

Antarctic and Sub-Antarctic species of *Psolidium* Ludwig (Echinodermata: Holothuroidea: Psolidae)

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Abstract

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Five new species of *Psolidium* Ludwig from Antarctica and Sub-Antarctica are described: *Psolidium emilyae* sp. nov., *P. normani* sp. nov.; *P. pawsoni* sp. nov.; *P. schnabelae* sp. nov.; *P. whittakeri* sp. nov. *Psolidium incertum* (Théel) is a junior synonym of *Psolidium poriferum* (Studer). *Psolidium tenue* Mortensen is raised out of synonymy with *P. incertum*. Six species of *Psolidium* Ludwig from Antarctica and Sub-Antarctica are diagnosed: *P. disciformis* (Théel); *P. dorsipes* Ludwig; *P. gaini* Vaney; *P. incubans* Ekman; *P. poriferum* (Studer); *P. tenue* Mortensen. A key is provided for the 11 Antarctic and Sub-Antarctic species of *Psolidium* Ludwig.

Keywords

Echinodermata, Holothuroidea, Psolidae, *Psolidium*, taxonomy, new species, key

Introduction

This study is based on the extensive collections of Antarctic and Sub-Antarctic holothuroids held in the National Museum of Natural History (NMNH) of the Smithsonian Institution in Washington DC, the New Zealand Oceanographic Institute (NZOI, now National Institute of Water and Atmospheric Research [NIWA]), and Museum Victoria (NMV), South Australian Museum (SAM) and Tasmanian Museum and Art Gallery (TMAG) in Australia. The material is representative of the Antarctic Ocean off both Eastern and Western Antarctica, and the Sub-Antarctic Islands in the Atlantic, Indian and Pacific oceans. The NMNH collection came from the United States Fish Commission *Albatross* expeditions, and the United States Antarctic Research Program (USARP), and collections by the research vessels *Eastwind*, *Edisto*, *Eltanin*, *Glacier*, *Hero* and *Islas Orcadas* (See O'Loughlin and Ahearn, 2005). The NIWA collections were made in the Ross Sea region by the research vessels *Endeavour* and *Tangaroa*. The NMV and SAM collections came from the Australian National Antarctic Research Expedition (ANARE), and were collected by the research vessels *Aurora Australis* and *Nella Dan*. Heard Island collections in TMAG were made for the Australian Antarctic Division by F/V *Southern Champion*. Some BANZARE holothuroids remained on loan to USNM, and were included in our study. Some specimens from the British Museum (The Natural History Museum) (BM[NH]) that were

collected by the *Discovery*, *Challenger* and *William Scoresby* were also available for our study. Some specimens taken by R/V *Vema* were donated to NMNH by the American Museum of Natural History. Recently collected holothuroids were donated to NMV from the AMLR R/V *Yuhz-morgeologiya* (2003) and *Icefish* (2004) expeditions to the southern Atlantic. Holothuroid specimens and data collected recently by the New Zealand International Polar Year Census of Antarctic Marine Life Project expedition to the Ross Sea by R/V *Tangaroa* were made available for collaborative study at NIWA in Nelson (New Zealand). The type specimen for *Psolidium poriferum* (Studer, 1876) was borrowed from the Humboldt-Universitaet museum für naturkunde in Berlin (ZMB).

We have reviewed the systematics of species of *Psolidium* Ludwig, 1886, described to date from Antarctica and Sub-Antarctica, and recognise six species. O'Loughlin (2002) has previously synonymised *Psolidium navicula* Ekman, 1927, and *Psolidium bistratum* Ludwig and Heding, 1935, with *Psolidium (Cucumaria) coatsi* Vaney, 1908, and referred *P. coatsi* to his new genus *Psolicrux* O'Loughlin, 2002. We have added five new species of *Psolidium* from Bouvet Island, South Sandwich Islands, South Shetland Islands, Weddell Sea, Ross Sea, Prydz Bay and Enderby Land. In the past some specimens from Antarctica and Sub-Antarctica have been determined as *Psolidium incertum* (Théel, 1886). These specimens, that are similar morphologically, represent a complex of five species.

Three are new and are described here. Two belong to previously described but unused or synonymised taxa: *Psolidium poriferum* (Studer, 1876) and *Psolidium tenue* Mortensen, 1925. Specimens of *Psolidium gaini* Vaney, 1914, showed significant variations in ossicle size and form and the possibility of another species complex is suggested. Molecular data will be an important additional source of evidence for further refinement of our work.

Preserved specimens of Psolididae typically have tentacles withdrawn, and there has been some historical reluctance to dissect to sample tentacles for ossicle study. We found tentacle ossicle form to be essential for diagnosis within the *Psolidium poriferum* species group. To assist in our diagnoses we describe "rod-plates", derived from rods with branches joined or with side-connections to create perforations (Figures 6e, f). These are distinguished from smooth perforated plates that show no evidence of rod derivation.

Materials and methods

SEM and some digital photography were done by Cynthia Ahearn. Specimens were photographed directly using a Nikon Coolpix 995 digital camera with flash lighting. Ossicles were photographed using the same camera with a Wild M20-34504 compound microscope. SEM images were taken using a Leica Stereoscan 440 with LaB6 electron source. Some specimen photographs were taken by Leon Altoff and Audrey Falconer, with Mark O'Loughlin, using a Pentax K10D digital SLR with a variety of lenses and lit using two electronic flashes. Preserved specimens were placed on or suspended above black velvet. Photos of some ossicles were taken by Chris Rowley, with Mark O'Loughlin, using a Leica DM5000 B compound microscope, and Leica DC500 camera with montage software.

Specimen registration number prefixes are: NMV F, SAM K, TMAG H, USNM E or without prefix (See O'Loughlin and Ahearn, 2005).

Dendrochirotida Grube, 1840 (restricted Pawson and Fell, 1965)

Psolididae Forbes, 1841

Remarks. A synonymy and diagnosis for Psolididae are provided by O'Loughlin and Maric (2008). Pawson and Fell (1965), and subsequent authors, have nominated Perrier (1902) as the systematic author of Psolididae. We recognise Forbes (1841) as the original author.

Key to genera of Psolididae (See O'Loughlin and Maric, 2008)

Key to Antarctic and Sub-Antarctic species of *Psolidium* Ludwig, 1886

1. Mid-ventral (sole) radial series of tube feet present **2**
 - Lacking mid-ventral (sole) radial series of tube feet **3**
2. Ossicles in sole include irregularly oval to round disc-like smooth plates, variably with few minute, closed to almost closed, perforations
 - *P. disciformis* (Théel, 1886) (S Chile)
 - Irregularly oval to round, disc-like smooth plates, variably with few minute, closed to almost closed, perforations, not present in sole
 - *P. dorsipes* Ludwig, 1886 (S Chile, S Argentina, Strait of Magellan, Burdwood Bank, Falkland Is)
3. Dorsally with deep goblet-like cups, closed across rim, vertical spines above rim; brood-protects in folds of sole
 - *P. incubans* Ekman, 1925 (South Georgia)
 - Dorsally lacking deep goblet-like cups closed across rim; no brood-protection in folds of sole **4**
4. Dorsal and lateral scales conspicuous; dorsal and lateral tube feet inconspicuous; lacking numerous dorsal and lateral tube feet support ossicles; crosses and small perforated plates rare to absent in sole **5**
 - Dorsal and lateral scales inconspicuous; dorsal and lateral tube feet numerous and conspicuous; dorsal and lateral tube foot support ossicles numerous; sole with numerous perforated plates **9**
5. Largest tentacle trunk ossicles predominantly thick, narrow rod-plates and perforated plates with prominent rod thickenings
 - *P. tenue* Mortensen, 1925 (Antarctic Peninsula, Ross Sea, Wilkes Land, Antipodes I., Prydz Bay)
 - Largest tentacle trunk ossicles predominantly smooth perforated plates **6**
6. Dorsal scales frequently with well-developed, radiating-to-margin, linear, rounded thickenings between rows of marginal perforations
 - *P. poriferum* (Studer, 1876) (Marion, Kerguelen, Heard, McDonald Is; MacRobertson Land)
 - Dorsal scales rarely with linear thickenings between rows of marginal perforations **7**
7. Dorsal scales frequently with smooth white thickening; perforations reduced, many almost closed
 - *P. pawsoni* sp. nov. (Weddell Sea, Ross Sea, Enderby Land)
 - Dorsal scales with irregular lumpy or reticulate thickening, rarely with smooth white thickening and almost closed perforations **8**
8. Largest tentacle trunk ossicles predominantly plates with large irregular perforations
 - *P. whittakeri* sp. nov. (South Sandwich, Bouvet, South Shetland Islands)
 - Largest tentacle trunk ossicles predominantly plates with large perforations centrally grading to numerous small close perforations marginally
 - *P. schnabelae* sp. nov. (off Prydz Bay, MacRobertson Land)
9. Ossicles in sole numerous crosses; rare perforated plates
 - *P. emilyae* sp. nov. (Prydz Bay)
 - Ossicles in sole perforated plates **10**

10. Dorsal scales single-layered only perforated plates; perforated plates in sole lacking irregular thickenings
P. gaini Vaney, 1914 (South Georgia, S Orkney Is, Weddell Sea, Antarctic Peninsula, Ross Sea, Prydz Bay)
- Dorsal scales single-layered with some secondary layering; sole with irregularly thickened, scale-like perforated plates
P. normani sp. nov. (Adelie Land, Prydz Bay, MacRobertson Shelf, Enderby Land)

Table 1. Distribution of Antarctic and Sub-Antarctic species of *Psolidium* Ludwig, 1886.

<i>Psolidium</i> species	Distribution
<i>P. disciformis</i> (Théel, 1886)	Chile, Comau Fiord to Strait of Magellan; 8-448 m
<i>P. dorsipes</i> Ludwig, 1886	S Argentina, Falkland Is, S Chile; 10-483 m
<i>P. emilyae</i> sp. nov.	E Antarctica, Prydz Bay, Four Ladies Bank; 450-556 m
<i>P. gaini</i> Vaney, 1914	South Georgia to Ross Sea to Prydz Bay; 19-646 m Weddell Sea; 260-795 m (Gutt, 1988)
<i>P. incubans</i> Ekman, 1925	South Georgia, Cumberland Bay; 12-38 m
<i>P. normani</i> sp. nov.	Adelie Land, Prydz Bay, Enderby Land; 105-193 m
<i>P. pawsoni</i> sp. nov.	Weddell Sea, Ross Sea, Enderby Land; 137-920 m
<i>P. poriferum</i> (Studer, 1876)	Marion, Kerguelen, Heard, McDonald Is; 100-600 m Eastern Antarctica, MacRobertson Land; 177 m
<i>P. schnabelae</i> sp. nov.	MacRobertson Land, slope off Prydz Bay; 1266 m
<i>P. tenue</i> Mortensen, 1925	Antarctic Peninsula to Ross Sea to Prydz Bay; 90-923 m New Zealand, Antipodes I.; 2010-2100 m
<i>P. whittakeri</i> sp. nov.	Bouvet, S. Sandwich, S. Shetland Is; 146-759 m

Psolidium Ludwig

Psolidium Ludwig, 1886: 9.—Mortensen, 1927: 413.—Deichmann, 1941: 141–43.—Deichmann, 1947: 336.—Lambert, 1996: 21.

Diagnosis (see O'Loughlin and Maric, 2008). Dendrochirotid holothuroids; small, up to 40 mm long; mid-body arched dorsally in transverse section, flat ventrally; dorsal and lateral body covered with imbricating scales, usually macroscopically conspicuous, irregular in size and arrangement; scales decreasing in size ventro-laterally, orally and anally; lacking large oral valves; extensible oral cone, anterior to anterior-dorsal to dorsal orientation; extensible anal cone, posterior to

posterior-dorsal to dorsal orientation; tube feet dorsally and laterally in mid-body, pass through scales.

Sole distinct, oval to elongate; discrete margin created by junction of small imbricating ventro-lateral scales with thin-walled, usually calcareous, sole that lacks scales; peripheral band of tube feet, may be discontinuous across the inter-radii anteriorly and posteriorly; peripheral tube feet frequently of 2 sizes, outer series smaller; mid-ventral radial series of tube feet present or absent.

Calcareous ring solid, plates sub-rectangular, radial and interradial plates with tapered anterior projections; radial plates with deep notch posteriorly, interradial plates with shallow concave indentation posteriorly; 10 dendritic tentacles, ventral 2 smaller.

Dorsal and lateral ossicles: multi-layered or single-layered perforated plates (scales), always some with tube foot canals; integument covering scales may have cupped crosses, cups, "thorn" ossicles (irregular branched rods pointed distally), buttons, perforated plates and rosettes; tube foot small endplates, and tube foot support ossicles that are irregular rods and plates, bent and curved, variably perforated.

Sole ossicles: inter-radii with small to large single-layered perforated plates (rarely with multi-layering), smooth to variably knobbed and thickened, sometimes with cupped crosses, cups, thorn ossicles, and rosettes; radii with additional tube foot ossicles, large endplates and tube foot support ossicles that are irregular rods and plates, bent and curved, variably perforated.

Tentacle ossicles: perforated plates, rod-plates and rods, thick to thin, long to short, straight or bent, flat or curved; dendritic tentacle branch endplates are small, irregular in shape, cupped, with a few large perforations and irregular margin; densely branched rosettes may be present.

Type species. *Psolidium dorsipes* Ludwig, 1886.

Antarctic and Sub-Antarctic species. *Psolidium disciformis* (Théel, 1886); *P. dorsipes* Ludwig, 1886; *P. emilyae* sp. nov.; *P. gaini* Vaney, 1914; *P. incubans* Ekman, 1925; *P. normani* sp. nov.; *P. pawsoni* sp. nov.; *P. poriferum* (Studer, 1876); *P. schnabelae* sp. nov.; *P. tenue* Mortensen, 1925; *P. whittakeri* sp. nov.

Psolidium disciformis (Théel)

Figures 1a, b; 4a

Psolus disciformis Théel, 1886: 85, pl. 9 fig. 6.

Theelia disciformis.—Ludwig, 1892: 350.—Perrier, 1902: 494.

Theelia (?*Psolidium*) *disciformis*.—Ludwig, 1894: 136.—Ludwig, 1898: 52.

Psolidium disciformis.—Deichmann, 1947: 337.—Pawson, 1969: 38, map 3.

Material examined. Syntypes (2): Chile, *Challenger* stn 311, 52°45'30"S 73°46'W, 448 m, BM(NH) [18]86.10.2.86.

Diagnosis. *Psolidium species* up to 18 mm long (25 mm in Théel, 1886); dorsal and lateral scales conspicuous, up to 1 mm wide; dorsal and lateral tube feet numerous, conspicuous, up to 2 penetrate each scale.

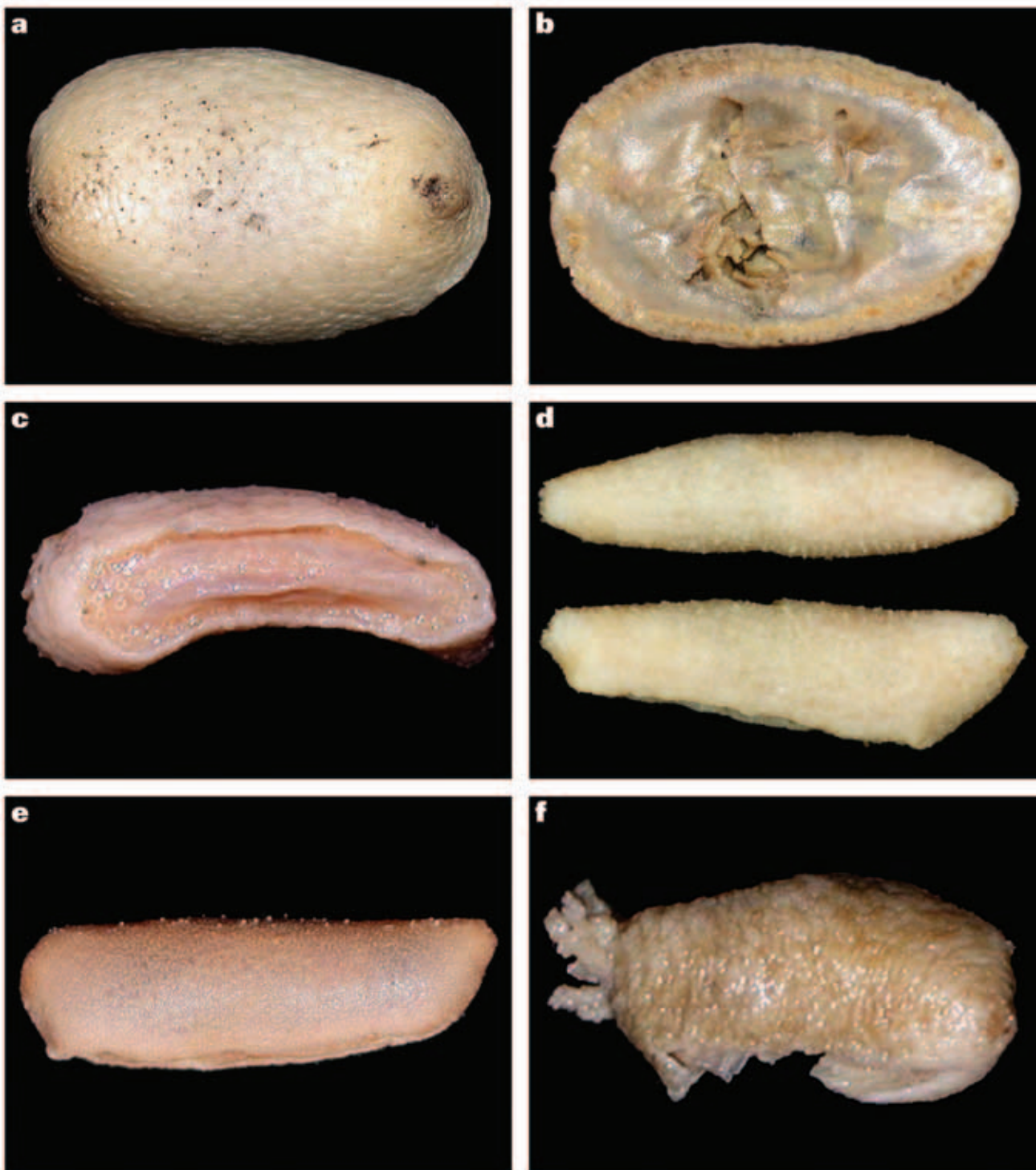


Figure 1. Photos of preserved specimens of species of *Psolidium* Ludwig, 1886 (a–c, e, f, by Cynthia Ahearn; d, by Leon Altoff and Audrey Falconer). a, b, *P. disciformis* (Théel, 1886), Chile, 18 mm long, holotype BM(NH) [18]86.10.2.86: a, dorsal; b, ventral. c, *P. dorsipes* Ludwig, 1886, Argentina, ventral, 14 mm long, USNM 1114252. d, *P. emilyae* sp. nov., Prydz, Bay, dorsal (above) and lateral (oral end right), 14 mm long, holotype SAM K2221. e, *P. gaini* Vaney, 1914, Victoria Land, lateral, 25 mm long, USNM E40556. f, *P. incubans* Ekman, 1925, South Georgia, lateral, 8 mm long, BM(NH) 2008.3190.

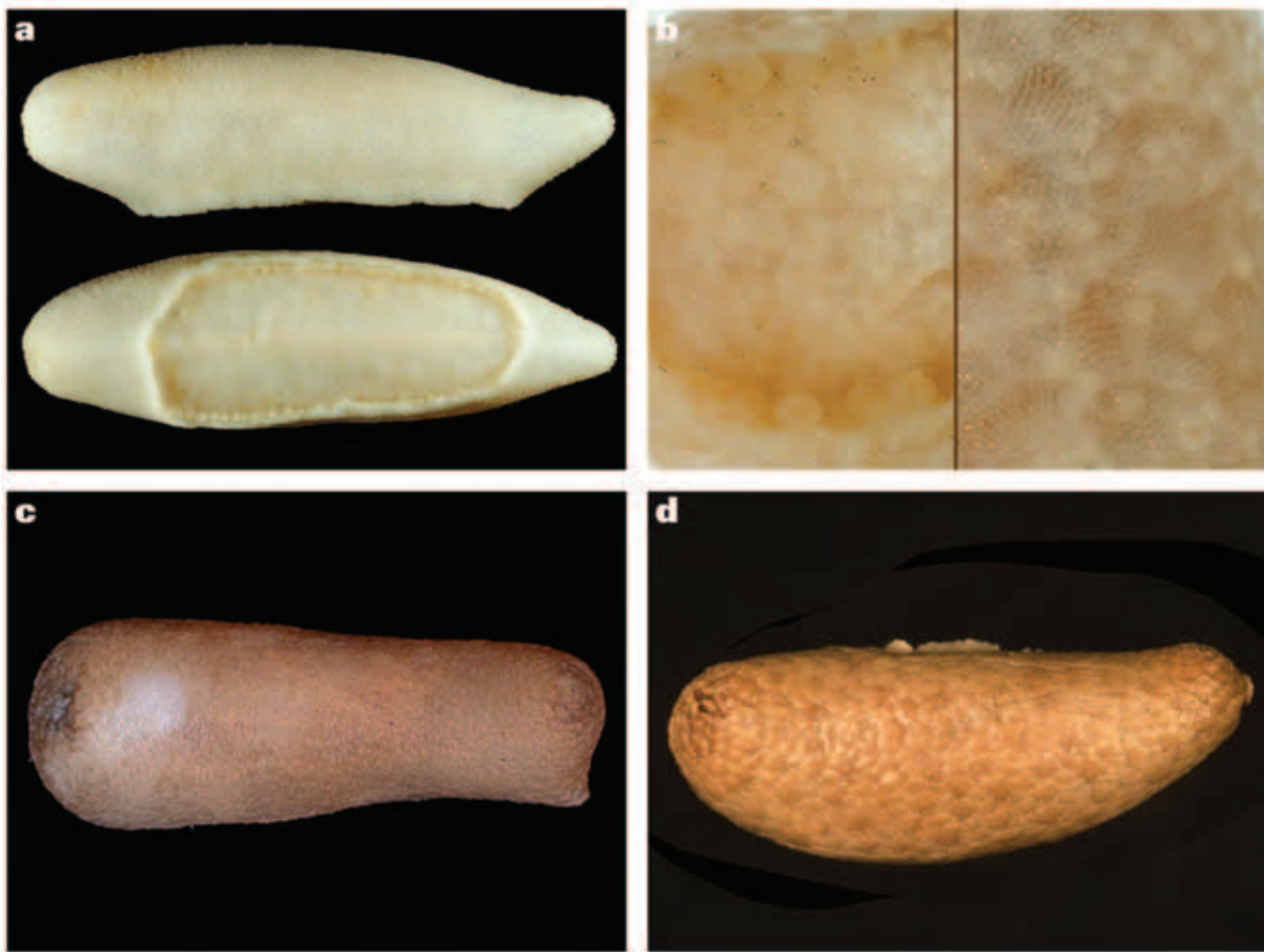


Figure 2. Photos of preserved specimens of species of *Psolidium* Ludwig, 1886 (a, b, by Leon Altoff and Audrey Falconer; c, by Cynthia Ahearn; d, by Mark Darragh). a, b, *P. normani* sp. nov., Prydz Bay: a, lateral (above) and ventral, 24 mm long, holotype NMV F157400; b, close-up of sole with scale-like plates (left), and of lateral scales (right), specimen 13 mm long, paratype NMV F69118. c, *P. pawsoni* sp. nov., Weddell Sea, dorso-lateral, 23 mm long, holotype, USNM 1112364. d, *P. poriferum* (Studer, 1876), Kerguelen I., dorsal, 20 mm long, holotype ZMB 2259.

Sole: outer peripheral single series of smaller tube feet; inner peripheral single series of larger tube feet; zig-zag series of mid-ventral (sole) radial tube feet.

Sole ossicles: numerous irregularly oval to round, disc-like smooth plates, variably with few small perforations, up to 220 μm long; rare shallow cupped crosses and more numerous 4-holed regular shallow cups with blunt marginal spines, cups 150 μm long.

Colour (live). White (P. Lambert, pers. comm.).

Distribution. SE Pacific Ocean, Chile, Comau Fiord to Strait of Magellan (42° to 56°S), on rock; 8–448 m (P. Lambert, pers. comm.).

Remarks. Théel (1886) noted the presence of dorsal and lateral tube feet in his new species, but Ludwig (1886) erected the genus

Psolidium for Psolidae with this diagnostic character in the same year. Deichmann (1947) assigned *Psolus disciformis* Théel, 1886, to *Psolidium* Ludwig, 1886. The form of the ossicles in the sole is diagnostically distinctive, and ossicles from dorsum and tentacles were not examined. Recent intensive field work on the Chilean coast under the auspice of the San Ignacio del Huinay Foundation has discovered an abundance of *P. disciformis* on the rocks in the coastal shallow from 8 to 27 m (P. Lambert, pers. comm.).

Psolidium dorsipes Ludwig

Figures 1c; 4b

Psolidium dorsipes Ludwig, 1886: 9–10, pl. 2, fig. 9.—Ludwig, 1892: 349.—Ludwig, 1894: 135 (*passim*).—Perrier, 1904: 16.—Perrier, 1905: 48, pl. 2 figs 5–15, text figs G–H.—Ekman, 1925: 112–13, text fig. 26.—Deichmann, 1941: 142–44, pl. 29 figs 1–12.—Deichmann, 1947:



Figure 3. Photos of preserved specimens of species of *Psolidium* Ludwig, 1886 (a, b, by Cynthia Ahearn; c-f, by Leon Altoff and Audrey Falconer). a, *P. schnabelae* sp. nov., Prydz Bay, dorso-lateral (oral end right), 26 mm long, holotype SAM K2345. b–d, *P. whittakeri* sp. nov.: b, South Sandwich Is, ventral, 28 mm long, holotype USNM 1112365; c, Deception I., lateral, 28 mm long, NMV F104834; d, tentacles, specimen 28 mm long, NMV F104834. e, f, *P. tenue* Mortensen, 1925, Prydz Bay, 28 mm long (two ventral small, bottom), NMV F107416; e, lateral; f, sole.

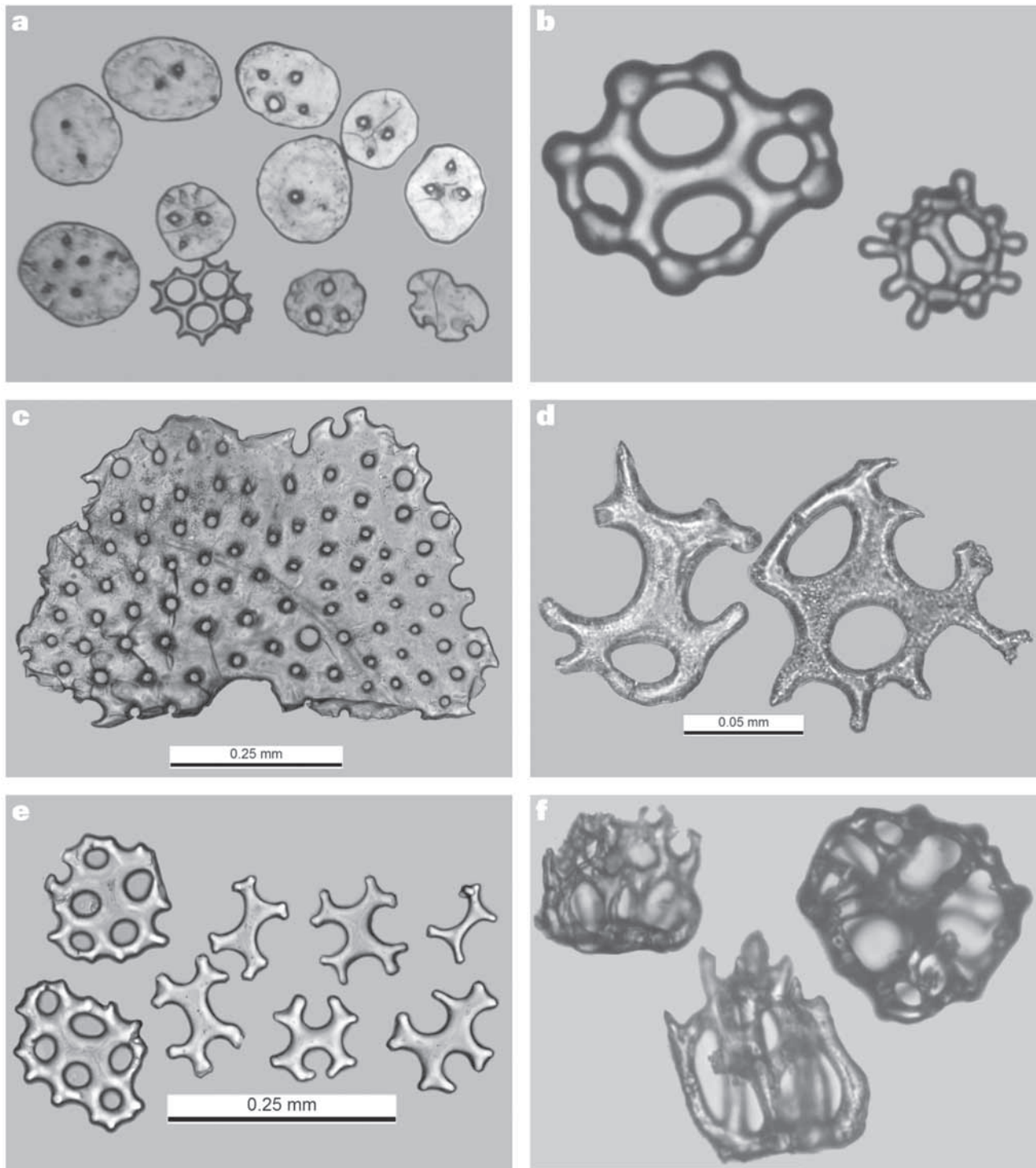


Figure 4. Photos of ossicles of species of *Psolidium* Ludwig, 1886 (a, b, f, by Cynthia Ahearn; c–e, by Chris Rowley). a, *P. disciformis* (Théel, 1886), shallow cup (bottom centre left, 150 μ m long) and disc-like plates from sole, holotype BM(NH) [18]86.10.2.86. b, *P. dorsipes* Ludwig, 1886, button (left, 90 μ m long) and cup from sole, USNM 1114251. c–e, *P. emilyae* sp. nov., holotype SAM K2221: c, dorsal scale; d, dorsal tube foot support plates; e, crosses and plates from sole. f, *P. incubans* Ekman, 1925, deep goblet-like dorsal cups, 70–90 μ m wide, 80–110 μ m high, BM(NH) 2008.3190.

336–37.—Hickman, 1962: 60.—Pawson, 1969: 38, map 3.—Pawson and Valentine, 1981: 453.—Lambert, 1996: 28–30, table 1.

Material examined. South Atlantic Ocean, Argentina, Santa Cruz, E of Grande Bay, 92 m, USNME2177 (2 specimens); E of Cabo Virgenes, 101 m, USNM 1114251 (5); near Strait of Magellan, 66 m, 1114252 (1); Tierra del Fuego, Staten I., E40823 (2); Cape Penas, 81 m, E40824 (2); R/V *William Scoresby* stn 834, Cape Virgenes, 0–38 m, BM(NH) 2008.3182 (1); Scotia Sea, E of Burdwood Bank, 419–483 m, E40825 (1).

South Pacific Ocean, Chile, Strait of Magellan, 36 m, E2178 (4); Cape Froward, 82 m, USNM 1081593 (1).

Diagnosis. *Psolidium* species up to 17 mm long; preserved form variably with low to high profile, short to elongate oval sole; dorsal and lateral scales conspicuous, smooth, up to 1.6 mm wide; dorsal and lateral tube feet conspicuous, numerous.

Sole: outer peripheral single series of smaller tube feet; inner peripheral single to double series of larger tube feet; mid-ventral (sole) radial single to zig-zag to double series of tube feet.

Dorsal ossicles: multi-layered plates (scales) thick, 0–2 canals and 0–2 marginal indentations for tube feet per scale; intergrade with large thick knobbed plates with developing secondary layers; perforated plates with thickenings (buttons), 100–150 μm long, 3 to many perforations; thick smooth perforated plates, 150–200 μm long; numerous shallow cups, oval, marginally with round knobs, biggest cups knobbed on cross and rim, 2 large central and 2 smaller end perforations, cups 40–60 μm long.

Sole ossicles: shallow cups, oval, 2 large central and 2 smaller end perforations, some imperfectly formed, variably finely knobbed on margin to thickly knobbed on margin and cross, cups 40–70 μm long; thickly knobbed, regular, 4-holed buttons, 80–100 μm long, some irregular, up to 150 μm long; shallow concave perforated plates variably knobbed on surface and margin, up to 16 perforations, up to 200 μm long.

Distribution. Argentina (E of Grande Bay), Burdwood Bank, Falkland Is; Chile, Tierra del Fuego, Strait of Magellan; 10–483 m.

Remarks. One *Psolidium dorsipes* specimen (USNM 1114251) has shallow cup-shaped indentations covering the sole that appear to indicate brood-protection under the body.

Psolidium emilyae sp. nov.

Figures 1d; 4c–e

Material examined. Holotype: Eastern Antarctica, Prydz Bay, Four Ladies Bank, ANARE 1991, *Aurora Australis* stn 25B, 68°31'S 77°27'E, 450–556 m, K. L. Gowlett-Holmes and W. Zeidler, 3 Feb 1991, SAM K2221.

Diagnosis. *Psolidium* species 14 mm long (preserved); elongate tubular body, transversely rounded form, sole narrower than body width; dorsal and lateral tube feet conspicuous, numerous, cover body closely; dorsal and lateral scales inconspicuous.

Sole: peripheral single series of tube feet; some slightly smaller outer tube feet in an incomplete series (partly concealed by projecting ventro-lateral scales); lacking mid-ventral (sole) radial series of tube feet.

Dorsal ossicles: thick, smooth, single-layered perforated plates (scales), lacking secondary developments, small perforations, tube foot canals, scales up to 0.7 mm wide; irregular, curved tube foot support ossicles, up to 4 perforations, up to 128 μm long.

Sole ossicles: numerous crosses, predominantly regular, elongate, 4-armed, thick, with distal pairs of swellings on arms, branches rarely joined to create perforations, up to 144 μm long; few thick perforated plates, up to 10 perforations, margin variably bluntly toothed to slightly knobbed, up to 224 μm long.

Colour (preserved). Off-white.

Distribution. Eastern Antarctica, Prydz Bay, Four Ladies Bank; 450–556 m.

Etymology. Named for Emily Whitfield (Marine Research Group of the Field Naturalists Club of Victoria) who first noticed the distinctive cross ossicles in the sole of this species, and in appreciation of her research assistance in Museum Victoria.

Remarks. The cross ossicles in the sole of *Psolidium emilyae* sp. nov. are diagnostically distinctive among Antarctic and Sub-Antarctic *Psolidium* species, and tentacle ossicles from the unique small holotype specimen were not examined. *P. emilyae* is similar morphologically to *Psolidium normani* sp. nov. from Prydz Bay (see below), but the depth of occurrence of *P. normani* (105–193 m) is shallower than *P. emilyae* (450–556 m). A single specimen from Prydz Bay (98–301 m) of the morphologically similar *Psolidium gaini* Vaney, 1914, also occurred at a shallower depth than *P. emilyae*. Ossicles from the sole of specimens of *P. gaini* and *P. normani* that were similar in size to the small type specimen of *P. emilyae* were examined, and found to be similar to those in larger specimens of the two species, and not the crosses typical of *P. emilyae*.

Psolidium gaini Vaney

Figures 1e; 5a–c; 6a, b

Psolidium gaini Vaney, 1914: 18–20, pl. 1 figs 7–9, pl. 4 figs 6–14.—Ekman, 1925: 5, 117–19, text-fig. 28.—Ekman, 1927: 414–15.—Grieg, 1929a: 13.—Grieg, 1929b: 9.—Pawson, 1969: 38, map 3.—Arnaud 1974: 651.—Cherbonnier, 1974: 608.—Gutt, 1988: 23, 28, 30, 32, 65, 73, 77.—Gutt, 1991a: 147, 149, 152, 153.—Gutt, 1991b: 324.

Psolidium sp. MoV 2081.—O'Loughlin et al., 1994: 552, 554.

Material examined. Antarctic Ocean, South Orkney Is, 298–302 m, USNM E40558 (1 specimen); South Shetland Is, Aspland I., 163–180 m, AMLR-03 stn 90, 20 Mar 2003, NMV F104812 (2); Antarctic Peninsula, Joinville I., 210–220 m, USNM E40559 (10); Graham Land, 91 m, E40561 (2); Palmer Archipelago, 85–130 m, E40552 (2); 102 m, E40553 (1); 38–70 m, E40554 (2); 70–150 m, E40555 (2); 55 m, E40562 (1).

Ross Sea, *Terra Nova* stn 340, 76°56'S 164°12'E, 293 m, BM(NH) 1932.8.11.253 (2); NZOI *Endeavour* stns A461, 0–550 m, NIWA 43882 (1); A534, 366 m, NIWA 43884 (2); A537, 546 m, NIWA 43885 (1); E209B, 163 m, NIWA 43886 (2); *Discovery* stn 1660, Pennell Bank, 0–351 m, BM(NH) 2008.3183–3189 (7); *Tangaroa* stn 0802/100, 451–447 m, NIWA 45696 (4).

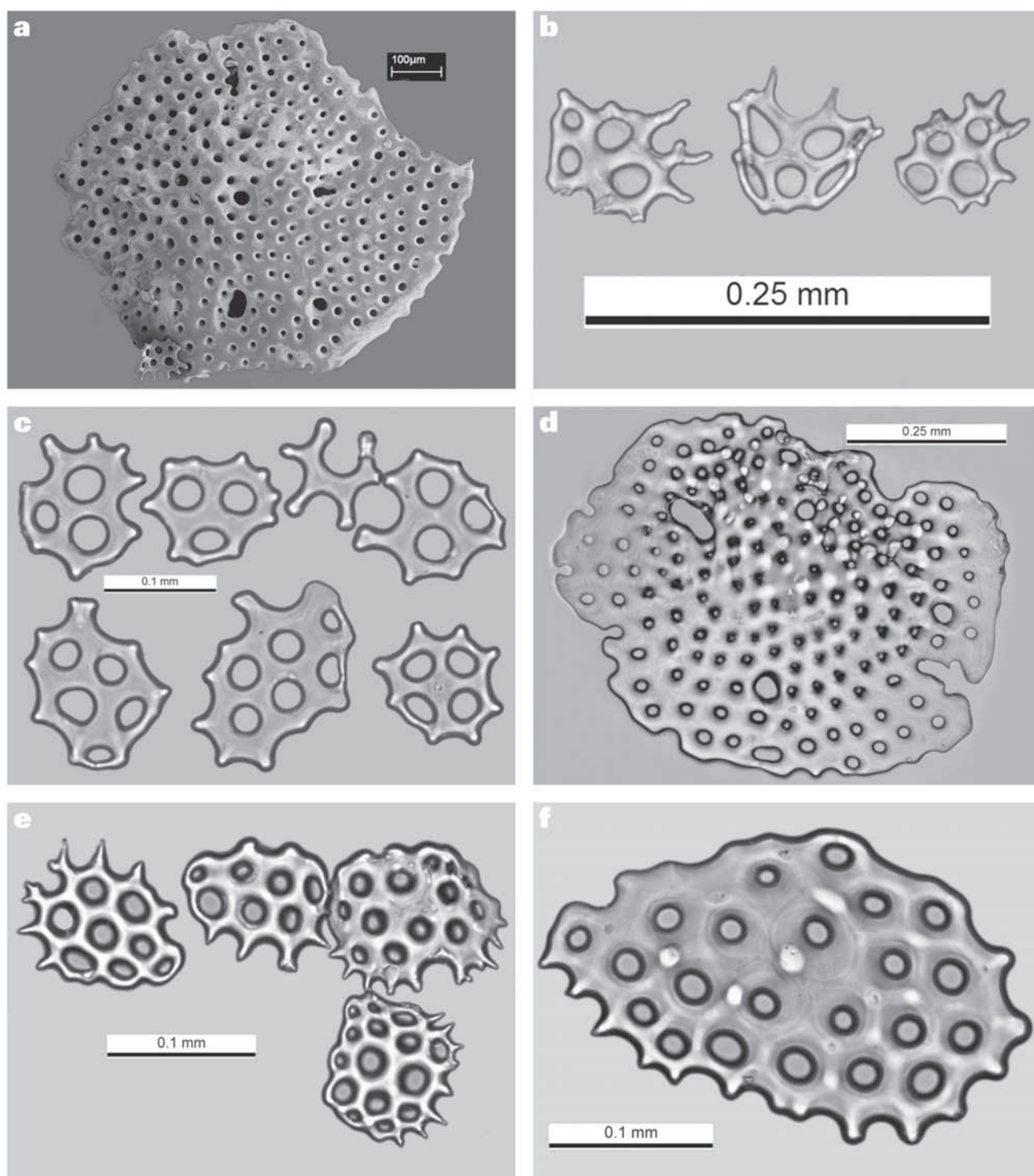


Figure 5. Photos of ossicles of species of *Psolidium* Ludwig, 1886 (a, SEM by Cynthia Ahearn; b–f, by Chris Rowley). a–c, *P. gaini* Vaney, 1914: a, dorsal scale and tube foot support plate (bottom left), USNM E40551; b, dorsal tube foot support plates, NMV F68112; c, plates from sole, NMV F68112. d–f, *P. normani* sp. nov.: d, dorsal scale, paratype SAM K2341; e, dorsal tube foot support plates, paratype NMV F68662; f, plate from sole, paratype SAM K2341.

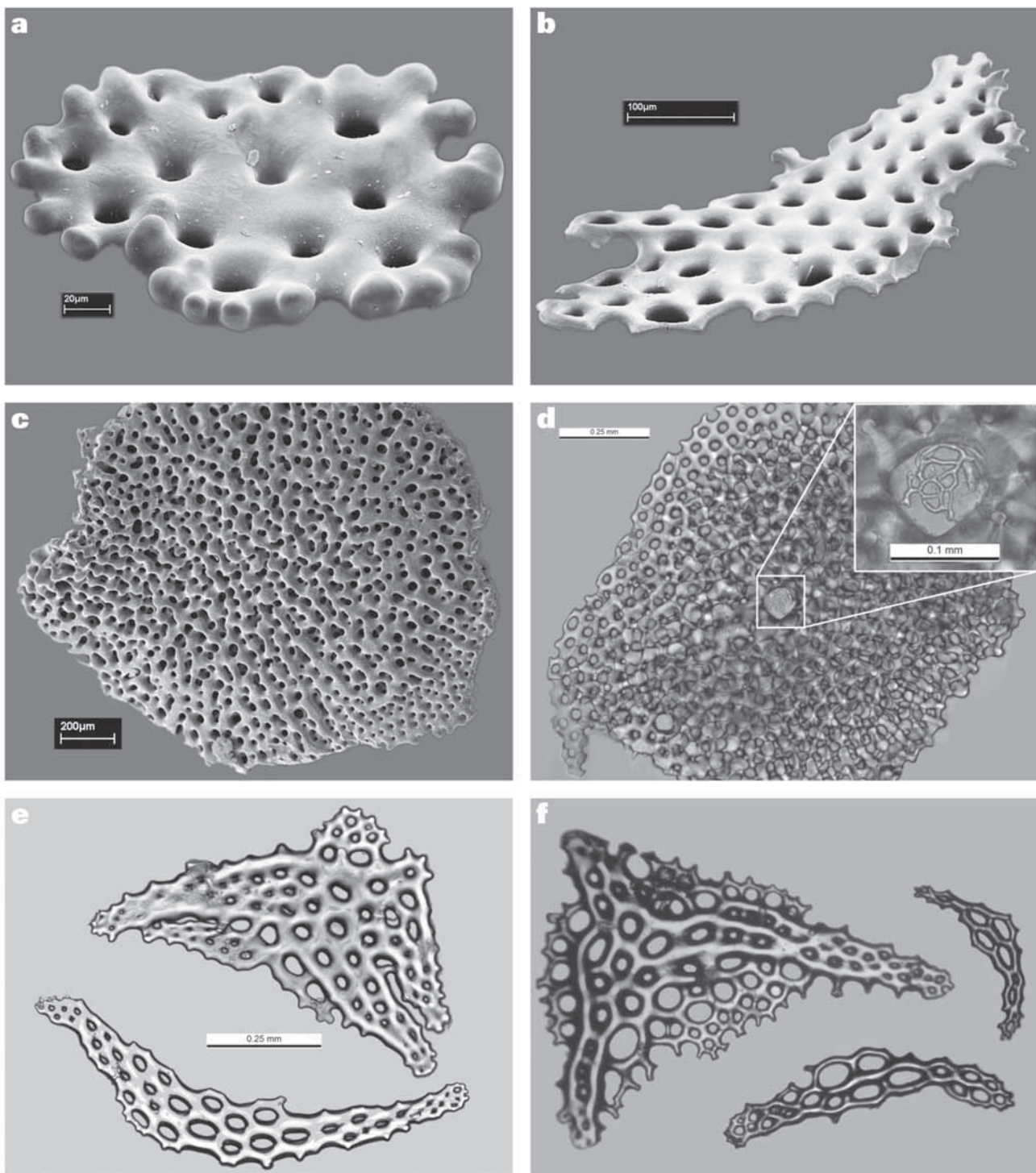


Figure 6. Photos of ossicles of species of *Psolidium* Ludwig, 1886 (a–c, SEM by Cynthia Ahearn; d, e, by Chris Rowley; f, by Cynthia Ahearn). a–b, *P. gaini* Vaney, 1914, USNM E40551: a, plate from sole; b, tentacle ossicle. c–f, *P. tenue* Mortensen, 1925: c, dorsal scale, USNM E40783; d, dorsal scale, with tube foot endplate in tube foot canal, and absence of tube foot support plates, NMV F107442; e, tentacle rod-plates, NMV F68113; f, tentacle rod-plates, largest 780 μm long.

Victoria Land, 640–646 m, USNM E40556 (2); 598–613 m, E40560 (1); 573–576 m, USNM 1082084 (1); 598–613 m, USNM 1112624 (1); Balleny Is, 55–146 m, E40551 (19); 150–157 m, E40557 (1); *Tangaroa* stn 0602, 140–150 m, NIWA 44712 (1).

Adelie Land, BANZARE stn 90, 66°21'S 138°28'E, 640 m, SAM K2340 (1).

Prydz Bay, Four Ladies Bank, 298–301 m, NMV F68112 (1).

Diagnosis. *Psolidium* species up to 27 mm long (up to 40 mm in Vaney, 1914); body elongate, transversely rounded form (preserved), sole narrower than body width; dorsal and lateral tube feet conspicuous, numerous, cover body closely; dorsal and lateral scales inconspicuous.

Sole: outer peripheral single series of smaller tube feet; inner peripheral single series of larger tube feet; lacking mid-ventral (sole) radial series of tube feet.

Dorsal ossicles: thick, smooth to irregularly thickened, single-layered, perforated plates (scales), up to 950 μm long, perforations small, up to 3 canals or marginal indentations for tube feet per scale; irregular, asymmetrical, curved tube foot support plates, 4–8 perforations, digitiform to bluntly spinous (South Shetland Is) to pointed spines (Prydz Bay) on one margin, opposite margin lacking projections, plates up to 176 μm long.

Sole ossicles: thick, regular, 4-holed buttons, variably knobbed to bluntly spinous marginally, 160–190 μm long; intergrade with thick, smooth, perforated plates, sometimes slightly concave, sometimes slightly knobbed marginally, sometimes margin upturned, number of perforations variable, size of plates variable; plates up to 14 perforations, up to 184 μm long, many knobbed marginally (South Shetland Is); plates up to 19 perforations, up to 255 μm long (Ross Sea); plates up to 17 perforations, up to 224 (rarely 272) μm long, slight swellings marginally (Prydz Bay).

Distribution. South Georgia, South Orkney Is, South Shetland Is, Weddell Sea, Antarctic Peninsula to Ross Sea to Prydz Bay; 19–795 m.

Remarks. Vaney (1914) reported the sizes of the two type specimens as 40 and 30 mm long. It is incongruous that none of the numerous specimens seen in this study is longer than 26 mm. Ekman (1925) noted some differences between the specimen that he examined and the description by Vaney (1914), and made a point that what Vaney described as “cups” dorsally, were for him tube foot support ossicles. We agree with Ekman (1925) that there are numerous tube foot support ossicles dorsally, that have the form of irregular curved perforated plates that are superficially cup-like. The dorsal and lateral tube feet in *Psolidium gaini*, *P. emilyae* sp. nov. (above) and *P. normani* sp. nov. (below) are conspicuous because of the presence of support ossicles, whereas the dorsal and lateral tube feet of *Psolidium poriferum* (below), *P. pawsoni* sp. nov. (below), *P. schnabelae* sp. nov. (below), *P. tenue* (below) and *P. whittakeri* sp. nov. (below) have at most rare tube foot support ossicles and are inconspicuous.

We noted plates from the sole of Antarctic Peninsula specimens (type region) up to 200 μm long with up to 13 perforations. Sole plates from Adelie Land specimens were up to 300 μm long with up to 23 perforations. Other variations are

noted in the diagnosis above. The variations are significant, and suggest that there may be more than one species.

Grieg (1929a, b) reported *Psolidium gaini* from South Georgia (55 m) and Graham Land (60–90 m), and noted reports of *P. gaini* from the South Shetland Is (19 m) and Emperor William Land (360 m). Gutt (1988) reported *P. gaini* from the Weddell Sea (260–795 m).

Psolidium incubans Ekman, 1925

Figures 1f; 4f

Psolidium incubans Ekman, 1925: 5, 113–116, text fig. 27.—Arnaud, 1974: 584. —Gutt, 1988: 73.

Material examined. South Georgia, *Discovery* stn MS67, E Cumberland Bay, 38 m, 28 Feb 1926, BM(NH) 2008.3190 (1 specimen).

Diagnosis. *Psolidium* species up to 12 mm long; wrinkled body surface, created by high cups; dorsal and lateral scales not conspicuous; dorsal and lateral tube feet conspicuous.

Sole: outer peripheral single series of smaller tube feet; inner peripheral single to zig-zag to double series of larger tube feet; lacking mid-ventral (sole) radial series of tube feet; sole soft, with folds for brood-protection.

Dorsal ossicles: perforated plates with anastomosing secondary developments and multi-layering (scales), up to 700 μm long, 0–2 tube foot canals per scale; shallow cups with 2 large central and 2 smaller end perforations, marginal knobs, cups 90 μm long; deep goblet-like cups closed across rim, vertical blunt spines above rim, cups 70–90 μm wide, 80–110 μm high.

Sole ossicles: shallow cupped crosses, shallow cups with small marginal knobs, cups 80 μm long; shallow concave perforated plates, upturned marginal knobs, up to 14 perforations, plates up to 150 μm long.

Distribution. South Georgia, Cumberland Bay; 12–38 m.

Remarks. As noted by Ekman (1925) this small species of *Psolidium* brood-protects in folds of the sole.

Psolidium normani sp. nov.

Figures 2a, b; 5d, f

Psolidium cf. *gaini*.—O'Loughlin et al., 1994: 552, 554 (non *Psolidium gaini* Vaney, 1914).

Material examined. Holotype: eastern Antarctica, MacRobertson Shelf, ANARE 1993, *Aurora Australis* stn 127, 67°16'S 65°26'E, 109–121 m, M. O'Loughlin, 12 Feb 1993, NMV F157400.

Paratypes: Type locality and date, F68661 (1 specimen); F69118 (1); Prydz Bay, Fram Bank, stn 130, 67°32'S 69°02'E, 105–114 m, F68662 (1); ANARE 1991, *Aurora Australis* stn 100, 67°28'S 68°50'E, 145–150 m, C. C. Lu and T. N. Stranks, 28 Feb 1991, F68111 (1); K. L. Gowlett-Holmes and W. Zeidler, SAM K2220 (1); Enderby Land, BANZARE stn 41, 65°48'S 53°16'E, 193 m, SAM K2341 (2); Adelie Land, BANZARE stn 90, 66°21'S 138°28'E, 640 m (possibly “much shallower”, according to BANZARE records), SAM K2349 (1).

Diagnosis. *Psolidium* species up to 30 mm long; body elongate, transversely rounded form (preserved), sole narrower than

body width; dorsal and lateral tube feet conspicuous, numerous, cover body closely; dorsal and lateral scales inconspicuous.

Sole: outer peripheral single series of smaller tube feet; inner peripheral single series of larger tube feet; lacking mid-ventral (sole) radial series of tube feet.

Dorsal ossicles: predominantly single-layered perforated plates (scales), some secondary layering; up to 4 tube foot canals or marginal indentations per plate; scales up to 800 μm wide; numerous tube foot support plates, curved, spinous on one side (rarely both sides), marginal spines sometimes bifurcate, up to 19 perforations, up to 136 μm long; tube foot 'endplates' small irregular mesh-like, up to 48 μm wide, few perforations, irregular marginal projections, not regularly perforated plates.

Sole ossicles: scale-like perforated plates, intergrading with buttons with 4 perforations; plates bluntly to sharply spinous to knobbed on one side, projections sometimes bifurcate; pronounced surface thickenings with ridges or lumps; up to 48 perforations per plate; plates up to 352 μm long.

Distribution. Eastern Antarctica, Adelie Land; Prydz Bay, Fram Bank; MacRobertson Shelf; Enderby Land; 105–193 m (? 640 m).

Etymology. Named for Mark Norman (Senior Curator, Marine Biology Section, Museum Victoria), with admiration of his enthusiastic engagement with marine invertebrate studies, with gratitude for his personal support, and in recognition of his contribution to collecting from Prydz Bay and Heard I.

Remarks. *Psolidium normani* sp. nov. is similar externally to *P. emilyae* sp. nov. (above) and *P. gaini* Vaney, 1914, but is distinguished by the scale-like plates in the sole and secondary thickening of the dorsal scales.

***Psolidium pawsoni* sp. nov.**

Figures 2c; 7a, b

Psolidium incertum.—Gutt, 1988: 1, 3, 23, 27–77.—Gutt, 1991a: 147–153.—Gutt, 1991b: 315, 320, 324–25 (non *Psolidium incertum* (Théel, 1886) = *Psolidium poriferum* (Studer, 1876) below).

Material examined. Holotype: Weddell Sea, Coats Land, Caird Coast, off Brunt Ice Shelf, USARP, R/V *Glacier*, cr 2 stn 1, 74°28'06"S 30°31'42"W, 513 m, 24 Feb 1969, USNM 1112364.

Paratypes: type locality and date, USNM E40798 (4); type locality and date, NMV F157430 (2).

Other material: Weddell Sea, 430 m, USNM E33925 (1).

Ross Sea, *Tangaroa* 0802, 67–69°S 170°E–178°W, 329–334 m, NIWA 38273 (1); 329–334 m, NIWA 38281 (1); 137–150 m, NIWA 38604 (1); 300–340 m, NIWA 38624 (6); 547–605, NIWA 39084 (12); 565–920 m, NIWA 39181 (2); 479–480 m, NIWA 39311 (6); 456–540 m, NIWA 45695 (8); 447–455 m, NIWA 45699 (1); *Tangaroa* 0602, stn 394, 67°S 179°E, 540–600, NIWA 44667 (5).

Enderby Land, BANZARE stn 34, 66°21'S 58°50'E, 603 m, SAM K2342 (2).

Diagnosis. *Psolidium* species up to 28 mm long; body form elongate, narrow, high; dorsal and lateral scales conspicuous, thin, smooth, up to 2.0 mm wide; dorsal and lateral tube feet inconspicuous.

Sole: outer peripheral single series of smaller tube feet; inner peripheral single series of larger tube feet; lacking mid-ventral (sole) radial series of tube feet.

Dorsal ossicles: multi-layered perforated plates (scales), single-layered marginally; plates frequently with smooth white thickening and reduced/small perforations aligned perpendicular to margin in parallel series; plates with reticulate thickening and multi-layered centrally, lacking frequent radiating linear thickenings between marginal perforations; up to 4 tube foot canals per plate; dorsal and lateral tube feet lacking support plates.

Sole ossicles: throughout most of sole rare, small, smooth, thin, irregularly shaped rods and perforated plates, sometimes as regular 4-holed plates with marginal knobs or digitiform projections, sometimes surface knobs, up to 200 μm long; near margin of sole and peripheral tube feet thicker, irregular, elongate, perforated rod-plates, surface with pronounced linear thickenings (suggesting branched rod origin), up to 420 μm long, intergrading with oval to elongate thick perforated plates, slightly concave, some with secondary layering, up to 320 μm long.

Tentacles: largest tentacle trunk ossicles irregular round to oval to elongate, smooth perforated plates, some thin with large perforations, some thicker with smaller perforations, plates up to 550 μm long, rarely with any secondary layering; few narrow perforated plates, lacking evidence of rod derivation, up to 650 μm long.

Colour (preserved). Body pale brown to off-white; scales with slightly discontinuous haloes; fine red-brown microscopic flecking over dorsal body.

Distribution. Weddell Sea, 260–795 m (Gutt, 1991b); Ross Sea, 137–920 m; Enderby Land, 603 m.

Etymology. Named for Dr David Pawson (USNM, Senior Research Scientist), with gratitude for his provision of the opportunity to pursue this research, and appreciation of his constant interest and encouragement.

Remarks. Massin (1992) examined specimens of *Psolidium poriferum* (as *P. incertum*) from both the Sub-Antarctic islands of the Indian Ocean and the Weddell Sea, and observed that there were significant differences in the structure of the dorsal scales. He judged that the Weddell Sea material "probably represents another species". We agree, and refer the Weddell Sea, Ross Sea and Enderby Land material to *Psolidium pawsoni* sp. nov. Gutt (1988) reported *Psolidium incertum* (Théel, 1886) from the Weddell Sea, and synonymised *Psolidium tenue* Mortensen, 1925, with *P. incertum*. We reject a synonymy of *P. incertum* with *P. tenue* (see our treatments of *P. poriferum* and *P. tenue*). We assume that the Weddell Sea material seen by Gutt is synonymous with our *Psolidium pawsoni* sp. nov. from the Weddell Sea, but acknowledge that *Psolidium tenue* might also occur in the Weddell Sea.

Psolidium pawsoni sp. nov. is distinguished diagnostically by the frequent occurrence on the dorsal and lateral scales of smooth white thickening with consequent reduced/small perforations.

***Psolidium poriferum* (Studer) syn. nov.**

Figures 2d; 7c-f

Cuvieria porifera Studer, 1876: 452–53.—Studer, 1879: 123.*Psolusporiferus*.—Bell, 1882: 644.—Lampert, 1889: 854.—Studer, 1889: 163.*Psolus poriferus* (*Cuvieria*).—Théel, 1886: 130.—Lampert, 1885: 122.*Psolus incertus* Théel, 1886: 86–87, pl. 8 fig. 4, pl. 6 fig. 5.—Studer, 1889: 163. (new synonymy).*Theelia incerta*.—Ludwig, 1892: 350.*Theelia* (? *Psolidium*) *incerta*.—Ludwig, 1894: 136.—Ludwig, 1898: 52.*Theelia porifera* (part).—Ludwig, 1898: 52.—Pawson, 1969: 38.*Psolidium incertum*.—Pawson, 1969: 38, map 3.—Pawson, 1971: 34, 37.—Guille, 1982: 70.—Massin, 1992: 317, 320–21, figs 8–9.—Branch, Jangoux, Alvá, Massin and Stapanato, 1993: 56, 61–65.—Thandar, 1999: 368.—Thandar, 2006: 38.*Psolidium poriferum*.—Pawson, 1971: 34, 37.—O’Loughlin and Maric, 2008: 3**Material examined.** *Psolidium poriferum* (Studer, 1876) holotype: Kerguelen, Royal Sound, *Gazelle*, 119 m, ZMB 2259.*Psolidium incertum* (Théel, 1886) syntypes (3; very poor condition): Kerguelen, Royal Sound, *Challenger* stn 149c, BM(NH) [18]86.10.2.89 (1); Heard I., stn 150, BM(NH) [18]86.2.88 (1); stn 151, BM(NH) [18]86.10.2.90 (1).Other material: Indian Ocean, McDonald Is, 210–234 m, USNM 1081576 (2 specimens); S of Kerguelen I., BANZARE stn 47, 150 m, SAM K2344 (23); Heard I., ANARE *Aurora Australis* AA90, 200 m, SAM K2189 (1); 260–380 m, K2190 (1); 260 m, K2191 (1); 266–380 m, K2205 (1); ANARE *Aurora Australis* AA92, 185–204 m, NMV F66849 (1); 229 m, F66850 (1); Heard I., F/V *Southern Champion*, cr SC26, Apr/May 2003, Western Plateau, 264–406 m, TMAG H3303 (1), H3306 (2), H3308 (2), H3317 (1), H3320 (4); Aurora Bank, 222–292 m, H3304 (4), H3305 (3), H3307 (4), H3309 (2), H3313 (2), H3314 (2), H3315 (1), H3318 (3), H3321 (6), H3322 (1); Coral Bank, 293–297 m, H3310 (3), H3311 (4); Shell Bank, 259–329 m, H3312 (1), H3316 (3), H3319 (2).

Eastern Antarctica, MacRobertson Land, BANZARE stn 107, 66°45’S 62°03’E, 177 m, SAM K2343 (1).

Diagnosis. *Psolidium* species up to 33 mm long; body form elongate, narrow, high; dorsal and lateral scales conspicuous, thin, smooth, up to 1.8 mm wide; dorsal and lateral tube feet inconspicuous.

Sole: outer peripheral single series of smaller tube feet; inner peripheral single series of larger tube feet; lacking mid-ventral (sole) radial series of tube feet.

Dorsal ossicles: multi-layered perforated plates (scales), single-layered marginally, frequently with well developed radiating-to-margin linear rounded thickenings between series of perforations, reticulate thickenings towards centre of plates, multi-layered centrally; up to 3 tube foot canals per plate.

Sole ossicles: throughout most of sole rare, small, smooth, thin, irregularly shaped rods and perforated plates, 0–10 perforations, bluntly spinous around margin, sometimes surface knobs, up to 220 μ m long; sometimes as regular 4-holed plates with marginal knobs, sometimes surface knobs, up to 160 μ m long; near margin of sole and peripheral tube feet some thicker, irregular perforated rod-plates, surface with linear thickenings and large knobs, rod-plates up to 370 μ m long, intergrading with oval to elongate perforated plates with secondary layering, up to 400 μ m long.Tentacles: largest tentacle trunk ossicles irregular round to triangular to oval, thick perforated plates, irregular large perforations, some small plates with secondary layering, plates up to 650 μ m long; some plates with irregular linear thickenings between perforations (suggesting rod origin), some rod-plates up to 800 μ m long.**Colour (preserved).** Body off-white; scales not haloed.**Distribution.** Marion, Prince Edward, Kerguelen, Heard and McDonald Is, 100–600 m (Massin, 1992), 150–406 m (this work); Eastern Antarctica, MacRobertson Land, 177 m.**Remarks.** Pawson (1971) indicated that the evidence was “quite strong” for a synonymy of *P. incertum* with *P. poriferum*, and O’Loughlin and Maric (2008, this volume) inferred this synonymy. Both species were described from the same type locality. Based on an examination of the type materials and the literature, *Psolidium incertum* (Théel, 1886) is synonymised here with *Psolidium poriferum* (Studer, 1876). *Psolidium poriferum* occurs abundantly on the Sub-Antarctic Islands of the Indian Ocean, with the exception of a single BANZARE specimen found on the MacRobertson Shelf on the Antarctic coast. *Psolidium poriferum* (Studer) is distinguished diagnostically by the frequent occurrence on the scales of well developed radiating-to-margin linear rounded thickenings between series of perforations.***Psolidium schnabelae* sp. nov.**

Figures 3a; 8a-c

Material examined. Holotype: Eastern Antarctica, MacRobertson Land, slope off Prydz Bay, BANZARE stn 29, 66°28’S 72°41’E, 1266 m, 25 Dec 1929, SAM K2345.

Other material: type locality and date, SAM K2346 (2).

Diagnosis. *Psolidium* species up to 25 mm long; body form elongate, high; dorsal and lateral scales conspicuous, thin, smooth, up to 2.5 mm wide; dorsal and lateral tube feet inconspicuous.

Sole: outer peripheral single series of smaller tube feet; inner peripheral single series of larger tube feet; lacking mid-ventral (sole) radial series of tube feet.

Dorsal ossicles: multi-layered perforated plates (scales), single-layered marginally, reticulate thickenings extend from margin towards centre of plate, multi-layered centrally, lacking frequent radiating linear thickenings between marginal perforations, lacking smooth white thickening with small perforations, margin with irregular thickenings and perforations, not smooth; up to 4 tube foot canals or marginal indentations per plate; small mesh-like tube foot endplates, about 5 perforations, 40 μ m wide; lacking dorsal and lateral tube foot support plates.Sole ossicles: throughout sole rare, small, smooth, thin, irregularly shaped rods and perforated plates, up to 10 perforations, up to 240 μ m long, sometimes as regular 4-holed plates with bluntly spined margin, sometimes surface knobs, up to 180 μ m long; near margin of sole and peripheral tube feet thicker irregular rod-plates and very thick irregular perforated plates, up to 300 μ m long.

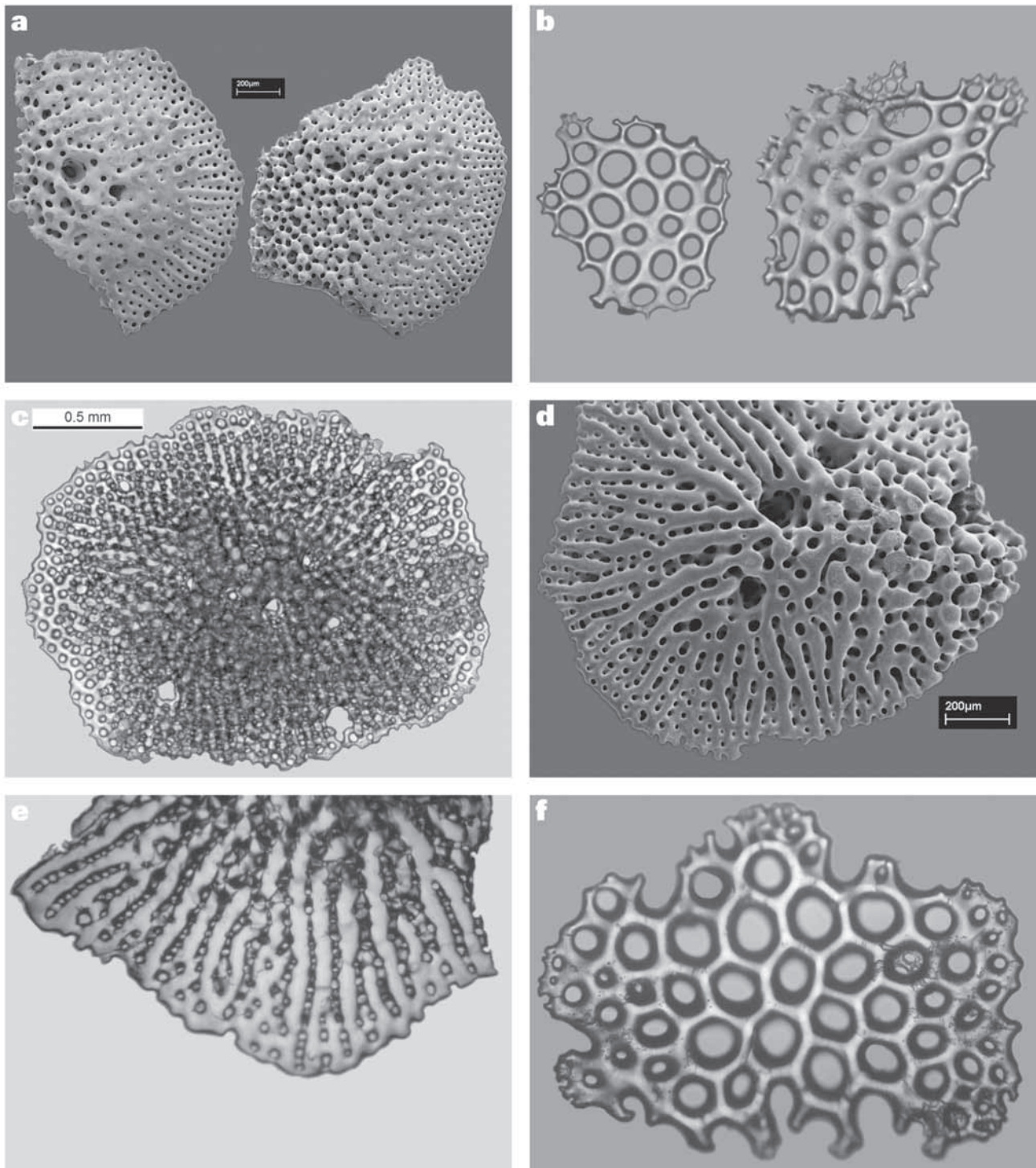


Figure 7. Photos of ossicles of species of *Psolidium* Ludwig, 1886 (a, d, SEM by Cynthia Ahearn; b, e, f, by Cynthia Ahearn; c, by Chris Rowley). a, b, *P. pawsoni* sp. nov., paratype USNM E40798: a, dorsal scales; b, tentacle ossicles, larger 520 μm long. c–f, *P. poriferum* (Studer, 1876): c, dorsal scale, holotype ZMB 2259; d, dorsal scale, SAM K2344; e, dorsal scale, SAM K2344; f, tentacle ossicle, 640 μm long, SAM K2344.

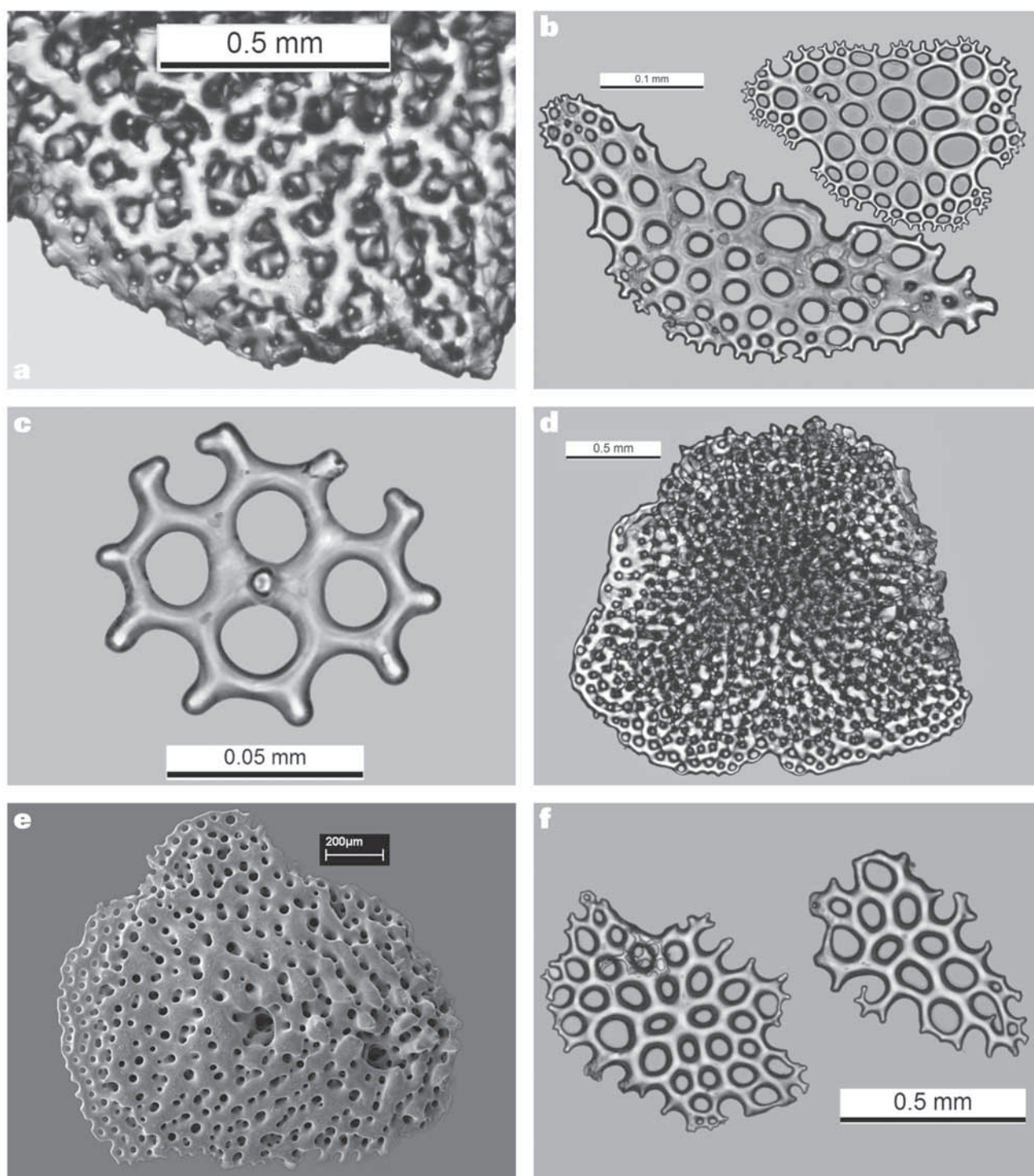


Figure 8. Photos of ossicles of species of *Psolidium* Ludwig, 1886 (a–d, f, by Chris Rowley; e, SEM by Cynthia Ahearn): a–c, *P. schnabelae* sp. nov.: a, dorsal scale, holotype SAM K2345; b, tentacle ossicles, holotype SAM K2345; c, plate from sole, paratype, SAM K2346. d–f, *P. whittakeri* sp. nov.: d, dorsal scale, NMV F104834; e, dorsal scale, paratype USNM E40795; f, tentacle ossicles, NMV F104834.

Tentacles: largest tentacle trunk ossicles predominantly smooth perforated plates, irregularly oval, large central perforations grading to numerous small close ones near margin, finely denticulate margin, plates up to 520 μm long; some thicker plates with large perforations, plates up to 300 μm long; few rod-plates, up to 300 μm long.

Colour (preserved). Body pale brown to off-white; scales haloed, with pale outer edge (single-layer perforated edge of scales with white thickening).

Distribution. Eastern Antarctica, MacRobertson Land, slope off Prydz Bay; 1266 m.

Etymology. Named for Kareen Schnabel (NIWA), with gratitude for her generous and gracious assistance with loan material and data from NIWA.

Remarks. The original BANZARE lot from station 29 comprises three specimens. We are not confident that the two smaller specimens are conspecific with the holotype, and they are assigned to "Other material" with reservation. We note that this species is recorded for a significantly greater depth than the other species of the *Psolidium poriferum* group. *Psolidium schnabelae* sp. nov. is distinguished diagnostically by the predominant form of the largest tentacle ossicles with large central perforations grading to small peripheral ones.

Psolidium tenue Mortensen

Figures 3e, f; 6c-f

Psolidium tenue Mortensen, 1925: 8–9, text figs 4–5.

Psolidium incertum.—O'Loughlin et al., 1994: 552, 554 (non *Psolidium incertum* (Théel, 1886) = *Psolidium poriferum* (Studer, 1876)).

Material examined. Antarctic Peninsula, 90 m, USNM E40789 (1 specimen); 265 m, E40790 (1); 100–200 m, E40791 (2); 270 m, E40792 (6); 330 m, E40793 (2); 212 m, E40794 (1); 311 m, E40796 (1); 325 m, E40801 (1); 670 m, USNM 1005859 (2); *Discovery* stns 181, Palmer Archipelago, 160–335 m, BM(NH) 2008.3191 (1); 182, 278–500 m, BM(NH) 2008.3192 (1); 187, 0–195 m, BM(NH) 2008.3193 (1); 190, 0–250 m, BM(NH) 2008.3194–3196 (3); 599, W of Adelaide I., 0–150 m, BM(NH) 2008.3197–3198 (2).

Ross Sea, 923 m, USNM E40776 (1); NIWA *Tangaroa* 0802, 67–74°S 167°E–179°W, 420–866 m, NIWA 36003 (1); 36027 (20); 38102 (1); 38545 (1); 38815 (4); 38842 (1); 38872 (1); 38884 (18); 38956 (9); 45698 (3); 45727 (2); 45728 (1); *Discovery* stns 1644, 626 m, BM(NH) 2008.3199 (1); 1649, 695 m, BM(NH) 2008.3200–3201 (2); 1652, 0–500 m, BM(NH) 2008.3202–3205 (4); 1660, 0–351 m, BM(NH) 2008.3206–3208 (3); 2200, Balleny Is, 512–532 m, BM(NH) 2008.3209–3218 (11); NZOI *Endeavour* stns A461, 0–550 m, NIWA 43870 (many specimens); A466, 555 m, NIWA 43871 (many); A521, 569 m, NIWA 43872 (5); A531B, 348 m, NIWA 44705 (1); A537, 546 m, NIWA 43873 (4); D216, 463 m, NIWA 43874 (4); E199, 278 m, NIWA 43875 (2); E200, 646 m, NIWA 43876 (1); E203, 187 m, NIWA 43877 (4); E220A, 371 m, NIWA 43883 (many); E220B, 371 m, NIWA 43878 (many); E212B, 91 m, NIWA 43879 (1).

Wilkes Land, 183 m, USNM E40799 (1); BANZARE stn 97, 474 m, SAM K2347 (1).

Prydz Bay, 320–768 m, NMV F68113 (2); F68116 (1); F68117 (2); F107415 (1); F107416 (1); F105417 (1); F107437 (1); F107438 (1); F107442 (1); F107443 (1); F107447 (1); SAM K2219 (1); BANZARE stn 103, SAM K2348 (4).

New Zealand, Antipodes I., 2100 m, USNM 1004885 (1).

Diagnosis. *Psolidium* species up to 50 mm long; body form elongate, narrow, high; dorsal and lateral scales conspicuous, thin, smooth, up to 3.0 mm wide; dorsal and lateral tube feet inconspicuous.

Sole: outer peripheral single series of smaller tube feet; inner peripheral single series of larger tube feet; lacking mid-ventral radial series of tube feet.

Dorsal ossicles: multi-layered perforated plates (scales), single-layered marginally, reticulate thickenings from near margin towards centre, multi-layered centrally; rarely any development of smooth white thickening with smaller perforations; rarely any development of radiating-to-margin thickenings; up to 3 tube foot canals per plate; rare tube foot support plates; endplates small, mesh-like.

Sole ossicles: throughout most of sole rare, small, smooth, thin, irregularly shaped perforated plates, 0–8 large perforations, up to 230 μm long; sometimes as regular 4-holed plates with slightly knobbed margin, sometimes with surface knobs, plates 100–200 μm long; near margin of sole and peripheral tube feet some thicker irregular perforated rod-plates, up to 570 μm long, intergrading with irregularly oval thick perforated plates, with secondary layering, up to 480 μm long.

Tentacles: largest tentacle trunk ossicles predominantly long, narrow, thick, rod-plates (rods joined to create perforations) and perforated plates with prominent rod thickenings; not predominantly smooth perforated plates; rod-plates variably straight or bent or curved, up to 800 μm long.

Colour (preserved). Body variably dark brown to pale brown to off-white; coarse red-brown flecking dorso-laterally; scales with a light-coloured "haloed" marginal appearance.

Distribution. Antarctic Peninsula, Ross Sea, Wilkes Land, Prydz Bay, 90–923 m; New Zealand, Antipodes I., 2010–2100 m.

Remarks. We raise *Psolidium tenue* Mortensen, 1925, out of a synonymy by Gutt (1988) with *Psolidium incertum* (Théel, 1886), synonymised above with *Psolidium poriferum* (Studer, 1876). *P. poriferum* is an almost exclusively Sub-Antarctic species. The single type specimen for *Psolidium tenue* Mortensen, 1925, was taken north of Discovery Inlet in the Ross Sea from 640 m. There are no inconsistencies between the original description and the material studied here from the Ross Sea. The length (preserved length of 30 mm), paucity of ossicles in the sole, single small knob sometimes present on the ossicles in the sole, and size of ossicles in the sole are all consistent with the Ross Sea material. *Psolidium tenue* Mortensen, 1925, is distinguished diagnostically by the rod-plate form of the largest tentacle ossicles.

Psolidium whittakeri sp. nov.

Figures 3b-d; 8d-f

Psolidium incertum.—Ludwig and Heding, 1935: 162–64, text figs 28–29 (non *Psolidium incertum* (Théel, 1886) = *P. poriferum* (Studer, 1876) (above)).

Material examined. Holotype: Scotia Sea, South Sandwich Is, Saunders I., 57°39'24"S 26°26'42"W, 415–613 m, R/V *Islas Orcadas*, USARP cr 575 stn 52, 26 May 1975, USNM 1112365.

Paratypes: type locality and date, USNM E40795 (39 specimens); NMV F157431 (6).

Other material: South Sandwich Is, 146–527 m, USNM E40817 (1); 355–468 m, E40818 (1); 302–375 m, E40819 (2); 360–486 m, E40827 (2); 452–759 m, E40828 (1).

Bouvet I., *Icefish* 2004 stn 59, 408–656 m, NMV F104857 (3); stn 71, 193–207 m, F104867 (1); stn 73, 316 m, F104896 (1); stn 76, 650–646 m, F104837 (7)

South Shetland Is., Elephant I., 326–382 m, AMLR-03 stn 38, NMV F104849 (1); Deception I., 460–484 m, AMLR-03 stn 88, F104834 (3); F104835 (1).

Diagnosis. *Psolidium* species up to 42 mm long; body form elongate, narrow, high; dorsal and lateral scales conspicuous, thin, smooth, up to 2.0 mm wide; dorsal and lateral tube feet inconspicuous.

Sole: outer peripheral single series of smaller tube feet; inner peripheral single series of larger tube feet; lacking mid-ventral (sole) radial series of tube feet.

Dorsal ossicles: multi-layered perforated plates (scales), single-layered marginally, multi-layered centrally; reticulate thickenings extend from near margin towards centre of plate, thickenings near margin sometimes parallel to edge of plate, sometimes coalesce into smooth thickenings with smaller perforations, lacking frequent radiating linear thickenings between marginal perforations; up to 4 tube foot canals or marginal indentations per plate; dorsal and lateral tube feet lack support ossicles.

Sole ossicles: throughout sole rare, small, smooth, thin, irregularly shaped rods and perforated plates, 0–9 large perforations, bluntly spined around margin, sometimes surface knobs, up to 260 μm long; sometimes as regular 4-holed plates with bluntly spined margin, sometimes surface knobs, up to 230 μm long; near margin of sole and peripheral tube feet thicker irregular rods and elongate perforated rod-plates, up to 420 μm long, intergrading with some round to oval, perforated thick plates up to 350 μm long, some with secondary layering.

Tentacles: largest tentacle trunk ossicles; perforated plates, irregularly round to oval to elongate to narrow, thick, smooth, lacking rod-like thickenings between perforations; perforations large, irregular in size, rare incipient secondary developments; plates up to 750 μm long; rare rod-plates, up to 440 μm long.

Colour (preserved). Dorsal and lateral body off-white (type material) to pale brown to brown (Bouvet and South Shetland Is material); scales faintly haloed, with pale outer edge (single-layer perforated edge of scales with white thickening); small dark brown markings; sole off-white to pale brown to brown.

Distribution. South Sandwich Is, South Shetland Is, Bouvet I.; 146–759 m.

Etymology. Named for Scott Whittaker (USNM), with appreciation and gratitude for his generous and gracious assistance to Cynthia Ahearn in preparing SEM images.

Remarks. We judge that the 10 specimens from Bouvet I. (567 m) that were referred to *Psolidium incertum* (Théel, 1886) (= *P.*

poriferum above) by Ludwig and Heding (1935) do not differ in any diagnostic characters from material from Bouvet I. examined here, and hence from *Psolidium whittakeri* sp. nov. In particular, the smooth perforated plate form of the tentacle trunk ossicles and the pale brown body and brown sole are the same. The preserved colour of the type material of *Psolidium whittakeri* sp. nov. (collected in 1975) is off-white. The recent material from Bouvet and the South Shetland Islands (collected in 2003 and 2004) is brown. It is difficult to judge whether this significant colour difference is due to preservation history or species difference. No significant morphological differences have been detected and it remains for current work on molecular genetic evidence to confirm species status. Of the series of *poriferum*-like species of *Psolidium*, we recognise that *P. whittakeri* sp. nov. (Bouvet, South Sandwich, South Shetland Is) is closest to *P. pawsoni* sp. nov. (Weddell Sea), but judge that there is significantly more frequent development of smooth white thickening on the scales of *P. pawsoni*. We note also that the *P. whittakeri* specimens are significantly larger (up to 42 mm long) than the *P. pawsoni* specimens that were available (up to 28 mm long).

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