

Indonesian sponges of the genus *Petrosia* Vosmaer (Demospongiae: Haplosclerida)

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Sponges of the genus *Petrosia* (Demospongiae: Haplosclerida) are large and characteristic components of many Indonesian reefs. We identify and provide descriptions of seven species of *Petrosia* collected recently on SW Sulawesi reefs (Eastern Indonesia), two of which are new to science: *Petrosia* (*Petrosia*) *alfiani* spec. nov. and *Petrosia* (*Petrosia*) *hoeksemai* spec. nov. Additional species recorded are *Petrosia* (*Petrosia*) *lignosa* Wilson, 1925, *Petrosia* (*Petrosia*) *nigricans* Lindgren, 1897, *Petrosia* (*Petrosia*) *plana* Wilson, 1925, *Petrosia* (*Strongylophora*) *corticata* (Wilson, 1925) and *Petrosia* (*Strongylophora*) *strongylata* Thiele, 1903. The species are discussed and compared with *Petrosia* records from other Indonesian and neighbouring Indo-West Pacific areas. We also present a key to the common *Petrosia* species of Sulawesi.

Introduction

If trends observed in other marine benthic groups also apply to sponges, Indonesian waters may be expected to contain the world's highest sponge biodiversity. Van Soest (1989, 1990, 1994) and Hooper et al. (2000) reviewed the sponge fauna of this area on the basis of literature and informal database records, and these reviews confirm the richness. However, the published knowledge base of Indonesian sponges is woefully incomplete: much of the collected material still awaits formal description and many locations in the area remain to be explored. The present study is induced by the search for sponge secondary metabolites with properties useful to mankind, financed under the EC-MAS3 project 'SYMBIOSPONGE' and the NWO-WOTRO-project (W84-474) 'Sponges as a potential resource of Eastern Indonesia'. It is also one of a recently started ongoing series of genus by genus revisions of the Indonesian sponge fauna (Hofman & Van Soest 1995; Van Soest, 1998), which eventually will result in a much greater accessibility of the Indonesian sponges for interested ecologists and chemists.

Materials and methods

The material was collected by Dr B.W. Hoeksema (fieldnumbers # BH97/xxxx/xx and 98/NS or SS/xxxx/BH/xx), N.J. de Voogd (NV/97/xx/xx; NV/xx/xx00/xx), Dr H. Moll and Dr R.W.M. van Soest from various locations in Indonesia. The specimens are preserved in 70% ethylalcohol and deposited in the sponge collection of the Zoological Museum Amsterdam (ZMA) and the National Museum of Natural History, Lei-

den (RMNH). The descriptions presented below are based on external morphology, skeletal architecture and shape and size of the spicules. 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 Canada-balsam 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 100% nitric acid (HNO_3), after which the residue was rinsed four times with water, once with hydrogen peroxide (H_2O_2) and finally once with 96% ethylalcohol. The spicules were air-dried on microscopic slides and prepared for study with the light microscope, as well as put on aluminium stubs and coated with gold for study with a Jeol Scanning Electron Microscope (SEM).

Systematics

Phylum Porifera Grant, 1835

Class Demospongiae Sollas, 1885

Order Haplosclerida Topsent, 1928

Suborder Petrosina Boury-Esnault & Van Beveren, 1982

Family Petrosiidae van Soest, 1980

Definition.— Haplosclerida with ectosomal skeleton consisting of an isotropic reticulation of single spicules or spicule tracts, and a choanosomal skeleton verging towards an isotropic reticulation of spicule tracts, in which primary and secondary tracts are indistinct.

Genus *Petrosia* Vosmaer, 1887

Definition.— Petrosiidae with an ectosomal triangular or polygonal reticulation of spicule tracts or single spicules, usually echinated at the nodes or along the tracts by a smaller category of spicules. Choanosomal skeleton basically a lamellate-isotropic reticulation of spicule tracts, and an interstitial unispicular reticulation. Megascleres with distinct size categories of strongyles or oxeas, often with a special category of ectosomal microxeas or microstrongyles.

N.B. This definition includes sponges referable to the genus *Strongylophora* Dendy, 1905. Its separate generic status vis-à-vis *Petrosia* is doubtful, and in a forthcoming revision (Desqueyrouz-Faúndez in litteris) both are treated as subgenera of *Petrosia*. This is followed here.

Reviews in Dendy (1905); van Soest (1980); Bergquist & Warne (1980); de Weerdt (1985); Desqueyrouz-Faúndez (1987 and forthcoming); Fromont (1991).

Subgenus *Petrosia* Vosmaer, 1887

Definition.— Spicule complement includes two or three size categories of oxeas or strongyles, in which the smallest is concentrated at the surface.

Petrosia (Petrosia) alfiani spec. nov.
(figs 1A, 2A-C)

Material examined.— Holotype: ZMA POR. 15992, SW Sulawesi, Spermonde Archipelago, NW Kudingareng Keke, 5°09'S 119°16'E, reef slope, on coral sand, 15 m, coll. B.W. Hoeksema, # BH97/0206/007, 2.vi.1997. Paratypes: ZMA POR. 13178, SW Sulawesi, Spermonde Archipelago, Bone Tambung, 5°02'S 119°18'E, reef slope, on coral sand, 20 m, coll. N.J. de Voogd, # NV/180697/K, 18.vi.1997; RMNH POR. 1362, SW Sulawesi, Spermonde Archipelago, NW Kapoposang, 4°60'S 118°98'E, vertical wall, 26 m, coll. B.W. Hoeksema, # 98/SS/MAY01/BH/052, 1.v.1998; ZMA POR. 15995, SW Sulawesi, Spermonde Archipelago, NW Kapoposang, 4°60'S 118°98'E, reef slope, on coral sand, 20 m, coll. B.W. Hoeksema, # BH97/2606/013, 26.vi.1997.

Description.— Shape massive, globular, or thick undividing arm-like branches, of a maximum length of 20 cm, 10 cm in width and 4 cm in height. Holotype ZMA 15992 measures $9 \times 7.5 \times 2$ cm, paratype ZMA 14499 is $8 \times 4 \times 3$ cm. Numerous small oscules are scattered across the sponge body, 2-6 mm in diameter. The surface is smooth and microscopically hispid. The consistency varies from stony hard to very slightly compressible.

Colour.— Bright canary yellow, turns cherry red-brown exposed to air. In spirit light to dark chocolate brown. Preservative turns very dark red-brown.

Skeleton: The ectosomal skeleton is an isodictyal reticulation of multispicular tracts (2-6 μ m), forming irregular round meshes (200-250 μ m in diameter), echinated at the nodes by brushes of the smaller sized spicules. The smaller sized spicules are only present in the ectosomal skeleton. The ectosomal skeleton is obscured by abundant pigment cells. The choanosomal skeleton is more compact with thick multispicular tracts (7-15 spicules) forming round meshes (200-400 μ m in diameter), regularly arranged parallel to the surface. Pigment cells are still present in the choanosome, but not so dense as in the ectosome. Spongin is scarce, causing the stony texture of the sponge.

Spicules.— The species has three sizes of abruptly pointed oxeas or strongyles with smooth rounded ends: $183-253 \times 10-15$ μ m, $106-153 \times 7-14$ μ m, and $60-70 \times 6-7$ μ m.

Etymology.— The species is named after Prof. Dr Alfian Noor. He is co-ordinator of the Buginesia Program and Head of the Radiation Chemistry Laboratory of the Hasanuddin University, Makassar.

Habitat.— On reef slopes, from shallow waters down to 40 m; growing as thick encrusting masses on coral blocks and rubble or coral sand.

Distribution.— Spermonde Archipelago, SW Sulawesi.

Remarks.— The sponge resembles *Petrosia similis* var. *compacta* (Ridley & Dendy, 1887) sensu Hentschel (1912); however the smaller oxeas and the changing from the bright yellow to red brown are not mentioned. The original description by Ridley & Dendy concerns a sponge from Kerguelen in the subantarctic Indian Ocean. It shares the bright yellow colour and it turns likewise to brown when exposed to air. However our newly described species does not exude abundant mucus mentioned by Ridley & Dendy, and the habitus is also very different.

It is unusual for a petrosid to be of a vivid yellow coloration as most of the species are beige, red, brown or black. Desqueyroux-Faundez (1987) described a lemon-yellow species, *Petrosia capsa* from New Caledonia, but this species differs substantially from the new species in oxea sizes and classes (two classes: $140-210 \times 2.5-10$ μ m and

40-60 × 6-8 µm), habitus (massive-cylindrical) and skeleton (thicker fibres). No colour change was noted for *P. capsa*.

Petrosia (Petrosia) hoeksemai spec. nov.
(figs 1B, 2D-F)

Petrosia contignata sensu Van Soest, 1989: 227, fig. 2-45 (not: Thiele, 1899).

Material.— Holotype: ZMA POR. 15991, SW Sulawesi, Spermonde Archipelago, NW Kudingareng Keke, # BH97/2604/002, 26.vi.1997. Paratypes: RMNH POR. 1361, N Sulawesi, SW Nain Island, 01°45'30"N 124°46'E, reef slope, 13 m, # 98/NS/MAY08/BH/094, 8.v.1998; ZMA POR. 16473, SW Sulawesi, Spermonde Archipelago, Bone Lola, 15 m, # NV/BL/260800/086, 26.viii.2000; ZMA POR. 13120, SW Sulawesi, Spermonde Archipelago, NW Langkai I., reef slope, 15 m, # NV/97/1005/004, 10.v.1997; ZMA POR. 13210, SW Sulawesi, Spermonde Archipelago, W Kudingareng Keke I., reef slope, 9 m, # NV/97/0704/008, 7.iv.1997; ZMA POR. 13214, SW Sulawesi, Spermonde Archipelago, E Kudingareng Keke I., reef slope, 9 m, # NV/97/2705/A, 27.v.1997; ZMA POR. 14450, SW Sulawesi, Spermonde Archipelago, W Bone Lola reef, reef slope, 9 m, # 98/SS/APR22/BH/003, 22.iv.1998; ZMA POR. 14474, SW Sulawesi, Spermonde Archipelago, W Langkai I., reef flat, 2 m, # 98/SS/APR29/BH/027, 29.iv.1998; ZMA POR. 14517, N Sulawesi, S off Tilisei I., E Tindila I., 01°48'N 125°03'30"E, reef slope, 19 m, # 98/NS/MAY06/BH/071, 6.v.1998; ZMA POR. 15998, SW Sulawesi, Spermonde Archipelago, NW Kondongbali I., reef slope, # BH97/2606/015, 26.vi.1997; ZMA POR. 16744, SW Sulawesi, Spermonde Archipelago, Kudingareng Keke I., 9 m, # NV/KK/120500/051, 12.v.2000.

Description.— Shape: Arm-thick creeping branches with thick walled oscular chimneys. In some specimens the oscules are more depressed and have a typical sieve-like grid. The texture is stony, the ectosome may be brittle or crumbly. The sponge exudes copious slime when handled, the amount of slime may vary per individual. The holotype is a fragment (5 × 7 × 9 cm) of a larger specimen (7 × 150 cm) and the oscules are 1.5 × 1.5 cm. This species can grow into great size, crawling across and under corals. Stomatopod crustacea are frequently lodged in the choanosome.

Colour.— A warm chocolate red-brown to dark brown-black. The sponge may be very pale in colour (e.g. like in fig. 1B) when growing in caves or underneath overhangs, this species clearly derives its colour from symbionts. The inside is lighter, almost greyish. The colour persists more or less in spirit, but a greyish tinge predominates.

Skeleton.— Ectosomal paucispicular tangential skeleton forming polygonal meshes 150-200 µm in diameter, surrounded by characteristic tufts of small spicules (5-15 spicules). The ectosome is carried by a subectosomal system of tracts (3-8 spicules) and 20-50 µm in width, forming polygonal meshes (250-350 µm in diameter). The ectosomal skeleton is obscured by dark pigment grains. The amount of these grains and the colour is variable between specimens. Choanosomal skeleton consists of thick spicule tracts forming a reticulation of more or less elongated rectangular meshes, 500-1000 µm with a thickness of 100-500 µm.

Spicules.— Abruptly pointed oxeas in three size categories: 240-305 × 10-20 µm, 90-130 × 7-12 µm and 40-75 × 5-9 µm. The smaller spicules only occur in the ectosomal skeleton and form the tufts.

Etymology.— This species is named after Dr Bert W. Hoeksema, renowned coral biologist and head co-ordinator of the marine research group at the National Museum of Natural History, Leiden.

Habitat.— Creeping across live and dead corals, cryptic underneath coral blocks.

Distribution.— Throughout Indonesia.

Remarks.— Previous records of this species were under the name *Petrosia contignata* Thiele, 1899 (e.g. van Soest, 1989), but subsequent examination of the type specimen from the Basel Museum (Nr. 31) showed that this is not a *Petrosia*, but a *Xestospongia* (no size categories of the oxeas). There is also a superficial resemblance to *P. pigmentosa* Fromont, 1991, described from the Great Barrier Reef. We re-examined the type specimen, Museum for Tropical Queensland QM 925020, Whitsunday Island, 20°48'S 149°16'E. This is a cake-shaped fragment with small more or less flush oscules. The skeleton consists of shorter and thinner spicules than those of *P. hoeksemai*, and these are also predominantly strongyles.

The species *P. hoeksemai*, *P. lignosa* and *P. plana* (cf. below) are easily distinguished from each other by habit (respectively repent-branching, cup-shaped and tubular), but their skeletons are very much alike. The meshes of the choanosomal skeleton of *P. lignosa* are somewhat smaller and the overall compactness of the skeleton is looser because of the lack of spongin. *P. plana* appears to be restricted to the Togian Islands and North Sulawesi, while *P. lignosa* is also a widespread species, but occurs in vertical reef habitats, rather than on shallow reef slopes. *P. hoeksemai* spec. nov. is the most common species in the Spermonde Archipelago, and is found in every shallow reef monitored.

Petrosia (Petrosia) lignosa Wilson, 1925
(figs 1C, 3A-C)

Petrosia lignosa Wilson, 1925: 403, pl. 41 fig. 3, pl. 48, fig. 9.

Petrosia spec. Colin & Arneson, 1995: 47, fig. 153.

Material.— ZMA POR. 14485, SW Sulawesi, Spermonde Archipelago, Kapoposang I., 4°60'S 118°98'E, vertical wall at 33 m, # 98/SS/MAY01/BH/038, 1.v.1998; ZMA POR. 14554, N Sulawesi, S Tetapaan I., 01°18'N 124°30'30"E, reef slope 26 m, # 98/NS/MAY12/BH/108, 12.v.1998; ZMA POR. 16745, SW Sulawesi, Spermonde Archipelago, Kapoposang I., vertical wall at 25 m, # NV/KP/020900/106, 2.ix.2000; ZMA POR. 16746, SW Sulawesi, Spermonde Archipelago, Kapoposang I., vertical wall at 30 m, # NV/KP/130900/134, 13.ix.2000.

Description.— Shape. Wide flaring vasiform bowls with a characteristic thickened rim. Outer surface irregular, with blunt projections or bumps. Size may be considerable, up to 1 m in diameter. Inner surface smooth with characteristic annulated ridges, with scattered small oscules. Texture is incompressible, stony.

Colour.— Dull golden brown, inside cream or slighter lighter.

Skeleton.— Ectosomal paucispicular tangential skeleton forming meshes, 150-200 µm in diameter, the sides of which are characteristic tufts of small spicules (5-10 spicules), consisting of an intermediately sized spicule carrying a bouquet of the smallest spicules. Pigment grains are adhering to the binding spongin, not dominating or obscuring the skeleton. The ectosomal skeleton in its turn carried by a subectosomal system of tracts of 3-8 spicules and 20-50 µm in width, forming polygonal meshes, 250-350 µm in diameter. Choanosomal skeleton consists of thick spicule tracts with a thickness of 250-450 µm forming a reticulation of more or less elongated rectangular meshes, 500-1500 µm in diameter.

Spicules.— The spicules are smooth, slightly curved, and range from oxeads to real strongyles; this may vary individually; some contain only strongylotes. The size ranges from large to very small ones, in which 3 categories may be distinguished, $230\text{--}300 \times 14\text{--}18 \mu\text{m}$, $75\text{--}150 \times 10\text{--}13 \mu\text{m}$ and $35\text{--}65 \times 7\text{--}10 \mu\text{m}$.

Distribution.— Sulawesi, Bali.

Habitat.— Vertical reef slopes, 25 m and deeper.

Remarks.— As mentioned above, *P. lignosa* is similar to *P. hoeksemai* and *P. plana* in skeletal features, but they differ strongly in habit. Desqueyroux-Faundez (1987) described a petrosid sponge, *P. capsa*, from New Caledonia which is very similar to *P. lignosa* in habit. She decided, that her species was different from Wilson's species based on skeletal features (much smaller, tighter choanosomal meshes of $300\text{--}400 \mu\text{m}$ only) and spicule dimensions (megascleres only up to $210 \times 10 \mu\text{m}$), and this is confirmed by our material.

Petrosia (Petrosia) nigricans Lindgren, 1897
(figs 1D, 3D-H)

Petrosia nigricans Lindgren, 1897: 5, pl. 17 fig. 5, pl. 19 fig. 4; Van Soest, 1989: 226.

Petrosia imperforata Thiele, 1899: 20, pl. 2 fig. 7, pl. 5 fig. 12.

Petrosia cancellata Thiele, 1903: 938, fig. 3.

Petrosia nigricans var *irregularis* Hentschel, 1912: 405.

Material.— Holotype: Uppsala University Zoological Museum, Nr. 391, Java.

ZMA POR. 09610, SW Sulawesi, Spermonde Archipelago, Samalona I., 18 m, coll. H. Moll, 18.x.1980; ZMA POR. 14448, SW Sulawesi, Spermonde Archipelago, Bone Lola reef, reef slope 7 m, coll. B.W. Hoeksema, # 98/SS/APR22/BH/001, 22.iv.1998; ZMA POR. 14491, SW Sulawesi, Spermonde Archipelago, Kapoposang I., $4^{\circ}60'S$ $118^{\circ}98'E$, vertical wall, 19 m, coll. B.W. Hoeksema, # 98/SS/May01/BH/044, 1.v.1998; ZMA POR. 14511, N Sulawesi, South off Bangka I., rocks off Tanjung Sahaong, $01^{\circ}45'N$ $125^{\circ}9'30"E$, 12 m, coll. B.W. Hoeksema, # 98/NS/May06/BH/064, 6.v.1998; ZMA POR. 15988, SW Sulawesi, Spermonde Archipelago, Samalona I., coll. B.W. Hoeksema, # BH97/0405/008, 4.v.1997; ZMA POR. 15989, SW Sulawesi, Spermonde Archipelago, Samalona I., coll. B.W. Hoeksema, # BH97/1205/001, 12.v.1997; ZMA POR. 15993, SW Sulawesi, Spermonde Archipelago, Samalona I., coll. B.W. Hoeksema, # BH97/1205/007, 12.v.1997.

Description.— Shape. Lamellate, flabelliform, cup-shaped or broadly tubular sponges. The size may be considerable, up to 150 cm in height, 200 cm in diameter and with a lateral thickness of up to 10 cm. The outside surface is undulate or irregularly sharply ridged, almost honeycombed, while the inner side is smooth. Oscules, other than an eventual vent in more tubular specimens are not very obvious, but are 0.5–1 cm in diameter and are slightly elevated. Copious slime is exuded when the sponge is cut or put in alcohol. The amount of slime may be variable per specimen.

Colour.— Chocolate-brown to dark, almost black-brown; choanosome is lighter coloured. These colours more or less persist in spirit, although a greyish tinge predominated.

Skeleton.— The ectosomal skeleton is a tangential reticulation of bundles and single larger megascleres, on the nodes of which short bushes of small megascleres are erected. Brushes consist of 6–8 spicules which are intertwining. The ectosomal skeleton often contains large pigment grains. The subectosomal tracts consist of 10–20 spicules and are

40-100 μm in diameter. The hexagonal subectosomal meshes are 100-450 μm in diameter. This region is independent from the choanosomal skeleton and is easily detachable. The choanosome is a system of thick spicule tracts forming large almost rectangular meshes, 500-900 μm in diameter. The tracts consist of 20 or more spicules and are 100-500 μm in diameter, sponging is not visible, but the tracts are distinct. Pigment grains are also present in the choanosome, but not so abundant as in the ectosome.

Spicules.— Oxeas and strongylote modifications, predominantly bluntly pointed, but occasionally sharply pointed or even rounded, in 3 distinct size categories: 240-305 \times 8-16 μm , 120-188 \times 9-10 μm , and 57-85 \times 5 μm . The smaller category only occurs in the ectosomal tufts.

Habitat.— From 3 to 45 m depth. Smaller specimens grow attached to coral rubble or more cryptic, whereas the larger sized specimens may grow on sand slopes. Lionfishes are often associated with this sponge and it provides shelter for large variety of reef animals. Crinoids and large numbers of holothurians of the genus *Synaptula* are often present on the outside of the sponges.

Distribution.— Apparently widely distributed in the Indo-Australian area.

Remarks.— The type specimen of Lindgren (fig. 3E) originated from the Java Sea. A small thick plate of 7 \times 7 \times 3 cm is the remnant of an originally larger specimen. The consistency is stony, the colour greyish brown and no oscules are visible. The oxeas of the type (fig. 3D) are obviously thicker (20 μm), than the specimens from the material we examined (up to 14 μm), but this may be caused by different environmental silica levels.

We re-examined Thiele's (1899) *P. imperforata* (Basel Museum nr. 28) and found the skeleton to be in complete accordance with our own specimens. The fragment of Thiele had an undulating but essentially smooth surface like Lindgren's fragment.

Fromont's (1991) *P. pigmentosa* from the Great Barrier Reef, which is a massive sponge with short protuberances, shows some similarity to *P. nigricans*. After examination we concluded that this is a different species, based on the differences in habit, texture and the size of the spicules (these are shorter and thinner strongyles in *P. pigmentosa*). Oscules are also not conspicuous. The importance of mucus is stressed here, but according to our observations, mucus excretion may vary between specimens of the same species.

Thiele (1903) described *P. cancellata* from Ternate (Indonesia, northern Moluccas) as a small fragment of an apparently bigger specimen. He mentioned that his specimen may very well be *P. nigricans*, but that the surface of Lindgren's type is completely smooth and even, while his specimen's surface is more undulating. The oxeas are of various sizes, but he gives only the largest measurements, 250 \times 16 μm . The habit is described ambiguously, but because he mentions the resemblance to *P. nigricans*, and because in our experience the surface features show great variation, from smooth to almost honeycombed, we suggest that *P. cancellata* is a synonym of *P. nigricans*.

Hentschel (1912) described *P. nigricans* var. *irregularis* from the Aru Islands (Indonesia, eastern Moluccas). He mentioned the similarities to Lindgren's material, but its skeleton is more confused and the oxeas are different in form. We believe this to fall within the variation of the nominal species.

P. nigricans is a common, prominent, large species in the Spermonde Archipelago and elsewhere in eastern Indonesia, and we think this species could hardly have been

overlooked in the past by collectors.

The skeleton and spicule sizes often differ only slightly between different *Petrosia* species, thus we stress the importance of the habit in designating the different species.

Petrosia (Petrosia) plana Wilson, 1925
(figs 1E, 4A-D)

Petrosia lignosa var. *plana* Wilson, 1925: 404, pl. 41 figs 4-5.

Material.— ZMA POR. 14516, N Sulawesi, S off Tilisei I., E slope Tindila I., 01°48'N 125°03'30"E, reef slope, 19 m, # 98/NS/MAY06/BH/070, 6.v.1998; ZMA POR. 14520, N Sulawesi, Tanjung Torowitan, 01°45'N 124°58'30"E, steep slope, 29 m, # 98/NS/MAY06/BH/074, 6.v.1998; ZMA POR. 14541, N Sulawesi, SW Nain I., 01°45'30"N 124°46'E, reef slope, 13 m, # 98/NS/MAY08/BH/095, 8.v.1998. All three specimens were collected by B.W. Hoeksema.

Description.— Shape. Massive cylindrical tube, several tubes may be fused together. The texture is stony and the surface is slightly roughened.

Colour.— Grey-brown to dark brown, choanosome lighter in colour. The colour persists more or less in spirit. Copious slime is exuded when handled.

Skeleton.— Ectosomal paucispicular tangential skeleton forming meshes, 60-150 µm in diameter, the sides of which consist of characteristic tufts of small spicules with intermediate sized spicules carrying a bouquet of 5-10 of the smallest spicules. The ectosome is carried by a subectosomal system of tracts, 3-8 spicules and 15-50 µm in width, forming polygonal meshes, 150-250 µm in diameter. Choanosomal skeleton consists of thick spicule tracts, 100-400 µm in width, forming a reticulation of more or less elongated, rectangular meshes, 500-1000 µm in size. Choanosomal tracts contain more spongin than those of the ectosome. Pigment grains are present throughout the body.

Spicules.— These are abruptly pointed oxeas in 3 size categories, 190-290 × 7-14 µm, 95-130 × 7-9.5 µm and 43-75 × 5-9 µm.

Habitat.— Reef slopes from 15m to deeper waters.

Distribution.— North Sulawesi, Togian Islands.

Remarks.— Wilson (1925) described two new petrosid species from the Togian Islands, *P. lignosa* and *P. lignosa* var. *plana*. He emphasised the similarities in habit and skeletal features, but distinguished a cylindrical var. *plana* with a smooth surface, from the cup-shaped nominal variety with irregular protuberances on the outside. *P. plana* is also similar in many features to *P. nigricans*, but that species has obviously thicker subectosomal tracts, consisting of 10-20 spicules, whereas those of *P. plana* have only 3-8 spicules.

Subgenus *Strongylophora* Dendy, 1905

Definition.— *Petrosia* with 4 or 5 categories of strongyles including sharp angled microxeas concentrated at the surface, occasionally partly oxeas, and sharp angled microxeas concentrated at the surface.

Petrosia (Strongylophora) corticata (Wilson, 1925)
(figs 1F, 5A-C)

Strongylophora corticata Wilson, 1925: 392, pl. 40 fig.7, pl. 48 figs 2,7.

Strongylophora strongylata; Colin & Arneson, 1995: 48, fig. 157 (not: Thiele, 1903).

Tabulocalyx corticatus; Pulitzer-Finali, 1996: 126, figs 23-24.

Material.— ZMA POR. 16748, SW Sulawesi, Spermonde Archipelago, Barang Lompo I., 15 m, # NV/BA/061000/151, 6.x.2000; ZMA POR. 08254, Tukang Besi Islands, southern reef of Karang Kaledupa, east of entrance, 05°56'S 123°48'E, 4-10 m, 6.ix.1984, coll. R.W.M. van Soest, Dutch-Indonesian 'Snellius II' Exped. stat. 016/III/44.

Description.— Shape. Undulating smooth branches, 3-10 cm diameter, up to 30+ cm long; numerous small typical sieve-like oscules (4-8 mm) are scattered across the surface. The ectosome forms a distinct, firm rind; is slightly transparent and easily detachable from subdermal regions. The inside is pulpy.

Colour.— Ochre-greenish tinge, in spirit dull brown.

Skeleton.— The ectosome is a paucispicular reticulation of the larger spicules forming irregular triangular meshes, with perpendicular tufts of the intermediate spicules, and with moderate amounts of echinating microxeas and microstrongyles. Subectosomal tracts form regular polygonal meshes, 100-300 μ m in diameter. The tracts of 2-4 spicules are 30 μ m in width, and consist mainly of the larger spicules. The choanosomal skeleton is dense, tracts are 250-300 μ m in width, and many spicules are scattered loosely and singly.

Spicules.— The dominating spicules are strongyles, smooth, slightly curved with evenly rounded ends. The strongyles appear to occur in 3 sizes, 300-360 \times 11-14 μ m, 80-200 \times 11-14 μ m, and 21-50 \times 3-9 μ m. Many immature spicules of these are oxeas, 70-300 \times 6 μ m, and these lie in between the meshes. Sharp angled ectosomal microxeas are 30-45 \times 1-3 μ m.

Habitat.— Shallow reefs.

Distribution.— Philippines, eastern Indonesia, Papua New Guinea.

Remarks.— Pulitzer-Finali (1996) assigned this species to the genus *Tabulocalyx* Pulitzer-Finali (Phloeodictyidae), because of the difference in the skeletal structure with other species of *Petrosia (Strongylophora)*, but admitted that the spiculation is indistinguishable from *Strongylophora*. The pulpy ectosome is clearly unusual for the normal stony texture of the family Petrosiidae; this feature together with the easily detachable ectosome fits better in the family Phloeodictyidae. However, the spicules are unmistakably those of *Petrosia (Strongylophora)*. Moreover, typical phloeodictyid sponges have fistules issuing from a turnip-shaped body.

Colin & Arneson (1995) mistook this species for the closely related *P. (S.) strongylata*. This is a dark coloured tube-shaped species, which also has clearly smaller ectosomal strongyles (see below).

Petrosia (Strongylophora) strongylata (Thiele, 1903)
(figs 1G, 5D-F)

Strongylophora strongylata Thiele, 1903: 938, fig. 2.

Not: *S. strongylata*; Colin & Arneson, 1995: 48, fig. 157 (= *P. corticata*).

Material.— ZMA POR. 13155, SW Sulawesi, Spermonde Archipelago, Bone Baku reef, 15 m, coll. N.J. de Voogd, # NV/97/2005/030, 20.v.1997; ZMA POR. 16747, SW Sulawesi, Spermonde Archipelago, Samalona I., 9 m, # NV/SA/241100/189, 24.xi.2000; ZMA POR. 9011, NE coast of Sumba, E of Melolo, 09°54.2'S 120°43.5'E, coll. R.W.M. van Soest, 15.ix.1984, dredged at 50 m, Dutch-Indonesian 'Snellius II' Exped. stat. 4.061/V/12.

Description.— Shape. Smooth tube, up to 4 cm in diameter, up to 6 cm long, rising from a broader base; conspicuous concentric rings inside the tube. Consistency extremely hard and stony.

Colour.— Dark-brown to black, choanosome lighter in colour.

Skeleton.— The ectosome is a tangential skeleton of single spicules arranged in triangular meshes forming a larger hexagonal system. Vague brushes of middle sized spicules are arranged on the nodes of the triangular meshes. Microxeas and microstrongyles echinate the single spicules. The subectosomal skeleton consists of larger spicules forming polygonal meshes (50-250 µm in diameter) of bundles consisting of 2-4 spicules. These bundles are 40-50 µm in diameter. A very dense choanosomal skeleton consists of a reticulation of spicule tracts, cored by 20+ larger and smaller spicules, diameter 70-150 µm, forming polygonal meshes, 150-250 µm in diameter. Loose single spicules are scattered in between the meshes.

Spicules.— True strongyles, isodiametric, some are curved, many juvenile stages are thin blunt oxeas; 3 size categories can be distinguished; $326 \times 18 \mu\text{m}$, $95\text{-}145 \times 10\text{-}12 \mu\text{m}$ and $44\text{-}60 \times 8\text{-}12 \mu\text{m}$. Abruptly pointed, curved microxeas; $28\text{-}32 \times 1\text{-}2 \mu\text{m}$.

Habitat.— Cryptic, in caves and under coral overhangs.

Distribution.— Throughout Indonesia, Papua New Guinea.

Remarks.— This species was originally assigned to the genus *Strongylophora*, based on the presence of microstrongylote spicules and characteristic sausage-shaped microstrongyles; however this feature is now included in the genus *Petrosia*. Both *P. corticata* and *P. strongylata* have the characteristic echinating micro-oxeas in the ectosomal skeleton, but the species are easily distinguishable from each other on basis of habit. In addition to this, the ectosomal microstrongyles of *P. corticata* ($21\text{-}50 \times 3\text{-}9 \mu\text{m}$) are much smaller in size than those of *P. strongylata* ($44\text{-}60 \times 8\text{-}12 \mu\text{m}$).

Key to the species genus *Petrosia* of eastern Indonesia

- 1 Creeping arms or thickly encrusting with prominent oscules 2
- Tubes, vases or lamellate 4
- 2 Bright yellow *Petrosia (Petrosia) alfiani*
- Brown or ochre-greenish 3
- 3 Detachable ectosome and pulpy from the inside *Petrosia (Strongylophora) corticata*

- Stony texture, pigment grains abundant *Petrosia (Petrosia) hoeksemai*
- 4 Microxeas echinating ectosomal tracts..... *Petrosia (Strongylophora) strongylata*
- Megascleres strongyles to oxeas, no microxeas 5
- 5 Cup/bowl-shaped with narrow base and a thickened rim.....
..... *Petrosia (Petrosia) lignosa*
- Tubes or vases with broad base, or upright plates..... 6
- 6 Cylindrical smooth tubes *Petrosia (Petrosia) plana*
- Lamellate, flabelliform, or broadly tubular sponge..... *Petrosia (Petrosia) nigricans*

Discussion

The *Petrosia* species treated here form a common and striking complement of Indonesian reefs. There is a considerable list of additional *Petrosia* species recorded from this area in the literature. Based on re-examination of type material or on published descriptions, many of these do not conform to the definition of *Petrosia* employed here, but rather are valid species or junior synonyms of species belonging to the genus *Xestospongia*. Examples are *P. chaliniformis* Thiele, 1899, *P. contignata* Thiele, 1899, *P. expansa* Thiele, 1903, *P. pulvilla* Thiele, 1899, *P. rava* Thiele, 1899, *P. seriata* Hentschel, 1912, *P. similis granulosa* Wilson, 1925, *P. truncata aruensis* Hentschel, 1912, and *P. densissima* Dendy, 1905.

Remaining species recorded from the Indo-Malayan area which are likely to be true *Petrosia* are: *Petrosia (Petrosia) brachysclera* Lévi & Lévi, 1989, *Petrosia (Petrosia) hebes* von Lendenfeld, 1888, and *Petrosia (Strongylophora) durissima* Dendy, 1905.

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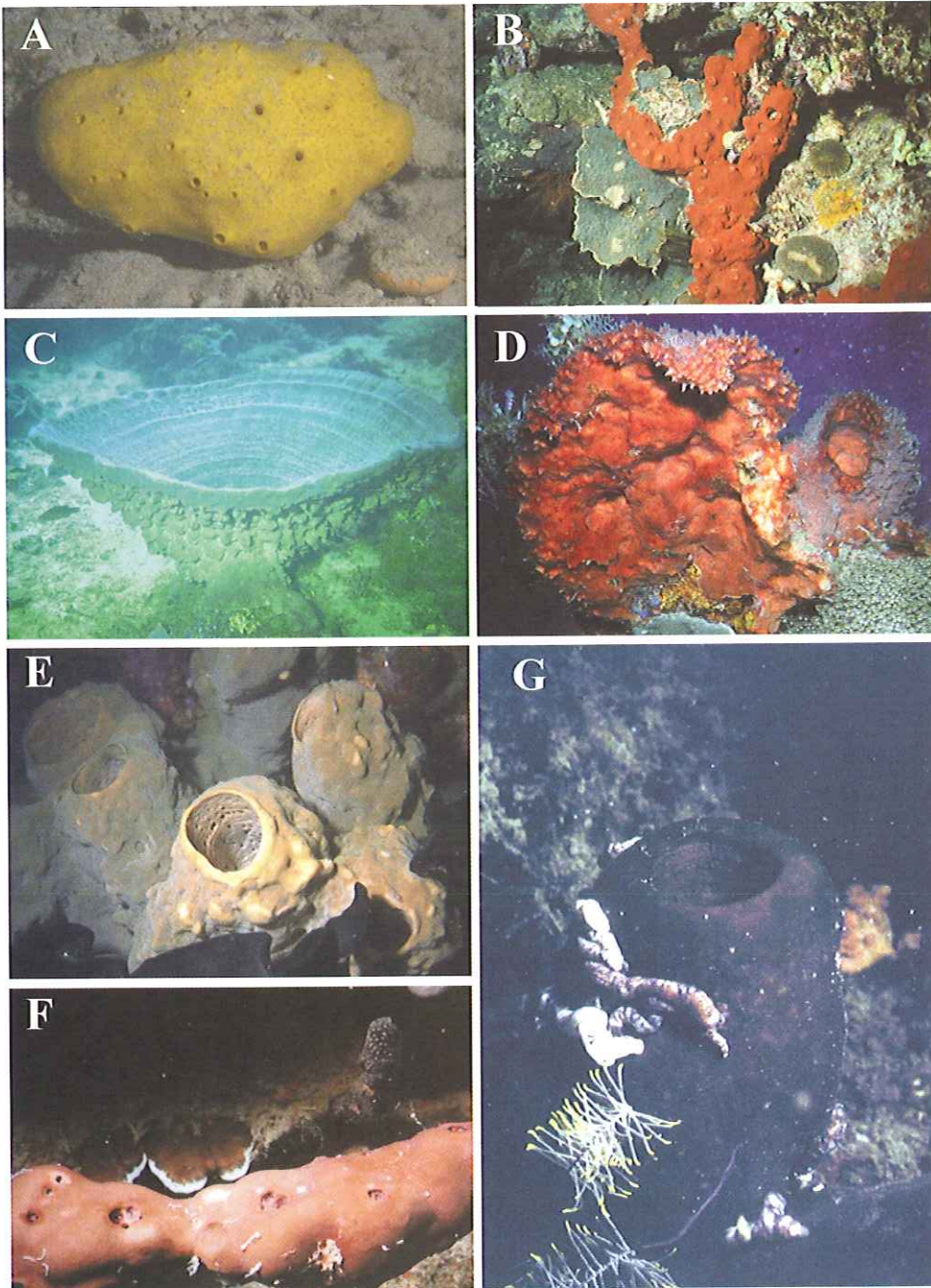


Fig. 1. In situ photos of Indonesian *Petrosia* species, A. paratype of *Petrosia alfiani* spec. nov. (ZMA POR. 14999), photo B.W. Hoeksema; B. holotype of *Petrosia hoeksemai* spec. nov. (ZMA POR. 15991), photo B.W. Hoeksema; C. *Petrosia lignosa* (ZMA POR. 14554), photo B.W. Hoeksema; D. *Petrosia nigricans* (ZMA POR. 15989), photo B.W. Hoeksema; E. *Petrosia plana* (ZMA POR. 14516 and ZMA POR. 14520), photo B.W. Hoeksema; F. *Petrosia corticata* (ZMA POR. 16478), photo N.J. de Voogd; G. *Petrosia strongylata* (ZMA POR. 16747), photo N.J. de Voogd.

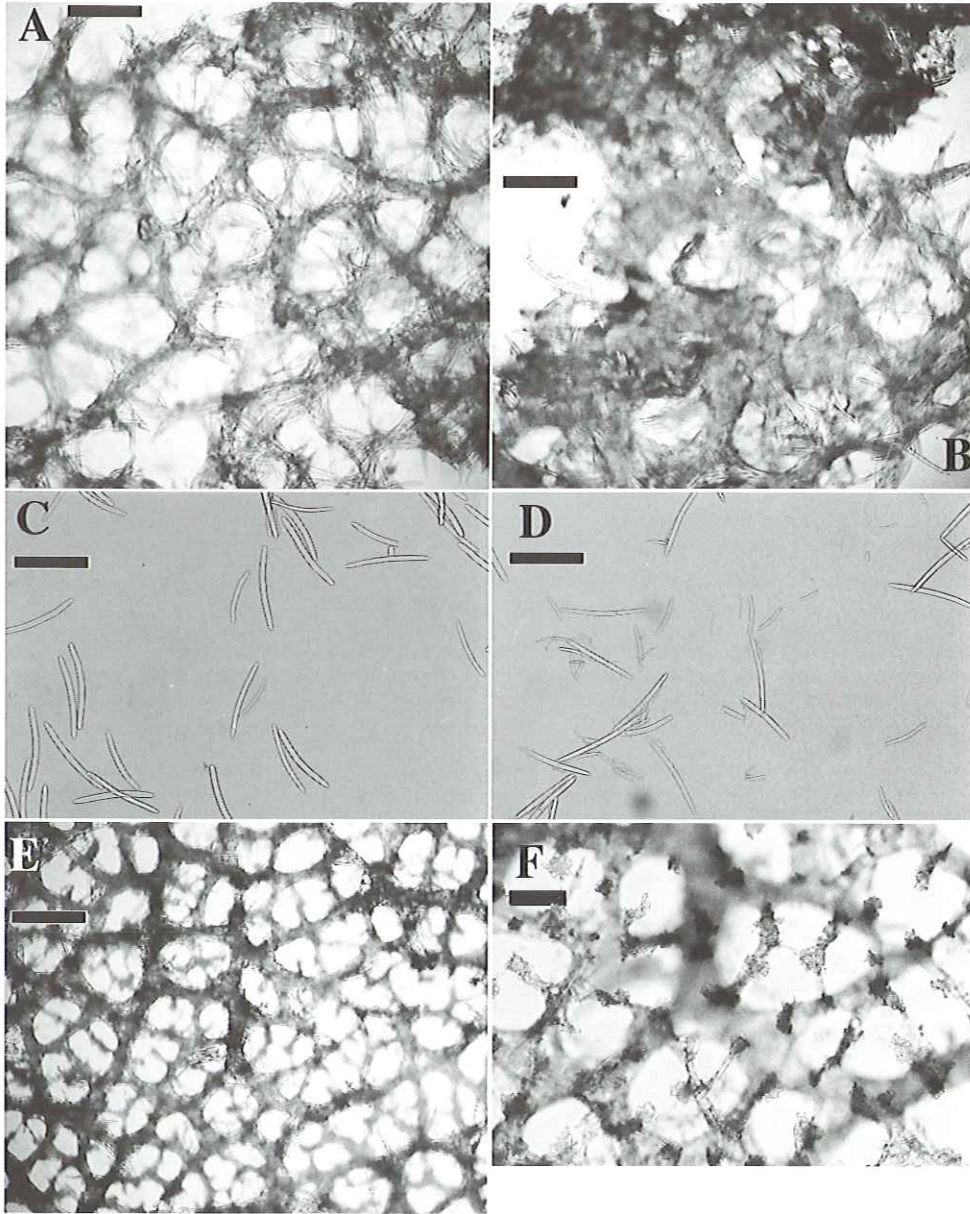


Fig. 2. A-C. *Petrosia (Petrosia) alfiani* spec. nov., holotype ZMA POR. 15992, A. tangential view of ectosomal skeleton (scale = 250 μ m), B. cross section of choanosomal skeleton (scale = 250 μ m), C. spicules (scale = 250 μ m). D-F. *Petrosia (Petrosia) hoeksemai* spec. nov., D. spicules (scale = 250 μ m), E. tangential view of ectosomal skeleton (scale = 250 μ m), F. ditto at larger magnification to show brushes of microxea (scale = 100 μ m).

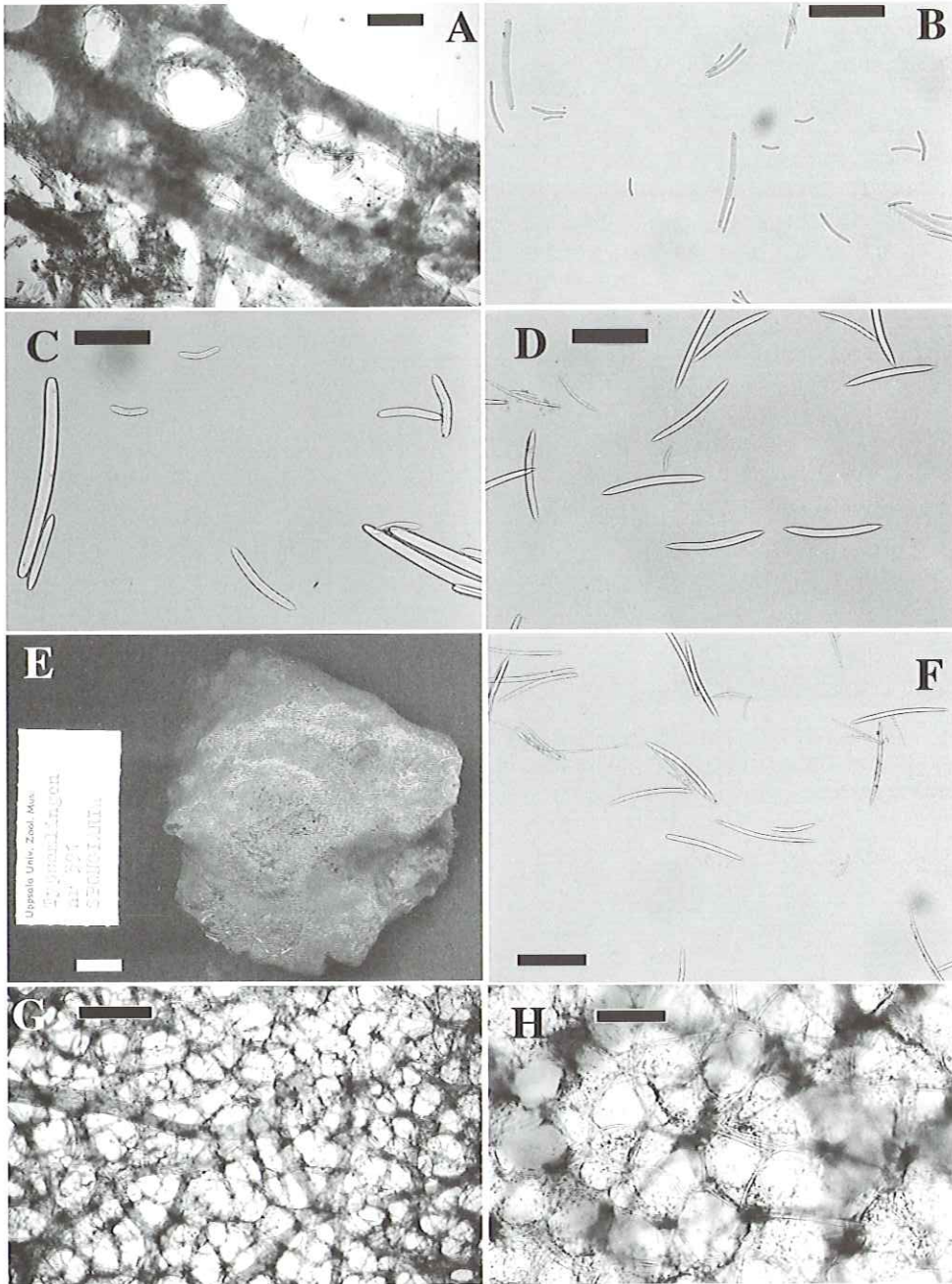


Fig. 3. A-C. *Petrosia (Petrosia) lignosa*, A. cross section of choanosomal skeleton (scale = 500 μ m), B. overview of spicules (scale = 250 μ m), C. detail of spicules (scale = 100 μ m). D-H. *Petrosia nigricans*, D. spicules of holotype Uppsala Mus. nr. 391 (scale = 100 μ m), E. holotype of *P. nigricans* Lindgren, Uppsala Mus. nr. 391 (scale = 1 cm), F. spicules of ZMA POR. 15989 (scale = 100 μ m), G. tangential view of ectosomal skeleton of ZMA POR. 15989 (scale = 250 μ m), H. detail of ectosomal skeleton of ZMA POR. 15989 (scale = 100 μ m).

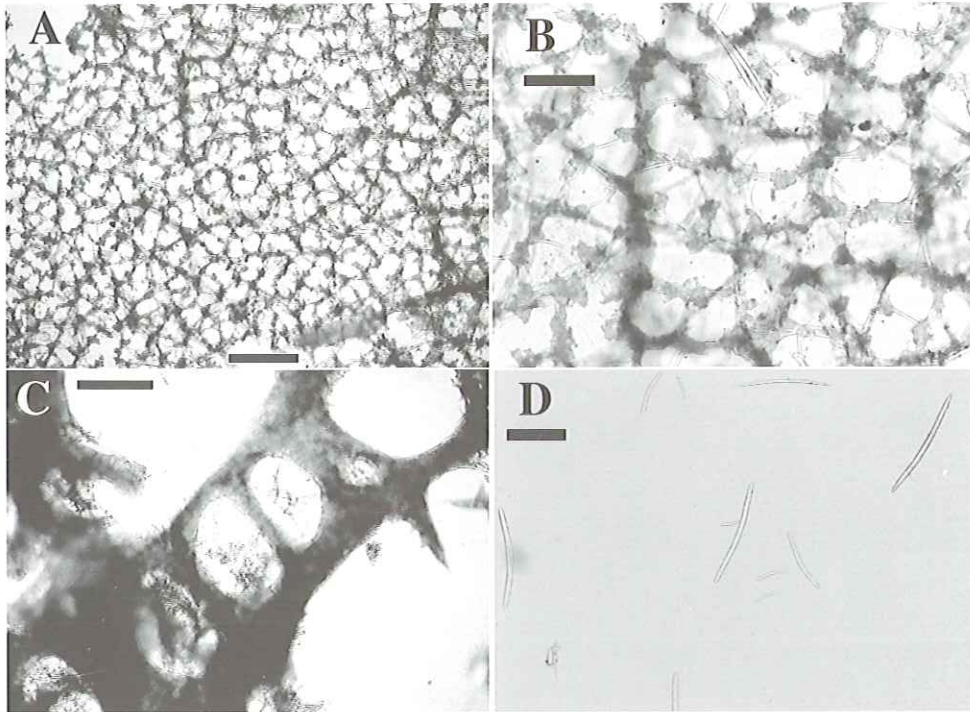


Fig. 4. *Petrosia (Petrosia) plana*, A. tangential view of ectosomal skeleton (scale = 250 μm), B. at greater magnification (scale = 100 μm), C. cross section of choanosomal skeleton (scale = 500 μm), D. spicules (scale = 100 μm).

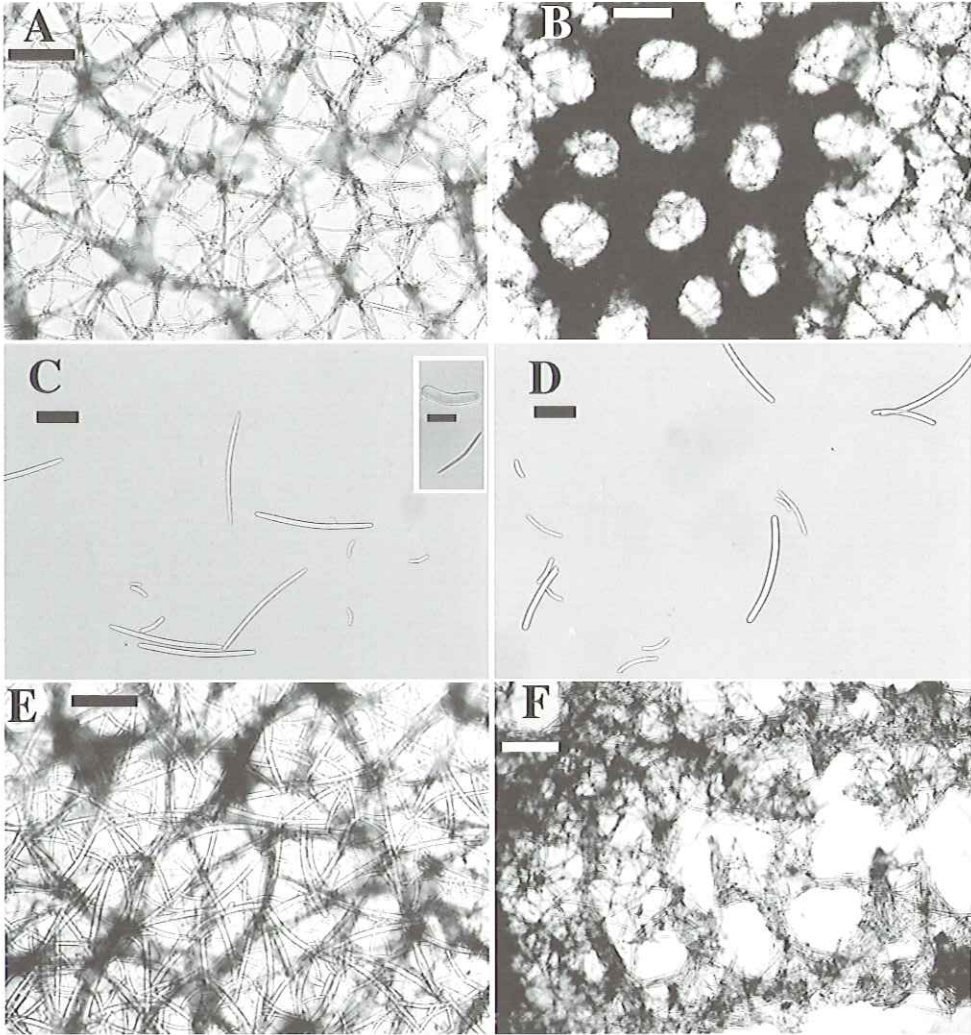


Fig. 5. A-C. *Petrosia (Strongylophora) corticata*, A. tangential view of ectosomal skeleton (scale = 100 μm), B. subectosomal skeleton (scale = 250 μm), C. spicule overview and detail of microxea/microstrongyle (scale overview = 100 μm , inset = 25 μm). D-F. *Petrosia (Strongylophora) strongylata*, D. spicules (microxeas lacking) (scale = 100 μm), E. tangential view of ectosomal skeleton (scale = 100 μm), F. cross section of choanosomal skeleton (scale = 250 μm).