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Horny sponges from the north-eastern coast of Papua New Guinea, Bismark Sea

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A small collection of horny sponges from the north-eastern coast of Papua New Guinea is recorded. It consists of 19 specimens belonging to ten species, of which three are new: *Thorectaxia papuensis*, *Chelonaplysilla delicata*, *Anomoianthella lamella*. *Thorectaxia* is proposed as a new genus in the family Thorectidae.

INTRODUCTION

The sponges recorded here have been collected in the shallow-waters of the island of Laing (04°09′S–144°52′E) in the north-eastern coast of Papua New Guinea (Figure 1). The marine environment of these coasts seems to be extremely favourable to the development of a rich and varied sponge fauna (Bakus & Orsmby, 1994). The factors that may contribute to the high species richness of the area are: (i) the survival of the descendants of the tethyan fauna (from late Jurassic) in refuges (Vermeij, 1978); (ii) the isolation of populations in marine basins by land bridges during the Eocene to Pleistocene (McManus, 1985); (iii) the high physical heterogeneity of coral reefs and the evolution in epibenthic invertebrates of allelochemical defences (Bakus, 1964, 1981). Notwithstanding Papua New Guinea is located in a geographic area (Indo–Polinesia) considered to contain the highest diversity of living species of shallow water marine animals (Briggs, 1987), few sponge species are recorded (Hooper & Levi, 1994), indeed very few papers (Bowerbank, 1877; Brønsted, 1934; Kelly-Borges & Bergquist, 1988; Thomas, 1982, 1991; Sarà, 1992; Pulitzer-Finali, 1996) describe the Porifera living in this region. The present paper increases the knowledge on the sponge richness and biodiversity of a very poorly studied geographic area.

MATERIALS AND METHODS

The hydrological and climatic conditions of the sampling site were described by Bouillon et al. (1986), and are characteristic of the Insular–Pacific biogeographic subregion (Indo-West-Pacific region) after Ekman (1953); the sponge habitat is summarized by Sarà (1992).

Sponge samples were collected by SCUBA in the summer 1986. Data on specimen morphology and ecology were recorded on a field note book just after collection; the specimens were catalogued (P.38, P.107, P.73, P.76, etc.), fixed in formaldehyde (4% in seawater), and preserved in 70% ethanol.

Sponge specimens were first photographed *in toto*, then fragments were studied by optical and scanning microscopy.

Skeletons were separated manually from the choanosome at the dissection stereo-microscope, dehydrated in a graded series of ethanol and mounted on stubs (after critical point drying and gold coating) for scanning electron microscopy (SEM) observations, with a Philips EM 515; traditional slides of skeletons were also mounted in Eukitt (O. KindlerGmbH & Co.) for light microscopy.

The study of histological features was performed by light microscopy on 5 μm sections mounted in metacrylate and stained with toluidine blue.

The sponge surface was studied by SEM on small fragments dried and coated as described.

The specimens are deposited at the 'Museo di Storia Naturale Giacomo Doria' (MSNG), via Brigate Liguria 9, I-16121, Genova, Italy.

SYSTEMATICS

Order DICTYOCERATIDA Minchin, 1900
Family SPONGIIDAE Gray, 1867

Carteriospongia flabellifera (Bowerbank) (Figure 2)
Polyfibrospongia flabellifera Bowerbank, 1877: 459.

Material. Specimen P. 38, depth 6 m, 15 August 1986.

The sponge consists of an upright, curved lamella 21 cm broad, 12 cm high, 2–3 mm thick, growing up from a narrow, 1 cm wide base. Its colour in life was noted as violet brown; it is light brown in spirit. The texture of the sponge is tough, compact, not compressible, but flexible and pliable owing to its foliose structure.

The convex, inhalant face of the lamella is marked by ridges (bearing numerous 0.2–0.5 mm wide ostia), starting from the base and diverging toward the margin (Figure 2A). Ridges are visible, even though less pronounced, on the concave face also. The latter bears scattered circular oscules flush with the surface, 0.5–1 mm wide, 1–2 cm apart.

A sandy layer (Figure 2B) covers both surfaces. The supporting skeletal network shows parallel structures (Figure 2C). The primary fibres of the skeleton are coarsely cored by sand grains, have a variable diameter, about 50–120 μm, and an uneven outline (Figure 2F). The secondary fibres are free of inclusions, 15–30 μm thick,

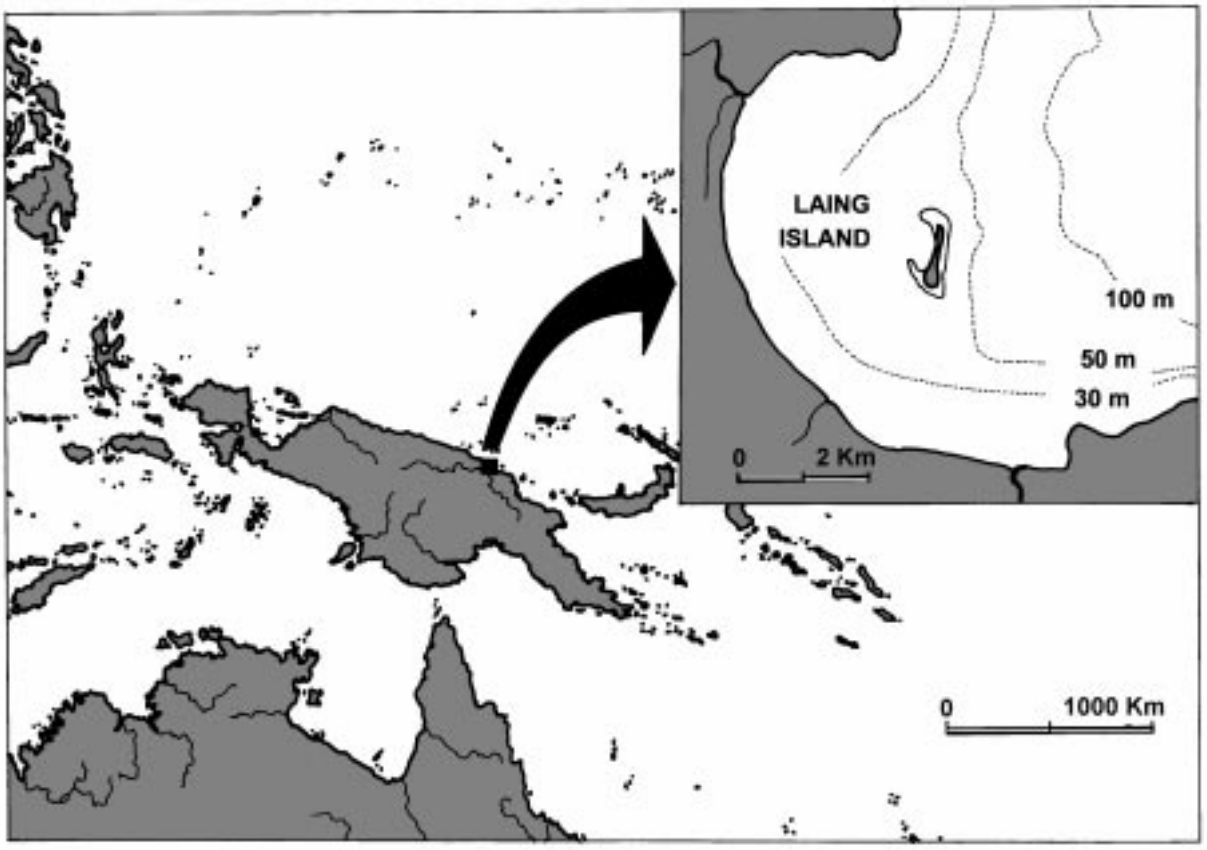

Figure 1. The island of Laing in the north-eastern coast of Papua New Guinea, Bismark Sea.

show a loose texture (Figure 2G). The vermiform elements are uncored, have a diameter of 5–15 μm and often anastomose (Figure 2E,H). Intertwined, the secondary fibres and vermiform elements, surround the ascending primary fibres (Figure 2D).

The morphological characters of our specimen are in agreement with Bergquist et al. (1988).

Distribution: Papua New Guinea, Eastern Australia.

Family THORECTIDAE Bergquist, 1978

Hyrtios gumminea (Ridley) (Figure 3)
Dysidea gumminea Ridley, 1884: 597.
Dysideopsis reticulata Thiele, 1899: 28.

Material. Specimens P.107, P.73, P.76, P.81, depth 15 m, 10–20 August 1986; specimens P.51, P.113, depth 1 m, 20 August 1986.

The specimens were growing erect, more or less regularly cylindrical, digitate. The largest fragment is 13 cm high, about 2 cm in diameter (Figure 3A). The consistency is tough, scarcely compressible but easy to break. The surface is regularly covered by minute conules, less than 1 mm high and 1.5–2 mm apart. A delicate, separable dermal membrane shows a fine reticulation radiating from the conules (Figure 3B). The oscules are few, sparse, round, 1–2 mm wide. The colour of preserved specimens is dark brown.

The skeleton is reticulated, dense, with irregular meshes about 150–380 μm wide (Figure 3C). The fibres, not distinguishable as primaries and connectives, consist of foreign debris (mostly sand grains, with few spicule fragments) bound by inconspicuous spongin (Figure 3F). They have a very irregular outline and are about 50–150 μm thick (Figure 3E). The conules are not the termination of a main fibre: their skeletal structure is reticulated, the same as in the rest of the body (Figure 3D). What in some conules may appear as a primary fibre is limited to the conule itself, never extending below into the mass of the sponge.

The lack of distinct primary fibres in all our specimens, in agreement with Ridley's original description, appears to be an important diagnostic feature which is not shared by some species currently synonymized with *H. gumminea* (cf. Hooper & Wiedenmayer, 1994: 231). In *Heteronema erecta* Keller, 1889: 340 the main fibres are conspicuous, four to five times thicker than the connective ones and fasciculated. In *Duriella nigra* Row (1911: 370) the strong main fibres are peculiar enough to deserve a new term: 'fibre-lines'.

Dysideopsis (now *Hyrtios*) *reticulata* Thiele (1899: 28), as redescribed by Bergquist (1995: 11) Figure 4B, does not appear to be distinct from *H. gumminea*. Bergquist's figure perfectly illustrates Ridley's observations that 'pseudo main fibres' are limited to the conules.

In our opinion, one of the peculiar characters of the genus *Hyrtios* is the absence of a differentiation of primary and secondary fibres in the skeletal network. At present some species, in which skeleton a differentiation in main and connective fibres is evident, are encompassed in the genus: this is the case of *Heteronema erecta* and *Duriella nigra* that might be separated in a different taxon.

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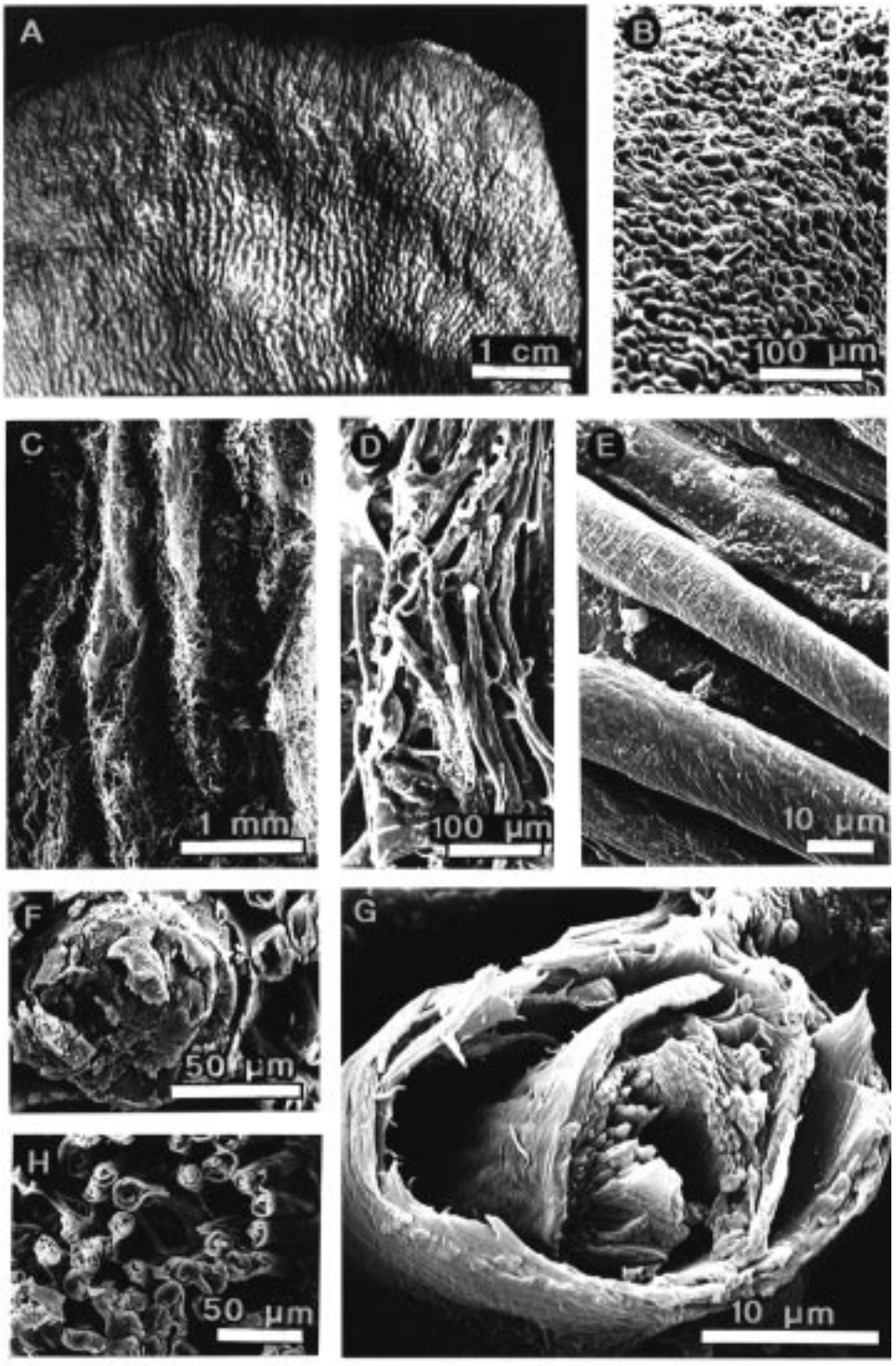

Figure 2. *Carteriospongia flabellifera*: (A) specimen P.38, inhalant surface; (B) the sandy layer shown by both sponge surfaces; (C,D) ascending skeletal columns of main and secondary fibres intertwined with vermiform elements; (E) surface of vermiform elements; (F) cross-section of main fibre; (G) cross-section of secondary fibre; (H) cross-section of vermiform elements.

Distribution: Indian Ocean, Red Sea, Eastern Mediterranean, Northern and Central Pacific.

Thorectaxia gen. nov.

Thorectidae with an axially concentrated skeleton consisting of fasciculated main fibres, irregularly connected by secondary ones. From this structure, single main fibres diverge toward the surface up to the conules. Main fibres and connective ones are always free of foreign inclusions, and show a laminate loose structure whose axis is granular or supplied with a large empty core.

The unique architecture of the skeletal network is quite different from any other described so far, allowing the establishment of a new genus. The concentric laminated structure of skeletal fibres permit inclusions of this new genus in the family Thorectidae; the diplodal organization of the spherical flagellate chambers is in agreement with the diagnosis of the family (Bergquist, 1980).

Type species: *Thorectaxia papuensis* sp. nov.

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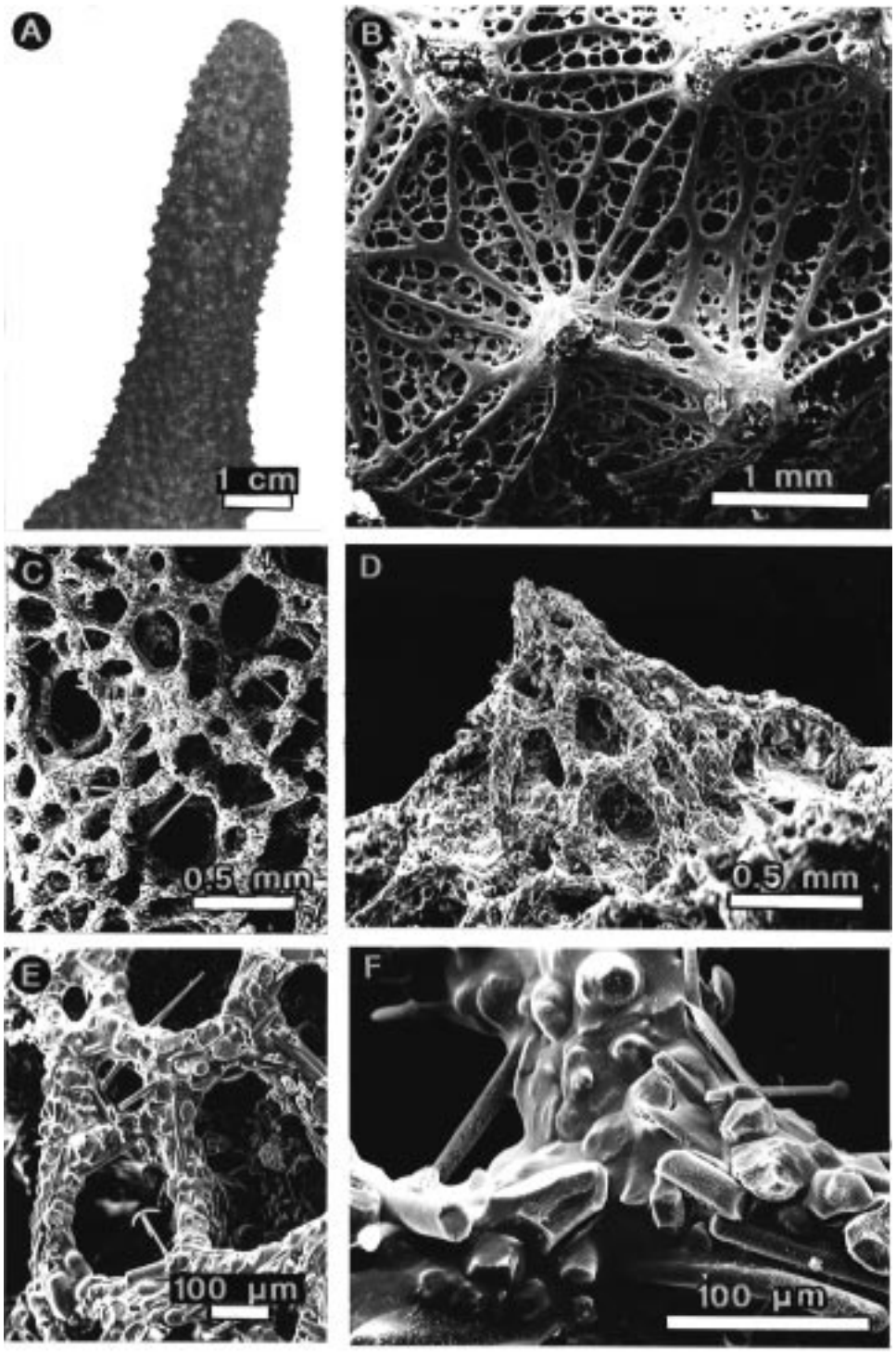

Figure 3. *Hyrtios gumminea*: (A) specimen P.107; (B) the dermal membrane connecting conules, specimen P.73; (C,E,F) the skeletal reticulation consisting of foreign debris (mostly sand grains with few spicule fragments) bound by inconspicuous spongin, specimen P.107; (D) the skeletal structure of a conule, specimen P.107.

Thorectaxia papuensis, sp. nov. (Figure 4)

Material. Specimen P. 42, depth 5 m, 23 August 1986.
Holotype. MSNG-C.E.49175.

The specimen is cylindrical, 1–1.5 cm thick, 10 cm long, the base is missing (Figure 4A). It was certainly growing erect. A field note mentions the colour as white; it is greyish-brown in spirit. The consistency is tough, not resilient. The surface is irregularly and finely granulated, (Figure 4B) conulose, the conules being about 1.5 mm high and 3–4 mm apart (Figure 4A). The oscules are few, oval, cribriform, about 2 mm wide. The choanosomal matrix is compact; the sponge surface is clearly organized in an ectosomal region, about 100 μm thick, easily separable. The flagellated chambers are numerous, roundish, 10–25 μm wide, diploidally organized.

The skeleton consists of stout ascending fibres 180–260 μm thick (Figure 4E), densely connected by

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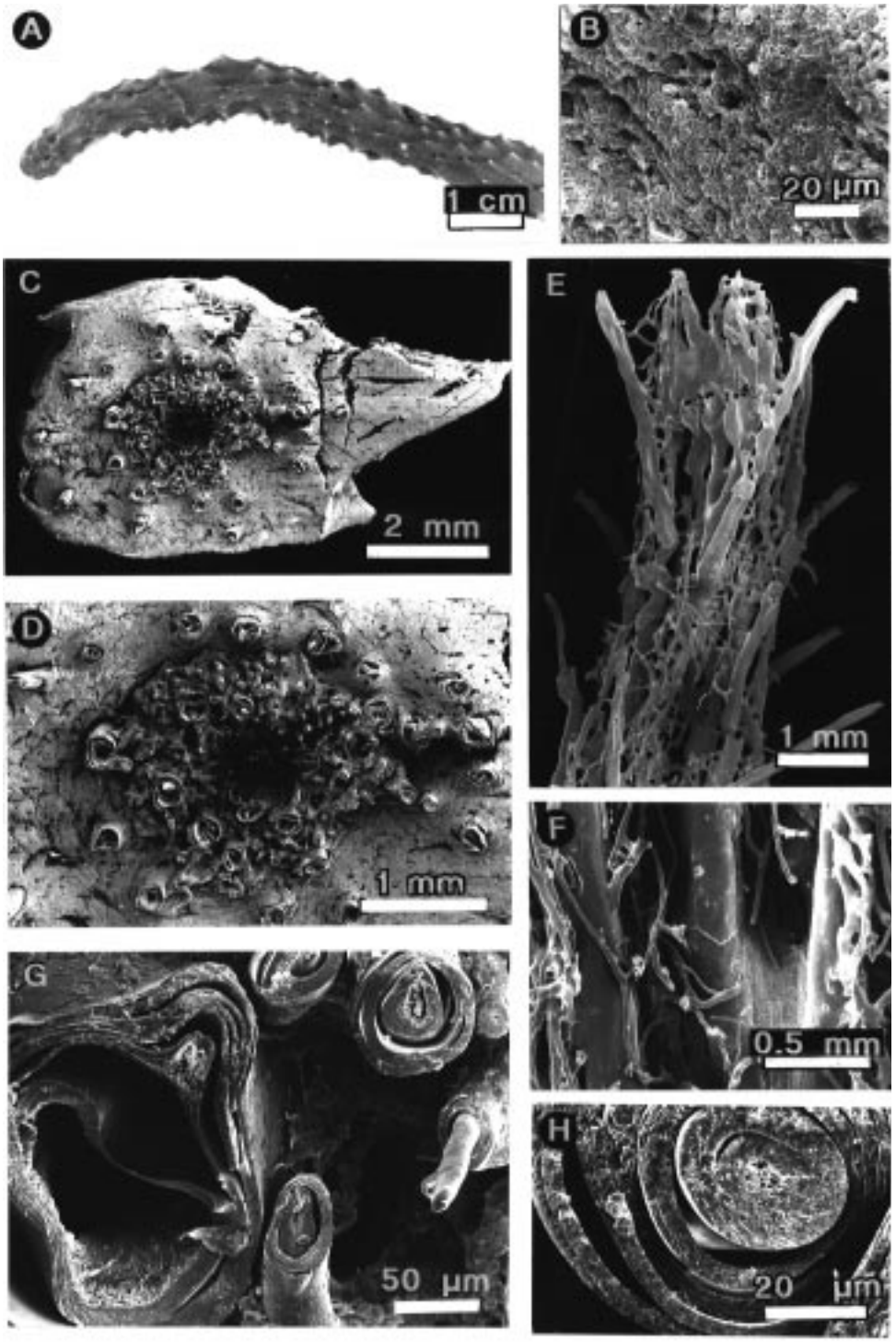

Figure 4. *Thorectaxia papuensis* sp. nov.: (A) specimen P.42; (B) view of the granulated surface; (C,D) transverse-sections showing the axial concentration of the skeleton; (E,F) longitudinal views of the ascending skeletal structure showing divergent main fibres and secondary connections; (G,H) cross-sections of fibres, laminated, with a granular pith.

secondary ones 20–80 μm thick (Figure 4F). This structure is concentrated in the centre of the sponge, where it occupies about one third, in diameter, of the body (Figure 4C,D). From this axis single main fibres, devoid of connections, diverge obliquely and run toward the surface, where they terminate in the conules (Figure 4E).

The fibres are laminated, free of foreign inclusions, amber coloured with an irregular, blackish, empty or granular pith (Figure 4G,H).

Family IRCINIIDAE Gray, 1867

Ircinia schulzei (Dendy) (Figure 5)
Hircinia schulzei Dendy, 1905: 221.

Material. Specimen P.82, depth 5 m (cavity), 23 August 1986.

The specimen, certainly incomplete, is irregularly cylindrical, 13 cm long, only about 4 mm thick (Figure 5A). It appears as part of a creeping sponge. Its colour in

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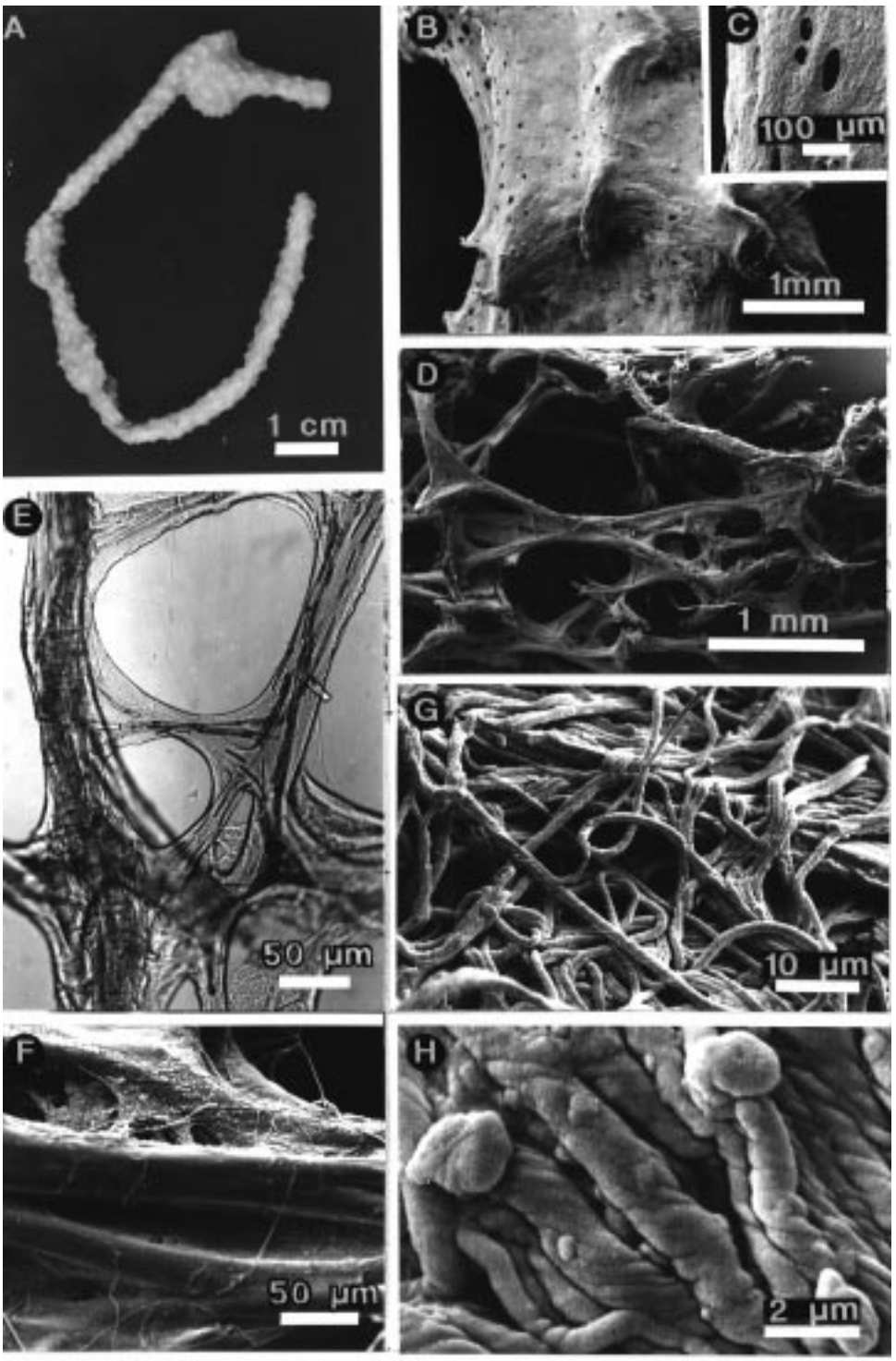

Figure 5. *Ircinia shulzei*: (A) specimen P.82; (B,C) details of surface with the openings of the aquiferous system; (D) skeletal structure; (E) spicule fragments inside the fibres in light microscopy; (F) detail of a fasciculated fibre; (G,H) spiralled filaments and their terminal knobs.

spirit is pale dull yellow; it was noted as violet in life. The consistency is firm, compressible. The surface is conulose, the conules about 1 mm high and about 4 mm apart (Figure 5B). The sponge surface, reticulated in transparency, is granulated and shows abundant openings of the aquiferous system, 20–200 μm in diameter (Figure 5B,C); inhalant pores and oscules are indistinguishable.

The fibres, amber coloured, contain a large amount of spicule fragments (Figure 5E), are fasciculated (Figure 5D) and about 100 μm thick (Figure 5F). It is quite impossible to distinguish a primary from a secondary network; the fascicles of 'main' fibres are interconnected by large plates. The filaments are about 1 μm thick, spiralled, with inconspicuous knobs.

Contrary to Burton's opinion (1934: 580), the present material appears to confirm the validity of *I. schulzei*, distinct from *I. dendroides* (Schmidt, 1862: 32). Dendy's species is well characterized by thinner filaments with

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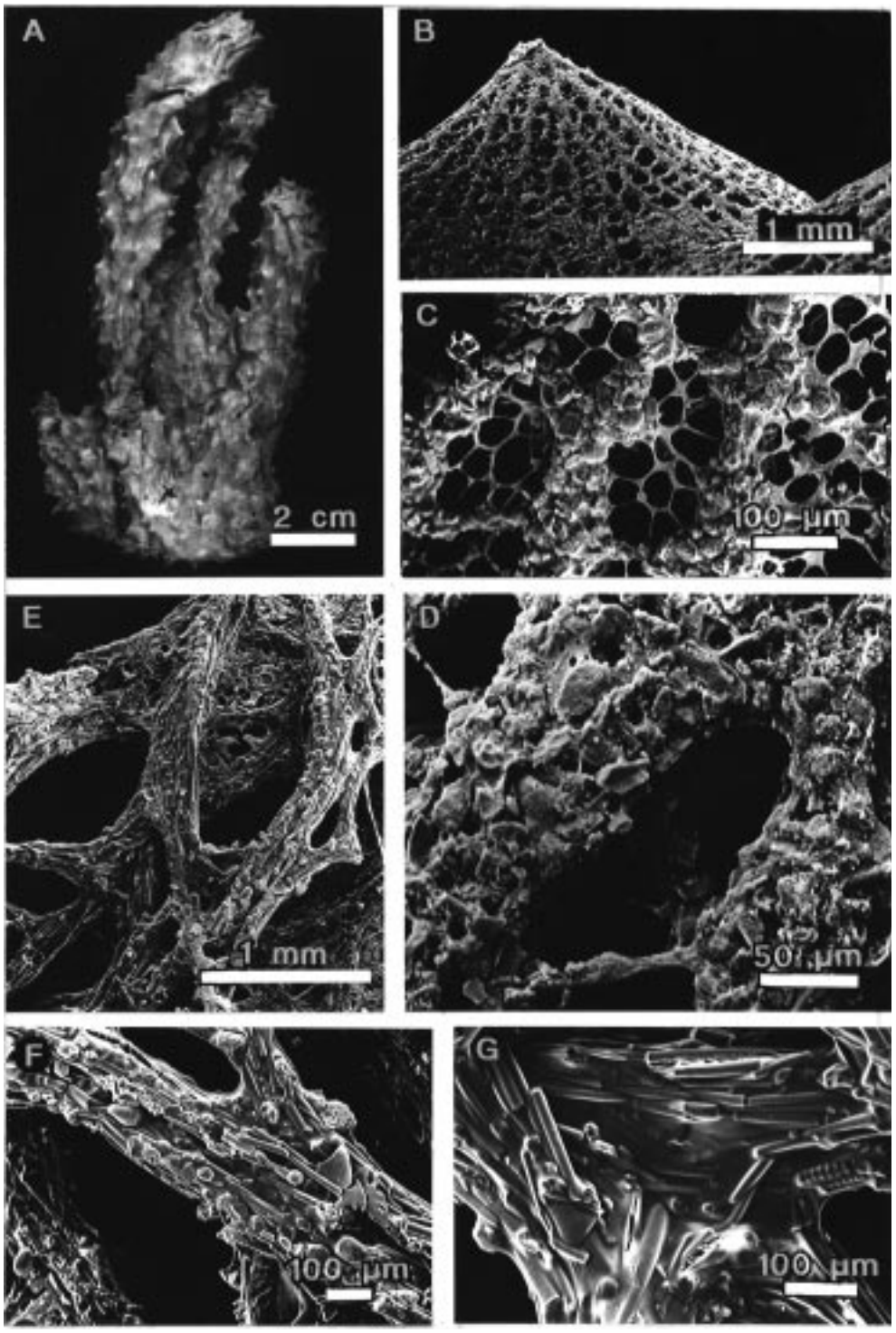

Figure 6. *Dysidea arenaria*: (A) specimen P.65; (B) a conule; (C) inhalant pores; (D) superficial sandy network; (E,F,G) fasciculated skeletal structure consisting of sand and abundant spicule fragments.

inconspicuous terminations. Very thin filaments and spicule fragments, as foreign inclusions inside the skeleton fibres, are characters shared with the (sub)genus *Sarcotragus* Schmidt (1862: 35) as previously evidenced (Vacelet, 1959; Boury-Esnault, 1971; Pulitzer-Finali & Pronzato, 1976, 1980). This affinity confirms the distinction, here maintained, from *I. dendroides*.

Distribution: Ceylon, Papua New Guinea.

Family DYSIDEIDAE Gray, 1867

Dysidea arenaria Bergquist (Figure 6)
Dysidea arenaria Bergquist, 1965: 144.

Material. Specimen P.13, depth 3 m; specimens P.65, P.102, depth 15 m; 18 August 1986.

Three, possibly incomplete samples, are available. The sponges consist of irregular flattened branches, growing

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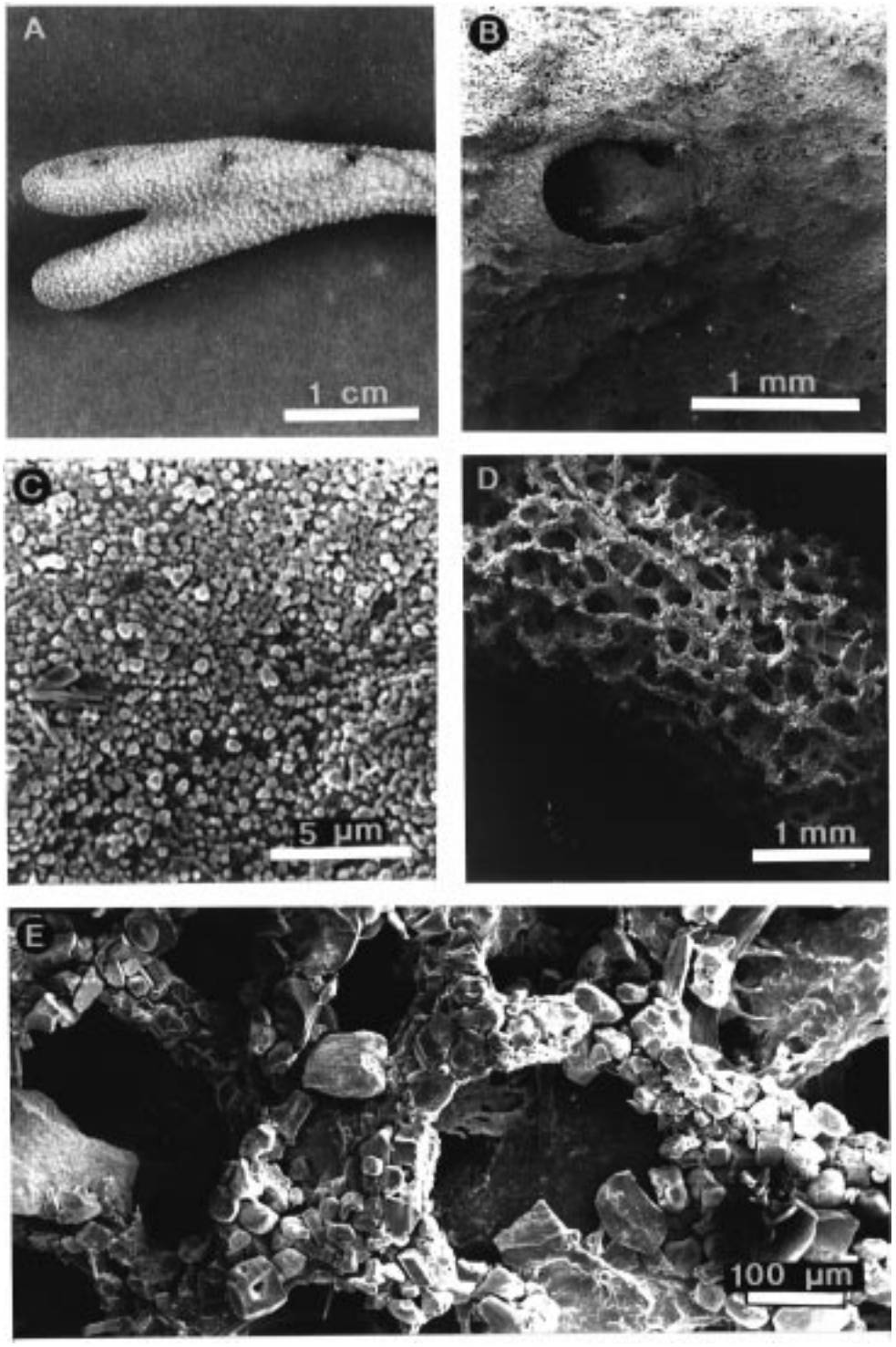

Figure 7. *Dysidea* sp.: (A) specimen P.47; (B) sponge surface and oscule; (C) the encrusted surface; (D,E) the skeletal structure consisting of sandy foreign debris.

erect or repent with several points of attachment to the substrate (Figure 6A). They are conspicuously conulose, the conules being up to 5 mm high, about 1 cm apart (Figure 6B). The colour of the specimens is indicated as sand in the field notes; it is now, in spirit, a dull, greyish middle brown. The consistency is moderately firm, flexible, easily torn. The surface is protected by a fine sandy network with regular inhalant meshes about 150 μm wide (Figure 6C,D). The oscules are rare, sparse, 1–2 mm wide.

The skeleton is reticulated (Figure 6E). The fibres are up to 400–500 μm thick (Figure 6F), and made from sand and abundant spicule fragments, bound by scarce spongin (Figure 6G). There is no apparent distinction between primary and secondary fibres.

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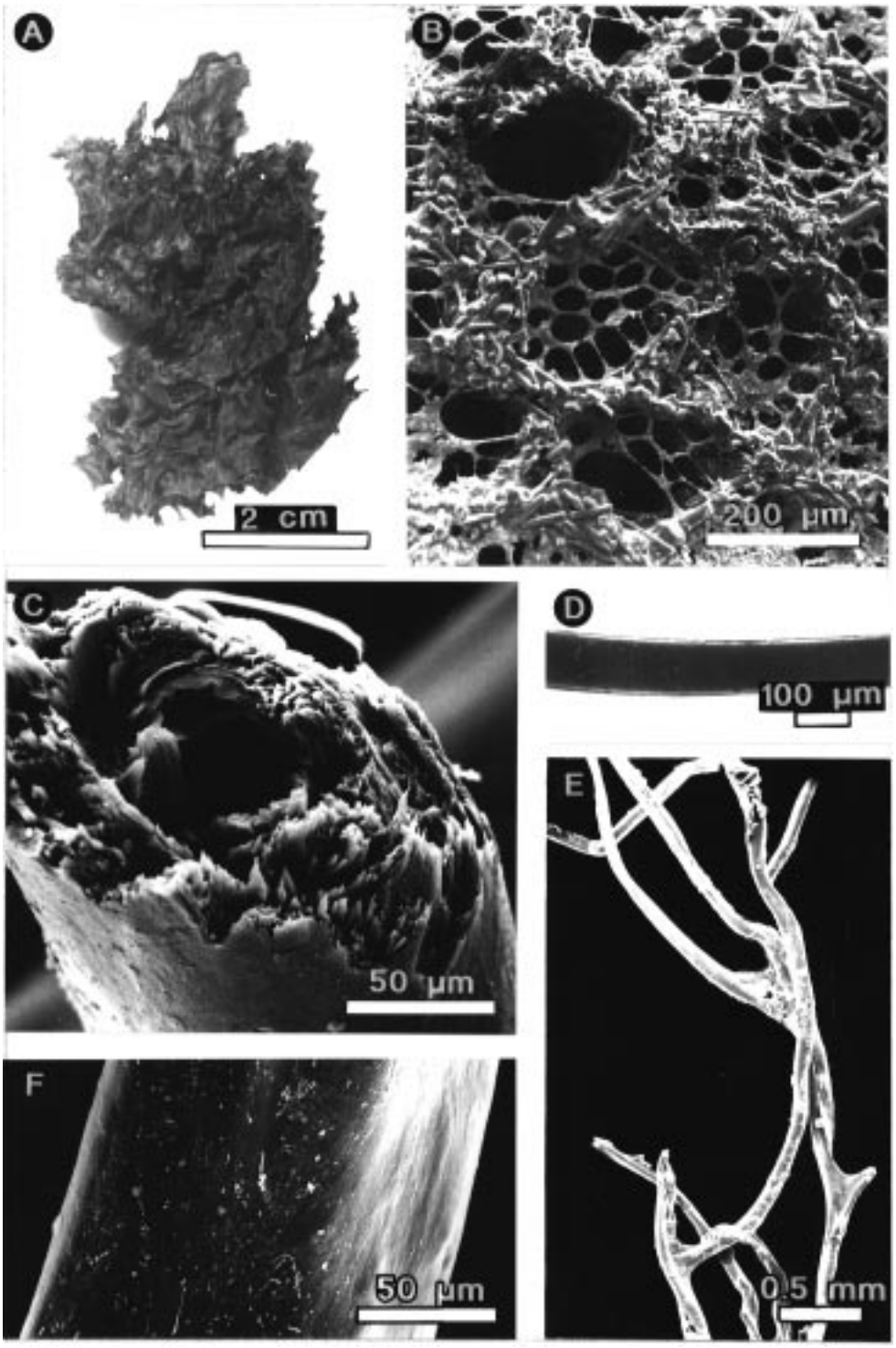

Figure 8. *Chelonaplysilla erecta*: (A) specimen P.46; (B) dermal reticulation; (C) cross-section of a fibre showing the fibrose texture and an empty pith; (D) a fibre, opaque in light microscopy; (F) the fibre surface; (E) occasional anastomoses of the dendritic fibres.

Distribution: Palau Island, New Caledonia, Papua New Guinea.

Dysidea sp. (Figure 7)

Material. Specimen P.47, depth 1 m, 20 August 1986.

The specimen was growing erect, it is subcylindrical, bifurcate at the apex, 4 cm high (the base of attachment is missing), about 4 mm thick (Figure 7A). Its colour in the field was noted as bluish-grey; it is light brown in spirit. The surface is, even microscopically, encrusted (Figure 7C), bearing conules that are only a fraction of a millimetre high and less than 1 mm apart. The oscules are few, sparse, a little less than 1 mm wide (Figure 7B); inhalant aquiferous openings are abundant, regularly scattered on the sponge surface, less than 10 μm large (Figure 7B). The reticulated fibres, about 100 μm in diameter (Figure 7E), consist of foreign sand debris bound by a scarce spongin; meshes are regular 100–200 μm wide (Figure 7D).

The attribution of this specimen to the genus *Dysidea* is due to its large eurypylous choanocyte chambers, more

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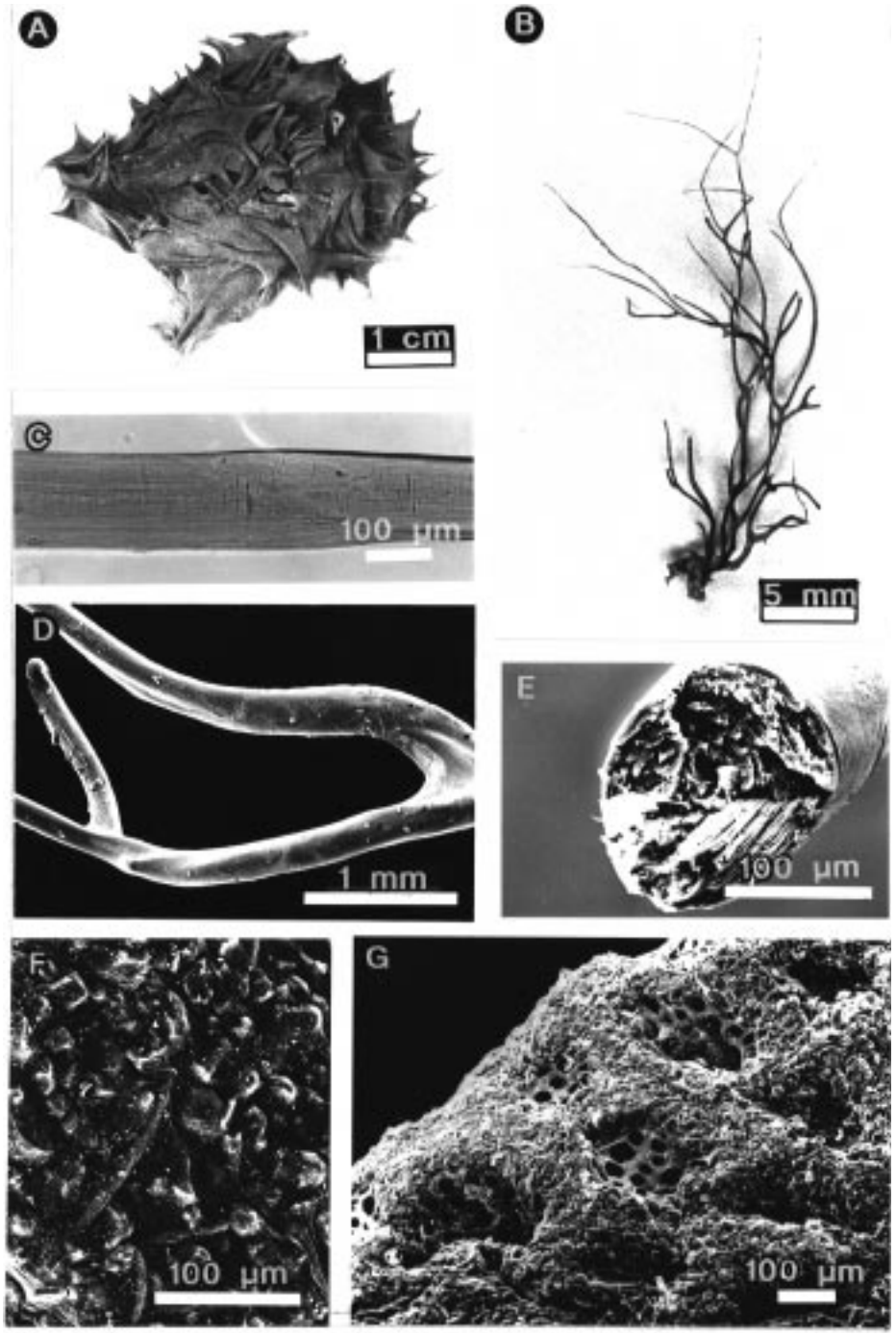

Figure 9. *Chelonaplysilla delicata* sp. nov.: (A) specimen P.8; (B) dendritic fibres; (C) fibre transparency in light microscopy; (D) the dichotomic termination of fibres; (E) cross-section of a fibre showing the fibrose and homogeneous texture; (F) sand debris engulfed in the surface; (G) the superficial network and inhalant pores.

than 50 μm in diameter. A more precise classification, at specific level, seems hazardous.

Order DENDROCERATIDA Minchin, 1900
Family DARWINELLIDAE Merejkowsky, 1879

Chelonaplysilla erecta Tsurnamal (Figure 8)
Chelonaplysilla erecta Tsurnamal, 1967: 96.

Material. Specimen P.46, depth 15m, 12 August 1986.

The available material, now in spirit, is contracted but still recognizable as an upright individual, 6 cm high, rather flattened, growing from a multiple base of attachment (Figure 8A). The conules are spaced, about 4 mm high; from their apices the tip of a fibre, sometimes bifid, briefly protrudes. The texture is softly flexible. The colour is very dark brown; it was noted as deep violet in life. The surface is covered by a uniform reticulation of sand grains (and some spicule fragments) forming meshes roundish or oval, 140–190 μm wide, filled by the fibrose delicate net of inhalant pores (Figure 8B). Oscules are not evident in the preserved specimen.

The dendritic fibres are dark violet and opaque in light microscopy (Figure 8D); their surface is smooth

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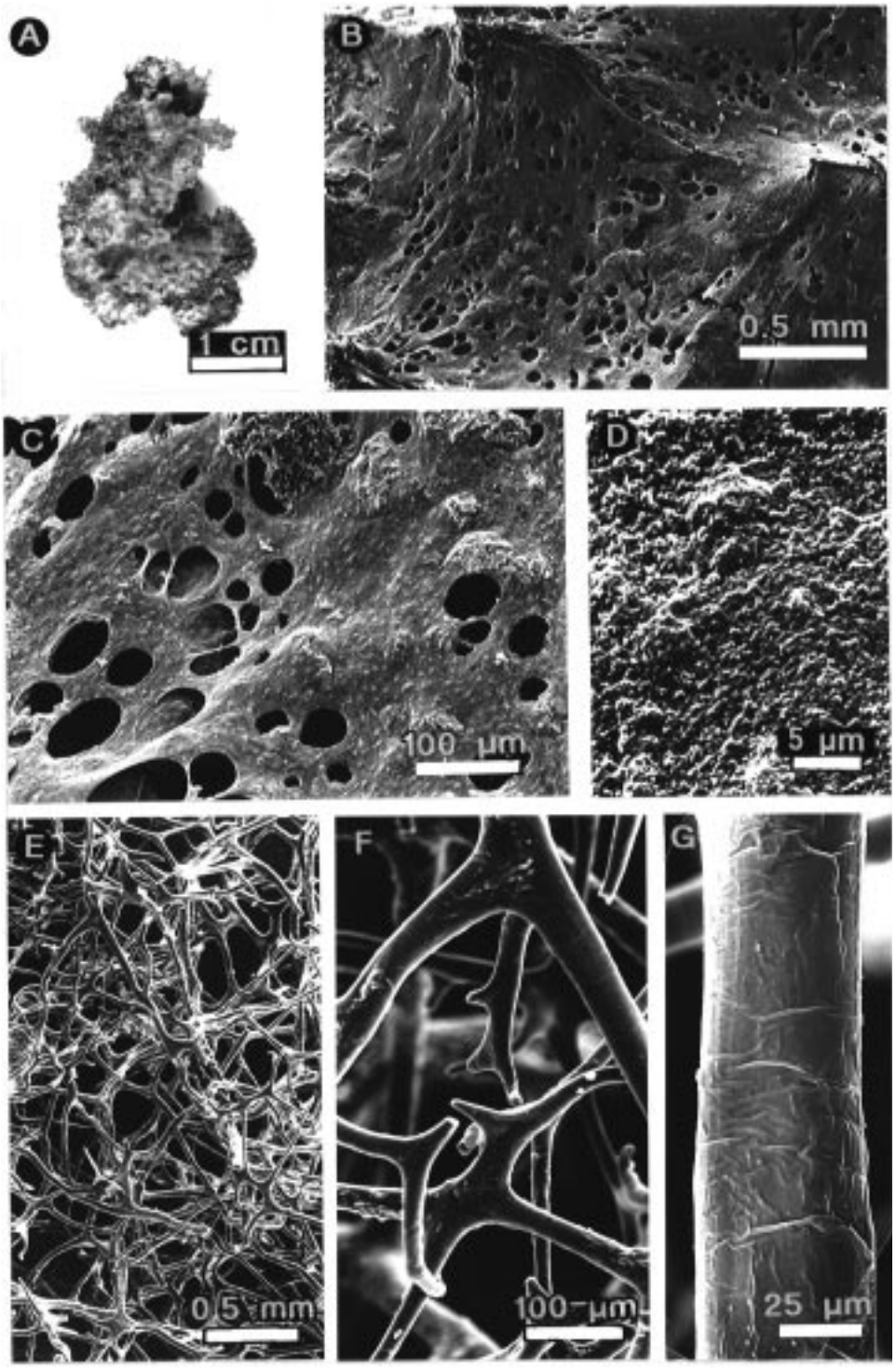

Figure 10. *Spongionella nigra*: (A) specimen P.15; (B) the conulose surface; (C) inhalant pores club-organized; (D) detail of the granulated surface; (E,F) the skeletal structure; (G) wrinkled surface of a fibre.

(Figure 8F), a cross-section shows their fibrose texture and an empty pith (Figure 8C). The skeletal network runs from the base to the border, repeatedly branching. The fibres are quite constant in diameter, 100–140 μm thick, rather fragile. Just as noted and figured in the original description, occasional anastomoses may occur between overlapping fibres (Figure 8E).

We do not follow Bergquist (1980: 486) affirming that *Megalopastas erectus* Row (1911: 360) (a sponge devoid of superficial sand encrustation, possessing conules less than 1 mm high, and a partly reticulated skeleton) belongs to *Chelonaplysilla* and is a senior synonym of *C. erecta* Tsurnamal.

Distribution: Mediterranean, Papua New Guinea.

Chelonaplysilla delicata sp. nov. (Figure 9)

Material. Specimen P.8, depth 7 m, 16 August 1986.
Holotype. MSNG-C.E.49176.

The only available specimen, in spirit, is contracted, flattened, soft and delicate; about 35 mm across, about

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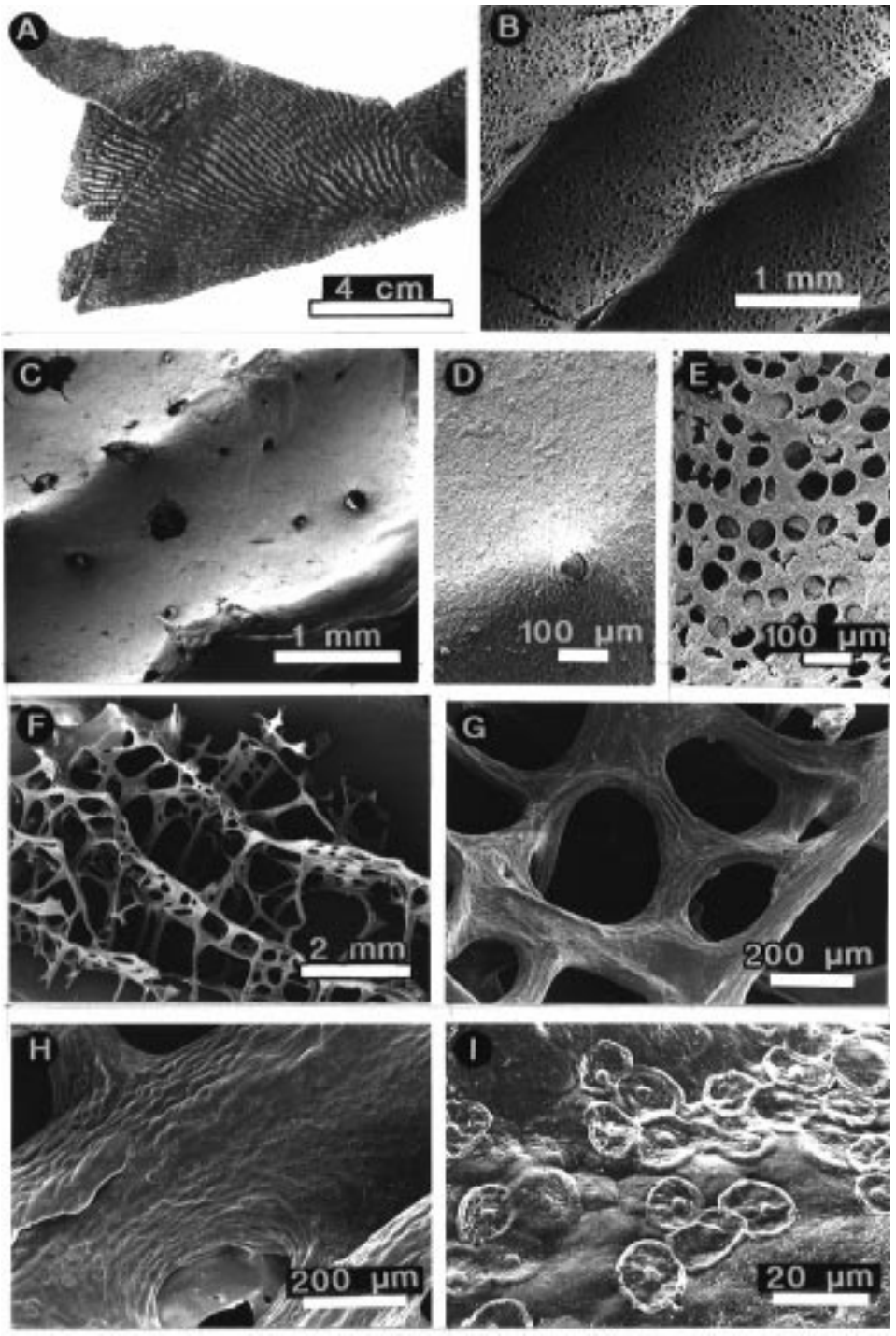

Figure 11. *Ianthella basta*: (A) specimen P.91; (B) the inhalant surface; (C) the exhalant surface; (D) a conule of the exhalant surface; (E) the pores of the inhalant surface; (F) the skeletal structure; (G) detail of a fenestrated main fibre; (H,I) the presence of spongocytes in the skeleton.

4 cm high; it appears collapsed from a more or less globose form not recorded in field notes, but certainly upright. Its colour is grey, as it was in life. Its conules, from which a large portion of fibre tips protrudes, are sharply pointed, they are up to 7 mm high, as much apart (Figure 9A).

The surface is encrusted, minutely reticulated. This network, surrounding the clusters of pores, is made by foreign material, mostly sand grains, with many spicule fragments (Figure 9F). The meshes are about 230 μm wide (Figure 9G). Oscules are not evident.

The skeleton consists of dendritic fibres rising from the base, branching, terminating in the conules, often protruding from them (Figure 9B). Up to 240 μm thick at their base, they gradually taper to their tips. They are flexible, easily separable from the flesh, light amber coloured, transparent in light microscopy (Figure 9C). Their surface is smooth (Figure 9D), the internal texture is fibrose and homogeneous (Figure 9E). They never anastomose.

The new species here proposed differs for some important skeletal characters from *C. erecta*, the only

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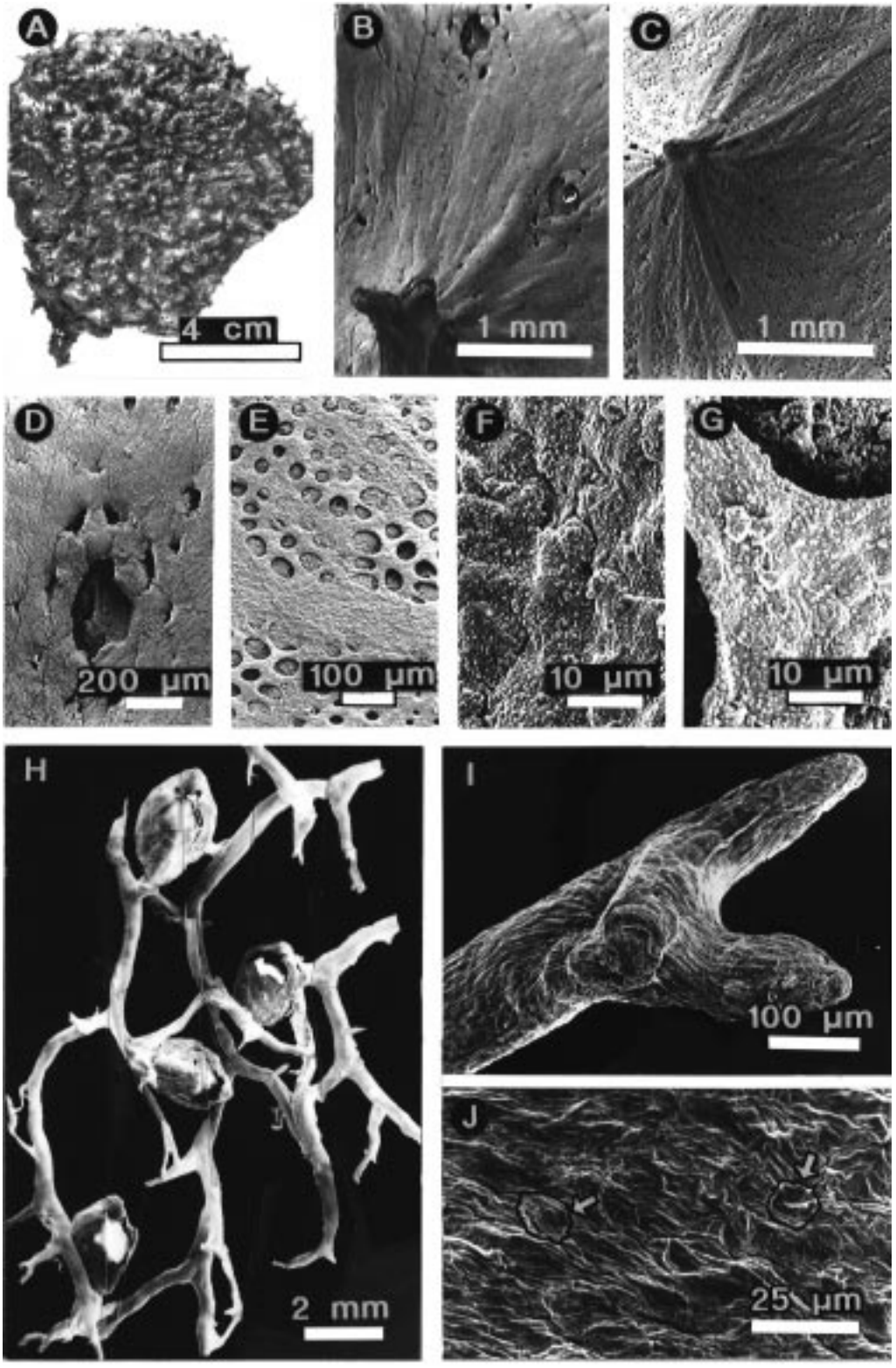

Figure 12. *Anomoianthella lamella* sp. nov.: (A) specimen P.117; (B,D) detail of the exhalant surface; (C,E) details of the inhalant surface; (F,G) the rough surface of the two sponge faces; (H) skeletal structure with symbiotic barnacles settled on fibres; (I) end of a fibre; (J) two spongocytes (indicated by arrows) in the skeleton.

other species of the genus *Chelonaplysilla* with an upright habit: (i) fibres never anastomose, grow thinner and thinner. resembling a tree branch (vs anastomosing and about constant in diameter fibres); (ii) they are light coloured, transparent and without an axial pith (versus deeply coloured, opaque and provided of an axial empty pith).

Family DICTYODENDRILLIDAE Bergquist, 1980

Spongionella nigra Dendy (Figure 10)

Spongionella nigra Dendy, 1889: 94.

Material. Specimen P.15, depth 15 m, 13 August 1986.

The specimen is small, cushion shaped to lobate (Figure 10A). Its consistency is resilient when dry. Its

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colour has been noted as black in the field; it is now dark grey. The surface is granulated (Figure 10D), bears acute conules about 1 mm high and about 2 mm apart (Figure 10B). The oscules are sparse, less than 0.5 mm wide. Inhalant pores are abundant, club-organized, 20–100 μm wide (Figure 10C).

The skeleton is a dense reticulation of spongin fibres (Figure 10E), middle brown, uncored, free of foreign inclusions, wrinkled in surface (Figure 10G). They are 22–45 μm thick (Figure 10F) and form meshes irregular as to shape and size, 370–750 μm wide. There is not a differentiation of primary and secondary network.

We follow the rearrangement proposed for this genus by Bergquist (1996).

Distribution: Indian Ocean, Western Central Pacific.

Order VERONGIIDA Bergquist, 1978
Family IANTHELLIDAE Hyatt, 1875

Ianthella basta (Pallas) (Figure 11)
Spongia basta Pallas, 1766: 309.

Material. Specimen P.91, depth 15 m, 13 August 1986.

The specimen is a simple, thin lamella rising from a small base of attachment, expanding into a flabellate structure 13 cm high, 21 cm wide, about 2 mm thick. The consistency of the sponge, in spirit, is rather stiff, moderately flexible. The colour in life was yellow; it is now dark purplish brown (Figure 11A).

On both faces parallel ridges about 1 mm high and 2 mm apart run from the base to the border. On one face, bearing the pores about 50 μm wide (Figure 11E), the ridges are slightly more marked (Figure 11B). The oscules, on the exhalant face, are extremely numerous, 2 mm or little more apart, only 100–350 μm wide (Figure 11C). In the exhalant surface are present small conules (Figure 11D).

The skeleton is a two-dimensional network (Figure 11F). Main fibres, in a single layer, run from the base to the border of the sponge, parallel to each other, about 2 mm apart, connected at regular intervals by secondary ones. The main fibres consist of a thin, flat, fenestrated structure about 2 mm wide, perpendicular to both surfaces of the sponge, forming with its edges the superficial ridges (Figure 11G).

Plenty of spongocytes may be observed in the interior of the fibres and at their surface (Figure 11H,I).

Distribution: Northern Australia, Torres Straits, Papua New Guinea, Guan, Mascarene Islands, Indian Ocean, New Caledonia.

Anomoianthella lamella sp. nov. (Figure 12)

Material. Specimens P.61, P.117, depth 15 m, 12 August 1986.
Holotype. (P.117): MSNG-C.E.49177.

Sponges are lamellar, thin, growing erect, not pedunculate. The largest sample (P.117) is 10 cm high and as much wide (Figure 12A). Both surfaces bear strong conules, acute, about 4 mm high and 3–5 mm apart. Between the conules the lamella is less than 3 mm thick. The consistency is flexible. The colour in life was indicated in the field notes as green for P.61, as green on one side and brown on the other side for P.117. The colour in spirit is purplish dark brown. On the exhalant side of the lamella the oscules are inconspicuous, less than 1 mm wide. The dermal membrane of the inhalant surface shows a delicate reticulation radiating from each conule (Figure 12C). Very small pores (10–50 μm in diameter) fill the space inside the superficial reticulation (Figure 12E). The exhalant surface shows small oscules cluster organized. A central opening, 200 μm in diameter, is surrounded by smaller ones, 50 μm wide (Figure 12B,D). Both surfaces are finely granulated.

The skeleton is reticulated, consisting of opaque spongin fibres up to 1 mm thick (thicker at the base), forming very irregular meshes 2–10 mm wide (Figure 12H). The fibre surface is irregular (Figure 12I). Little evident spongocytes are engulfed in the interior of the fibres up to the surface (Figure 12J).

The sponge choanosome is inhabited by polychaetes and barnacles.

Most peculiar features, distinguishing the new species from *A. popeae* Bergquist (1980: 497) and *A. rubra* Bergquist (1995: 47) the only two species of the genus *Anomoianthella* hitherto recorded, are: (i) green colour in life (vs brownish-orange and orange-red respectively); (ii) thin lamellar form (vs thickly-lamellate and compact-low-fan respectively); (iii) evidently different organization of inhalant-external and exhalant-internal faces (vs indifferentiation in both Bergquist's species).

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