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On sand-bearing myxillid sponges, with a description of *Psammochela tutiae* sp. nov. (Poecilosclerida, Myxillina) from the northern Moluccas, Indonesia

NICOLE J. DE VOOGD
Netherlands Centre for Biodiversity Naturalis, 2300 RA Leiden, the Netherlands.
E-mail: Nicole.deVoogd@ncbnaturalis.nl

Abstract

Sand-bearing sponges belonging to the suborder Myxillina are mainly observed in South Australia. Recent biodiversity surveys in Indonesia yielded several of these sand-bearing sponges belonging to three different genera, *Chondropsis*, *Desmapsamma* and *Psammochela*. These sponges are distributed across three different families and the ecological and evolutionary implications for the incorporation of sand and detritus in the skeleton remain unresolved so far. In the present paper *Psammochela tutiae* sp.nov. (Poecilosclerida: Myxillina: Myxillidae) is described from the northern Moluccas, Indonesia. The new species is compared with all other (five) *Psammochela* species occurring in the Indo-West Pacific. The new species differs from the other species by overall morphology, absence of polydentate chelae and presence of thin strongylote megascleres. The current position of *Psammochela* within the Myxillidae and its relation to other arenaceous Myxillina are discussed here, and an identification key to all known species of *Psammochela* is given.

Key words: Porifera, Myxillidae, sand-sponges, Indo-West Pacific, new species

Introduction

Scientific museum collections are ideal tools for detecting long-term changes in biodiversity, especially if the specimens are well-curated and accompanied by reliable documentation on locality and time of collecting (Hoeksema *et al.*, 2011). At present such specimens can be important as reference material for historical studies of marine biota, especially in relation to the mortality and possible local extinction of coral reef species as an effect of the El Niño Southern Oscillation (ENSO) events. For the recognition of global change signals and rational choice of indicator taxa, a solid historical baseline is needed (Hoeksema & Koh, 2009; van der Meij *et al.*, 2010; de Voogd & van Soest, 2010; Hoeksema *et al.*, 2011). This may be achieved by the compilation of reliable and validated Indonesian biodiversity data as far back in time as possible. Some Indonesian coral reefs were extensively studied during the past 125 years, especially during expeditions covering major animal and plant groups. One of those collections was made a little bit over a century ago by the German professor Kükenthal who sailed the Moluccas seas and collected about 100 sponges near the island of Ternate. The collection was described by Kieschnick (1896) and revised by Thiele (1900, 1903). These papers are still the most important works on sponge taxonomy from Indonesia, with a total of 51 new species (de Voogd & van Soest, 2010). Some of these species can be found around the coral reefs of the Indonesian archipelago and beyond (i.e. *Petrosia strongylata*, *Penares sollasi*), while others have never been reported since their descriptions. In 2009 a marine biodiversity survey was done during which I was able to investigate the reefs around Ternate. This effort yielded a collection of over 300 specimens, many of which were not observed during the earlier collections by Kükenthal.

An interesting sand-bearing sponge was observed at three different sites near the island of Ternate which bears affinities to *Chondropsis* (Chondropsidae), *Desmapsamma* (Desmacididae) and *Psammochela* (Myxillidae). Sand-bearing sponges are distributed across different sponge orders (Haplosclerida, Poecilosclerida, Dictyoceratida), but they are most striking in the order Poecilosclerida where foreign debris partially replaces siliceous spicules. It is especially common within the suborder Myxillina, where it is observed in almost all families, however, the importance of sand incorporation cannot be used as a discriminating character above genus level (van Soest, 2002).

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Sand-sponges are most frequent in the families Chondropsidae and Myxillidae and the distinction between these two families is mostly based on the orientation of the skeleton, respectively being plumose or reticulate, and the presence of either arcuate or anchorate chelae. The genus *Chondropsis* (Chondropsidae) was erected in 1886 by Carter, receiving sand sponges with a skeleton cored by foreign material and strongyles, sigmas and arcuate or unguiferate chelae. These species all have thin strongyles, and some may have very thin sigmas in addition. The genus *Psammochela* was erected in 1916 by Arthur Dendy, receiving Desmacididae (sensu Dendy, which comprised a large portion of what is now considered the order Poecilosclerida) with a reticulate skeleton composed of sandy and sometimes partly spicular fibres, with megascleres consisting of styles, strongyles or both (see van Soest, 2002). Interestingly, another genus within the Myxillina bears striking similarities with *Psammochela* where the skeleton is partially replaced by foreign material together with a similar set of spicule morphologies. The sand-bearing *Desmapsamma* Burton, 1934 (Desmacididae) differ from *Psammochela* in having exclusively oxeote megascleres, but share the combination of sigmas and anchorate and/or unguiferate tridentate chelae. In the present paper I place the new Indonesian species in *Psammochela* and compare it with the other known species in the genus. In addition I discuss the relation of *Psammochela* to other sand-bearing species within the Myxillina, and provide an identification key to all known species in the former.

Material & Methods

The specimens described below were collected in the northen Moluccas, Indonesia using SCUBA in November 2009. The specimens are preserved in 70 % ethanol and deposited in the sponge collection of the Netherlands Centre for Biodiversity Naturalis (RMNH). The descriptions presented below are based on external morphology, skeletal architecture and shape and size of the spicules. Spicule dimensions are given as range of length measurements x range of width measurements of 20 spicule measurements (when possible) for each type and size category. For study of the skeletal architecture hand-cut tangential sections of the ectosome and perpendicular sections of the choanosome were made. The sections were air-dried, mounted in Ultrabed on a microscope slide, and studied under a Leitz high power light microscope. Spicule preparations were made by dissolving a small piece of the specimen in 60% nitric acid (HNO_3), after which the residue was rinsed four times with water, once with 96% ethanol. The spicules were air-dried on microscopic slides and prepared for study with the light microscope by mounting them in Ultrabed, as well as put on aluminium stubs and coated with gold for study with a Jeol Scanning Electron Microscope (SEM). Abbreviations used in the present paper are BMNH (Natural History Museum, London, United Kingdom), RMNH (Naturalis, Leiden, the Netherlands) ZMA (Zoological Museum of Amsterdam, the Netherlands), ZMB (Museum für Naturkunde und der Universität Humbolt zu Berlin, Berlin, Germany).

The classification used here follows the Systema Porifera (Hooper & Van Soest, 2002).

Results & Discussion

Systematic description

Order Poecilosclerida

Suborder Myxillina

Family Myxillidae Dendy, 1922

Genus *Psammochela* Dendy, 1916

Psammochela tutiae sp. nov.

(Fig. 1A–D, 2A–E)

Material examined. Holotype RMNH POR. 5490, Indonesia, Halmahera mainland Tanjung Sidangolo, stat TER.020, N 0°53'39.6", E 127°29'28.1", 05-11-2009, depth 27 m. Fieldnr #TER20/051109/241, coll. Y. Tuti

Paratypes: RMNH POR. 5509, Indonesia, Halmahera, Ternate Sulamadah I., stat TER.022, N 0°52'3.6", E 127°19'33.1", 06-11-2009, depth 20 m, Fieldnr #TER22/061109/260, coll. K. van Egmond; RMNH POR. 5475 Indonesia, Halmahera, Tidore SW of Tobala, stat TER.019, N 0°44'56.6", E 127°23'13.5", 04-11-2009, depth 30 m, Fieldnr #TER19/041109/226, coll. K. van Egmond.

Other Material examined: *Psammochela rigida* (Bowerbank, 1875), unreg. type BMNH (as *Halichondria rigida*). *Psammochela fibrosa* (Ridley, 1884), unreg. type BMNH (as *Phoriospongia fibrosa*), Torres Strait, Northern Great Barrier Reef. *Psammochela elegans* Dendy, 1916, Lectotype BMNH 1920.12.9.36, Indian Ocean, India. *Psammochela chaliniformis* (Dendy, 1896), BMNH 1886:12:15:341 (as *Dysidea chaliniformis*). *Psammochela psammodes* (Hentschel, 1911), Holotype ZMB 4414 (as *Desmacidon psammodes*). *Psammochela psammodes*, ZMA POR. 9463, Snellius II, 14.10.1984, Indonesia, Sulawesi, NE Take Bone Rate, stn. 222, 06°31.5' S 121°08' E, 58 m, coll. R.W.M. van Soest. *Psammochela elegans*, ZMA POR. 9053, Snellius II 16.09.1984, Indonesia, Nusa Tenggara, NE Coast of Sumba, stn. 068, 09°57' S 120°48' E, light red, sandy bottom with sponges and gorgonians, dredged at 50 m, coll. R.W.M. van Soest.

Description. Shape: The holotype consists of a part of a larger specimen (see fig. 1a and 1b). The specimen is bushy with anastomosing thorny branches with pointy endings. Raised oscules (diameter of 2–5 mm) along one side of the branch every 2–3 cm. The surface is irregularly rugose and smooth in between and the ectosomal reticulation is clearly visible in live and preserved specimens. Colour is pale salmon pink to light orange alive, grayish in spirit. The texture is compressible, brittle.

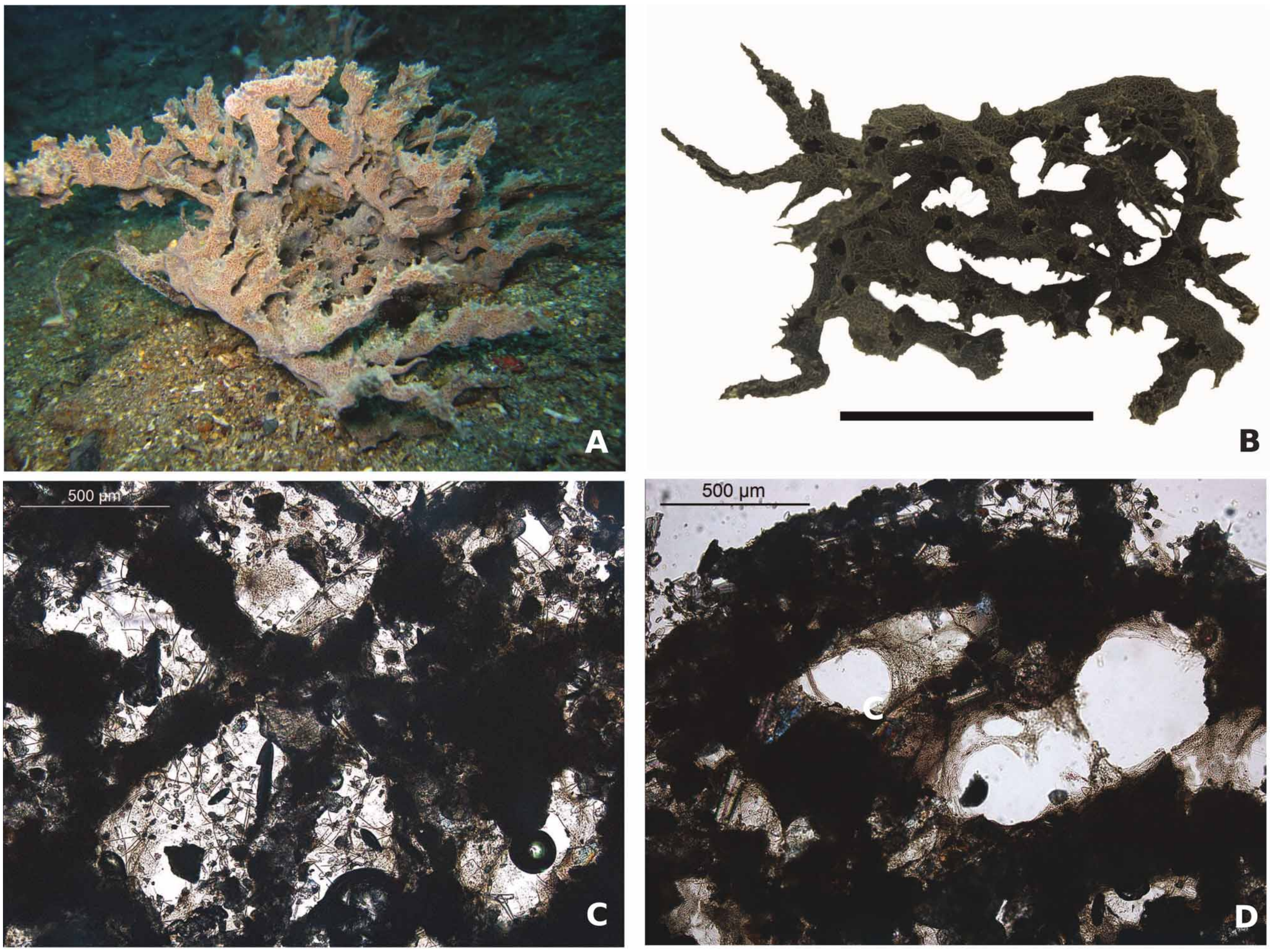

FIGURE 1. A, *Psammochela tutiae* sp.nov., in situ photograph of holotype (photo Y. Tuti); B, preserved specimen (scale bar 5 cm); C, Light micrograph of ectosomal skeleton; D, Light micrograph of choanosomal skeleton.

Skeleton. Ectosomal skeleton consists of a large irregular meshed reticulation outlined by large sand grains, other foreign material and thin strongyles, meshes 0.4–1 cm in diameter with few microscleres in the soft tissue between the fibres. Choanosomal skeleton is an isotropic to irregular reticulation of spicule tracts mixed with foreign material. The mega-and microscleres are obscured by the large size of the foreign materials.

TABLE 1. Comparison of spicule dimensions (µm) among specimens of *Psammochela tutiae*.

Specimen	*Locality*	*Strongyles*	*Sigma I*	*Sigma II*	*chelae*
RMNH 5409*	Halmahera	125–142 x 2.5	25–32.5	12.5–20	15–17.5
RMNH 5509	Ternate	120–140 x 2.5	27.5–40	15–20	17.5–20
RMNH 5475	Tidore	137.5–155 x 2.5	30–35	15–17.5	15–17.5

* holotype

Spicules. Thin strongyles (120–155 x 2.5 µm), two sizes of sigmas (I 25–40 µm; II 12.5–20 µm) and spatulate and/or equianchorate chelae (15–20 µm) (see table 1 and fig. 2).

Ecology. Reef slopes and sandy bottom 10–40 m deep.

Geographic distribution. Specimens were found near the island of Ternate, Tidore & Halmahera in the northern Moluccas, Indonesia.

Etymology. *Psammochela tutiae* is named after Ir. Yosephine Tuti, who collected and photographed the type specimen. She is also acknowledged for all the logistic support provided in the past years to make our biodiversity studies in Indonesia possible.

FIGURE 2. *Psammochela tutiae* sp.nov. Scanning electron micrographies of spicules made from the holotype and paratype. A, Strongyle; B, Anchorate chelae RMNH 5509; C, RMNH 5490; D, Sigma I; E, sigma II (scale bars 10 µm, except B, C 5 µm)

Psammochela tutiae is characterized by its bushy growth form, thin strongyles and absence of polydentate chelae. Only five other species belonging to *Psammochela* are presently recognized: *P. rigida* (Bowerbank, 1875) from the Strait of Malacca, *P. fibrosa* (Ridley, 1884) from NW Australia, *P. chaliniformis* (Carter, 1885) from South Australia, *P. elegans* (Dendy, 1916) from NW India and *P. psammodes* (Hentschel, 1911) from SW Australia. For the present study I re-examined the type specimens of all species and discovered some crucial differences in spicule combination and dimensions deviating from the original descriptions. In addition I examined as comparative material some recent specimens deposited at the Zoological Museum of Amsterdam from Indonesia (Table 2 & Fig. 3). The type specimens of *P. elegans* and *P. chaliniformis* have already been depicted and discussed in the recent revision of the classification of sponges (van Soest, 2002a:618, fig.11), however the spicule measurements deviated somewhat from the present ones (see table 2). *Psammochela chaliniformis* is very different from the other *Psammochela* species; the megascleres are completely replaced by sand grains and it has only polydentate unguiferate isochelae. These chelae differ subtly from those in other species: the shaft is rather straight and the alae are shorter, more numerous and pointy (fig.3 and Van Soest, 2002a:618, fig.11L). Although Burton

TABLE 2. Comparison of spicule dimensions (µm) among species of *Psammochela*

specimen	source	megasclers	Sigma I	Sigma II	Chelae I Anchorate	Chelae II polydentate
*P. rigida**	b	Styles 150–175 x 5–6	30–40	11–15	20–22.5	9–11
*P. fibrosa**	a	Styles 160–190	32	-	22	-
*P. fibrosa**	b	(aniso) Strongyles 140–155 x5	30–37.5	10–12.5	17.5– 22.5	8–10
*P. chaliniformis**	c	-	-	-	-	10–12
	b				-	12.5–17.5
*P.elegans**	a	Styles (strongylote)160 x 5–	33	12	24	12
*P.elegans**	b	Styles 145–160 x 5	30–37.5	10–15	21.5–22.5	10–12.5
*P.elegans**	c	Styles 160 x 5–7	50	12	24–25	12
ZMA.9053	b	Styles 155–180 x 5	30–35	10	20–22.5	8
*P. psammodes**	a	(aniso) Strongyles 136–166	25–32	10–12	15–17	9–10
*P. psammodes**	b	(aniso) Strongyles 145–175 x 2.5	25–30	10–12.5	13–17.5	8–12.5
ZMA.9463	b	(aniso) Strongyles 160–175	25–35	12.5–17.5	13–17.5	10–12.5

*type species. Abbreviations: a) original description, b) present study, c) van Soest, 2002

(1934) synonymized *P. elegans* with *P. fibrosa*, there are some clear differences between the two species. Strangely enough, the original description by Ridley misses the small polydentate chelae and the second category of sigmas. More importantly, the megascleres consist of strongyles and aniso(strongyles) instead of styles (Fig.3d). He might have confused alien styles as real megascleres. This species is therefore more related to *P. psammodes*, but the latter species has smaller microscleres (both sigmas and chelae) and I believe that both *P. elegans* and *P. fibrosa* are valid species. *P. rigida* was described by Bowerbank (1875) from the Strait of Malacca as a *Halichondria*, and he described 'tension spicule acuate' (=styles); rather numerous 'bihamate spicula' (=sigmas), simple and contort, rare, rather stout 'bidentate equianchorates' (=anchorate chelae). The sponge itself is massive and the surface is rugged, uneven and full of ridges and depressions. After examining the type of *P. rigida*, I conclude that it is very similar to *P. elegans* and might be a senior synonym of *P. elegans*. The type localities of both are also close to each other (NE India and Strait of Malacca). The shapes of all type specimens were more or less similar, being massive to irregularly shaped with digitate processes. The ectosomal skeletons of all specimens are also very similar having a tight meshed reticulation of fine sand grains and can therefore not be used as distinguishing character among species (Fig. 3G, I). Species belonging to *Psammochela* are not often observed during biodiversity surveys and the specimens collected during the present study show some variation in the abundance of the microscleres as often observed in some Poecilosclerid sponges. For instance, paratype RMNH POR.5475 has only few chelae in contrast with the other specimens, thus showing the difficulty in identifying this species despite its very characteristic outer

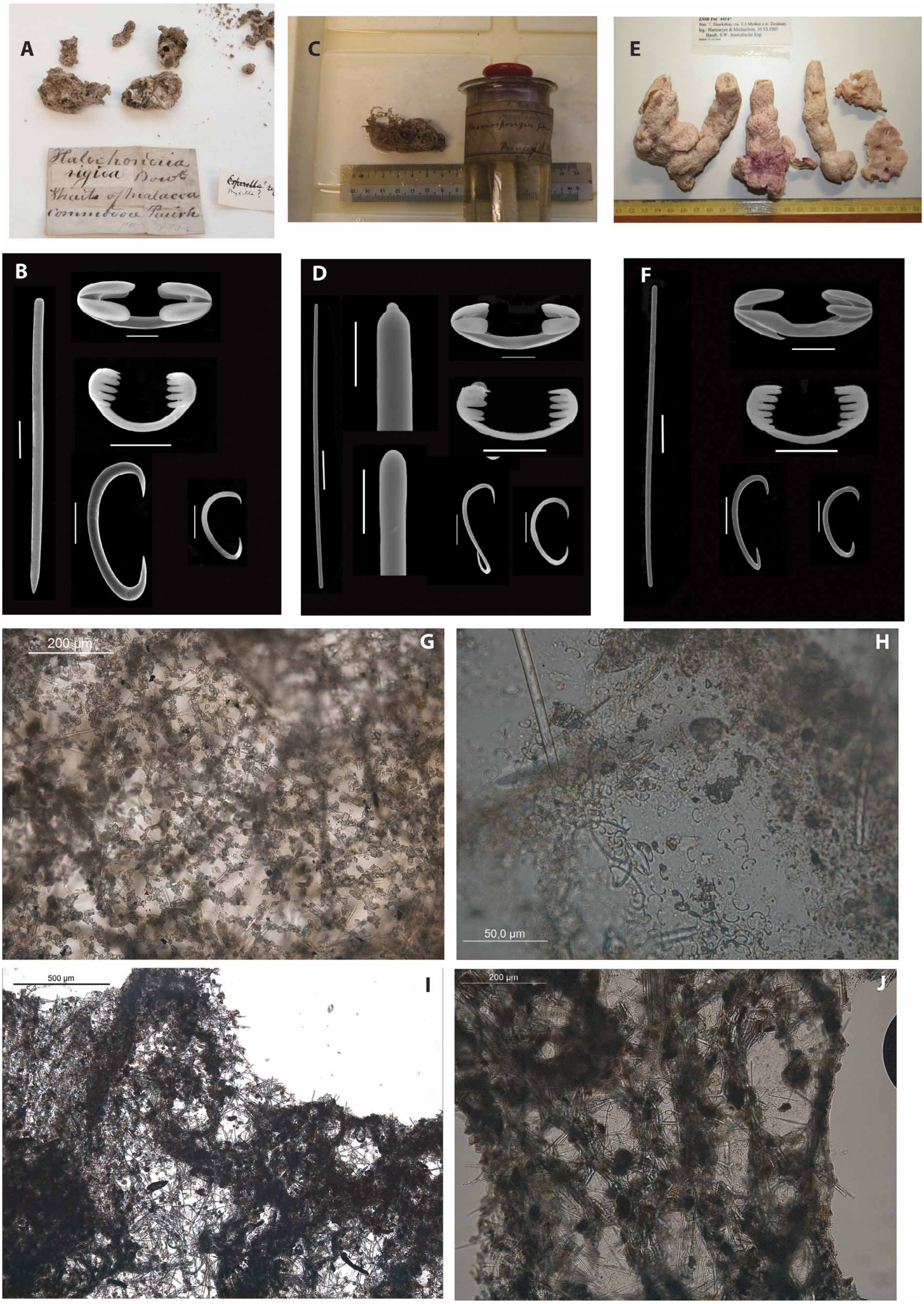

FIGURE 3. A–B, Unreg. type BMNH *Psammochela rigida* (Bowerbank, 1875 as *Halichondria*); C–D, unreg. type BMNH *Psammochela fibrosa* (Ridley, 1884 as *Phoriospongia*); E–F, ZMB 4414 *Psammochela psammodes* (Hentschel, 1911 as *Desmacidon*) (scale bars SEM, strongyle & style 20 µm; sigma I 10 µm; chelae, sigma II, tip strongyle 5 µm; G–J, Light micrographies. G, Ectosomal skeleton and H, choanosomal skeleton of *P. elegans;* I *Psammochela psammodes* ectosomal skeleton, J, choanosomal skeleton.

morphology. The polydentate chelae were observed in all species, except in *P. tutiae* sp. nov., and are very numerous in the interstitial membranes of the choanosomal skeleton together with the sigmas. On the other hand, all species have spatulate anchorate chelae, characteristic of the Myxillidae, but these are not very numerous and are hard to detect among the foreign material. A striking similarity is observed in the species *Desmapsamma vervoorti* Van Soest, 1998 and *Psammochela elegans*. The species cannot be distinguished by the outer morphology and the same holds true for both the ectosomal and choanosomal skeleton. The only difference lies in the morphology of the spicules; *Desmapsamma vervoorti* has exclusively hastate oxeote megascleres and two sizes of anchorate chelae and sigmas, but lacks polydentate chelae.

The species, *P. fibrosa*, *P. psammodes* and *P. tutiae* sp. nov. share thin strongyles also observed with *Chondropsis*, but the present species all have chelae. Looking more closely at *Chondropsis*, of the 13 species currently assigned to the genus, only *Chondropsis australis* (as *Desmacidon australis*) contains reduced thin isochelae (van Soest 2002b), but this species clearly has an irregular plumose arrangement characteristic for the Chondropsidae. In contrast, the six species united here under *Psammochela* share the presence of a reticulate skeleton of sand grains and/or of megascleres and anchorate chelae and/or polydentate chelae. In other respects they show considerable differences and their relationships with members of the Chondropsidae and Desmacididae remains unclear. Further research on evolutionary signal contained in different classes of morphological characters (e.g. Hajdu & Van Soest, 1996) coupled to the search for molecular markers may eventually yield more objective criteria for decisions on which competing character states may best direct genus assignments in the sand-sponges.

Identification key for species of *Psammochela*

1. Skeleton is composed only of sand grains and polydentate chelae . . . . *P. chaliniformis*
   Skeleton is composed of sand grains, megascleres, sigmas and chelae 2
2. Megascleres are styles . . . . *P. rigida*
   Megascleres are (aniso) strongyles 3
3. Strongyles, 2 types of sigmas and anchorate chelae . . . . *P. tutiae*
   Strongyles, 2 types of sigmas, anchorate and polydentate chelae 4
4. Strongyles up to 175 µm, sigma type I between 25–30 µm . . . . *P. psammodes*
   Strongyles up to155 µm, sigma type I between 30–37.5 µm . . . . *P. fibrosa*

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