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Taxonomy, reproduction and ecology of new and known Red Sea sponges

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SARSIA

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Ten of the most abundant sponge species from the northern Red Sea were studied. Six of them are new species that are described here: *Callyspongia paralia*, *Hemimycale arabica*, *Rhabderemia batatas*, *Niphates rowi*, *Petrosia elephantotus*, and *Topsentia aqabaensis*. An additional species has been re-assigned and renamed: *Dactylochalina viridis* Keller, 1889 was assigned to *Amphimedon* and renamed *A. chloros* to avoid homonymy with *A. viridis* Duch. & Mich. *Callyspongia paralia* and *N. rowi* were found restricted to shallow water (<4 m), whereas the other species were also detected in deeper water. The reproduction of most of these new species as well as of *Theonella swinhoei* Gray, 1868, and *Theonella conica* (Kieschnick, 1896) was determined based on histological examination of their reproductive elements (oocytes, embryos and larvae). *Theonella swinhoei*, *T. conica* and *T. aqabaensis* were shown to be oviparous, whereas *H. arabica*, *A. chloros*, and *Siphonochalina siphonella* are viviparous, as is also known for *N. rowi* and *C. paralia*.

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Keywords: *Amphimedon*; *Callyspongia*; coral reef; distribution; *Hemimycale*; *Rhabderemia*; *Niphates*; *Petrosia*; Porifera; *Theonella*; *Topsentia*.

Abbreviations: ICZN – International Code of Zoological Nomenclature; MNHN – Muséum National d'Histoire Naturelle, Paris; BMNH – British Museum of Natural History; IUI – InterUniversity Institute, Marine Sciences Institute, Elat; MOM – Musée Océanographique de Monaco; MTQ – Museum of Tropical Queensland/Townsville; MZUT – Museo e Instituto di Zoologica Sistematica dell'Università di Torina; SMF – Senckenberg Museum Frankfurt; ZMA – Zoological Museum of Amsterdam; ZMB – Zoological Museum of Berlin; ZMTAU – Zoological Museum, Tel Aviv University.

INTRODUCTION

Sponges are one of the major benthic groups with a prominent role in many coral reef communities. During the last two decades, interest in Red Sea sponges has risen considerably due to the high number of natural products found within them and their important role in reef ecology. However, many fundamental taxonomic and biological aspects concerning their reproduction, distribution, ecology and physiology are still uninvestigated. About 240 species of Demospongiae have been recorded so far from the Red Sea. Most of these records come from large monographs by Keller (1889, 1891), Row (1909, 1911) and Lévi (1958, 1965), with additions by Topsent (1892, 1906), Burton (1926, 1952, 1959), Kelly-Borges & Vacelet (1995) and Vacelet & al. (2001). Upon diving in the northern parts of the Red Sea it becomes apparent that a variety of species have not yet been described. Moreover, the studies mentioned above concentrated only on the taxonomy of the sponges, and were nearly always based on preserved material. Reproduction of sponges has been studied in a moderate number of species world-wide compared with other taxa. The majority of the studies concerning sponge reproduction examined brooding (viviparous) species, probably because their reproductive season is longer than that of broadcasting (oviparous) species and because their reproductive elements are usually larger. Some of these studies were carried out in coral reefs with only a handful in the Red Sea (Ilan & Loya 1988, 1990; Ilan & Vacelet 1993; Ilan 1995; Meroz & Ilan 1995).

The aim of the present investigation was, therefore, to add knowledge concerning some of the more abundant Red Sea sponges. Basic ecological data, mainly regarding reproduction, are given for 10 of the

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most abundant, shallow water Demospongiae of the Gulf of Elat (northern Red Sea). Six of these are newly described (from fresh material) species, and one is a new assignment.

MATERIAL AND METHODS

TAXONOMIC PROCEDURES

Sponge specimens were collected in shallow water near the Interuniversity Institute for Marine Sciences in Elat, Red Sea by SCUBA and by snorkelling.

All specimens were fixed either for light microscopy in 4% formalin in seawater for 24 h and then preserved in ethanol (70%), or fixed in 2.5% glutaraldehyde for electron microscopy. Spicules were prepared by dissolving the soft tissue of small pieces of sponge (including ecto- and choanosome) in sodium hypochlorite followed by five consecutive washes in distilled water and two in ethanol. Clean spicules were dried on a glass slide and mounted in Permount (Fisher Scientific). Measurements of spicule length (n = 50), width (n = 10) and of fibre thickness or mesh width (n = 10) were taken under a microscope. For all newly described species, the microscope slide from which the measurements were taken was kept and is noted in "Material examined".

Skeletal organization was determined from sections perpendicular and tangential to the surface of the sponges that were mounted in Euparal (GBI) on a cover slide.

Some spicule preparations and sections were put on stubs for examination by scanning electron microscope. These spicules were air dried and the sections were critical-point dried before sputtering them with gold. The preparations were viewed with 25 kW on a JEOL 840A scanning electron microscope.

Taxonomic decisions as to the order and family of the sponges investigated followed the relevant sections in Hooper (2002).

DISTRIBUTION

To examine the population distribution of two of the species studied, 24 belt transects were placed (each 10 × 1 m) parallel to the shore, at depths of 0.5, 1, 1.5, 2, 2.5, 3, 3.5 and 4 m.

REPRODUCTION

In order to histologically examine sponges for reproductive elements, tissue samples were taken monthly depending upon availability, which led to records existing for between 6 and 12 months of a year. These tissue samples were fixed, preserved, and further treated for light and electron microscopical observations, according to published procedures (e.g. Ilan 1995).

RESULTS

During this study, 10 sponge species, six of them new, were examined.

Porifera
Demospongiae
Tetractinomorpha
Lithistida

Remarks

The recent Lithistida are considered for morphological (e.g. Lévi 1991) and molecular (Kelly-Borges & Pomponi 1994) reasons as a polyphyletic group. This is a group of prominent reef builders that were especially important during the Mesozoic.

Theonellidae von Lendenfeld, 1903

Genus: *Theonella* Gray, 1868
Type species: *Theonella swinhoei* Gray, 1868.

Theonella swinhoei Gray, 1868

Remarks

This abundant species occurs throughout the entire Indo-Pacific area. A useful description of this species collected in Abulat (Saudi Arabia, Red Sea) is given by Lévi (1958) and the description of the genus (and therefore the species) type as appears in Pisera & Lévi (2002). Briefly, it can be described as follows: a massive thick-walled tubes or vases sponge with a single osculum at the top. Subsequent descriptions portray long cylindrical sponges. Ectosomal spicules are strongly differentiated phyllotriaenes (460–560 µm) with a very short rhabd. There are numerous microscleres on the dermal membrane as well as in subdermal lacunae. These are spinose rhabds (14–23 µm) mostly bent in the middle. Choanosomal skeleton with tetraclone desmas (325–360 µm) smoother close to the outer surface. In addition there are slender slightly curved strongyles (700–900 µm). In the Red Sea, Lévi (1958) described the strongyles as tylotes.

Reproduction

Theonella swinhoei was found to be an oviparous species. Except for during spring (March–June), small oocytes (26 ± 10 µm; n = 32) were found to be present within most *T. swinhoei* specimens examined. These

oocytes seem to grow by phagocytosis of some of the numerous bacteria that exist within the choanosome of *T. swinhoei* (Fig. 1A). Only once (during August) were sperm observed (by scanning electron microscope) but the spermatic cyst was not located. It could be that spermatic cysts develop fast and hence were not detected in most specimens. However, because the individual with spermatic cysts was also devoid of oocytes, we suggest that *T. swinhoei* might be a gonochoric species.

Theonella conica (Kieschnick, 1896)

Remarks

This species, which is much less common in the northern Gulf of Aqaba compared with its congener *T. swinhoei*, is nonetheless relatively abundant further south along the Sinai Peninsula reefs. Lévi (1958) described a Red Sea specimen from Marmar (Saudi Arabia). This species differs from the former *T. swinhoei* by the following: the tips of the desmas are pointed compared with the rounded tips in *T. swinhoei*. The strongyles (275–450 μm) are straight and slender (not tylote) and sometimes oxea can be seen. All acanthorhabds are straight and smaller (9–11 μm) than in the former species. The colour of the interior of this sponge is very typical deep blue, compared with the cream colour of *T. swinhoei*.

Reproduction

Like *T. swinhoei*, *T. conica* is an oviparous species that has relatively small (44 ± 14 μm; n = 35) oocytes, which seem to grow by phagocytosis of adjacent cells (Fig. 1B). Although only one specimen with spermatic cysts was observed (during October), these were highly abundant within its choanosome (Fig. 1C).

Ceractinomorpha
Poecilosclerida
Hymedesmiidae Topsent, 1928

This family contains 10 genera with the so far monospecific *Hemimycale* being one of them (Van Soest 2002).

Genus: *Hemimycale* Burton, 1934
Type species: *Desmacidon columella* (Bowerbank, 1874) by monotypy, not examined.

Hymedesmiidae devoid of microscleres or acanthose spicules. Spicules exclusively smooth styles and strongyles not divisible into ectosomal or choanosomal spicules.

Hemimycale arabica n. sp.

Material examined

Holotype. Thick cushion-like specimen (1.5 cm) collected on 9 October 1988 in Ras Um Sid in shallow water (2 m) by M. Ilan (with many polychaete tubes and many sand grains, ZMTAU SP25158).

Paratypes. Thick crust (0.5 cm) collected on 17 March 1987 by M. Ilan in shallow water (1.5 m) in Elat (ZMTAU SP25162); thick crust (1.5 cm) collected on 1 January 1999 in Elat, in 2 m depth by I. Yfrach (voucher 200) (ZMTAU SP25163); thinly encrusting specimen (2 mm) on a dead coral collected on 17 March 1987 in Elat, oil terminal in shallow water by M. Ilan (ZMA POR17084).

Additional material. Skeletal preparation of specimens ZMTAU SP25163 and ZMA POR17084 and spicule preparation of specimens ZMTAU SP25162 and SP25163.

Synonymy

Hemimycale sp. in Vacelet & al. (1987) and Van Soest & al. (1996).

External appearance

Colour in life: the ectosome is dark blue-black-green, the choanosome is yellow-green. Colour in alcohol: beige-white. Openings of the aquiferous system are organized in very numerous areolated pore fields that form slight depressions. Compared with other species, they are rather large and rounded or angular. The pore fields result in a reticulated appearance of the surface due to the yellow-green of the choanosome shining through, interspersed among the dominant darker colour of the ectosome. Although these pore fields are not always conspicuous, they are always present. The oscules are raised into small tubes (1–5 mm in diameter) irregularly distributed over the surface.

This sponge mostly builds thin crusts several millimetres thick and covers areas of up to 15 cm; sometimes its growth form is more cushion-like, up to 2.5 cm thick. The sponge is usually very soft.

Skeleton

No visible differentiation between choano- and ectosome. The skeleton consists of plumose tracts, with many disorganized interstitial spicules (Fig. 2). Inside the sponge the tracts form a plumoreticulate pattern organized with tracts distributed randomly through the sponge. Near the surface the tracts become more plumose. Many single spicules protrude from the surface (Fig. 2). No spongin is visible.

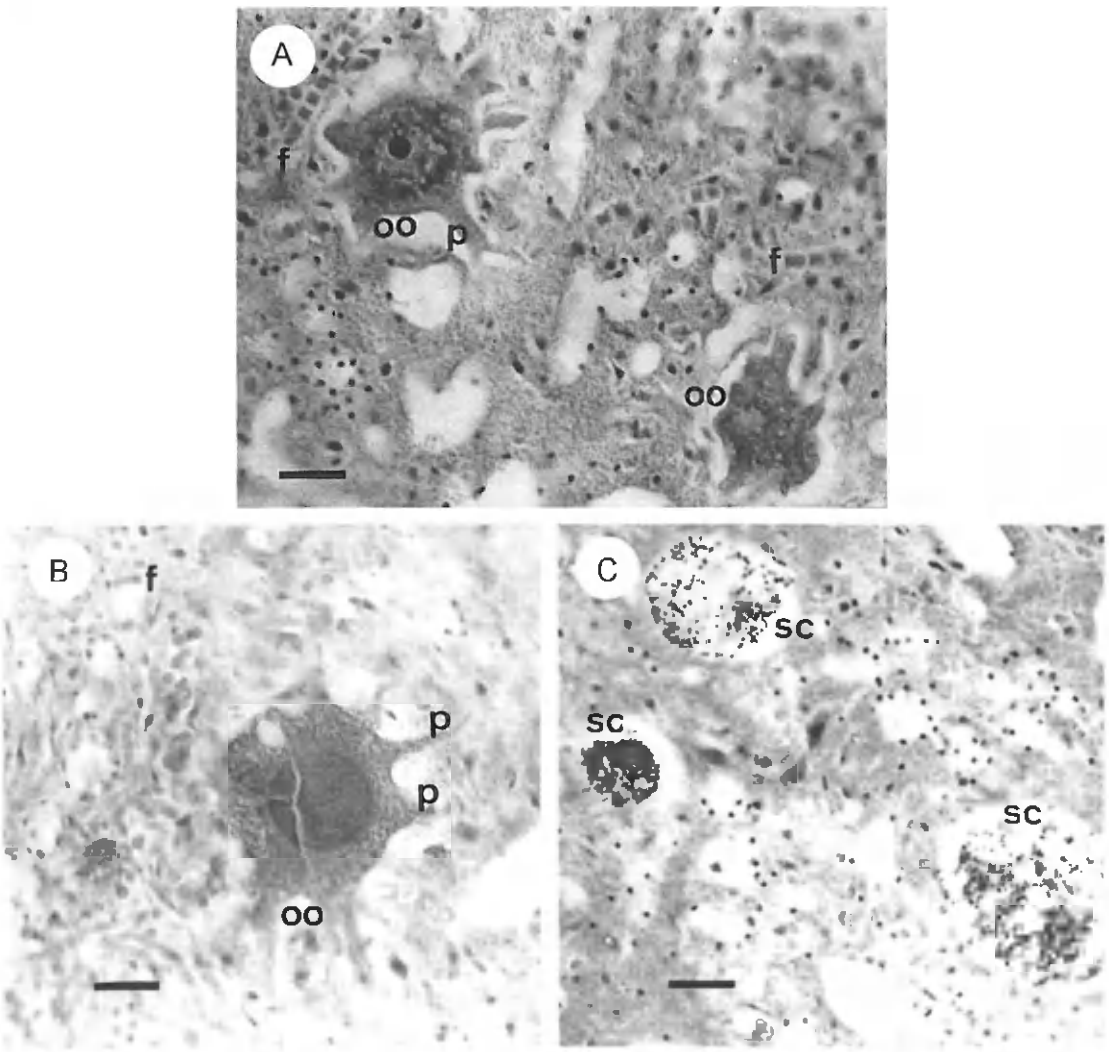

Fig. 1. *Theonella* spp. reproductive elements. *Theonella swinhoei*. A. Primary oocyte (oo) with pseudopodia (p); the choanosome is full with the recently described filamentous bacteria (f) *Candidatus Entotheonella palauensis* (Schmidt & al. 2000). *Theonella conica*. B. Primary oocyte (oo) with pseudopodia (p). C. Several spermatic cysts (sc) can be seen in the choanosome. Scale bar 25 µm.

Especially massive specimens tend to incorporate many sand grains.

Spicules

The spicules are very straight, thin strongyles with a wide axial canal. Frequent occurrence of anisostrongyles with one tip slightly subtylote. Among the strongyles approximately 15% are styles. The styles are mostly straight, but sometimes slightly bent and significantly shorter yet thicker than the strongyles (measurements are given in Table 1).

Etymology

Frank Nobbe first described the species, without publishing it, and we chose the name he intended to give the species, after its locality next to the Arabian Peninsula.

Remarks

Frank Nobbe already deposited a "holotype" in the SMF in Frankfurt (no. 5165). One of us (JG) examined the specimens in Frankfurt and confirmed their conspecificity with the present species.

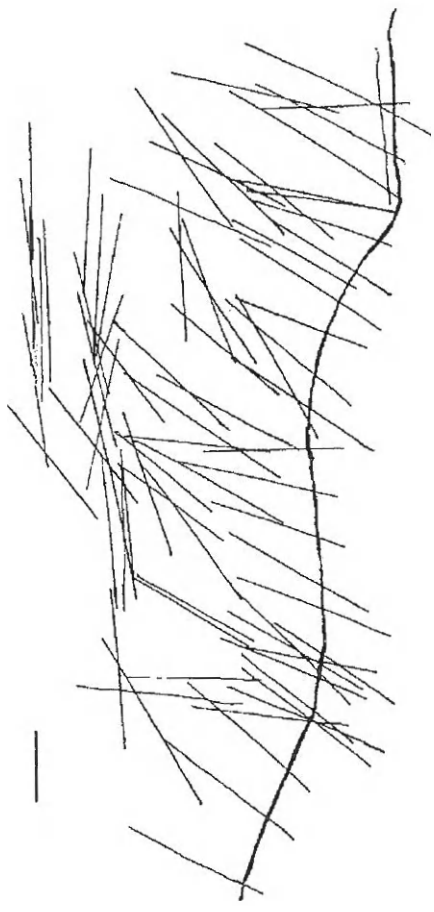

Fig. 2. *Hemimycale arabica*. Spicules arrangement. Peripheral skeleton. Scale bar 100 µm.

Hemimycale was considered a monotypical genus with *H. columella* as the single species (Van Soest 2002). *Hemimycale arabica* n. sp. differs from *H. columella* in several characters. There are about 15% of styles among the spicules of *H. arabica* compared with only a few styles in the latter species. Also, the styles of the new species are significantly shorter and thicker than the strongyles, compared with nearly the same size (or slightly smaller) styles in *H. columella*. Although the strongyles of *H. columella* from Marseille are only slightly longer than those of the Red Sea species, specimens from Naples, Roscoff, Exmouth and Plymouth are much larger and thicker than those of *H. arabica* (see Vacelet & al. 1987, table I). In addition, the two species differ in their external surface (with the numerous circular depressions of *H. columella* which are less prominent in *H. arabica*), their colours, and their chemical content (Van Soest & al. 1996). All these differences, together with the distribution of the temperate species compared with the tropical one, strengthen the decision that these two are separate species.

Table 1. *Hemimycale arabica*, spicule measurements.

Spicule type	Length, range (µm), n = 50	Length, mean ± SD (µm), n = 50	Width, range (µm), n = 10	Width, mean ± SD (µm), n = 10
Strongyles	200–290	266 ± 19	2.5–4	3.5 ± 0.5
Styles	190–250	218 ± 12	3.5–5	4.7 ± 0.5

SD – Standard deviation.

The ordinal position of the genus was debated, as to whether *Hemimycale* belongs to the Halichondrida (family Hymeniacidonidae) or to the Poecilosclerida (see Van Soest 2002). The main arguments for placement within the Poecilosclerida are the possession of distinct pore fields both in *H. columella* and in *H. arabica*, as well as some characteristics of the larvae of *H. arabica* observed here.

Within the Poecilosclerida, *H. arabica* n. sp. shares with the genera *Crambe* Vosmaer, 1880 and *Monanchora* Carter, 1883 the possession of polycyclic guanidine alkaloids that are not present in *H. columella* (Van Soest & al. 1996).

Vacelet & al. (1987) discovered, in preserved specimens of *H. columella* and *H. arabica*, calcareous spherules, which they thought to be artefacts due to preservation. Old specimens (from the 80s) of *H. arabica*, as well as Nobbe's "holotype", have these spherules. In recent collections, however, they were not observed, possibly due to differences in preservation.

Ecology

Hemimycale arabica often grows on the tips of live or dead branching stony coral or fire coral (*Millepora dichotoma*) colonies. The sponge often harbours a large number of sabellid tube worms.

Reproduction

Whether this sponge is in reproduction or not is easily recognized, even in situ, when a cut is made through its body. Reproductive elements (oocytes, embryos and larvae) have a distinct bright orange colour, whereas the rest of the sponge choanosome (inner part) is pale yellow. *Hemimycale arabica* is a hermaphroditic viviparous species like its congener *H. columella* (Lévi 1965). The spermatic cysts (33 ± 10 µm; n = 31) have been found dispersed within the sponge choanosome (Fig. 3A). Given the size of the primary spermatids, it is

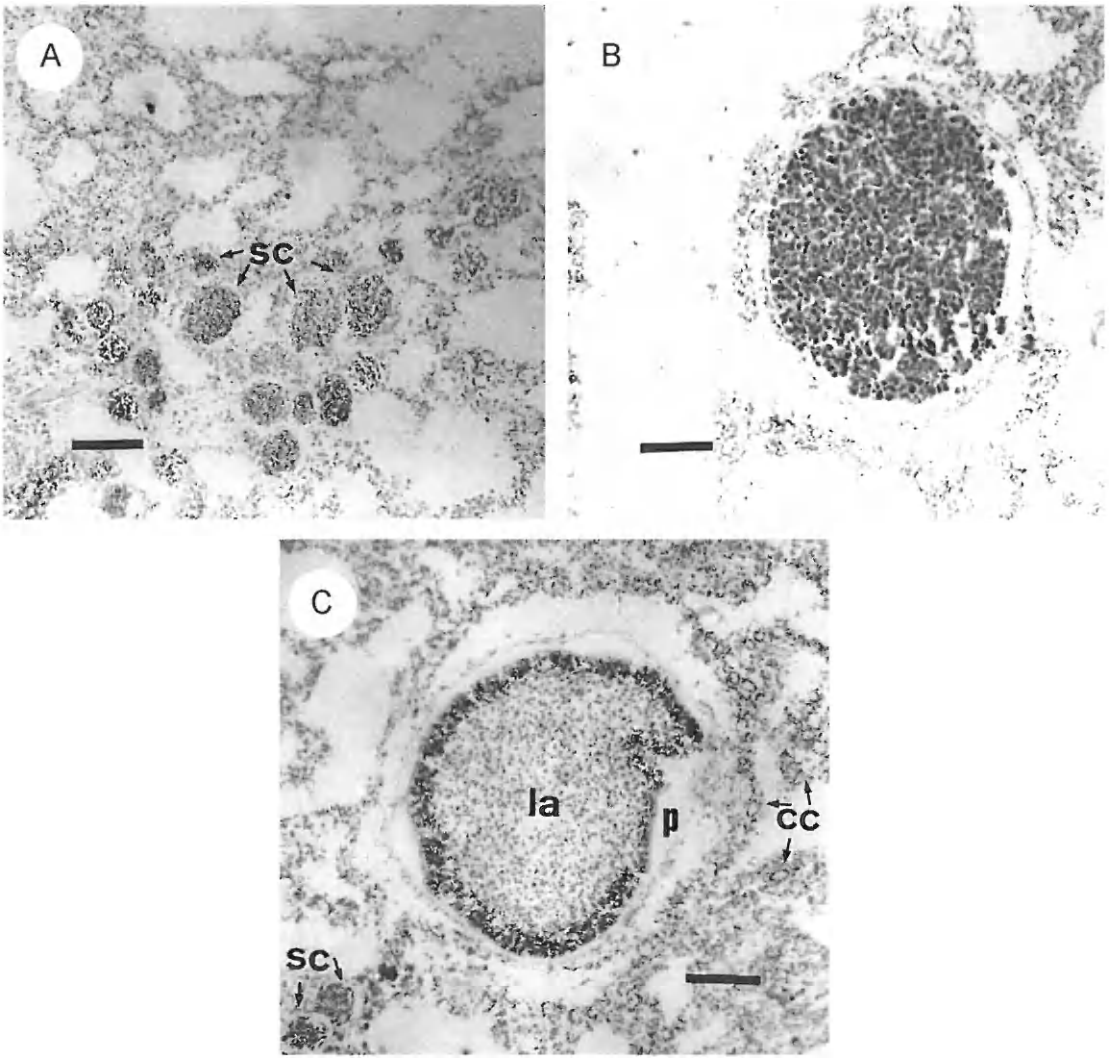

Fig. 3. *Hemimycale arabica*, reproductive elements. A. Large number of spermatic cysts (sc) in the choanosome. B. A mature incubated oocyte. C. An incubated ciliated larva (la), with only the posterior part (p) devoid of cilia. For comparison of size, spermatic cysts (sc) and choanocyte chambers (cc) are labelled. Scale bar 100 μm.

suggested that they develop from the choanosome's amoebocytes (e.g. archeocytes) and not from the much smaller choanocytes. The larvae are of medium size (305 ± 57 μm; n = 16) and like other poecilosclerid larvae are covered by cilia except for one pole (Fig. 3C). This sponge does not appear to reproduce during the winter, as embryos were found between May and October. Because spermatic cysts were observed in October, the reproductive season might be more extended, but no samples were taken in November or December. However, during winter it was sampled in January and March and if just a small fraction of the population was reproducing, this might have been overlooked.

Rhabderemiidae Topsent, 1928

This is a monogeneric family, with *Rhabderemia* as a single genus (Hooper 2002).

Genus: *Rhabderemia* Topsent, 1890

Type species: *Microciona pusilla* Carter, 1876 corrected to *minutula* by Carter himself, 1880 (Van Soest & Hooper 1993), not examined.

Synonymy

Summarized in Hooper (2002).

Diagnosis

As in the family.

Rhabderemia batatas n. sp.

Material examined

Holotype. Collected on 5 March 1998 in Elat, IUI in shallow water by I. Yfrach (voucher 065, ZMTAU SP25161).

Paratypes. Collected in December 1997 in Elat, IUI in shallow water by I. Yfrach, (voucher 009, ZMA POR17086); collected on 17 March 1999 in Elat, IUI in 2 m depth on the underside of an overhanging rock by J. Gugel, (ZMTAU SP25168).

Additional material. Spicule preparation from ZMTAU SP25167 and skeletal preparation of ZMTAU SP25167 and SP25168.

External appearance

Colour in life: surface is ochre, where illuminated, otherwise yellow. The choanosome is yellow. Colour in alcohol: surface is grey or yellow-grey, with some pink. The internal choanosome is creamy. This sponge is fleshy, soft, compressible, not elastic, easy to cut and hardens considerably in alcohol.

Specimens have irregular shape with conical protuberances often bearing a single oscule on top. The surface is smooth. The oscules have a diameter of about 0.5 cm. The protuberance openings are more or less oval and are mostly 5–8 cm long and in the widest part 2.5–4 cm wide. A single specimen consists of several of these protuberances.

Skeleton

Choanosomal skeleton: consists of very loose tracts, some of which are oriented towards the surface, but most are directionless. In between the tracts many single spicules are dispersed in all directions. No visible spongin fibres. The skeleton is not nearly as packed with spicules as, for example, in *Topsentia*. Many canals occur in the subectosome or ectosome that are not visible to the naked eye (Fig. 4).

Ectosomal skeleton: mostly no spicules at all, occasionally single spicules tangentially. Single tracts protruding at regular intervals from the ectosome, rarely protruding from the surface. Ectosome barely or not detachable, consisting of a denser (than the choanosome), organic layer (Fig. 4).

Spicules

Rhabdostyles or "rhabdostrongyles", rarely regular styles occasionally with vestigial spines (Fig. 4, 165–218 ± 25–275 × 2.7–3.5 ± 0.8–4.5 μm). Sometimes bent spicules. Styles or rhabdostyles might be replaced by strongyles (Fig. 4) but true oxea are lacking. Microscleres are curved extremely thin microstyles (17–24 ± 6–35 μm), and microspined spirosigmata (Fig. 4, 5.2–6.9 ± 1.0–9.2 μm).

Etymology

The species bears some resemblance to a sweet potato (*Ipomoea batatas*).

Remarks

The assignment to *Rhabderemia* is based on the presence of the unique type of the spirosigmatose microscleres (Fig. 4). In the most recent review of the species within this genus (van Soest & Hooper 1993), 26 species were described. After ruling out all the species with rhabdostyles of two size categories, and those with either addition of different types of microscleres or absence of those which appear in *R. batatas* n. sp., there are four species left. *Rhabderemia profunda* has all the spicules more than three times larger than in the present species. Moreover, it is a deep-water species from the western Mediterranean. *Rhabderemia stellata* also has larger spicules. The smooth and thick rhabdostyles in addition to the microstyles differ in shape from the present species. *Rhabderemia indica* was described from the Gulf of Manar. Although the size and shape of its macroscleres do resemble *R. batatas* n. sp., this species differs from the present one by: (1) being an encrusting species, (2) having all the styles bent at the edge, (3) having much (twice) larger contorted sigmas, (4) having much (twice) larger (and straight) microstyles. *Rhabderemia spirophora* described from Natal is the last of these four species and the one that most closely resembles *R. batata* n. sp. However, all its spicules are larger, especially the microstyles (53 μm). In addition, unlike *R. batatas*, *R. spirophora* has an ectosomal thin membrane full with microscleres, and its rhabdostyles are entirely smooth.

Halichondrida
Halichondriidae Gray, 1867

The genus *Topsentia* is one of 11 genera within this family (according to Erpenbeck & Van Soest 2002).

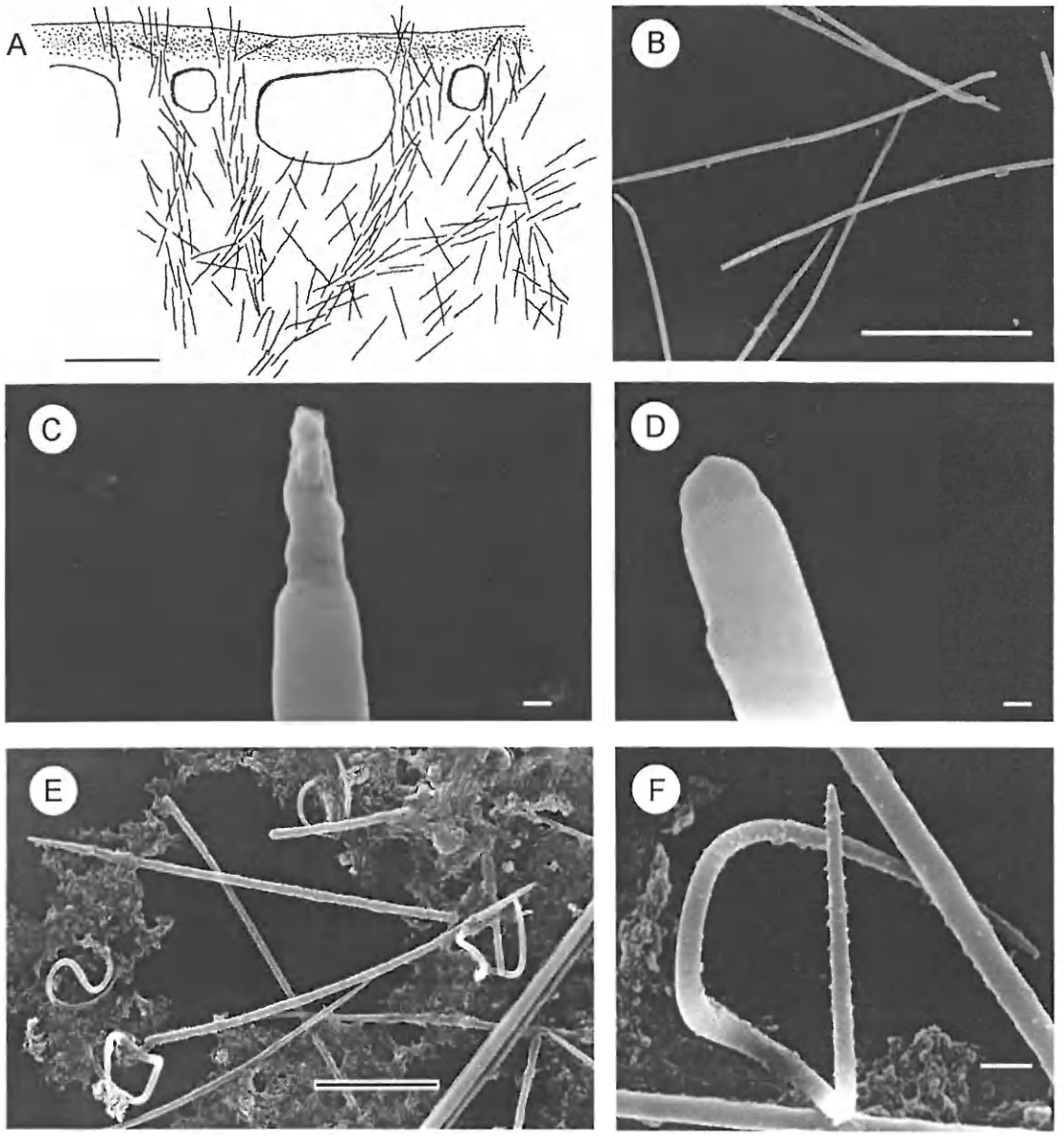

Fig. 4. *Rhabderemia batatas* skeleton. A. Drawing of peripheral spicules arrangement. Scale bar 100 µm. B. Spicules. Scale bar 100 µm. C. The stepped tip of a style. Scale bar 1 µm. D. Blunt tip of a style. Scale bar 1 µm. E. Styles (some spined) and spirosigmata microscleres. Scale bar 10 µm. F. Microspined spirosigma microscleres. Scale bar 1 µm.

Genus: *Topsentia* Berg 1899
Type species: *Anisoxya glabra* Topsent, 1898, MOM: syntypes 04 0369, 04 0707, not examined.

Synonymy

Summarized in Erpenbeck & Van Soest (2002).

Diagnosis

Halichondriidae of massive amorphous to lobate shape, with brittle and rough texture. Ectsosomal skeleton consisting of a crust-like partly tangential or paratangential arrangement of small spicules grading into the densely confused choanosomal skeleton of larger

spicules. Choanosome skeleton lacks spongin fibres and very little collagen: as a consequence spicules show a confused, directionless and packed arrangement around canals, cavities, etc. Smaller spicules concentrated at the surface usually arranged without any organization produce a compact, paratangential, ectosomal layer, creating a microhispid surface. Spiculation consists of oxeas in a wide size range, with two or three size classes distinguished. Twisted, bent and double-bent spicules sometimes present. No raphide microscleres (according to Erpenbeck & Van Soest 2002).

Topsentia aqabaensis n. sp.

Material examined

Holotype. Fragment of a specimen collected on 11 November 1998 in Elat, IUI in 2 m depth by J. Gugel (ZMTAU SP25156).

Paratypes. Collected on 13 May 1998 in Elat, IUI in shallow water by I. Yfrach (voucher 152; ZMA POR17085); collected in December 1997 in Elat, IUI in shallow water by I. Yfrach (voucher 004, ZMTAU SP25166).

Additional material. Spicule preparation of specimen ZMTAU SP25156.

External appearance

Colour in life: purple-grey, yellow-grey, light greenish, depending on illumination; internal: dirty cream, about 3 mm below the surface a thin, purple layer, mostly covered by a external greyish-yellowish-greenish layer (not along the ectosome–choanosome boundary). In the absence of sediment cover, the external layer colour is greyish-yellowish-greenish. Often, however, the whole sponge is covered by sediment, eliminating the light green colour of the external layer and the sponge surface is purple. Colour in alcohol: grey or yellow grey.

This massive sponge may reach 20 × 10 × 10 cm with a few large oscules.

Skeleton

Choanosomal skeleton: very densely packed spicules mainly of the largest size category, the other size categories becoming more frequent towards the outside (Fig. 5A). The spicules are arranged in vague tracts (about 75–250 µm thick, with greatly varying thickness, even within the same specimen), many directionless spicules, very little spongin.

Ectosomal skeleton: the small oxea build a paratangential outer crust of variable thickness (Fig. 5A). Often the small oxea protrude above the surface for a short distance (Fig. 5B), producing an optically smooth but rough to the touch surface.

Spicules

Principal oxea: slightly curved–straight, rarely stylote, or strongylote, existing in a wide size range, many immature still growing oxea. Small oxea: straight, rarely slightly curved. Measurements are given in Table 2.

Etymology

The species was first described by F. Nobbe without publishing it, and we chose the name he intended to give the species after the city Aqaba at the northern tip of the Red Sea.

Remarks

A specimen of this species was deposited in SMF in Frankfurt (SMF 5152) as a "holotype" with the name *Topsentia* (= *Epipolasis*?) *aqabaensis*, (F. Nobbe, pers. comm.), but its description was never published. One of us (JG) validated its identity with the species described here.

Using the key to the genera given by Erpenbeck & Van Soest (2002), we eliminated all options for generic placement except for *Topsentia* and *Epipolasis*. A decision is drawn here based on the absence of trichodragmata typical of *Epipolasis*. The present species agrees in general with the description of *Trachyopsis halichondroides* Dendy, 1905, especially in the dimensions of the large (but slightly curved) oxea (Dendy 1905; Row 1909) (Dendy and Row gave only measurements of large oxea). The figures of spicules by Dendy also resemble both types of oxea of the present species. *Trachyopsis halichondroides* was also reported by Burton (1926) from the Suez Canal. The skeletal arrangement of Dendy's holotype, which was drawn by Burton (1926) and Van Soest & al. (1990), is clearly different from *Topsentia aqabaensis*. Burton (1926) gave an overview of the species variability, and none of his skeletal figures agrees with the present species.

Table 2. *Topsentia aqabaensis*, spicule measurements.

Spicule type: oxea	Length, range (µm), n = 50	Length, mean ± SD (µm), n = 50	Width, range (µm), n = 10	Width, mean ± SD (µm), n = 10
Principal	530–800	655 ± 63	7–27	20.8 ± 3.3
Small	155–215	181 ± 15	3–8.8	5 ± 1.5

SD – Standard deviation.

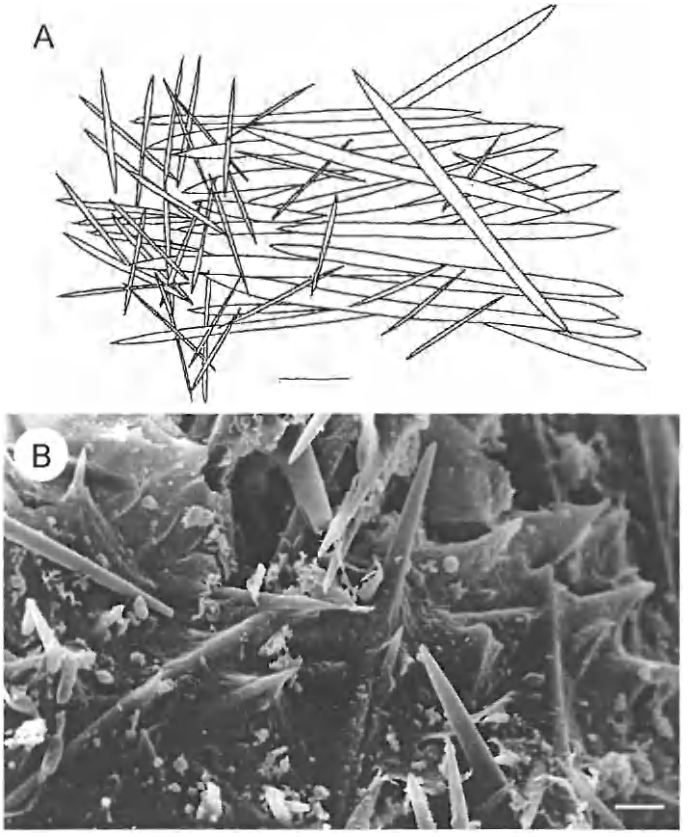

Fig. 5. *Topsentia aqabaensis* skeleton. A. Drawing of the peripheral skeleton. Scale bar 100 µm. B. Scanning electron micrograph of the surface with protruding spicules. Scale bar 10 µm.

Burton (1926) puts *T. halichondroides* in synonymy with *Halichondria granulata* Keller, 1891, *H. tuberculata* Keller, 1891 and *H. minuta* Keller, 1891, none of which seems to be conspecific with the present species. *Halichondria granulata* is soft and membrane-like, covers corals and bears strongyles. *Halichondria tuberculata* is also soft and fleshy with separate "hills", while *H. minuta* has paper thin encrustation. The genus type species *T. glabra* also differs from *Topsentia aqabaensis* n. sp. by the absence of visible oscules, and by having oxea in three size categories.

Reproduction

Oocytes were found from winter to summer (January to June). It seems that *T. aqabaensis* does not reproduce in autumn as no reproductive elements were found during October. The oocytes, which appear granulated in histological preparations (Fig. 6), were relatively small (46 ± 10 µm; n = 31), up to 75 µm. Their growth might be achieved by either absorption of dissolved organic matter, or by synthesis de novo. This assumption is based on the absence of nursing cells around the growing oocytes. No spermatic cysts were detected.

Haplosclerida
Niphatidae Van Soest, 1980

This family contains 12 genera, of them nine are considered valid, including *Amphimedon* and *Niphates* (Desqueyroux-Faúndez & Valentine 2002b).

Genus: *Amphimedon* Duchassaing & Michelotti 1864
Type species: *Amphimedon compressa* Duchassaing & Michelotti, 1864 (examined: lectotype from ZMA (00863)).

Synonymy

Summarized in Desqueyroux-Faúndez & Valentine (2002b).

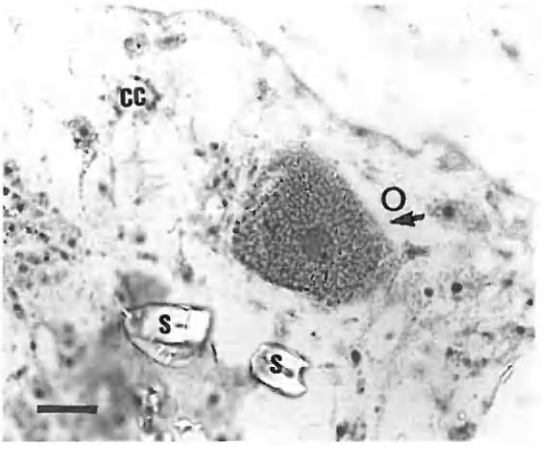

Fig. 6. *Topsentia aqabaensis* oocyte (O). The granulated appearance resembles that of accompanying nurse cells. For comparison, note the size of a choanocyte chamber (cc) and fragments of spicules (s). Scale bar 25 µm.

Diagnosis

Niphatidae with an optically smooth surface, due to rarely protruding primary fibres. Ectosomal skeleton with regular tangential reticulation with rounded meshes of a single size, spongin abundant, no microscleres.

Amphimedon chloros n. nom.

This species, originally named *Dactylochalina viridis* Keller, 1889, is in need of re-description because of problematic portrayal.

Material examined

Slide of a lectotype from Keller's *D. viridis*, ZMB2920; cushion-like specimen, collected on 9 January 1999 in Elat, IUI in 2.5 m depth by J. Gugel (ZMTAU SP25157); finger-like, creeping specimen collected on 9 January 1999 in Elat, IUI in 2.5 m depth by J. Gugel (ZMTAU SP25169); cushion-like specimen, collected on 9 January 1999 in Elat, IUI in 2.5 m depth by J. Gugel (ZMTAU SP25170); collected in December 1997 in Elat, IUI in shallow water by I. Yfrach (voucher 001, ZMTAU SP25171); cushion-like specimen, collected on 9 January 1999 in Elat, IUI in 2.5 m depth by J. Gugel (ZMTAU SP25172); cushion-like specimen collected on 9 January 1999 in Elat, IUI in 2.5 m depth by J. Gugel (ZMA POR17081).

Additional material. Slides with preparations of the skeleton and spicules of ZMTAU SP25157.

Other material examined. *Amphimedon viridis* Duchassaing & Michelotti, 1864 from Curacao, Fuikbaai, 1–3 m, coll. W.H. de Weerdt, ZMA Por. 06424.

Synonymy

Dactylochalina viridis Keller, 1889
Hemihaliclona viridis (Duchassaing & Michelotti, 1864) in Burton (1937)
Callyspongia viridis (Keller, 1889) in Burton (1952)
Haliclona viridis (Duchassaing & Michelotti, 1864) in Thomas (1986)

External appearance

Colour in life: bright green throughout the "tissue". Colour in alcohol: dirty brown, loses its green colour rather slowly.

The sponge has a soft consistency, is elastic, relatively resistant to cut or tear and the colour bleaches out easily when it is torn.

Growth form: mostly cushion-like patches, but often finger-like processes. The cushions are thick, about 10 × 4 cm, the finger-like processes up to 20 cm long, with up to 3 cm diameter and even branch. The finger-like processes are in part upright, in part lying on the substrate, attached to it.

Surface: smooth, with ridges on some parts of the surface of certain specimens. Oscules: scattered all over the surface of the sponge, about 1.2–2.5 cm apart, with diameter 2.8–4.3 mm, average 3.4 mm, with a sharp margin, usually not elevated except in larger (older) specimens, where the rim is slightly elevated.

Skeleton

Choanosomal skeleton: close reticulation, meshes in the periphery polygonal to rectangular and becomes rounded to disorganized towards the centre. Multispicular primaries ascend to the surface (but do not protrude from it) and branch near the surface in an irregular manner. Secondaries are uni-, pauci- or multispicular (Fig. 7A). Interstitial spicules are common. Spongin is dominant, but spicules are numerous and quite conspicuous.

The measurements of fibres and meshes are given in Table 3.

Ectosomal skeleton: regular reticulation of multispicular fibres with rounded meshes, sometimes interconnected by a fine network of mostly aspicular spongin fibres (Fig. 7B), tangential to paratangential (often difficult to see).

The sponge bears many pore sieves on the surface (emerging from the ectosomal skeleton), that Keller

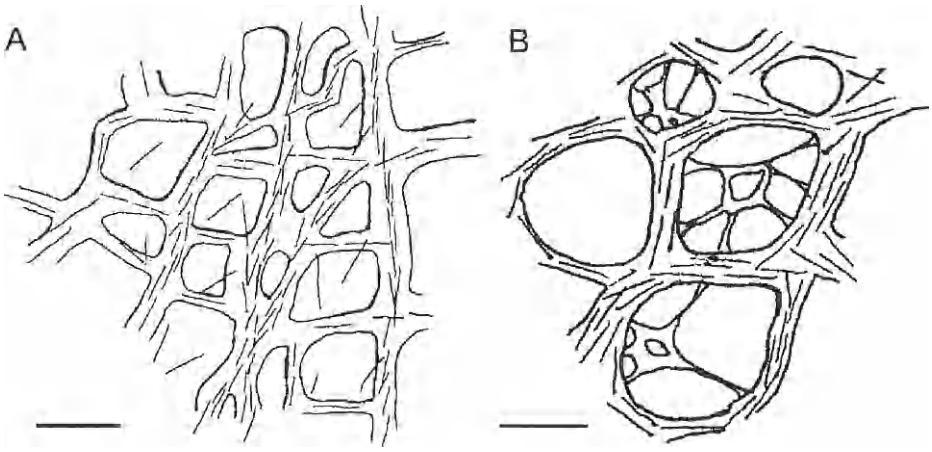

Fig. 7. *Amphimedon chloros* skeleton. A. Choanosome. B. Ectosome, tangential view. Scale bars 100 µm.

(1889: 26) already described and figured (plate 23, fig. 40).

The spongin fibres are often difficult to see, especially in xylol-based mounting media (see below).

Spicules

Oxea (90–111 ± 10–130 × 2.5–3.5 ± 0.7–4.5 µm), sometimes strongylote, rarely stylote, slightly curved to straight.

Etymology

From the Greek "chloros" = green.

Remarks

We re-described the species because we believe that *D. viridis* Keller should have been transferred to *Amphimedon*. However, the name *Amphimedon viridis* is already occupied by a different Caribbean sponge, described by Duchassaing & Michelotti (1864). Transfer to *Amphimedon* would, therefore, create a secondary homonym. According to the ICZN, articles 59b and 59c, in such a case the secondary junior homonym (here *D. viridis*) must be rejected and replaced. If it should again be placed in a different genus, the original species name will be reinstated.

Table 3. *Amphimedon chloros*, measurements of fibres and meshes.

	Range (µm), n = 10	Mean (µm), n = 10
Choanosomal meshes (width)	75–130	107
Primaries (diameter)	28–50	37
Secondaries (diameter)	10–20	15.5
Ectosomal meshes (width)	100–210	155
Fibres (diameter)	20–45	26

In the present species, spongin fibres are much more developed in comparison with spicule tracts than in most other *Amphimedon* species, including the type species *A. compressa*. Nevertheless it fits well with the general description of *Amphimedon*. The description agrees with that of Keller for *Dactylochalina viridis*. However, there remain some differences with Keller's diagnosis in the overall size of the sponge, the size of the oscules and their slight elevation in Keller's specimens, as well as the uneven surface with ridges of Keller's specimens, and slight differences in the dimensions of the spicules and fibres. These differences might originate from the fact that the described and illustrated holotype (ZMB 2920; Keller 1889: plate 23, fig. 37) is a very luxurious specimen. As indicated above, ridges on the surface and slightly elevated oscules occur in larger specimens. As the sponge itself grows, the oscules grow larger and the fibres tend to be thicker and contain fewer spicules in older specimens (see Burton 1952).

Another problem relates to the skeleton: the spongin fibres tend to disappear (optically) in xylol-based mounting media (see above). Keller was probably aware of this problem as he stained his skeleton preparations (typeslide: ZMB 2920) with Carmin. Following staining with Congo Red or mounting in a non-xylol-based media (e.g. Euparal), skeleton preparations resemble Keller's original slide and figures; moreover, any unstained preparations might lead to misinterpretation concerning the amount of spongin. The description and measurements of the spicules agree

with Keller's figures and values, being only slightly shorter (Keller's values: 120–150 × 5 µm).

Comparison with Amphimedon viridis *Duchassaing & Michelotti, 1864, and* Amphimedon paraviridis *Fromont, 1993*

Descriptions of *Amphimedon viridis* Duchassaing & Michelotti, 1864, as well as descriptions (e.g. Van Soest 1980) and examined slides of a schizotype from the BMNH (BMNH: 1928.11.12. 35a, 1928.11.12.36a), clearly indicate much less spongin in *A. viridis* Duchassaing & Michelotti 1864. But as stated above, unstained preparations of *A. chloros*, especially when mounted in a medium based on xylol, might lead to an underestimation of the amount of spongin present. Such preparations indeed look very much like those of *A. viridis*.

The spicules of *A. chloros* (measured values, Keller's values of *Dactylochalina viridis*, Indo-Pacific records of "*A. viridis*": Desqueyroux-Faúndez 1984; Thomas 1986; Burton 1937: 60–150 µm) are slightly shorter than those of the "true", Caribbean *A. viridis* (Van Soest 1980; Pulitzer-Finali 1986: 150–180 µm).

Of course, it is questionable if all Indo-Pacific records of *A. viridis* can be summarized under *A. chloros*. There might be other green Haplosclerids in this area, like *A. paraviridis* Fromont 1993. *Amphimedon paraviridis* Fromont, 1993 differs from *A. chloros* mainly in the dimensions of the spicules (Fromont 1993), which are much thicker: holotype 133–151 × 3.9–8.0 µm. Even specimens with rather small dimensions (holotype: MTQ G 25033) have slightly elevated oscules not found in *A. chloros*. On the other hand, *A. paraviridis* has ectosomal pore sieves similar to *A. chloros*.

Another genus whose species have some resemblance to *A. chloros* is *Ceraochalina* (a chalinid sponge with spongin fibres). Examination of *C. gibbossa*, *C. ochracea*, *C. granulata*, and *C. densa*, shows that the first three species differ from *A. chloros* by having styles as the main skeletal spicules and the fourth has a *Callyspongia*-like skeletal arrangement.

Reproduction

This species distribution starts from shallow water (1 m) but is found most frequently between 15 and 35 m. Although numerous (hundreds) specimens were examined over a period of 4 years, reproductive elements were only located in three individuals. Nonetheless this enabled determination that *A. chloros* is a hermaphroditic viviparous species. Only in one case were both oocytes (62 ± 9 µm; n = 12) and spermatic cysts (18 ± 7 µm; n = 22) found simultaneously during mid-summer (August) distributed throughout the choanosome. It seems that oocyte growth is achieved by phagocytosis of surrounding nurse cells (Fig. 8A).

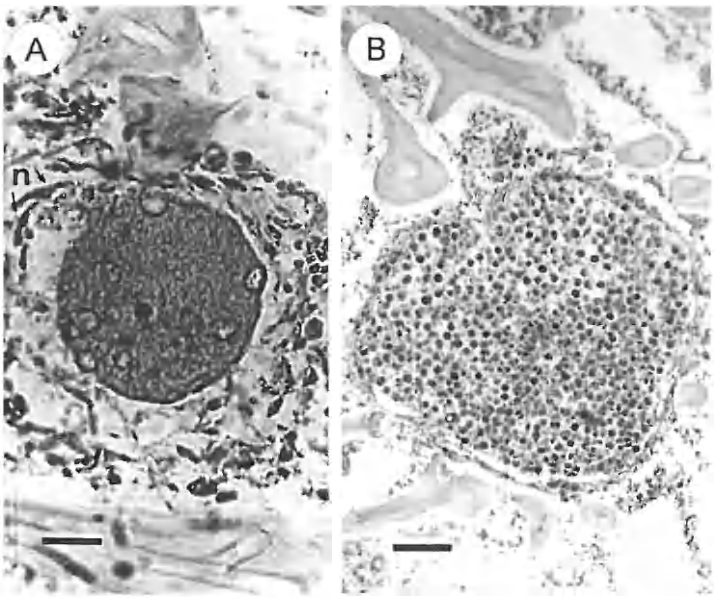

Fig. 8. *Amphimedon chloros* reproductive elements. A. An oocyte surrounded by nurse cells (n). Scale bar 25 µm. B. An incubated embryo. Some cells starting to differentiate. Scale bar 100 µm.

On two other occasions (June and July), incubating embryos (416 ± 38; n = 9) were detected (Fig. 8B).

The small number of reproducing individuals found in the present study suggests that only a small fraction of the population reproduces, probably only during the summer (June–August).

Amphimedon chloros also reproduces asexually. It is relatively common in *A. chloros* to see some branches growing from an encrusting base, and attaching themselves to another part of a substrate, followed by fission between the new attachment point and the original sponge.

Genus: *Niphates* Duchassaing & Michelotti, 1864
Type species: *Niphates erecta* Duchassaing & Michelotti, 1864, examined lectotype from ZMA (01633).

Diagnosis

Niphatidae with a paratangential ectosomal reticulation of fibres or tracts, obscured by the conulose surface produced by the ends of primary, multispicular, longitudinal fibres. Interconnecting secondary fibres pauci- to multispiculate, well developed to form rounded to irregular meshes. Spongin is abundant and covers the spicules. Megascleres are oxeas. Microscleres, if present, are sigmas (after Desqueyroux-Faúndez & Valentine 2002b).

Niphates rowi n. sp.

Material examined

Holotype. Encrusting specimen, collected on 8 January 1999 in Elat, IUI in 1 m depth by J. Gugel (ZMTAU SP25155).

Paratypes. Encrusting specimen, collected on 8 January 1999 in Elat, IUI in 1.5 m depth by J. Gugel (ZMTAU SP25174); two fragments of encrusting specimens, collected on 7 January 1999 in Elat, IUI in 1 m depth by J. Gugel (ZMTAU SP25175); three fragments of encrusting specimens, collected on 7 January 1999 in Elat, IUI in 1 m depth by J. Gugel (ZMTAU SP25176); three fragments of encrusting specimens, collected on 8 January 1999 in Elat, IUI in 1 m depth by J. Gugel (ZMTAU SP25177); three fragments of encrusting specimens, collected on 7 January 1999 in Elat, IUI in 1 m depth by J. Gugel (ZMA POR17083).

Additional material. Preparation of the choanosome and ectosome skeleton, as well as spicule preparation from the holotype (ZMTAU SP25155) all on microscope slides.

Synonymy

Niphates sp. in Ilan & Loya (1988).

External appearance

Colour in life: light bluish, slight grey, sometimes (rarely) light brown external, internal light brownish-grey and sometime orange. Colour in alcohol: greyish brown. Texture: elastic, rather stiff, feels a bit "slippery" during collection, difficult to cut in the fresh state. Growth form: low crusts (about 1.5 cm thick), irregular outline, edges rounded, average about 5 × 2.5 cm in size. Surface more or less smooth, but a bit roughened, feels a bit furry in the preserved state.

Oscules: evenly distributed over the surface (about 0.5–1.5 cm apart from each other), not (or rarely very slightly) elevated, round with a sharp margin, measuring 1.8–4 mm (average 2.6 mm) in diameter, becoming slightly larger in older (larger) specimens.

Skeleton

Choanosomal skeleton: reticulation of spongin fibres cored by multispicular tracts of oxea. Primaries cored by thick spicule tracts, ascending to the surface. Spicule brushes (often prominent) protruding it regularly; secondaries: interconnections between primaries, uni–multispicular (never as dense tracts as the primaries); meshes tend to be rectangular, often rounded; many interstitial spicules (Fig. 9A).

Ectosomal skeleton: rather regular quadrangular meshes of multispicular fibres (Fig. 9B), often obscured, surface protruded by upright spicule brushes originating from the choanosomal primaries.

The measurements of fibres and meshes are given in Table 4.

Spicules

Slightly curved to straight oxea, slowly tapering (115–140 ± 13–170 × 5.5–6.5 ± 0.8–7.5 µm).

Etymology

In honour of R. W. H. Row, one of the most important contributors to the study of the Red Sea sponge fauna.

Remarks

The present species has slightly more spongin in relation to spicules and its outer appearance is less hispid than many other *Niphates* species, including the type species. Nevertheless the species fits very well in the general diagnosis of the family Niphatidae and the genus *Niphates*. The upright spicule brushes are especially conspicuous. The absence of microscleres, the abundant

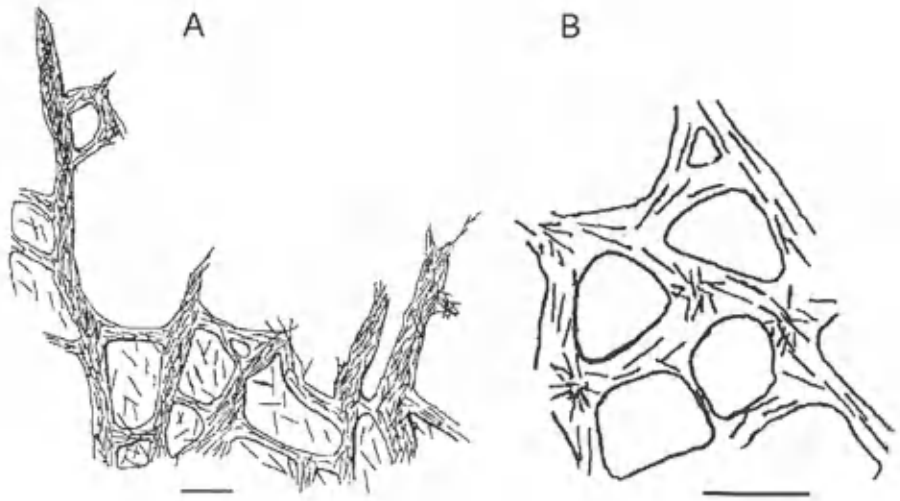

Fig. 9. *Niphates rowi* skeleton. A. Choanosome. B. Ectosome, tangential view. Scale bars 100 µm.

spongin, and the absence of a strong crust and continuous palisade of spicule brushes, rule out all other genera within Niphatidae (Desqueyroux-Faúndez & Valentine 2002b). No other *Niphates* species was described from the Red Sea. Other related haplosclerid species from the Red Sea do not conform with the genus description. Similarly, the *Amphimedon* species described by Pulitzer-Finali (1993) from East Africa, all differ from the present species, by spicule morphology, choanosomal skeleton, amount of spongin, and growth form.

Ecology

Niphates rowi has only been found in very shallow locations (Fig. 10). It appeared in high numbers at the highest subtidal locations and was never observed below a depth of 4 m. The highest numbers of the species were found at a depth between 1 and 2 m. *Niphates rowi* was found mostly on vertical walls (76%) rather than horizontal (9%), overhanging (5%) or ascending (10%) substrates. It usually grew on barren rocks, occasionally near living corals. Details of its reproductive biology have been described elsewhere (Ilan & Loya 1988).

Table 4. *Niphates rowi*, measurements of fibres and meshes.

	Range (µm), n = 10	Mean (µm), n = 10
Choanosomal meshes (width)	115–200	160
Primaries (diameter)	35–60	49
Secondaries (diameter)	15–25	20
Ectosomal meshes (width)	70–115	99
Fibres (diameter)	20–35	28

Family: Callyspongiidae

This large family contains 23 nominal genera of which today only eight are considered valid and include *Callyspongia* and *Siphonochalina* (Desqueyroux-Faúndez & Valentine 2002a).

Callyspongia Duchassaing & Michelotti 1864
Type species: *Callyspongia fallax* Duchassaing & Michelotti, 1864 (not examined).

Synonymy

Summarized in Hooper & Wiedenmayer (1994).

Diagnosis

Callyspongiidae with a choanosomal reticulation by spongin fibres with a well-developed network of primary longitudinal fibres with spongin sheath always present. Ectosomal skeleton a tangential network formed by secondaries and sometimes tertiaries (triple mesh ectosomal layer) or less ramified and with regular size of mesh (single mesh ectosomal layer) (after Desqueyroux-Faúndez & Valentine 2002a).

Callyspongia (Euplacella) paralia n. sp.

Material examined

Holotype. Massive specimen collected on 8 January 1999 in Elat, IUI in 1.5 m depth by J. Gugel (ZMTAU SP25154).

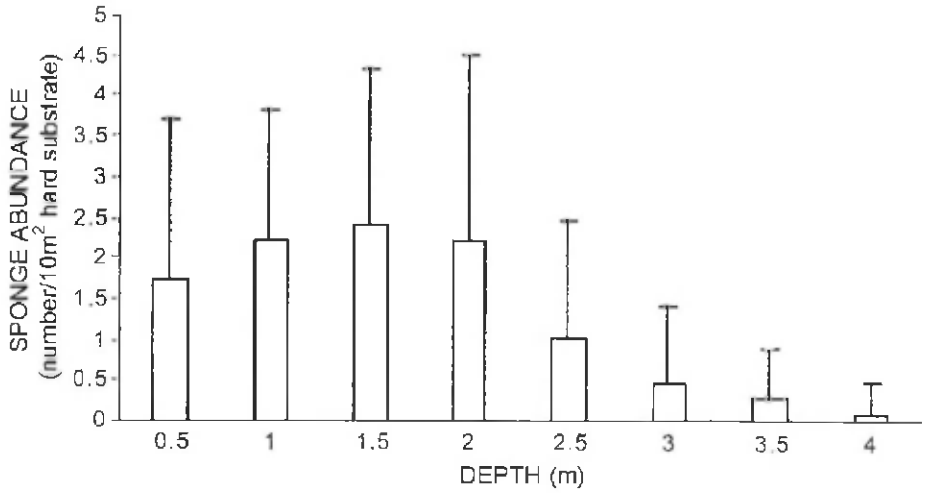

Fig. 10. Depth distribution of *Niphates rowi* in the northern Red Sea.

Paratypes. Massive specimen growing on a dead coral collected on 8 January 1999 in Elat, IUI in 1.5 m depth by J. Gugel (ZMTAU SP25179); massive encrusting specimen collected on 8 January 1999 in Elat, IUI in 1 m depth by J. Gugel (ZMTAU SP25180); massive specimen collected on 8 January 1999 in Elat, IUI in 1.5 m depth by J. Gugel (ZMTAU SP25181); encrusting specimen collected on 7 January 1999 in Elat, IUI in 1 m depth by J. Gugel (ZMA 17082).

Additional material. Preparation of the skeleton of the choanosome, ectosome and spicule preparation of the holotype (ZMTAU SP25154, microscope slides).

Synonymy

Chalinula sp. in Ilan & Loya (1990).

External appearance

Colour in life: surface grey, elevated rim of oscules often whitish, inside beige/light brown. Colour in alcohol: greyish brown. Texture: elastic, rather stiff, feels a bit "oily", difficult to cut in the fresh state. Growth form: crusts until massive growth form (about 2–3 cm thick), irregular outline, average about 10 × 5 cm. Surface more or less smooth (see Ilan & Loya 1990: fig 4).

Oscules: scattered over the surface, they grow with the sponge, i.e. the largest sponge specimens have the largest oscules. "Small oscules" appear more at the edge, about 1–2 cm apart (1.8–4.2 mm in diameter, average 3 mm), while "large oscules" are located near the centre, about 2–3 cm apart (4–7 mm in diameter, average 5 mm). "Double oscules" appear regularly. The rim of the oscules is slightly (1–2.5 mm) chimney-like elevated. The oscules are round with sharp margins.

Skeleton

Choanosomal skeleton: reticulation of spongin fibres cored by oxea. Ascending primaries cored by multispicular tracts of oxea, interconnecting secondaries pauci–unispicular, meshes irregular polygonal (Fig. 11A).

The measurements of fibres and meshes are given in Table 5.

Ectosomal skeleton: often obscured reticulation of unispicular fibres consisting of considerably less spongin than the choanosomal fibres. They are strictly tangential, irregular with wide-spaced meshes (Fig. 11B), often upright spicule brushes on the surface (not comparable with those of *Niphates*). In some specimens less wide spaced and more regular meshes exist or even an almost isodictycal reticulation of spicules enclosed by spongin can be found.

The primaries and secondaries are not distinguishable.

The measurements of fibres and meshes are given in Table 5.

Spicules

Straight, sharp pointed oxea (80–103 ± 7.5–120 × 3–4.3 ± 0.7–5 µm).

Etymology

The species is restricted to shallow coastal waters. "Paralia" in Greek means beach, coast, seashore, etc.

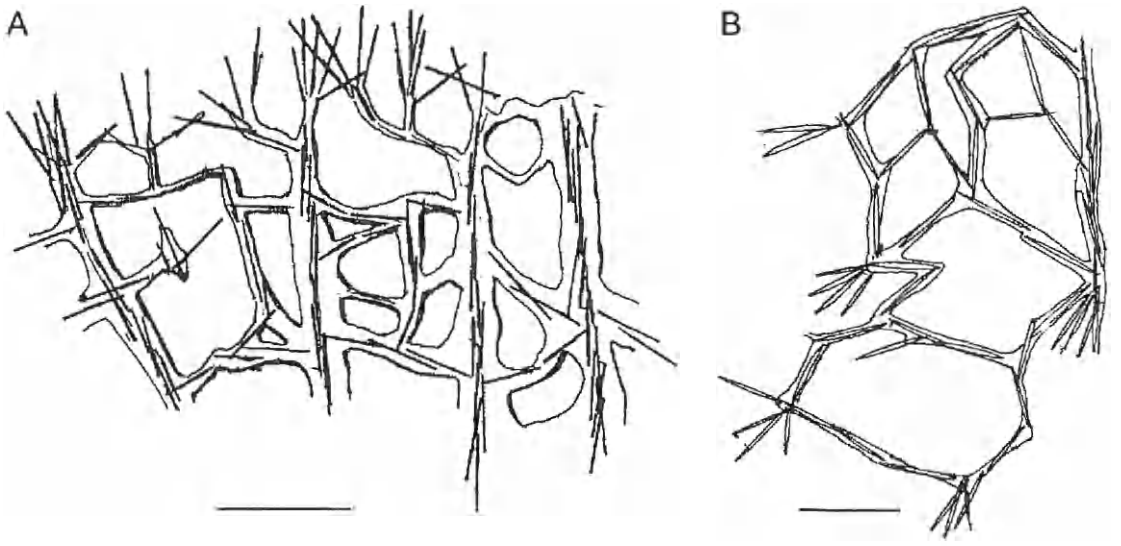

Fig. 11. *Callyspongia paralia* peripheral skeleton. A. Choanosome. B. Ectosome, tangential view. Scale bars 100 µm.

Remarks

It fits with the family diagnosis of Callyspongiidae. It should also be noted that the spicule brushes (although they do not occur in every specimen and not over the entire surface) are not typical for Callyspongiidae except for the *Callyspongia* subgenus *Euplacella*. These spicule brushes are part of the ectosome, not protruding primaries of the choanosome. Within the Callyspongiidae, characters of the skeleton resemble *Siphonochalina* Schmidt, 1868 (Griessinger 1971; Van Soest 1980) except for the outer form. Wiedenmayer (1977) stresses that the peripheral choanosome should be compressed, which is not the case in the present species, but Bergquist & Warne (1980) pointed out that this feature is absent from original diagnoses. On the other hand, the irregularity of both choanosome and ectosome are included in the diagnoses of *Siphonochalina* (Griessinger 1971) and the primaries and secondaries in this genus are not distinguishable in the ectosome (Griessinger 1971; Van Soest 1980).

Table 5. *Callyspongia paralia*, measurements of fibres and meshes.

	Range (µm) n=10	Mean (µm) n=10
Choanosomal meshes (width)	85–180	123
Primaries (diameter)	35–50	44
Secondaries (diameter)	10–25	20
Ectosomal meshes (width)	120–200	157
Fibres (diameter)	10–22.5	16

Ecology

Callyspongia paralia is only distributed in extremely shallow water. The first sponges were found 0.5 m below the water surface. The species was not observed deeper than 3.5 m. The highest abundance was found at a depth between 1 and 2.5 m (Fig. 12).

The preferred substrate was, as in the case of *Niphates rowi*, barren rock, although no preference for vertical walls was found.

Details concerning the reproductive biology of this species were provided by Ilan & Loya (1990).

Siphonochalina siphonella (Lévi, 1965)

Material examined

Holotype. ZMA POR198; several tubes fused together collected on 8 January 1986 in IUI Elat, at 2.5 m depth by M. Ilan (ZMTAU SP25186).

Remarks

Siphonochalina siphonella was originally described by Lévi (1965) from Elat, where the present study of its reproduction was carried out. This species is widely distributed throughout the Gulfs of Aqaba and Suez from shallow water but mostly deeper than 5 m. This species is one of the most widespread sponges in the northern Red Sea.

Reproduction

Histological examination revealed spermatic cysts in

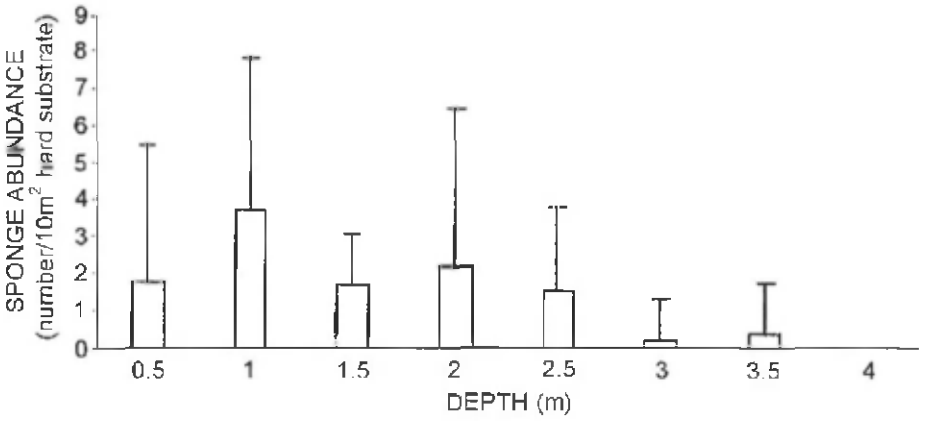

Fig. 12. Depth distribution of *Callyspongia paralia* in the northern Red Sea.

only 5% (n = 19) of the specimens examined. The spermatic cysts (32 ± 12 µm; n = 19) with small primary spermatids were dispersed throughout the choanosome in large quantity. It is assumed that spermatids originate from choanocytes as transitional stages seem to be present within the different spermatic cysts (Fig. 13A).

Oocytes, on the other hand, were detected in most specimens during all seasons, whereas incubated embryos and larvae were seen during October–November. Whereas the oocytes generally remain small, growth occurs mainly during the autumn (October–November). Like the spermatic cysts, the oocytes and embryos are distributed all over the choanosome. Because of their light beige colour that resembles the sponge colour, it is hard to detect them in vivo. *Siphonochalina siphonella* primary oocytes (23 ± 8 µm; n = 18) grow to a final stage (~270 µm) probably by absorption of nurse cells (Fig. 13B–D). Like other haplosclerid sponges, *S. siphonella* is a viviparous species (Fig. 13E, F).

Ecology

This species is often found on manmade constructions in the ocean, from the shallowest (e.g. on floating docks) to deeper water. *Siphonochalina siphonella* is one of the first organisms to settle on such substrates.

Petrosiidae Van Soest 1980

The family was recently reduced to contain four genera including *Petrosia* with its two subgenera (Desqueyroux-Faúndez & Valentine 2002c).

Genus: *Petrosia* Vosmaer, 1885
Type species: *Rayneria dura* (Nardo, 1833) (not examined).

Diagnosis

Petrosiidae with tangential ectosomal unispicular or spicule tracts reticulation usually echinated by smaller category of spicules. Choanosomal skeleton consisting of lamellate isotropic reticulation of spicule tracts and inbetween unispicular reticulation. At least two categories of oxeote or strongylote spicules and usually large ectosomal microxeas (after Desqueyroux-Faúndez & Valentine 2002c).

Petrosia (*Petrosia*) *elephantotus* n. sp.

Material examined

Holotype. Collected on 5 March 1998 in Elat, IUI in shallow water by I. Yfrach (ZMTAU SP25160, voucher No. 072).

Additional material. Spicule preparation from the holotype (ZMTAU SP25160). Holotype of *Haliclona pellasarca* (USNM 22336).

External appearance

Colour in life: surface reddish-brown, inside creamy. Colour in alcohol: greyish, ectosome darker than choanosome.

Rather soft consistency, not elastic, easy to cut, brittle, surface smooth.

Growth form: plate-like crusts, mostly about 2–4 cm thick or fan-shaped of about 2 cm thickness. Often resembling an "elephant ear". Sometimes certain parts of the sponge are fixed crusts and parts of the same specimen are free plates lying on the substrate without fixation.

Very large specimens can reach a size of almost 1 m^2.

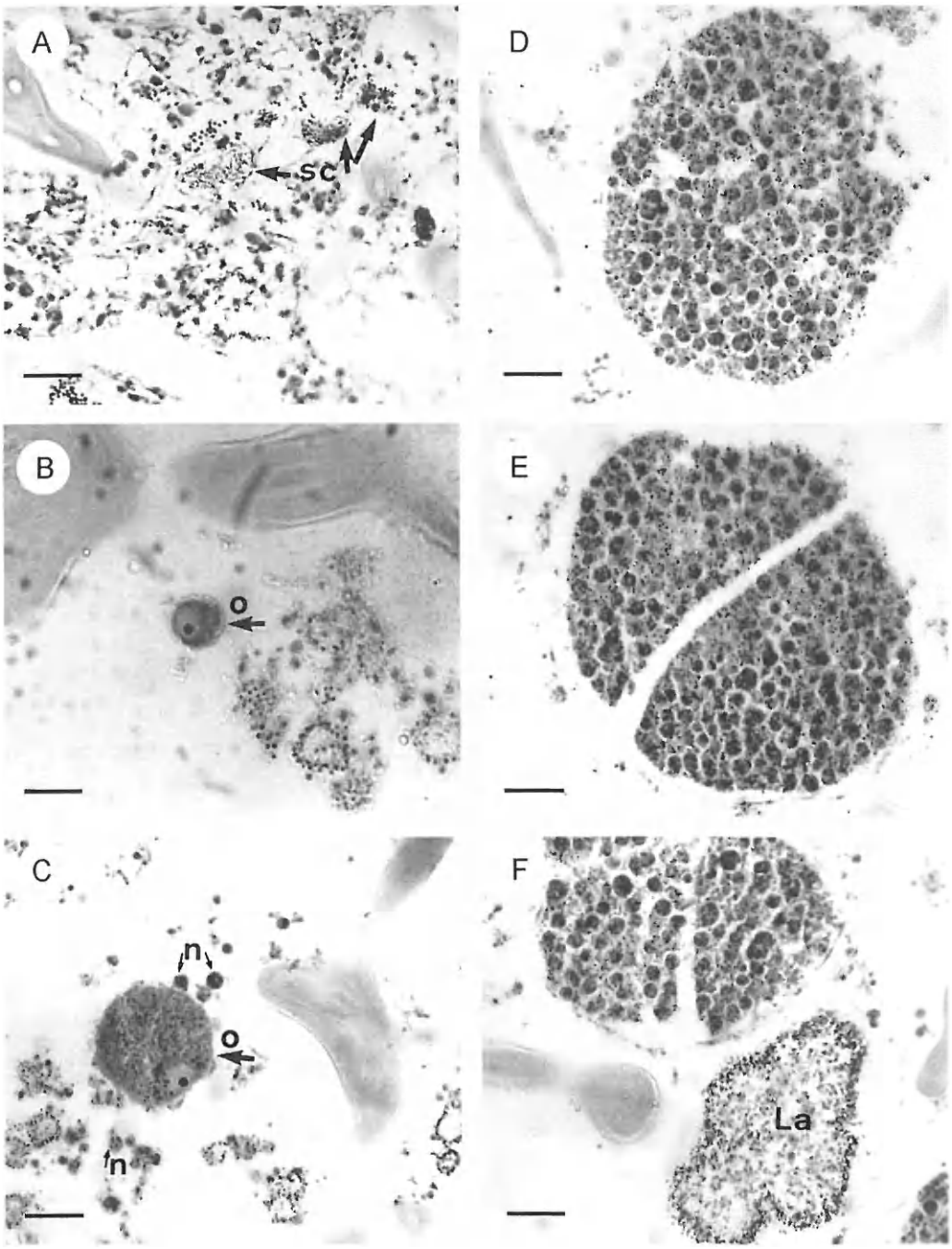

Fig. 13. *Siphonochalina siphonella* reproductive elements. A. Developmental stages of spermatic cysts (sc). B–D. Oocyte development from primary oocyte (B) to mature oocyte (D). Growth is achieved by ingesting nurse cells (n). (E) An incubated embryo after the first cell division. (F) A larva (La) next to an embryo. Scale bar in (A) 25 µm; others 40 µm.

Skeleton

Choanosomal skeleton: reticulation of loose multispicular spicule tracts forming rounded meshes (Fig. 14, width 140–210 µm, mean 173 µm), not as dense as in other species of the genus, which leads to a soft consistency.

In some specimens or certain areas of a specimen, paucispicular tracts are interconnected by single spicules, resulting in an isotropic, almost *Haliclona*-like reticulation (Fig. 14). No distinction exists between primaries and secondaries. The spicules are cemented together by a considerable amount of spongin, but no spongin fibres exist. Many interstitial spicules and immature spicules exist.

Many subectosomal and choanosomal canals, visible with the naked eye.

Ectosomal skeleton: tangential reticulation of single spicules or loose tracts (rarely), reticulation sometimes isotropic but mostly rather irregular, easily detachable.

Spicules

Three size classes of oxea are present. The medium and small oxea occur only in or near the ectosome. All oxea are slender, fusiform spicules, slightly tapering. Strongylote and sometimes stylote oxea occur rarely. The spicules are usually bent and rarely straight. Many medium-sized oxea occur in the skeleton, probably immature large oxea, the small and medium oxea differ from the large (principal) oxea in size but not in shape. Spicule measurements are given in Table 6.

Etymology

For the frequent growth form that resembles an elephant ear.

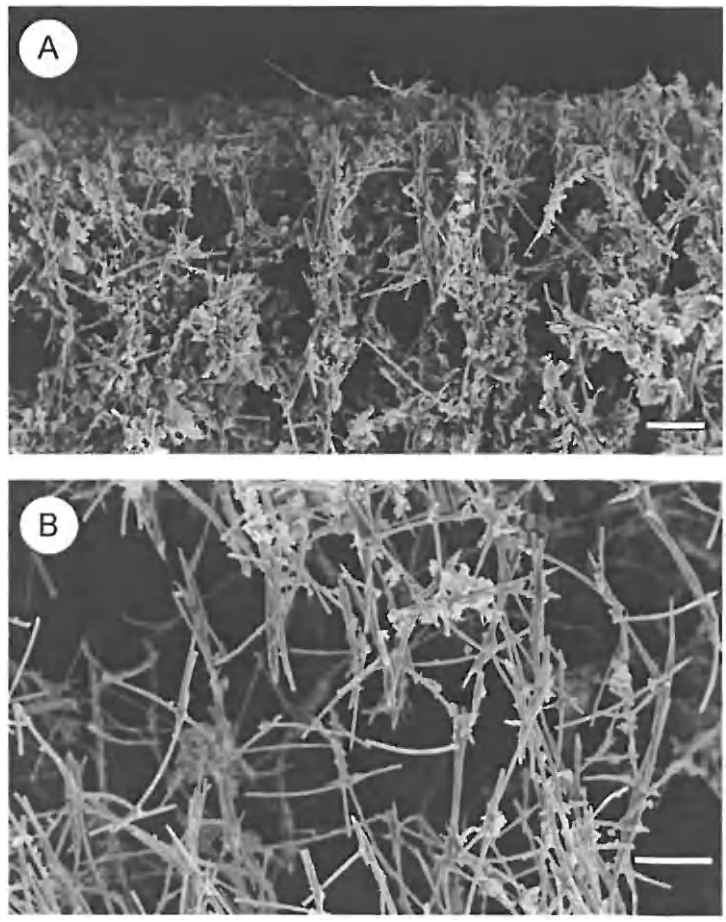

Fig. 14. *Petrosia elephantotus* skeletal elements. A. Peripheral skeleton. B. Very loose choanosomal reticulation. Scale bars 100 µm.

Table 6. *Petrosia elephantotus*, spicule measurements.

Spicule type	Length, range (µm), n = 50	Length, mean ± SD (µm), n = 50	Width, range (µm), n = 10	Width, mean ± SD (µm), n = 10
Large oxea	190–240	220 ± 12	4.5–5.2	4.8 ± 0.2
Medium oxea	60–140	83.5 ± 19	2.2–2.8	2.5 ± 0.2
Small oxea	25–55	35.8 ± 7.4	1.2–2.0	

SD – standard deviation.

Remarks

Assignment of the present species to *Petrosia* subgenus *Petrosia* is mainly justified through the presence of three size classes of oxea. This species resembles a Caribbean species: *Haliclona pellasarca* de Laubenfels, 1934. Examination of the holotype of the latter species revealed that it also has oxea of three size categories, and not only the single size class as reported in the original description (de Laubenfels 1934). Lehnert & Van Soest (1996) assigned *H. pellasarca* to *Petrosia* and they too found additional size classes of rare oxea. The present *Petrosia* species differs from *P. pellasarca* and from most other described *Petrosia* species in the size of the largest spicules. In addition, *P. pellasarca* has been reported in water deeper than 20 m (de Laubenfels 1934; Lehnert & Van Soest 1996, 1998). In contrast, the present species is (so far) known only from shallow water. Both these species, *P. pellasarca* and *P. elephantotus*, also share the presence of a *Haliclona*-like skeletal architecture. In *P. pellasarca*, however, this seems to be always the case, whereas in *P. elephantotus* it exists only in part of the skeleton.

The reproduction of this species was not examined.

DISCUSSION

This small collection contributes to our knowledge of Red Sea sponge fauna. At least two of the species of this collection show close morphological similarities with Caribbean species (*Petrosia elephantotus* with *P. pellasarca* de Laubenfels, 1934, and *Amphimedon chloros* with *A. viridis* Duchassaing & Michelotti 1864). Because such disjunct distribution is unlikely, it indicates the unreliability in many cases of focusing solely on the morphology of a species. This is especially true for the so-called "cosmopolitan" species as determined by the present relatively conservative traditional systematics. Ecological and molecular data can contribute to resolving this problem (Knowlton 2000).

ENDEMISM

The six new species described in this study join one of the three other species mentioned here, all of which are reported as endemic to the Red Sea (or even just to the Gulf of Aqaba). These species belong to the high proportion (nearly 50%) of endemic species found upon examining the entire list of over 250 sponge species described from this region [Row (1911) recorded 186 species based on his works and those of Carter, Keller, Topsent and Schulze, Lévi (1958, 1965) added 63, Burton (1926, 1952) added five species, Kelly-Borges & Vacelet (1995) three to four additional species and Wörheide (1998) another one. Overall, 258 recorded species (excluding only hexactinellids) of which several have later been synonymized with other species etc.]. In comparison, of nearly 300 scleractinian corals found in the same region, only 18 species (6%) are thought to be endemic to the Red Sea (Veron 2000). This apparent difference is probably due to the comparatively small number of broad-based taxonomic studies that examined sponges from the Indian Ocean, especially along the African coasts (with the exception of Madagascar, the Seychelles, and Zanzibar). In addition, since the monumental studies of Row (1909, 1911) and Lévi (1958, 1965), no comprehensive study has examined the Red Sea sponge record, and since then much of the taxonomic status and the geographical distribution of the species has changed. It is thus reasonable to assume that the true endemism level among Red Sea sponges is much lower than the reported one.

REPRODUCTION

The size of *T. swinhoei* oocytes is among the smallest known in the Porifera (Fell 1983). However, because the mean oocyte size was not observed to change throughout their existence, this may indicate that it is their final size upon release. Embryos of *A. chloros* are within the size range of other larvae within the order Haplosclerida, whereas those of *S. siphonella* are relatively small.

The apparently low number of individuals active in sexual reproduction found within *A. chloros* is probably compensated by the asexual reproduction achieved by its special growth, which enables asexual reproduction via fission of established sponges. The absence of spermatic cysts in several of the species examined might be due to the low proportion of males in the population, or because of rapid sperm development that eluded the sampling. In the Caribbean *Neofibularia nolitangere*, for example, sperm develop and are released within 7 days (Hoppe & Reichert 1987). Because the study was carried out at the northern tip of the Red Sea, for most species this is the northern limit of the species' geographical distribution. The

temperatures may therefore be too low for production of sperm, whereas established sponges can survive in these temperatures. If this is the case, then sponges are expected to be recruited from other reproducing populations further south in the Red Sea.

The results regarding the sex ratio in *S. siphonella* may indicate either many more females in the population or rapid spermatic cyst development. Moreover, although within the individuals with spermatic cysts no oocytes were found, hermaphroditism (as found within most other haplosclerid sponges) cannot be ruled out.

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