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DESCRIPTIONS OF SPECIES OF THE PETROSIDA (PORIFERA: DEMOSPONGIAE) OCCURRING IN THE TROPICAL WATERS OF THE GREAT BARRIER REEF.

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ABSTRACT

This taxonomic study was undertaken on tropical Australian species of marine sponges assigned to the order Petrosida. Six species are described, three of these are new to science. A synopsis of the history of this order is also given.

KEYWORDS: Taxonomy, Porifera, Petrosida, Oceanapiidae, Petrosiidae, *Xestospongia*, *Petrosia*, *Oceanapia*, Great Barrier Reef.

INTRODUCTION

The history of the order Petrosida is brief and controversial. Wiedenmayer (1977a) used the name Nepheliospongiidae Clarke, 1900, to establish a family within the Haplosclerida. In 1980 this family became the basis for a new order, the Nepheliospongida (Bergquist 1980). In the present discussion this order is referred to as Petrosida, following Hartman (1982), and a synopsis of the history of the order is presented (Table 1).

Wiedenmayer's (1977a) examination of type material of the fossil species *Nepheliospongia avocensis*, type specimens of the fossil sponge family Heliospongiidae Finks, 1960, and some other extant haplosclerids, convinced him that these three groups of sponges belonged to the same family. His decision required that a family encompassing the three groups should be given the name Nepheliospongiidae, as this name had priority (Wiedenmayer 1977b). Wiedenmayer found similarities between these groups in their spiculation, growth form and architecture of the skeleton. He assigned Recent genera to this family, all of which are characterized by a strong development of megascleres and therefore by a stiff and hard, occasionally friable consistency. The basic skeletal architecture of these sponges consists of ascending tracts connected by tangential tracts parallel to the surface (Wiedenmayer 1977a).

Bergquist (1980) raised the Nepheliospongiidae to ordinal status, the Nepheliospongida (Table 1). Her decision was based, in part, on Wiedenmayer's (1977a, 1977b) palaeontological evidence, skeletal characteristics as mentioned above, and also on additional chemical and reproductive characters. Bergquist reported the presence of novel sterols having cyclopropene rings in the side chain in three genera of the Nepheliospongida, and noted the condition of oviparity in *Xestospongia muta* - reported by Reiswig (1976). Oviparity (broadcasting eggs), as compared to viviparity (incubating larvae), is thought to have a phylogenetic basis in the Demospongiae (Lévi 1957; Bergquist 1980).

Van Soest (1980) did not support the ordinal status proposed by Bergquist (1980) for this group of sponges (Table 1). He considered that if the reproductive character of ovipary was a primitive condition within the Demospongiae (Bergquist 1978, 1980), then it could not be used to define a group. His conclusion stems from a cladistic approach to taxonomy whereby monophyletic groups can only be defined by derived (advanced) character states (van Soest 1990). In addition, van Soest (1980) suggested there was no evidence that oceanapiids and petrosiids were more closely related to each other than to any other groups

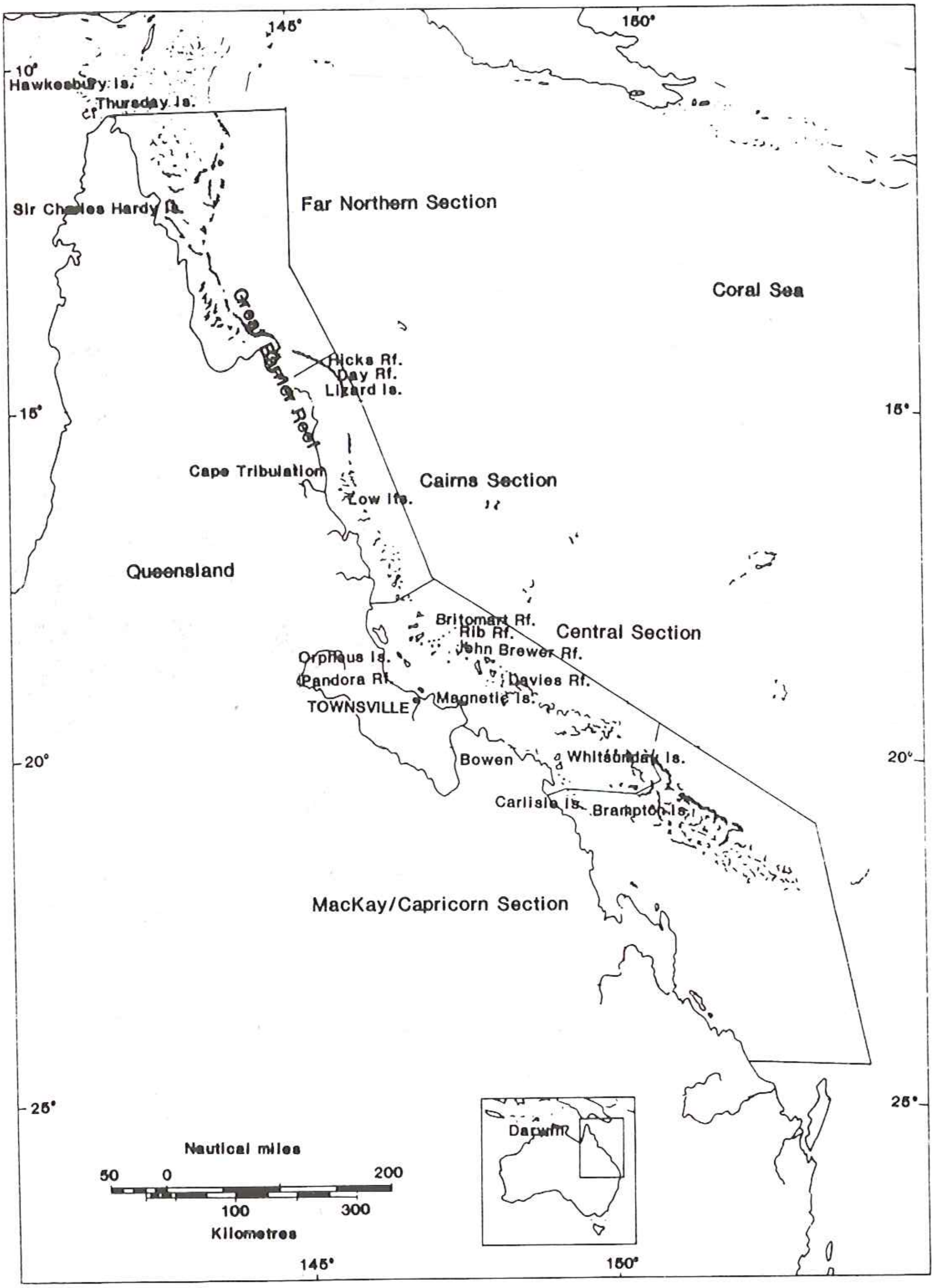


Fig. 1. Locality map of the Great Barrier Reef showing where sponges were collected for this study.

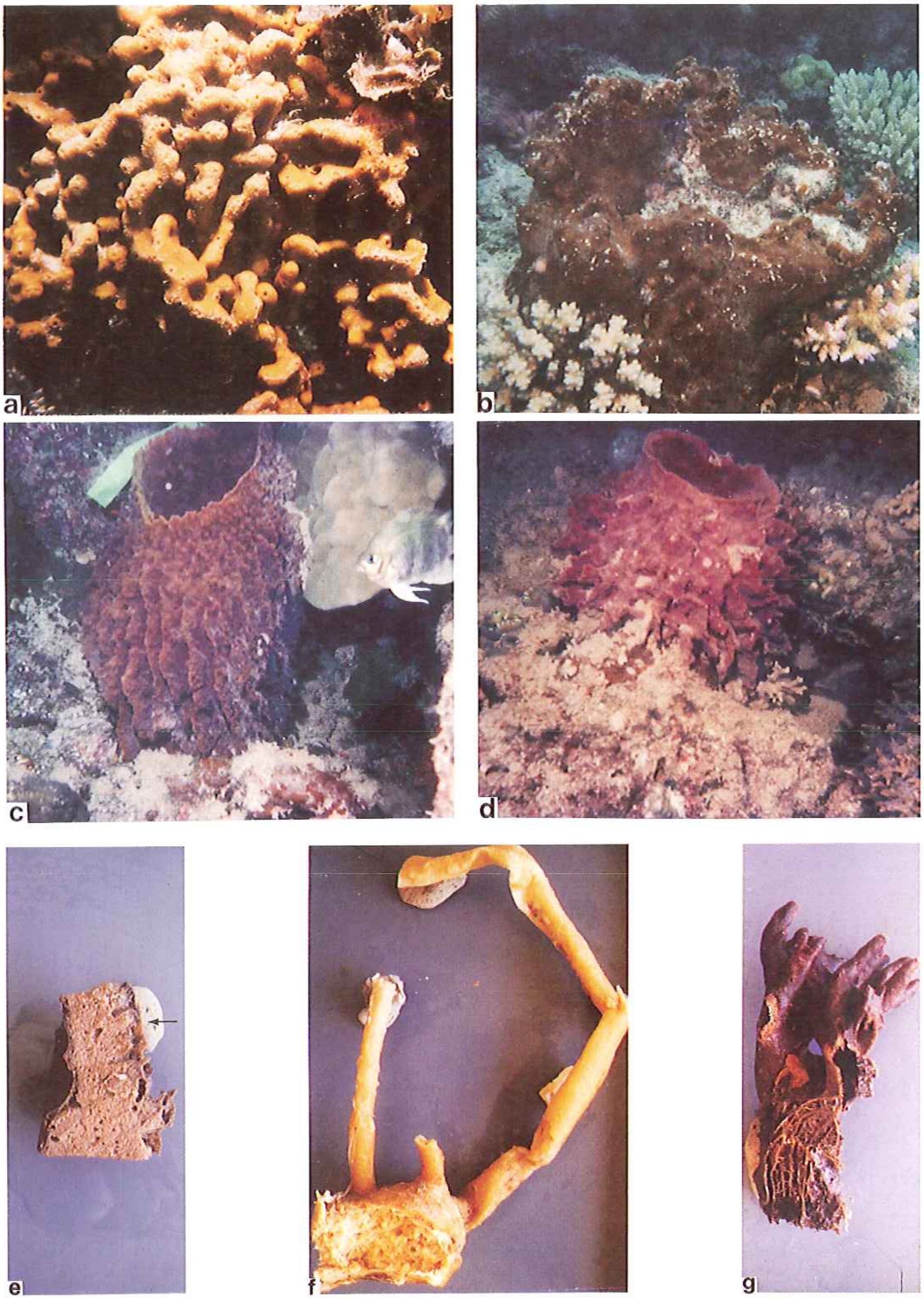


Fig. 2. a, *Xestospongia exigua*, *in situ*, Magnetic Island. **b**, *Xestospongia exigua*, *in situ*, Lizard Island. **c,** *Xestospongia testudinaria*, *in situ*, Orpheus Island. **d,** *Xestospongia bergquistia*, *in situ*, Orpheus Island. **e,** *Petrosia pigmentosa*, alcohol preserved piece of sponge, (top of sponge indicated by arrow). **f,** *Oceanapia fistulosa*, alcohol preserved piece of sponge. **g,** *Oceanapia desquefaundia*, alcohol preserved piece of sponge.

within the Haplosclerida. Therefore, they were not sufficiently distinctive to be separated at the ordinal level.

Van Soest (1980) established three new families within the Haplosclerida, two of which, the Petrosiidae and Oceanapiidae, incorporated those genera which Wiedenmayer (1977a) had previously placed in the Nepheliospongiidae (Table 1). He refrained from using Wiedenmayer's family name, Nephelio-spongiidae, as he considered the association of Recent genera with fossil genera was made on insubstantial evidence, and concluded that these two groups should not be incorporated into one family. In addition, van Soest (1980) reported that Wiedenmayer agreed with his proposal *in litteris*.

Hartman (1982) upheld the use of two orders, but used the name Petrosida rather than Nepheliospongida as he agreed with van Soest's suggestion that the palaeontological evidence was insufficient to link fossil and extant genera. He placed only one family, the Petrosiidae, in the Petrosida (Table 1). His separation of species into two orders was based on skeletal, biochemical and reproductive characters, following Bergquist (1980).

Subsequently, a dichotomy has occurred among sponge workers regarding the use of this order (or family). Some (e.g. Hartman 1982; Desqueyroux-Faundez 1987a, 1987b, 1990) adopt the two-order system, Haplosclerida and Petrosida, whereas others (e.g. van Soest 1980; de Weerdt 1985) recognise only one order, the Haplosclerida (Table 1). Furthermore, differences of opinion occur regarding the placement of families within the two orders: Bergquist and Warne (1980) and Desqueyroux-Faundez (1987a, 1987b, 1990) include the two families Petrosiidae and Oceanapiidae in the Petrosida; van Soest (1980) and de Weerdt (1985) retain the two families in

Table 1. Different classification systems, and authors who have used them, for the Haploscleida (and Petrosida) since 1977.

AUTHOR YEAR	ORDER	FAMILIES	GENERA
Wiedenmayer 1977a	Haplosclerida	Haliclonidae:	*Haliclona, Callyspongia, Niphates, Spinosella.*
		Adociidae:	*Sigmadocia.*
		Nepheliospongiidae:	*Petrosia, Xestospongia, Oceanapia, Siphonodictyon, Cribrochalina, Hemigellius, Vagocia, Calyx, Rhizochalina, Biminia.*
Bergquist 1980	Nepheliospongida	Nepheliospongiidae:	*Petrosia, Xestospongia, Oceanapia, Strongylophora, Foliolina, Calyx, Vagocia, Biminia.*
van Soest 1980	Haplosclerida	Haliclonidae:	*Haliclona, Adocia, Sigmadocia, Cladocroce,, Reniera.*
		Petrosiidae:	*Petrosia, Xestospongia, Strongylophora.*
		Niphatidae:	*Niphates, Amphimedon, Siphonodictyon, Gelliodes, Cribrochalina.*
		Oceanapiidae:	*Oceanapia, Pellina, Pachypellina.*
		Callyspongiidae:	*Callyspongia.*
Bergquist & Warne 1980	Haplosclerida	Haliclonidae:	*Haliclona.*
		Adociidae:	*Adocia, Sigmadocia, Orina, Toxadocia.*
		Callyspongiidae:	*Callyspongia, Chalinopsilla, Dactylia.*
	Nepheliospongida	Nepheliospongiidae:	*Petrosia, Xestospongia.*
		Oceanapiidae:	*Oceanapia, Vagocia.*
Hartman 1982	Haplosclerida	Haliclonidae:	*Haliclona, Adocia, Reniera.*
		Niphatidae:	*Niphates.*
		Callyspongiidae:	-
		Oceanapiidae:	*Oceanapia, Siphonodictyon, Foliolina.*
	Petrosida	Petrosiidae:	*Xestospongia.*
Desqueyroux-Faundez 1984, 1987a,b	Haplosclerida	Haliclonidae:	*Haliclona, Reniera, Gellius.*
		Niphatidae:	*Niphates, Amphimedon, Gelliodes.*
		Callyspongiidae:	*Callyspongia, Toxochalina, Arenosclera.*
	Petrosida	Petrosiidae:	*Petrosia, Xestospongia.*
		Oceanapiidae:	*Oceanapia, Pellina, Inflatella.*
de Weerdt 1985, 1986	Haplosclerida	Chalinidae:	*Haliclona, Acervochalina.*
		Petrosiidae:	*Petrosia, Xestospongia.*
		Niphatidae:	-
		Oceanapiidae:	*Oceanapia, Pachypellina, Calyx, Foliolina,, Vagocia*
		Callyspongiidae:	-
Kelly-Borges & Bergquist 1988	Haplosclerida	Haliclonidae:	*Haliclona.*
		Niphatidae:	*Siphonodictyon, Niphates, Gelliodes.*
		Adociidae:	*Sigmadocia, Orina.*
		Callyspongiidae:	*Callyspongia.*
	Nepheliospongida	Nepheliospongiidae:	*Xestospongia.*

the Haplosclerida; and Hartman (1982) includes the Petrosiidae in the Petrosida and Oceanapiidae in the Haplosclerida (Table 1).

In this study, the palaeontological evidence originally proposed by Wiedenmayer (1977a), relating fossil nepheliospongiids and Recent petrosiids is rejected, because I consider that it is not sufficiently strong to relate the two groups. The two-order separation for extant species is upheld here, but I do not consider it to be resolved. This uncertainty is due to the paucity of taxonomic characters within the Haplosclerida and Petrosida. Additional non-morphological data (Fromont 1991, in prep.a) failed to differentiate these two orders using sterol chemical characteristics. However, three species of Petrosida, all belonging to the genus *Xestospongia*, were found to be oviparous (Fromont 1991, in prep.b), supporting previous results of Reiswig (1976). It is suggested that until new methods are employed to compare species of both orders, such as molecular systematic techniques, the two orders should be retained separately.

In this study, the two families Petrosiidae and Oceanapiidae (*incertae sedis*) are placed in the Petrosida. The family Petrosiidae has a stony consistency and the Oceanapiidae have a dense ectosomal crust of spicules. This latter feature was previously considered to be typical for this order of sponges (Wiedenmayer 1977a; Bergquist 1980; Hartman 1982).

The present study is restricted to the tropical marine petrosiids of Australia. A second paper, dealing with key species of tropical haplosclerids, is in preparation. The petrosiid fauna is largely unknown from this region, despite the fact that although both the Petrosida and the Haplosclerida are considered to be amongst the most important and diverse groups of Demospongiae in tropical seas (Wiedenmayer 1977a), especially in clear waters (e.g. coral reefs).

MATERIAL AND METHODS

Sponges were collected using SCUBA at various localities on the Great Barrier Reef, photographed *in situ* and preserved in 70% ethanol.

Skeletal architecture and spicule morphology were examined using light microscopy. Spicules were prepared by boiling small pieces of sponge, including ectosome and choanosome, in concentrated nitric acid. This solution was centrifuged consecutively through two changes each of distilled water and absolute alcohol. The spicule extract was dried on a glass slide and mounted in a polystyrene-based mounting medium (DePeX, Gurr Products).

The skeleton was prepared by cutting a representative section at right angles to the surface of the sponge, dehydrating it through an ascending ethanol series, clearing in toluene and infiltrating in paraffin wax at 56°C using an automatic tissue processor on a 9 hour cycle. The sponge tissue was further infiltrated with paraffin under a vacuum of 635mm Hg for 30 minutes prior to embedding in paraffin wax. Blocks were sectioned at 100 µm thickness with a Leitz base-sledge microtome, and section rolling was eliminated by placing filter paper, moistened with distilled water, on top of the block. Sections were placed on a glass slide smeared with egg albumin for adhesion, dried overnight at 60°C and dehydrated in two changes of xylene. They were mounted in either a low viscosity epoxy resin (Spurr's) polymerised overnight at 60°C, or more conveniently in DePeX and dried for 48 hours at 40°C. Liberal quantities of DePeX were needed to prevent air bubbles occurring within the sections. Sections of the surface skeleton were prepared in the same manner, but cut parallel to the surface.

Illustrations of spicules and skeletons were drawn using an Olympus CH-2 microscope equipped with drawing apparatus, and measured with a calibrated micrometer eyepiece. Photographs of these characters were taken with an Olympus BHS microscope and an automatic camera system.

The species descriptions provided here emphasize morphological characters which can be recognised in the field, and wherever possible a description of species variability is given. The taxonomic characters utilised here include skeletal organisation, spicule morphologies and spicule sizes, growth form, colour, texture, surface appearance, habitat descriptions and species distributions. To avoid confusion with nomenclature a glossary of terms is provided in Appendix I.

Primary importance is given to the organisation of the skeleton, the spicule to spongin fibre ratio, regional differentiation of the skeleton, and the type and size of spicules. Form and size of spicules may assist in describing a species, if the extent of variability in size and shape is reported. Consequently, these characters were examined from as many specimens, from as many sites, as possible. Thinner forms of the principal spicules were found in many of the sponges investigated and these are considered to be developmental stages of the thicker principal forms. In sponges where thinner spicules are common they were measured as a separate category, and therefore the mean size and range of the principal spicules is not skewed by the inclusion of atypical features. Microscleres are used as a character at a species level only.

Sponge growth form, invaluable for field identification, is difficult to describe. Consequently, photographs of all species examined are provided in addition to descriptions. Some sponges have large variation in their overall form, although the species can usually be easily recognised in conjunction with information on their colour and consistency. Pigmentation is known to vary within a particular species from different microhabitats and depths, but the colour range of a species is often characteristic, and this feature is a most useful guide to identification (Bergquist and Warne 1980). Texture and consistency of sponges are manifestations of the architectural components of the underlying skeleton. They can be used for family allocation (Bergquist and Warne 1980), and in many cases they can be species specific (de Weerdt 1985). Appearance and texture of the surface may vary between geographic localities, but usually a specific structural conformation can be recognised and is often species specific.

Information on the species' habitat and geographic distributions is also included, as some species occur in restricted environments whereas others have large geographic ranges, occurring in many different habitats.

Type material and voucher specimens are lodged in the Museum of Tropical Queensland (QM), Townsville; other abbreviations used in the text: BMNH, The Natural History Museum, London; NTM, Northern Territory Museum, Darwin.

SYSTEMATICS

Order Petrosida Hartman

Petrosida Hartman, 1982:651; Desqueyroux-Faundez 1987a:181; 1987b: 67.

Diagnosis. Demospongiae with a reticulate skeleton that is characteristically isotropic or round-meshed, with enhanced spicule or spicule and fibre development. The mineral skeleton may become so dense that the architecture of the skeleton itself becomes obscured. The megasclere complement is diactinal, usually oxeas but also including strongyloxeas or strongyles in some groups. Some genera (e.g. *Petrosia*) have distinct size categories of megascleres. Microscleres, if present, are toxas, microxeas or microstrongyles. The Petrosida are characterised by the dominance of mineral skeleton over soft tissue, and sponges have a brittle stony texture (Bergquist and Warne 1980).

Family Petrosiidae van Soest

Petrosiidae van Soest, 1980:66; Hartman 1982:651; de Weerdt 1985:82; Desqueyroux-Faundez 1987a:181; 1987b:71.

Diagnosis. Petrosida, in which there is dominance of the mineral skeleton over soft tissues and spongin elements, hence species typically have a brittle or stony texture. The ectosomal skeleton is a tangential reticulation of spicules, frequently isotropic, as is the choanosomal skeleton. The choanosomal skeletal structure varies between genera (e.g. *Xestospongia* - isotropic skeleton with some spicule tracts; *Petrosia* - more organised, round meshed reticulation). The spicules are always diactinal, usually oxeas or strongyles, occurring in one size category (*Xestospongia*) or two or three categories (*Petrosia*). Microscleres may be present and consist of microxeas, microstrongyles, sigmas or toxas.

Genus *Xestospongia* de Laubenfels

Xestospongia de Laubenfels, 1932:115; Wiedenmayer 1977a:112; van Soest 1980:66; Bergquist and Warne 1980:36; Desqueyroux-Faundez 1987a:194.

Diagnosis. Sponges with a choanosomal skeleton that is isotropic and without fibre (e.g. *Xestospongia exigua*), coarsely organised into a reticulation with some fibre (e.g. *X. bergquistia*), or a reticulate skeleton with fibre development (e.g. *X. testudinaria*). Spicules are abundant, of a single size class, but occasionally with thinner (possibly developmental) forms. The dermal skeleton is an unmodified extension of the choanosome and does not form a surface crust. No microscleres.

Type Species. *Xestospongia diprosopia* de Laubenfels, 1932.

Remarks. A slide of the type species *X. diprosopia* (BMNH.29.8.22.59a) was examined and contained large oxeas (mean = 393 x 22 µm) as well as thinner forms (333 x 9.7 µm). The skeleton was an isotropic isodictyal arrangement of spicules in tracts with little or no binding spongin. *Xestospongia bergquistia* and *X. diprosopia* have similar skeletal organisations and amount of spongin fibre development.

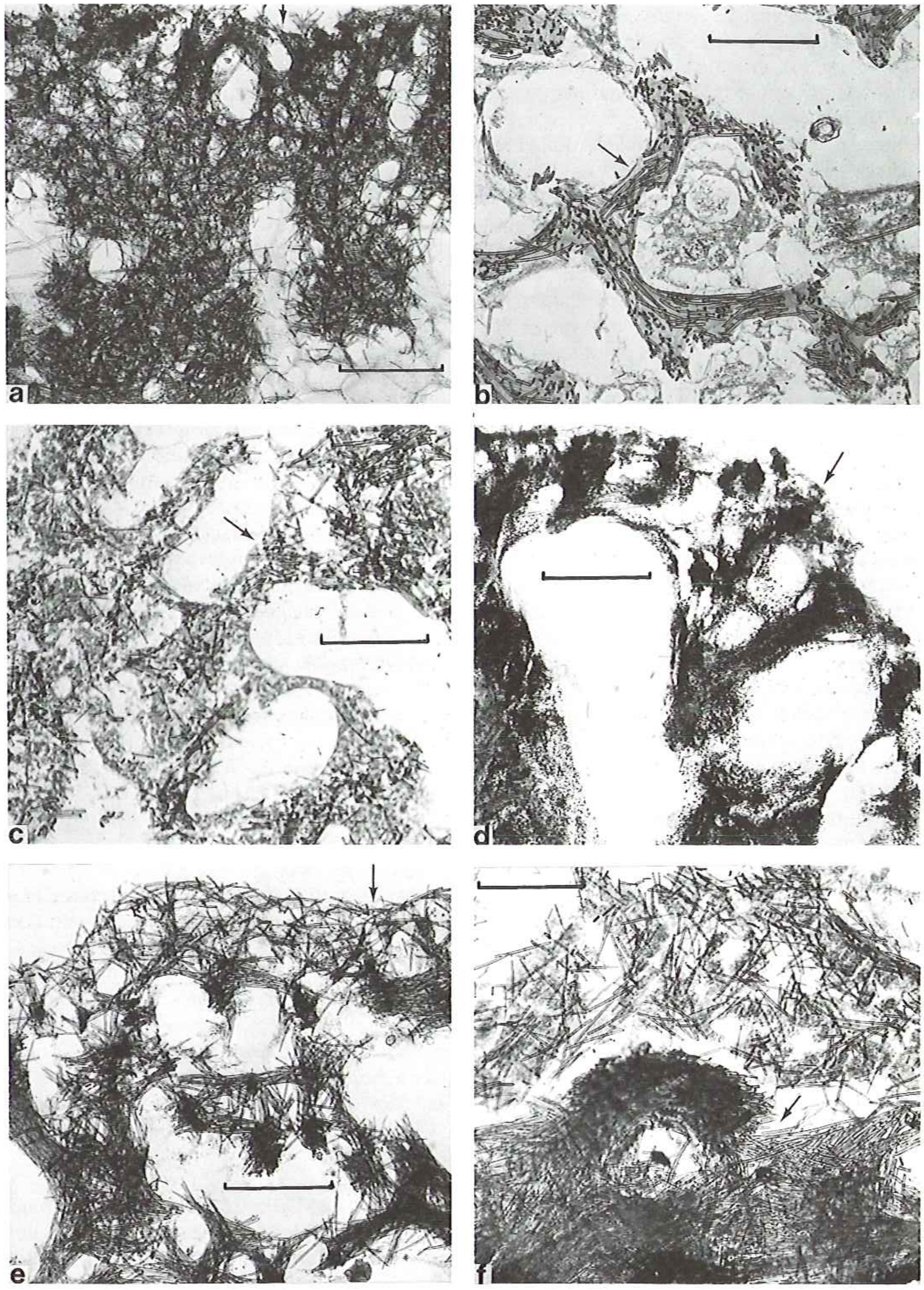


Fig. 3. Scale bar = 500 µm. **a,** *Xestospongia exigua*, l.s. choanosome and surface (arrow) **b,** *Xestospongia testudinaria*, l.s. of choanosomal skeleton showing spongin fibre development, stained with haematoxylin eosin (arrow). **c,** *Xestospongia bergquistia*, l.s. of choanosomal skeleton stained with haematoxylin eosin (arrow). **d,** *Petrosia pigmentosa* l.s. of choanosome and surface skeleton (arrow). **e,** *Oceanapia fistulosa*, l.s. of fistule skeleton (= surface). **f,** *Oceanapia desquefaundia*, l.s. of choanosome showing dense spicule skeleton (arrow).

Xestospongia testudinaria has a skeleton structurally similar to *X. diprosopia* and *X. bergquistia*, but with enhanced spongin fibre development. The two Great Barrier Reef species, *X. bergquistia* and *X. testudinaria*, are distinguished almost exclusively on the basis of skeletal characters, with the latter species having enhanced spongin fibre development.

The inclusion of the three species, *X. testudinaria*, *X. bergquistia* and *X. exigua*, within the genus *Xestospongia*, is not considered accurate in this study. These three species conform to the generic definition, and *X. testudinaria* and *X. bergquistia* are similar to the type species in skeletal architecture, but *X. exigua* has quite different skeletal characters, much smaller spicules (129 x 4.7 µm), a very compact and disorganised reticulation, extreme emphasis of the spicule component of the skeleton and a brittle and crumbly texture. This species is most likely better located in another genus within this family. However, additional species with similar combinations of skeletal characters should be examined before such a step is taken.

Xestospongia exigua (Kirkpatrick)

(Figs 1, 2a-b, 3a, 4)

Petrosia exigua Kirkpatrick, 1900:139, Pl.12, fig.7, Pl.13, fig.4.

Xestospongia exigua - de Laubenfels 1949:126; Bergquist 1965:149, fig.14; Bergquist and Tizard 1967:181, Pl.2, fig.1.

Xestospongia pacifica Kelly Borges and Bergquist, 1988:155, Pl.6c,d.

Type material. HOLOTYPE - BMNH 1898.12.20.49.

Additional material. QM G25013: Geoffrey Bay, Magnetic Island, Great Barrier Reef, 19°09'S 146°52'E, 15 September 1986, 5 m depth, coll. J. Fromont, SCUBA. QM G25014: Geoffrey Bay, Magnetic Island, Great Barrier Reef, 19°09'S 146°52'E, 19 August 1986, 5 m depth, coll. J. Fromont, SCUBA. QM G25015: Pioneer Bay, Orpheus Island, Great Barrier Reef, 18°36'S 146°29'E, 26 July 1986, 5 m depth, coll. J. Fromont, SCUBA; NTM Z0183: East Point, Darwin, NT, 12°25.0'S 130°49.01'E, 13 September 1981, 0.5m depth, coll. J.N.A. Hooper, by hand. QM G25016: Britomart Reef, Great Barrier Reef, 18°14'S 146°44'E, 29 October 1986, 12 m depth, coll. J. Fromont, SCUBA. QM G25017: North East Reef, Lizard Island, Great Barrier Reef, 14°40'S 145°27'E, 7 October 1987, 9 m depth, coll. J. Fromont, SCUBA.

Distribution. Type locality: reef flat, Flying Fish Cove, Christmas Island (Kirkpatrick 1900). In this study *X. exigua* was found in inshore waters near Darwin, and from Sir Charles Hardy Islands (11°55'S 143°28'E) to Magnetic Island (19°09'S 146°52'E) on the Great Barrier Reef (Fig.1).

Habitat. Attached to dead coral or rock, this species is common over a broad range of habitats. It is found in high sediment areas such as mainland fringing reefs, as well as clear waters on midshelf reefs and outer barrier reefs. It occurs on reef flats and beneath overhangs in depths of 3-4 m (Fig. 2a), and is also found on reef slopes to depths of 15 m (Fig. 2b).

Description. The morphology of this species is variable, ranging from a 1-3 cm thick encrustation

Table 2. Spicule measurements of *Xestospongia exigua* (µm; n=10).

LOCALITY Depth	OXEAS Mean *Range*	THIN OXEAS Mean *Range*
Type	104 x 4.6	-
BMNH 1898.12.20.49	*88-122* x *3-6*	-
Magnetic Island	142 x 5.6	127 x 2.5
5 m depth (branching)	*109-170* x *3.2-7.4*	*116-141* x *2.1-3.8*
Magnetic Island	137 x 5.3	122 x 2.5
5 m depth (encrusting)	*111-160* x *3.6-7.4*	*111-137* x *2.0-3.8*
Orpheus Island	149 x 5.1	145 x 2.4
5 m depth (encrusting)	*118-168* x *4.2-6.3*	*124-168* x *2.0-3.2*
East Point, Darwin	144 x 5.6	121 x 2.4
intertidal (encrusting)	*105-168* x *4.2-6.3*	*103-134* x *1.7-3.4*
Britomart Reef	95.3 x 3.0	90 x 1.4
12 m depth (encrusting)	*82-105* x *2.2-4.2*	*80-99* x *0.6-2.0*
North East Reef, Lizard Is	129 x 3.6	126 x 1.7
9 m depth (encrusting)	*105-145* x *2.7-4.2*	*109-137* x *1.1-2.1*

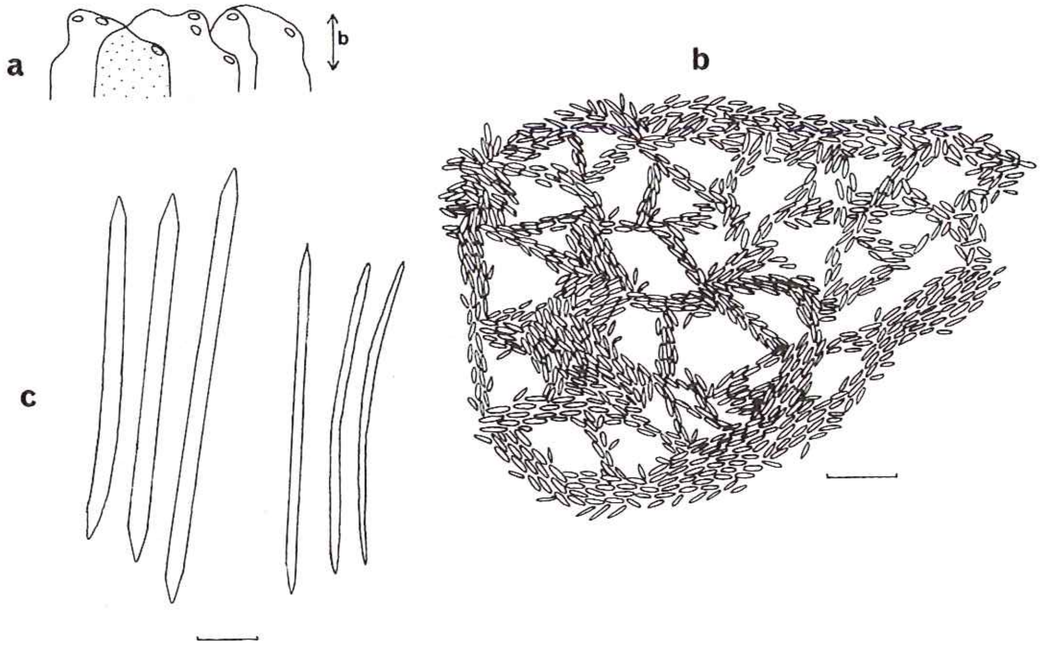


Fig. 4. Skeleton and spicules of *Xestospongia exigua*. **a,** Plan view of the sponge showing orientation of the skeletal diagrams. **b,** Choanosomal skeleton beneath the surface of the sponge where the skeleton is less dense and the isodictyal reticulation is visible, scale bar = 100 µm. **c,** Thick and thinner oxeas, scale bar = 20 µm. All drawings from a Magnetic Island sponge.

to an erect sponge with lobes or turrets up to 15 cm high. The latter morphology is more commonly found in deep water or sheltered areas beneath overhangs. Small oscules, 1 mm across, occur on raised surface areas at distances of 1-2 cms apart.

Colour. In life the specimens have a light ochre (Fig. 2a) to medium or dark brown surfaces (Fig. 2b), with a yellowish to beige interior. In alcohol they are uniform medium to dark chocolate brown.

Texture. The sponges are compressible and crumbly, characteristically sticky to touch when alive, leaving some of the ectosome adhering to the fingers.

Surface. The exterior is smooth but microscopically hispid. A thin layer of tissue and pigmented cells cover most of the superficial spicules.

Skeleton. The ectosomal skeleton is a continuation of the dense and irregular, uni- or multispicular isodictyal reticulation that forms the internal skeleton of the sponge. The internal meshes are triangular or circular and compact, 58-168 µm wide (Fig. 4b). In the centre of the sponge the spicules occasionally form vertical parallel tracts (Fig. 3a). Dark staining symbionts are frequently visible in the mesohyl beneath the sponge surface in thin sections (<10 µm).

Spicules. (Table 2). The principal spicules are consistently oxeote but may have hastate or fusiform ends (Fig. 3c). Rare forms have double points at one end. There are thin (probably developmental) forms of the spicules as well as the principal megascleres, both of which are straight or gently curved.

Remarks. *Xestospongia exigua* has been well described and discussed at length by Bergquist (1965). The present description provides additional field characters for recognition of the species, and emphasizes the variability of some of these features.

Specimens from shallow water (e.g. Magnetic Island, 5 m depth; Fig. 2a), are generally an ochre colour possibly as a response to high light conditions. They often have uneven "knobbly" surfaces with oscules on raised ridges. Specimens on mid-shelf and outer reefs in deeper water (e.g. Lizard Island, 9 m depth; Fig. 2b), are consistently darker in colour, frequently encrusting and without a knobbly surface. These growth forms occur on exposed reef slope where a smooth encrusting shape, rather than forms with elevated ridges, may be less prone to damage by water turbulence.

The spicules of the sponges from shallow water (e.g. specimens from Magnetic Island, Orpheus

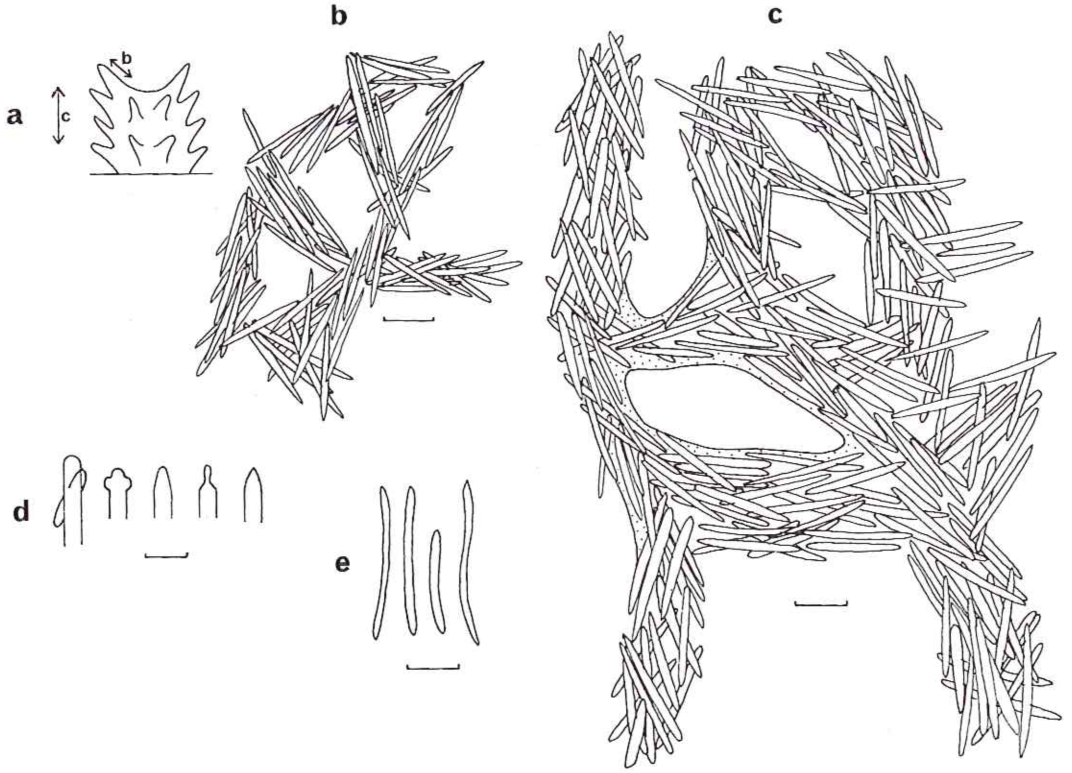


Fig. 5. Skeleton and spicules of *Xestospongia testudinaria*. **a,** Plan view of the sponge showing orientation of the skeletal diagrams. **b,** Surface skeleton showing the isodictyal reticulation, scale bar = 100 µm. **c,** Choanosomal skeleton. Stippling denotes spongin development, scale bar = 100 µm. **d,** Some of the variability in spicule ends, scale bar = 20 µm. **e,** Strongyloxeas, scale bar = 100 µm. All drawings are of a specimen from Orpheus Island.

Table 3. Spicule measurements of *Xestospongia testudinaria* (µm; n=10).

LOCALITY Depth	STRONGYLOXEAS Mean *Range*			THIN FORMS Mean *Range*		
Orpheus Island	291	x	8.7	255	x	2.3
15 m depth	*168-336*	x	*5.3-10.5*	*151-294*	x	*2.0-4.0*
Low Isles	299	x	11.0	296	x	3.3
6 m depth	*227-353*	x	*6.3-19.0*	*277-319*	x	*2.0-6.0*
Cape Tribulation	300	x	12.0	300	x	2.6
6 m depth	*202-361*	x	*8.4-15.0*	*277-336*	x	*2.0-4.0*
Pandora Reef	280	x	11.0	295	x	2.6
10 m depth	*176-336*	x	*8.4-16.8*	*286-319*	x	*2.0-5.3*

Island, and Darwin), were larger and thicker than spicules of specimens from deeper water and from mid-shelf reefs (i.e. Britomart Reef and North-east Reef; Table 2). The pronounced tracts of spicules observed by Bergquist (1965) were not prevalent in the Great Barrier Reef specimens, but this may relate to an encrusting growth form not requiring an erect supporting skeleton.

Material of *X. pacifica* Kelly Borges and Bergquist (1988) was examined and found to conform to the description of *X. exigua*, and consequently it has been synonymised with this species.

There are many sponges closely related to *X. exigua* in external morphological features, but none are common on the Great Barrier Reef. They have similar field characters, are shades of brown or black, sticky to handle, encrusting, massive or lobed, and are difficult to define and distinguish easily. A study throughout the Australian tropics, including reproductive biology, morphological characters and molecular systematic techniques, could distinguish these species and may be the only method of differentiating them.

Xestospongia testudinaria (Lamarck)
(Figs 1, 2c, 3b, 5)

Alcyonium testudinarium Lamarck, 1815:167.

Reniera testudinaria - Ridley 1884:409, Pl.39, fig.d, Pl.41, fig.u,u'.

Material. BMNH 1881.10.21.266: Cape Denison, Queensland, 20°03'S 149°03'E (Ridley 1884). QM G25009: Pioneer Bay, Orpheus Island, Great Barrier Reef, 18°36'S 146°29'E, 18 February 1987, 15 m depth, coll. J. Fromont, SCUBA. QM G25010: Low Isles, Great Barrier Reef, 16°23'S 145°34'E, 18 October 1986, 6 m depth, coll. J. Fromont, SCUBA. QM G25011: Cape Tribulation, Great Barrier Reef, 16°05'S 145°28'E, 18 October 1986, 6 m depth, coll. J. Fromont, SCUBA. QM G25012: Pandora Reef, Great Barrier Reef, 18°49'S 146°26'E, 30 October 1986, 10 m depth, coll. J. Fromont, SCUBA.

Distribution. Type locality: seas of Europe, (locality queried by Ridley 1884). This species occurs from Lizard Island, 14°40'S 145°27'E, to the Whitsunday Islands of the Great Barrier Reef, 20°19'S 149°03'E. Within the Great Barrier Reef the species is known to range from inshore fringing reefs to midshelf reefs such as John Brewer Reef, 18°38'S 147°04'E, and Davies Reef, 18°50'S 147°39'E (Fig.1).

Habitat. Sponge individuals are found in lagoonal areas, on fore reefs and back reefs between depths of 5-15 m. Sponges occur in full light conditions on rock or dead coral substrata, and are common in silty areas inshore as well as less turbid mid-shelf areas.

Description. An erect cup-shaped sponge, colloquially described as the "volcano" sponge, with vertical flukes or ridges on its outer surface (Fig. 2c). These ridges may be very pronounced extending at right angles up to 5 cm from the surface, or they may be flatter and form rounded knobs. Individuals range in size from 15 cm to 1.5 m high, with the apical cup forming a central hollow up to one third of the overall height of the sponge.

Colour. The sponges are red-brown in life; in alcohol they are a uniform beige colour.

Texture. Sponges are firm, springy and slightly compressible when alive. They can be torn by hand but this requires some force. The tissue is very compact and interspersed with canals 0.5 cm in diameter.

Surface. The exterior is microscopically granular and has a thin superficial skeleton firmly attached to the underlying choanosome.

Skeleton. The surface skeleton is an extension of the choanosome, and consists of an isotropic isodictyal reticulation of spicule tracts forming small meshes 90-227 µm wide (Fig. 5b). The tracts are 2-6 spicules wide and 34-84 µm across. The internal skeleton is a multispicular reticulation with irregular oval meshes 360-640 µm across. Tracts forming the reticulation are 100-150 µm across and cored by 10-20 strongyloxeas (Fig. 5c). Thin spicules, more oxeote in shape, occur interstitially. Spongin fibre development occurs around the spicule tracts, especially at the nodes of the reticulation, and is emphasised when stained with haematoxylin-eosin (Fig. 3b).

Spicules. (Table 3). The principal spicules (Fig. 5d, e) are extremely variable in size and shape. Many have strongylote endpoints but others have stepped ends or tapering oxeote ends. Occasionally, knob-like protuberances extend from near the end of the spicules. The shapes range from short squat to long thin forms, and all combinations of length and width are found.

Remarks. *Xestospongia testudinaria* has been cited as a species name by many authors (e.g. Dendy 1905; Hentschel 1912; Topsent 1920, 1933; Wilson 1925; Lévi 1961; Vacelet *et al.* 1976; Desqueyroux-Faundez 1987a), and the literature suggests that the species is very widespread throughout the Indo-Pacific. However, during the present investigation it was found that two sibling species of "barrel sponges" occur on the Great Barrier Reef, *X. testudinaria* and *X. bergquistia*, both of which have been included under the name *X. testudinaria*. For this reason a full synonymy of the species is not given. Specimens described by previous authors require reexamination before correct species designations can be made. For further discussion of this species, see the remarks below for *X. bergquistia*.

Xestospongia bergquistia n.sp.
(Figs 1, 2d, 3c, 6)

Type material. HOLOTYPE - QM G25018: Pioneer Bay, Orpheus Island, Great Barrier Reef, 18°36'S 146°29'E, 18 February 1987, 15 m depth, coll. J. Fromont, SCUBA. PARATYPE - QM G25019: Low Isles, Great Barrier Reef, 16°23'S 145°34'E, 18 October 1986, 6 m depth, coll. J. Fromont, SCUBA.

Distribution. This species occurs from Cape Tribulation, 16°05'S 145°28'E, to the Whitsunday Islands, 20°19'S 149°03'E, of the Great Barrier Reef (Fig.1). It is found in sympatry with *X.*

testudinaria on inshore fringing reefs, but has not been found on mid-shelf reefs.

Habitat. Individuals occur on dead coral and rock substrata in areas of high sediment load, in caves, as well as in full light conditions.

Description. An erect cup-shaped sponge with vertical flukes or ridges on its outer surface (Fig. 2d). These ridges may be very pronounced extending at right angles up to 5 cm from the surface, or flatter and forming rounded knobs. Individuals range in size from 5 cm to 1 m, with the apical cup forming a central hollow up to one third of the overall height of the sponge.

Colour. In life the sponges are maroon to red-brown; in alcohol a uniform fawn colour.

Texture. This species is firm and compressible when alive, and does not spring back when compressed, unlike *X. testudinaria*, and can be pulled apart relatively easily. The sponge tissue is very compact and interspersed with canals 0.5 cm in diameter.

Surface. The exterior is smooth, as there is a thin membrane firmly attached to the underlying choanosome.

Skeleton. The surface skeleton is an isotropic isodictyal reticulation of spicule tracts forming small meshes 100-210 µm wide (Fig. 6b). The tracts, 40-220 µm across, contain 2-6 loosely aligned spicules. Internally, the skeleton is a multispicular reticulation with irregular oval meshes 320-640 µm across, the tracts forming the reticulation are 100-200 µm across and cored by 6-12 oxeas (Figs 3c, 6c). Thinner oxeote spicules occur interstitially.

Spicules. (Table 4). The principal spicules are extremely variable in size and shape; many have oxeote endpoints but others have stepped ends, strongylote ends or are simply stylote. Occasionally, knob-like protuberances extend from near the end of the spicules (Fig. 6d). The shapes range from short squat spicules to long thin forms and all combinations of length and width are found. The spicules are usually gently curved, some are centrally bent while others are undulating (Fig. 6e).

Etymology. This species is named after Professor Patricia Bergquist, Department of Zoology, University of Auckland, New Zealand, in

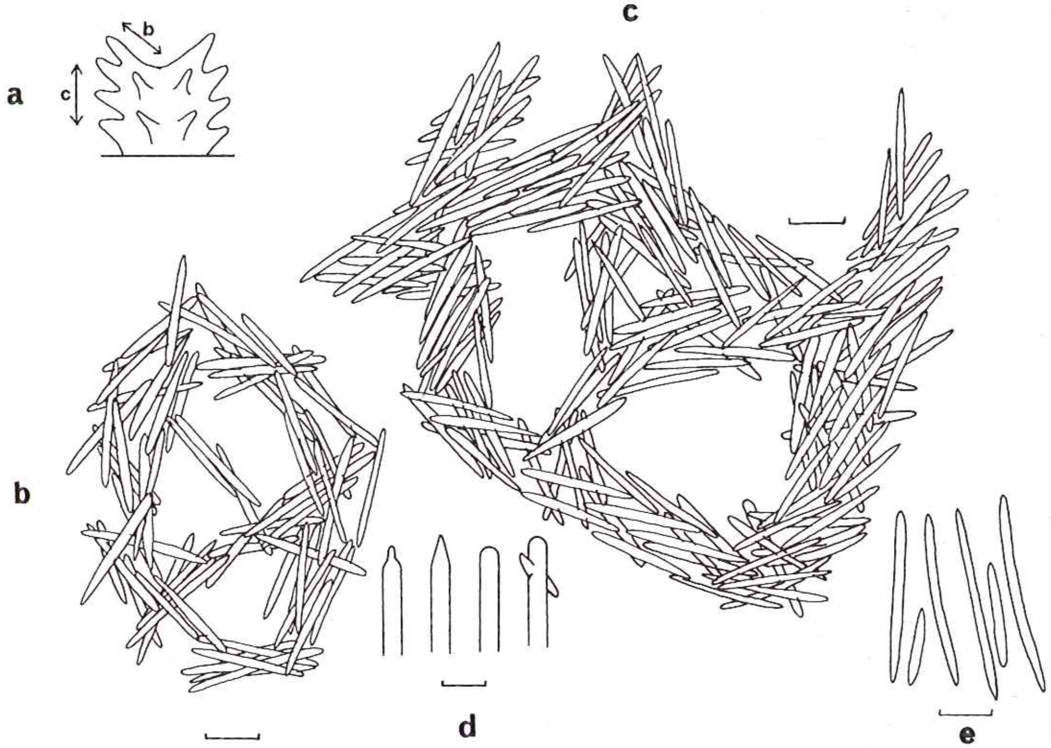


Fig. 6. Skeleton and spicules of *Xestospongia bergquistia*. **a,** Plan view of the sponge showing orientation of the skeletal diagrams. **b,** Surface skeleton showing the isotropic, isodictyal reticulation, scale bar = 100 µm. **c,** Choanosomal skeleton, scale bar = 100 µm. **d,** Some spicule ends showing strongylote and oxeote modifications, scale bar = 20 µm. **e,** Principal megascleres, scale bar = 100 µm. All drawings are of a specimen from Orpheus Island.

Table 4. Spicule measurements of *Xestospongia bergquistia* (μm; n=10).

LOCALITY Depth	OXEAS Mean *Range*			THIN FORMS Mean *Range*		
Orpheus Island 15 m depth	328 *218-386*	x x	11.4 *10.0-12.6*	301 *269-336*	x x	4.0 *2.0-8.4*
Low Isles 6 m depth	321 *269-378*	x x	12.9 *8.4-16.0*	303 *269-336*	x x	3.5 *2.0-6.3*

recognition of her expertise and enormous input to the study of marine Porifera worldwide, but particularly in Australia and New Zealand.

Remarks. *Xestospongia bergquistia* is characterised by its more open skeleton and lack of spongin fibre development, which produces sponges that are not as elastic as *X. testudinaria*. In the field they can be positively identified by piercing or cutting the specimen - if this is relatively easy, not requiring a sawing action or a lot of strength, then the sponge is a specimen of *X. bergquistia*. This species has only been found on inshore reefs.

Xestospongia testudinaria and *X. bergquistia* are similar in many morphological characters. *Xestospongia bergquistia* differs from *X. testudinaria* in lacking spongin fibre around the spicule tracts and as a consequence it is less robust, easier to tear, and more compressible. *Xestospongia testudinaria* has a more compact consistency in the live organisms, while *X. bergquistia* is more porous. *Xestospongia testudinaria* may have a thinner apical cup wall and is usually reddish-brown in colour, in contrast to *X. bergquistia* which may be reddish-brown or maroon. Neither of the latter two characters are consistent however; all intergrading shapes and colours occur in both species. *Xestospongia testudinaria* has a broader cross-shelf distribution, occurring on inshore fringing reefs with high sediment loadings as well as on mid-shelf reefs.

The species are almost identical in their spiculation, with strongyles and oxeas occurring in similar size ranges, similar skeletal design and mesh sizes, and similar superficial skeletons and gross morphologies (Figs 2c-d, 3b-c, 5, 6).

Most authors who have described specimens of *X. testudinaria* have commented on the variability of spicule types from strongyles to oxeas, and the great range of spicule widths. Aspects of these species descriptions, such as spicule sizes, spicule morphologies and amount of spongin development, provide a sufficiently broad scope to allow the inclusion of both *X. testudinaria* and *X. bergquistia* under the old concept of "*X. testudinaria*". It has been possible only by observations *in situ* to confirm that two morphologies exist, and hence two sympatric species can be differentiated: texture in life is the best field guide to species identification. A study of reproductive biology of these two species (Fromont 1988) disclosed a temporal isolation of their spawning events and their distinctively different sterol chemistry (Fromont 1991; in prep.a), and this further supports the differentiation of these sibling species.

A further problem has been to resolve which of the species should receive Lamarck's name *X. testudinaria*. Lamarck's type specimen in the Paris Museum, supposedly from the seas of Europe, has been lost (Topsent 1933; Lévi pers. comm.). A slide of this material in the British Museum, the only surviving type material of this species, was not available for loan to the author (Stone pers. comm.). However, for the purposes of this study, Shirley Stone (BMNH) examined this material on my behalf, consisting of three sections (T.S. and surface). These show a loose skeletal network of oxeas with faint fibre development, immature oxeas measuring 290 x 3 μm and structural spicules, oxeas and strongyles, measuring 430 x 12 μm. Ridley (1884) also reexamined Lamarck's type material when he described a specimen from Cape Denison, a fringing reef area south of Bowen, Queensland, Australia (Fig.1). This specimen was described as *X. testudinaria*. In his description Ridley (1984) mentions stout, strong, multispicular skeleton-fibre, and examination of Ridley's material (BMNH 1881.10.21.266), stained with haematoxylin-eosin, showed evidence spongin fibre development. Fibre development is easily visible when skeletal material is stained with haematoxylin-eosin but is more difficult to observe if material is not stained.

Shirley Stone also compared Lamarck's surviving type material (BMNH 1954.2.20.60), fragments of schizotype material (BMNH 1954.2.20.60), and Ridley's material (BMNH 1881.10.21.266) using light microscopy and Nomaski interference microscopy. She found sparse spongin development around spicule tracts in all this material (pers.comm.). In addition, a fragment of Lamarck's material was stained with haemotoxylin and sparse spongin was also found. These findings indicate that the species name, *X. testudinaria*, should be applied to those specimens which have some degree of spongin fibre development. Conversely, the new species, *X. bergquistia*, is reserved for specimens that lack any form of spongin development in their skeleton.

Other authors have established other names for species closely related to *X. testudinaria*. Vacelet *et al.* (1976) created the species name *Reniera viridenigra* for specimens which they had previously referred to *X. testudinaria* (Vacelet and Vasseur 1965:111, 1971:109). This species was not illustrated by the authors, but from the spicule measurements (230-280 x 6-11 µm), the skeletal characters (irregular network of paucispicular fibre in the choanosome) and colour (green-black) it is not the same the new species from the Great Barrier Reef described here.

Wilson (1925) erected the name *X. testudinaria* variety *fistulophora* for a sponge in which the outer surface had fistular processes instead of vertical ridges, but fistules have not been found in any Great Barrier Reef specimens (although they have been observed from specimens in the vicinity of Phuket, Andaman Sea (Hooper pers.comm.). Wilson also described a new species, *Petrosia lignosa*, which is vase-shaped, has irregular external outgrowths and little spongin in the skeleton. Examination of the type material (USNM 21283) found that the spiculation was different from that of *X. bergquistia.*

Genus *Petrosia* Vosmaer

Petrosia Vosmaer, 1887; Dendy 1905:144; van Soest 1980:74; Bergquist and Warne 1980:35; Desqueyroux-Faundez 1987a:181.

Diagnosis. Sponges with an ectosomal unispicular reticulation and an internal skeleton that is lamellate-isotropic or lamellate with round-meshes. Megascleres, with distinct size categories, are strongyles or oxeas.

Type species. *Reniera dura* (Schmidt, 1862).

Petrosia pigmentosa n.sp.

(Figs 1, 2e, 3d, 7)

Type material. HOLOTYPE - QM G25020: Carlisle Island, Whitsunday Islands, Great Barrier Reef, 20°48'S 149°16'E, 7 September 1986, 12 m depth, coll. J. Fromont, SCUBA.

Habitat. Found on dead coral or rock substrata in full light conditions on an inshore fringing reef (Fig.1).

Description. A massive sponge with short protuberances over the surface (Fig. 2e).

Colour. Dark maroon exterior with cream interior when alive, and in alcohol, a dark brown ectosome 1.7 mm thick and medium brown interior.

Texture. Very firm, slightly compressible and springy.

Surface. Smooth and microscopically hispid.

Skeleton. The ectosomal skeleton is an extension of the choanosomal skeleton with the addition of occasional fans of short spicules extending to, or just beyond, the surface (Fig. 7b). This superficial area, 1.7 mm deep, is covered with pigment cells. Immediately beneath the surface are small subdermal spaces, 200-230 µm diameter, separated by tracts 15-20 µm wide containing 2 or 3 spicules (Figs 3d, 7b). Below this region are extensive spaces, up to 730 µm wide, supported by thick tracts, 500 µm across, containing 20-25 spicules. Internally, the skeleton is more compact containing tracts of 15 to 20 tightly packed spicules bound by spongin and forming a reticulate fibre skeleton. The fibres are 160-300 µm across and the circular or oval interstitial spaces 270-300 µm in diameter (Fig. 7c). Most of the large sizes of strongyles core the choanosomal fibres but all sizes of spicules occur throughout the sponge.

Spicules. (Table 5). The species has 4 sizes of strongyles that have smooth rounded ends (Fig. 7d). Thin oxeas occur but are not abundant.

Etymology. This species name is derived from the abundance of pigment in its ectosomal region.

Remarks. *Petrosia pigmentosa* is characterised by its graded skeleton, which superficially is simple and multispicular, and internally is a thick fibre reticulation cored with many spicules (Figs 3d, 7b), and its dense surface pigmentation. Neither the massive shape nor the maroon colour are unique, but in conjunction with skeletal organisation and spicules, these characters may distinguish the species.

Other species of *Petrosia* have been described with some characters similar to *Petrosia pigmentosa*, but the new species does not conform in all characters to any of these descriptions. For example, *P. spheroida* Tanita (1967), redescribed by Vacelet *et al.* (1976), has strongyles, microstrongyles and microxeas of similar sizes to those of *Petrosia pigmentosa*, but it also has characteristic, prominent apical oscules. *Petrosia*

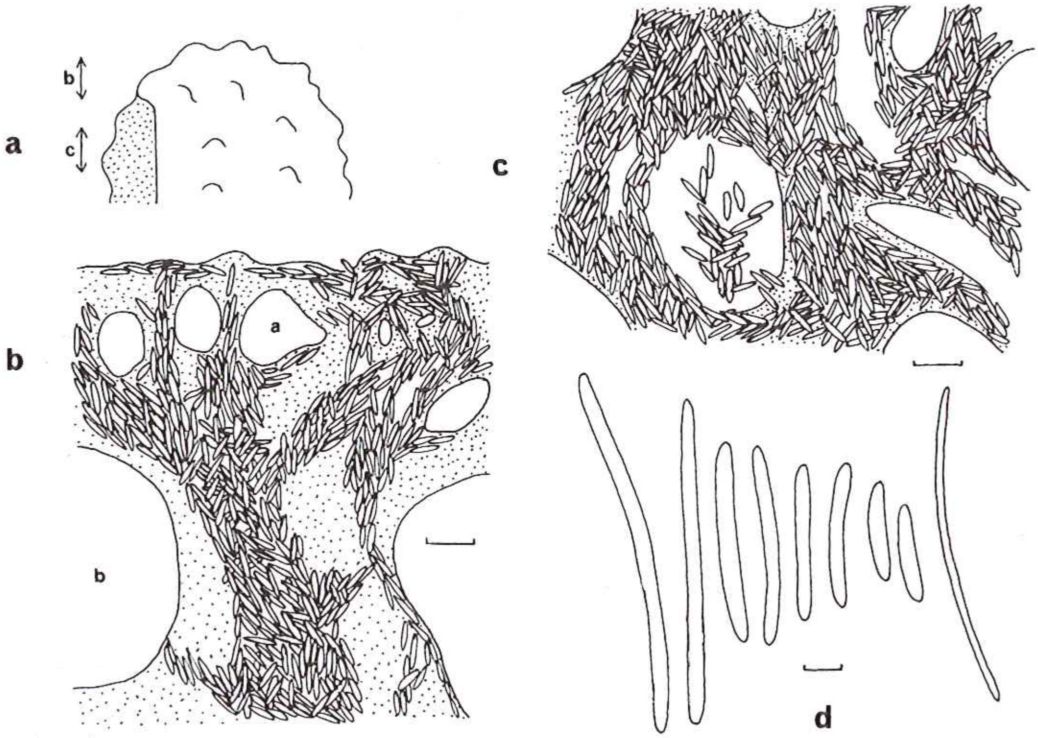


Fig. 7. Skeleton and spicules of *Petrosia pigmentosa*. **a,** Plan view of the sponge showing orientation of the skeletal diagrams. **b,** Choanosomal skeleton with the surface at the top of the diagram, showing small superficial spaces (A) and large subdermal spaces (B). Stippling denotes pigment cells, scale bar = 100 µm. **c,** Choanosomal skeleton showing fibre development (stippling) enclosing densely packed spicules, scale bar = 100 µm. **d,** Four size categories of strongyles and the thin oxeas, scale bar = 20 µm.

Table 5. Spicule measurements of *Petrosia pigmentosa* (µm; n=10).

LOCALITY Depth	STRONGYLES Mean *Range* 1	2	3	4	THIN OXEAS Mean *Range*
Carlisle Is	210 x 9.6	180 x 9.7	104 x 7.1	62 x 5.6	190 x 3.3
12 m depth	*202-218* x *8.4-12.6*	*168-196* x *8.4-11.6*	*89-126* x *6.3-8.4*	*53-76* x *4.2-6.3*	*151-210* x *2.1-4.2*

canariensis (de Weerdt and van Soest 1986) has much larger spicules (290 x 24 and 135 x 8 µm) than *P. pigmentosa*, and *P. volcano* Hoshino (1976), a red-brown massive sponge distinguished by three large oscules on the upper surface, has a characteristic growth form unlike that of *P. pigmentosa*. *Petrosia solida* Hoshino (1981) is spheroidal in shape with oscules on the upper surface, and does not contain the dense fibre and spicule tracts that occur in *P. pigmentosa*. Desqueyroux-Faundez (1987a) described *P. capsa* which has similar spicules and external morphology to *P. pigmentosa*, but that species is lemon yellow when alive, exudes abundant mucus, and does not contain the dense fibre skeleton found in *P. pigmentosa*.

Family Oceanapiidae van Soest

Oceanapiidae van Soest, 1980:80; Bergquist and Warne 1980:37; Hartman 1982:650; de Weerdt 1985:73; Desqueyroux-Faundez 1987a:200; 1987b:71; Wiedenmayer 1989:119.

Diagnosis. Sponges with an irregular tangential ectosomal skeleton which may form a crust reinforced by spongin. Fistules are common. The choanosomal skeleton is an isotropic unispicular reticulation interspersed with spicule tracts usually parallel to the surface. The weak organization of the interstitial skeleton produces a pulpy appearance after death. Megascleres are oxeas or strongyles. Microscleres may be present and are sigmas and/or toxas.

Genus *Oceanapia* Norman

Oceanapia Norman, 1869:334.
Rhizochalina Schmidt, 1870:35.
Phloeodictyon Carter, 1882:122.

[For full synonymy see Wiedenmayer (1990:120)].

Diagnosis. Fistule-bearing sponges with walls supported by an irregular reticulation of spicule tracts bound by spongin. A spongin-reinforced tangential ectosomal crust covers the surface of the sponges. The choanosomal skeleton is a combination of spicule tracts and single spicules without apparent orientation. Megascleres are oxeas or strongyles and microscleres sigmas and/ or toxas.

Type species. *Desmacidon jeffreysii* (Bowerbank, 1866).

Remarks. In recent publications the two genera *Rhizochalina* and *Phloeodictyon* have been synonymised with *Oceanapia* (Bergquist and Warne 1980; van Soest 1980; de Weerdt 1985; Wiedenmayer 1989) All these genera have a fistulose habit and a bark-like dermal crust.

The original descriptions of *Oceanapia* and *Phloeodictyon* differ in that the latter genus was described as possessing sigma microscleres. Both genera have spicule tracts internally, as well as an isodictyal unispicular skeleton which produces a pulpy texture.

Rhizochalina has abundant spongin and a reticulate spicule-fibre skeleton (Topsent 1920;

Table 6. Spicule measurements of *Oceanapia fistulosa* (µm; n=10).

LOCALITY Depth		OXEAS Mean *Range*	
	1	2	3
Little Pioneer Bay 20 m depth	212 x 8.5 *200-226* x *7.8-10.4*	196 x 3.6 *182-208* x *1.8-5.5*	92 x 3.4 *83-101* x *2.6-4.4*

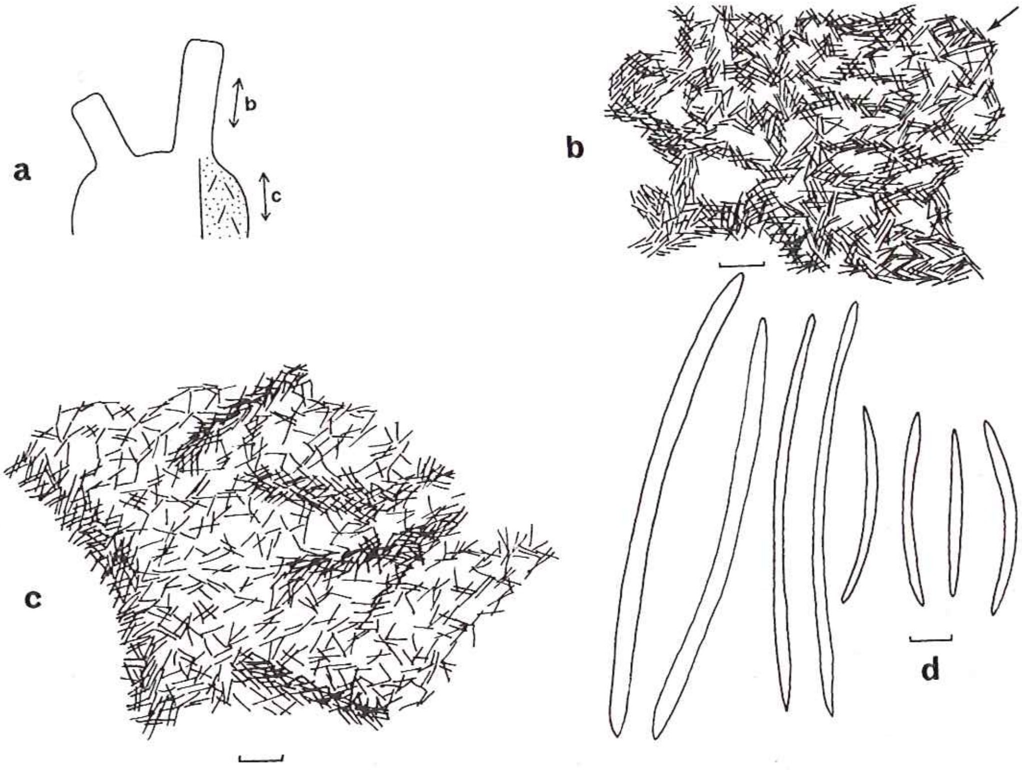


Fig. 8. Skeleton and spicules of *Oceanapia fistulosa*. **a,** Plan view of the sponge showing orientation of the skeletal diagrams. **b,** A longitudinal section through a fistule displaying the strongly developed skeleton at the centre, and the thinner tracts nearer the edges (arrow), scale bar = 200 µm. **c,** Choanosomal isodictyal skeleton with occasional spicule tracts and a band of parallel spicules around internal pores, scale bar = 200 µm. **d,** Oxeas of three size categories, scale bar = 20 µm.

Bergquist 1965) which produces firm solid sponges. Recently de Weerdt and van Soest (1986) suggested that *Rhizochalina* should be retained as a subgenus for sponges with strongly developed spongin fibres and a subgenus *Oceanapia* should be reserved for pulpy sponges.

The two species from the Great Barrier Reef examined in this study have different textures. *Oceanapia fistulosa* is pulpy, as the bulk of the skeleton is formed by a unispicular reticulation with few tracts of spicules and no fibre development. In contrast, *Oceanapia desquefaundia* sp. nov. is a firm, incompressible sponge with a bark-like dermal region and tangential layers of spicules and fibre internally (cf. Figs 2 f, g, 8c, 9c). This species has the strong skeletal development described for the genus *Rhizochalina*, and it may need to be reallocated should *Rhizochalina* eventually prove to be valid.

Oceanapia fistulosa (Bowerbank)

(Figs 1, 2f, 3e, 8)

Desmacidon fistulosa Bowerbank, 1873:19, Pl.4, fig.7, 8; Carter 1882:121.

Rhizochalina fistulosa var. *infradensata* - Ridley 1884:420.

Rhizochalina fistulosa - Ridley and Dendy 1887:32, Pl.8, fig.2, 2a, Pl.9, fig.4. [For full synonymy see Desqueyroux-Faundez (1987a: 203)].

non *Oceanapia fistulosa* - Desqueyroux-Faundez 1987a:203, fig.10a,b, fig.3, 43-48.

Type material. HOLOTYPE - BMNH 1877.5.21.1353.

Additional material. BMNH 1887.5.2.246, 1887.5.2.264, 1954.2.16.30. QM G25021: Pioneer Bay, Orpheus Island, Great Barrier Reef, 18°36'S 146°29'E, 30 August 1987, 20 m depth, coll. J. Fromont, SCUBA (Fig.1).

Distribution. Type locality: Fremantle, Western Australia (Bowerbank 1873). The species has a widespread Indo-Pacific distribution.

Habitat. Found on a silty/sandy flat bottom.

Description. A massive sponge that is buried except for the fistules, and the whole sponge can be dug from the sediment by hand. The hollow fistules are up to 25 cm long and 1 cm in diameter, and the fistule walls are 1 mm thick (Fig. 2f).

Colour. The single live sponge observed had long beige turrets, was inhabited by a pink zooanthid, and had a cream-beige interior. In alcohol the fistules are beige or light brown and the internal colour is unchanged from the live state.

Texture. The sponge is compact but crumbly and forms a pulp around some supporting stringy fibre.

Surface. There is a surface crust or skin 2 mm thick which is microscopically hispid (Fig.2f).

Skeleton. The choanosome is a unispicular isodictyal reticulation with rings of parallel spicules where the fistules extend upwards (Fig. 8c). Tracts of spicules are aligned within fibres and reinforce the isodictyal reticulation (Fig. 8c). The fistules have reticulate tracts of 20 spicules centrally, with a closer reticulation towards the surface of the fistule consisting of less densely packed tracts with fewer spicules (Figs 3e, 8b).

Spicules. (Table 6). Hastate oxeas of 3 size categories (Fig. 8d).

Remarks. The Great Barrier Reef material was compared with Bowerbank's (1873) *Desmacidon fistulosa* from Fremantle, WA (BMNH 1877.5.21.1353, 2 slides) and Ridley and Dendy's (1887) *Challenger* material of *Rhizochalina fistulosa* (BMNH 1887.5.2.246, 264 and 1954.2.16.30). The skeletal characters agree well with the type material although the spicules of the Great Barrier Reef specimens are slightly thinner and there is an additional smaller size category. Ridley and Dendy (1887) mention small dermal spicules, 213 µm in length, in one specimen they examined. Small spicules are apparent in their material (BMNH.1954.2.16.30) and measure 83-114 x 5.2-7.3 µm. Thin forms of the large oxeas were also present, measuring 208 x 3.1 µm. Small spicules were found in the slide of BMNH 1887.5.2.264 and measured 94-114 x 5.2-6.2 µm.

The Great Barrier Reef specimens have extremely long fistules, up to 25 cm. No previous descriptions of the species record the presence of fistules of this length, but many of these records report that fistules were broken prior to, or during, collection of the sponges.

This species has an extensive published distribution and depth range, reportedly extending from 10 m in Puerto Rico to 1800 m in the Azores. However, it is likely that there is more than one sibling species being named *O. fistulosa*, and the published variability of the "species" is very wide, allowing the incorporation of all these records.

Oceanapia desquefaundia n.sp.

(Figs 1, 2g, 3f, 9)

Oceanapia fistulosa Desqueyroux-Faundez, 1987a:203, fig.10a,b, figs 43-48.

Type material. HOLOTYPE - QM G25022: Pelorus - Orpheus Island channel, Great Barrier Reef, 18°34'S 146°29'E, 20 m depth, 29 August 1987, coll. J. Fromont, SCUBA.

Additional material. PARATYPE - QM G25023: Hawkesbury Island, Torres Strait, 10°22'S 142°09'E, 12 m depth, 5 May 1987, coll. J. Fromont, SCUBA. MNHG 978/534: Cap du Noulin, New Caledonia (Desqueyroux-Faundez 1987a).

Habitat. This species occurs on fringing reefs with high sediment loads. The Hawkesbury Island specimen was found encrusting around a coral branch, and the specimen from Orpheus Island was buried in sediment with fistules protruding.

Description. A massive spherical sponge with erect tapering fistules 3 to 5 cm tall (Fig. 2g). The fistules are hollow with a 1 mm thick wall, normally rounded at the apex, but a few oscular fistules are open at the apex.

Colour. Alive, the sponges have an orange surface and fistules with a pale orange interior, and in alcohol the whole sponge is medium to dark brown.

Texture. Firm and incompressible. The tissue is compact, fibrous, arranged radially and parallel to the surface in concentric bands (Fig. 2g).

Surface. The exterior is a smooth crust with the same appearance and texture as the fistule walls.

Skeleton. The ectosomal skeleton is a fibrous reticulation; each fibre centrally cored by 4-6 spicules and 160-200 µm wide (Fig. 9b). The mesh spaces between them are 330-670 µm in diameter. A thin dark coloured layer of tissue covers the fibre skeleton. The internal skeleton is a reticulation of fibre cored by spicules forming dense fibre bands parallel to the surface (Fig. 9c). The fibres are 320-530 µm across and enclose 10-20 spicules. These areas of fibre are interspersed with areas of pulpy mesohyl where the spicules are dispersed irregularly (Fig. 3f). The fistule walls are supported by a thick fasciculate spongin fibre tract up to 350 µm across packed with up to 50 spicules (Fig. 9d). Spicules extend at right angles to these tracts and irregular spicule fans support the surface (Fig. 9d).

Spicules. (Table 7). Smooth strongyles of four size categories, although the two larger thick sizes intergrade. Thin forms also occur as do very thin toxa (Fig. 9e, f).

Etymology. This species is named after Dr. Ruth Desqueyroux-Faundez in recognition of her contribution to the knowledge of the sponge fauna of the Southern Hemisphere.

Remarks. *Oceanapia desquefaundia* is readily recognised by its orange colour, fistular habit and very concentric skeletal development.

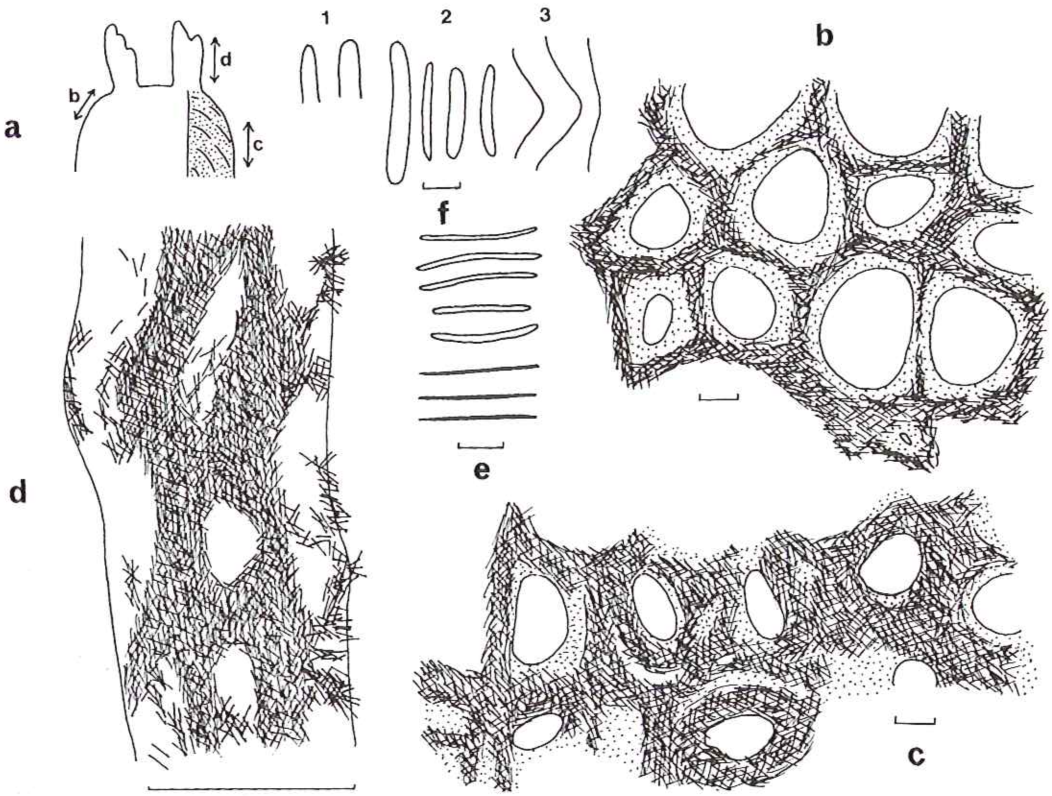
Oceanapia desquefaundia resembles *O. fistulosa* Bowerbank (1873), described and figured by Desqueyroux-Faundez (1987a). Desqueyroux-Faundez also commented on the variability in the skeletal characters of specimens assigned to *O. fistulosa*, and she found differences between her specimens and Bowerbank's type material. Nevertheless, she retained Bowerbank's species name for the New Caledonia material (MHNG 978/534). Comparison of her material with specimens described above from the Great Barrier Reef leaves no doubt that they are conspecific. This material is identical in external morphology and colour, skeletal architecture and spicule morphology. The absence of toxas and thin, probably developing, strongyles in the New Caledonian specimen is not considered sufficient reason to divide the specimens into two species. Conversely, a comparison of type material of *O. fistulosa* (BMNH 1877.5.21.1353, 1887.5.2.246, 264, 1954.2.16.30) with *O. desquefaundia* showed that these were not conspecific.

The only species of *Oceanapia* previously described with toxas, *O. arcifera* Dendy (1924), has oxeas as the principal megasclere whereas strongyles are present in *O. desquefaundia*. The new species does not conform to *O. arcifera* in any other significant details.

DISCUSSION

Both families described here in the order Petrosida are easily recognised and quite distinctive from each other, using the major differentiating features of skeletal arrangement and spicule:spongin fibre ratio. However, from examination of skeletal characters, it was not possible to positively conclude that these features can be used to reliably distinguish the Petrosida from the Haplosclerida. Chemical and reproductive characters (Fromont 1991, in prep.a,b) provide conflicting information regarding the separation of these orders.

Problems at the generic level were found in the genus *Xestospongia*. *Xestospongia exigua* has quite different skeletal characters from both *X. testudinaria* and *X. bergquistia*, and other differences between these two groups have been found in their chemical and reproductive characteristics (Fromont 1991, in prep.a,b). This supports the findings of Bergquist *et al.* (1980, 1986), who



9. Skeleton and spicules of *Oceanapia desquefaundia*. **a,** Plan view of the sponge showing orientation of the skeletal diagrams. **b,** Tangential ectosomal skeleton showing the fibrous reticulation (stippling) cored by spicules, scale bar = 200 µm. **c,** A choanosomal fibre band cored by numerous spicules, scale bar = 200 µm. **d,** Skeleton of the fistule walls with a central fasciculate tract, loose spicules at right angles and spicule fans at the surface, scale bar = 1000 µm. **e,** Two large sizes of strongyles and thin strongyles, scale bar = 100 µm. **f,** Detail of the strongyle ends (1), the small size category of strongyles (2), and toxas (3), scale bar = 20 µm.

Table 7. Spicule measurements of *Oceanapia desquefaundia* (µm; n=10).

LOCALITY	STRONGYLES			THIN STRONGYLES	TOXAS
Depth	1	Mean *Range* 2	3	Mean *Range*	Mean *Range*
Hawkesbury Is 12 m depth	282 x 11.3 *260-302* x *8.4-12.6*	216 x 11.4 *107-252* x *6.9-14.7*	70 x 6.7 *48-81* x *4.2-7.4*	265 x 3.4 *244-294* x *2.1-6.3*	78 x 1 *73-92* x *1*
Orpheus Is 20 m depth	280 x 9.6 *260-311* x *8.4-11.6*	231 x 11.3 *218-252* x *10.5-12.6*	55 x 6.0 34-71 x 4.8-7.4	258 x 4.4 *235-277* x *3.2-5.3*	78 x 1 61-105 x 1

suggested that the "genus *Xestospongia*" contains more than one generic entity.

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APPENDIX I

Glossary of terms (compiled from Wiedenmayer 1977a and Bergquist 1978).

Choanosome: The area of the sponge where choanocyte chambers occur, and in general terms refers to the interior of the sponge.

Diactinal: A category of megasclere pointed at both ends.

Ectosome: The superficial region of a sponge.

Endosome: Internal skeleton, a term interchangeable with choanosome.

Fasciculate: Fibres collected together in groups.

Fibre: A discrete column of spongin and/or spicules and one of the chief structural elements of the skeleton of many demosponges.

Fistule: A hollow erect structure like a pipe or reed and used to describe erect columns extending vertically from the sponge surface.

Fusiform: Shaped like a spindle; tapering at both ends.

Haematoxylin-eosin: A histological stain that colours collagen light pink.

Hastate oxea: A spear-shaped oxea.

Hispid: Rough or bristly.

Interstitial: Spaces or openings between the skeletal tracts.

Isodictyal: A skeletal network where the meshes are commonly triangular in all directions.

Isotropic: Disorganised, random.

Megascleres: The larger structural spicules.

Mesohyl: The intermediate or central area of the sponge body.

Microscleres: Smaller spicules which are frequently of ornate shape and used for reinforcing membranes or for packing the skeleton.

Microstrongyles: Small strongyles.

Microxeas: Small oxeas.

Oxeas: Megasclere spicules pointed at both ends.

Reticulate skeleton: Skeletal architecture characterized by branching and anastomosing of fibres, tracts, or megascleres to form a ladder-like network.

Sigma: A cor s-shaped type of microsclere.

Spicule: A discrete skeletal element consisting of silica in the Class Demospongiae.

Spongin: Collagenous material deposited in the form of fibres.

Strongyle: A megasclere with both ends blunt and rounded.

Strongyloxea: An oxea with either one (anisostrongyloxea) or both ends blunt but not rounded -between an oxea and a strongyle.

Style: A megasclere with one end rounded and the other pointed.

Tangential skeleton: Orientated parallel to the surface.

Toxa: A bow-shaped type of microsclere.