



New species of *Psolus* Oken from Antarctica (Echinodermata: Holothuroidea: Psolidae)

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Abstract

Three new species of *Psolus* Oken from Antarctica are described: *Psolus byrdae* **sp. nov.** from the Marie Byrd Seamount; *Psolus carolineae* **sp. nov.** from South Georgia; *Psolus lockhartae* **sp. nov.** from the South Orkney Islands.

Key words: Amundsen Sea, Antarctic Peninsula, Scotia Sea, South Georgia, South Orkney Islands, BAS, BIOPEARL, US AMLR

Introduction

An overview of Antarctic and Sub-Antarctic species of Psolidae Forbes, 1841 assigned to *Psolidium* Ludwig, 1886 was provided by O'Loughlin & Ahearn 2008. That paper anticipated a further work on Antarctic and Sub-Antarctic species of Psolidae assigned to *Psolus* Oken, 1815. Molecular analyses are currently providing significant insight into the systematics of these species, and further molecular data are expected in the near future to enable us to further clarify the systematics of Antarctic species of Psolidae. Meanwhile we have recently had the opportunity to study holothuroid specimens from the Amundsen Sea, Antarctic Peninsula and the Scotia Sea that were collected by the BIOPEARL I and II British Antarctic Survey (BAS, 2006 & 2008; currently on loan to Museum Victoria—NMV) and 2009 US Antarctic Marine Living Resources cruise (AMLR; made available to NMV by the US National Oceanic and Atmospheric Administration—NOAA), and the collections in the United States National Museum (USNM, Smithsonian Institution, Washington) that include the US AMLR 2006 collection lodged there by NOAA. Examination of these holothuroids has led us to recognize the three morphologically distinctive new species of *Psolus* that are described here. Two of these species occur at significantly greater depths (up to 2897 and 3446 m) than previously described species of *Psolus*.

Methods

Photographs of specimens were taken by Caroline Harding using a SLR Canon EOS5D digital camera with 65 and 100 mm lenses. Ossicles were cleared for observation using commercial bleach. Photographs of ossicles were taken by Caroline Harding, with Mark O'Loughlin, using a Leica CTR5000 compound microscope, Leica DC500 digital camera, and Auto-Montage software. Figures were prepared by Caroline Harding. Museum Victoria echinoderm registration numbers are NMV with prefix F. Historically three types of registration number have been used for United States National Museum specimens. Echinoderm catalogue numbers prior to 1920 did not have a prefix, subsequently had the prefix E, and since 2001 the EMU on-line system has been used and registrations reported as USNM without an E prefix.

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

Psolidae Forbes, 1841

Remarks. For synonymy and systematic records, diagnosis, key to genera and discussion see O'Loughlin & Maric 2008.

***Psolus* Oken, 1815**

Diagnosis. Species of Psolidae with large imbricating or contiguous dorsal and lateral scales; ventro-lateral scales at margin clearly demarcated from thin sole that lacks conspicuous scales; tube feet absent dorsally and laterally, except sometimes present orally and anally.

Remarks. In their key to genera of Psolidae, O'Loughlin & Maric 2008 stated that the conspicuous dorsal and lateral scales of species of *Psolus* lacked calcareous towers. A close dorsal and lateral cover of apically spinous towers on the scales is the diagnostically distinctive character of one of the new species described below. The diagnosis in O'Loughlin & Maric 2008 has been appropriately emended here.

***Psolus byrdae* sp. nov.**

Figures 1a–f.

Material examined. Holotype. Antarctica, Amundsen Sea, Marie Byrd Seamount, 69.2°S 117.5°W, 2214 m, BAS BIOPEARL stn BI07–AGT–2000, K. Linse et al., 15 Mar 2008, NMV F168626.

Paratypes. Ross Sea, Scott I. Bank, 516–595 m, USNM 1132854 (11).

Other material. Scotia Sea, South Georgia, 56°18–23'S 37°04–37'W, 3413–3446 m, USNM 1132855 (2).

Diagnosis. *Psolus* species up to 28 mm long, 5 mm high, 12 mm wide (holotype); elongate oval form, low vertical profile, lacking oral and anal cones; scales imbricating, macroscopically smooth, microscopically finely beaded, irregular shapes, large and small, rounded and angular, mosaic arrangement, up to 5 mm wide, small near ventral margin; lacking 5 discrete oral valves, oral scales numerous, digitiform or narrow pointed or triangular pointed; tentacles 10, 8 large, 2 small ventrally; calcareous ring with digitiform radial and interradial anterior projections, radial projections larger, concave radial and interradial posterior indentations; thin non-calcareous sole, single to zig-zag series of larger inner peripheral tube feet, widely separated from outer peripheral series of smaller tube feet, lacking mid-ventral tube feet, wide calcareous margin comprising large dorsal and small ventral plates between larger and smaller tube feet series; gonad tubules unbranched.

Dorsal and lateral multilayered ossicles only. Central sole with rare irregular smooth cross-like ossicles and plates, cross branches sometimes joined distally to create small plates with up to 6 perforations, cross-like ossicles commonly 120 μ m long, perforated plates up to 208 μ m long. Margin of sole with numerous cross-like ossicles and perforated plates, up to 144 μ m long; elongate, narrow, perforated tube foot support plates, bluntly denticulate on concave margin, up to 400 μ m long; thick, irregular, rods and perforated plates, sometimes thick knobs on margin and surface, up to 320 μ m long. Largest tentacle ossicles irregularly oval and rounded triangular perforated plates, up to 424 μ m long, surface smooth, bluntly denticulate margin, commonly 2 large and 2 smaller perforations in cross formation in centre of plate.

Colour (preserved). Off-white with pale and dark brown flecking; sole is yellow, transparent, with narrow dark brown border inside the peripheral series of larger tube feet.

Distribution. Antarctic Ocean, Amundsen, Ross and Scotia Seas, 516–3446 m.

Etymology. Named after the Marie Byrd Seamount from which the holotype for this deep Antarctic psolid species was taken. Marie Byrd Land, near the Amundsen Sea, was claimed for the United States by Richard E. Byrd in 1929 and named in honour of his wife Marie.

Remarks. *Psolus byrdae* sp. nov. has been found at great depths in the Antarctic Ocean, and has not been found on the continental shelf of Antarctica. It is distinguished morphologically from all other Antarctic

Psolus species by a combination of: consistently low vertical profile; absence of discrete oral valves; wide calcareous ventral margin around the sole; irregular thick knobbed rods, plates, and numerous smaller cross-like ossicles and plates around the margin of the sole; rare smooth cross-like ossicles and plates in the central sole; lacking ossicles other than scales dorsally and laterally.

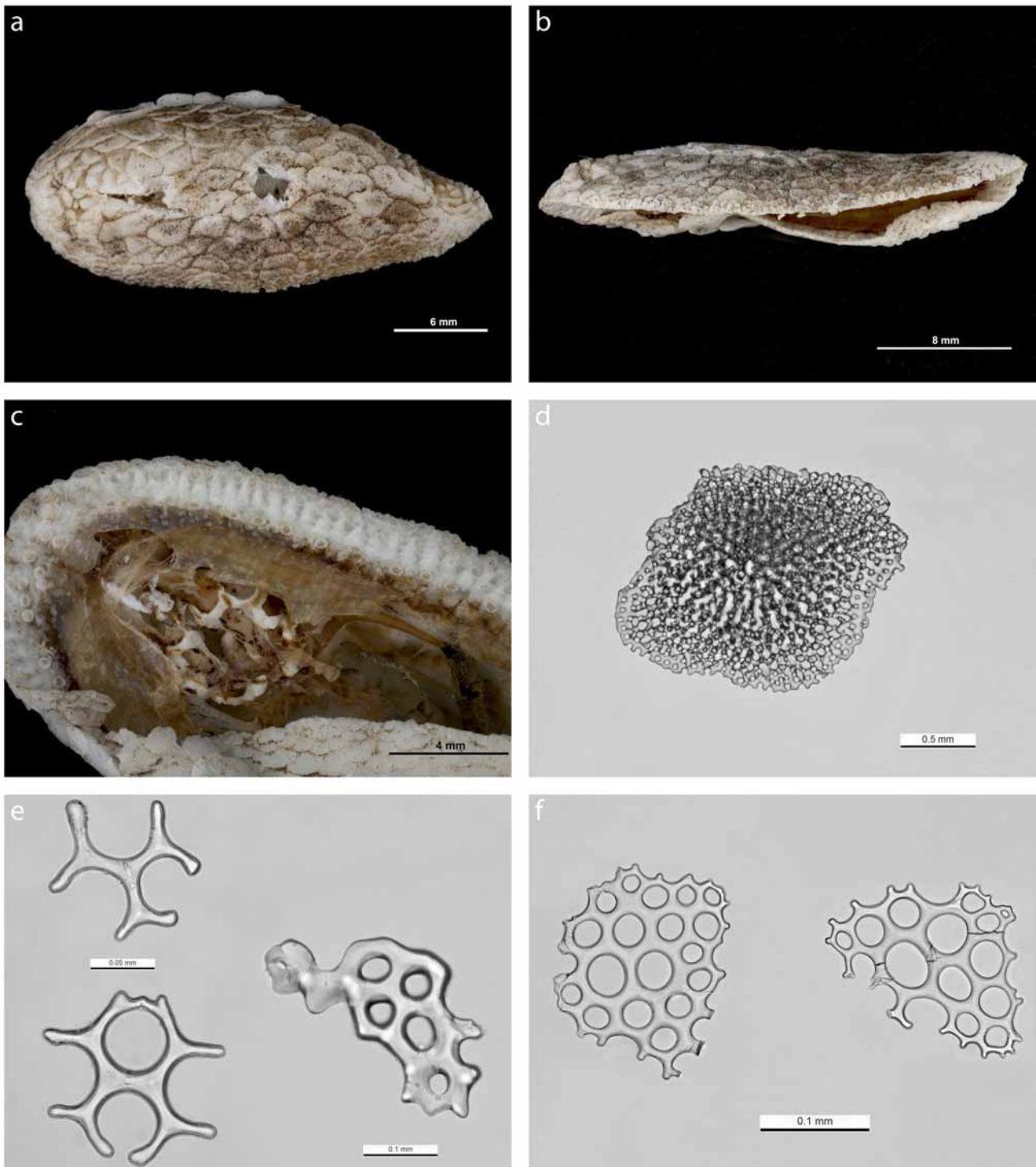


FIGURE 1. *Psolus byrdae* sp. nov. holotype (NMV F168626): a, dorsal view; b, lateral view; c, ventral view (oral end); d, dorsal scale (from USNM 1132854); e, thick knobbed plate and cross-like ossicles with arms sometimes joined to create perforations, from margin of sole (from holotype); f, tentacle ossicles (from holotype).

Psolus carolineae sp. nov.

Figures 2a–f, 3a–d.

Material examined. Holotype. Antarctica, Scotia Sea, South Georgia, 55.06°S 35.24°W, 116 m, ICEFISH 2004 stn 47–BT–25, S. Lockhart, 12 Jun 2004, NMV F168623.

Paratypes. From type series (type locality on same date), NMV F104996 (5); Shag Rocks, 53.63°S 40.91°W, 206 m, BAS 2006 stn SR–EBS–4, NMV F168627 (1).

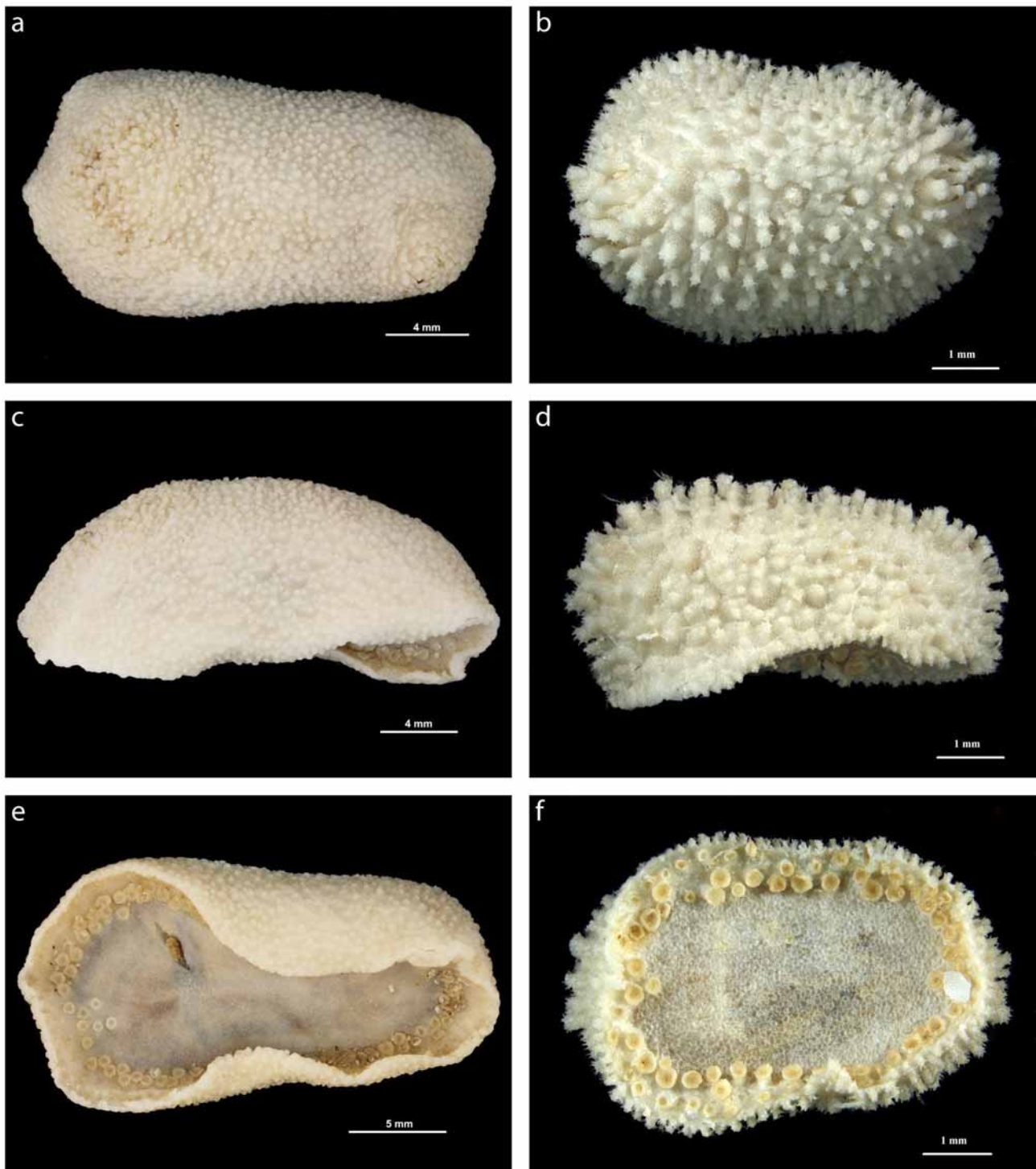


FIGURE 2. *Psolus carolineae* sp. nov. holotype (a, c, e, NMV F168623): a, dorsal view; c, lateral view; e, ventral view; paratype, juvenile specimen (b, d, f, NMV F168627): b, dorsal view; d, lateral view; f, ventral view.

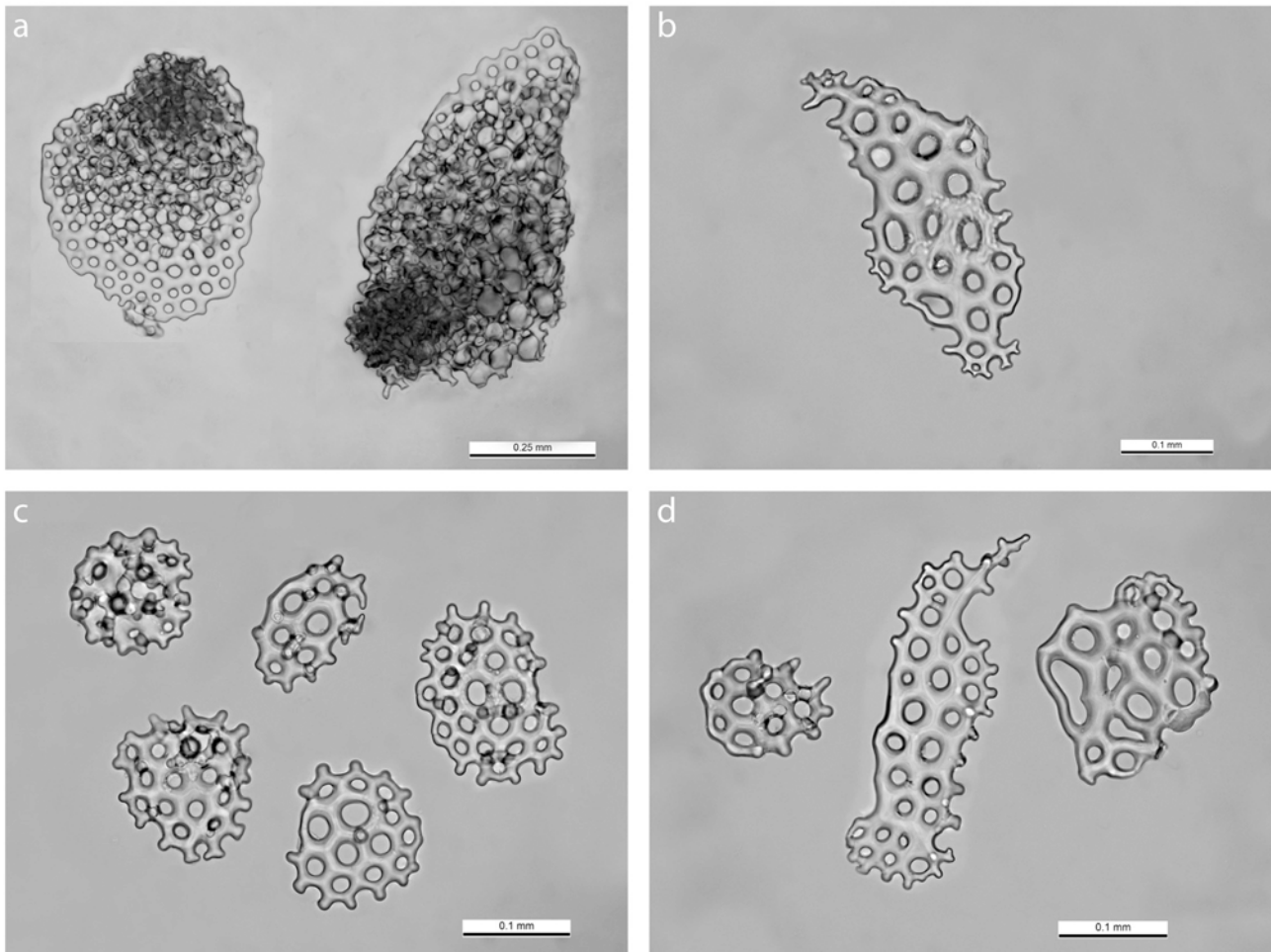


FIGURE 3. *Psolus carolineae* sp. nov. paratype (NMV F104996): a, dorsal scales (multilayered ossicles with single marginal pillar); b, tentacle ossicle; c, ossicles from sole; d, ossicles from tube foot.

Other material. Antarctic Peninsula, N of Bransfield Strait, 227–231 m, US AMLR 2006 stn 33–18, USNM 1132590 (2); N of D’Urville I., 238 m, US AMLR 2006 stn 39–52, USNM 1132592 (1); N of D’Urville I., 238 m, US AMLR 2006 stn 39–52, USNM 1132593 (8).

Diagnosis. *Psolus* species up to 22 mm long, 9 mm high, 11 mm wide; high to low convex body, slightly tapered posteriorly, lacking oral and anal cones; scales obscured by close cover of large and small apically spinous pillars on the scales, up to 0.5 mm high; lacking 5 discrete oral valves, oral scales numerous, apically pointed, marginally spinous; tentacles 10, 8 large, 2 small ventrally; calcareous ring with distally rounded radial and interradial anterior projections, radial projections larger, concave radial and interradial posterior indentations; thin calcareous sole, single outer peripheral series of small tube feet, zig-zag to double series of larger inner peripheral tube feet, lacking mid-ventral tube feet; bi-lobed dorsal madreporite; single ventral polian vesicle; gonad tubules unbranched.

Dorsal and lateral multilayered ossicles only. Sole with irregular round to oval perforated plates and shallow bowls, commonly 136 μm long, frequently with upturned margin, surface and marginal knobs. Largest tentacle ossicles irregularly oval or triangular or elongate thick perforated plates, surface smooth, bluntly denticulate margin, up to 560 μm long. Largest tube feet support ossicles up to 320 μm long, elongate curved narrow perforated plates, bluntly denticulate margin, rare sparse surface knobs.

Colour (preserved). White to off-white, slightly translucent sole.

Distribution. Antarctic Ocean, South Georgia, Shag Rocks, Antarctic Peninsula, 116–238 m.

Etymology. Named for Caroline Harding (Museum Victoria Entomology Department), with appreciation of her generous collaborative assistance in doing both the montage photography of specimens and ossicles in this study, and the preparation of the figures.

Remarks. *Psolus carolineae* **sp. nov.** is distinguished from all other Antarctic *Psolus* species by the distinctive apically spinous pillars that arise from and closely cover the dorsal and lateral scales.

Psolus lockhartae **sp. nov.**

Figures 4a–f, 5.

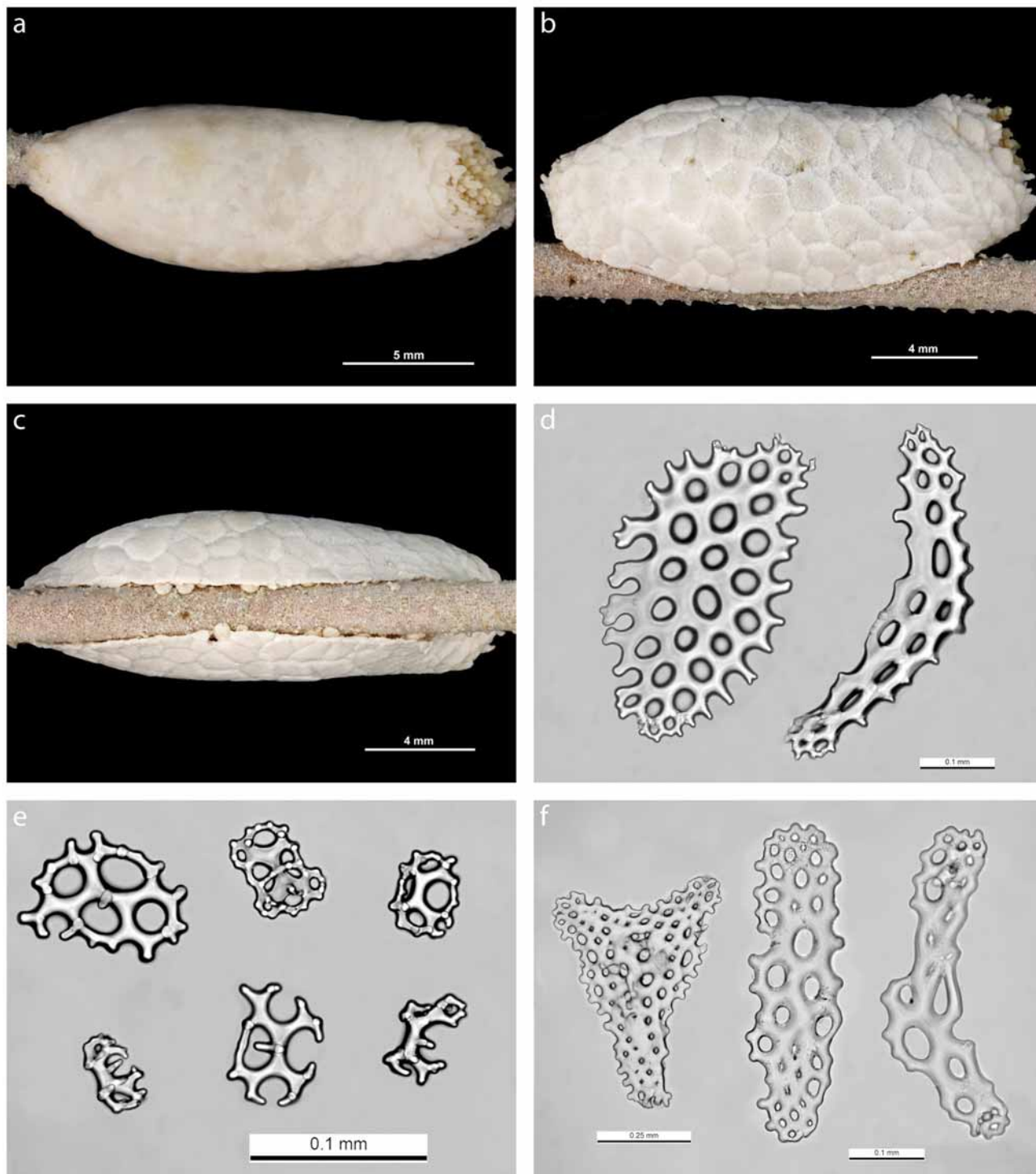


FIGURE 4. *Psolus lockhartae* **sp. nov.** holotype (a–c, NMV F168861): a, dorsal view; b, lateral view; c, ventral view; paratype (d–f, NMV F168860): d, tentacle ossicles; e, ossicles from sole; f, ossicles from tube foot.

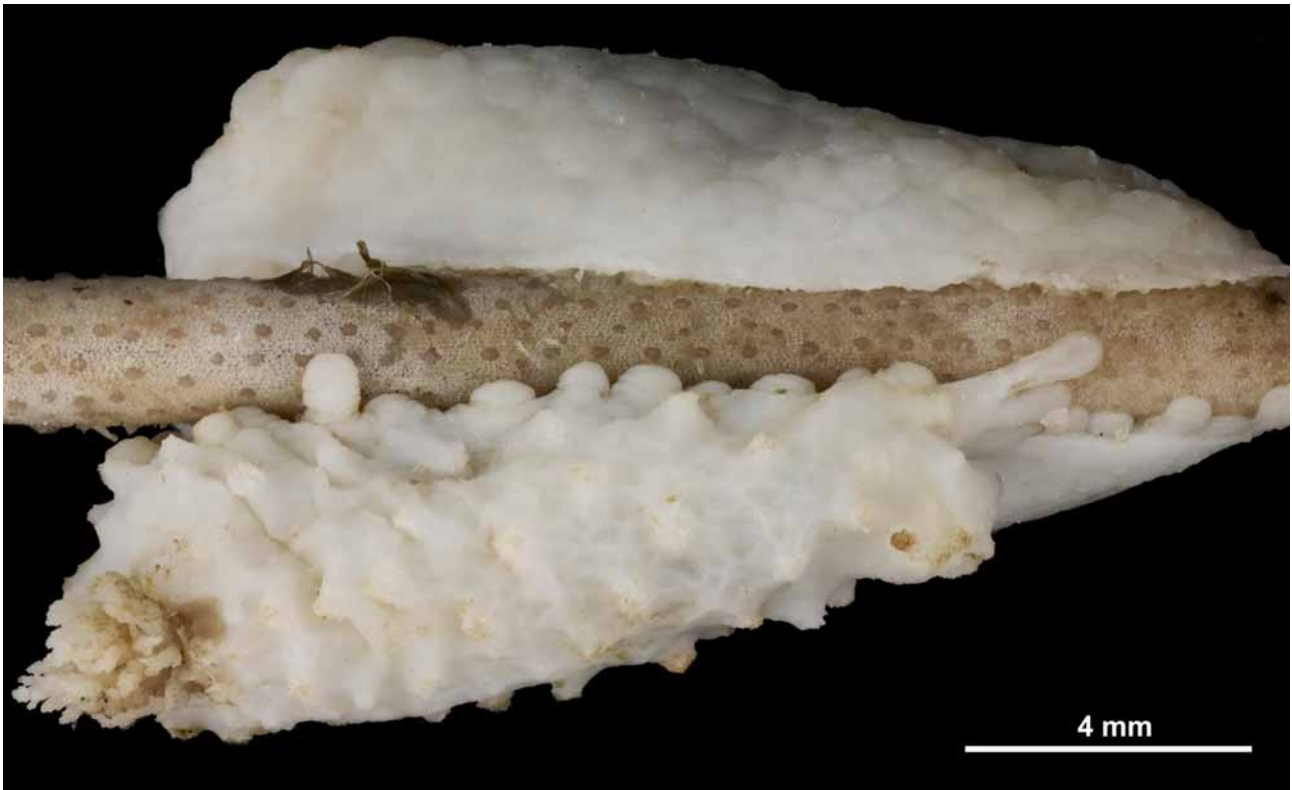


FIGURE 5. *Ctenocidaris speciosa* Mortensen, 1910 spine with specimens of *Psolus lockhartae* sp. nov. above (NMV F168857) and *Echinopsolus acanthocola* Gutt., 1990 below (NMV F168858).

Material examined. Holotype. Antarctica, Scotia Sea, South Orkney Is, 60°36.21'S 44°19.67'W, 211 m, US AMLR 2009 stn 19–13, S. Lockhart, 13 Feb 2009, NMV F168861.

Paratypes. South Orkney Is, 60°26.52'S 45°17.91'W, 497 m, US AMLR 2009 stn 12–7, 11 Feb 2009, NMV F168857 (1); NMV F168859 (5); NMV F168860 (3).

Other material. South Orkney Is, 298–302 m, USNM E43073 (3); 593–598 m, USNM E43074 (2); 2355–2897 m, USNM E43076 (63); 567–671 m, USNM E43080 (3); 759–857 m, USNM E43081 (7); South Shetland Is, 300 m, USNM E43075 (3); 220–240 m, USNM E43078 (1); South Georgia, 1968–2188 m, USNM E43079 (3); Burdwood Bank, 339–357 m, USNM E43077 (4).

Diagnosis. *Psolus* species up to 20 mm long, 10 mm high, 8 mm wide; form sub-cylindrical, smooth, rounded oral and anal ends, lacking oral and anal cone; scales up to 3 mm wide, imbricating, macroscopically smooth, microscopically finely beaded, mosaic arrangement of large and small, rounded and angular scales; lacking 5 discrete oral valves, oral scales numerous, digitiform or narrow pointed or triangular pointed; tentacles 10, 8 large, 2 small ventrally; calcareous ring with digitiform radial and interradian anterior projections, radial projections slightly swollen distally, concave radial and interradian posterior indentations; thin calcareous sole, single to zig-zag to double series of large inner peripheral tube feet, lacking outer peripheral series of smaller tube feet, rare mid-ventral tube feet present; single ventral polian vesicle; gonad tubules unbranched.

Dorsal and lateral multilayered ossicles only. Sole with crosses, thick, finely knobbed or bluntly-spinous, shallow concave or cupped, small and large, commonly 88–112 μm long, rarely 168 μm long, upturned branched arms of crosses may join to form cups with up to 8 perforations, marginal projections sometimes joined to create anastomosing branches over cups or transverse bridges across cups. Largest tentacle ossicles irregularly oval or triangular or narrow perforated plates, up to 480 μm long, surface smooth, bluntly denticulate margin. Largest tube feet support ossicles up to 560 μm long, thick smooth perforated plates, irregularly oval or triangular or narrow, bluntly denticulate margin.

Colour (preserved). White.

Habit. Lives with the lateral margins of the sole wrapped around Cidaridae echinoid spines of different species, with type specimens found on spines of *Ctenocidaris speciosa* Mortensen, 1910 and *Rhynchocidaris triplopora* Mortensen, 1909.

Distribution. South Atlantic Ocean, Burdwood Bank; Antarctic Ocean, Scotia Sea, South Georgia, South Shetland Is, South Orkney Is, 211–2897 m.

Etymology. Named for Susie Lockhart (US National Oceanic and Atmospheric Administration), with appreciation of her generous collaborative assistance in creating the opportunity for us to study US AMLR Antarctic holothuroid specimens.

Remarks. *Psolus lockhartae* **sp. nov.** is the only known species of *Psolus* that lives on echinoid spines. The psolids *Echinopsolus acanthocola* Gutt, 1990 and *Echinopsolus parvipes* Massin, 1992 have a similar life habit. In this study one specimen of *Psolus lockhartae* **sp. nov.** (NMV F168857) was found attached to the same spine from the echinoid *Ctenocidaris speciosa* as a specimen of *Echinopsolus acanthocola* (NMV F168858). In addition to a unique habit, the morphological characters that distinguish this species from all other Antarctic *Psolus* species are a combination of: smooth sub-cylindrical body form; absence of oral valves; absence of an outer peripheral series of smaller tube feet on the sole; distinctive thick knobbed and bluntly spinous concave crosses and cups in the sole; lacking ossicles other than scales dorsally and laterally.

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