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New and rare sponges from the deep shelf of the Alboran Island (Alboran Sea, Western Mediterranean)

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Abstract

The sponge fauna from the deep shelf (70 to 200 m) of the Alboran Island (Alboran Sea, Western Mediterranean) was investigated using a combination of ROV surveys and collecting devices in the frame of the EC LIFE+ INDEMARES Grant aimed to designate marine areas of the Nature 2000 Network within Spanish territorial waters. From ROV surveys and 351 examined specimens, a total of 87 sponge species were identified, most belonging in the Class Demospongiae, and one belonging in the Class Hexactinellida. Twenty six (29%) species can be regarded as either taxonomically or faunistically relevant. Three of them were new to science (*Axinella alborana* **nov. sp.**; *Axinella spatula* **nov. sp.**; *Endectyon filiformis* **nov. sp.**) and 4 others were Atlantic species recorded for the first time in the Mediterranean Sea (*Jaspis eudermis* Lévi & Vacelet, 1958; *Hemiasterella elongata* Topsent, 1928; *Axinella vellerea* Topsent, 1904; *Gelliodes fayalensis* Topsent, 1892). Another outstanding finding was a complete specimen of *Rhabdobaris implicata* Pulitzer-Finali, 1983, a species only known from its holotype, which had entirely been dissolved for its description. Our second record of the species has allowed a neotype designation and a restitution of the recently abolished genus *Rhabdobaris* Pulitzer-Finali, 1983, also forcing a slight modification of the diagnosis of the family Bubaridae. Additionally, 12 species were recorded for the first time from the shelf of the Alboran Island, including a few individuals of the large hexactinellid *Asconema setubalense* Kent, 1877 that provided the second Mediterranean record of this "North Atlantic" hexactinellid. ROV explorations also revealed that sponges are an important component of the deep-shelf benthos, particularly on rocky bottoms, where they make peculiar sponge gardens characterized by a wide diversity of small, erect species forming a dense "undergrowth" among a scatter of large sponges and gorgonians. The great abundance and the taxonomic singularities of the sponge fauna occurring in these deep-shelf bottoms strongly suggest these habitats to be considered within the environmental protection of the Nature 2000 Network.

Key words: Atlantic immigrants, benthic communities, biodiversity, deep benthos, environmental protection, Mediterranean invasions, sponge gardens, Porifera

Introduction

The Alboran Sea occupies the westernmost basin of the Mediterranean. It is known to be a transitional region between the North Atlantic Ocean and the Mediterranean *sensu stricto*, in terms of both hydrography and organismal distributions. The influx of North Atlantic surface water during most of the Quaternary and in Recent times favors the penetration of many "Atlantic species" in this western Mediterranean zone (Péres & Picard 1964). Consequently, the sublittoral communities in this area often present high biodiversity relative to equivalent communities in nearby Lusitanian and Mauritanian areas (Templado *et al.* 2006; Coll *et al.* 2010).

At the heart of the Alboran basin, the Island of Alboran (Fig. 1), a tiny (642 m long and 265 m wide) islet made of volcanic rocks, emerges from a large (45 km long and 10 km wide) submerged shelf, remnant of an ancient (7–16 my old) volcanic cone. This cone is in turn part of an ancient submerged volcanic chain that crosses the Alboran basin with Northeast-Southwest direction. The bottom of the basin in this area reaches a maximum depth of 1500 m and consists of a thinned crustal microplate formed during the Lower Miocene (about 18 my ago) at an important seismic area where the Euroasian and African plates collided (Comas *et al.* 1992; Martínez-García *et al.* 2010).

Although the hydrography of the Alboran Sea is quite complex, it has been well documented that in the central area where the Alboran Island is located, the incoming Atlantic seawater forms a low-salinity (~36.5 ‰), 150–200 m thick, upper layer above the underlying Mediterranean water (~38.2‰), influencing to a varying extent all the communities on the shelf of the island. The singularity and ecological relevance of the benthic communities on the upper shelf (above 70 m) of the Alboran Island has long been recognized (reviewed in Templado *et al.* 2006), and the upper shelf is currently protected under both Spanish and European legislation by declaration of a Marine Reserve, a Fish Reserve, a Special Area of Mediterranean Importance (SPAMI), and a Site of Community Importance (SCI). Additionally, the shelf of the Alboran Island, due to its strategic location at the Mediterranean entry, may provide a unique reference site for early detection of migration and invasion processes into the Mediterranean by Atlantic organisms.

Previously available information on the sponge fauna of the Alboran Sea (Templado *et al.* 1986; Pansini *et al.* 1987; Maldonado & Benito 1991; Maldonado 1992; Boury-Esnault *et al.* 1994; Maldonado & Uriz 1996, 1999; Rosell & Uriz 2002; Templado *et al.* 2006) strongly suggests that sponges may be an important component of the benthos at the still ill-known deep shelf of the Alboran Island. Interestingly, the deep-shelf sponge fauna of the Alboran Island bears some similarities with that reported from the easternmost areas of the western Mediterranean,

such as the Ligurian Sea and the Strait of Sicily (Pansini *et al.* 1987; Maldonado & Uriz 1995; Bertolino *et al.* 2013a; Bertolino *et al.* 2013b). Additionally, some studies have suggested a continued input of sponge species from the Lusitanian region into the Alboran Sea over the Quaternary (Maldonado & Uriz 1995), despite sponges being sessile organisms with short-living planktonic larvae lacking recognizable strategies for long-distance dispersal (Maldonado 2006). Since global warming enhances northward migration of subtropical marine species (Coll *et al.* 2010), it is urgent to improve our knowledge of these deep-shelf Alboranian communities before the immigrants get integrated in them and further complicate both discrimination of the pre-warming original fauna and the understanding of future Mediterranean faunal shifts (Vermeij 2012).

Materials and methods

Within the frame of an EC Grant LIFE+ INDEMARES aimed to list and designate marine areas for the Nature 2000 Network in Spanish territorial waters, we explored the deep shelf (70 to 200 m) of the Alboran Island, using a remotely operated underwater vehicle (ROV) along with traditional dredging and trawling devices to collect benthic fauna.

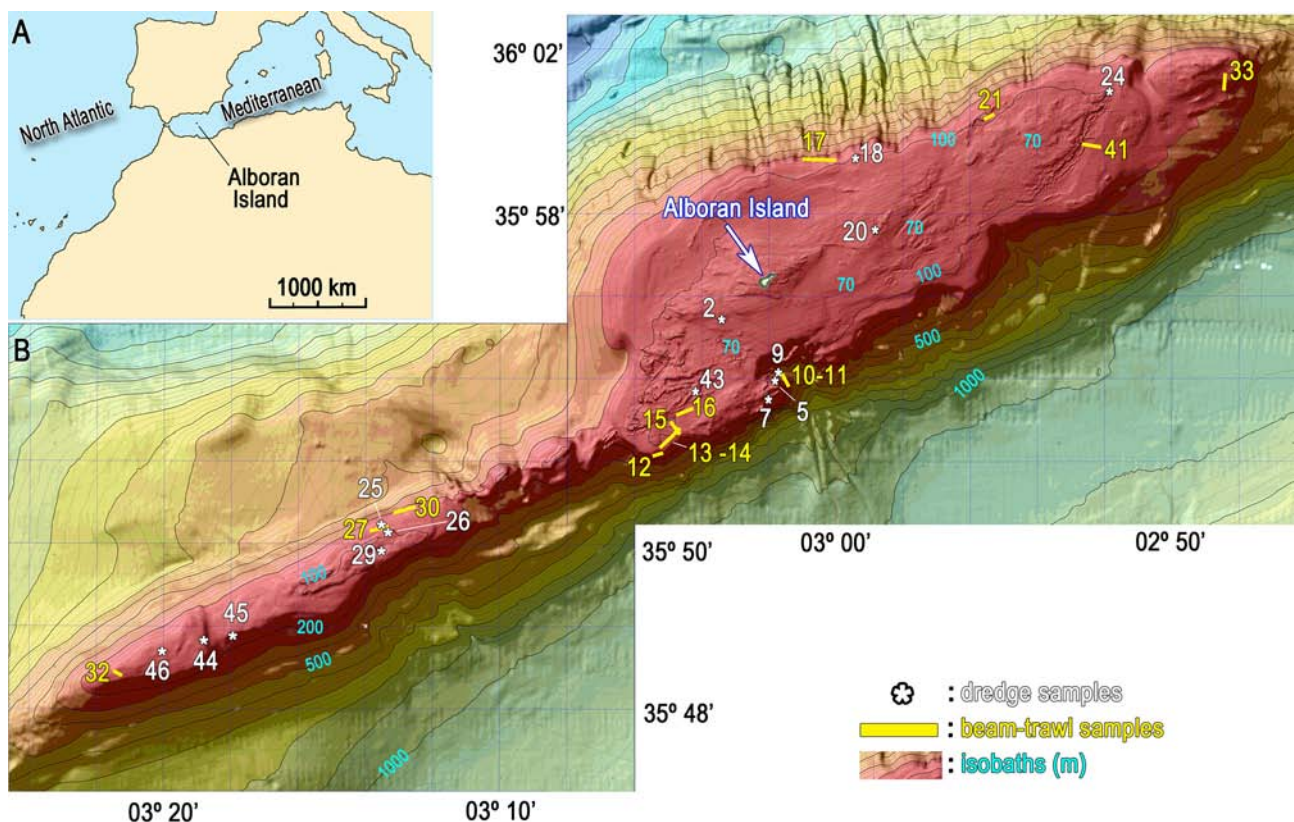


FIGURE 1. (A) Localization of the Alboran Island in the Mediterranean. (B) Distribution of the 25 studied sampling stations over the bathymetric map of the shelf of the Alboran Island.

Prior to any collecting tasks, scientific partners of the INDEMARES-Alboran grant developed a detailed bathymetric profiling of the island shelf using side scan sonar (Geotecnia, Hidrología and Medio Ambiente S.L.) and outlined the location of the most relevant benthic communities through suspended still video (information available through Juan Goutayer). Using this basic information, a first detailed assessment of the benthic communities at the deep shelf of the Alboran Island was carried out by running 9 video transects (19 hours of recording) at depths ranging from 65 to 205 m in September 2011, using a SEAEYE FALCON ROV. A second research stage involved collecting cruises in 2011 and 2012, during which a total of 44 sites were sampled in the 25–290 m depth range, using a small beam trawl on soft bottoms and a dredge on hard bottoms. Here we are reporting on the sponge fauna collected in 25 sampling stations (Fig. 1; Table 1), incorporating, whenever possible,

the information available from the video transects. Collected specimens were fixed in 4% formalin for 2–3 months, rinsed in distilled water, and subsequently transferred to 70% ethanol. Because of an initial fixation step in formalin, the collected sponge material is not suitable for molecular analysis. Taxonomic identifications were accomplished by considering the external morphology and skeleton, using standard techniques to prepare spongin fibres and spicules for light microscopy observation. Body features, spicules, and skeletal arrangements were described according to the thesaurus of sponge morphology (Boury-Esnault & Rützler 1997). When required, acid-cleaned spicules were mounted on aluminum stubs, gold-coated, and studied through a HITACHI TM3000 Scanning Electron Microscope (SEM), following standard protocols for sample preparation. Features of the collected material were compared, when required, to those of holotypes and additional material borrowed from sponge collections of the Muséum National d'Histoire Naturelle (MNHN) of Paris, the Musée Océanographique of Monaco (MOM), and the Museo Civico di Storia Naturale Giacomo Doria of Genoa (MSNG). All collected material during the INDEMARES-Alboran cruises, holotypes included, has been stored in the Invertebrate Collection of the National Museum of Natural Sciences (MNCN), Madrid, Spain.

Results and discussion

Taxonomic and ecological singularities. Taxonomic identification of 351 collected specimens along with additional identifications derived from ROV video monitoring yielded a list of 87 sponge species (Table 2), most belonging to the Class Demospongiae. The Hexactinellida were represented by only one species, *Asconema setubalense* Kent, 1870, identified through ROV recordings. Eleven specimens of Calcarea were collected, but they were not taxonomically investigated. The results of the present study have increased the previous number of sponge species known from the Alboran Island Platform and the bottoms of the surrounding abyssal plain by 33, leading to a total of 196 species (Table 6).

Twenty six (29%) out of 87 identified species were considered as relevant from either a taxonomical or faunistical point of view. Three of them were new to science (*Axinella alborana* **nov. sp.**; *Axinella spatula* **nov. sp.**; *Endectyon filiformis* **nov. sp.**) and 4 others were recorded in the Mediterranean Sea for the first time (*Jaspis eudermis* Lévi & Vacelet, 1958; *Hemiasasterella elongata* Topsent, 1928; *Axinella vellerea* Topsent, 1904; *Gelliodes fayalensis* Topsent, 1892). Another outstanding finding was a complete specimen of *Rhabdobaris implicata* Pulitzer-Finali, 1983, a species only known from the holotype, which was entirely dissolved for the preparation of a spicule slide. Twelve additional species were recorded for the first time from the shelf of the Alboran Island: *Acanthella acuta* Schmidt, 1862; *Calthropella recondita* Pulitzer-Finali, 1983; *Dendroxea lenis* (Topsent, 1892); *Endectyon delaubenfelsi* Burton, 1930; *Erylus discophorus* (Schmidt, 1862); *Eurypon lacazei* (Topsent, 1891); *Prosuberites longispinus* Topsent, 1893; *Rhizaxinella gracilis* (Lendenfeld, 1898); *Spongosorites intricatus* (Topsent, 1892); *Hexadella racovitzae* Topsent, 1896; *Terpios fugax* Duchassaing & Michelotti, 1864; and *Asconema setubalense*. From a conservation point of view, there were 4 rare Mediterranean endemic species (*Axinella salicina* Schmidt, 1868; *Crambe tailliezi* Vacelet & Boury-Esnault, 1982; *Sarcotragus pipetta* Schmidt, 1868; *Vulcanella aberrans* (Maldonado & Uriz, 1996)), and 2 other species, *Tethya aurantium* (Pallas, 1766) and *Axinella polypoides* Schmidt, 1862, listed as vulnerable in the current environmental legislation (Templado *et al.* 2004).

Collecting devices and ROV explorations revealed that sponges are relevant or dominant benthic organisms in 3 major habitats of the deep shelf: 1) the rhodolith beds (60–120 m; Fig. 2A–B); 2) the rocky plains moderately sloping, which correspond to the flanks of the ancient volcanic cone (80–120 m; Fig. 2C–D); and 3) the isolated rocky outcrops surrounded by soft sediments (Fig. 2E–F).

The rhodolith beds occupied vast areas in the 60–100 m depth range. Although the species composition of the general sessile fauna varied widely from one rhodolith to another, a wide variety of encrusting sponges was often abundant on them (Fig. 2B). Species such as *Bubaris vermiculata* (Bowerbank, 1866), *Diplastrella bistellata* (Schmidt, 1862), *Dercitus (Stoeba) plicatus* (Schmidt, 1868), and several members of the genera *Eurypon* Gray, 1867 were common. Small submassive and erect species of the genera *Axinella*, *Suberites*, *Phakellia* or *Poecillastra compressa* (Bowerbank, 1866) were also frequent.

The slopy rocky plains, which showed moderate charges of fine sediments, often hosted important populations of flabellate and lamellate, erect and massive sponges, typically including *Phakellia robusta* Bowerbank, 1866 (Fig. 2C), *Phakellia ventilabrum* (Linnaeus, 1767), *Poecillastra compressa* (Fig. 2C),

Characella pachastrelloides (Carter, 1876), *Pachastrella monilifera* Schmidt, 1868, *Vulcanella aberrans* (Fig. 2D), along with a lower abundance of other large astrophorids and halichondrids. Among the scatter of large sponges, there was a dense, peculiar "undergrowth" made of a variety of small erect sponges (Fig. 2C). Stipitate or lollipop morphologies, such as *Podospongia lovenii* Bocage, 1869, *Rhizaxinella elongata* (Ridley & Dendy, 1886), *Rhizaxinella gracilis* or *Crella (Yvesia) pyrula* (Carter, 1876), and digitate or branching morphologies, such as *Axinella vellerea* Topsent, 1904, *Axinella pumila* Babic, 1922, *Stelligera stuposa* (Ellis & Solander, 1786), and *Stelligera rigida* (Montagu, 1818), were common in the undergrowth (Fig. 2C–D, G–H). These communities can indeed be regarded as Mediterranean "sponge gardens", characterized by high diversity and abundance of small erect species growing among the large astrophorids and axinellids that typically build the "sponge gardens" or "sponge grounds" at similar depth ranges on North-Atlantic margins (Hogg *et al.* 2010). On the deepest zone of the sloping rocky flats some isolated individuals of the large hexactinellid *Asconema setubalense* also occurred (e.g., 181 m deep; 35° 53.190' N, 03° 02.111' W), providing the second Mediterranean record of this species. This hexactinellid had traditionally been reported from greater depths in the North-Atlantic ocean, but it was recently recorded first in the Mediterranean during the ROV exploration of another deep site (> 250 m) of the Alboran Sea, the "Seco de los Olivos" ("Chella" Seamount; Pardo *et al.* 2011). Whether a denser population of *A. setubalense* occurs deeper in the slope of the Alboran Island remains to be explored.

TABLE 1. Information on sampling stations, indicating station number, type of collecting device (DR= dredge; BV= beam trawl), geographical coordinates of starting and end point of sampling transects, depth range (m) during the transect, and bottom type (R= rock, G= gravel, OG= organogenic gravel, RH= rhodolith bed, LS= lava stone bed).

Station number	Collection device	Transect start point (lat. and long.)	Transect end point (lat. and long.)	Starting depth (m)	Ending depth (m)	Bottom type
02	DR	35°55.422'N 03°03.307'W	35°55.452'N 03°03.378'W	54	52	RH
05	DR	35°53.980'N 03°01.806'W	35°53.917'N 03°01.810'W	130	109	R
07	DR	35°53.506'N 03°02.092'W	35°53.416'N 03°02.051'W	87	92	RH
10	BV	35°53.990'N 03°01.570'W	35°54.116'N 03°01.610'W	214	290	G
11	BV	35°54.068'N 03°01.613'W	35°53.811'N 03°01.413'W	243	240	G
12	BV	35°52.222'N 03°05.215'W	35°52.167'N 03°05.388'W	120	112	OG
13	BV	35°52.379'N 03°05.182'W	35°52.825'N 03°04.591'W	99	95	G
14	BV	35°52.723'N 03°04.668'W	35°52.340'N 03°05.265'W	96	100	G
15	BV	35°52.668'N 03°04.656'W	35°52.900'N 03°04.924'W	96	96	G
16	BV	35°53.103'N 03°04.738'W	35°53.256'N 03°04.289'W	92	82	RH
17	BV	35°59.326'N 03°00.044'W	35°59.364'N 03°01.000'W	121	169	G
18	DR	35°59.395'N 02°59.396'W	35°59.386'N 02°59.460'W	92	94	R
20	DR	35°57.663'N 02°58.848'W	35°57.672'N 02°58.810'W	48	42	RH
21	BV	36°00.399'N 02°55.318'W	36°00.288'N 02°55.570'W	101	93	OG

.....continued on the next page

TABLE 1. (Continued)

Station number	Collection device	Transect start point (lat. and long.)	Transect end point (lat. and long.)	Starting depth (m)	Ending depth (m)	Bottom type
25	DR	35°50.413'N 03°13.390'W	35°50.421'N 03°13.491'W	111	114	OG
26	DR	35°50.294'N 03°13.248'W	35°50.251'N 03°13.304'W	94	97	OG
27	BV	35°50.415'N 03°13.245'W	35°50.398'N 03°13.722'W	109	100	OG
29	DR	35°49.768'N 03°13.090'W	35°49.996'N 03°13.432'W	93	94	OG /RH
30	BV	35°50.756'N 03°13.165'W	35°50.896'N 03°12.434'W	180	163	OG
32	BV	35°46.869'N 03°21.413'W	35°46.843'N 03°21.301'W	125	122	R
33	BV	36°01.034'N 02°48.487'W	36°01.397'N 02°48.433'W	173	134	G
41	BV	35°59.617'N 02°52.077'W	35°59.677'N 02°52.666'W	112	102	G
44	DR	35°47.716'N 03°17.986'W	35°47.820'N 03°17.902'W	152	135	R /G
45	DR	35°47.589'N 03°18.679'W	35°47.560'N 03°18.769'W	134	120	G
46	DR	35°47.404'N 03°19.984'W	35°47.437'N 03°20.037'W	103	104	G/ LS

The rocky outcrops standing out from soft bottoms, with their impressive rocky crests, walls, overhangs, and crevices, provided an optimal substrate for suspension feeders, often hosting a large variety of sponges, cnidarians, brachiopods, molluscs, sabellid tube worms, ascidians, etc (Fig. 2E). The ROV inspections revealed that encrusting, branching, and massive sponges often co-occurred on the outcrops, favored by the multiplicity of microhabitats that these tortuous rocky structures offer. Common sponges were *Dysidea fragilis* (Montagu, 1818), *Sarcotragus pipetta*, *Hexadella racovitzae*, *Penares helleri* (Schmidt, 1864), *Crambe tailliezi*, *Terpios fugax*, *Caminus vulcani* Schmidt, 1862, *Dercitus plicatus*, *Craniella cranium* (Müller, 1776), and also several species of *Suberites*, *Calthropella* Sollas, 1888, *Erylus* Gray, 1867, *Haliclona* Grant, 1836, *Spongosorites* Topsent, 1896, and *Phorbas* Duchassaing & Michelotti, 1864. Large astrophorids (Fig. 2F), such as *Geodia* spp., *Stelletta* spp., *Pacahastrella monilifera*, *Poecillastra compressa*, *Characella pachastrelloides*, *Vulcanella aberrans*, along with small digitate and stalked sponges were also present, though in lower abundance.

Large areas of the deep shelf were covered with soft bottom, particularly on the north side of the island. The substrate mostly consisted of coarse sand mixed with calcareous gravel, more rarely incorporating a low proportion of mud. In contrast to the above-described hard-bottom communities, the soft bottoms were poor in sponges. Nevertheless, despite their general low sponge abundance, this bottom type hosted scattered individuals of rare and/or endemic species, such as *Axinella salicina* (Fig. 2I) and a new species of the genus *Endectyon*.

A total of 631 demosponges *sensu lato*: (i.e., Demospongiae + Homoscleromorpha) have been listed for the Mediterranean (Voultsiadou 2009; Calcinae *et al.* 2013; the present study). Interestingly, the bottoms around the Alboran Island host 194 demosponge species (Table 6), which means about 30.4% of the total Mediterranean demosponge fauna. Such a remarkable percentage points clearly this island shelf to be a remarkable biodiversity hotspot in terms of demosponge fauna (and probably of several other groups of benthic invertebrates as well). Altogether, the abundance and taxonomic singularity of the sponge fauna occurring in these deep-shelf bottoms strongly suggest these habitats to be accommodated within the environmental protection of the Nature 2000 Network.

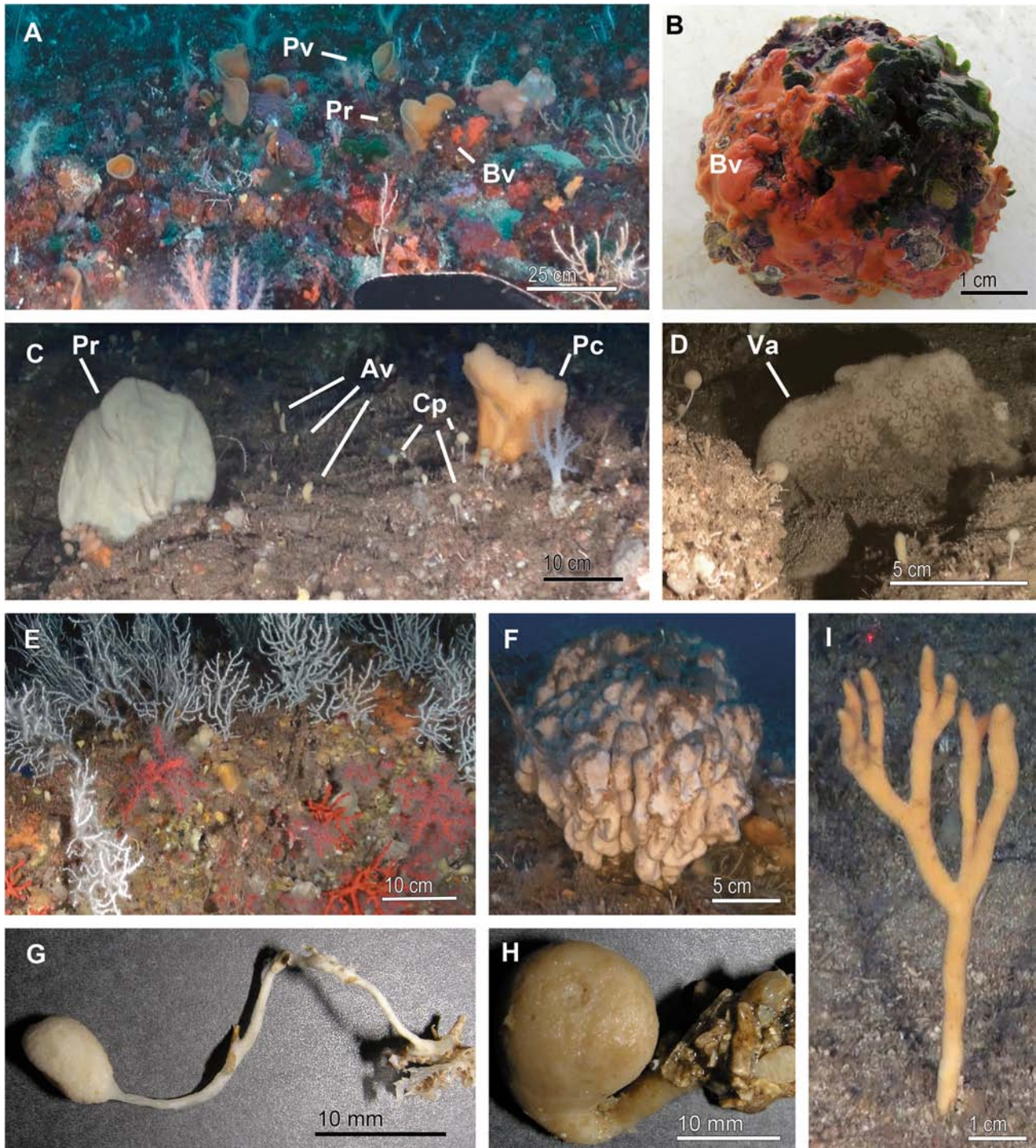


FIGURE 2. Benthic communities on the deep shelf of the Alboran Island in which sponges are important members. (A) View of a rhodolith bottom dominated by cnidarians and sponges. The most abundant sponges were *Phakellia ventilabrum* (Pv), *Phakellia robusta* (Pr), and *Bubaris vermiculata* (Bv). (B) Detail of a rhodolith, largely encrusted by *Bubaris vermiculata* (Bv). (C) View of a gently sloping rocky bottom, showing large specimens of *Phakellia robusta* (Pr) and *Poecillastra compressa* (Pc) together with a dense "canopy" of small digitiform, claviform and globiform sponges, such as *Axinella vellea* (Av) and *Crella pyrula* (Cp). (D) Individual of *Vulcanella aberrans* (Va) surrounded by small globiform and digitiform sponges. (E) Benthic community on the outcrops dominated by cnidarians, including the octocoral *Corallium rubrum*. Abundant massive, submassive and encrusting sponges are common under the gorgonian forest. (F) Large astrophorid (*Geodia* spp.) sighted from the ROV on the top of an outcrop. (G) Collected specimen of *Crella* (*Yvesia*) *pyrula* (MNHN-Sp136-DR44). (H) Collected specimen of *Rhizaxinella gracilis* (MNHN-Sp22-BV14). (I) A solitary specimen of *Axinella salicina* located by the ROV on a coarse-sand and gravel bottom, a substrate type that generally shows low abundance of sponges.

Systematics

Here we provide taxonomic description of eight demosponges collected from the deep shelf of the Alboran Island, which we consider of special interest because they are new to science, are new records for the Mediterranean Sea or are exceptionally rare species.

Phylum PORIFERA Grant, 1836

Class DEMOSPONGIAE Sollas, 1885

Order ASTROPHORIDA Sollas, 1887

Family ANCORINIDAE Schmidt, 1870

Genus *Jaspis* Gray, 1867

Diagnosis. Encrusting or massive sponges without triaenes; choanosomal skeleton composed of oxeas irregularly interlaced, ectosomal skeleton formed by a layer of paratangential oxeas generally smaller than those in the choanosome; microscleres are euasters without a centrum; never being spherasters (*sensu* Uriz 2002).

Jaspis eudermis Lévi & Vacelet, 1958

(Figs. 3A, 4; Table 2)

Material examined. Specimen MNCN-Sp71-BV10 collected from Stn. 10 (Table 1; Fig. 1).

Comparative material: Holotype of *Jaspis eudermis* Lévi & Vacelet, 1957 (MNHN DCL-738) from Princess Alice Bank, Azores (Stn. 62; 37°47'N 29°03'W, 330 m deep, 1955–1956).

Macroscopic description. Creamy white (in alcohol), cushion-shaped sponge, being 45 x 23 mm in size (Fig. 3A). Consistency firm, but friable. Surface nearly glabrous, covered by a friable, detachable, thick membrane (crust-like), with no discernible aquiferous openings. At the zones where the ectosomal crust is lost, subdermal aquifer canals of up to 1mm in diameter are evident.

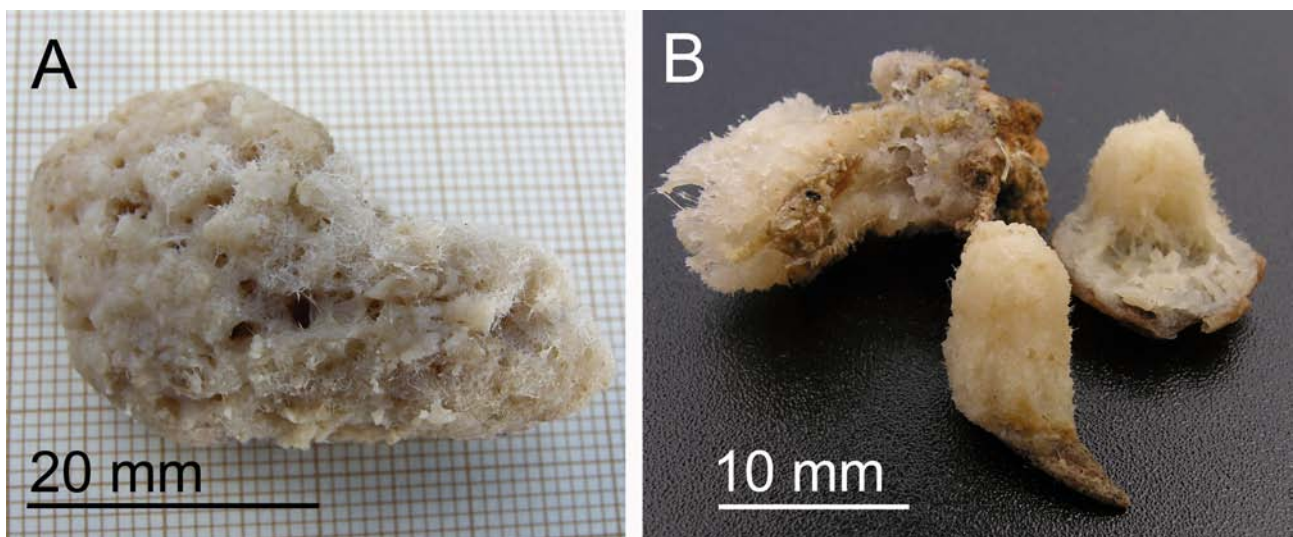


FIGURE 3. (A) Specimen of *Jaspis eudermis* Lévi & Vacelet, 1958 collected from the Alboran Sea and photographed on graphic paper (MNCN-Sp71-BV10). (B) Three Alboranian specimens of *Hemiasterella elongata* Topsent, 1928 (from left to right, MNCN-Sp66-BV21, MNCN-Sp66 B & A).

Skeleton. Megascleres are oxeas, which seem to occur in two categories. Oxeas I are 1125–2000 x 20–40 μm and fairly abundant. They are once or twice slightly bent, frequently asymmetric, usually with acerate tips, occasionally blunt (Fig. 4A–B). Oxeas I showing irregular shapes are also occasional (Fig. 4C). Oxeas II are 390–1500 x 5–10 μm , and comparatively quite scarce; they are slightly curved, sometimes centrotylote, and with conical or acerate ends (Fig. 4A). Microscleres are oxyasters, with 12–20 conical, smooth actines (Fig. 4A, D); their total diameter ranges from 20 to 65 μm , but with no discernible size categories.

There is an ectosomal, crust-like skeleton consisting of abundant oxyasters and tangential oxeas (mostly type II) irregularly disposed in small groups. The choanosomal skeleton consists of oxeas in disordered arrangement, along with abundant oxyasters.

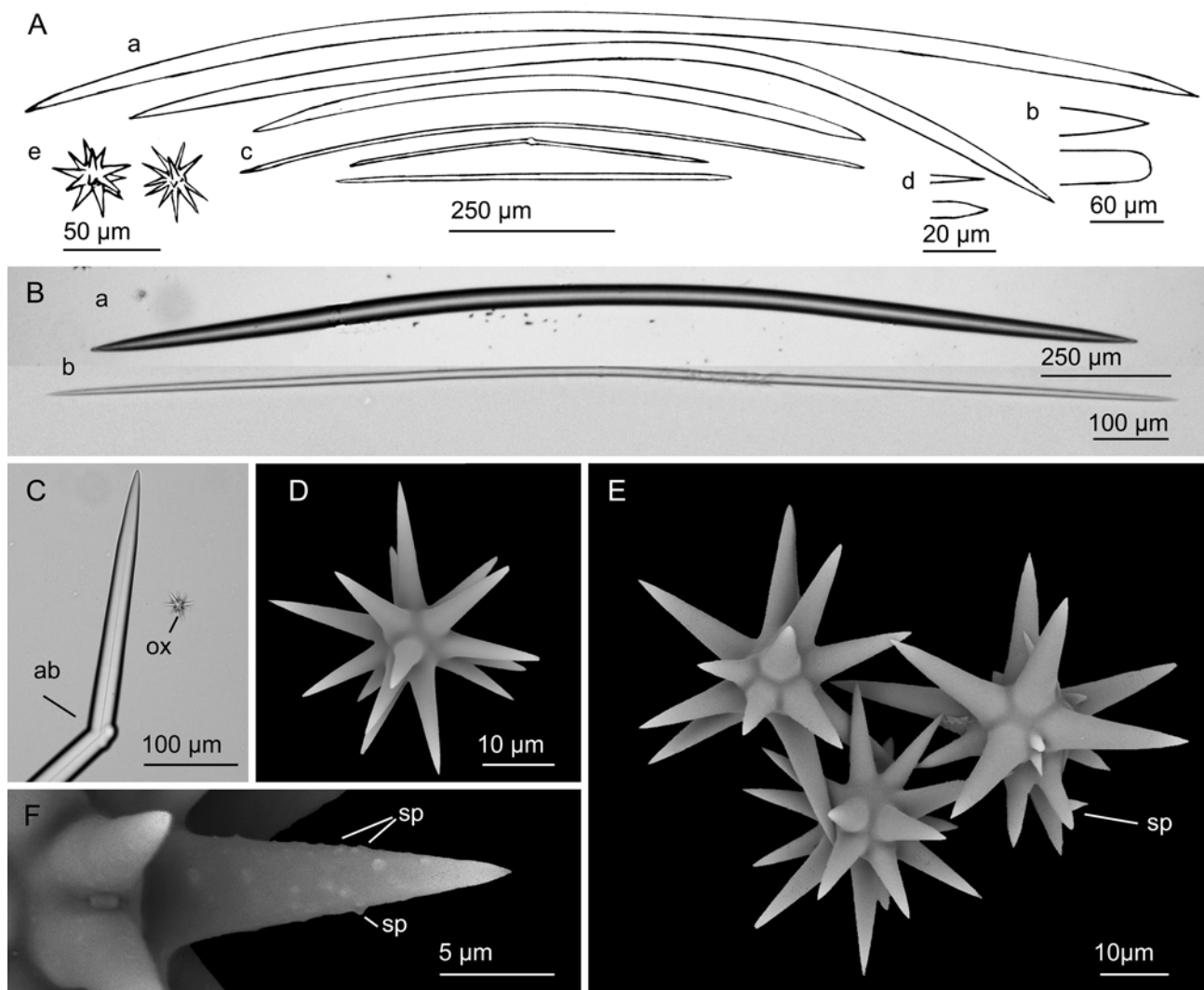


FIGURE 4. *Jaspis eudermis* Lévi & Vacelet, 1958: (A) Line drawing of the spicule complement of the Alboran specimen (MNCN-Sp71-BV10), consisting of oxeas I (a) with acerate or blunt ends (b), oxeas II (c) with acerate or conical ends (d), and oxyasters (e). (B) Light microscope micrographs of oxeas I (a) and oxeas II (b). (C) An abnormal end (ab) of an oxea I next to an oxyaster (ox). (D) SEM micrograph of an entirely smooth oxyaster. (E) SEM image of several oxyasters of the holotype of *J. eudermis* (Stn. 62 MNHN DCL738), one having some large spines (sp) on some actines. (F) Detail of an oxyaster actine of the holotype showing minute spines (sp).

Distribution and ecology notes. Rare species, previously known only from Azores (eastern North Atlantic). The only specimen herein collected from a gravel bottom at depths of 214–290 m provides the first record of the species in the Mediterranean Sea.

Taxonomic remarks. Several species of *Jaspis* occur in the Mediterranean or/and in the adjacent eastern North-Atlantic zone, but most of them have spicules clearly smaller than those of *J. eudermis*. The only exception is *Jaspis incrustans* (Topsent, 1890), which has fairly large oxeas that reach 1250 μm in length. Nevertheless,

oxyasters of *J. incrustans* measure only up to 26 µm in total diameter and their actines are clearly spiny rather than smooth (Maldonado 1993).

Our material fits reasonably the only brief description available for *J. eudermis*, which corresponds to the holotype, a fragmentary, 2 x 2 x 1 cm, cushion-shaped sponge. It was reported to have a single category of 1200–1650 x 45 µm oxeas (versus two in our specimens) and 35–45 µm oxyasters. The oxyasters were pictured by Lévi & Vacelet (1958) as having more than 10 actines with a smooth (not spiny) surface. Our revision of the holotype indicates that there are indeed two size categories of oxeas, discernible not only because of their thickness (1225–1725 x 30–60 µm and 660–850 x 8–10 µm, with some occasional transitional stage), but also because of their shape, being the smaller category isodiametric and more markedly curved than the fusiform oxeas of the larger category. This reinterpretation of the oxea size distribution brings our specimen and the holotype in full skeletal agreement, as they also share the general traits of the macroscopic morphology and skeletal architecture. Furthermore, they both are the only *Jaspis* material in the Atlantic-Mediterranean region having large, "smooth" oxyasters with more than eleven actines. In this regard, our SEM re-examination of the holotype provides new interesting information. The oxyasters of the holotype measure 30–55 µm in total diameter and have 16 to 20 actines. Most of the actines are entirely smooth (Fig. 4E), as it also happens consistently in the Alboranian specimen (Fig. 4D). Nevertheless, under high SEM magnification approximately 20% of the oxyasters of the holotype show subtle microspines in one or more of their actines (Fig. 4F). In very few occasions, large, isolated spines also occur (Fig. 4E). Therefore, the "smooth" nature of the actines of *J. eudermis* is to be assessed in further detail when more specimens are collected.

Order HADROMERIDA Topsent, 1894

Family HEMIASTERELLIDAE Lendenfeld, 1889

Genus *Hemiassterella* Carter, 1879

Diagnosis. Hemiasterellidae with vasiform, plate-like, flattened branching or massive growth form; choanosomal and peripheral skeletons are loosely organized, vaguely plumoreticulate, without apparent axial compression or differentiation between axial and extra-axial regions. The spicule complement consists of styles and/or oxeas without functional arrangement to any particular part of skeleton and euasters predominantly located in peripheral region of the sponge but not forming a surface crust. The euasters typically show thick, acanthose, strongylote, curved, asymmetrical or branching actines; sometimes calthrop-like, reduced in number to 2–4 actines (sensu Hooper 2002a).

***Hemiassterella elongata* Topsent, 1928**

(Figs. 3B, 5; Table 2)

Material examined. Four specimens collected: MNCN-Sp66-BV21 from Stn. 21; MNCN-Sp04-DR29 from Stn. 29 m; and MNCN-Sp20-BV33A & B from Stn. 33 (Table 1, Fig. 1).

Macroscopic description. Specimens with columnar shape, measuring 5–15 x 4–7 mm (Fig. 3B). The individuals are settled on rock pieces, over which slightly expand their base. The surface shows irregularly shallow folds and grooves, mostly running parallel to the longest body axis. The ectoderm is membrane-like and bears a sparse and uneven hispidation. Pore-like aquiferous openings are visible, especially in the lower half of the body. Color is bright to creamy white both in life and after preservation in ethanol.

Skeleton. Megascleres are styles, measuring 1316–2250 x 10–30 µm. They are straight, markedly curved, or just with a slight asymmetrical curvature (Fig. 5A–B). The round end of the styles may also be in a stronglyloxa fashion; the pointing end is regularly acerate or, less frequently, stepped, not very sharp (Fig. 5A–C). Styles with both ends modified into oxea are very rare (e.g., one of 1825 x 10 µm per slide) or absent, depending on the individuals. Microscleres are abundant spherostongylasters, with only a moderately developed centrum and 10–15 strongylote, slightly conical, spiny actines (Fig. 5A, C–E). Spines are more dense toward the end of the actines. Spherostongylasters range from 14 to 23 µm in total diameter.

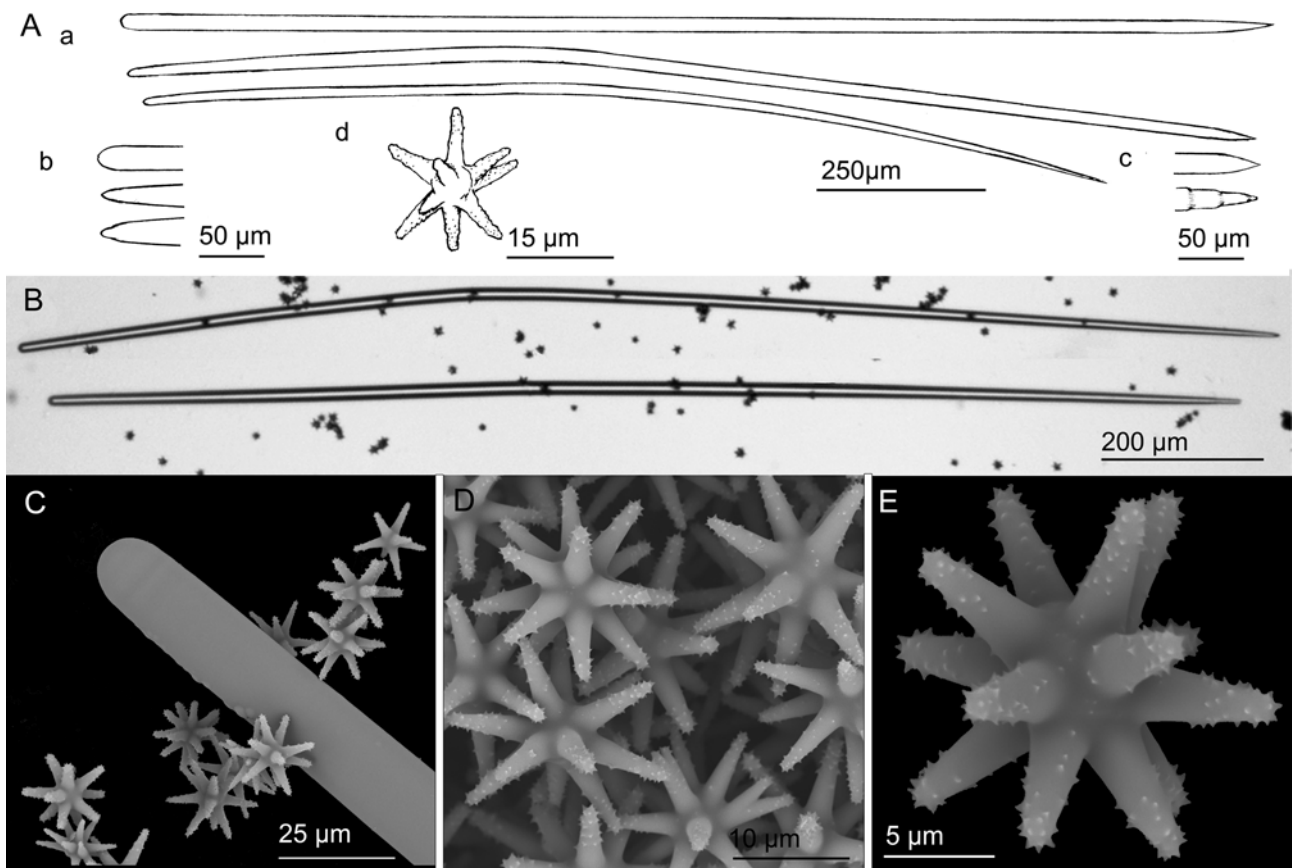


FIGURE 5. *Hemiasterella elongata* Topsent, 1928: (A) Line drawing summarizing the skeletal complement of the Alboranian specimens, consisting of long, isodiametric styles (a) with a round to strongylote end (b) and an acerate or stepped distal end (c), and spiny spherostromylasters (d). (B) Light microscope view of two differently curved styles. (C) SEM micrograph of a typical round end of a style surrounded by spherostromylasters. (D–E) SEM details of spherostromylasters, with spiny actines.

The skeletal arrangement shows no axial condensation. Ascending plumose pauci- or multispiculate tracts of styles ramify below the ectosome and may end in plumose tufts that make an hispid surface. There is scarce spongin connecting and packing the spicules in the tracts. Spherostromylasters are very abundant overall the skeleton, but especially at the periphery, where they make a layer reinforcing the ectosome.

Distribution and ecology notes. Rare species, previously known only from its holotype collected at Cape Verde Islands, eastern North Atlantic (Topsent 1928). The herein collected individuals provide the first record of the species for the Mediterranean Sea. All the collected specimens inhabited 93 to 173 m deep, soft bottoms rich in organogenic gravel, occasionally mixed with pieces of dead rhodoliths.

Taxonomic remarks. The collected specimens bear overall similarity with the holotype described by Topsent (1928). Nevertheless, some morphological differences occur. The holotype shows two incipient branches, while the Alboranian specimens show no sign of branching. Another difference is that the Alboranian individuals have thinner styles (10–30 μm) than the holotype (25–60 μm).

Hemiasterella aristoteliana Voultziadou-Koukoura & Van Soest, 1991, the only *Hemiasterella* representative recorded in the Mediterranean previously, occurs in the northern Aegean Sea. Although it has also styles and strongylasters as the only spicule types, the species is clearly distinguishable from *H. elongata*, because the former has much longer styles (1800–3000 \times 18–37 μm) and its asters are commonly reduced to forms with only 1 to 3 actines (Voultziadou-Koukoura & van Soest 1991).

As noted by Topsent (1928), there are some similarities between *H. elongata* and *Hemiasterella vasiformis* (Kirkpatrick, 1903) from South Africa. Nevertheless, the latter has a caliculate body shape, many styles becoming tylostyles and strongyles, and a bit larger asters (up to 30 μm of diameter) (Kirkpatrick 1903).

Together with the Antarctic *Hemiasterella digitata* Burton, 1929, *H. elongata* shows an uncommon shape within the genus, but that of *H. digitata* is better described as palmo–digitate, with a surface strongly hispid in small patches and neither oscules nor pores visible (Burton 1929).

Order HALICHONDRIDA Gray, 1867

Family AXINELLIDAE Carter, 1875

Genus *Axinella* Schmidt, 1862

Diagnosis. Ramose, bushy or lamellate habit. Surface generally smooth, with choanosomal spicules projecting slightly. Oscules, when visible, with stellate morphology (i.e., superficial canals leading to opening 'imprinted' in superficial skeleton). Ectosome without specialized skeleton. Choanosomal skeleton differentiated in axial and extra-axial regions; axial skeleton compressed or vaguely reticulated. Extra-axial skeleton plumose or plumoreticulate. Megascleres styles, or styles and oxeas, or oxeas; when both present, one type may be rare; modifications of megascleres common in several species. Microscleres, if present, microraphides and raphides, mostly in tightly packed trichodragmata (*sensu* Alvarez & Hooper 2002).

Remarks. Recent molecular work based on 18S rRNA, 28S rRNA, and CO1 has suggested that the genus *Axinella* is polyphyletic, containing at least two major clades (Gazave *et al.* 2010; Morrow *et al.* 2012). One of the clades ? the proper "Axinella clade" ? revolves around the type species, *Axinella polypoides* Schmidt, 1862, while the other, which includes species such as *Axinella damicornis* (Esper, 1794), *Axinella verrucosa* (Esper, 1794), and *Axinella corrugata* (George & Wilson, 1919), shows greater affinities to agelasid sponges than to the *A. polypoides* clade. The name "Cymbaxinella clade" has been proposed to allude these latter molecular-based group, following the phylocode (Gazave *et al.* 2010). As no morphological synapomorphies can be found to decide when an "Axinella-like" species should be allocated to the "Cymbaxinella" clade or the "Axinella" clade (Gazave *et al.* 2010), whenever the molecular information is not available for a species, a serious practical gap rises between the phylocode proposal and the traditional Linnean classification. Subsequent work based on 28S rRNA and CO1 molecular markers has revealed that the "Axinella-like" members of the "Cymbaxinella" clade are closer to encrusting species, such as *Hymerhabdia typica* Topsent, 1892 (formerly in Bubaridae) and *Prosuberites* spp. (formerly in Suberitidae), than to *Agelas* spp. On those arguments, a new family Hymerhabdiidae was erected in the Order Agelasida to assemble together *Prosuberites* spp., *Hymerhabdia* spp., those "Axinella" species in the "Cymbaxinella" clade, and some species formerly in the genus *Stylissa* (Morrow *et al.* 2012). But again, no morphological clues have been provided to decide in the absence of molecular information when either a newly described or an old, revisited "Axinella-like" species could belong to this new family. Tentatively, Morrow and co-workers (2012) have suggested that "true *Axinella*" species, such as *A. polypoides*, have raphides in trichodragmata, while those in the "Cymbaxinella" clade of Agelasida "apparently lack this spicule type". Following this tentative argument, we cannot rule out the possibility that at least one of new species herein described as *Axinella* but lacking raphides (i.e., *Axinella alborana* **nov. sp.**) could be reallocated into another genus in the future if newly collected specimens can ever be analyzed by molecular methods and the emerging molecular clades are finally given taxonomic status. Likewise, this could also be the case of the rare *Axinella vellerea* Topsent, 1904, which is herein morphologically revisited in detail.

Axinella alborana **nov. sp.**

(Figs. 6A–C, 7; Tables 2, 3, 4)

Etymology. This species is named after the Alboran Island, where it occurs abundantly.

Material examined. Holotype MNCN-Sp155-DR44A from type locality Stn. 44 (Table 1, Fig. 1), a rocky bottom at depths of 135 to 152 m on the Alboran Island shelf. Thirty-three paratypes designated: MNCN-Sp03DR05A to C from Stn. 5; MNCN-Sp13-DR07A & B from Stn. 7; MNCN-Sp14-BV13A & B from Stn. 13; MNCN-Sp34-BV14A to F from Stn. 14; MNCN-Sp19-DR29A to D from Stn. 29 m; MNCN-Sp146-BV33 A to N from Stn. 33; MNCN-Sp191-BV41 from Stn. 41; and MNCN-Sp155-DR44B from Stn. 44 (Table 1, Fig. 1).

Comparative material: Syntype material of *Axinella flustra* (Topsent, 1892) = *Tragosia flustra* Topsent, 1892, since no holotype was designated by Topsent (1892) for this species (Table 3). Syntypes were two specimens (MOM-040044) from Bay of Biscay (Stn. 58; 43°40'N 8°55'W, 134 m deep, 7 August 1886) and two specimens (MOM-040272) from Azores (Stn. 247; 38°23.500'N 30°20.333'W, 318 m deep, 30 August 1888).

TABLE 2. Porifera species identified by ROV exploration and examining sampled material from 25 stations (see Table 1, Fig. 1). Species are listed alphabetically according to order and family. Numbers in the Table indicate number of collected individuals for sampling station (DR= dredge, BV= beam trawl). Missing stations (relative to Fig. 1; i.e., 25DR, 26DR, 45DR, 46DR) indicate that no sponge was collected. Species identified through ROV observations are indicated by “+”. Order abbreviations are as it follows: At= Astrophorida; Dt= Dictyoceratida; Hd= Hadromerida; Hl= Halichondrida; Hp= Haplosclerida; Pc= Poecilosclerida; Sp= Spiroporida; Ly= Lyssacosinorida; Ve= Verongida. Family abbreviations are as it follows: An= Ancorinidae; Ca= Calathropellidae; Ge= Geodiidae; Pa= Pacastrellidae; Th= Theneidae; Vu= Vulcanellidae; Dy= Dysideridae; Ir= Irciniidae; Spo= Spongiidae; Cl= Clionidae; He= Hemisterellidae; Pol= Polymastriidae; Spi= Spirastrellidae; St= Stelligeridae; Su= Suberitidae; Teh= Tethyidae; Tj= Timeidae; Ax= Axinellidae; Bu= Buvanidae; Di= Dictyonellidae; Hal= Halichondrida; Cha= Chalinidae; Ni= Niphatidae; Pe= Petrosiidae; Ros= Rossellidae; Ac= Acarimidae; Cho= Chondropsidae; Co= Coelosphaeridae; Cra= Crambeidae; Cre= Crellidae; Des= Desmacellidae; Ham= Hamacanthidae; Hym= Hymedesmiidae; Mic= Microcionidae; Myx= Myxillidae; Pod= Podospongiidae; Ra= Raspailiidae; Ted= Tedaniidae; Tei= Tetillidae; Ia= Ianthellidae.

Order	Family	Species	Sampling stations																								
			ROV	02 DR	05 DR	07 DR	10 BV	11 BV	12 BV	13 BV	14 BV	15 BV	16 BV	17 BV	18 DR	20 DR	21 BV	27 BV	29 DR	30 BV	32 BV	33 BV	41 BV	44 DR			
At	An	<i>Dercitus plicatus</i>	5	1																				1			
At	An	<i>Jaspis eudermis</i>			1																						
At	An	<i>Jaspis inerustans</i>										2					2										
At	An	<i>Stryphnus mucronatus</i>									2																
At	An	<i>Stryphnus ponderosus</i>			+																						
At	Ca	<i>Calthropella recondita</i>										1															
At	Ge	<i>Caminella intuta</i>																							1		
At	Ge	<i>Caminus vulcani</i>			1							1	1												2		
At	Ge	<i>Erylus discophorus</i>						1																			
At	Ge	<i>Penares helleri</i>										1													1		
At	Pa	<i>Characella tripodaria</i>																							1		
At	Pa	<i>Pachastrella monilifera</i>					1																		1		
At	Th	<i>Thenea muricata</i>						1						1											1		
At	Vu	<i>Poecillastra compressa</i>							1		2		6	2							5				6		
At	Vu	<i>Vulcanella aberrans</i>						1																	5		
Dt	Dy	<i>Dysidea cf. fragilis</i>																							1		
Dt	Ir	<i>Sarcotragus pipetta</i>																							1		
Dt	Spo	<i>Spongia officinalis</i>																							1		
Hd	Cl	<i>Cliona rhodensis</i>			1																				1		
Hd	Cl	<i>Cliona viridis</i>			2																				2		
Hd	He	<i>Hemisterella elongata</i>																							1		
Hd	Pol	<i>Polymastia polylyota</i>																							1		
Hd	Pol	<i>Polymastia</i> spp.																							1		
Hd	Sp	<i>Diplastrella bistellata</i>																							1		

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TABLE 2. (Continued)

Order	Family	Species	Sampling stations																						
			ROV	02 DR	05 DR	07 DR	10 BV	11 BV	12 BV	13 BV	14 BV	15 BV	16 BV	17 BV	18 DR	20 DR	21 BV	27 BV	29 DR	30 BV	32 BV	33 BV	41 BV	44 DR	
Hd	St	<i>Stelligera rigida</i>	3																						
Hd	St	<i>Stelligera stupeosa</i>	2																						
Hd	Su	<i>Aptos aaptos</i>	1															1							
Hd	Su	<i>Prosuberites longuispinus</i>		1	1																				
Hd	Su	<i>Rhizaxinella elongata</i>	5	7																	1	3			
Hd	Su	<i>Rhizaxinella gracilis</i>	1																			1			
Hd	Su	<i>Suberites carnosus</i>			1																				6
Hd	Su	<i>Terpios fugax</i>																							
Hd	Teh	<i>Tethya aurantium</i>																							1
Hd	Ti	<i>Timea unistellata</i>		6																					
Hi	Ax	<i>Axinella alborana</i> nov. sp.			3	2																			2
Hi	Ax	<i>Axinella cf. cinnamomea</i>								2	6	1													
Hi	Ax	<i>Axinella damicornis</i>																							
Hi	Ax	<i>Axinella egregia</i>																							3
Hi	Ax	<i>Axinella polypoides</i>																							
Hi	Ax	<i>Axinella pumila</i>																							1
Hi	Ax	<i>Axinella salicina</i>																							
Hi	Ax	<i>Axinella spatula</i> nov. sp.																							
Hi	Ax	<i>Axinella vellerea</i>																							4
Hi	Ax	<i>Phakellia robusta</i>								2															1
Hi	Ax	<i>Phakellia ventilabrum</i>																							3
Hi	Bu	<i>Bubaris vermiculata</i>																							2
Hi	Bu	<i>Rhabdobaris implicata</i>																							1
Hi	Di	<i>Acanthella acuta</i>																							1
Hi	Di	<i>Dictyonella incisa</i>																							1
Hi	Hal	<i>Spongosorites intricatus</i>																							1
Hp	Cha	<i>Dendroxea lenis</i>																							1
Hp	Cha	<i>Haliclona angulata</i>																							1
Hp	Cha	<i>Haliclona cf. cinerea</i>																							1
Hp	Cha	<i>Haliclona cf. perlucida</i>																							1
Hp	Cha	<i>Haliclona cf. subtilis</i>																							2

.....continued on the next page

TABLE 2. (Continued)

Order	Family	Species	Sampling stations																						
			ROV	02 DR	05 DR	07 DR	10 BV	11 BV	12 BV	13 BV	14 BV	15 BV	16 BV	17 BV	18 DR	20 DR	21 BV	27 BV	29 DR	30 BV	32 BV	33 BV	41 BV	44 DR	
Hp	Cha	<i>Haliclona fulva</i>				1																			
Hp	Cha	<i>Haliclona lacazei</i>											1												
Hp	Cha	<i>Haliclona mucosa</i>					1													1	1	1	1		
Hp	Ni	<i>Gelliodes fayalensis</i>				1																			
Hp	Pe	<i>Petrosia ficiformis</i>																							
Ly	Ros	<i>Asconema setubalense</i>	+																						
Pc	Ac	<i>Iophon nigricans</i>																	1						
Pc	Cho	<i>Batzella inops</i>																							
Pc	Co	<i>Lissodendoryx lundbecki</i>															2								
Pc	Cra	<i>Crambe tailiezi</i>		12																					
Pc	Cre	<i>Crella elegans</i>													1										1
Pc	Cre	<i>Crella pyrula</i>																							
Pc	Des	<i>Desmacella annexa</i>																							
Pc	Des	<i>Desmacella inornata</i>																							1
Pc	Des	<i>Dragmatella aberrans</i>								1															18
Pc	Ham	<i>Hamacantha falcata</i>																							1
Pc	Hym	<i>Hymedesmia paupertas</i>																							1
Pc	Hym	<i>Hymedesmia peachi</i>																							3
Pc	Hym	<i>Phorbas fictitius</i>																							
Pc	Hym	<i>Phorbas topsentii</i>																							
Pc	Mic	<i>Antho involvens</i>																							
Pc	Myx	<i>Myxilla rosacea</i>																							
Pc	Pod	<i>Podospongia lovenii</i>																							
Pc	Ra	<i>Aulospongia spinosus</i>																							8
Pc	Ra	<i>Endecyon fitiformis</i> nov. sp.																							1
Pc	Ra	<i>Endecyon delaubemfelsi</i>																							
Pc	Ra	<i>Eurypon cinctum</i>																							
Pc	Ra	<i>Eurypon coronula</i>																							
Pc	Ra	<i>Eurypon lacazei</i>																							
Pc	Ted	<i>Tedania</i> spp.																							
Sp	Tei	<i>Craniella cranium</i>																							1
Ve	Ia	<i>Hexadella racovitzai</i>																							

TABLE 3. Comparative data of *Axinella* spp. previously described from the Atlantic-Mediterranean region and skeletally and/or morphologically related to those reported in the present study (bottom of species list). Numbers in brackets following the species name indicate bibliographic references, as it follows: (1) Descatoire 1966; (2) present study; (3) Topsent 1892; (4) Topsent 1896; (5) Topsent 1928; (6) Lendenfeld 1897; (7) Lévi 1957; (8) Pulitzer – Finali 1983; (9) Babic 1922; (10) Boury-Esnault *et al.* 1994; (11) Pansini 1984; (12) Topsent 1904; (13) Burton 1931. Dashes refer to the absence of data in the references and blanks in the "Styles" or "Oxeas" columns indicate the absence of a particular spicule type. Abbreviations for skeletal structure are: pl= plumose; pr= plumoreticulate.

<i>Axinella</i> spp. (reference)	Specimen location	Shape and size (length x width in mm)	Color	Styles (μm)	Oxeas (μm)	Trichodragmata (μm)	Skeletal structure
<i>A. alba</i> (1)	Glénan Islands (Atlantic Ocean)	encrusting base (25mm long) with 3 erect processes (15 x 5-8)	white	250-1200 x 15-18 (I) 260-950 x 3-10 (II)	700-1000 x 1.5-18	40-60 (length)	pl
<i>A. alborana</i> nov.sp. (2)	Alboran Island (Mediterranean Sea)	erect, stalked, and flattened, sometimes with incipient branches (10-28 x 2-19)	pale to bright orange (in alcohol)	630-2375 x 5-20	260-650 x 5-20		pr
<i>A. flustra</i> (3)	Bay of Biscay, Azores (Atlantic Ocean)	erect, stalked, with flattened branches (50 x 50)	beige (in alcohol)	870 x 16	185 x 7 (axis) 255 x 13 (body)		pr
<i>A. flustra</i> , herein revised (2)	Bay of Biscay, Azores (Atlantic Ocean)	erect, stalked, with 1-8 flattened branches (24-50 x 30-50)	yellowish white (in alcohol)	190->900 x 10-20	160-340 x 7.5-15	47-50 (length)	pr
<i>A. flustra</i> , as <i>A. padina</i> (4)	Golf of Lion (Mediterranean Sea)	erect, foliaceous, with 4 spatula-shaped lobes (40x35)		650-900 x 8-10	250-275 x 3-6	40 (length)	pr
<i>A. flustra</i> , as <i>Tragosia flustra</i> (5)	Cape Verde (Atlantic Ocean)	erect, stalked, foliaceous (30-40 x 35-40)	orange yellow (in vivo)	300- >1000 x 10-20	160-320 x 3-15	25-36 x 3-5	pr
<i>A. infundibuliformis</i> , as <i>Trinacchophora microdragma</i> (6)	Rockall bank (Atlantic Ocean)	flabellate or calciculate (no size given)		300-600 x 12-16	250-500 x 10-15	15-20 x 5-6	pr
<i>A. minuta</i> (7)	Gabes Gulf, Alexandria (Western Mediterranean)	cushion-shaped encrusting base from which some processes rise up (2 x 2) incipiently and irregularly branched (15 x 11)		120-300 (I) 1200 (II)	120-300		pr
<i>A. minuta</i> (8)	Corse (Mediterranean Sea)	erect, stalked, resembling a grass lawn (no size given)	yellowish pink (in alcohol)	150-490 x 5.5-14 (I) 1300-1700 x 11.5-30 (II)	180-600 x 4.5-14		
<i>A. pumila</i> (9)	Adriatic Sea (Mediterranean Sea)	erect, stalked, with 4 spatula-shaped lobes (40x35)	white (in alcohol)	255-935 x 8-6 (I) 2000 x 19 (II)	170-730 x 2-18		
<i>A. pumila</i> (10)	Alboran Sea (Mediterranean)	massive (no size given)	white (in alcohol)	790-1300 x 20-25	350-520 x 12-15		pr
<i>A. spatula</i> nov.sp.; beige (2)	Alboran Island (Mediterranean Sea)	erect, flabellate, undivided or with 2 branches (35-75 x 6-13)	beige (in alcohol)	119-1400 x 3-30	180-750 x 2.5-20	25-35 x 5-7.5	pr
<i>A. spatula</i> nov.sp.; black (2)	Alboran Island (Mediterranean Sea)	erect, flabellate, undivided or with 2-3 branches (35-100 x 2-8)	black (in alcohol)	350-1400 x 5-20	120-500 x 2.5-20	25-30 x 6-10	pr
<i>A. vacileti</i> (11)	Portofino, Marsicille, Marconi Gulf (Mediterranean Sea)	flabellate (50-60 x 40-50)	orange (in vivo); white (in alcohol)	270-1450 x 2.5-14	250-370 x 2-12		pl
<i>A. vasonuda</i> (12)	Azores (Atlantic Ocean)	erect, with a narrow base, mostly ramified (30-60 x 15-20)	yellowish white (in alcohol)	>1000 x 20	\geq 1500 x 50		pr
<i>A. vellerea</i> (12)	Azores (Atlantic Ocean)	clavate or stalked and branched (45-90 x 17)	yellowish white (in alcohol)	1000 x 30-40 (I) 1800 (II)			pl
<i>A. vellerea</i> , herein revised (2)	Azores (Atlantic Ocean)	markedly or slightly branched (45-97 x 18-40)	ochre (in alcohol)	825-1625 x 12-35			pl
<i>A. vellerea</i> (13)	Folden Fiord (Norwegian Sea)	massive, as incipient, erect columns (no size given)	yellowish white (in alcohol)				
<i>A. vellerea</i> (2)	Alboran Island (Mediterranean Sea)	columnar, undivided or with 2-3 incipient lobule-like branches (10-30 x 5-8)	ochre to light brown (in alcohol)	470-1725 x 11-30	700-1120 x 5-20		pr

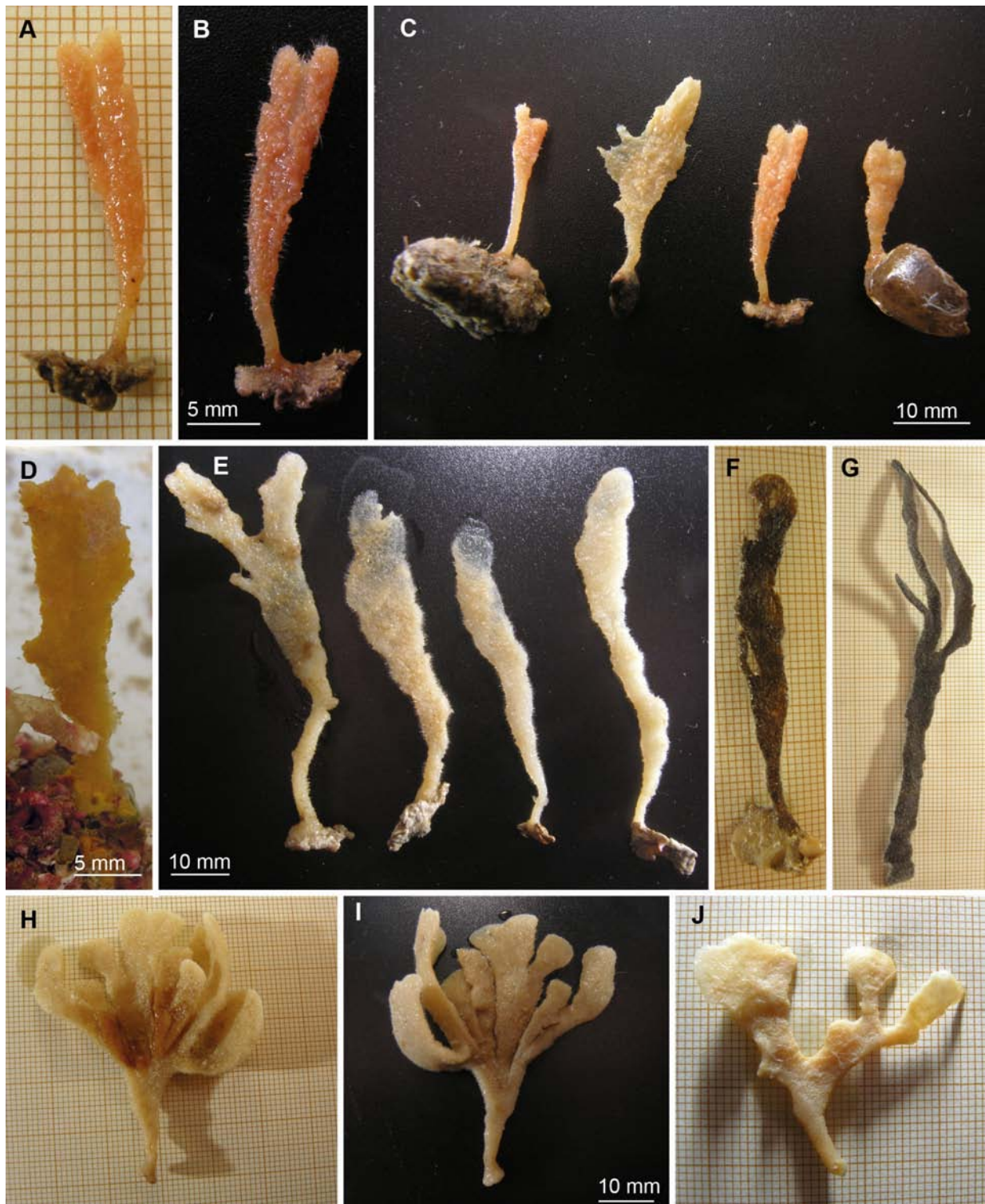


FIGURE 6. (A–B) Holotype of *Axinella alborana* nov. sp. seen from its both sides (MNCN-Sp155-DR44A). (C) Holotype and 3 additional, collected specimens of *A. alborana* nov. sp. (from left to right, MNCN-Sp3-DR05A, MNCN-Sp146-BV33A, MNCN-Sp155-DR44A, MNCN-Sp146-BV33B). (D) Specimen of *Axinella spatula* nov. sp., photographed on board immediately after collection. (E) Preserved specimens of *A. spatula* nov. sp., being the first (from left to right) the holotype (MNCN-Sp145); the remaining specimens are BV33B, MNCN-Sp116-BV15A & B, and MNCN-Sp65-BV21B. (F–G) Blackish specimens (MNCN-Sp57-BV21A and MNCN-Sp57-BV21B, respectively) of *A. spatula* nov. sp. The former shows an incipient branching, while the latter is clearly branched and with no narrowing at the stalk. (H–J) Syntypes of *Tragosia flustra* (Topsent, 1892) collected by Topsent in 1888 (Stn. 247. M. O. M. 040272) and in 1886 (Stn. 58. M. O. M. 040044), respectively. The former (H–I) is shown on its both sides, being profusely ramified, while the latter (J) shows only 3 branches.

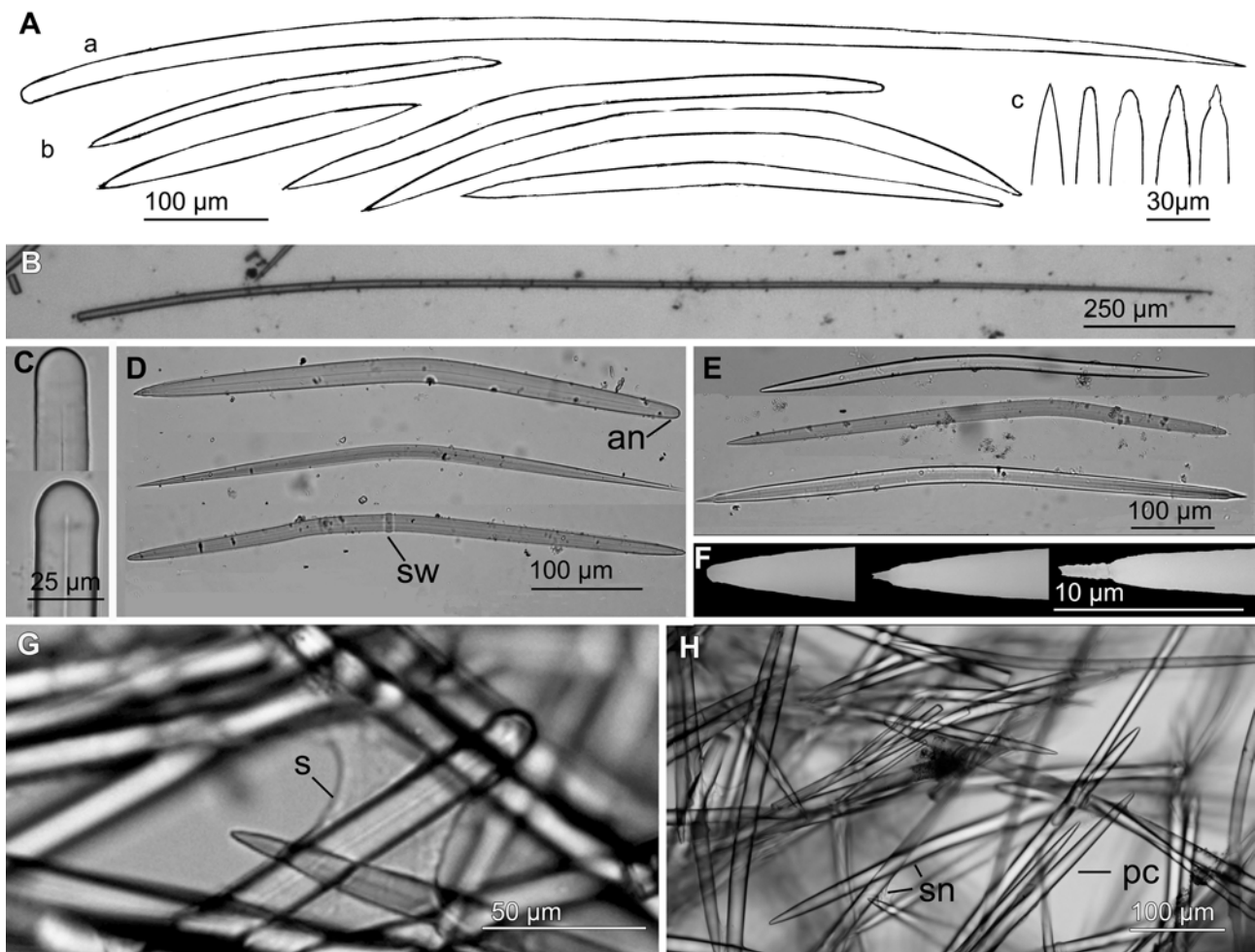


FIGURE 7. *Axinella alborana* nov. sp.: (A) Line drawing summarizing the skeletal complement of the Alboranian specimens, consisting of styles (a) and oxeas (b) with acerate, blunt or mucronate ends (c). (B–C) Light microscope view of a style, with examples of the round end. (D–E) Light microscope views of oxeas. Note the varying curving angle, the anisoxea (an) character in some spicules, and the annular swelling (sw) of others. (F) SEM details of oxea ends, being typically either blunt or mucronate. (G) Light microscope view of the skeletal arrangement, showing a style embedded in spongin (s) in the extra-axial skeleton. (H) Light microscope view of oxeas at the extra-axial plumoreticulate skeleton occurring either in paucispicular tracts (pc) or free (sn).

Macroscopic description. Erect, stalked, flattened sponge, typically attached to small fragments of rocks or shell fragments (Fig. 6A–C; Table 4). The stalk is either cylindrical or compressed, no longer than one quarter of the total sponge length, and hardly recognizable in some specimens. The flattened part of the body is flexible and relatively rectangular, except for the apical margin of the lamina that may be irregularly lobate. Some specimens show an incipient, terminal ramification; none is markedly divided nor further branched. The sponges measure 10–28 mm in height, with a lamina up to 19 mm in wideness and 1–2 mm in thickness. The surface is irregularly hispid, with no aquiferous opening discernible. The color ranges from creamy to reddish orange in life, clearing after preservation in ethanol.

Skeleton. Megascleres are styles and oxeas (Table 4). Styles are slightly curved at a third of their length (Fig. 7A–B), with a regular round end that occasionally forms one or two slight substyles and/or annular swellings (Fig. 7C). The pointed end is usually sharp, but rarely blunt ends occur. Styles measure 630–2375 × 5–20 μm, although two specimens showed a low proportion (<1%) of abnormally shorter or longer styles, measuring respectively down to 580 μm and up to 3000 μm in length (Table 1). Oxeas are slightly or markedly fusiform, curved once or twice, either symmetrically or asymmetrically (Fig. 7A, D). Points are usually acerate; anisoxeas are fairly common and variations like mucronate and blunt ends are frequent, depending on the specimen (Fig. 7D). Occasionally they are centrotylote, with annular or subspherical swellings (Fig. 7D) being smooth or rarely rugose.

They measure 260–650 x 5–20 µm, but shorter oxeas, down to 180 and 125 µm in length, occur respectively in 2 of the studied specimens. As a rule of thumb, oxeas are more abundant than styles.

An axial skeleton is discernible in the stalk, made of ascending compact tracts of oxeas embedded by spongin and crossed by isolated (i.e., not packed) oxeas arranged confusedly. From the axial skeleton, an extra-axial plumoreticulate skeleton emerges, consisting of ascending loose pauci—and multispicular tracts of oxeas reinforced with some spongin (Fig. 7G). In the extra-axial region, there are isolated inter-crossed oxeas forming a confusing reticule-like arrangement (Fig. 7H). Long styles, either isolated or in small groups (2–4), project outward from the spongin cover of the extra-axial tracts, piercing the sponge surface to make it hispid.

TABLE 4. Comparative data of *Axinella alborana* **nov. sp.** specimens, including branching level, color after preservation, and size range of styles and oxeas.

Specimen	Branching	Color (alcohol)	Styles (µm)	Oxeas (µm)
MNCN-Sp03-DR05A	unbranched	orange	990–1800 x 10–20	270–560 x 5–20
MNCN-Sp03-DR05B	2 incipient branches	reddish orange	1100–2375 x 1–20	180–580 x 7.5–15
MNCN-Sp14-BV13A	2 incipient branches	pale orange	630–2075 x 5–20	260–650 x 5–20
MNCN-Sp34-BV14A	2 incipient branches	pale orange	580–1300 x 10–20	125–620 x 5–15
MNCN-Sp34-BV14B	2 incipient branches	whitish orange	975–2000 x 10–20	360–630 x 10–20
MNCN-Sp19-DR29A	damaged	pale orange	710–1625 x 7.5–15	360–610 x 7.5–20
MNCN-Sp146-BV33A	2 incipient branches	pale orange	630–1400 x 7.5–20	290–580 x 10–20
MNCN-Sp146-BV33B	2 incipient branches	pale orange	730–2250 x 5–20	280–620 x 5–20
MNCN-Sp191-BV41A	unbranched	whitish orange	825–1750 x 7.5–20	350–550 x 10–20
MNCN-Sp155-DR44A	2 incipient branches	reddish orange	1000–3000 x 10–20	390–600 x 15–20

Distribution and ecology notes. The individuals were collected at the deep shelf (87 to 173 m) of the Alboran Island, from rocky, detritic-organogenic gravel, and rhodolith bottoms.

Taxonomic remarks. No previously known *Axinella* spp. in the Atlantic-Mediterranean area have characteristics similar to those of the new species (Table 3). The external morphology of *A. alborana* **nov. sp.** bears some external resemblance to *A. flustra* (Fig. 6H–J), especially to Topsent's (1904) syntypes from Stn. 247 (Fig. 6H–I). Nevertheless, both species strongly differ skeletally, having *A. flustra* trichodragmata and shorter oxeas (Table 3). *Axinella vaceleti* Pansini, 1984 is also a flabellate species, but with a marked fan-shaped, undulating lamina, which is also larger (50–60 mm high) and thicker (4–5 mm) than that of the *A. alborana* **nov. sp.** specimens. Additionally, *A. vaceleti* has smaller spicules, specially the styles, ranging from 270 to 1450 µm (Pansini 1984).

Specimens of *Axinella alborana* **nov. sp.** were investigated for the first time about twenty years ago, as part of a study on the deep-shelf Alboranian sponges carried out by Maldonado (1993). Nevertheless, no description of material was published at that time because of the risk that the small individuals now described as *A. alborana* **nov. sp.** might correspond to juvenile stages of some poorly known, large *Axinella* spp. growing at the ill-known deep shelf. However, our recent exploration of those deep-shelf habitats using an ROV has revealed that there is no dense population of any other large *Axinella* spp. in the areas where *A. alborana* **nov. sp.** occurs. In the light of these findings, the idea that the dense undergrowth of small individuals might correspond to juvenile sponges makes no sense and these small sponges can indeed be identified as adults of *A. alborana* **nov. sp.**

Axinella spatula **nov. sp.**

(Figs. 6D–G, 8; tables 2, 3, 5)

Etymology. The species is named after the "spatula" tool (a diminutive form of the Latin "spatha"), which bears resemblance to the external shape of the specimens.

Material examined. Holotype MNCN-Sp145-BV33B collected from type locality Stn. 33 (Table 1, Fig. 1), a 134 to 173 m deep, gravel bottom at the deep shelf of the Alboran Island.

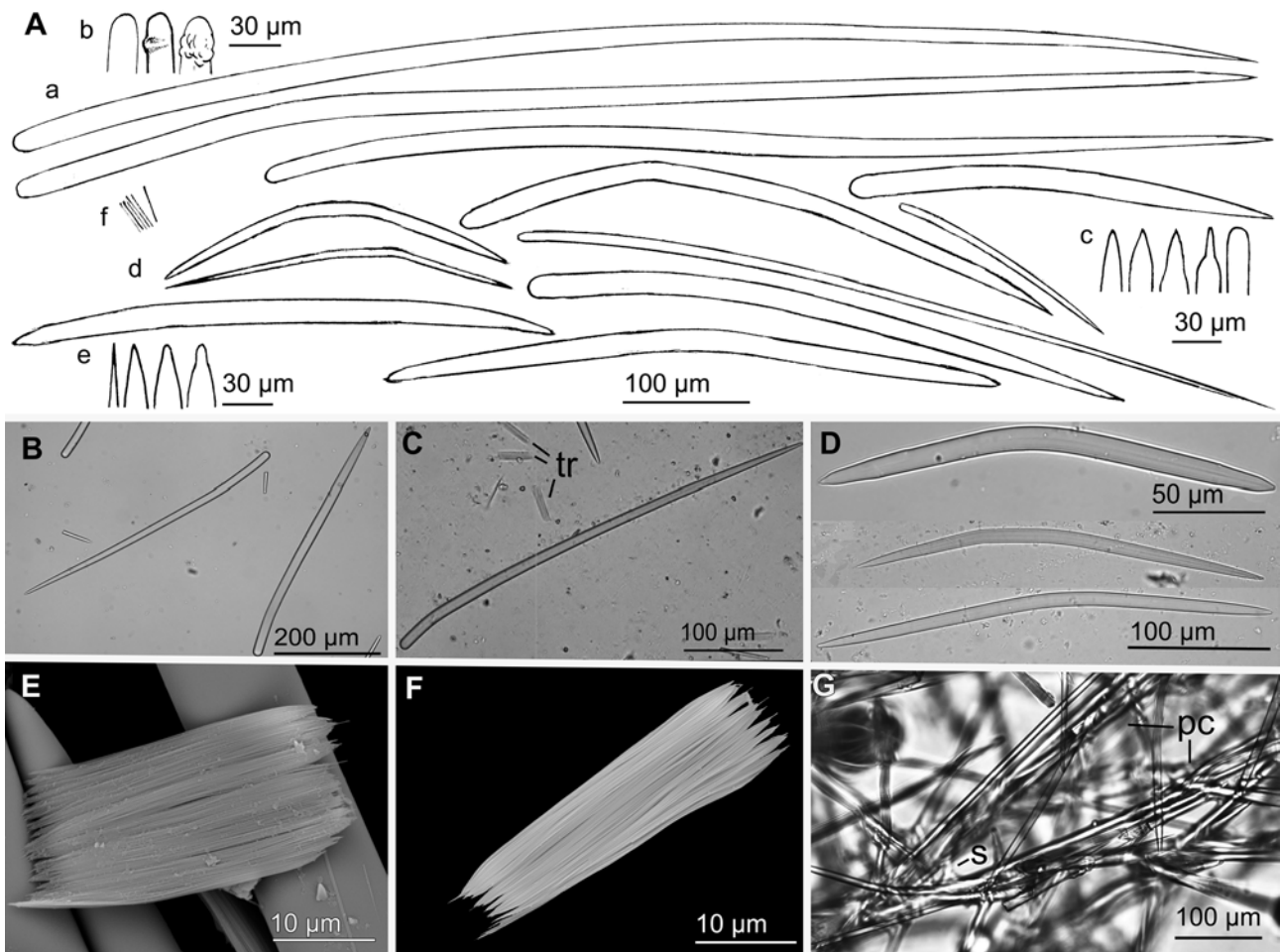


FIGURE 8. *Axinella spatula* nov. sp.: (A) Line drawing summarizing the skeletal complement of the Alboranian specimens. It consists of styles (a) in a wide range of sizes, with a round end that occasionally shows one or more swellings (b) and a distal end that can be acerate, stepped or blunt (c). Oxeas of varying shape (d), with acerate to mucronate ends (e). Raphides (f) are in trichodragmata. (B–C) Light microscope views of styles and trichodragmata (tr). (D) Light microscope view of oxeas. (E) SEM micrograph of the flattened trichodragmata typically found in the beige specimens (e.g., in MNCN-Sp65-BV21A). (F) SEM micrograph of a more cylindrical trichodragmata typically found in blackish specimens (e.g., in MNCN-Sp57-BV21A). (G) Detail of the plumoreticulate and somewhat irregular skeletal arrangement at the lamina region of the sponge. Note the spongin (s) embedding the paucispicular tracts (pc).

Twenty-two paratypes designated: MNCN-Sp28-BV14A to C from Stn. 14; MNCN-Sp116-BV15A to I from Stn.15; MNCN-Sp57-BV21A to C (blackish specimens) and MNCN-Sp65-BV21A & B from Stn. 21; MNCN-Sp145-BV33A & C to D from Stn. 33; MNCN-Sp188-BV41A & B from Stn. 41 (Table 1, Fig. 1).

Comparative material: Syntype material of *Axinella flustra* (Topsent, 1892) = *Tragosia flustra* Topsent, 1892, since no holotype was designated by Topsent (1892) for this species (Table 3). Syntypes were two specimens (MOM-040044) from Bay of Biscay (Stn. 58; 43°40'N 8°55'W, 134 m deep, 7 August 1886) and two specimens (MOM-040272) from Azores (Stn. 247; 38°23.500'N 30°20.333'W, 318 m deep, 30 August 1888).

Macroscopic description. Erect, flabellate sponges (Fig. 6E–G; Table 5). They are 35–100 mm in height, with a basal stalk-like region in which the lamina progressively increases in wideness from the attachment point up to about 1/4 of the height, where it becomes approximately rectangular (3–9 mm in wideness). The lamina is thin (1–1.5 mm) and flexuous. It can be undivided, or, in some individuals, forming two or three flattened branches, all with a regular apical margin (Fig. 6E). The sponge surface is porous to the dissecting microscope, largely and irregularly hispid. Most collected individuals are pale orange when alive, turning into yellowish white to beige after ethanol preservation. Nevertheless, three of the specimens show remarkable color dissimilarity, being dark brown to black, at least after preservation in ethanol (Fig. 6F–G). Some of these blackish specimens (part of the paratype series) also account for the largest sizes (up to 100 mm in height) and have the stalk-like region more flattened than the orange-beige individuals.

TABLE 5. Comparative data of *Axinella spatula* **nov. sp.** specimens, including branching level, color after preservation, and size range of styles and oxeas.

Specimen	Branching	Color (alcohol)	Styles (μm)	Oxeas (μm)	Trichodragmata (μm)
MNCN-Sp28- BV14A	unbranched	beige	170–1300 x 8–20	180–430 x 5–12	22.5–32.5 x 8–10
MNCN-Sp28- BV14B	unbranched	beige	310–1250 x 5–10	210–450 x 4–10	25–28 x 5–8
MNCN-Sp57- BV21A	unbranched	black	350–1400 x 5–20	220–500 x 2.5–20	25–30 x 6.25–10
MNCN-Sp57- BV21B	2 incipient branches	black	245–1225 x 8–18	120–432 x 9–12	25–30 x 6–10
MNCN-Sp65 -BV21A	unbranched	beige	220–1100 x 5–30	220–520 x 5–10	25–30 x 9–10
MNCN-Sp145-BV33A	2 incipient branches	beige	165–1050 x 3–15	180–520 x 2.5–15	25–30 x 5–8
MNCN-Sp188- BV41A	unbranched	beige	119–1400 x 4–15	190–750 x 5–20	25–35 x 5–8

Skeleton. Megascleres are styles and oxeas (Table 5). Styles occur in a wide variety of size and shape, with abundant intermediate forms that prevent making putative categories. Styles are often slightly curved, either symmetrically or asymmetrically; sometimes they have more than one flexion point and can even be angulated and, more rarely, slightly sinuous (Fig. 8A–C). The round end is usually regular, occasionally with an annular swelling (Fig. 8A). The distal end is of variable morphology, from sharp hastate or acerate type to stepped, mucronate, and almost blunt (strongyloxea-like) type (Fig. 8A). Styles measure 119–1400 x 3–30 μm , not being further categorizable according to their size. They are also difficult to separate according to their location, but most of those in the choanosomal region are not larger than 550–620 x 10–20 μm . Styles in the black specimens have a size range (245–1400 x 5–20 μm) virtually identical to that of the orange-beige individuals, although predominating sizes are usually over 800 x 10 μm . Oxeas, some more abundant than the styles, are also relatively variable in size and shape, but variability ranges are similar among specimens. They can be slightly or markedly curved, once or twice, and symmetrically or asymmetrically (Fig. 8A, D). Tips are usually acerate or blunt, although mucronate ends also occur (Fig. 8A). They measure 180–750 x 2.5–20 μm in the orange-beige specimens and 120–500 x 2.5–20 μm in blackish individuals. Microscleres in both orange-beige and blackish individuals are raphides in highly packed trichodragmata (Fig. 8E–F), measuring 22.5–35 x 5–13.7 μm . Although no evident size difference exists in trichodragmata between orange-beige and blackish individuals, their shape can be flattened or cylindrical in the orange-beige ones (Fig. 8E), but only cylindrical trichodragmata (Fig. 8F), and in higher abundance, are found in the blackish ones.

The skeletal structure is plumoreticulate. There is an evident axial skeleton in the stalk-like region, built by multispiculate tracts of oxeas. In the thin lamina there is no clear distinction between axial and extra-axial skeleton. Rather, there are pauci—and multispicular, ascending and ramifying tracts, compressed in the sense of the lamina and consisting of mainly oxeas, with sparse styles (Fig. 8G). These tracts are looser than in the axial skeleton of the stalk, and are connected each other by an irregular reticule that becomes more apparent in the thinnest parts of the lamina. In the three blackish specimens, the styles in the ascending tracts are somewhat more abundant and usually slightly longer than those in the orange-beige specimens. There are peripheral styles with their round end embedded in the tracts, piercing perpendicularly surface and making it hispid. The hispidating styles are usually long and occur isolated or in plumose tufts of up to 7 styles. Trichodragmata are predominantly located near the surface, especially in the blackish specimens. Spongin is abundant in the axial skeleton although it does not entirely embed all the spicules. It occurs moderately in the plumose tracts of the lamina (Fig. 8G).

Distribution and ecology notes. All the collected specimens came from gravel bottoms, sometimes with organogenic components, at depths ranging from 93 to 173 m.

Taxonomic remarks. Except for color, the morphological and skeletal differences between the orange-beige individuals and the blackish ones are minor (Table 5) and we judged them not enough to support a differentiation into two separated species. Both color varieties share relevant features, such as similar body morphology and plumoreticulate skeleton with the same spicule categories and similar size ranges. In addition to the obvious color differences, it can be noticed: 1) a higher abundance of cylindrical trichodragmata in the blackish individuals; 2) a slightly more organized reticule-like arrangement linking the plumose tracts in the orange-beige individuals; and 3)

higher frequencies of short styles in the orange-beige specimens. Even though we are herein assuming that these differences correspond to ill-known aspects of intraspecific variation, we cannot discard that future studies based on molecular features of new collections and/or "in vivo" observations may lead to a species split.

Trichodragmata similar to those in *A. spatula* **nov. sp.** are also found in some other *Axinella* spp. (Table 3), such as *Axinella infundibuliformis* (Linnaeus, 1759). Nevertheless, this latter species has a caliculate or fan-like body shape, a plumoreticulate skeleton of oxeas and styles clearly smaller (300–600 x 12–16 µm), as well as smaller (15–20 µm long) trichodragmata (Lendenfeld 1897; Arndt *et al.* 1935). It is also worth noting that the earliest descriptions of *A. infundibuliformis* were little accurate and apparently overlooked the small trichodragmata (Johnston 1842; Bowerbank 1866; Hansen *et al.* 1885; Fristedt 1887). *Axinella alba* (Descatoire, 1966) also shows trichodragmata, but it is an encrusting species and has oxeas (700–1000 x 15–18 µm) longer than those of *A. spatula* **nov. sp.** Trichodragmata and styles also occur in *Axinella flustra* (Descatoire 1966), but, again, although these styles and trichodragmata are in a size range similar to those of *A. spatula* **nov. sp.**, the branching body shape (Fig. 6H–J) and shorter oxeas make *A. flustra* easily distinguishable (Table 3).

Some members of the axinellid genus *Dragmacidon* Hallman, 1917 (Table 3) bear some vague resemblance to *A. spatula* **nov. sp.**, namely occurrence of raphides and the absence of a clear axial and extra-axial skeleton differentiation. Furthermore, phylogenetic analyses based on 18S rRNA, 28S rRNA and CO1 have brought *Dragmacidon* species and raphide-bearing *Axinella* species into a same clade (Gazave *et al.* 2010; Morrow *et al.* 2012). *Dragmacidon tuberosum* (Topsent, 1928) is the only geographically close species in the genus having trichodragmata, but those are distinctive, having the raphides projecting from each side of the packets; besides, this species has shorter styles (Topsent 1928).

***Axinella vellerea* Topsent, 1904**

(Figs. 2B, 9, 10; Tables 2, 3)

Material examined. Thirteen specimens collected from the deep shelf of Alboran Island: MNCN-Sp51-DR05A & B from Stn. 5; MNCN-Sp148-BV33 from Stn. 33; MNCN-Sp196-BV41 from Stn. 41; MNCN-Sp142-DR44 A to I from Stn. 44 (Table 1, Fig. 1)

Comparative material: Syntype material of *Axinella vellerea* Topsent, 1904 (since no holotype was originally designated by Topsent), consisting of two specimens from Stn. 866 at Azores Islands (38°52.833'N 27°23.083'W; water depth: 599 m; 2 August 1897), and currently stored at the Monaco Museum (MOM-040631).

Macroscopic description. Specimens are erect, columnar, undivided or with two-tree incipient, lobule-like ramifications (Fig. 9A–H). The sponges measure 10–30 x 5–8 mm. The consistency is fleshy but hardly flexible. The surface is irregular, grooved, and porous. In some specimens, the oscules can be observed in the translucent epithelium folding the grooves, which run usually vertically, parallel to the longest axis of the body. The hispidation of the ectosome is short and not very dense, mostly verifiable under the dissecting microscope. The animal color in ethanol is ochre or pale brown.

Skeleton. Megascleres are only styles and, in some individuals, a very low number of oxeas. Styles occur in a wide range of shapes and sizes, but without making discernible categories. They are slightly curved to somewhat angulate, some curved nearly the round end, similarly to rhabdostyles (Fig. 10A–B). The round end may be regular, but substyles and annular swellings are also common, either in terminal or subterminal position (Fig. 10A–C). The point is usually acerate, but sometimes stepped or even blunt (Fig. 10A). Spicule malformations occasionally occur as well. Styles measure 470–1725 x 11–30 µm, but diameters smaller than 15 µm are uncommon. Some scattered oxeas have been observed in some specimens, in which case they are angulated or have a two-point curvature (Fig. 10D), sometimes asymmetrical; they may also be centrotylote. When present, they measure 700–1120 x 5–20 µm.

The skeletal arrangement consists of a somewhat central, compressed, plumoreticulate axis from which a plumoreticulate extra-axial skeleton spreads (Fig. 10E). The ascending extra-axial tracts become thinner as they reach the surface, and their terminal styles pierce the ectosome causing hispidation. Moderate spongin embeds the spicules but without forming fibres (Fig. 10F); spongin becomes less abundant in the extra-axial region.

Distribution and ecology notes. The individuals were collected from depths ranging from 102 to 173 m, on rock, gravel or dead rhodolith pieces. The collected material makes the first Mediterranean record of this rare species. To date only four specimens had previously been reported: three of them collected from a 599 m deep,

gravel bottom at Azores (Topsent 1904), and one from 200–290 m depths at the Folden fiord of the Norwegian Sea (Burton 1931).

Taxonomic remarks. The size of the examined syntypes of *A. vellerea* (97 x 40 mm and 45 x 18 mm) is slightly larger than that of any of the Alboranian individuals, being the remaining aspects of the external morphology notably similar between both specimen groups (Fig. 9A–H). The largest syntype also shows two branches better developed (Fig. 9F–G) than the incipient branches often characterizing the Alboranian individuals (Fig. 9A–E). Regarding the spicules, the Alboranian specimens and the syntypes of *A. vellerea* show styles in nearly identical size and shape ranges (Table 3). A small skeletal difference is that oxeas are not found in neither the original description by Topsent (1904) nor in our re-examination of the syntypes. Burton (1931) did report occasional "oxeote styles" in his Norwegian specimen. In the Alboranian, specimens, we found oxeas in only a minority of individuals and always in low abundance. Therefore, the oxeas appear to be a variable element in the spicule complement of *A. vellerea*, as it is also the case of other *Axinella* spp.

As previously noticed by Topsent (1904), *A. vellerea* and *Axinella vasonuda* Topsent, 1904 bear similarity in both their external morphology and the skeletal organization. Nevertheless, *A. vasonuda* is characterized by having oxeas as main spicule type, showing only scarce styles, the occurrence of which is limited to the peripheral zones of the skeleton.

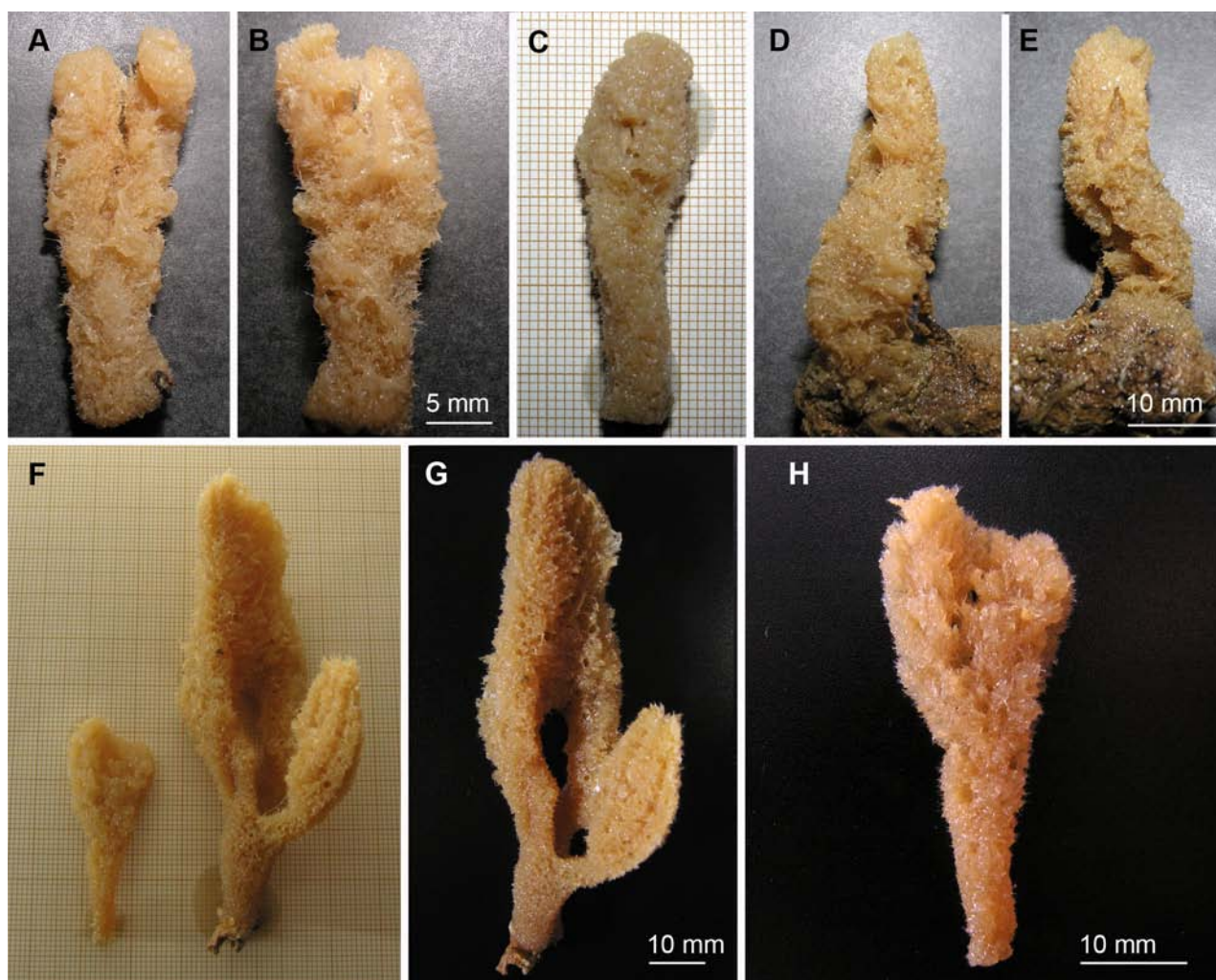


FIGURE 9. *Axinella vellerea* Topsent, 1904. (A–B) One of the collected Alboranian specimens (MNCN-Sp51-DR05A) shown on its both sides and bearing an incipient branching. (C) A branchless Alboranian specimen (MNCN-SP51-DR05B) of *A. vellerea* photographed on graphic paper. (D–E) Another unbranched Alboranian specimen (MNCN-Sp142-DR44A) attached to a piece of gravel, shown on its both sides. (F) Photograph of the holotype (the large sponge to the right) and the syntype (to the left) of *A. vellerea*, collected by Topsent in 1897 (Stn. 866. M. O. M. 040631). (G) Close up of the holotype of *A. vellerea*, being clearly ramified and larger than most specimens collected from the Alboran Island. (H) Close up of the syntype of *A. vellerea*, showing an incipient branch.

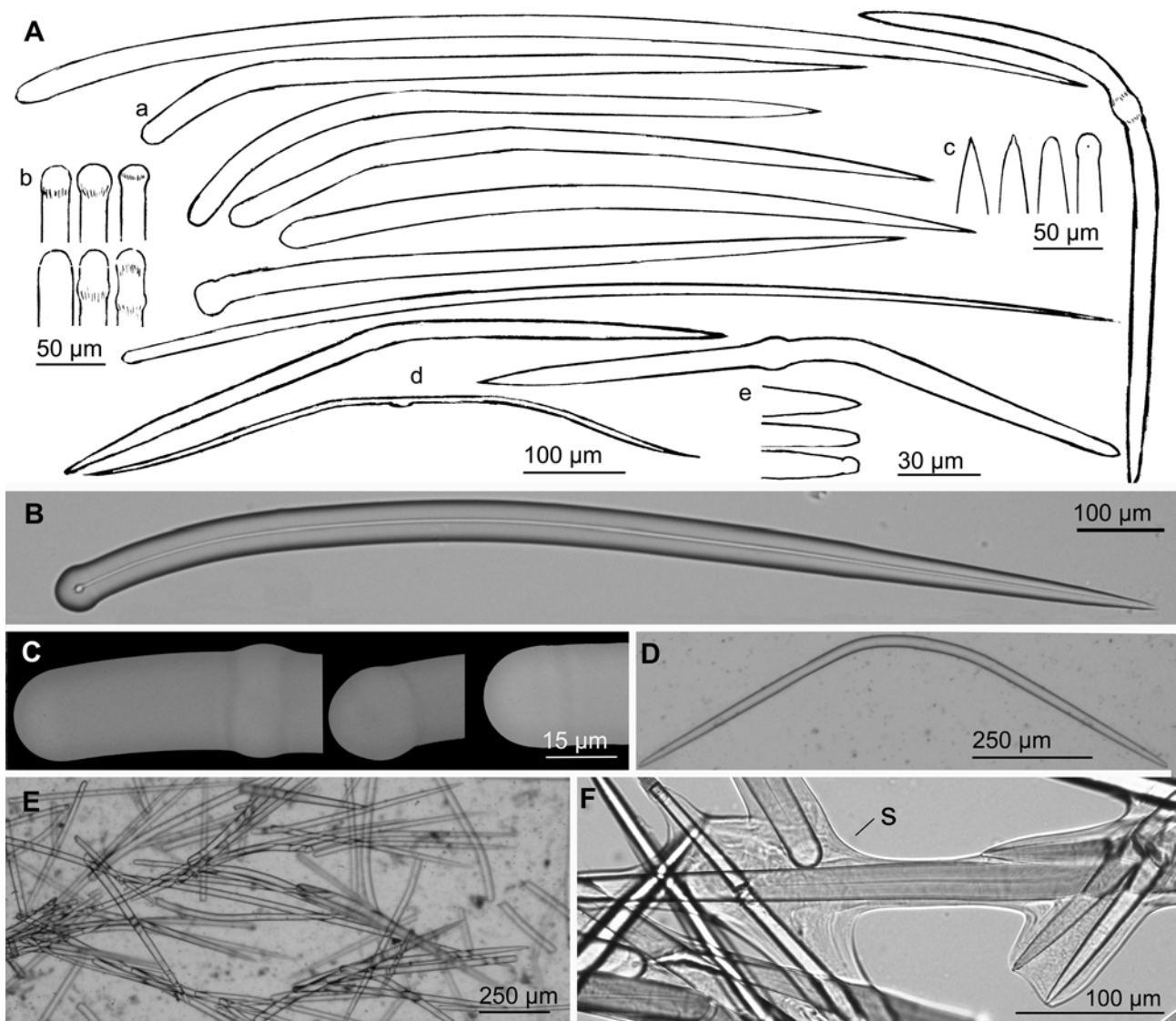


FIGURE 10. *Axinella vellerea* Topsent, 1904: (A) Line drawing summarizing the skeletal complement of the Alboranian specimens. Styles (a) are in a wide variety of shapes, with a round end that can be regular or showing one or more swellings (b) and a distal end (c) that can be regular to blunt, sometimes with mucronate variations. Oxeas (d) occur in varying size and shapes, with ends ranging from acerate to mucronate (e). (B) Light microscope view of a style with a subtylote end. (C) SEM detail of three typical morphologies (i.e., subterminal ring, subtylote, and regular) of the round end of styles. (D) Light microscope view of a double-bent oxea. (E) Light microscope view of plumose arrangement in the extra-axial skeleton. (F) Detail of styles embedded by spongin (s).

Family BUBARIDAE Topsent, 1894

Genus *Rhabdobaris* Pulitzer-Finali, 1983

Diagnosis. Monotypic genus of Bubaridae, characterized by stalked and flabellate body shape, possessing long hispidating styles and a plumoreticulate internal skeleton made of choanosomal rhabdostyles, oxeas, and strongyles, with smooth and spiny forms co-occurring. Microscleres are raphides in trichodragmata (genus diagnosis herein redefined after *Rhabdobaris* being restituted as a valid genus; not a junior synonym of *Cerbaris* Topsent, 1898).

Remarks. See the "Taxonomic remarks" section of *Rhabdobaris implicata* for further discussion and concerns about the morphological affinity of the herein restituted genus *Rhabdobaris* and members of the family Raspailiidae.

***Rhabdobaris implicata* Pulitzer-Finali, 1983**

(Figs. 11A–B, 12; Table 2)

Synonymy. *Cerbaris implicatus* (Pulitzer-Finali, 1983): Alvarez & Van Soest 2002, 751–752.

Material examined. Only one individual (MNCN-Sp23-BV14) collected from Stn. 14 (Table 1, Fig. 1), a 96–100 m deep, gravel bottom on the deep shelf of the island. The collected individual is herein designated the neotype, given that the previously available holotype specimen was entirely acid-dissolved to obtain a spicule slide. We are reasoning herein (see the *Taxonomic remarks* section) that type material in which the macroscopic body features and the skeletal arrangement can be evaluated is crucial to recognize the distinct nature of the monotypic genus *Rhabdobaris* within the family Bubaridae and, therefore, to support the nomenclatorial restitution of the genus. These "exceptional circumstances" strongly advise the neotype designation to preserve the stability of the nomenclature, following article 75 of the International Code of Zoological Nomenclature.

Comparative material: Original holotype of *Rhabdobaris implicata* Pulitzer-Finali, 1983. The only available material of the original holotype is the spicule slide (MSNG-47170) resulting from boiling in nitric acid the small specimen collected off Calvi, N-W of Corse, at 121–149 m depth (Pulitzer-Finali 1983).

Macroscopic description. Stalked, flabellate sponge (Fig. 11A–B), with a thin lamina measuring 15 mm long x 25 mm wide x 1 mm thick; the stalk, somewhat compressed, measures 7 mm in length x 2.5 mm in wideness. There are 3 and 4 reinforcement ribs at each side of the lamina (Fig. 11A–B), making the lamina poorly flexible. There are no aquiferous openings discernible to the naked eye. The surface of the lamina is markedly hispid, with long spicules protruding uniformly at moderated density. The stalk is less hispid. The color of the alcohol-preserved specimen is creamy white.

Skeleton. Megascleres are in seven categories: long hispidating styles, rhabdostyles, oxeas, strongyles, acanthoxeas, acanthostyles, acanthostrongyles. Microscleres are raphides in trichodragmata. Hispidating styles are long, gently conical, nearly straight or softly curved, with a regular round end and a sharp, acerate or hastate point (Fig. 12A–B). They are 754–1557 μm long and 8–16 μm wide. Rhabdostyles have a slight to marked curvature on their first $\frac{1}{4}$ of their length (Fig. 12A, C), rarely becoming regular styles. Other variations occurring in the rhabdostyles are annular or irregular swellings in the vicinity of the round end and polyaxial malformations in the vicinity of the pointing end (Fig. 12C); the points can be acerate, stepped, or even bifid (Fig. 12A). Rhabdostyles measure 137–304 x 5–13 μm , although some thinner, growing stages (Fig. 12A) can occasionally be observed, measuring 107–212 x 3–6 μm . Oxeas are isodiametric, in a wide range of morphologies, showing from one to three flexion points, and more asymmetrical (Fig. 12A, E); they can occasionally be centrotylote, sometimes with the swelling placed asymmetrically. Oxea ends are acerate, conical, mucronate or stepped, with bifid and polyaxonic malformations also occurring (Fig. 12A, E). Oxeas measure 222–405 x 5–10 μm , although, as it happens in the rhabdostyles, thinner growing stages (Fig. 12A) measuring 185–285 x 1–3 μm occasionally occur. Strongyles are curved once or twice, regularly or irregularly (Fig. 12A), occasionally symmetrically or asymmetrically centrotylote, measuring 160–310 x 14–15 μm . Strongyles are clearly less abundant than rhabdostyles and oxeas.

The rhabdostyles, the oxeas and the strongyles have "acanthose versions", which usually are slightly smaller and less abundant than their respective smooth counterparts. Acanthorhabdostyles measure 125–187 x 6–11 μm and show from scarce to abundant small spines, equally or unequally distributed along the spicule and not necessarily confined to one of the ends (Fig. 12D). Acanthoxeas measure 120–280 x 7–9 μm and show few to abundant spines, often more concentrated towards the ends (Fig. 12A, F). In few acanthoxeas, the spines were relatively thick and blunt, becoming a sort of tubercles. Acanthostrongyles measure 129–409 x 5–12 μm , being entirely or partially spiny (Fig. 12A). Microscleres are toxiform raphides, occurring in trichodragmata (Fig. 12A, H) that measure 22–50 x 10–20 μm .

The skeletal architecture is plumoreticulate. The stalk contains a compact plumoreticulate skeleton with ascending multispiculate tracts including all categories of choanosomal megascleres (i.e., except the long hispidating styles) embedded in moderate spongin. Nevertheless, in order not to damage the stalk, we only sampled a tiny peripheral portion of stalk tissue and cannot discard the occurrence of a pure axial skeleton in its central region. In the lamina, the ascending tracts ramify and reticulate irregularly, compressed in the plane of the lamina; there are also free oxeas and styles arranged obliquely to the ascending tracts. Long hispidating styles with their round end embedded in the ascending tracts protrude largely the surface of the sponge at the lamina. Additionally,

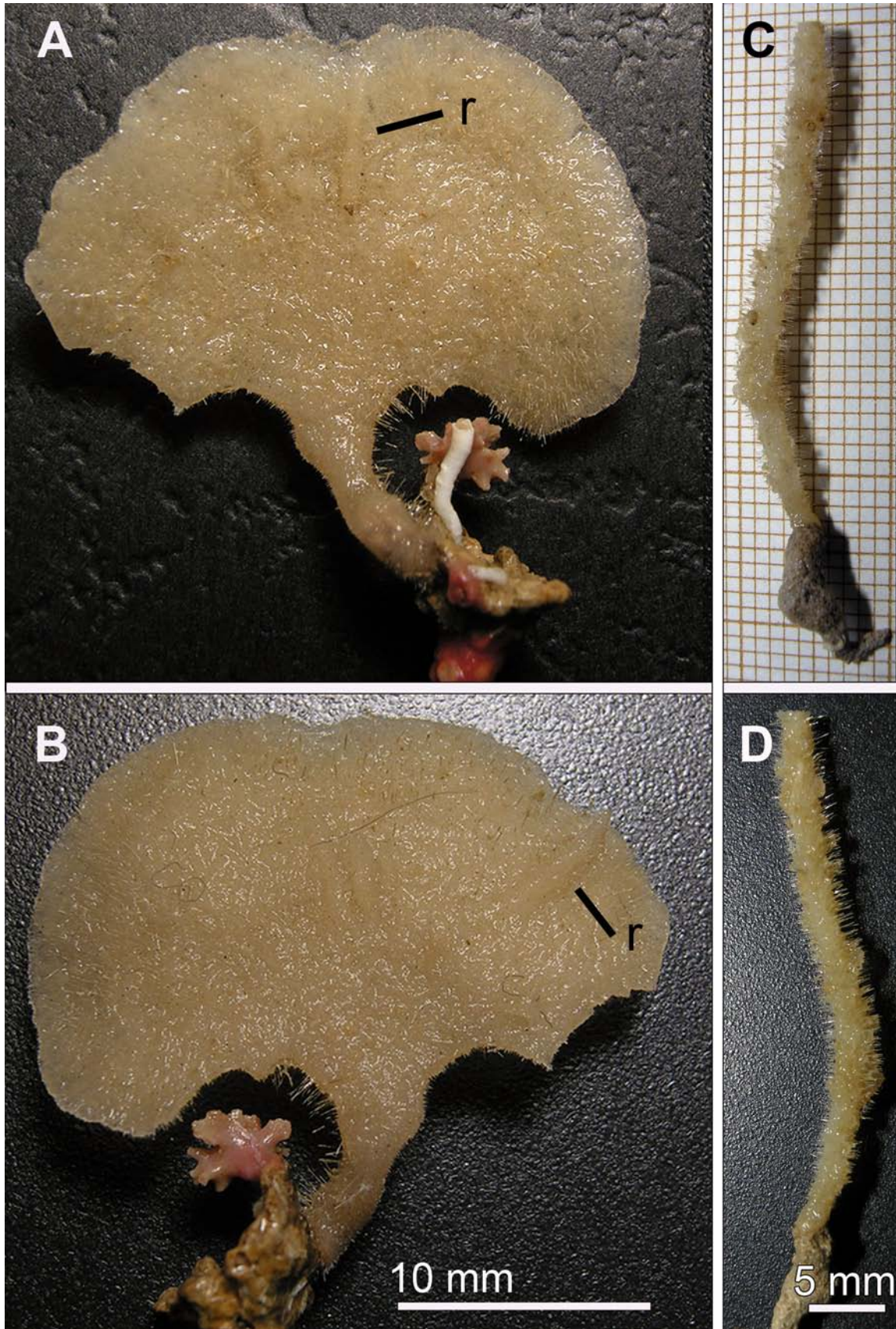


FIGURE 11. (A–B) Neotype (MNCN-Sp23-BV14) of *Rhabdobaris implicata* Pulitzer-Finali, 1983 collected from the Alboran Island and photographed on its both sides. Note some ribs (r) on the lamina. (C–D) Holotype of *Endectyon (Hemectyon) filiformis* **nov. sp.** (MNCN-Sp69 BV21) attached on a small piece of gravel, photographed on its both sides.

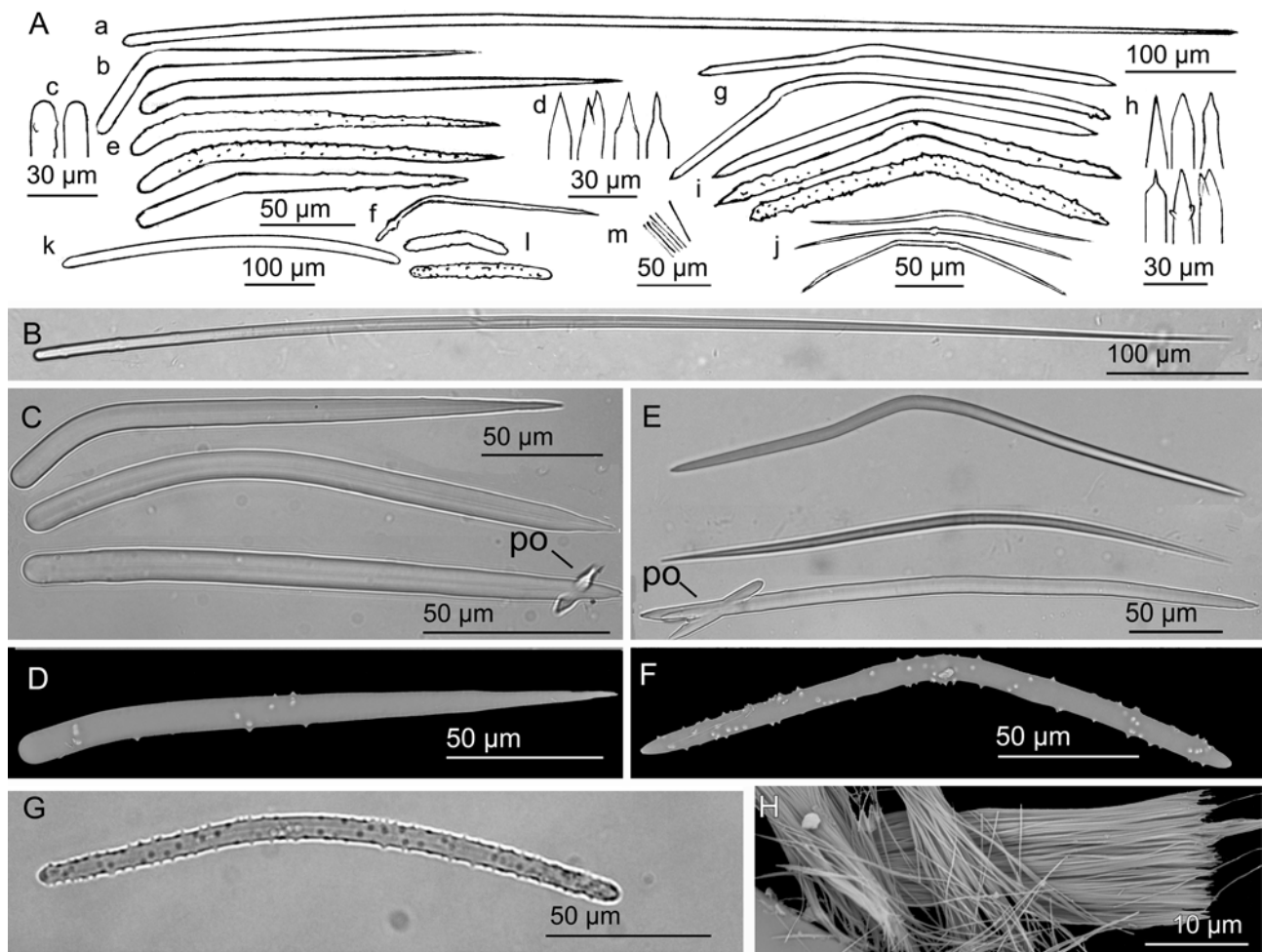


FIGURE 12. *Rhabdobaris implicata* Pulitzer-Finali, 1983: (A) Line drawing summarizing the skeletal complement of the Alboranian specimen (MNCN-Sp23-BV14), consisting of hispidating styles (a), smooth rhabdostyles (b) with a regular or swollen round end (c) and acerate, bifid to polyactinal, or stepped distal end (d), acanthostyles (e), small styles (f), smooth oxeas (g) with acerate, stepped, mucronate or polyactinal ends (h), acanthoxeas (i), developing stages of oxeas (j), strongyles (k), acanthostrongyles (l), and toxiform raphides in trichodragmata (m). (B–D) Light microscope views of an hispidating style (B) and choanosomal rhabdostyles (C), sometimes with abnormal, polyactinal points (po). (D) SEM view of an acanthostyle. (E) Light microscope view of oxeas in various shapes, sometimes showing polyactinal ends (po). (F) SEM micrograph of an acanthoxea. (G) Light microscope view of an acanthostrongyle of the holotype *Rhabdobaris implicata* Pulitzer-Finali, 1983 (MSNG-47170). (H) SEM image of two overlapped trichodragmata of toxiform raphides in the Alboranian specimen.

among the long hispidating styles, there is also a short, dense and uniform hispidation caused mostly by non-acanthose rhabdostyles and oxeas. Likewise, the hispidation of the stalk is only due to these shorter spicules, lacking the long hispidating styles.

Distribution and ecology notes. Rare species, only known previously from the holotype (Pulitzer-Finali 1983), a specimen collected at 121–149 m, off Calvi (Corse Island, Western Mediterranean). Our Alboranian specimen, collected from a 96–100 m deep, gravel bottom with a very rich associated invertebrate fauna, provides the second record of the species in the Mediterranean.

Taxonomic remarks. The body shape and the spicule complement of the newly collected material matches notably well with the original description of *Rhabdobaris implicata* by Pulitzer-Finali (1983), who indicated that it was a new "stipitate" genus in the family Bubaridae. The only difference is that acanthostrongyles (Fig. 12G) are more abundant than acanthoxeas in the holotype, while it is the opposite in the Alboranian individual.

The genus *Rhabdobaris* Pulitzer-Finali, 1983 was declared a junior synonym of *Cerbaris* by Alvarez & Van Soest (2002) on the argument that they both share the occurrence of acanthose diactines in the basal, choanosomal skeleton. However, the features of the newly collected individual of *R. implicata* make clear that it does not fit the genus diagnosis of *Cerbaris* provided by Alvarez & Van Soest (2002). *Cerbaris*, among other traits, is

characterized by encrusting sponges, with a choanosomal skeleton consisting of a basal layer of acanthose and smooth diactines and monactines projecting perpendicularly to the substratum. Therefore, the current diagnosis of *Cerbaris* reflects several major mismatches relative to the features of *Rhabdobaris implicata*: 1) *R. implicata* is a stalked, flabellate sponge (Fig. 11A–B), rather than an encrusting form; 2) the skeleton is not a basal layer, but consists of a plumoreticulate structure of ascending tracts; 3) it lacks the distinct ceroxas (M-shaped oxeads) of *Cerbaris*; 4) *Rhabdobaris implicata* has acanthostyles in great abundance, a spicule type often missing in *Cerbaris*. Altogether, the differences in body shape, spicule complement and skeletal organization advice to re-establish the original genus *Rhabdobaris* erected by Pulitzler-Finali (1983) in the family Bubaridae. Likewise, the existence of *Rhabdobaris* makes compulsory a modification of the current definition for family Bubaridae, as it is currently defined by Alvarez & Van Soest (2002) only to host sponges with an encrusting growth habit supported by a basal layer of interlacing choanosomal diactines.

A comparison of the spicule complement of our Alboranian specimen to *Cerbaris* spp. occurring in or near the Western Mediterranean region reveals only vague resemblance to *Cerbaris* (formerly *Bubaropsis*) *curvisclera* (Lévi & Vacelet 1958) from Azores and *Cerbaris* (formerly *Rhabdoploca*) *curvispiculifer* (Carter 1880), originally described from the Indian Ocean (Gulf of Manaar) and subsequently found in Azores (Topsent 1904) and Banyuls (Vacelet 1969). These two latter *Cerbaris* species are encrusting forms that also lack the plumoreticulate skeleton. In addition, *C. curvispiculifer* lacks raphides, having a spicule complement that varies across described specimens. For instance, it lacks both smooth and acanthose oxeads in the Indian and North-Atlantic specimens, but not in the Mediterranean material. *Cerbaris curvisclera* has raphides and smooth oxeads, but lacks any kind of style or acanthostyle. Therefore, *R. implicata* is clearly distinguishable from these *Cerbaris* species.

Although the genus *Rhabdobaris* is herein restituted within the original family in which it was erected, that is Bubaridae, there are concerns that *Rhabdobaris* could be a raspailiid. Indeed, the body shape, the spicule complement, and the general skeletal organization match better the traits characterizing the family Raspailiidae than those of the family Bubaridae. Nevertheless, *Rhabdobaris* lacks the hispidating bouquets around the long hispidating styles, which typically characterize most—but not all—raspailiids. Therefore, a definitive family assignment may require further inference of the phylogenetic relationships of *Rhabdobaris* using molecular markers.

Order POECILOSCLERIDA Topsent, 1928

Suborder MIICROCIONINA Hajdu, van Soest & Hooper, 1994

Family RASPAILIIDAE Nardo, 1833

Subfamily RASPAILIINAE Nardo, 1833

Genus *Endectyon* Topsent, 1920

Diagnosis. Prominently hispid, conulose surface, and typically arborescent growth form. Skeleton with marked axial and extra-axial differentiation; axial skeleton with well-developed spongin fibres forming a compressed reticulation, cored by stout choanosomal styles; extra-axial subectosomal skeleton being radial or plumose, with multi- or paucispicular tracts of long subectosomal styles (subgenus *Endectyon*) or choanosomal styles (subgenus *Hemectyon*), sometimes connected by unispicular tracts forming hexagonal meshes, usually protruding the surface. Ectosomal skeleton varies from typical raspailiid condition, with thin ectosomal styles grouped in brushes around protruding subectosomal styles (subgenus *Endectyon*), to surface brushes composed of subectosomal styles only (nominal genus *Basiectyon*), to brushes of acanthostyles surrounding choanosomal styles (subgenus *Hemectyon*). Erect brushes of echinating acanthostyles located on the outer margin of the axial skeleton, making a boundary between the extra-axial and axial regions, or forming plumose brushes along the length of the extra-axial tracts, or localized exclusively at the base of the sponge (nominal genus *Basiectyon*). Structural megascleres are smooth styles of 2–3 size categories, along with echinating acanthostyles and/or acanthostyles with peculiar strongly curved (clavulate) hooks on the shaft, base, and/or apex. Microscleres are absent (*sensu* Hooper 2002b).

Subgenus *Hemectyon* Topsent, 1920

Diagnosis. Erect, probably undivided (see "Taxonomic Remarks"), growth form. Skeletal organization with recognizable axial, extra-axial and ectosomal regions. Axial skeleton of multispiculate-cored fibres densely reticulated. Extra-axial skeleton consisting of a more lax reticulum of pauci- to multispicular radiating primary tracts intercrossed by uni- to paucispicular secondary tracts. Spongin fibres and tracts of the axial and extra-axial regions are cored by smooth choanosomal styles; the radiating primary tracts of the extra-axial skeleton may be sparsely echinated by acanthostyles, particularly in their subectosomal regions. In the subectosomal region, the peripheral nodes of the extra-axial network serve as basis for small bouquets of longer (subectosomal) styles, which pierce the sponge ectosome to make a long, dense hispidation. At the point where each of these protruding bouquets of styles pierce the sponge ectosome, a surrounding brush consisting mostly of acanthostyles (but also incorporating some choanosomal styles) occurs, being this skeletal trait a distinct character for the subgenus *Hemectyon* (modified herein to accommodate the features of the new species).

Endectyon (Hemectyon) filiformis nov. sp.

(Figs. 11C–D, 13; Table 2)

Etymology. This species is named after its erect, undivided body shape.

Material examined. Holotype: Specimen MNCN-Sp69 BV21, from type locality Stn. 21 (Table 1, Fig. 1), a 93 to 101 m deep, gravel bottom on the deep shelf of the island.

Macroscopic description. Flexible, slender, thread-like sponge, measuring 54 mm in height and 3 mm in diameter, attached to a gravel piece. The surface is densely and markedly hispid (Fig. 11C–D), with no obvious oscules. The color in life is bright orange, turning into creamy white in ethanol.

Skeleton. Megascleres in 4 spicule categories: Subectosomal styles, choanosomal styles, occasional oxeas, and acanthostyles. The subectosomal styles are long and slender, slightly curved at the centre or near the round end, with a regular round end, and an acerate point that can be sometimes softly stepped or, in the thinner growth stages, hastate (Fig. 13A); they measure 713–1465 x 3.2–20 µm. The choanosomal styles measure 187.4–272.5 x 6.4–9 µm, being irregularly curved once or twice, sometimes in a rhabdostyle fashion, with hastate or acerate points (Fig. 13A–B). These styles may show a slight swelling either near the round end or towards central positions. The oxeas are less common than the previous categories, typically curved at the middle, with sharp conical ends that can be slightly different (Fig. 13A, C), measuring 234–277 x 3–9 µm. The acanthostyles are nearly straight or slightly curved and show scarce, large, conical spines. Spines are usually sparse over the spicule length, mostly making a sort of verticillate cluster at the round end, producing a clavulate acanthostyle; the spines very rarely appear around the sharp end of the spicule. The number of spines varies from one to four at the round end and from one to ten over the shaft length, and they can be straight, curved toward the spicule points or in the opposite direction (Fig. 13A, D). The acanthostyles are far less abundant than the choanosomal styles and measure 114–150 x 6–7 µm.

Axial and extra-axial skeleton are poorly differentiated. The axial skeleton is a relatively more compact reticule of pauci- and multispicular tracts of choanosomal styles surrounded by moderate spongin (Fig. 13F). The reticule becomes progressively less compact towards the periphery (extra-axial region?) and is built with thinner tracts (pauci- and unispiculate) of choanosomal styles and occasional oxeas. From the periphery of this extra-axial network, groups of 2 to 10, long subectosomal styles project radially (Fig. 13E), piercing the surface and causing the long hispidation of the surface. At the point where one of these radiating tracts of long subectosomal styles pierces the sponge ectosome, a surrounding brush consisting mostly of acanthostyles (but also incorporating some oxea or choanosomal style) occurs (Fig. 13E); this skeletal trait is a diagnostic character for the subgenus *Hemectyon*.

Distribution and ecology notes. The only individual of *Endectyon (Hemectyon) filiformis* nov. sp. was collected from a 93 to 100 m deep, organogenic-gravel bottom.

Taxonomic remarks. Members of the genus *Endectyon* are the only raspailiids having echinating acanthostyles with clavulate morphology and located outside the axial skeleton (Hooper 1991; Hooper 2002b). Within the subgenus *Hemectyon*, only one species had been described to date: *Endectyon (Hemectyon) hamatum* (Schmidt, 1870). This species was originally reported from the Caribbean (Schmidt 1870; Topsent 1920). It was subsequently cited from the East Africa (North Kenya) by Pulitzer-Finali (1993), but a revision of that specimen assignation would be advisable, as it contains abundant raphides and the brief skeletal description suggests it to be a raspailiid different from *Endectyon* spp.

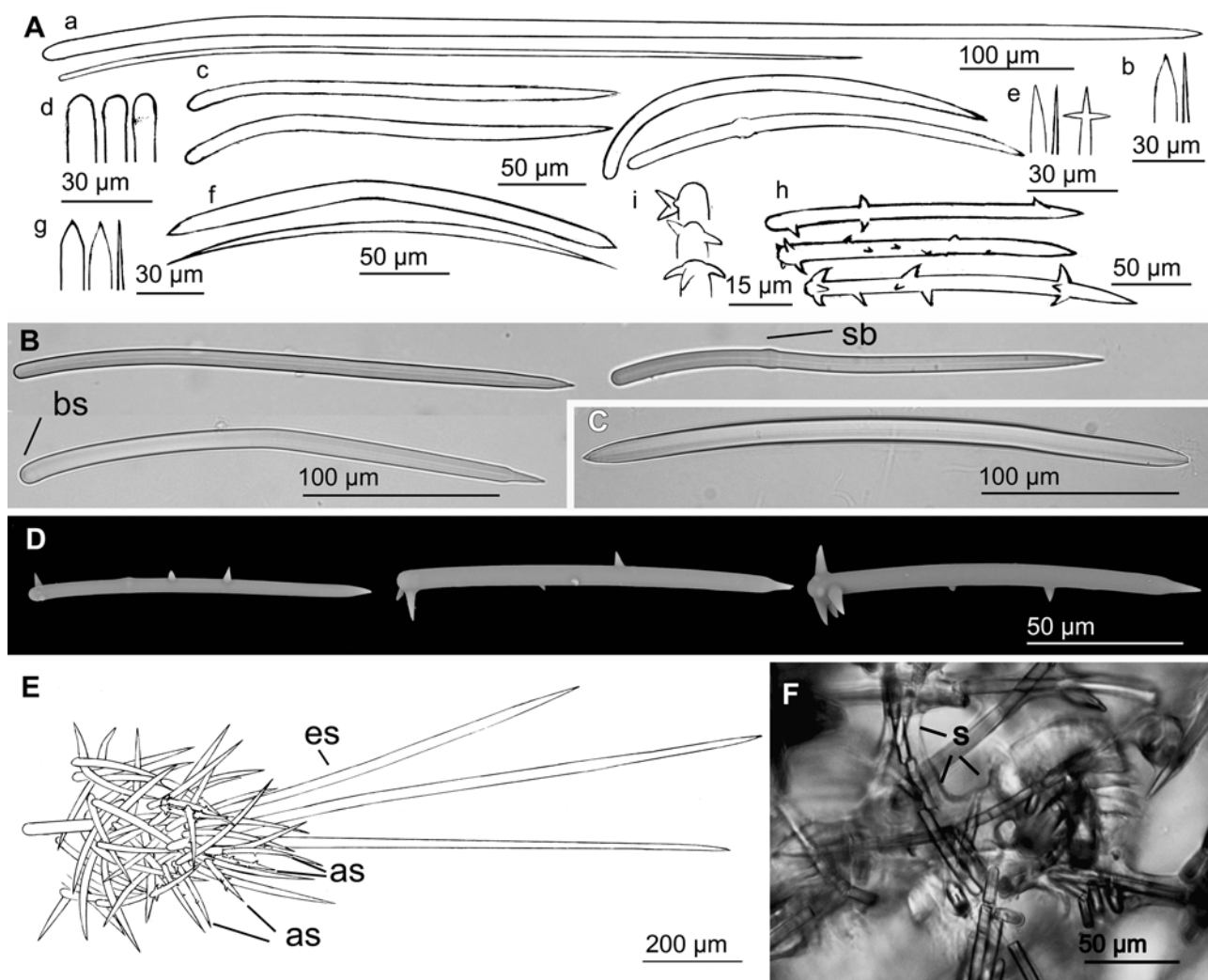


FIGURE 13. *Endectyon (Hemectyon) filiformis* **nov. sp.**: (A) Line drawing summarizing the spicule complement of the holotype (MNCN-Sp69-BV21). There are subectosomal styles (a) with a round end and an acerate or hastate distal end (b) and choanosomal styles with a regular or swollen round end (d) and an acerate, hastate or polyaxonic distal end (e). There are also oxeas (f) with conical to hastate ends (g) and acanthostyles (h) with large spines that can be clavulate at the round end (i). (B) Light microscope view of choanosomal styles, with slight subterminal swelling (bs) or a subtle subtype (sb). (C) Light microscope view of an oxea. (D) SEM micrographs of acanthostyles. (E) Line drawing sketching the organization of the ectosomal skeleton, which consists of the subectosomal styles (es) surrounded by an hispidating brush of acanthostyles (as). (F) Light microscope view of the choanosomal skeleton where spongin (s) can be observed embedding the choanosomal styles.

The occurrence of acanthostyle brushes surrounding the groups of hispidating styles clearly indicates that the newly described Alboranian material belongs to the subgenus *Hemectyon*, making the second known species in this subgenus. The differences between *E. (H.) hamatum* and *E. (H.) filiformis* **nov. sp.** are clear: 1) the axial and extra-axial differentiation is less marked in the new species, as well as the differentiation between radiating primary tracts and secondary intercrossing tracts; 2) the primary radiating tracts are only very rarely echinated by the acanthostyles in the new species; 3) the acanthostyles do not have clavulate spines at the round end in *E. (H.) hamatum*, but they do have them in the new species; 4) The hispidating styles in *E. (H.) hamatum* are relatively small (220–275 x 2 µm) and shorter than those coring the choanosomal fibres and tracts (270–615 x 6–18 µm), whereas they are notably longer (up to 1465 x 20 µm) in the new species; and 5) the new species contains occasional oxeas, while they do not occur in *E. (H.) hamatum*. Indeed, oxeas are an uncommon spicule type in *Endectyon* spp., although occasional modifications of styles into oxeas and strongyles have already been recorded in *Endectyon (Endectyon) tenax* (Schmidt, 1870) from North Carolina by Wells *et al.* (1960) and *Endectyon (Endectyon) multidentatum* (Burton, 1948) from Congo Coast (Burton 1948).

To accommodate the skeletal features of this new species, it has been necessary to modify herein the last accepted diagnosis of subgenus *Hemectyon*, which was proposed by Hooper (2002b) on the basis of the only species available at that time. An additional reason to revise the subgenus diagnosis is the growth habit. Originally, *Hemectyon* was erected on a partial sponge fragment that was assumed to be part of a larger, branched individual (Schmidt 1870; Topsent 1920). Ever since, the successive genus diagnoses have included terms such as "rameuse" (Topsent 1920) or "arborescent" (Hooper 2002b), a branching condition that has never been corroborated objectively. Given that the holotype of *E. (H.) hamatum* is an undivided cylindrical fragment (23mm x 3.5) and that the complete holotype of *E. (H.) filiformis* **nov. sp.** is also an undivided, digit-like growth form, there is no reason to support any longer that the sponges of the subgenus *Hemectyon* are arborescent. Rather, they should be postulated as erect, branchless growth forms, at least until future collections of new material disprove it.

Order HAPLOSCLERIDA Topsent, 1928

Suborder HAPLOSCLERINA Topsent, 1928

Family NIPHATIDAE Van Soest, 1980

Genus *Gelliodes* Ridley, 1884

Diagnosis. Thickly incrusting to massive, tubular growth form, intricately branching, long cylindrical stems irregularly ramified and anastomosing at points of contact (single branches attain a length of about 100 mm), rampant or erect, arising from a common basal portion. Oscules usually numerous, unevenly scattered over the surface and often conspicuous. Surface uneven, membranous, strongly aculeated at intervals of about 2–5mm, sustained by strong, slender, sharp ramified spines, 2–3 mm long surface may be also ridged or tuberculate or smooth, and finely hispid or velvety. Texture very hard. Ectosomal skeleton is a tangential network of secondary fibres, free oxeas and abundant sigmas, often interrupted by the ends of the strong primary longitudinal fibres protruding from the choanosomal skeleton to form the spines. Choanosomal skeleton composed of primary longitudinal-radial multispicular and ramified primary fibres, distinct and very compact. Primary fibres form rectangular to rounded meshes, subdivided irregularly by secondary fibres, and mesh containing abundant free spicules. Megascleres consist of robust oxeas with sharp apices. Microscleres are abundant sigmata (*sensu* Desqueyroux-Fáundez & Valentine 2002).

Gelliodes fayalensis Topsent, 1892

(Figs. 14, 15; Table 2)

Synonymy. *Adocia fayalensis* (Topsent, 1892): (Burton 1956,)145.

Material examined. Specimen MNCN-Sp137 DR07 collected from Stn. 7 (Table 1, Fig. 1).

Macroscopic description. Ovate, cushion-shaped sponge, attached to a small piece of rhodolith (Fig. 14A–B). It measures 30 x 20 mm and is fouled around its basal region by a thickly encrusting individual of *Haliclona* sp. Surface is smooth, consisting of a thin, delicate, translucent membrane. The ectosomal membrane is damaged in many areas of the body, showing a highly cavernous subectosomal tissue. Ectosome damage makes difficult to discriminate the occurrence of oscules from ectosome breakages. The consistency is hard but friable. The color in alcohol is beige.

Skeleton. Megascleres are oxeas in a size range that could well represent two categories. The oxeas in the large category measure 280–400 x 10–15 µm and are slightly curved, typically showing two flexion points (Fig. 15A–B, E). The ends are acerate, with occasional malformations (Fig. 15A, C). The oxeas in the small category are less abundant, measure 200–270 x 2–5 µm, are regularly curved over their entire length (Fig. 15A, D–E), and have relatively regular hastate ends (Fig. 15A). Nevertheless, we cannot discard that the smaller oxeas are early developing stages of the larger oxeas. Microscleres are abundant sigmata, 15–27 µm in maximum length (Fig. 15A, E–F).

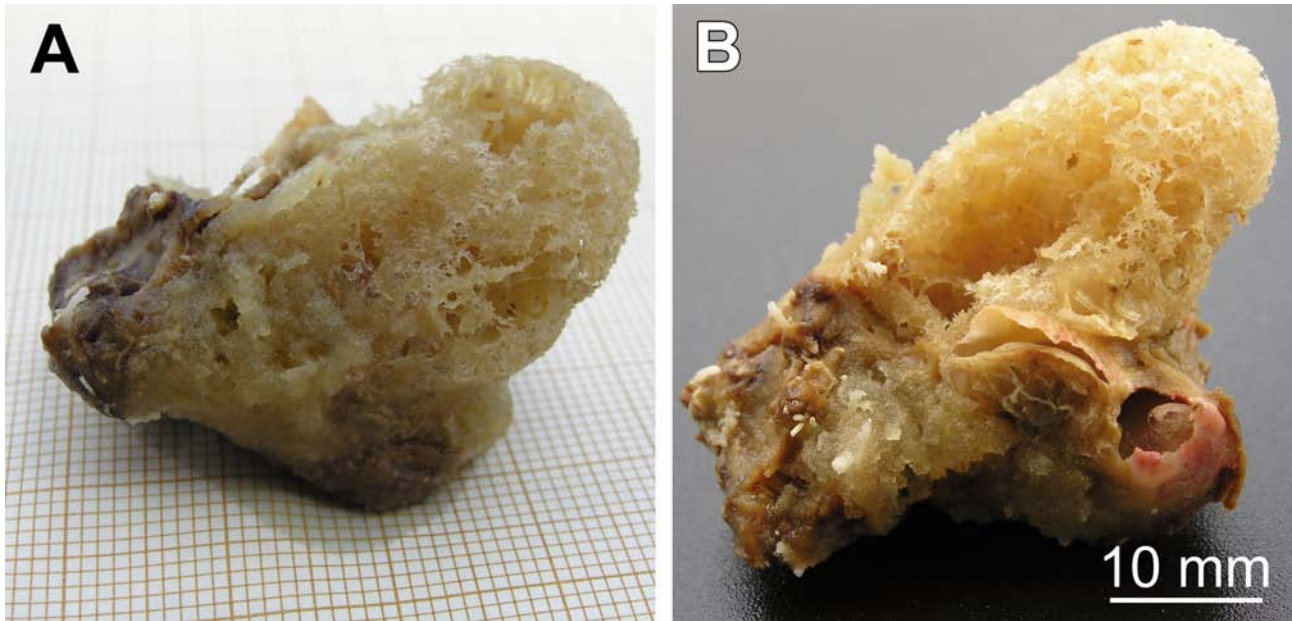


FIGURE 14. *Gelliodes fayalensis* Topsent, 1892. Specimen from the Alboran Island (MNCN-Sp137-DR07), photographed on its both sides while attached to a rhodolith fragment.

The ectosomal skeleton is a reticule of tangential oxeas made of uni- or paucispicular lines. The choanosomal skeleton is an irregular network (Fig. 15G) consisting of compact, primary multispicular tracts of oxeas with moderate spongin (Fig. 15H), which branch and subdivide when running from the deep choanosome towards the periphery. Primary tracts are 250–625 μm wide and connect each other by secondary, pauci- or multispicular secondary tracts, which are 125–200 μm wide. Microscleres are abundant at the subectosomal region, also occurring in the choanosome, some partially embedded in the oxea tracts.

Distribution and ecology notes. Rare species, known from the original description of 5 individuals from Azores (Topsent 1892, 1904), all coming from the Fayal Channel (Azores), growing on gravel bottoms rich in organogenic elements, at depths of 98–100 m. The herein described Alboranian specimen, collected from a rhodolith bottom at depths ranging from 109 and 130 m, provides the first record of the species in the Mediterranean Sea.

Taxonomic remarks. The spicule complement, the spicule size, and the skeletal organization of the Alboranian individual are strongly similar to those of *Gelliodes fayalensis* Topsent, 1892. A minor difference is that Topsent (1892) did not split the oxeas of *G. fayalensis* into two size categories. Nevertheless, we are not completely certain that the smaller oxeas that we are herein describing are a size category themselves; they could rather be early growth stages. The only size data for oxeas in Topsent's description (1892) is 270 x 9 μm , which approximately represents the median of the size range found in the oxeas of the Alboran specimen.

All specimens described from Azores by Topsent (1892, 1904) were reported to have several distinct oscules. The preservation condition of our Alboranian specimen did prevent us to discriminate oscules from the frequent ectosomal breakages and, indeed, hindered a relevant comparison in terms of external morphology features.

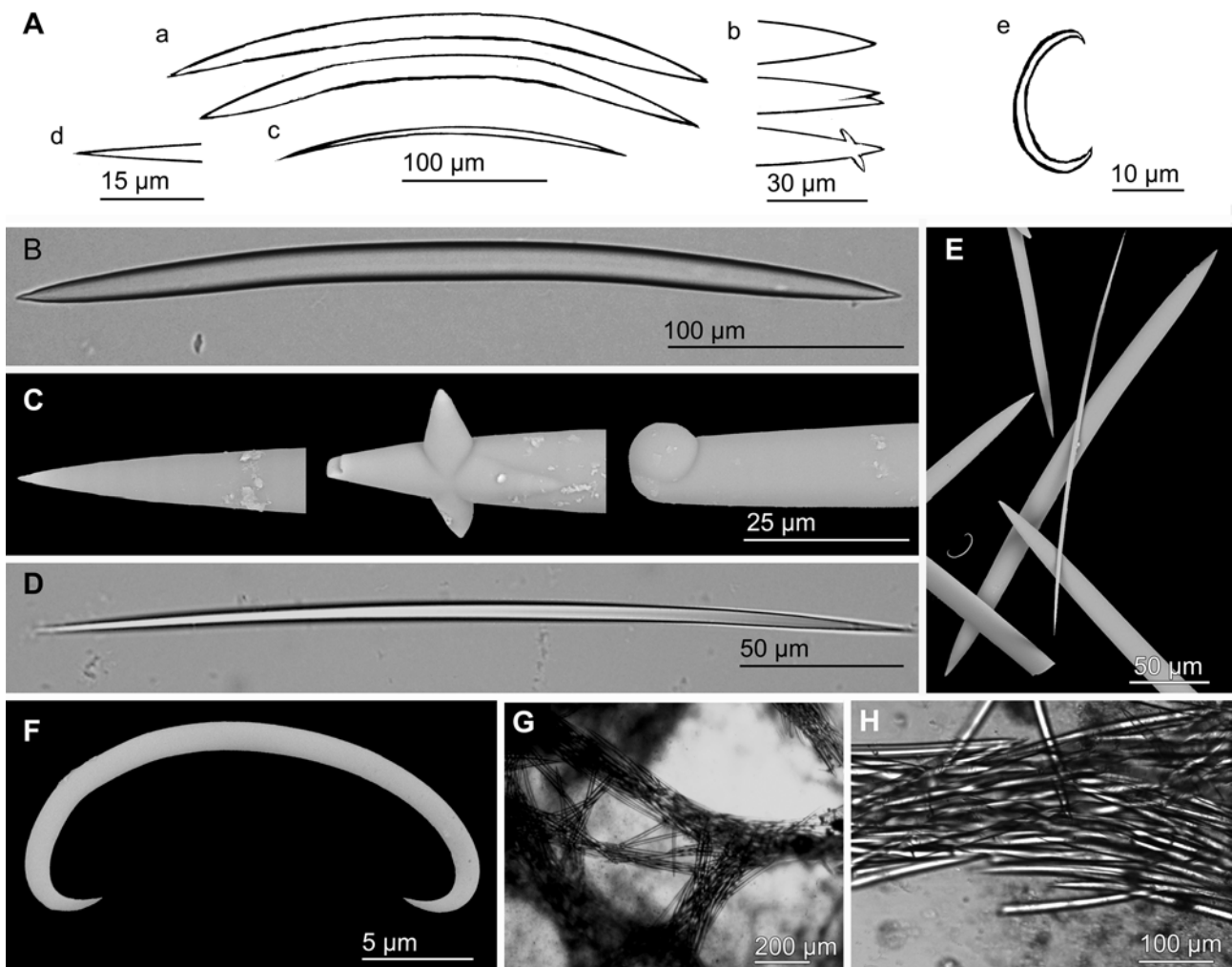


FIGURE 15. *Gelliodes fayalensis* Topsent, 1892: (A) Line drawing summarizing the spicule complement of the Alboranian specimen (MNCN-Sp137-DR07), consisting of fusiform oxea I (a) with acerate to malformed ends (b), isodiametric oxea II (c) with acerate ends (d), and sigmata (e). (B) Light microscope view of Oxea I. (C) SEM detail of regular and abnormal ends of oxea I. (D) Light microscope view of isodiametric Oxea II. (E) SEM view oxea I and II and a sigma. (F) SEM detail of a sigma. (G) Light microscope view of multispiculate tracts of oxea I and II forming a network. (H) Light microscope detail of a multispiculate tract.

Concluding remarks

The bottoms of the Alboran Island are characterized by elevated sponge richness and substantial diversity, hosting representatives of about 30 % of the known Mediterranean demosponges (Table 6). Among this fauna, there are also a good number of Mediterranean endemisms and rare species, along with numerous "Atlantic" species that appear to have penetrated in this westernmost Mediterranean area and that, surprisingly, may reach notable abundances (e.g. *Axinella vellea*). While recent invasions of shallow habitats by sponges have relatively been easy to detect in several oceans and seas (e.g., *Mycale (Mycale) grandis* Gray, 1867; *Terpios hoshinota* Rützler & Muzik, 1993; *Paraleucilla magna* Klautau, Monteiro & Borojevic, 2004), faunal expansions taking place in deep-sea habitats can go unnoticed for decades. It remains unclear whether the common occurrence of "North-Atlantic" deep-shelf immigrants that has been detected in this and previous sponge studies at the Alboran Island reflects only vestiges of ancestral faunal expansions during the Quaternary interglacial periods or it is also partially derived from recent northward expansions favored by man-driven global warming. While the former mechanism is more likely the main cause, our results contribute to reinforce the idea that the Alboran shelf provides a privileged natural laboratory from where to document past, present, and future biotic exchange between the Atlantic and the Mediterranean (Aguilar *et al.* 2011; Vermeij 2012). From this notion, two major actions would be advisable for the

immediate future: 1) to complete timely an exhaustive, global characterization of the benthic assemblages of the deep shelf of the Alboran Island, establishing a crucial baseline for further monitoring steps; 2) to extend the environmental protection currently given to the shallow-shelf communities of the Alboran Island to the singular and ecologically valuable deep-shelf bottoms, taking the opportunity of the currently developing frame of the Nature 2000 Network.

TABLE 6. Porifera species hitherto reported from the Alboran Island Platform and the bottoms of the surrounding abyssal plain. Species are listed alphabetically according to class, order, family, and species name.

<p>Class CALCAREA</p> <p>Order Clathrinida Family Clathrinidae <i>Clathrina coriacea</i> (Montagu, 1818)</p> <p>Class DEMOSPONGIAE</p> <p>Order Agelasida Family Agelasidae <i>Agelas oroides</i> (Schmidt, 1864)</p> <p>Order Astrophorida Family Ancorinidae <i>Dercitus (Stoeba) plicatus</i> (Schmidt, 1868) <i>Jaspis eudermis</i> Lévi & Vacelet, 1958 <i>Jaspis incrustans</i> (Topsent, 1890) <i>Jaspis johnstonii</i> (Schmidt, 1862) <i>Stelletta hispida</i> (Buccich, 1886) <i>Stelletta mediterranea</i> (Topsent, 1893) <i>Stryphnus mucronatus</i> (Schmidt, 1868) <i>Stryphnus ponderosus</i> (Bowerbank, 1866) Family Calthropellidae <i>Calthropella (Calthropella) pathologica</i> (Schmidt, 1868) <i>Calthropella (Corticellopsis) recondita</i> Pulitzer-Finali, 1983 Family Geodiidae <i>Caminnella intuta</i> (Topsent, 1892) <i>Caminnus vulcani</i> Schmidt, 1862 <i>Erylus discophorus</i> (Schmidt, 1862) <i>Erylus papulifer</i> Pulitzer-Finali, 1983 <i>Geodia anceps</i> (Vosmaer, 1894) <i>Geodia cydonium</i> (Jameson, 1811) <i>Penares candidata</i> (Schmidt, 1868) <i>Penares helleri</i> (Schmidt, 1864) Family Pachastrellidae <i>Characella tripodaria</i> (Schmidt, 1868) <i>Pachastrella monilifera</i> Schmidt, 1868 Family Theneidae <i>Thenea muricata</i> (Bowerbank, 1858) Family Thoosidae <i>Alectona millari</i> Carter, 1879 <i>Delectona alboransis</i> Rosell, 1996 Family Vulcanellidae <i>Poecillastra compressa</i> (Bowerbank, 1866) <i>Vulcanella aberrans</i> (Maldonado & Uriz, 1996) <i>Vulcanella gracilis</i> (Sollas, 1888)</p> <p>Order Chondrosida Family Chondrillidae <i>Chondrosia reniformis</i> Nardo, 1847</p>	<p>Order Dendroceratida Family Darwinellidae <i>Aplysilla sulfurea</i> Schulze, 1878 <i>Darwinella viscosa</i> Boury-Esnault, 1971 Family Dictyodendrillidae <i>Spongionella pulchella</i> (Sowerby, 1804)</p> <p>Order Dictyoceratida Family Dysideidae <i>Dysidea fragilis</i> (Montagu, 1818) <i>Pleraplysilla reticulata</i> Maldonado & Uriz, 1999 <i>Pleraplysilla spinifera</i> (Schulze, 1879) Family Irciniidae <i>Ircinia dendroides</i> (Schmidt, 1862) <i>Ircinia variabilis</i> (Schmidt, 1862) <i>Sarcotragus fasciculatus</i> (Pallas, 1766) <i>Sarcotragus pipetta</i> (Schmidt, 1868) <i>Sarcotragus spinosulus</i> Schmidt, 1862 Family Spongiidae <i>Spongia (Spongia) agaricina</i> Pallas, 1766 <i>Spongia (Spongia) nitens</i> (Schmidt, 1862) <i>Spongia (Spongia) officinalis</i> Linnaeus, 1759 <i>Spongia spinosula</i> (Schmidt, 1868) <i>Spongia (Spongia) virgultosa</i> (Schmidt, 1868) Family Thorectidae <i>Fasciospongia cavernosa</i> (Schmidt, 1862) <i>Hyrtios collectrix</i> (Schulze, 1880)</p> <p>Order Hadromerida Family Clionidae <i>Cliona celata</i> Grant, 1826 <i>Cliona rhodensis</i> Rützler & Bromley, 1981 <i>Cliona viridis</i> (Schmidt, 1862) <i>Dotona pulchella mediterranea</i> Rosell & Uriz, 2002 <i>Pione vastifica</i> (Hancock, 1849) <i>Spiroxya levispira</i> (Topsent, 1898) Family Hemiasterellidae <i>Hemiasterella elongata</i> Topsent, 1928 <i>Paratimea constellata</i> (Topsent, 1893) Family Polymstiidae <i>Polymastia mamillaris</i> (Montagu, 1806) <i>Polymastia polytylota</i> Vacelet, 1969 <i>Polymastia</i> spp. <i>Pseudotrachya hystrix</i> (Topsent, 1890) Family Spirastrellidae <i>Diplastrella bistellata</i> (Schmidt, 1862) <i>Spirastrella cunctatrix</i> Schmidt, 1868</p>
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TABLE 6. (continued)

Family Stelligeridae	Family Chalinidae
<i>Stelligera rigida</i> (Montagu, 1818)	<i>Chalinula limbata</i> (Montagu, 1818)
<i>Stelligera stuposa</i> (Ellis & Solander, 1786)	<i>Dendroxea lenis</i> (Topsent, 1892)
Family Suberitidae	<i>Haliclona</i> (<i>Gellius</i>) <i>flagellifera</i> (Ridley & Dendy, 1886)
<i>Aaptos aaptos</i> (Schmidt, 1864)	<i>Haliclona</i> (<i>Gellius</i>) <i>lacazei</i> (Topsent, 1893)
<i>Prosuberites longuispinus</i> Topsent, 1893	<i>Haliclona</i> (<i>Halichoclona</i>) <i>fulva</i> (Topsent, 1893)
<i>Protosuberites rugosus</i> (Topsent, 1893)	<i>Haliclona</i> (<i>Halichoclona</i>) <i>perlucida</i> (Griessinger, 1971)
<i>Pseudosuberites hyalinus</i> (Ridley & Dendy, 1886)	<i>Haliclona</i> (<i>Haliclona</i>) <i>reptans</i> (Griessinger, 1971)
<i>Rhizaxinella elongata</i> (Ridley & Dendy, 1886)	<i>Haliclona</i> (<i>Haliclona</i>) <i>simulans</i> (Johnston, 1842)
<i>Rhizaxinella gracilis</i> (Lendenfeld, 1898)	<i>Haliclona</i> (<i>Reniera</i>) <i>aquaeductus</i> (Schmidt, 1862)
<i>Suberites carnosus</i> (Johnston, 1842)	<i>Haliclona</i> (<i>Reniera</i>) <i>cinerea</i> (Grant, 1826)
<i>Suberites domuncula</i> (Olivi, 1792)	<i>Haliclona</i> (<i>Reniera</i>) <i>citrina</i> (Topsent, 1892)
<i>Pseudosuberites sulphureus</i> (Bowerbank, 1866)	<i>Haliclona</i> (<i>Reniera</i>) <i>subtilis</i> Griessinger, 1971
<i>Terpios fugax</i> Duchassaing & Michelotti, 1864	<i>Haliclona</i> (<i>Soestella</i>) <i>implexa</i> (Schmidt, 1868)
Family Tethyidae	<i>Haliclona</i> (<i>Soestella</i>) <i>mucosa</i> (Griessinger, 1971)
<i>Tethya aurantium</i> (Pallas, 1766)	<i>Haliclona</i> <i>pocilliformis</i> (Griessinger, 1971)
Family Timeidae	Family Niphatidae
<i>Timea cumana</i> Pulitzer-Finali, 1978	<i>Gelliodes fayalensis</i> Topsent, 1892
<i>Timea unistellata</i> (Topsent, 1892)	Family Petrosiidae
Order Halichondrida	<i>Petrosia</i> (<i>Petrosia</i>) <i>ficiformis</i> (Poiret, 1789)
Family Axinellidae	Order Poecilosclerida
<i>Axinella alborana</i> nov. sp.	Family Acarnidae
<i>Axinella</i> cf. <i>cinnamomea</i> (Nardo, 1833)	<i>Acarnus tortilis</i> Topsent, 1892
<i>Axinella damicornis</i> (Esper, 1974)	<i>Iophon hyndmani</i> (Bowerbank, 1858)
<i>Axinella egregia sensu</i> Topsent, 1892	<i>Iophon nigricans</i> (Bowerbank, 1858)
<i>Axinella polypoides</i> Schmidt, 1862	Family Chondropsidae
<i>Axinella pumila</i> Babic, 1922	<i>Batzella inops</i> (Topsent, 1891)
<i>Axinella salicina</i> Schmidt, 1868	Family Coelosphaeridae
<i>Axinella spatula</i> nov. sp.	<i>Coelosphaera</i> (<i>Histodermion</i>) <i>cryosi</i> (Boury-Esnault, Pansini & Uriz, 1994)
<i>Axinella vellerea</i> Topsent, 1904	<i>Forcepia</i> (<i>Leptolabis</i>) <i>brunnea</i> (Topsent, 1904)
<i>Axinella verrucosa</i> (Esper, 1794)	<i>Forcepia</i> (<i>Leptolabis</i>) <i>luciensis</i> (Topsent, 1888)
<i>Phakellia robusta</i> Bowerbank, 1866	<i>Forcepia</i> (<i>Leptolabis</i>) <i>megachela</i> (Maldonado, 1992)
<i>Phakellia ventilabrum</i> (Linnaeus, 1767)	<i>Lissodendoryx</i> (<i>Lissodendoryx</i>) <i>isodictyalis</i> (Carter, 1882)
Family Bubaridae	<i>Lissodendoryx</i> (<i>Lissodendoryx</i>) <i>lundbecki</i> Topsent, 1913
<i>Bubaris vermiculata</i> (Bowerbank, 1866)	Family Crambeidae
<i>Cerbaris alborani</i> (Boury-Esnault, Pansini & Uriz, 1994)	<i>Crambe crambe</i> (Schmidt, 1862)
<i>Rhabdobaris implicata</i> Pulitzer-Finali, 1983	<i>Crambe tailliezi</i> Vacelet & Boury-Esnault, 1982
Family Dictyonellidae	<i>Crambe tuberosa</i> Maldonado & Benito, 1991
<i>Acanthella acuta</i> Schmidt, 1862	Family Crellidae
<i>Dictyonella incisa</i> (Schmidt, 1880)	<i>Crella</i> (<i>Crella</i>) <i>elegans</i> (Schmidt, 1862)
<i>Dictyonella marsilii</i> (Topsent, 1893)	<i>Crella</i> (<i>Grayella</i>) <i>pulvinar</i> (Schmidt, 1868)
Family Halichondriidae	<i>Crella</i> (<i>Pytheas</i>) <i>sigmata</i> Topsent, 1925
<i>Axinyssa aurantiaca</i> (Schmidt, 1864)	<i>Crella</i> (<i>Yvesia</i>) <i>pyrula</i> (Carter, 1876)
<i>Ciocalypta penicillus</i> Bowerbank, 1862	<i>Crella</i> (<i>Yvesia</i>) <i>rosea</i> (Topsent, 1892)
<i>Ciocalypta porrecta</i> (Topsent, 1928)	Family Desmacellidae
<i>Halichondria</i> (<i>Halichondria</i>) <i>bowerbanki</i> Burton, 1930	<i>Biemna parthenopea</i> Pulitzer-Finali, 1978
<i>Halichondria</i> (<i>Halichondria</i>) <i>panicea</i> (Pallas, 1766)	<i>Biemna variantia</i> (Bowerbank, 1858)
<i>Halichondria</i> (<i>Halichondria</i>) <i>semitubulosa</i> Lieberkühn, 1859	<i>Desmacella annexa</i> Schmidt, 1870
<i>Hymeniacidon perlevis</i> (Montagu, 1818)	<i>Desmacella inornata</i> (Bowerbank, 1866)
<i>Spongosorites flavens</i> Pulitzer-Finali, 1983	<i>Dragmatella aberrans</i> (Topsent, 1890)
<i>Spongosorites intricatus</i> (Topsent, 1892)	Family Desmacididae
Order Haplosclerida	<i>Desmacidon fruticosum</i> (Montagu, 1818)
Family Callyspongiidae	Family Esperioptidae
<i>Siphonochalina balearica</i> Ferrer-Hernandez, 1916	<i>Esperiopsis fucorum</i> (Esper, 1794)
<i>Siphonochalina coriacea</i> Schmidt, 1868	<i>Ulosa stuposa</i> (Esper, 1794)
	Family Hamacanthidae
	<i>Hamacantha</i> (<i>Vomerula</i>) <i>falcula</i> (Bowerbank, 1874)

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TABLE 6. (continued)

Family Hymedesmiidae	Family Podospongiidae
<i>Hemimycale columella</i> (Bowerbank, 1874)	<i>Podospongia lovenii</i> Bocage, 1869
<i>Haliclona</i> (<i>Gellius</i>) <i>angulata</i> (Bowerbank, 1866)	Family Raspailiidae
<i>Hymedesmia</i> (<i>Hymedesmia</i>) <i>baculifera</i> (Topsent, 1901)	<i>Aulospongos spinosus</i> (Topsent, 1927)
<i>Hymedesmia</i> (<i>Hymedesmia</i>) <i>pansa</i> Bowerbank, 1882	<i>Endectyon</i> (<i>Hemectyon</i>) <i>filiformis</i> nov. sp.
<i>Hymedesmia</i> (<i>Hymedesmia</i>) <i>paupertas</i> (Bowerbank, 1866)	<i>Endectyon</i> (<i>Endectyon</i>) <i>delaubenfelsi</i> Burton, 1930
<i>Hymedesmia</i> (<i>Hymedesmia</i>) <i>peachi</i> Bowerbank, 1882	<i>Eurypon cinctum</i> Sarà, 1960
<i>Hymedesmia</i> (<i>Stylopus</i>) <i>coriacea</i> (Fristedt, 1885)	<i>Eurypon coromula</i> (Bowerbank, 1874)
<i>Phorbas dives</i> (Topsent, 1891)	<i>Eurypon lacazei</i> (Topsent, 1891)
<i>Phorbas fibulatus</i> (Topsent, 1893)	<i>Raspailia agnata</i> (Topsent, 1896)
<i>Phorbas fictitius</i> (Bowerbank, 1866)	Family Tedaniidae
<i>Phorbas mercator</i> (Schmidt, 1868)	<i>Tedania</i> (<i>Tedania</i>) <i>anhelans</i> (Vio in Olivi, 1792)
<i>Phorbas plumosus</i> (Montagu, 1818)	<i>Tedania</i> spp.
<i>Phorbas tenacior</i> (Topsent, 1925)	Order Spirophorida
<i>Phorbas topsenti</i> Vacelet & Perez, 2008	Family Tetillidae
Family Latrunculiidae	<i>Craniella cranium</i> (Müller, 1776)
<i>Latrunculia</i> (<i>Biannulata</i>) <i>citharistae</i> Vacelet, 1969	Order Verongida
<i>Sceptrella insignis</i> (Topsent, 1890)	Family Aplysinidae
Family Microcionidae	<i>Aplysina aerophoba</i> Nardo, 1833
<i>Antho</i> (<i>Acarnia</i>) <i>cf. novizelanica</i> (Ridley & Duncan, 1881)	<i>Aplysina cavernicola</i> (Vacelet, 1959)
<i>Antho</i> (<i>Antho</i>) <i>involvens</i> (Schmidt, 1864)	Family Ianthellidae
<i>Clathria</i> (<i>Clathria</i>) <i>coralloides</i> (Scopoli, 1772)	<i>Hexadella racovitzai</i> Topsent, 1896
<i>Clathria</i> (<i>Microcionia</i>) <i>armata</i> (Bowerbank, 1862)	Class HEXACTINELLIDA
<i>Clathria</i> (<i>Microcionia</i>) <i>duplex</i> Sarà, 1958	Order Lyssacinoida
<i>Clathria</i> (<i>Microcionia</i>) <i>gradalis</i> Topsent, 1925	Family Rossellidae
<i>Clathria</i> (<i>Microcionia</i>) <i>spinarcus</i> (Carter & Hope, 1889)	<i>Asconema setubalense</i> Kent, 1870
Family Mycalidae	Class HOMOSCLEROMORPHA
<i>Mycale</i> (<i>Aegogropila</i>) <i>rotalis</i> (Bowerbank, 1874)	Order Homosclerophorida
<i>Mycale</i> (<i>Aegogropila</i>) <i>syrinx</i> (Schmidt, 1862)	Family Oscarellidae
<i>Mycale</i> (<i>Carmia</i>) <i>macilentata</i> (Bowerbank, 1866)	<i>Oscarella lobularis</i> (Schmidt, 1862)
<i>Mycale</i> (<i>Paresperella</i>) <i>serrulata</i> Sarà & Siribelli, 1960	Family Plakinidae
Family Myxillidae	<i>Plakina monolopha</i> Schulze, 1880
<i>Myxilla</i> (<i>Myxilla</i>) <i>rosacea</i> (Lieberkühn, 1859)	<i>Plakina trilopha</i> Schulze, 1880
	<i>Plakinastrella mixta</i> Maldonado, 1992

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