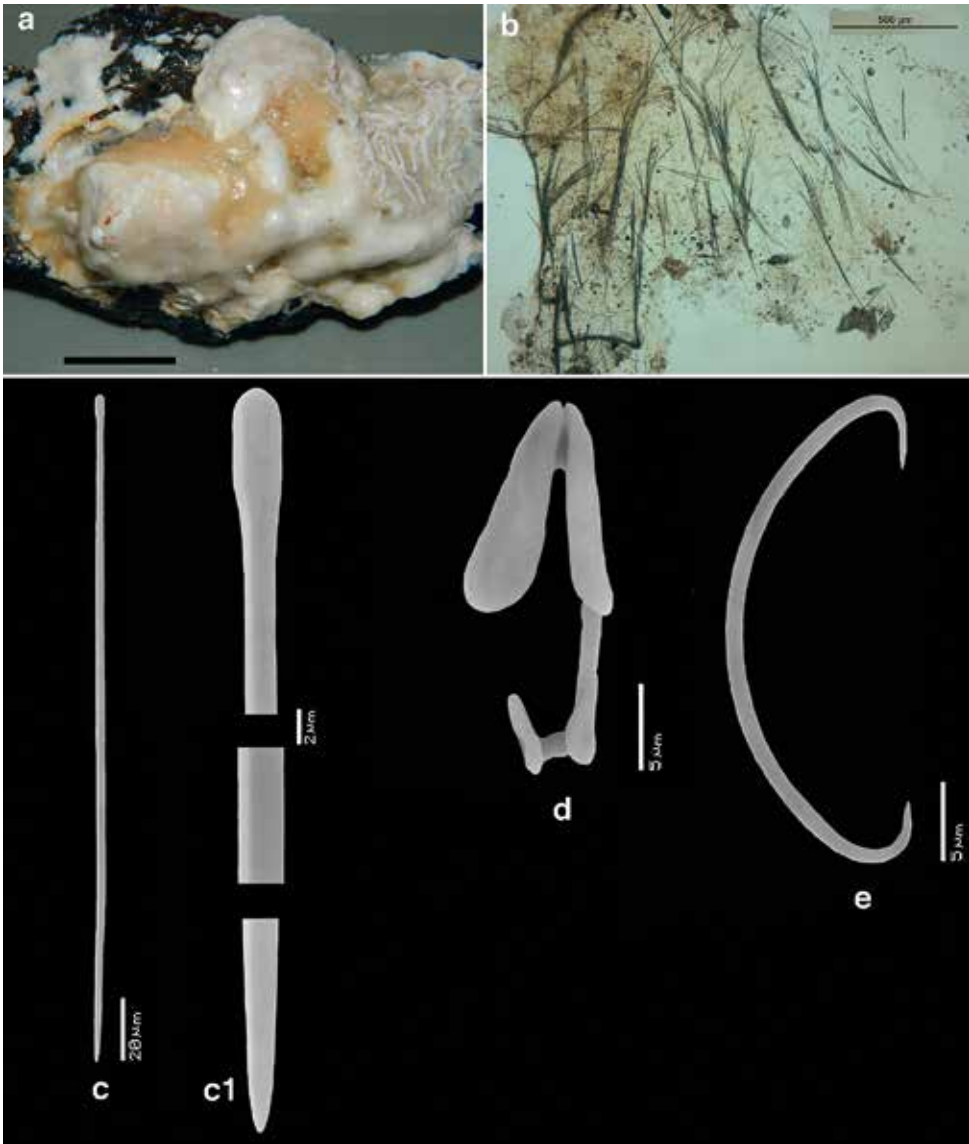


Fig. 14. *Mycale* (*Carmia*) *senegalensis* Lévi, 1952, ZMA Por. 20835 from Ascension Island, a, preserved habit (scale bar = 1 cm), b, cross section of skeleton (scale bar = 500 µm), c-e, SEM images of spicules, c, style, c1, details of style, d, anisochela, e, sigma.

Skeleton.— Overall spicular density high. The choanosomal skeleton consists of strongly developed spicule tracts (fig. 15b), up to 100 µm in diameter (up to 30 spicules in cross section), dendritically dividing and fanning out at the surface. There is no special ectosomal skeleton, the organic membrane contains scattered loose megascleres and many microscleres.

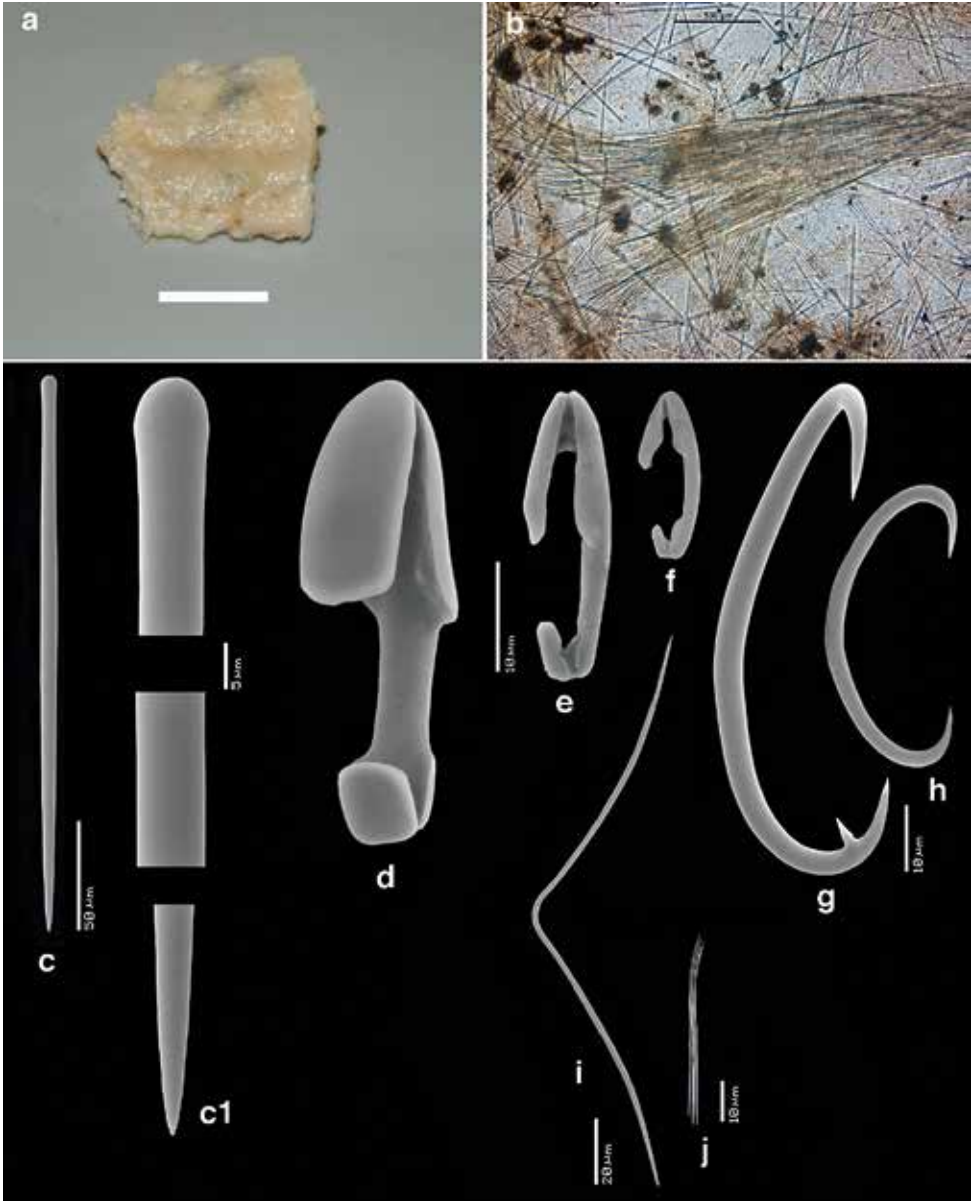


Fig. 15. *Mycale (Carmia) subclavata* (Bowerbank, 1866), ZMA Por. 13351 from the Azores, a, preserved habit (scale bar = 1 cm), b, cross section of skeleton (scale bar = 100 μ m), c-j, SEM images of the spicules, c, styles, c1, details of style, d, anisochelae 1, e, anisochela 2, f, anisochela 3, g, sigma 1, h, sigma 2, i, toxa, j, trichodragma.

Spicules. — Styles, anisochelae in three size categories, sigmas in two overlapping size categories, toxas, and trichodragmas. The various microsclere categories show unusual overlapping and generally a large size variation.

Styles (figs 15c, c1), subterminally elongately constricted, fusiform, variable in thickness, 243-264.6-288 × 2.5-7.1-9 µm.

Anisochelae 1 (fig. 15d), relatively rare, robust, with thick shaft, 30-31.8-34 µm.

Anisochelae 2 (fig. 15e), narrow, lateral alae thin, 19-22.4-25 µm.

Anisochelae 3 (fig. 15f), short alae and relatively robust shaft, 11-13.4-16 µm.

Sigmas 1 (fig. 15g), robust, elongately curved, 63-72.4-84 µm.

Sigmas 2 (fig. 15h), elongate, also robust, but thinner than sigma 1, 34-43.4-51 µm.

Toxas (fig. 15i), thin, widely but sharply curved, variable in size, 53-151.1-216 µm.

Trichodragmas (fig. 15j), thin, pointed at both ends, 33-53.4-75 × 2-3.8-7 µm.

Ecology. — Shallow-water.

Distribution. — Azores; elsewhere Mediterranean and Celtic Seas.

Remarks. — The Azores material conforms in all details with Topsent's (1924, as *M. (C.) similaris*) comprehensive treatment of this species.

Subgenus *Naviculina* Gray, 1867

Mycale (Naviculina) cruzi spec. nov.

(figs 16a-g)

Mycale (Aegogropila) sp. 1; Cruz, 2002: 149.

Material. — Holotype: ZMA Por. 07332, Cape Verde Islands, SW of Maio, Ponta Inglez / Ponta Preta, 15.1167°N 23.2333°W, 61 m, coll. R.W.M. van Soest, dredge, bottom calcareous nodules, CANCAP 7 Exped. stat. 059/21, 26 August 1986;

Not type material. — ZMA unnumbered (slide # E306), don. T. Cruz, Canary Islands, Tenerife, S coast, under stones.

Description. — Thinly encrusting, thickness 1-2 mm, lateral size several mm². Holotype is a soft yellow microconulose crust on barnacles (fig. 16a, arrow). The Canary Island material apparently was whitish (see Cruz, 2002).

Skeleton. — The ectosomal skeleton has a typical 'aegogropila' structure (fig. 16b) with intercrossing tangential spicule tracts, mostly two spicules per tract, occasionally single spicules. Rosettes of the larger anisochelae are crowded in the free spaces between the tracts. Rosettes are 70-80 µm in diameter and include approximately 15 chelae. Choanosomal skeleton with thick spicule tracts, 100-200 µm in diameter, which fan out in the subectosomal region to carry the surface skeleton.

Spicules. — Styles, anisochelae, naviculichelae, sigmas.

Styles (figs 16c, c1), fusiform, with clearly demarcated head, 288-319.9-345 × 5-6.4-8 µm.

Anisochelae 1 (fig. 16d), normal shaped, with broad lateral alae, smaller alae of lower half squarish, 31-38.9-43 µm.

Anisochelae 2 (figs 16e, e1, e2), naviculichelae, quite variable in shape, with upper frontal alae thin, erected on a wide ridge, whereas lower frontal alae are more or less as in normal shaped anisochelae; upper lateral alae either thin or broader, in which case

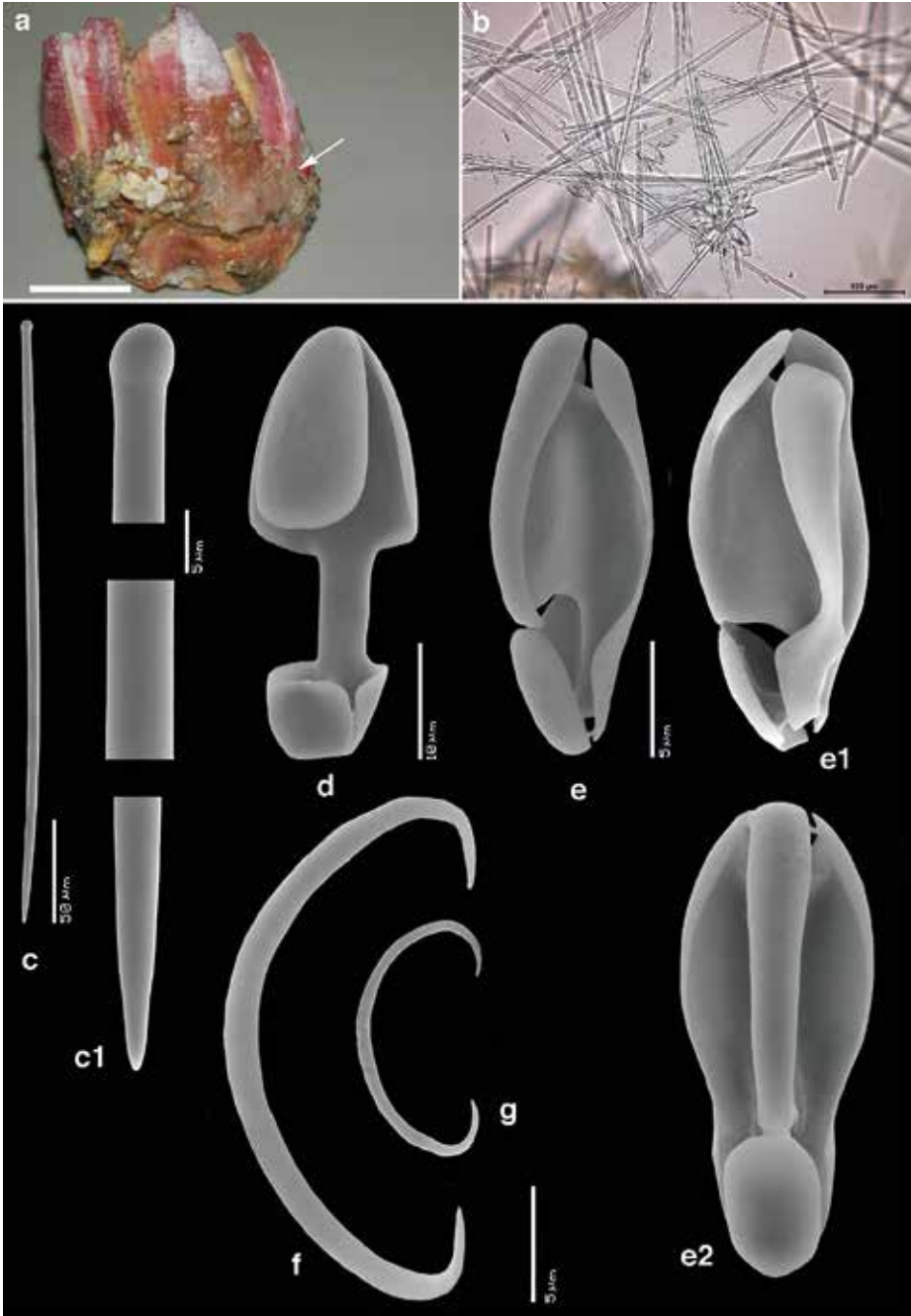


Fig. 16. *Mycale* (*Naviculina*) *cruzi* spec. nov., holotype ZMA Por. 07332 from the Cape Verde Islands, a, preserved habit (arrow) (scale bar = 1 cm), b, tangential view of the surface skeleton, c-g, SEM images of the spicules, c, style, c1, details of style, d, anisochela 1, e, anisochela 2 (naviculochela) in side view, e1, variation of naviculochela in side view, e2, naviculochela in frontal view, f, sigma 1, g, sigma 2.

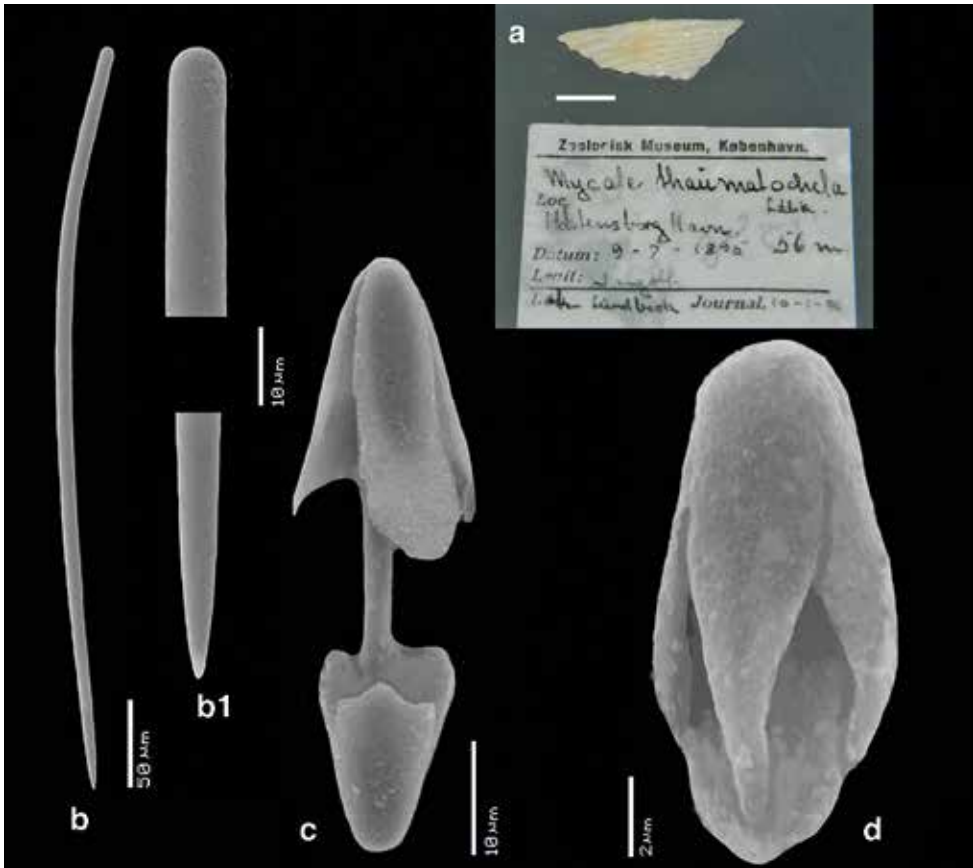


Fig. 17. *Mycale (Naviculina) thaumatochela* Lundbeck, 1905, lectotype from ZMUC-DEM-000323 J, a, habit encrusting a bivalve shell fragment (scale bar = 1 cm), b-d, SEM images of spicules, b, style, b1, details of style, c, anisochela 1, d, anisochela 2 (naviculochela).

the alae show a deep groove; size quite variable, at first glance seemingly divisible in two size classes, but these cannot be distinguished after measuring 25 or more spicules, so a single size is given here, 15-20.3-26 μm .

Sigmas 1 (fig. 16f), normal shaped but with relatively strongly incurved apices, large and thick, 29-46.2-54 μm ,

Sigmas 2 (fig. 16g), small and thin, 10-15.3-24 μm .

Ecology. — On hard substratum, down to 61 m.

Distribution. — Cape Verde Islands, Tenerife.

Etymology. — Named after Tomás Cruz Símo, who described this species for the first time from Tenerife, and also to honour his excellent monograph on the marine sponges of the Canary Islands.

Remarks. — A difference with Cruz' description of *Mycale (Aegogropila)* spec. 1 is that he recorded raphides and toxas. Of the latter, only small toxas were found in the slide donated by Cruz to the ZMA collection, but their virtually triangular shape reminds

rather strongly of Haplosclerida, for instance those of *Haliclona marismedi* reported also from Tenerife by Cruz. Since the other spicules, including the distinctive naviculichelae, conformed closely to those of the Cape Verde Island specimen, we conclude that the toxas are likely contaminants.

Through its peculiar naviculichelae this species belongs to a worldwide assemblage of *Mycale* species grouped in the subgenus *Naviculina*, revived by Hajdu (1999) and further conformed by Van Soest & Hajdu (2002). The World Porifera Database (Van Soest et al. 2014) lists 11 species of *Mycale* (*Naviculina*), only one of which, *M. (N.) thaumatochela* Lundbeck (1905) is from the North Atlantic. This species, reported from Arctic waters [West and East Greenland, Kara Sea, Okhotsk and Bering Sea, cf. Lundbeck (1905), Hentschel (1929) and Koltun (1959)], differs clearly from our material in the absence of sigmas, and having larger normal isochelae (47–60 μm) and smaller naviculichelae (12–17 μm). We borrowed type material from the Copenhagen Museum. There were two small tubes, one of which did not contain any remaining material, while the other consisted of a few thin tissue lines encrusting the ridges of a small bivalve shell fragment (fig. 17a). Nevertheless, we were able to study the spicules under SEM, from this fragment, which we hereby select as lectotype. We found the spicules much eroded (see figs 17c–d), but conforming closely to Lundbeck's (1905) description. The naviculichelae of *M. thaumatochela* appear rather different in shape from our new species in lacking the lower frontal ala entirely.

A very close representative of this group of species is the Brazilian *M. (N.) acuiris* Lerner & Hajdu (2002). In fact the only difference is the size range of the small sigmas, which is limited to 9–14 μm , whereas those of our new species are up to 24 μm . It is another example of close correspondence of species on both sides of the deep Central Atlantic. Elsewhere, South Korean species bearing naviculichelae appear also close to our new species: *Mycale (N.) neunggulensis* Sim & Kang (2004) from South Korea is similar in spicule complement (styles, anisochelae, naviculichelae and two size categories of sigmas), with the only difference appearing to be the size of the mycalostyles (430–600 \times 5–15 μm), clearly exceeding the mycalostyles of our new species. *M. (N.) chungjae* Lerner & Hajdu (2002) (replacement name for the preoccupied *Mycale hentscheli* Sim & Lee, 2001) appears also close, but it lacks the larger category of sigmas, whereas *M. (N.) ulleungensis* Sim & Kang (2004) lacks the smaller category of sigmas. The remaining representatives of the subgenus appear more distant in having toxas in the microsclere complement, lacking normal anisochelae, or having peculiar flagelliform sigmas.

Subgenus *Paresperella* Dendy, 1905

Mycale (Paresperella) janvermeuleni spec. nov. (figs 18a–f)

Material. — Holotype: ZMA Por. 20615a, Cape Verde Islands, Brava, Porto do Fajã, 14.87°N 24.73°W, 0–5 m, underside of corals, coll. J.H. Stock & J.J. Vermeulen, field nr. 86–72, 15 January 1986.

Description. — Thin, orange-red, semi-transparent encrusting sponge on an oyster overgrown by algae (fig. 18a, arrows). Size of several patches less than 0.5 \times 0.5 cm. Soft consistency.

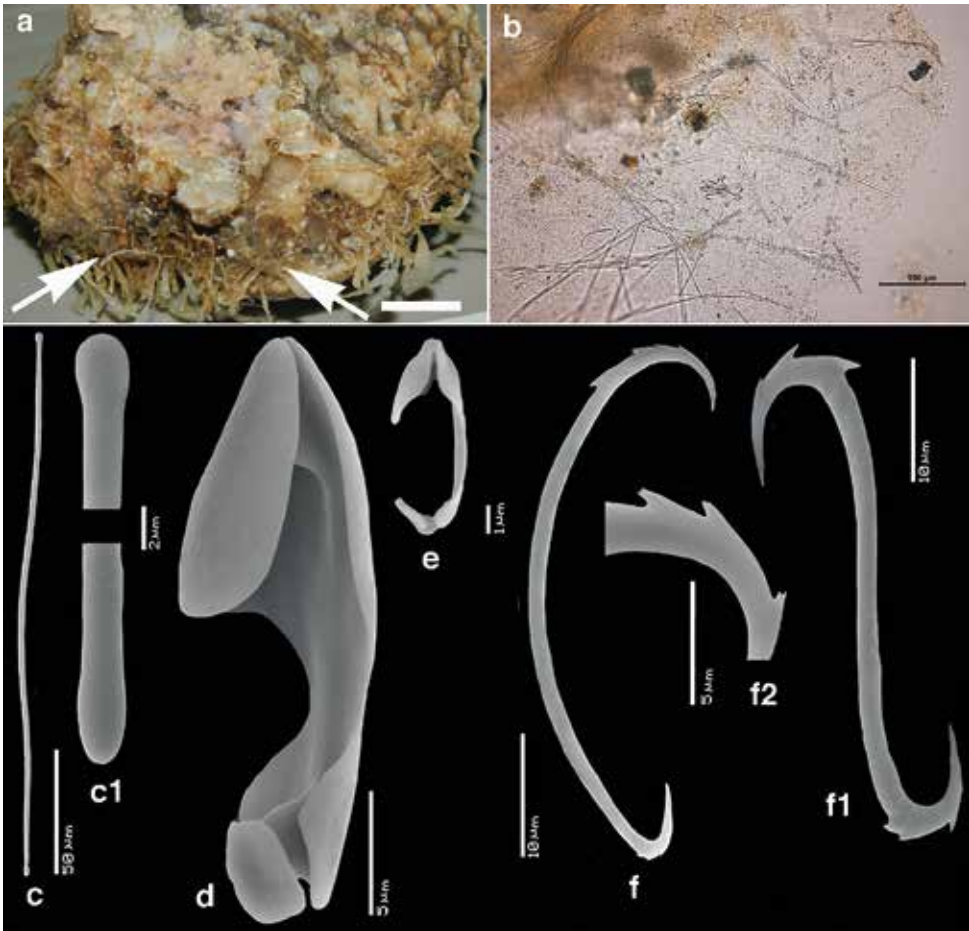


Fig. 18. *Mycale* (*Paresperella*) *janvermeuleni* spec. nov., holotype ZMA Por. 20615a, a, preserved patches (arrows) on oyster shell overgrown with algae and bryozoans (scale bar = 1 cm), b, tangential view of surface skeleton (scale bar = 100 µm), c-f, SEM images of spicules, c, anisostrongyle, c1, details of anisostrongyle, d, anisochela 1, e, anisochela 2, f, spined sigma, f1, s-shaped variation of spined sigma, f2, detail of spined sigma.

Skeleton.— Technically ‘aegogropila’-like (fig. 18b), with thin intercrossing tracts at the surface, 1-3 spicules in cross section, carried by thin choanosomal tracts (20-40 µm in diameter) fanning out to support the ectosomal skeleton. Few rosettes situated in between the surface tracts, 45-60 µm in diameter, with up to 20 chelae in each.

Spicules.— Anisostrongyles/anisotylotes, two size categories of isochelae, serrated sigmas.

Stylote megascleres in majority with rounded ends on both sides (fig. 18c, c1), with ‘normal’ swollen heads and subterminal constriction as is usual for mycalostyles, with the opposite end swollen elongatedly, or simply strongylote, shaft thin, straight or wispy, 189-222.2-237 × 1.5-2.1-3 µm.

Anisochelae 1 (fig. 18d), normal shaped, with lateral alae almost touching along the shaft, 18-22.8-28 μm .

Anisochelae 2 (fig. 18e), tiny, with small thin alae, 6-7.7-9 μm .

Sigmas (fig. 18f, f1, f2), thin, relatively narrow, with strong hooks/spines on the upper and lower curves, 40-44.3-51 μm .

Ecology. — Shallow water, under corals.

Distribution. — Only known from the type locality, Cape Verde Islands, on the W coast of Brava.

Etymology. — Named for Jan J. Vermeulen, for many years the collection manager of the ZMA sponge collection, to acknowledge his efforts and for collecting this specimen during the 1986 'Plancius' cruise.

Remarks. — In the East Atlantic - Mediterranean region, three species of *Mycale* (*Paresperella*) have been described, viz. *M. (P.) atlantica* (Stephens, 1917), *M. (P.) dentata* Sarà (1958), and *M. (P.) serrulata* (Sarà & Siribelli, 1960). Off the Atlantic coast of Namibia and South Africa a further two species have been recorded, *M. (P.) toxifera* (Lévi, 1963) and *M. (P.) levii* (Uriz, 1987). Across the Atlantic another two species are found, *M. (P.) spinosigma* (Boury-Esnault, 1973) and *M. (P.) vitellina* Van Soest (2009). None of these species possess such small anisochelae 2 (6-9 μm), such small serrated sigmas (40-50 μm), and anisostrongyles for megascleres as occur in our specimen. Closest are *M. (P.) dentata* and *M. (P.) vitellina*, which have anisochelae 2 measuring 10-20 μm , but both have larger sigmas (70-90 μm). *M. (P.) spinosigma* has both large styles and oxeas for megascleres and much larger sigmas (up to 156 μm), which combination is peculiar and supports Hajdu & Rützler's (1998) observation that this may not be a *Mycale* species at all. *M. (P.) atlantica* and *M. (P.) toxifera* possess toxas, and have much larger megascleres. *M. (P.) serrulata* and *M. (P.) levii* do not have anisochelae 2 at all, and have larger megascleres and sigmas.

Subgenus *Rhaphidotheca* Kent, 1870

Mycale (Rhaphidotheca) verdensis spec. nov.

(figs 19a-k)

Material. — Holotype: ZMA Por. 21304, Cape Verde Islands, SE of Cima, 14.95°N 24.6333°W, depth 650-720 m, coll. R.W.M. van Soest, 1.2 m Agassiz trawl, bottom with gorgonians, CANCAP 7 Expedition stat. 040, 24 August 1986.

Description. — Thick rounded greyish brown crust (fig. 19a) on dead *Lophelia* coral, size 2.5 cm in diameter, 0.5 cm thick. Surface divided up into low rounded hillocks separated by thin grooves, hispid; consistency firm, rough.

Skeleton. — At the surface tangential spicules are confusedly arranged ('mycale' ectosome) (fig. 19b), among exotyles and styles protruding beyond the surface; choanosomal skeleton consisting of thick spicule tracts, 120-180 μm in diameter, which fan out in the subectosomal region to carry the tangential surface skeleton. The anisochelae do not form rosettes.

Spicules. — Styles, exotyles, anisochelae in three size categories, sigmas in three size categories, trichodragmas.

Styles (figs 19c, c1), fusiform, polytylote, oxea-like with thin blunt head and sharp point at the opposite end, 517-750.1-912 \times 13-17.2-21 μm .

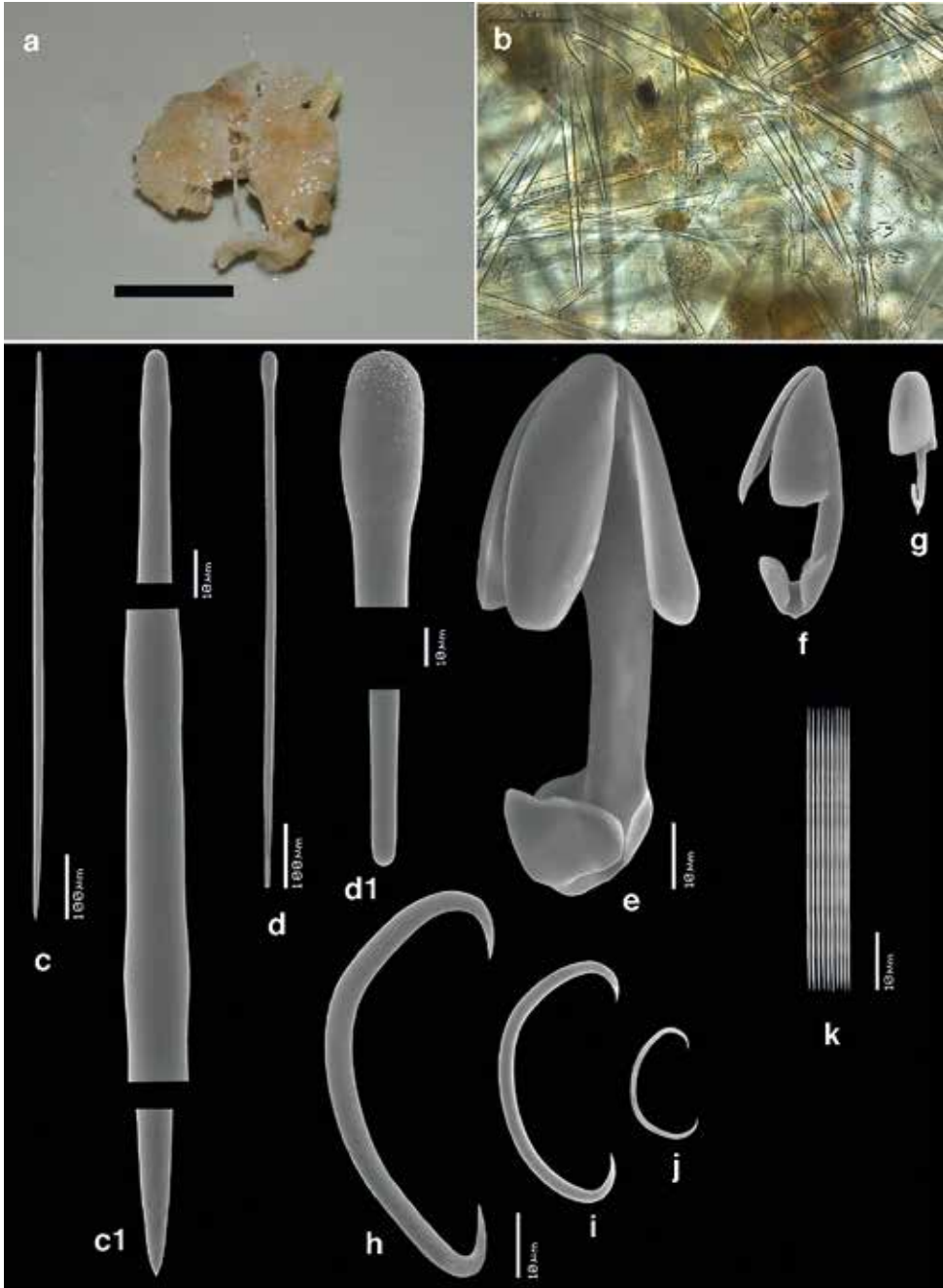


Fig. 19. *Mycale* (*Rhaphidotheca*) *verdensis* spec. nov., holotype ZMA Por. 21304, a preserved habit (scale bar = 1 cm), b, tangential view of surface skeleton (scale bar = 100 μ m), c-k, SEM images of spicules, c, style, c1, details of style, d, exotyle, d1, details of exotyle, e, anisochele 1, f, anisochele 2, g, anisochele 3, h, sigma 1, i, sigma 2, j, sigma 3, k, trichodragma.

Exotyles (figs 19d, d1), with relatively thin elongate tyle, which is microspined in approximately one third of the upper part, with the point tapering to a bluntly rounded end, entire spicule 776-834.1-903 × 15-16.4-19 μm, swollen tyle 60-74.3-84 × 24-29.8-36 μm.

Anisochelae 1 (fig. 19e), robust, with relatively narrow frontal upper ala, and shaft protruding slightly beyond the lower alae, 91-101.5-111 μm.

Anisochelae 2 (fig. 19f), the most common microsclere, with broad long upper alae, and slight spur on the lower shaft, 36-41.4-45 μm.

Anisochelae 3 (fig. 19g), not very common, with barely developed lower alae, showing just a thin front ala and lacking any side alae, shaft ending in a sharp spur; upper frontal alae broad covering the lateral alae almost completely, 18-20.2-22 μm.

Sigmas 1 (fig. 19h), robust, normal shaped, 54-64.7-75 μm.

Sigmas 2 (fig. 19i), also robust, with slightly incurved apices, 38-42.7-49 μm.

Sigmas 3 (figs 19j), most common, thin, with slightly incurved apices, 16-19.2-22 μm.

Trichodragmas (fig. 19k), not very common, 48-62.3-65 × 9-24 μm, individual raphides less than 1 μm in thickness.

Ecology.— On deep-water coral beds, at greater depth (down to 720 m).

Distribution.— Known only from the type locality off the Cape Verde Islands.

Etymology.— Named after the type locality (Cape Verde Islands).

Remarks.— The new species stands out among North Atlantic *Mycale* (*Rhaphidotheca*) species because of its diversity of chelae and sigmas. No other specimens have been described possessing three distinct categories of anisochelae and three categories of sigmas. In most other respects the new species is similar to the common North Atlantic *Mycale* (*Rhaphidotheca*) *marshallhalli* (Kent, 1870), which shares the sizes and shapes of the styles, exotyles, large and middle-sized anisochelae, small sigmas and trichodragmas. We were able to compare our new species with a dozen specimens assigned to this species in the ZMA collection from Norway and Ireland. Minor differences are the wider tyles of the exotyles and the shorter frontal alae of the largest anisochelae in *M. (R.) marshallhalli*. None of these specimens had the smallest chela category nor the large sigmas. Apparently, in *M. (R.) marshallhalli* the largest chelae do occur in rosettes, unlike in our new species.

The second North Atlantic species, *M. (R.) loricata* (Topsent, 1896), differs more strongly in having peculiarly flattened tyles on the exotyles and much shorter length of both styles and exotyles, and smaller anisochelae of the largest category. Likewise, the Arctic species *M. (R.) arctica* (Hentschel, 1929), has overall smaller spicules.

The smallest anisochela category is also reported for Indian Ocean *Mycale* (*Rhaphidotheca*) *coronata* (Dendy, 1926); this species has peculiar exotyles with a crown of spines.

The only report of large sigmas in *Mycale* (*Rhaphidotheca*) similar to those of our new species was made by Green & Bakus (1994). These authors described a '*Rhaphidotheca ? rhopalophora*' specimen collected off the coast of California with two categories of anisochelae, sigmas of 55-62 μm, and trichodragmas. The styles and exotyles were only up to 450 μm, and no smallest categories of anisochelae and sigmas, similar to those reported here, were present. It is likely that this material belongs to an undescribed species.

The subgenus *Rhaphidotheca* is well established in the Northern North Atlantic at least since the Middle Miocene, as Bukry (1979: pl. 8 figs 1-3) reported isolated exotyles very similar to those of *M. (R.) marshallhalli* and *M. (R.) loricata* from deep-sea cores taken SW of Iceland.

Subgenus *Zygomycale* Topsent, 1930*Mycale (Zygomycale) sierraleonensis* spec. nov.
(figs 20a-l)

Mycale contarenii sensu Burton, 1956: 128 (not: *Halichondria contarenii* Lieberkühn, 1859)

Material. — Holotype ZMUC-DEM-000326 (ZMK 26a), Sierra Leone, off Freetown, 8.5°N 13.23°W, 15 m depth, Atlantic Exped. stat. 141, 9 April 1946.

Examined for comparison. — *Mycale (Zygomycale) angulosa* (Duchassaing & Michelotti, 1864), ZMA Por. 14338, Curaçao, St. Jorisbaai, 12.132°N 68.806°W, 4–6 m, coll. E. Kardinaal, Scuba, fieldnr. 98/CU/JUN16/MK205, 16 June 1998.

Description. — Massively growing together with other sponges (notably an encrusting haplosclerid), corals and other benthic invertebrates (fig. 20a); also overgrown itself. The combined mass reaching a size of 20 × 16 cm, thickness up to 1 cm. Oscules not apparent. Consistency firm, but easily damaged.

Skeleton. — ‘Aegogropila’ structure, with an ectosomal network of intercrossing spicule tracts (fig. 20b-c), 20–50 µm in diameter containing 2–8 spicules in cross section, forming triangular meshes of up to 200 µm in diameter. The choanosomal skeleton consists of spicule tracts of up to 120 µm in diameter containing up to 15 spicules in cross section, which subdivide peripherally into thinner tracts carrying ectosomal skeleton.

Spicules. — Styles, anisochelae, isochelae, sigmas in three size categories, toxas, trichodragmas.

Styles (figs 20d, d1), straight, with elongate heads and elongately constricted neck, 294–327.8–360 × 7–8.9–11 µm.

Anisochelae 1 (fig. 20e), robust, compact, arranged in rosettes, 48–52.9–58 µm.

Anisochelae 2 (fig. 20f), compact with relatively long upper alae, almost touching the robust lower alae, 21–23.4–28 µm.

Isochelae (figs 20c, 20g), rather robust, very slightly anisochelate, 10–11.6–13 µm.

Sigmas 1 (fig. 20h), robust, sharp points, 75–81.8–94 µm.

Sigmas 2 (fig. 20i), thin, rather symmetrical, 26–32.6–38 µm.

Sigmas 3 (fig. 20j), thin, rather symmetrical, often with slightly inturned apices, 15–18.5–24 µm.

Toxas (fig. 20k), mostly in dragmas, thin, with shallow curve and slightly upturned apices, 24–67.9–99 µm, dragmas 4–5 µm in thickness.

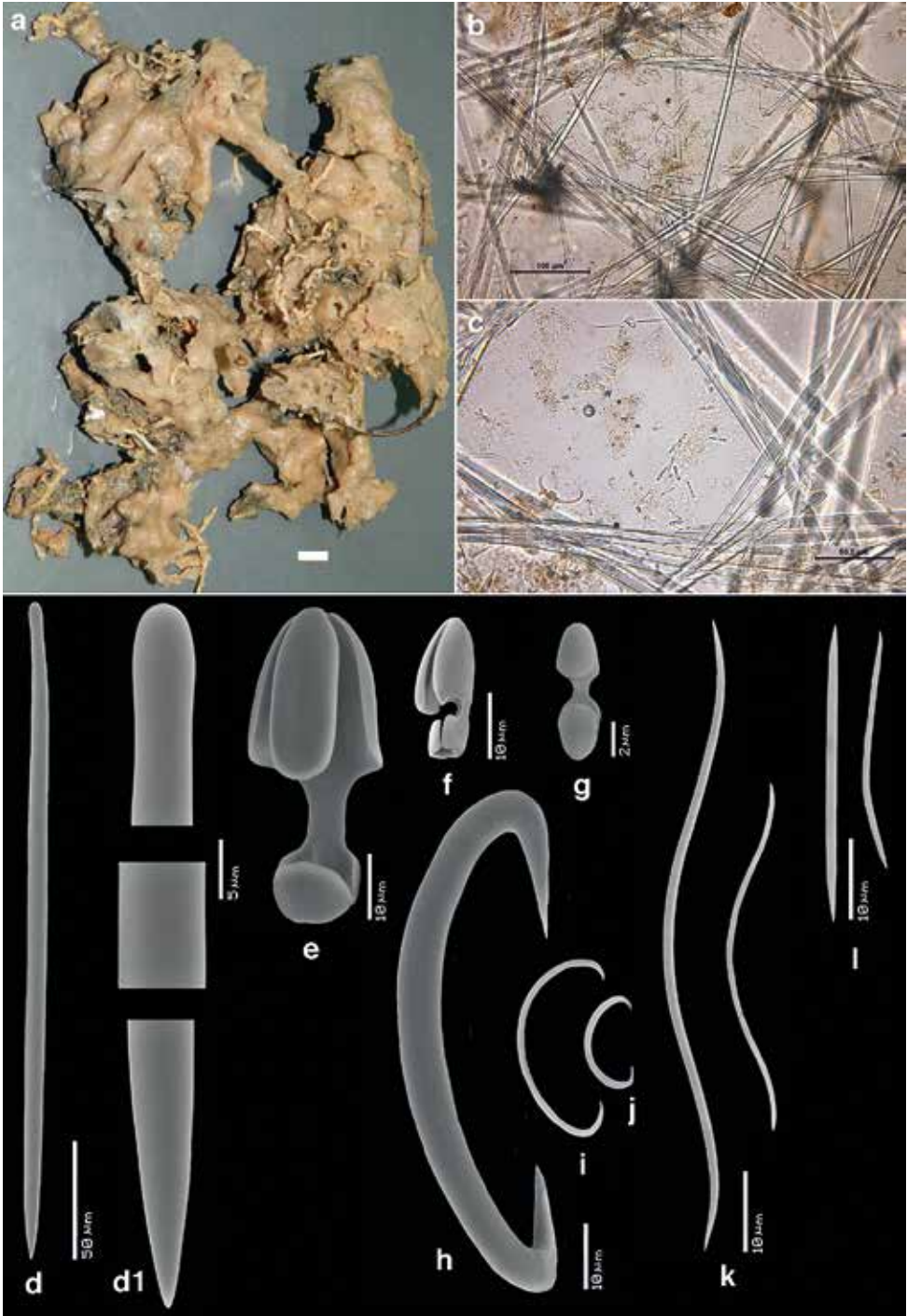
Trichodragmas, straight or slightly curved, 25–29.3–36 µm, dragmas 5–8 µm in thickness, individual raphides (figs 20l), straight or curved, 25 × 1 µm.

Ecology. — Shallow water, 15 m.

Distribution. — Off the coast of Freetown, Sierra Leone.

Etymology. — The name refers to the type locality.

Remarks. — The new species is very close to the West Atlantic *M. (Z.) angulosa* (Duchassaing & Michelotti, 1864 as *Pandaros*), as spicule sizes and categories are almost indistinguishable in both (as measured in ZMA Por. 14338 from Curaçao). Compared to the most detailed description (Van Soest, 1984: 16), which included the type of *Pandaros angulosa*, Mus. Torino POR. 54, only one feature appears distinctly different, viz. the possession in our new species of a third category of sigmas lacking in the Caribbean



species. In combination with the distance and the ocean depths separating the Gulf of Guinea and the Central West Atlantic, this difference is judged to be indicating the two are closely related but different species. Furthermore, all spicules in our new species appear slightly larger than those of *M. (Z.) angulosa*, but these differences do not appear significant.

We do not know the colour of the present material, but the Caribbean species may be purple (Hechtel, 1965 as *Zygomycale parishii*) or (greyish) blue (Lehnert & Van Soest, 1998). Although the habit of the Caribbean material is basically also encrusting, it is often described as forming upright branches and bushes, which is not clearly the case in our specimen, as it appears to be encrusting branching substratums, rather than forming branches itself.

With the present record, the subgenus *Zygomycale* is established as a circumtropical monophyletic species group, occurring in West Africa, the Central West Atlantic, the East Pacific (*M. (Z.) ramulosa* Carballo & Cruz-Barraza, 2010) and the Indo-West Pacific [*M. (Z.) parishii* (Bowerbank, 1875)].

Additional species of *Mycale* in Northwest African waters

Next to the sixteen species described above, a further six *Mycale* species have been reported from the region considered here. We briefly characterize these reports to complete this monographic treatment of the *Mycale* species of Northwest Africa and the offshore Atlantic islands.

Mycale (Mycale) lingua (Bowerbank, 1866)

Mycale (Mycale) lingua; Boury-Esnault et al. 1994: 96, fig. 70.

Description.— Massive shapes or thick columns, yellow or dirty white, with irregular furrowed surface and large oscules. The Gulf of Cadiz specimen reported by Boury-Esnault et al. 1994 was fragmented. Choanosomal skeleton an irregular dendritic reticulation of thick spongin-enforced spicule tracts, ectosomal skeleton a tangential mass of individual spicules and irregular tracts. Spicules styles (350-560-620 × 8-9.5-17 μm), large anisochelae (60-68-77 μm) forming rosettes, middle anisochelae (28-34-38 μm), small anisochelae (16-18-20 μm), small thin sigmas (14-19-28 μm), and trichodragmas (50-63-74 μm).

Ecology and distribution.— Dredged at a depth of 520 m in the Gulf of Cadiz. Elsewhere, the species occurs in deeper water in the North Atlantic and the Arctic.

Comment.— The spicule size data conform closely to the description of *M. (M.) lingua* by Topsent (1924).

◀ Fig. 20. *Mycale (Zygomycale) sierraleonensis* spec. nov., holotype ZMUC DEM000326, ZMK 26a, a, preserved habit (scale bar = 1 cm), b, tangential view of surface skeleton (scale bar = 100 μm), c, detail of surface showing scattered isochelae (scale bar = 50 μm), d-l, SEM images of spicules, d, style, d1, details of style, e, anisochela 1, f, anisochela 2, g, isochela, h, sigma 1, i, sigma 2, j, sigma 3, k, toxas, l, raphides from trichodragmas.

***Mycale (Aegogropila) tunicata* (Schmidt, 1862)**

Esperella tunicata; Topsent, 1904: 200.

Description.— A yellow branching sponge with conulose surface (Gugel et al. 2006). The Azores material of Topsent consisted of fragments. ‘Aegogropila’ ectosomal skeleton, choanosomal skeleton of thick spicule tracts fanning out to the surface. Spicules styles ($435 \times 9 \mu\text{m}$), large anisochelae ($50 \mu\text{m}$) forming rosettes, two other categories were not mentioned by Topsent (1904), but subsequently reported to be present in Topsent (1924: 99), and trichodragmas ($40 \mu\text{m}$). Topsent (1904) also mentioned rare sigmas of $28 \mu\text{m}$, but declared them subsequently as foreign in Topsent (1924: 99).

Ecology and distribution.— Dredged at 98 m depth, SE of Pico, Azores. Elsewhere the species occurs in the Mediterranean (e.g. Gugel et al. 2006) and west of Ireland (Van Soest et al. 2007).

Comment.— Topsent’s (1904) description is not convincing, but he included this material in his redescription of the species in his 1924 review.

***Mycale (Anomomycale) titubans* (Schmidt, 1870)**

Mycale (Anomomycale) titubans; Topsent, 1924: 116, fig. 16.

Description.— No clear description of the habit was given by Topsent, but from other authors reporting this species (Schmidt, 1870: 55; Carter, 1882: 298; Lundbeck, 1905: 41) it may be deduced that it is a small irregular yellow form. The skeleton is a polyspicular reticulation of large styles ($875 \times 27 \mu\text{m}$), while at the surface there are loose smaller styles ($430 \times 8 \mu\text{m}$). The major feature of the species is the possession of a single category of peculiar ‘cleistochelate’ anisochelae, 21–35 μm in length, which apparently occur in rosettes (Carter, 1882: 298). Sigmas in a large size range but apparently not divisible in size categories, 50–130 μm .

Ecology and distribution.— At 845 m SW of Terceira, Azores. Elsewhere reported from deep water off Iceland, Florida and Bretagne.

Comment.— Possibly, this species does not belong to the genus *Mycale* (cf. 18S results in Hajdu et al. 2013).

***Mycale (Carmia) fascibula* (Topsent, 1904)**

Esperella fascibula Topsent, 1904: 201, pl. XVII fig. 7.

Mycale fascibula; Stephens, 1921: 22.

Mycale (Carmia) fascibula; Topsent, 1924: 115.

Description.— Tiny whitish or brownish patches on deep-water corals. Consistency soft. Skeleton consists of dendritic tracts of megascleres. The surface membrane is charged with microscleres. Spicules polytylote styles ($410 \times 7 \mu\text{m}$), large anisochelae ($40\text{--}45 \mu\text{m}$), small anisochelae ($24\text{--}25 \mu\text{m}$) (no third category of anisochelae), huge sigmas (often in groups, up to $270 \times 10 \mu\text{m}$), small sigmas ($30\text{--}40 \mu\text{m}$), toxas in toxodragmas ($25\text{--}40 \mu\text{m}$) (in the original description these were considered raphides).

Ecology and distribution.— At greater depths (153-800+ m) on dead corals. Reported from the Azores (Topsent, 1904), off the coasts of Ireland (Stephens, 1921), SE of Rockall Bank (Van Soest et al. 2007) and off the W coast of Scotland (Roberts et al. 2009).

Comment.— This is a northern deep-water species, recognizable by its excessively large sigmas.

Mycale (Carmia) fusiformis Lévi, 1960

Mycale fusiformis Lévi, 1960: 754, fig. 9.

Description.— This sponge apparently forms a single branch of 3.5 cm long and 0.8 cm in diameter on a thin stalk of 2 mm. It is greyish white in alcohol. Surface smooth, without openings. The skeleton is axially condensed, with spicule tracts verging outwards from the center of the sponge. The surface membrane contains numerous microscleres, including rosettes of anisochelae. Spicules styles (200-280 × 8-11 μm), large anisochelae (68-75 μm), small anisochelae (25-27 μm) (apparently no third category of isochelae), large sigmas (42-47 μm), middle sigmas (25 μm), small sigmas (18 μm), raphides (35-36 μm).

Ecology and distribution.— At intermediate depths (35-42 m), Senegal, between Ile Gorée and Cap Manuel (16.65°N 17.4°W).

Comments.— The species has a similar shape as *Mycale (Aegogropila) syringosimilis* spec. nov., but differs substantially in spicule categories and sizes.

Mycale (Carmia) micracanthoxea Buizer & Van Soest, 1977

Mycale micracanthoxea Buizer & Van Soest, 1977: 299, pl. I figs 1-8, pl. 2 figs 1-6; Carballo & García-Gómez, 1994: 13, fig. 2.

Mycale (Carmia) micracanthoxea; Cruz, 2002: 152.

Description.— Smooth orange encrustation under stones, size small. Surface with veins radiating from small oscules. Skeleton consists of vertical columns of styles and single loose styles. Spicules styles (250-290 μm), large anisochelae (33-41 μm), small anisochelae (13-25 μm), large sigmas (80-92 μm), small sigmas (13-33 μm), toxas deeply curved (40-250 μm), and micracanthoxeas (8-10 μm).

Ecology and distribution.— Under stones in shallow-water, in the southern part of Tenerife; elsewhere known from SW Netherlands and Strait of Gibraltar.

Comments.— This rare species was first reported from The Netherlands, but it is likely it has arrived there from the south by transport of oyster spat. Possibly, the Canary Islands was the source population.

Mycale (Rhaphidotheca) loricata (Topsent, 1896)

Gomphostegia loricata Topsent, 1896: 149, fig. 2.

Rhaphidotheca loricata; Topsent, 1904: 202, pl. XIV fig. 15.

Description.— Greyish encrustation on coral, size 0.5 × 0.4 cm, with thickness of 1.2 mm. Skeleton at the surface with protruding exotyles and the pointed ends of styles,

also with irregular tangential crust of styles. Spicules styles (390-480 × 10 µm), exotyles (300-370 µm) with flattened warty discs (60-70 µm), large anisochelae (70-75 µm), small anisochelae (25 µm), sigmas (18 µm), trichodragmas (60-90 µm).

Ecology and distribution. — On deep-water corals at 845 m. Known so far only from the Azores, SE of Terceira (38.5°N 26.8°W).

Comments. — The species stands out among the North Atlantic *Rhaphidotheca* by its flattened exotyles and relatively small megascleres. So far it has been reported only once.

Table 1. Summary of spicule size data (in µm), habit, depth (m) and locality of species of the genus *Mycale* Gray, 1867

species	styles	anisochelae 1	anisochelae 2	anisochelae 3	sigmas 1	sigmas 2
<i>M. (M.) lingua</i>	350-620×8-17	60-77	24-38	16-20	not	14-28
<i>M. (M.) massa</i>	489-810×10-22	61-123	30-48	16-24	30-63	13-27
<i>M. (Ae.) contarenii</i>	231-276×3-6	33-41	18-25	11-16	75-102	18-23
<i>M. (Ae.) rotalis</i>	276-331×5.5-13	33-39	21-28	14-20	54-81	21-30
<i>M. (Ae.) syringosimilis</i> spec.nov.	306-345×6.5-8.5	43-51	21-26	11-13.5	114-138	19-27
<i>M. (Ae.) syrinx</i>	344-388×11-14	40-51	25-39	14-18	91-114	16-30
<i>M. (Ae.) tenerifensis</i> spec. nov.	238-267×3-4.5	not	not	11-15	39-60	18-26
<i>M. (Ae.) tunicata</i>	435×9	50	30	20	not	not
<i>M. (An.) titubans</i>	(1) 875×27 (2) 430×8	21-35	not	not	50-130	not
<i>M. (Ar.) africanucosa</i> spec. nov.	168-271×2-3.5	not	not	17-22	66-89	not
<i>M. (C.) atropa</i> spec.nov.	228-267×4-6.5	not	not	12.5-16	not	31-37
<i>M. (C.) fascibula</i>	410×7	40-45	24-25	not	270×10	30-40
<i>M. (C.) fusiformis</i>	200-280×8-11	68-75	25-27	not	42-47	25
<i>M. (C.) guineensis</i> spec. nov.	207-244×3-6	30-37	21-35	11-15	75-91	15-28
<i>M. (C.) macilenta</i>	249-297×2.5-6.5	28-44	17-27	12-18	78-105	18-36
<i>M. (C.) micracanthoxea</i>	250-290	33-41	13-25	not	80-92	13-33
<i>M. (C.) senegalensis</i>	213-249×2-3.5	not	16-21	not	not	28-39
<i>M. (C.) subclavata</i>	243-288×2.5-9	30-34	19-25	11-16	63-84	34-51
<i>M. (N.) cruzi</i> spec.nov.	288-345×5-8	31-43	15-26 (nav.)	not	29-54	10-24
<i>M. (P.) janvermeuleni</i> spec. nov.	189-237×1.5-3	not	18-28	6-9	40-51 (spined)	not
<i>M. (R.) loricata</i>	(styles) 390-480×10, (exotyles) 300-370	70-75	25	not	not	18
<i>M. (R.) verdensis</i> spec.nov.	(styles) 517-912×13-21, (exotyles) 776-903×15-19	91-111	36-45	18-22	54-75	38-49
<i>M. (Z.) sierraleonensis</i> spec. nov.	294-360×7-11	48-58	21-28	(iso) 10-13	75-94	26-38

Key to the species of *Mycale* occurring in Northwest Africa and the offshore Atlantic Islands

The species keyed out here are described above, including those not represented in our collections but reported in the literature. Data on all species are summarized in Table 1.

- 1. Exotyles present 2
- No exotyles 3
- 2. Exotyles oval, rounded *M. (R.) verdensis* spec. nov.
- Exotyles flattened *M. (R.) loricata*

known to occur in Northwest Africa and the offshore Atlantic Islands. (micr. = micracanthoxeas).

sigmas 3	toxas	trichodragmas	habit	depth (m)	locality
not	not	50-74	massive	520	Gulf of Cadiz
not	not	33-75	massive, encrusting	57-742	Gulf of Cadiz, Azores, Mauritania, Canary Islands, Cape Verde islands, Senegal
not	27-242	not	encrusting	2-4	Canary Islands
not	not	not	encrusting	0-52	Azores, Mauritania
not	60-126	not	arborescent	260-720	Mauritania, Cape Verde Islands, Senegal
not	45-61	not	spiny tubes	450	Mauritania, Senegal
not	60-135	not	encrusting	0-4	Canary Islands, Cape Verde Islands
not	not	40	arborescent	98	Azores
not	not	not	encrusting	845	Azores
not	not	not	spiny tubes, spiny mass	0-60	Cape Verde Islands, Ascension, St. Helena, ?Gulf of Guinea
not	not	not	encrusting	30	Guinea
not	25-40	not	encrusting	153-800+	Azores
18	not	35-36	arborescent	35-42	Senegal
not	42-225	not	digitate	32	Guinea
not	7-204	not	encrusting	0-7	Canary Islands
not	(1) 40-250, (2) 8-10 (micr.)	not	encrusting	0-4	Canary Islands
not	not	not	encrusting	0-4	Ascension
not	53-216	33-75	encrusting	9	Azores
not	not	not	encrusting	61	Cape Verde Islands, Canary Islands
not	not	not	encrusting	0-5	Cape Verde Islands
not	not	60-90	encrusting	845	Azores
16-22	not	48-65	encrusting	650-720	Cape Verde Islands
15-24	24-99	25-36	massive	15	Sierra Leone

3. Ectosomal skeleton of 'aegogropila' type (i.e. tangential arrangement of intercrossing megasclere tracts) 6
- Ectosomal skeleton of 'mycale' type (i.e. tangential layer of irregularly arranged megascleres) 4
- No special ectosomal skeleton of megascleres 12
4. Anisochelae with peculiar twisted alae *M. (An.) titubans*
- Anisochelae normal-shaped 5
5. Larger (up to 60 μm) and smaller (< 30 μm) sigmas *M. (M.) massa*
- Only small sigmas (up to 30 μm) *M. (M.) lingua*
6. Chelae include naviculichelae (i.e. the upper and lower alae meet and the shaft is extended to fill the space between the alae) *M. (N.) cruzi* spec. nov.
- No naviculichelae but next to anisochelae there are small isochelae
..... *M. (Z.) sierraleonensis* spec. nov.
- Chelae are only normal anisochelae 7
7. Sigmas are spined *M. (P.) janvermeuleni* spec. nov.
- Sigmas not spined 8
8. Only a single category of small anisochelae *M. (Ae.) tenerifensis* spec. nov.
- At least two categories, often three, of anisochelae 9
9. Sigmas present 10
- Sigmas absent *M. (Ae.) tunicata*
10. Sponge shape a large erect tube, stiff, small toxas (< 60 μm) *M. (Ae.) syrxinx*
- Sponge shape arborescent, limp, toxas longer (up to 125 μm)
..... *M. (Ae.) syringosimilis* spec. nov.
- Sponge shape encrusting 11
11. Toxas absent, styles average 10 μm in thickness *M. (Ae.) rotalis*
- Toxas present, styles average <5 μm in thickness *M. (Ae.) contarenii*
12. Sponge thickly spinose mass or thick-walled tube, extremely slimy when taken out of the water *M. (Ar.) africanucosa* spec. nov.
- Small crusts or thin branches, smooth surface 13
13. Large sigmas up to 270 μm *M. (C.) fascibula*
- Sigmas less than 110 μm 14
14. Single category of anisochelae 15
- Two or three categories of anisochelae 16
15. Anisochelae with thick shafts and barely developed alae, 'atrophied'
..... *M.(C.) atrophia* spec. nov.
- Anisochelae normal-shaped 00 *M. (C.) senegalensis*
16. Raphides in trichodragmas present 17
- Raphides absent 18
17. Encrusting sponge *M. (C.) subclavata*
- Sponge an erect branch *M. (C.) fusiformis*
18. Styles centrotylote, sponge digitate/branching *M. (C.) guineensis* spec. nov.
- Styles not centrotylote, sponge encrusting 19
19. Microscleres include micracanthoxeas *M. (C.) micracanthoxea*
- No micracanthoxeas *M. (C.) macilenta*

Discussion

The diversity of *Mycale* species in the region considered is found to comprise 22 species, making it comparable to but distinctly higher than that of the Mediterranean (14 species) and Northwestern Europe (18 species). One of the major reasons is the enhanced endemism evident in the southern ecoregions (in the sense of Spalding et al. 2007), viz. Cape Verde (with four endemic species), Sahelian Upwelling (Senegal, with two endemic species) and the Gulf of Guinea West (with three endemic species). Although the diversity between those southern areas and the northern marine ecoregions (Saharan Upwelling and Azores-Madeira-Canary ecoregions) is not different, – all ecoregions have diversities varying between 5 and 7 species –, there is hardly any endemic species and most species are shared with Mediterranean and Western European areas. A similar trend was found for the Microcionidae of the present region (cf. Van Soest et al. 2013). More to the south along the west coasts of Africa further endemic *Mycale* species have been reported, viz. *M. (Paresperella) toxifera* (Lévi, 1963) and *M. (Paresperella) levii* (Uriz, 1987), *M. (Carmia) urizae* Carballo & Hajdu (1998) and *M. (Aegogropila) kolletae* Carballo & Hajdu (2001), all from Namibia and the Atlantic coasts of South Africa. These observations support the postulation that Mediterranean-Atlantic distributions reach only southward to the Saharan Upwelling region, where they are replaced by tropical Northwest-African distributions (Van Soest, 1993a; Spalding et al. 2007).

Acknowledgments

The late Dr Jaap van der Land organized the CANCAP- and Mauritania Expeditions. Captains and crews of H.M.S. Tydemann and R.V. Tyro are thanked for their expert assistance. Jan J. Vermeulen, formerly of the Zoological Museum of Amsterdam assisted during the Mauritania II Expedition and collected further material during the 'Plancius' cruise. Dr Ole S. Tendal and Dr. Martin V. Sorensen of the Zoological Museum of the University of Copenhagen kindly arranged the loan of specimens.

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Received: 15.x.2014

Accepted: 22.x.2014

Edited: L.P. van Ofwegen