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A NEW SPECIES OF TOXIC MARINE SPONGE (PORIFERA: DEMOSPONGIAE: POECILOSCLERIDA) FROM NORTHWEST AUSTRALIA.

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ABSTRACT

A new species of marine sponge, *Biemna saucia* sp.nov., belonging to the order Poecilosclerida, family Desmacellidae, is described from NW Australian coastal waters. It is compared with other desmacellids from Australasia, bringing the total number of species of *Biemna* known for this region to 14. The species contains a chemical irritant (p-hydroxybenzaldehyde), which is suspected to contribute to the contact allergic response, previously only known to occur in the related genus *Neofibularia*.

KEYWORDS: Porifera, Demospongiae, Poecilosclerida, Desmacellidae, *Biemna*, new species, Timor Sea, Indian Ocean, taxonomy, toxic sponge, chemical irritant.

INTRODUCTION

In 1982 a SCUBA diver in Northern Territory waters first reported contracting a severe dermatitis reaction from handling sponges. Several other cases were reported subsequently. The species of sponge thought to be responsible for this contact allergic reaction was isolated, and its identity was confirmed by experimental application of sponge fragments and mucus onto human tissue, producing erythema. Biochemical analysis of the sponge isolated a toxic metabolite (p-hydroxybenzaldehyde), thought to be the causal agent of the contact allergic response (Hodder *et al.* 1991). This compound has not been reported previously from marine sponges, although it is known to occur naturally in marine algae and bacteria.

Symptoms of the allergic response included marked inflammation and severe itching of the skin soon after contact with the sponge, followed by swelling and pain to the affected area. Divers also reported mild toxic reactions following physical disturbance to the fragile "colonies" of the sponge, i.e. without direct contact with the sponge, probably caused by sponge exudate suspended in the water column. This exudate, which probably also includes suspended spicules, appears to be able to penetrate through or under lycra, thin neoprene wet suits and gloves. Symptoms of direct contact may last for up to two hours, although the application of a salve (e.g. 1% butamben picrate) is useful in reducing the allergic reaction.

Several other species of sponges are well documented as being chemically toxic, including two Australian species of the closely related genus *Neofibularia*. Southcott (1987) provides a summary of these species and symptoms they produce. The present paper provides a description of the toxic sponge. Further details on the chemical structure of the irritant and the symptoms it produces are given by Hodder *et al.* (1991).

METHODS

Sponges were collected by SCUBA in the Darwin region, and by trawling on the Northwest Shelf of WA. Methods of spicule preparation for light and scanning electron microscopy are described elsewhere (Hooper 1986). Measurements of spicules provided here are based on 25 spicules of each category for each individual, and expressed as range (and mean) of length x width. Abbreviations used in the text: NTM, Northern Territory Museum, Darwin; NWS, Northwest Shelf, WA; SMF, Natur-Museum und Forschungsinstitut Senckenberg, Frankfurt.

SYSTEMATICS

Family Desmacellidae Ridley and Dendy
Genus *Biemna* Gray

Biemna saucia sp.nov.
(Figs 1-18, Table 1)

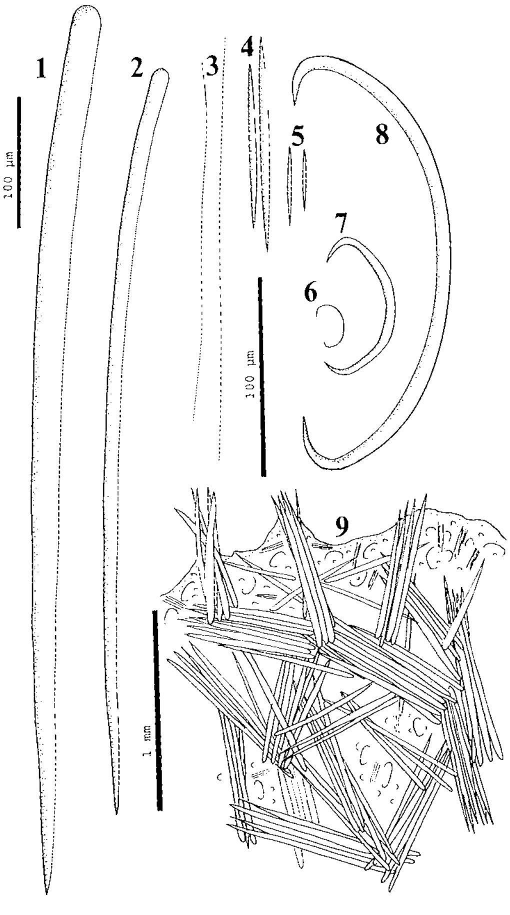
Type material. HOLOTYPE - NTM Z2644: "Sponge Gardens", East Point Marine Reserve, Darwin, NT, 12°24.5'S, 130°48.0'E, 12m depth, 3 April 1986, coll. J.N.A. Hooper and D. Low Choy (stn. EP28), SCUBA. PARATYPE - NTM Z2626: same locality.

Additional material. NTM Z0896: same locality, 12°25.0'S, 130°48.04'E, 10m depth, 31 August 1982, coll. J.N.A. Hooper (stn. EP8), SCUBA. NTM Z2060: same locality, 6m depth, 10 May 1984 (stn. EP14). NTM Z3015: N of Bedout I., NW of Amphinome Shoals, NWS, WA, 19°09.6'S, 118°56.6'E, 74m depth, 19 August 1987, coll. J.N.A. Hooper, RV "Akademik Oparin" (stn. NWS54), beam trawl.

Ecology. Not abundant. Found on shallow water subtidal reefs, 6-20m depth, usually at the base of laterite rock outcrops, partially buried in sand (Fig. 10). Known depth distribution extends to 74m, on broken rock or dead coral reefs.

Distribution. This species appears to be endemic to NW Australia, extending from the Port Hedland region, WA (19°S, 119°E), to the Darwin region, NT (12°S, 131°E). The species has not yet been recorded east of Arnhem Land, despite recent surveys of the Cobourg Peninsula (11°S, 132°E) and Wessel Islands regions (11°S, 136°E).

Description. Shape and surface features: Massive, fibrous, vaguely cylindrical base, partially burrowed into sand substrate, usually with fragments of rock, coral or other debris embedded within the basal portion. Arising from the base are numerous erect fibrous digits, each with many plumose lateral processes (Fig. 10). Some digits are completely free, tapering towards the apex, giving the sponge an extremely fibrous-hispid appearance, but in most cases lateral processes are fused between adjacent digits, producing an open-reticulate consistency. The overall appearance of the sponge is shaggy-digitate and delicate. This general morphology is distinctive and easily recognizable in the field. Basal diameter of the described material ranges from 100-350mm, although one sighting of the species (with nearly 600mm basal diameter) suggests that it can grow substantially larger. Surface digits range from very small (9-20mm long) with minute lateral processes (1-3mm long), to rela-



Figs 1-9. Spicules of *Biemna saucia* sp.nov. **1**, large choanosomal style; **2**, small choanosomal style; **3**, raphides; **4**, large microxeas (I); **5**, small microxeas (II); **6**, small sigma (III); **7**, medium sigma (II); **8**, large sigma (I); **9**, section through peripheral skeleton.

tively large and thick (100-180mm x 20-80mm), with small lateral processes (up to 8mm long).

Oscules: The surface is excavated by small (1-2mm diameter) and large pores (up to 8mm diameter), which are scattered over digits.

Colour: Live colouration was typically pale yellow-beige (Munsell 2.5Y 8/6-8/8), although several near-white or nearly yellow-brown individuals have also been seen in Darwin Harbour. Pigmentation in ethanol is similar to that in life.

Texture: The sponge has a distinctive fibrous stringy texture. Its fragile *Halichondria*-like consistency reflects the low spongin content of the skeleton, which permits easy fragmentation upon physical contact.

Ectosome: Surface is membraneous, without specialized regional spiculation. A prominent feature of the peripheral skeleton is the occurrence of spicule bundles standing erect on the surface (Fig. 9). These bundles are composed of up to 25 tracts of choanosomal styles and form the lateral processes on digits described above. They occur at irregular intervals, 300-1000µm apart, and may extend up to 700µm from the surface. Between these erect bundles there are single spicules or spicule bundles orientated more tangentially to the surface. A thin layer of light brown, granular, collagenous spongin forms the ectosome proper, coating the outer surface of the peripheral skeleton, including the protruding spicule bundles, and this layer of enhanced collagen deposition contains abundant microscleres.

Choanosome: The choanosomal skeleton can be described as reneiroid reticulate near the periphery, becoming vaguely halichondroid-reticulate near the axis (Figs 11-12). Towards the periphery the skeletal tracts form discrete bundles, usually 3-8 spicules wide (but sometimes up to 15). These tracts are short, because spicule bundles are rarely continuous for more than 3-4 lengths (2-3mm), whereupon they merge into the more disorganized halichondroid reticulation near the axis. Skeletal meshes formed by peripheral spicule bundles are irregularly rectangular, 150-360µm wide. Spongin fibres are absent, although very light deposits of granular collagenous spongin, containing abundant microscleres, is dispersed between meshes, and spicule bundles are bonded together at their bases and points with a spongin accretion (Fig. 12). Microscleres are extremely abundant in the choanosomal skeleton, and in some places they are seen to form dense crusts around megasclere bundles (Fig. 12).

Megascleres: (Comparisons in dimensions between type specimens and other material is given in Table 1). Styles (Figs 1-2) - Two size classes (? age classes) of choanosomal styles occur within skeletal tracts, both forming spicule bundles and lateral surface processes, and differing from each other only in thickness. Styles are long, relatively slender, tapering to fusiform points, typically curved near the basal end, with smooth rounded or very slightly subtylote bases; (I: 522-(616.8)-764µm length x 15-(21.4)-29µm width; II: 326-(530.6)-684µm length x 3-(7.7)-12µm width).

Microscleres: Sigmas (Figs 6-8, 13-15) - Three size categories occur, identical in geometry but differing greatly in length and thickness, and with some intermediate forms. Most sigmas are c-shaped; only very rare examples of s-shaped forms were seen; (I: 53-(132.4)-208µm chord length x 2.5-(5.0)-8.0µm width; II: 22-(29.1)-45µm chord length x 1.5-(2.5)-4.0µm width; III: 8-(16.4)-25µ chord length x 0.5-(0.9)-1.5µm width).

Microxeas (Figs 4-5, 16-17) - Two separate size classes of microxeas exist, differentiated only by their length, with only few examples of

Table 1. Comparison in spicule dimensions between type specimens and other material of *Biemna saucia* sp.nov. Measurements are given in micrometers and denoted as ranges (and means) of lengths x widths.

SPICULE	MATERIAL of *B. saucia* sp.nov.		
	Holotype	Paratype	Others (N=3)
Styles			
I	532 - (585.6) - 676 x 15 - (23.0) - 28	543 - (589.4) - 648 x 15 - (18.6) - 23	522 - (636.4) - 764 x 16 - (21.8) - 29
II	490 - (538.6) - 592 x 7 - (9.8) - 12	401 - (506.4) - 580 x 3 - (7.4) - 12	326 - (536.1) - 684 x 4 - (7.1) - 12
Sigmas			
I	83 - (134.4) - 175 x 3.5 - (4.7) - 6	171 - (187.6) - 208 x 4 - (6.0) - 8	53 - (113.3) - 190 x 2.5 - (5.0) - 8
II	24 - (32.8) - 36 x 1.5 - (2.4) - 3	31 - (32.8) - 45 x 2 - (2.6) - 3.5	22 - (26.6) - 44 x 1.5 - (2.5) - 4
III	12 - (16.0) - 21 x 0.5 - (0.8) - 1	13 - (17.2) - 25 x 0.5 - (0.9) - 1.5	8 - (16.2) - 21 x 0.5 - (0.9) - 1.5
Microxeas			
I	63 - (92.8) - 118 x 2 - (2.6) - 3.5	82 - (108.4) - 125 x 1.5 - (2.4) - 3.5	62 - (99.9) - 122 x 1.5 - (2.8) - 4
II	36 - (43.4) - 58 x 1.5 - (1.8) - 2.5	35 - (40.8) - 48 x 1.5 - (1.9) - 2.5	25 - (38.7) - 53 x 1.5 - (1.9) - 3
Raphides			
I	175 - (199.8) - 244 x 0.5 - (0.8) - 1.0	141 - (179.6) - 208 x 0.5 - (0.7) - 1.0	140 - (188.4) - 215 x 0.2 - (0.6) - 1.5

intermediate sizes. Both forms are robust, tapering to hastate points, and markedly thicker at the centre than at the apex. Microxeas occur singly or in bundles within the skeleton; (I: 62-(100.2)-125μm length x 1.5-(2.6)-4.0μm maximum width; II: 25-(40.1)-58μm length x 1.5-(1.9)-3.0μm maximum width).

Raphides (Figs 3, 18) - One category of wispy hair-like raphides occurs singly or in large bundles within the skeleton. Raphides are relatively long, very slender, straight or recurved; sometimes one end is slightly asymmetrical (slightly more elongate, slightly curved); (140-(188.9)-244μm long x 0.2-(0.7)-1.5μm wide).

Etymology. The species name *saucia* (gk.) means wounded or hurt, and alludes to the toxic and irritating properties of this species.

Remarks. Within the family Desmacellidae there are currently four well established genera and two of less certain placement. Bergquist and Fromont (1988:30) most recently discussed the family, including several genera which they considered should be placed there, but their treatment of the group was not complete and some of their conclusions require further discussion. A brief summary follows of the differences between each genus, together with remarks on their most likely affinities.

1. *Biemna* Gray (with synonyms *Allantophora* Whitelegge and *Toxemna* Hallmann) contains species with a plumose or plumoreticulate choanosomal skeleton, with variable development of spongin fibres, an erect ectosomal skeleton and often shaggy surface, and megascleres consisting of styles or subtylostyles of one size only. Microscleres always include sigmas and raphides, and may also include microxeas, commas, microstrongyles and spheres.

2. *Sigmaxinella* Dendy (with synonym *Sigmaxia* Hallmann) contains species with a condensed axial skeleton, a plumose or plumoreticulate extra-axial skeleton, well developed spongin fibres, a plumose-erect ectosomal skeleton, and megascleres consisting of styles of one size only. Microscleres are sigmas and microxeas. This genus was previously assigned

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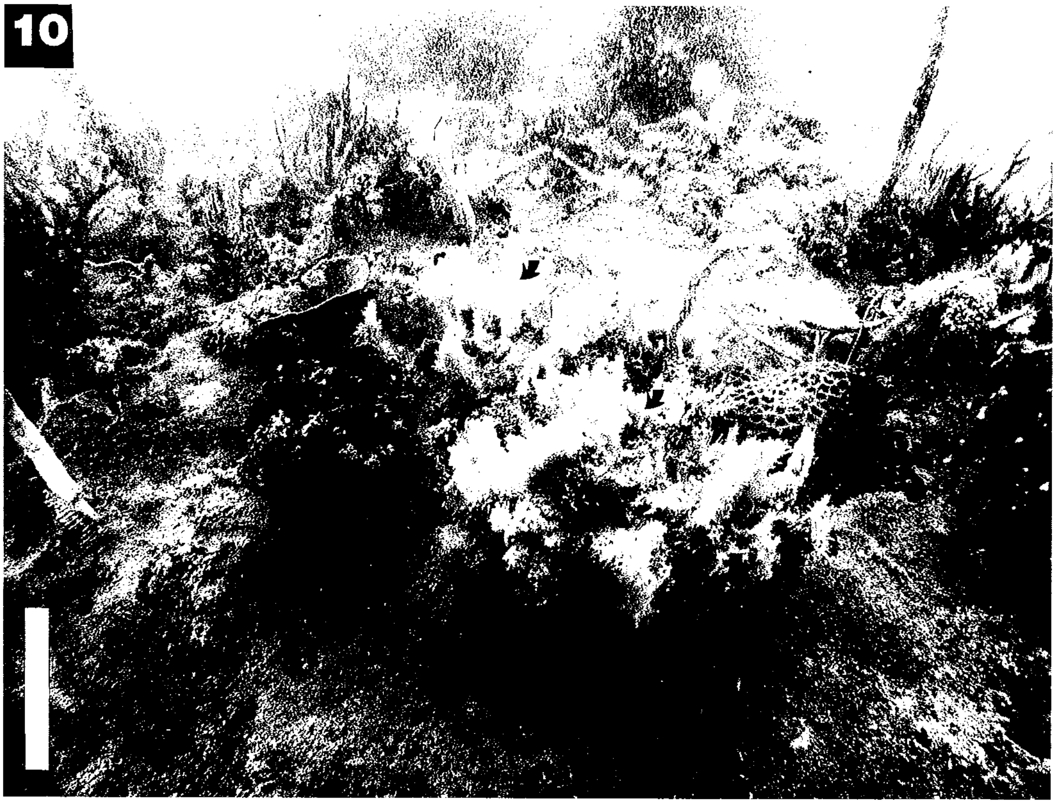
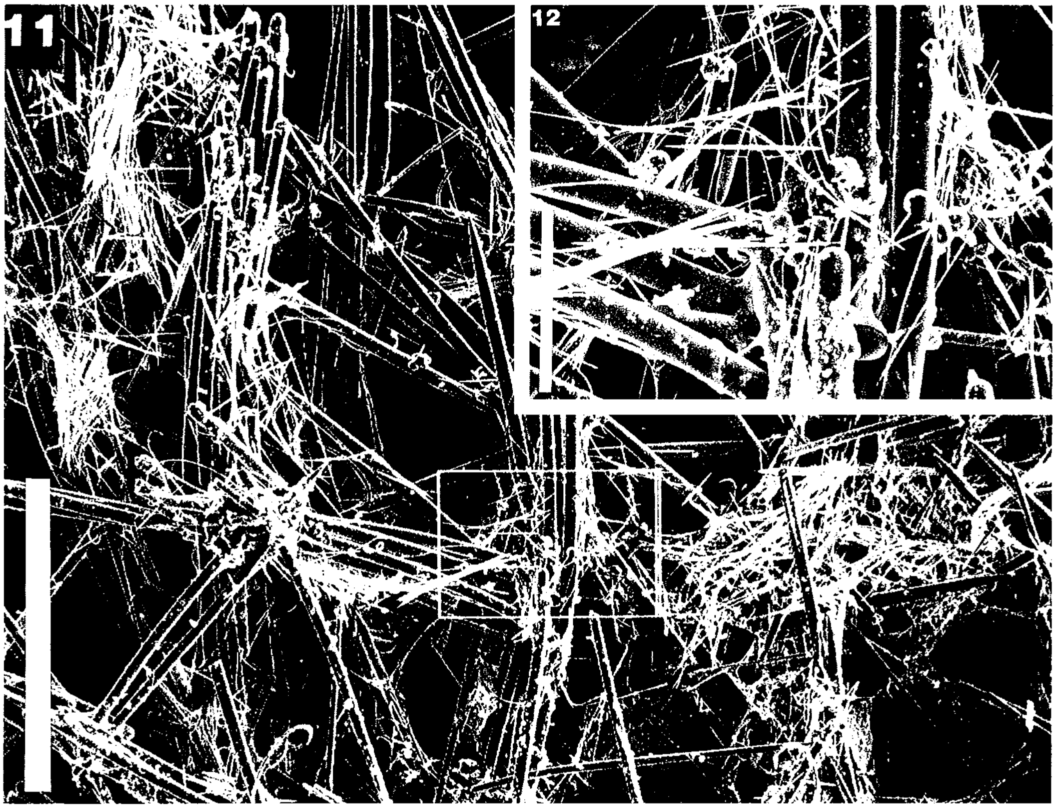


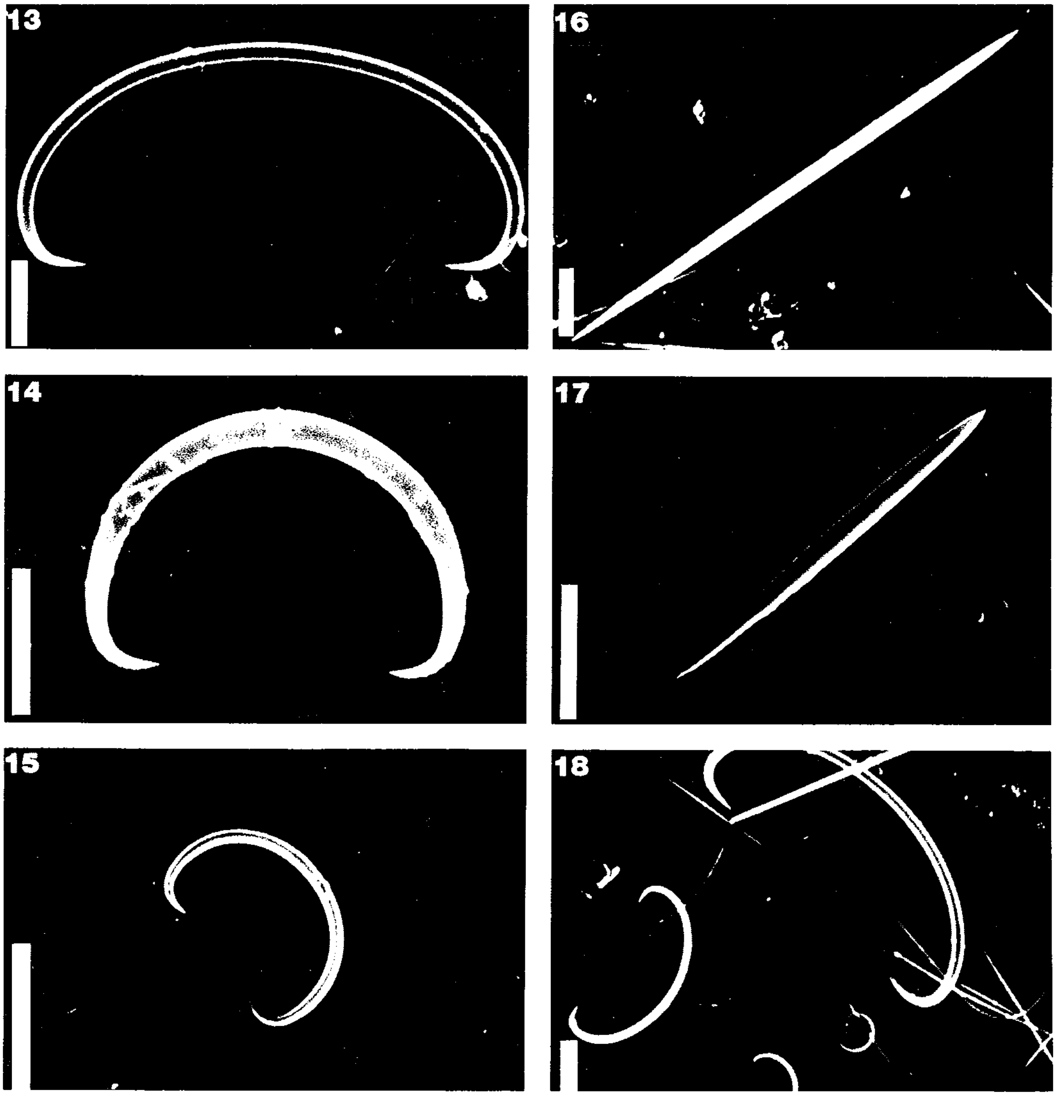
Fig. 10. Holotype of *Biemna saucia* sp.nov. (NTM Z2644), *in situ* at East Point "Sponge Gardens" (centre of photo, in two clumps, as indicated by arrows; taken from a colour slide; scale is 200mm long).

to the family Sigmaxinellidae Lévi, order Axinellida (e.g. Bergquist 1970; Hartman 1982) on the basis of its axially compressed skeleton. Hooper (1984) subsequently merged it with the poecilosclerid group Desmacellidae (a senior name for Biemnidae Hentschel, 1923), although he included the group in the polyphyletic "order" Axinellida. It can be asserted that the desmacellids should be included in the Poecilosclerida, because although they lack the synapomorphy for this order (chelate microscleres) they have closest affinities with the Mycalidae and Hamacanthidae (skeletal structure, geometry of some microscleres). However, Bergquist and Fromont (1988) argue that axial compression of the skeleton found in *Sigmaxinella* is a character which is of primary importance at the ordinal level of classification, and thus on this basis they maintain the distinction between Desmacellidae (Poecilo-sclerida) and Sigmaxinellidae (Axinellida). This interpretation is not accepted here. Supporting evidence for the position adopted in this work can be found readily in other poecilosclerids, such as *Esperiopsis* (family Esperiopsidae/Desmacididae) (e.g. *E. desmop-hora* Hooper and Lévi) and *Axociella* (family Microcionidae) (e.g. *Clathria* (*Axociella*) *canaliculata* Whitelegge), both of which have chelate microscleres and compressed axial and plumose or plumoreticulate extra-axial skeletons (Hooper and Lévi 1989; Hooper, in prep.).

3. *Desmacella* Schmidt (with synonyms *Sigmatoxella* de Laubenfels, *Sigmotylotella* Burton, *Tylodesma* Thiele and *Tylosigma* Topsent) has a reticulate, plumo-reticulate and vaguely halichondroid choanosomal skeleton, with poorly developed spongin fibres, a tangential halichondroid ectosomal skeleton, and megascleres consisting of well formed tylostyles. Microscleres are sigmas and raphides. The distinction between *Desmacella* (with true tylostyles and a vaguely halichondroid skeleton) and other desmacellids, *Biemna* in par-



Figs 11-12. Scanning electron micrographs of skeletal structure in *Biemna saucia* sp.nov. holotype NTM Z2644. **11,** Reticulate organization of the peripheral skeleton (magnified 46.4 times, scale is 500μm long); **12,** enlarged view (shown as a box on Fig. 11) of the junction between two spicule bundles, showing an accretion of spongin around the bases of megascleres and a carpet of microscleres covering megasclere bundles (magnified 247 times, scale is 100μm long).



Figs 13-18. Scanning electron micrographs of microscleres in *Biemna saucia* sp.nov., holotype NTM Z2644 (all scales are 10µm long). **13**, sigma I; **14**, sigma II; **15**, sigma III; **16**, microxea I; **17**, microxea II; **18**, sigmas and curved raphides.

ticular, is not at all straightforward: some intermediate conditions occur.

4. *Neofibularia* Hechtel has an irregular isodictyal reticulate choanosomal skeleton, with well defined spongin fibres, a membraneous or tangential ectosomal skeleton and typically smooth surface, and megascleres consisting of mostly diactinal spicules (strongyles, oxeas or sometimes styles). Microscleres are sigmas, raphides and microxeas (commas occur in one species). Apart from the possession of diactinal spicules, *Neofibularia* fits best with the desmacellids, showing closest similarities to several species of *Biemna*. All species of *Neofibularia* so far recorded are toxic, but this feature is not confined to this genus (cf. Wilkinson 1978), as demonstrated by the discovery of *B. saucia* sp.nov.

5. ? *Microtylostylifer* Dendy has an irregularly reticulate choanosomal skeleton, poorly developed spongin fibres, a specialized tangential ectosomal skeleton of small microstyles, and megascleres consist of styles. Microscleres are microstyles only. This genus does not fit easily into the Desmacellidae (cf. Bergquist and Fromont 1988), lacking sigmas,

and its microstyles are not the same as microxeas or raphides in other desmacellids. It is possible that the type species (*M. anomalus* Dendy) has closer affinities to the "axinellid" genus *Amorphinopsis* Carter, which Van Soest *et al.* (1990) referred to Halichondrida. *Amorphinopsis* also has small dermal styles, and in some species both the smaller and larger styles have constricted heads, as seen in *Microtylostylifer*.

6. ? *Kerasemna* Pulitzer-Finali has a reticulate choanosomal skeleton with well developed spongin fibres, a tangential ectosomal skeleton, and megascleres consisting of subtylostyles. Microscleres are stated to be sigmas, "toxas" and raphides. This genus is dubious and may be related to *Arenochalina* (Mycalidae): "toxas" recorded by Pulitzer-Finali (1982) are simply curved raphides, occuring singly or in trichodragmata, and subtylostyles described in the type species (*K. tenuityla* Pulitzer-Finali) verge on the tylote condition, and are embedded in well developed spongin fibres.

Within the Australasian region 13 species of *Biemna* have been previously recorded, many of which occur in tropical waters in the vicinity of NW Australia. Table 2 compares spicule dimensions for each of these species. In the diversity of spicules *B. saucia* has obvious affinities with three other species, although

Table 2. Comparison in spiculation between new and known species of *Biemna* found in the Indo-Australian region. All measurements are given in micrometres, and denoted as length or length x width. Measurements are taken from the literature, except those species indicated (*) which were taken from examination of type material.

SPECIES		CHARACTER					LOCALITY
		styles	sigmas	microxeas	raphides	others	
1. *B. saucia* sp.nov.	I	522-764x15-29	53-208x2.5-8	62-125x1.5-4	140-244x0.2-1.5	-	Indian Ocean
	II	326-684x3-12	22-45x1.5-4	25-58x1.5-3			and Timor Sea*
	III		8-25x0.5-1.5				
2. *B. aruensis*	I	365-688x10-16	-	-	95-190	-	Arafura Sea*
Hentschel (1912:352)	II	58-240x2-4.5					
3. *B. ciocalyptoides*	I	500x18	16-17	-	30	-	Port Phillip, Vic.
(Dendy, 1897:242)							
4. *B. fistulosa*	I	300-330x8	58x2	105x3	110	-	Ambon, Indonesia
(Topsent, 1897:462)							
5. *B. fortis*	I	939-1416x20-23	90-112x4-6	-	140-160	-	Ambon, Banda Sea,
Topsent (1897: 463)	II	20-21X1					Arafura Sea,
							Straits of Malacca,
							Indonesia , and Red Sea
6. *B. fragilis*	I	400-500x29-40	90	-	200-300	90-100	Ambon, Indonesia
Kieschnick (1898:53)	II	19				(toxas)	
7. *B. humilis*	I	220-8	20-1	-	36	-	Ternate, Indonesia
Thiele (1903:944)							
8. *B. liposphaera*	I	424-625	70-240	52-158	168-219	-	Arafura Sea*
Hentschel (1912:352)	II		40-65				
	III		10-27				
9. *B. megalosigma*	I	555-719x12-25	75-222	49-122	156-211	9 diam.[1]	Arafura Sea*
Hentschel (1912:351)	II		30-52			(spheres)	
	III		19-25				
10. *B. microstrongyla*	I	336-496x7-22	9-10	40-60	160-240	-	Arafura Sea
(Hentschel, 1912:354)							
11."*B. microxa*"[2]	I	216-288x4-6	-	65-77x1	25	-	Shark Bay and
Hentschel (1911:316)							Abrolhos Is, WA
12. *B. trirhaphis*	I	350-500x15-18	70-80x3	40-170	80	12	Ambon and Ternate,
(Topsent, 1897:461)	II		40-45x2			(commas)	Indonesia
	III		18-20x1				
13. *B. truncata*	I	272-304x4-6	50-60	-	-	-	Arafura Sea and
Hentschel (1912:353)							Seychelles
14. *Biemna* sp.	I	528-632x8-10	35	-	80-32	-	Arafura Sea
Hentschel (1912:352)							

[1] described by Hentschel (1912) but not found during a re-examination of the holotype.
[2] a synonym of *B. tubulata* Dendy from Ceylon.

specific dimensions of spicules differ between them. *Biemna fistulosa* (Topsent, 1897) from Ambon, has a fragile consistency, an elongate, open fistulose growth form, and an irregularly reticulate non-fibrous skeleton. Desqueyroux-Faundez (1981) also noted that commas may be native to the species, although these were not described by Topsent (1897). *Biemna megalosigma* Hentschel (1912:351) (holotype SMF1056) and *B. liposphaera* Hentschel (1912:352) (holotype SMF960T), both from Aru I., Arafura Sea, and both originally described as varieties of a single species, are massive, erect and branching sponges. They have shaggy irregular surfaces, irregularly reticulate choanosomal skeletons and irregular ectosomal skeletons. Hentschel (1912) also found spheres present amongst the microscleres of *B. megalosigma*, although these were not seen in the fragments of the holotype examined. Altogether, *B. saucia* is most similar to *B. megalosigma* in its spicule diversity and spicule dimensions, although *B. saucia* has a second category of smaller microxeas. *Biemna saucia* is also most distinctive in its halichondroid choanosomal skeleton (reminiscent of the genus *Desmacella*), but with formed by discrete bundles of styles, and its toxicity is very similar to that found in the three known species of *Neofibularia*.

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