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Sea cucumbers of the Kerguelen Plateau, with descriptions of new genus and species (Echinodermata: Holothuroidea)

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Abstract

O'Loughlin, P.M., Skarbnik-López, J., Mackenzie, M. and VandenSpiegel, D. 2015. Sea cucumbers of the Kerguelen Plateau, with descriptions of new genus and species (Echinodermata: Holothuroidea). *Memoirs of Museum Victoria* 73: 59–93.

A new genus of holothuroid, *Calcamariina* O'Loughlin, and five new species of holothuroids, with authors O'Loughlin & Skarbnik-López, from near Heard and McDonald Islands on the Kerguelen Plateau in the Southern Ocean are described: *Calcamariina hibberdi*, *Calcamariina moorea*, *Echinocucumis ampla*, *Psolus heardi*, *Paracaudina championi*. The new species *Paracaudina championi* has the diagnostic characters of both *Paracaudina* Heding and *Hedingia* Deichmann. *Molpadia violacea* Studer is raised out of synonymy with *Molpadia musculus* Risso. *Molpadia violacea* is reviewed, and an extended distribution around Antarctica is proposed. The distribution of *Molpadia magdae* O'Loughlin (in O'Loughlin *et al*.) is extended from the South Shetland Islands to Prydz Bay. *Pseudopsolus macquariensis* forma *gruai* Cherbonnier & Guille is raised to species status. *Laevocnus* O'Loughlin (in O'Loughlin *et al*.) is an objective junior synonym of *Pentactella* Verrill. A *sensu stricto* diagnosis is provided for *Pentactella*. The always smaller, brood-protecting *Psolus ephippifer* Thomson specimens may be juveniles of the sympatric and always larger, non-brooding, *Psolus paradubiosus* Carriol & Féral specimens. Comprehensive lists are provided for all holothuroids that have been reported from the vicinity of Heard and McDonald Islands, and for the Kerguelen Plateau. Individual lists are provided for all holothuroid specimens from the vicinity of Heard and McDonald Islands that are held in Museum Victoria, the South Australian Museum, and the Tasmanian Museum and Art Gallery. Holothuroid species variably common to the Kerguelen Plateau, coast of Antarctica, Macquarie Island, Magellanic Region and Bouvetoya Island are listed.

Keywords

Antarctica, *Challenger*, *Gazelle*, HIMI, Bouvetoya, Heard, Kerguelen, Macquarie, Magellanic, new species, *Calcamariina*, *Echinocucumis*, *Hedingia*, *Molpadia*, *Paracaudina*, *Pentactella*, *Pseudopsolus*, *Psolus*.

Introduction

Heard and McDonald Islands are Australian territories (since 1947) on the southern Kerguelen Plateau that lies central-south of the Indian Ocean and south of the Antarctic Convergence. Heard and McDonald Islands and surrounding territorial waters were inscribed as a UNESCO World Heritage Site in 1997. Extending beyond the territorial waters is an Exclusive Economic Zone that includes four Marine Reserves. Names have been given to the principal regions within the EEZ (Figure 1 map). The Marine Reserves include the *Coral* and *Aurora Banks* to the northwest, *Discovery Bank* to the north, and *Shell Bank* to the northeast. The Australian National Antarctic Research Expeditions (ANARE) was established in 1947 to conduct the Australian Antarctic program. In 1948 the Australian Antarctic Division (AAD) was established to administer the program. For the past decade the name ANARE has fallen out of use and been replaced by AAD. Following collecting from the Kerguelen Plateau by the HMS *Challenger* and SMS *Gazelle* in 1874, the US Transit of Venus Expedition in 1875, and The British

Australian and New Zealand Research Expedition (BANZARE) over the years 1929–1931, ANARE commenced expeditions in 1967 to the now Exclusive Economic Zone for Heard and McDonald Islands (HIMI).

A series of AAD marine survey expeditions has recovered an extensive collection of sea cucumbers from HIMI that are held by the Australian Antarctic Division at Kingston in southern Tasmania (specimens not registered), the Tasmanian Museum and Art Gallery in Hobart, the South Australia Museum in Adelaide, and Museum Victoria in Melbourne. Mark O'Loughlin has established the systematic identity of the specimens in NMV, SAM and TMAG. Ty Hibberd and Kirrily Moore determined the identity of specimens that have remained in the AAD facility at Kingston by comparison with voucher specimens identified by Mark O'Loughlin. Tissue samples from preserved specimens collected in recent surveys have been sent to Gustav Paulay in the University of Florida for genetic sequencing. CO1 sequences from some of these specimens have informed this study (see O'Loughlin *et al*. 2010). A comprehensive species list and individual museum specimen lists are provided below for all holothuroids reported from HIMI. Some other localities where HIMI species are reported are detailed and discussed.

The generic names *Thyone* Oken, 1815 and *Psolus* Oken, 1815 were introduced by Oken (1815) in a work that was suppressed by the ICZN in Opinion 417 because the paper was not consistently binominal. Gustav Paulay and Mark O'Loughlin have requested the ICZN to reinstate the names (Case 3598; *Bulletin of Zoological Nomenclature* 69(4) Dec 2012). The case is awaiting decision. We use the name *Psolus* Oken, 1815 provisionally.

Methods

Specimens collected by the FV *Southern Champion* were frozen and subsequently preserved in 70% ethanol. Tissue samples from recently preserved specimens were sent to Gustav Paulay (University of Florida) for molecular genetic sequencing. Jessica Skarbnik-López photographed the large specimens in this study with a Nikon D70 DSLR camera using a Nikkon 105 mm lens (and 2x adapter). Jessica Skarbnik-López and Melanie Mackenzie photographed the small specimens using a Leica DC5000 high-resolution digital camera system with auto montage software. Didier VandenSpiegel took the scanning electron microscope (SEM) images. Ossicles were cleared from tissue using commercial bleach, air dried, mounted on aluminium stubs and coated with gold. Observations were made using a JEOL JSM-6480LV SEM. Measurements were made with Smile view software. Slide photos of the Studer specimens on loan from ZMB were taken in NMV by Mark Darragh (see Figure 16). Melanie Mackenzie took the photo of the phosphatising *Molapdia* table through a microscope using a Canon PowerShot D30 waterproof camera.

Abbreviations

AAD	Australian Antarctic Division
AFMA	Australian Fisheries Management Authority
ANARE	Australian National Antarctic Research Expeditions
BANZARE	The British, Australian and New Zealand Antarctic Research Expedition
CEAMARC	Collaborative East Antarctic Marine Census
CSIRO	Commonwealth Scientific and Industrial Research Organization
EEZ	Exclusive Economic Zone
FAS	Fisheries Audit Services (NZ0 Ltd.)
HIMI	Heard and McDonald Islands territorial waters and Exclusive Economic Zone
ICZN	International Commission on Zoological Nomenclature
MNHN	Muséum national d'Histoire naturelle
MOL AF	UF tissues sequence code
NMV	Museum Victoria, with specimen registration prefix F
SAMA	South Australian Museum, with specimen registration prefix K
SC	Fishing Vessel *Southern Champion*
TMAG	Tasmanian Museum and Art Gallery, with registration prefix H
UF	Florida Museum of Natural History, University of Florida
USNM	United States National Museum of Natural History (Smithsonian Institution)
ZMB	Museum für Naturkunde – Leibniz Institute for Evolutionary and Biodiversity Research at the Humboldt University, Berlin.

Reports of HIMI holothuroids

In the first months of 1874 specimens representing five holothuroid species were collected from the HIMI region by HMS *Challenger* and reported by Théel (1886): *Pentactella laevigata* Verrill, 1876 (as *Cucumaria laevigata*) at *Challenger* Station 151 (immediately north of Heard I.; -52.99 73.59, 137 m); *Pentactella serrata* (Théel, 1886) (as *Cucumaria serrata*) at *Challenger* Station 150 (*Coral Bank* NW of Heard I.; -52.07 71.37, 274 m); *Pentactella intermedia* (Théel, 1886) (as *Cucumaria serrata* var *intermedia*) at *Challenger* Stations 150, 151 (see above); *Psolidium poriferum* (Studer, 1876) (= *Psolus incertus* Théel, 1886) at *Challenger* Stations 150, 151 (see above); *Psolus ephippifer* Thomson, 1877 at *Challenger* Stations 150, 151 (see above).

Subsequently the SMS *Gazelle* arrived at the Kerguelen Islands in October 1874 and collected holothuroid specimens representing five species that were reported by Studer (1876): *Pentactella laevigata* Verrill, 1876; *Psolidium poriferum* (Studer, 1876) (as *Cuvieria porifera* Studer, 1876); *Trachythyone muricata* Studer, 1876; *Molpadia violacea* Studer, 1876; *Sigmodota contorta* (Ludwig, 1875) (as *Sigmodota purpurea* Studer, 1876). All were from near the Kerguelen Islands, none from the HIMI region although all have been subsequently reported from HIMI. Mark O'Loughlin

examined the Studer holotypes while on loan to NMV from ZMB. Photos of the preserved Studer holotypes are provided in Figures 14 and 16.

In January 1875 *The United States Transit of Venus Expedition* collected *Pentactella laevigata* Verrill, 1876 from the Kerguelen Islands.

O'Loughlin (2009) reported on the BANZARE (1929–1931) holothuroids, some of which were collected from around the Kerguelen Islands but none from the HIMI region. Earlier, O'Loughlin (2002) had reported on selected BANZARE and ANARE holothuroids that included ANARE specimens from HIMI: *Heterocucumis godeffroyi* (Semper, 1867) (as *Cucumaria godeffroyi*); *Staruocucumis liouvillei* (Vaney, 1914); *Trachythyone lechleri* (Lampert, 1885); *Sigmodota contorta* (Ludwig, 1875) (as *Chiridota pisanii* Ludwig, 1887). Three specimens from HIMI that were listed by O'Loughlin & VandenSpiegel (2010) under *Sigmodota contorta* were subsequently identified as *Paradota weddellensis* Gutt, 1990.

Eight marine expeditions to HIMI, commencing in 1967, have collected holothuroid specimens (Table 1). A map is provided for the various regions of the HIMI (Figure 1). In this paper we report all holothuroid species collected from the HIMI region (Table 2), and the individual specimens held in NMV (Table 3), SAMA (Table 4), and TMAG (Table 5).

Hibberd & Moore (2009) have provided a field guide to the holothuroids of HIMI that is available on-line at: http://heardisland.antarctica.gov.au/__data/assets/pdf_file/0015/2166/HIMI_Invertebrate_Identification_guide1.pdf

We note that this paper indicates a need for an update of this guide. Reidentifications and new species are reported below.

Order **Dendrochirotida** Grube, 1840

Family **Cucumariidae** Ludwig, 1894

Subfamily **Cucumariinae** Ludwig, 1894 *sensu* Panning 1949

Remarks. The subfamily Cucumariinae has plates only in the body wall, while the second subfamily Colochirinae Panning, 1949 has plates and cup/basket ossicles in the body wall.

Calcamariina O'Loughlin gen. nov.

Zoobank LSID. http://zoobank.org:act:C8E4BCE3-5C82-421B-A0F5-49990CC0FE8E

Diagnosis. Cucumariinid genus; body fusiform, up-turned tail; tentacles eight and two small ventral; complete calcareous body cover of imbricating thick, single-layered, knobbed, perforated plates, or thick, knobbed, rod-plates, some plates and rod-plates with spinous or knobbed part-margins; complete cover of tube feet surmounting calcareous papillae; absence of cups and tables; tentacles with thick rod-plates, rods and small perforated plates, lacking rosettes.

Type species and locality. Calcamariina hibberdi O'Loughlin & Skarbnik-López sp. nov. (south Kerguelen Plateau)

Second assigned species. *Calcamariina moorea* O'Loughlin & Skarbnik-López sp. nov. (south Kerguelen Plateau)

Etymology. Named *Calcamariina* from the Latin *calx* (meaning "chalk/limestone", referring to the calcareous body wall), and *mariina* (from the sub-family Cucumariinae).

Remarks. The complete body-cover of thick, calcareous single-layered perforated plates or rod-plates some with spinous or knobbed part-margins, complete cover of tube feet surmounting calcareous papillae, and absence of cups or tables, is a unique generic combination amongst the cucumariinid genera. There are no near-similar genera. We are most reluctant to establish yet another genus, but we cannot find a cucumariinid genus into which we can provisionally assign the new species.

Calcamariina hibberdi O'Loughlin & Skarbnik-López sp. nov.

Zoobank LSID. http://zoobank.org:act:548D6DA2-AAC9-4C4C-B403-56BD914DD3CE

Tables 1–3, 5, 6; figures 1–3, 6.

Material examined. Holotype. Southern Ocean, S Kerguelen Plateau, NE Heard Island, *Shell Bank*, AAD *Southern Champion* cruise 46 haul 125, beam trawl, -51.69 76.19, 234 m, 25 Jun 2007, NMV F165750 (UF tissue sequence code MOL AF703).

Paratypes. HIMI, *Aurora Bank*, SC26(184), 247 m, 1 May 2003, TMAG H3542 (1); S *Shell Bank*, SC26(253), 341 m, 8 May 2003, TMAG H3543 (1).

Description. Body fusiform with slightly up-turned oral and anal ends, anal end tapered to a tail, curved semi-U-shaped body up to 15 mm wide (U-shape width), mid-body diameter up to 6 mm (TMAG H3543); body grey/off-white, hard, calcareous, covered with low rounded calcareous papillae each with apical terminal tube foot, papillae with tube feet more numerous ventrally than dorsally. Five anal scales. Calcareous ring cucumariid-like, plates with high anterior radial and inter-radial prolongations, lacking posterior prolongations. Tentacles dendritic, 8 large, 2 ventral small. Single polian vesicle.

Ossicles of body wall and bases of papillae thick perforated plates, irregularly oval to elongate to triangular, perforations never two large perforations centrally in plates, single-layered, variably knobbed on plate surface and thickened, generally smooth at the end embedded in the body wall, many with spinous marginal projections at narrow end of plate that projects from the body wall, ossicles up to about 550 μm long. Extended tube feet above papillae about 650 μm long; tube feet with endplates and support plates; endplate diameters variable, up to about 200 μm; tube foot/papilla wall supported by an open curved mesh of contiguous small perforated plates and rod-plates, elongate, curved, variable form but typically with four large central perforations and few distal small perforations, inner concave plate margin smooth, outer convex margin with blunt denticulations, plates up to about 140 μm long. Tentacles with small concave perforated plates, marginally denticulate, about 60–100 μm

across; curved, thick, perforated plates, perforated rod-plates and rods, bluntly denticulate on the outer margin, up to 320 μm long; lacking rosettes.

Distribution. Southern Ocean, S Kerguelen Plateau, *Aurora* and *Shell Banks*, 234–341 m.

Etymology. Named for Ty Hibberd who followed Kirrily Moore in the curation and identification of the HIMI collections, and with appreciation of his generous collaboration on the systematics of sea cucumbers from Eastern Antarctica and HIMI.

Remarks. The holotype was donated to NMV by the AAD. Initial preservation was by freezing, with subsequent transfer to 70% ethanol. The combination of generic diagnostic characters of *Calcamariina* O'Loughlin gen. nov. distinguishes the two species *Calcamariina hibberdi* O'Loughlin & Skarbnik-López sp. nov. and *Calcamariina moorea* O'Loughlin & Skarbnik-López sp. nov. (below) from all other cucumariinid species. *Calcamariina hibberdi* is in turn distinguished from *Calcamariina moorea* (below) in the Remarks for that species. The paratypes above were taken by *Southern Champion* cruise 26 and are registered in TMAG. There are probably more specimens of this new species held but not registered and not readily accessible in the AAD in Kingston.

The superficially similar species *Neopsolidium kerguelensis* (Théel, 1886) that also occurs on the Kerguelen Plateau is distinguished from the *Calcamariina* species by the former having narrow bare ventral inter-radii, and cups and multi-layered ossicles in the body wall (illustrated here in Figure 6).

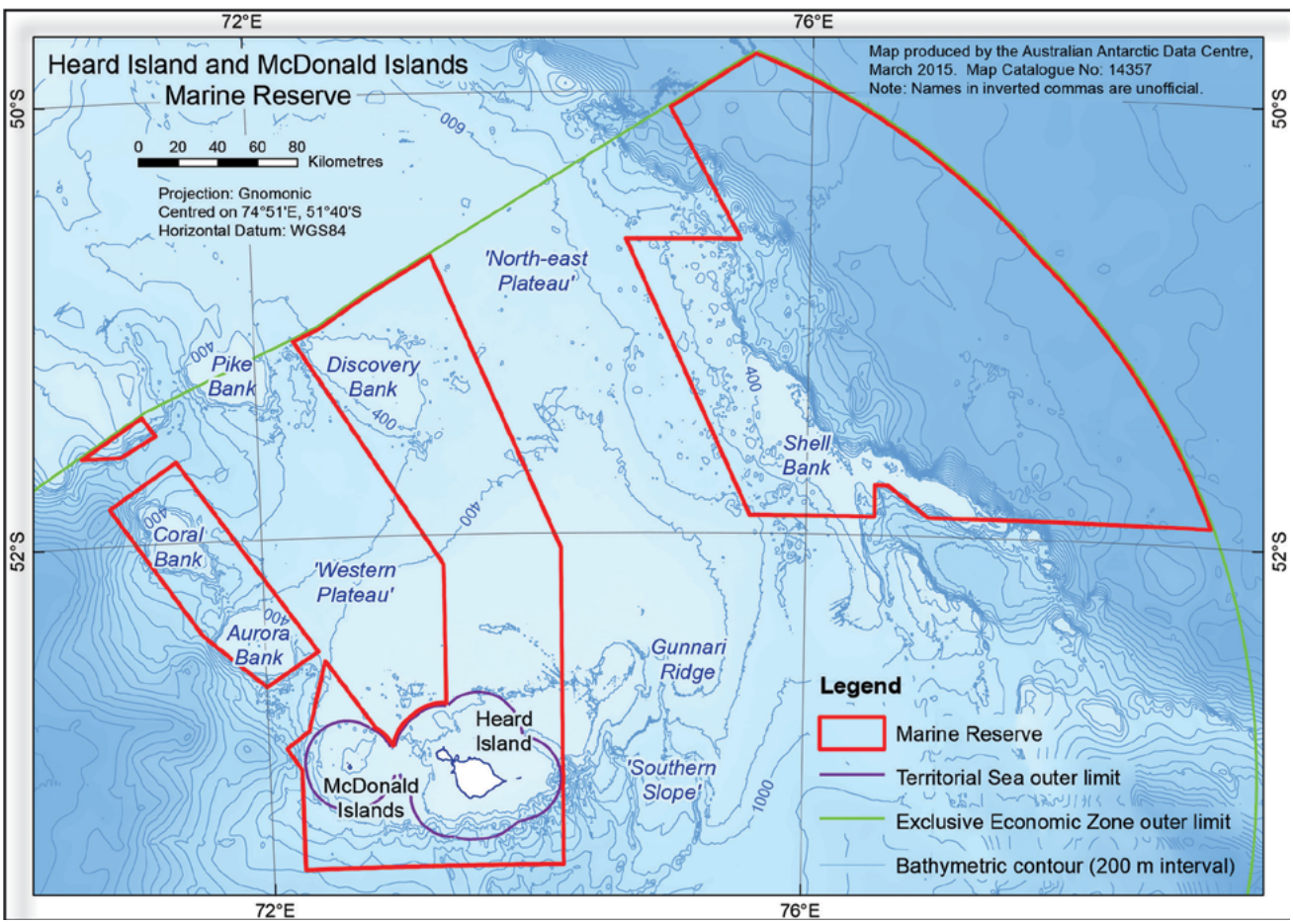

Figure 1. Map of the southern part of the Kergulen Plateau detailing the Heard and McDonald Islands Territorial Sea, Exclusive Economic Zone, Marine Reserve and localities (map is courtesy of the Australian Antarctic Division © Commonwealth of Australia 2015). Names on the map in commas are used in this study but not formally recognized by the AAD.

Table 1. Voyages to HIMI that collected Holothuroidea specimens.

Year, code	Research vessel, cruise	Collector	Museum collection	Locations visited
1967 AD[1]	*Umitaka Maru*	R. Poole	NMV	off Heard Island
1985 HRD	*Nella Dan*	M. Norman	NMV	off Heard Island
1990 AA	*Aurora Australis* V7	W. Zeidler, L. Hobbs	SAMA	*Aurora, Coral, Discovery, Pike, Shell Banks, Gunnari Ridge,* off Heard I., off McDonald Is, North-east Plateau, Southern Slope
1992 AA	*Aurora Australis* V2	C. Materia	NMV	*Aurora, Pike, Shell Banks, Gunnari Ridge*, off Heard I., North-east Plateau, Southern Slope, Western Plateau
1993 HRD	*Aurora Australis* V1	T. Stranks	NMV	*Gunnari Ridge*, Heard I., North-east Plateau, *Shell Bank*, Southern Slope
2003 SC	*Southern Champion* 26	[2] T. Lamb, [3] S. Davenport, [4] C. Sutherland	AAD, TMAG	*Aurora, Coral, Shell Banks*, Western Plateau
2007 SC	*Southern Champion* 46	[2] R. Kilpatrick, [3] J. Hamill, [4] T. Cantwell	AAD, NMV	*Shell Bank*, North-east Plateau
2008 SC	*Southern Champion* 50	[3] J. Hamill, [4] T. Cantwell	AAD, NMV	*Gunnari Ridge, Pike Bank*, Southern Slope

Notes for Table 1: [1] Data in CSIRO 'Cronulla files'; [2] AAD; [3] AFMA; [4] FAS

Table 2. Holothuroidea species from HIMI (systematic identity established by Mark O'Loughlin).

Order	Species	AAD code
Aspidochirotia	*Pseudostichopus peripatus* (Sluiter, 1901)[1]	HOL 17
	Pseudostichopus spiculiferus (O'Loughlin, 2002)[1]	HOL 9
	Zygothuria lactea (Théel, 1886)[1]	HOL 26
	Synallactes species[2]	HOL 2
Dendrochirotida	*Calcamariina hibberdi* O'Loughlin & Skarbnik-López sp. nov.	None
	Calcamariina moorea O'Loughlin & Skarbnik-López sp. nov	HOL 14
	Echinocucumis ampla O'Loughlin & Skarbnik-López sp. nov.	HOL 10
	Heterocucumis godeffroyi (Semper, 1867)	HOL. 4
	Neopsolidium kerguelensis (Théel, 1886)	HOL 19
	Pentactella intermedia (Théel, 1886)[3]	HOL 20
	Pentactella laevigata Verrill, 1876[3]	HOL 3
	Pentactella serrata (Théel, 1886)[3]	HOL 21
	Psolidium poriferum (Studer, 1876)	HOL 7

Order	Species	AAD code
	Psolus antarcticus (Philippi, 1857)[4]	HOL 23
	Psolus ephippifer Thomson, 1877[5]	HOL 15
	Psolus paradubiosus Carriol & Féral, 1985[5]	HOL 6
	Psolus heardi O'Loughlin & Skarbnik-López sp. nov.	HOL 23
	Staurocucumis liouvillei (Vaney, 1914)[6]	HOL 1
	Trachythyone lechleri (Lampert, 1885)	None
	Trachythyone muricata Studer, 1876	HOL 8
Molpadida	*Paracaudina championi* O'Loughlin & Skarbnik-López sp. nov.	HOL 11
	Molpadia violacea Studer, 1876[7]	HOL 12
Synaptida	*Sigmodota contorta* (Ludwig, 1875)	None
(Apodida)	*Paradota weddellensis* Gutt, 1990	HOL 5

Notes on determinations in Table 2:

[1]Uncertain determinations; lack supporting genetic data.

[2]Probable new species (very damaged specimen).

[3]Phylogenetic CO1 tree in O'Loughlin *et al*. 2014 supports discrete species.

[4]CO1 sequence clades with *Psolus antarcticus* specimens from Antarctica and Bouvetoya Island within a species complex.

[5]Similar morphological appearance and ossicles. The always smaller, brood-protecting *Psolus ephippifer* may be juveniles of the sympatric and always larger, non-brood-protecting *Psolus paradubiosus*.

[6, 7]CO1 sequences clade closely with those of Antarctic coast specimens. (See phylogenetic trees in O'Loughlin *et al*. 2010).

Museum Specimens of HIMI Holothuroidea

Many specimens of HIMI Holothuroidea are held at the AAD in Kingston (Tasmania) and cannot be readily accessed. Those that are registered in museum collections and accessible are listed in the three tables below.

Table 3. Holothuroidea specimens from HIMI held in NMV.

Reg No NMV F	Species	Station	Lat. Long.	Depth m	Date collected
165750	*Calcamariina hibberdi* sp. nov.	SC46(125)	-51.69 76.19	234	25/06/2007
85002	*Calcamariina moorea* sp. nov.	AA92 28	-51.56 76.04	230-247	30/01/1992
85003	*Calcamariina moorea* sp. nov.	HRD93 71 S	-50.72 75.07	514-528	28/09/1993
85004	*Calcamariina moorea* sp. nov.	HRD 006	-53.00 73.38	60	03/10/1985
165735	*Echinocucumis ampla* sp. nov.	SC46(479)	-50.68 74.62	708	30/07/2007
198492	*Echinocucumis ampla* sp. nov.	SC46(479)	-50.68 74.62	708	30/07/2007
85001	*Heterocucumis godeffroyi*	HRD93 49 B	-52.61 75.29	209	18/09/1993
84999	*Heterocucumis godeffroyi*	AA92 35	-51.27 75.61	367-379	31/01/1992
85000	*Heterocucumis godeffroyi*	AA92 29	-51.64 76.03	235-250	30/01/1992
110516	*Heterocucumis godeffroyi*	HRD93 71 S	-50.72 75.07	514-528	28/09/1993

Reg No NMV F	Species	Station	Lat. Long.	Depth m	Date collected
110520	*Heterocucumis godeffroyi*	AA92 41	-51.29 71.98	250-252	03/02/1992
76842	*Molpadia violacea*	AD 40	-52.95 73.34	112	03/02/1967
165737	*Molpadia violacea*	SC50(010)	-51.31 71.77	273	31/05/2008
84997	*Neopsolidium kerguelensis*	HRD 007	-53.16 73.22	62-80	04/10/1985
165736	*Paracaudina championi* sp. nov.	SC46(479)	-50.68 74.62	708	30/07/2007
84977	*Paradota weddellensis*	AA92 01	-52.94 73.36	159-176	23/01/1992
84978	*Paradota weddellensis*	AA92 08	-52.68 72.94	215-228	25/01/1992
84979	*Paradota weddellensis*	AA92 06	-53.21 73.68	120-132	24/01/1992
84982	*Pentactella intermedia*	HRD 007	-53.16 73.22	62-80	04/10/1985
84984	*Pentactella intermedia*	HRD 002	-53.02 73.83	85-93	02/10/1985
85009	*Pentactella laevigata*	AD 41	-52.93 73.34	177	03/02/1967
71905	*Pentactella laevigata*	AA92 01	-52.94 73.36	159-176	23/01/1992
66723	*Pentactella laevigata*	AA92 42	-51.35 71.78	297-301	03/02/1992
66726	*Pentactella laevigata*	AA92 33	-51.53 75.45	506-510	31/01/1992
67296	*Pentactella laevigata*	AA92 50	-52.46 72.42	449-457	08/02/1992
66724	*Pentactella laevigata*	AA92 43	-51.30 71.93	252-248	05/02/1992
67298	*Pentactella laevigata*	AA92 43	-51.30 71.93	252-248	05/02/1992
66732	*Pentactella laevigata*	AA92 24	-52.19 74.89	274-288	29/01/1992
67312	*Pentactella laevigata*	AA92 12	-52.71 74.22	190-202	26/01/1992
66729	*Pentactella laevigata*	AA92 13	-52.71 74.46	185-204	26/01/1992
85010	*Pentactella laevigata*	HRD93 20 B	-51.27 75.69	265-281	08/09/1993
85008	*Pentactella laevigata*	HRD93 49 B	-52.61 75.29	209	18/09/1993
85013	*Pentactella laevigata*	AA92 06	-53.21 73.68	120-132	24/01/1992
66728	*Pentactella laevigata*	AA92 29	-51.64 76.03	235-250	30/01/1992
85011	*Pentactella laevigata*	HRD 006	-53.00 73.38	60	03/10/1985
67297	*Pentactella laevigata*	AA92 48	-52.42 72.11	226-231	06/02/1992
85007	*Pentactella laevigata*	HRD93 51 B	-52.85 74.14	173	18/09/1993
66725	*Pentactella laevigata*	AA92 09	-52.53 73.16	229	25/01/1992
71904	*Pentactella laevigata*	AA92 17	-52.68 75.16	205-297	27/01/1992
66730	*Pentactella laevigata*	AA92 08	-52.68 72.94	215-228	25/01/1992
71903	*Pentactella laevigata*	AA92 14	-52.68 75.02	410-513	26/01/1992
66731	*Pentactella laevigata*	AA92 19	-52.74 75.10	391-421	28/01/1992

Reg No NMV F	Species	Station	Lat. Long.	Depth m	Date collected
85012	*Pentactella laevigata*	HRD 008	-53.20 73.10	200	04/10/1985
85014	*Pentactella laevigata*	HRD 008	-53.20 73.10	200	04/10/1985
85006	*Pentactella laevigata*	HRD93 50 B	-52.75 74.14	189	18/09/1993
71902	*Pentactella laevigata*	AA92 05	-52.92 74.14	149-172	24/01/1992
85005	*Pentactella laevigata*	HRD93 71 S	-50.72 75.07	514-528	28/09/1993
66727	*Pentactella laevigata*	AA92 41	-51.29 71.98	250-252	03/02/1992
165738	*Pentactella laevigata*	SC50(258)	-52.44 75.18	265	30/06/2008
84981	*Pentactella serrata*	AA92 35	-51.27 75.61	367-379	31/01/1992
165742	*Pentactella serrata*	SC46(124)	-51.72 76.33	228	25/06/2007
165746	*Pentactella serrata*	SC46(125)	-51.69 76.19	234	25/06/2007
165749	*Pseudostichopus peripatus*	SC46(478)	-50.59 75.91	799	30/07/2007
165751	*Pseudostichopus peripatus*	SC46(113)	-51.81 76.80	297	24/06/2007
165740	*Pseudostichopus peripatus*	SC50(050)	-52.71 74.92	558	04/06/2008
165739	*Pseudostichopus spiculiferus*	SC46(126)	-51.70 76.41	279	25/06/2007
66849	*Psolidium poriferum*	AA92 13	-52.71 74.46	185-204	26/01/1992
66850	*Psolidium poriferum*	AA92 09	-52.53 73.16	229	25/01/1992
165743	*Psolidium poriferum*	SC46(124)	-51.72 76.33	228	25/06/2007
168624	*Psolus antarcticus*	SC50(010)	-51.31 71.77	273	31/05/2008
165741	*Psolus antarcticus*	SC50(010)	-51.31 71.77	273	31/05/2008
66733	*Psolus ephippifer*	AA92 13	-52.71 74.46	185-204	26/01/1992
84987	*Psolus ephippifer*	HRD93 71 S	-50.72 75.07	514-528	28/09/1993
67099	*Psolus ephippifer*	AA92 06	-53.21 73.68	120-132	24/01/1992
84988	*Psolus ephippifer*	HRD93 54 B	-52.49 74.85	244-248	19/09/1993
84989	*Psolus ephippifer*	HRD 006	-53.00 73.38	60	03/10/1985
67100	*Psolus ephippifer*	AA92 48	-52.42 72.11	226-231	06/02/1992
165747	*Psolus ephippifer*	SC50(010)	-51.31 71.77	273	31/05/2008
84986	*Psolus heardi* sp. nov.	HRD93 71 'S'	-50.72 75.07	514-528	28/09/1993
198493	*Psolus heardi* sp. nov.	HRD93 71 'S'	-50.72 75.07	514-528	28/09/1993
84991	*Psolus paradubiosus*	HRD93 21 B	-51.29 75.43	337-541	08/09/1993
84990	*Psolus paradubiosus*	HRD93 68 BA	-51.68 76.50	214-220	24/09/1993
110513	*Sigmodota contorta*	AA92 29	-51.64 76.03	235-250	30/01/1992
85031	*Staurocucumis liouvillei*	AA92 01	-52.94 73.36	159-176	23/01/1992

Reg No NMV F	Species	Station	Lat. Long.	Depth m	Date collected
85023	*Staurocucumis liouvillei*	AA92 42	-51.35 71.78	297-301	03/02/1992
85029	*Staurocucumis liouvillei*	AA92 43	-51.30 71.93	252-248	05/02/1992
85028	*Staurocucumis liouvillei*	AA92 41	-51.29 71.98	250-252	03/02/1992
85025	*Staurocucumis liouvillei*	HRD93 48 B	-52.24 74.34	254	18/09/1993
85020	*Staurocucumis liouvillei*	HRD93 17 B	-51.59 75.92	243-260	07/09/1993
85019	*Staurocucumis liouvillei*	HRD93 64 B	-51.38 75.82	250-260	23/09/1993
85021	*Staurocucumis liouvillei*	HRD93 68 B	-51.70 76.52	217-228	24/09/1993
85034	*Staurocucumis liouvillei*	AA92 06	-53.21 73.68	120-132	24/01/1992
85026	*Staurocucumis liouvillei*	AA92 06	-53.21 73.68	120-132	24/01/1992
85032	*Staurocucumis liouvillei*	AA92 06	-53.21 73.68	120-132	24/01/1992
85018	*Staurocucumis liouvillei*	HRD93 21 B	-51.29 75.43	337-541	08/09/1993
85022	*Staurocucumis liouvillei*	HRD93 69 B	-51.67 76.36	218	24/09/1993
85024	*Staurocucumis liouvillei*	HRD 006	-53.00 73.38	60	03/10/1985
85030	*Staurocucumis liouvillei*	AA92 02	-53.00 73.72	108-115	23/01/1992
84996	*Staurocucumis liouvillei*	HRD 008	-53.20 73.10	200	04/10/1985
85016	*Staurocucumis liouvillei*	HRD93 51 B	-52.85 74.14	173	18/09/1993
85015	*Staurocucumis liouvillei*	HRD93 50 B	-52.75 74.14	189	18/09/1993
85033	*Staurocucumis liouvillei*	HRD93 18 B	-51.55 76.07	191-231	07/09/1993
85017	*Staurocucumis liouvillei*	HRD93 56 B	-52.52 74.89	279	19/09/1993
85027	*Staurocucumis liouvillei*	AA92 05	-52.92 74.14	149-172	24/01/1992
135032	*Staurocucumis liouvillei*	HRD 008	-53.20 73.10	200	04/10/1985
165744	*Staurocucumis liouvillei*	SC46(125)	-51.69 76.19	234	25/06/2007
165748	*Staurocucumis liouvillei*	SC46(125)	-51.69 76.19	234	25/06/2007
110518	*Staurocucumis liouvillei*	AA92 08	-52.68 72.94	215-228	25/01/1992
110519	*Staurocucumis liouvillei*	AA92 19	-52.74 75.10	391-421	28/01/1992
110514	*Staurocucumis liouvillei*	AA92 09	-52.53 73.16	229	25/01/1992
110517	*Staurocucumis liouvillei*	AA92 50	-52.46 72.42	449-457	08/02/1992
110515	*Staurocucumis liouvillei*	AA90 40	-51.15 74.36	~420-429	06/06/1990
84993	*Trachythyone lechleri*	AA92 01	-52.94 73.36	159-176	23/01/1992
84992	*Trachythyone lechleri*	AA92 06	-53.21 73.68	120-132	24/01/1992
84995	*Trachythyone lechleri*	HRD 006	-53.00 73.38	60	03/10/1985
84994	*Trachythyone lechleri*	AA92 09	-52.53 73.16	229	25/01/1992
165745	*Trachythyone muricata*	SC46(127)	-51.63 75.81	362	25/06/2007

Table 4. Holothuroidea specimens from HIMI held in SAMA.

Reg. No. SAMA K	Species	Station AA90	Lat. Long.	Depth m	Date collected 1990
2307	*Pseudostichopus peripatus*	61	-52.56 72.3	655-800	11/6
2308	*Pseudostichopus peripatus*	20	-52.41 71.81	275	1/6
2309	*Pseudostichopus peripatus*	16	-52 71.33	290	30/5
2310	*Pseudostichopus peripatus*	31	-51.81 76.2	275	4/6
2311	*Pseudostichopus peripatus*	19	-52.41 71.81	275	31/5
2312	*Pentactella laevigata*	41	-51.16 72.98	270	7/6
2313	*Pentactella laevigata*	14	-51.88 71.31	300	29/5
2314	*Pentactella laevigata*	19	-52.41 71.81	275	31/5
2315	*Pentactella laevigata*	42	-51.21 74.68	270	7/6
2316	*Pentactella laevigata*	19	-52.41 71.81	275	31/5
2317	*Pentactella laevigata*	76	-53.2 73.73	130	19/6
2318	*Pentactella laevigata*	4	-51.71 76.53	230	24/5
2319	*Pentactella laevigata*	14	-51.88 71.31	300	29/5
2320	*Pentactella laevigata*	14	-51.88 71.31	300	29/5
2321	*Pentactella laevigata*	76	-53 73.7	90	18/6
2322	*Pentactella laevigata*	80	-52.68 73	210	20/6
2323	*Pentactella laevigata*	18	-52.41 71.81	320	31/5
2324	*Pentactella laevigata*	23	-52.91 74.23	165	2/6
2326	*Pentactella laevigata*	44	-51.28 72.03	260	7/6
2327	*Pentactella laevigata*	82	-53.15 73.18	175	20/6
2328	*Pentactella laevigata*	78	-52.91 74.08	200	19/6
2329	*Pentactella laevigata*	47	-51.28 73.01	280	8/6
2330	*Pentactella laevigata*	78	-52.91 74.08	200	19/6
2331	*Pentactella laevigata*	2	-52.71 75.13	380	23/5
2332	*Pentactella laevigata*	57	-52.2 72.66	430	10/6
2333	*Pentactella laevigata*	78	-52.91 74.08	200	19/6
2334	*Pentactella laevigata*	7	-51.26 75.63	285	25/5
2335	*Pentactella laevigata*	24	-52.7 74.53	200	2/6
2336	*Pentactella laevigata*	25	-52.58 74.75	300	2/6
2337	*Pentactella laevigata*	60	-52.56 72.18	260-380	11/6
2338	*Pentactella laevigata*	70	-52.05 74.16	280	14/6

Reg. No. SAMA K	Species	Station AA90	Lat. Long.	Depth m	Date collected 1990
2305	*Pentactella intermedia*	76	-53 73.7	90	18/6
2304	*Neopsolidium kerguelensis*	76	-53 73.7	90	18/6
2287	*Staurocucumis liouvillei*	32	-51.63 76.05	250	4/6
2288	*Staurocucumis liouvillei*	4	-51.71 76.53	230	24/5
2289	*Staurocucumis liouvillei*	76	-53.2 73.73	130	19/6
2290	*Staurocucumis liouvillei*	5	-51.55 76.05	240	24/5
2291	*Staurocucumis liouvillei*	16	-52 71.33	290	30/5
2292	*Staurocucumis liouvillei*	33	-51.56 75.88	270	4/6
2293	*Staurocucumis liouvillei*	6	-51.38 75.81	260	25/5
2294	*Staurocucumis liouvillei*	14	-51.88 71.31	300	29/5
2295	*Staurocucumis liouvillei*	41	-51.16 72.98	270	7/6
2296	*Staurocucumis liouvillei*	47	-51.28 73.01	280	8/6
2297	*Staurocucumis liouvillei*	42	-51.21 74.68	270	7/6
2298	*Staurocucumis liouvillei*	19	-52.41 71.81	275	31/5
2299	*Staurocucumis liouvillei*	49	-51.3 74.05	420	8/6
2300	*Staurocucumis liouvillei*	39	-51.15 74.33	450	6/6
2301	*Staurocucumis liouvillei*	12	-51.35 71.86	290	29/5
2302	*Staurocucumis liouvillei*	82	-53.15 73.18	175	20/6
2325	*Staurocucumis liouvillei*	2	-52.71 75.13	380	23/5
2303	*Trachythyone muricata*	53	-51.83 73.38	470	9/6
2189	*Psolidium poriferum*	78	-52.91 74.08	200	19/6
2190	*Psolidium poriferum*	60	-52.56 72.18	260-380	11/6
2191	*Psolidium poriferum*	44	-51.28 72.03	260	7/6
2205	*Psolidium poriferum*	61	-52.56 72.3	720	11/6
2192	*Psolus ephippifer*	76	-53.2 73.73	130	19/6
2193	*Psolus ephippifer*	47	-51.28 73.01	280	8/6
2194	*Psolus ephippifer*	41	-51.16 72.98	270	7/6
2195	*Psolus ephippifer*	19	-52.41 71.81	275	31/5
2200	*Psolus ephippifer*	82	-53.15 73.18	175	20/6
2196	*Psolus paradubiosus*	31	-51.81 76.2	275	4/6
2197	*Psolus paradubiosus*	21	-52.8 72.43	230	1/6
2198	*Psolus paradubiosus*	44	-51.28 72.03	260	7/6

Reg. No. SAMA K	Species	Station AA90	Lat. Long.	Depth m	Date collected 1990
2199	*Psolus paradubiosus*	6	-51.38 75.81	260	25/5
2201	*Psolus paradubiosus*	59	-52.43 72.15	235	11/6
2202	*Psolus paradubiosus*	76	-53.2 73.73	130	19/6
2203	*Psolus paradubiosus*	19	-52.41 71.81	275	31/5
2204	*Psolus paradubiosus*	4	-51.71 76.53	230	24/5
2206	*Psolus paradubiosus*	82	-53.15 73.18	175	20/6
2207	*Psolus paradubiosus*	60	-52.56 72.18	260-380	11/6
2306	*Molpadia violacea*	76	-53.2 73.73	130	19/6

Table 5. Holothuroidea specimens from HIMI held in TMAG.

Reg. No. TMAG	Species	Station SC26	Lat. Long.	Depth m	Date 2003
H3239	*Synallactes* species	267	-51.82 76.02	472	10/5/2003
H3291	*Synallactes* species	267	-51.82 76.02	472	10/5/2003
H3289	*Pseudostichopus peripatus*	275	-51.76 76.44	268	10/5/2003
H3430	*Pseudostichopus peripatus*	201	-52.07 71.50	297	2/3/2003
H3290	*Pseudostichopus spiculiferus*	275	-51.76 76.44	268	10/5/2003
H3538	*Pseudostichopus spiculiferus*	255	-51.83 76.90	290	9/5/2003
H3303	*Psolidium poriferum*	173	-52.35 72.74	264	30/4/2003
H3304	*Psolidium poriferum*	178	-52.42 71.88	263	1/5/2003
H3305	*Psolidium poriferum*	177	-52.37 71.98	222	1/5/2003
H3306	*Psolidium poriferum*	161	-52.39 72.62	302	30/4/2003
H3307	*Psolidium poriferum*	179	-52.48 71.75	275	1/5/2003
H3308	*Psolidium poriferum*	174	-52.33 72.68	284	30/4/2003
H3309	*Psolidium poriferum*	196	-52.57 72.04	292	2/5/2003
H3310	*Psolidium poriferum*	201	-52.07 71.50	297	2/5/2003
H3311	*Psolidium poriferum*	216	-51.94 71.29	293	4/5/2003
H3312	*Psolidium poriferum*	256	-51.77 76.69	259	9/5/2003
H3313	*Psolidium poriferum*	198	-52.54 72.11	247	2/5/2003
H3314	*Psolidium poriferum*	191	-52.41 72.05	238	2/5/2003

Reg. No. TMAG	Species	Station SC26	Lat. Long.	Depth m	Date 2003
H3315	*Psolidium poriferum*	192	-52.37 71.98	222	2/5/2003
H3316	*Psolidium poriferum*	277	-51.81 76.47	329	10/5/2003
H3317	*Psolidium poriferum*	158	-52.30 72.69	406	29/4/2003
H3318	*Psolidium poriferum*	184	-52.53 72.10	247	1/5/2003
H3319	*Psolidium poriferum*	184	-52.53 72.10	247	1/5/2003
H3320	*Psolidium poriferum*	153	-52.50 72.88	284	24/4/2003
H3321	*Psolidium poriferum*	176	-52.41 72.05	237	1/5/2003
H3322	*Psolidium poriferum*	194	-52.48 71.75	275	2/3/2003
H3431	*Echinocucumis ampla* sp. nov.	264	-51.87 75.78	779	9/5/2003
H3432	*Trachythyone muricata*	152	-52.49 72.88	283	29/4/2003
H3433	*Molpadia violacea*	263	-51.80 75.50	628	9/5/2003
H3540	*Molpadia violacea*	179	-52.48 71.75	275	1/5/2003
H3541	*Molpadia violacea*	267	-51.82 76.02	472	10/5/2003
H3434	*Paracaudina championi* sp. nov.	165	-52.34 72.50	462	30/4/2003
H3539	*Paracaudina championi* sp. nov.	162	-52.44 72.67	287	30/4/2003
H3436	*Calcamariina moorea* sp. nov.	156	-52.34 72.75	274	29/4/2003
H3544	*Calcamariina moorea* sp. nov.	251	-51.77 76.70	252	8/5/2003
H3545	*Calcamariina moorea* sp. nov.	178	-52.42 71.87	263	1/5/2003
H3548	*Calcamariina moorea* sp. nov.	189	-52.38 72.08	230	2/5/2003
H3437	*Paradota weddellensis*	176	-52.41 72.05	237	30/4/2003
H3438	*Heterocucumis godeffroyi*	193	-52.42 71.87	264	2/5/2003
H3439	*Psolus ephippifer*	179	-52.48 71.75	275	1/5/2003
H3440	*Pentactella laevigata*	191	-52.41 72.05	238	2/5/2003
H3441	*Psolus paradubiosus*	191	-52.41 72.05	238	2/5/2003
H3442	*Staurocucumis liouvillei*	194	-52.48 71.75	275	2/5/2003
H3542	*Calcamariina hibberdi* sp. nov.	184	-52.53 72.10	247	1/5/2003
H3543	*Calcamariina hibberdi* sp. nov.	253	-50.91 77.11	341	8/5/2003
H3547	*Neopsolidium kerguelensis*	203	-52.05 71.40	~290	2/5/2003

Remarks. Table 5 of specimen lots held in TMAG lists specimens from cruise SC26 only, but does not list all specimens taken during SC26 and some from cruises SC46 and SC50. Most specimens from cruises SC46 and SC50 are held in the AAD and are not currently accessible for species identity confirmation and listing here.

Table 6. Kerguelen Islands and HIMI holothuroid species distributed beyond the Kerguelen Plateau.

Kerguelen Plateau	**Antarctica**	**Macquarie Island**	**Magellanic**	**Bouvetoya**
Pseudostichopus peripatus	*Pseudostichopus peripatus*			
Pseudostichopus spiculiferus	*Pseudostichopus spiculiferus*			
[1] *Zygothuria lactea*	*Zygothuria lactea*		*Zygothuria lactea*	
[2] *Clarkiella deichmannae*				
Echinocucumis ampla				
Heterocucumis godeffroyi			*Heterocucumis godeffroyi*	
Calcamariina hibberdi				
Calcamariina moorea				
Pentactella intermedia				
Pentactella laevigata		*Pentactella laevigata*		
Pentactella serrata				
Neopsolidium kerguelensis				
Pseudopsolus gruai				
Psolidium poriferum				
[3] *Psolus antarcticus*	*Psolus antarcticus*	*Psolus antarcticus*	*Psolus antarcticus*	*Psolus antarcticus*
Psolus ephippifer				
[4] *Psolus paradubiosus*				
Psolus heardi				
Staurocucumis liouvillei	*Staurocucumis liouvillei*			*Staurocucumis liouvillei*
Trachythyone lechleri			*Trachythyone lechleri*	
Trachythyone muricata				
Paracaudina championi				
Molpadia violacea	*Molpadia violacea*			
Sigmodota contorta	*Sigmodota contorta*		*Sigmodota contorta*	*Sigmodota contorta*
Paradota weddellensis	*Paradota weddellensis*			

Notes for Table 6:

[1] Gebruk *et al*. (2012) reported a cosmopolitan distribution for *Zygothuria lactea* and a bathymetric range of 694 to 5278 m. There are no specific reports of its occurrence at Bouvetoya Island or Macquarie Island.

[2] A single BANZARE specimen collected from off NE Tasmania was considered by O'Loughlin (2009) to be conspecific.

[3] CO1 sequences indicate a species complex (see O'Loughlin *et al*. 2010).

[4] Six very small CEAMARC psolid specimens from off Terra Adélie were identified as *Psolus paradubiosus* by Mark O'Loughlin and Niki Davey in Paris in 2010 (MNHN catalogue number 2008–5315). We are not confident here of their identification of this sole record of the species from the Antarctic coast.

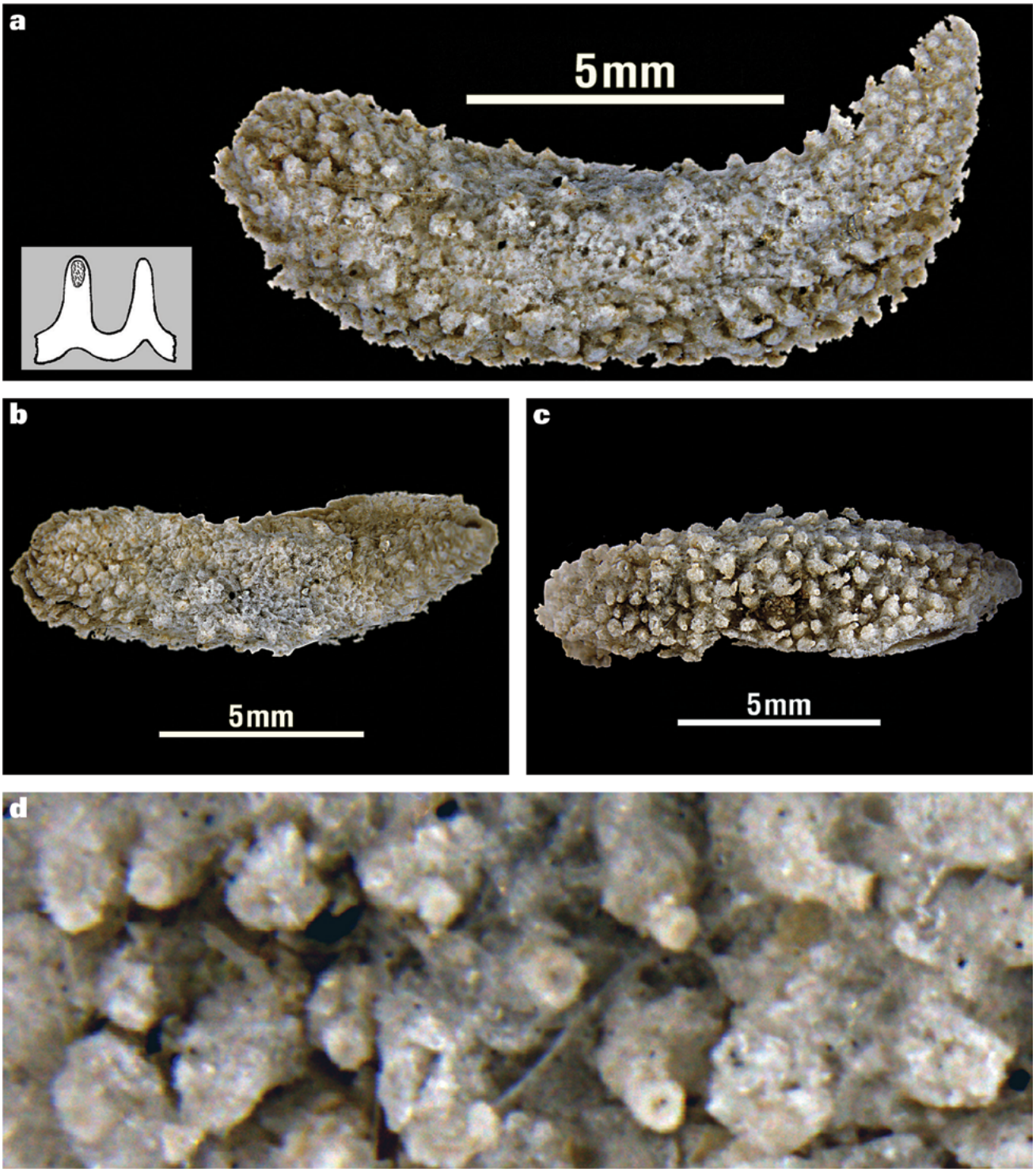

Figure 2. *Calcamariina hibberdi* O'Loughlin & Skarbnik-López sp. nov. holotype photos (NMV F165750). a, left lateral view of holotype with oral end left (insert with drawing of radial (left) and inter-radial plates of the calcareous ring); b, dorsal view of holotype with oral end left; c, ventral view of holotype with oral end left; d, close-up view of some ventral tube feet surmounting calcareous papillae.

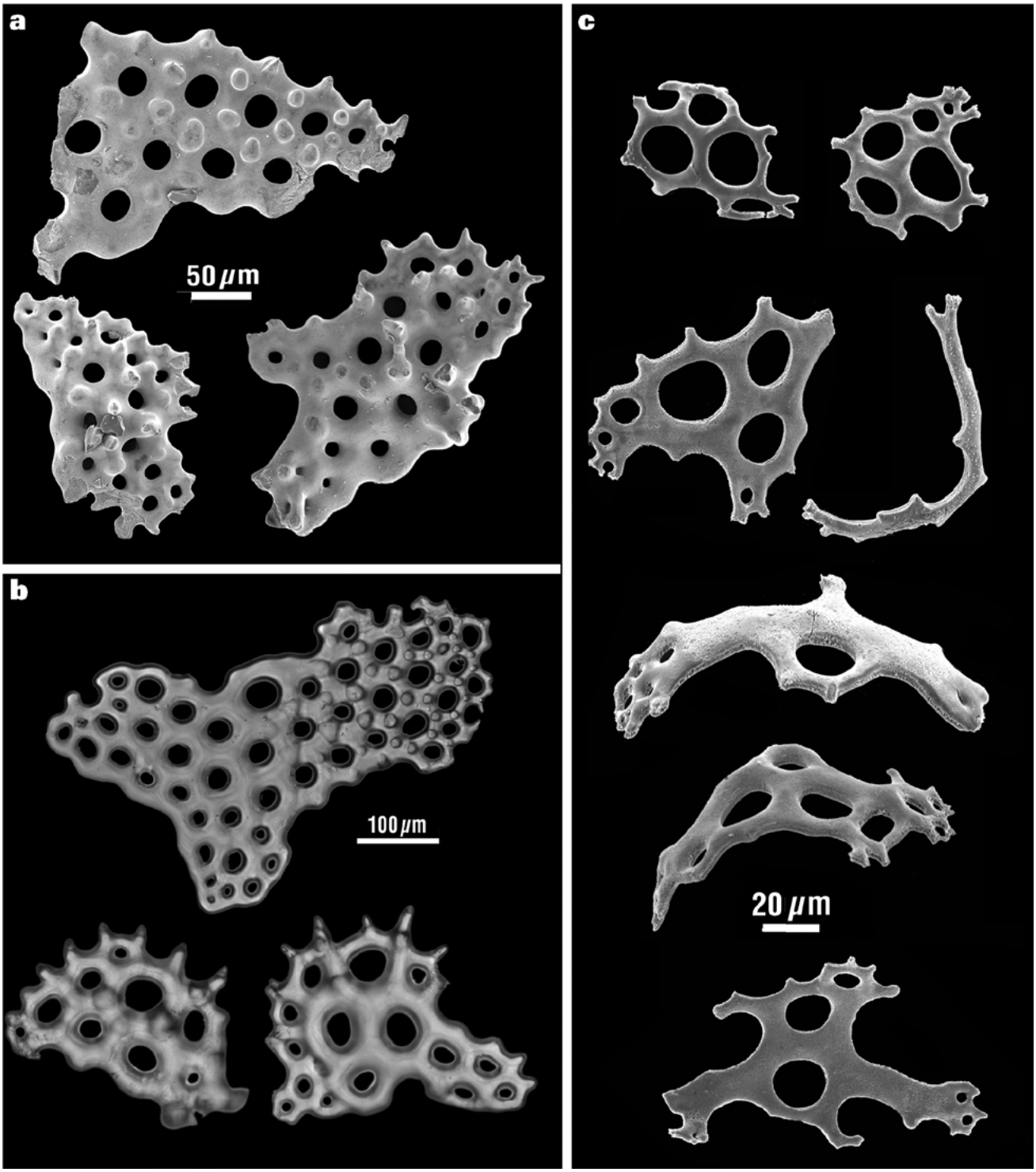

Figure 3. Ossicles from the holotype and a paratype of *Calcamariina hibberdi* O'Loughlin & Skarbnik-López sp. nov. (holotype NMV F165750, paratype TMAG H3542). a, SEM images of variably knobbed and thickened plate fragments from the ventral body wall and papillae, with some marginal spines (from holotype); b, microscope photos of large body wall plate with smooth perforated base and knobbed projecting distal end that has lost its distal spinous edge (top, from holotype; scale bar refers to this ossicle only), and two tube foot/papilla support plates with projecting outer marginal spinous edge (bottom, from paratype; up to about 140 μm long; scale bar does not refer to these ossicles), and; c, SEM images of small perforated, concave plates (top), curved plates, rod and rod-plates from a tentacle (from holotype).

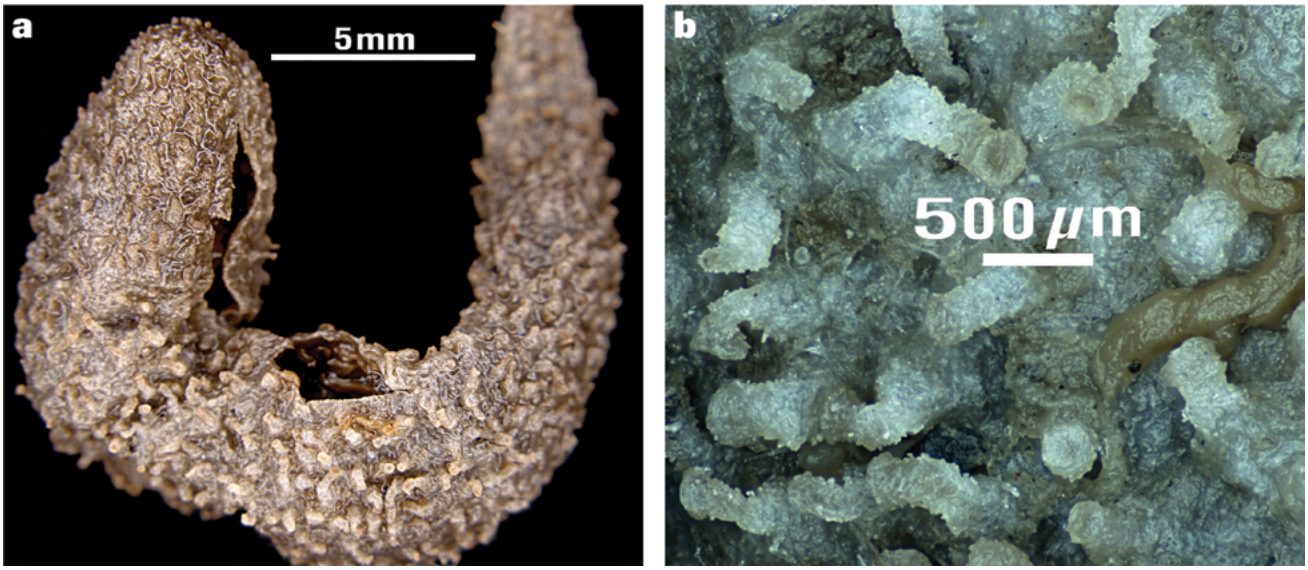

Figure 4. *Calcamariina moorea* O'Loughlin & Skarbnik-López sp. nov. holotype photos (TMAG H3436). a, left lateral view of holotype with oral end left; b, close-up view of some lateral tube feet surmounting calcareous papillae.

Calcamariina moorea O'Loughlin & Skarbnik-López sp. nov.

Zoobank LSID. http://zoobank.org:act:69F0EDED-FC18-4B0E-8E48-203D73B6831D

Tables 1–3, 5, 6; figures 1, 4–6.

Cucumaria sp. nov. (HOL 14). Hibberd & Moore, 2009: 119, 146.
Cucumaria kerguelensis (HOL 19). Hibberd & Moore, 2009: 119.

Material examined. Holotype. Southern Ocean, S Kerguelen Plateau, N of Heard Island, Western Plateau, AAD *Southern Champion* cruise 26 haul 156, beam trawl, -52.34 72.75, 274 m, 29 Apr 2003, TMAG H3436 (AAD species code: HOLO 14).

Paratypes (AAD species code: HOLO 14). HIMI, S *Shell Bank*, SC26(251), 252 m, 8 May 2003, TMAG H3544 (1); *Aurora Bank*, SC26(178), 263 m, 1 May 2003, TMAG H3545 (1); *Aurora Bank*, SC26(189), 230 m, 2 May 2003, TMAG H3548 (2); *Shell Bank*, AA92(28), 230–247 m, 30 Jan 1992, NMV F85002 (1); North-east Plateau, HRD93(71S), 514–528 m, 28 Sep 1993, NMV F85003 (1); Heard I., HRD006, 60 m, 3 Oct 1985, NMV F85004 (1).

Description. Body fusiform, up to 29 mm long, curved semi-U-shaped body 16 mm wide/across in lateral view, mid-body diameter 6 mm (holotype TMAG H3436), slightly up-turned rounded oral end, up-turned tapered tail; body dark grey-brown (holotype) to off-white (smaller types), hard, calcareous, covered with low rounded calcareous papillae each with apical terminal tube foot (most evident in larger holotype), tube feet more numerous ventrally than dorsally. Smallest specimens with poorly defined, narrow, ventral, mid-body inter-radii lacking papillae. Lacking anal papillae or scales. Tentacles dendritic, 8 large, 2 ventral small. Calcareous ring cucumariid-like, plates with high anterior radial and inter-radial prolongations, lacking posterior prolongations. Single polian vesicle. Two tufts of un-branched gonad tubules.

Ossicles of body wall and bases of papillae thick rod-plates, fewer narrow, elongate plates, irregular, perforated (frequently with two large parallel and two smaller distal perforations in cross formation centrally), elongate, single-layered, variably with surface and marginal knobs, never marginal spines, rod-plates and plates up to about 350 μm long. Tube feet with endplates and support rod-plates; endplate diameters variable, up to about 240 μm; tube foot wall supported by rod-plates, elongate, curved, variable form but typically with two large transverse central perforations and few distal small perforations, plate margin projecting from body wall sometimes with blunt denticulations, rod-plates up to about 220 μm long.

Distribution. Southern Ocean, S Kerguelen Plateau, *Aurora* and *Shell Banks*, North-east Plateau, *Western Plateau*, Heard I., 60–528 m.

Etymology. Named for Kirrily Moore, Collection Manager for Invertebrate Zoology in TMAG, with recognition of her initial sorting and curation and establishment of a voucher reference collection for the HIMI holothuroids, and with our appreciation of her generous collaboration with loan material and data relevant to our work.

Remarks. *Calcamariina moorea* O'Loughlin & Skarbnik-López sp. nov. is distinguished from *Calcamariina hibberdi* O'Loughlin & Skarbnik-López sp. nov. by the predominance of body wall rod-plates, with paired large central perforations and knobbed only part-margins. In contrast *C. hibberdi* has a predominance of body wall irregular plates that lack large central paired perforations and have part-margin spinous edges.

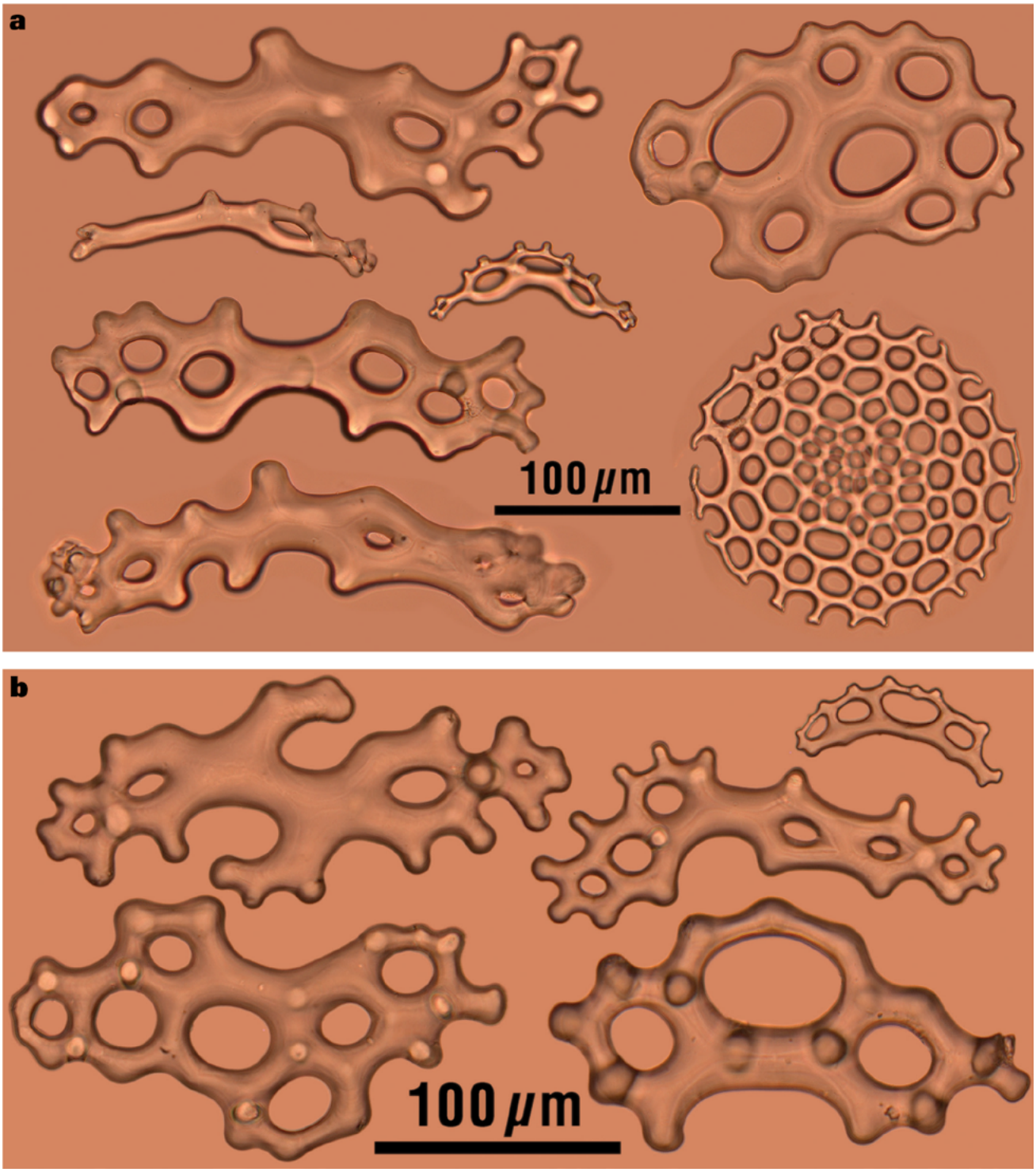

Figure 5. Microscope photos of ossicles from the holotype and a paratype of *Calcamariina moorea* O'Loughlin & Skarbnik-López sp. nov. (holotype TMAG H3436, paratype TMAG H3548). a, endplate, papilla support rods and rod-plates, body wall plate (from holotype); b, tube foot support plates and body wall rod-plates (from paratype).

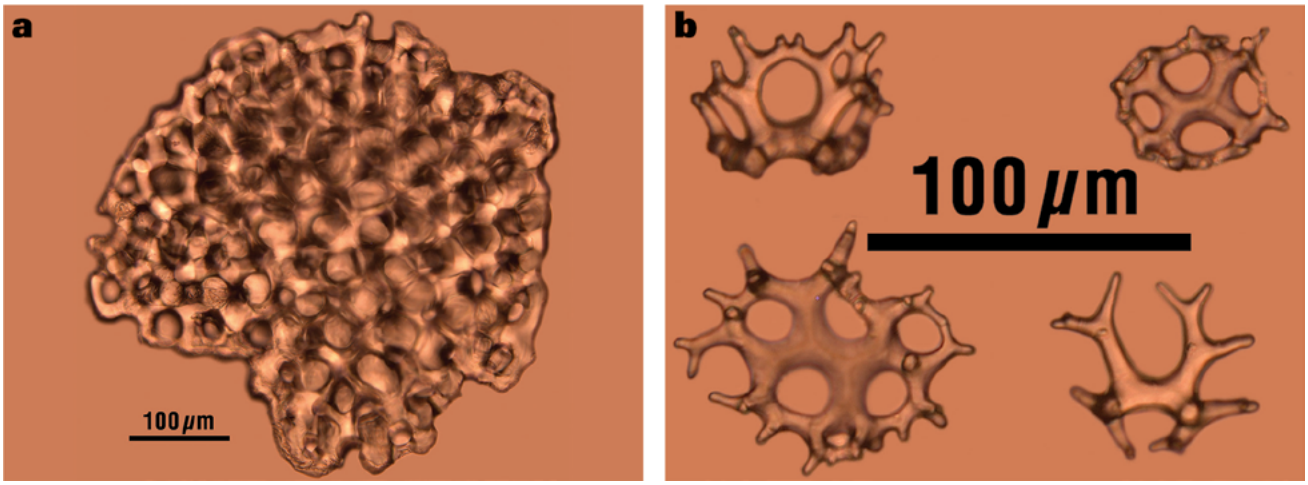

Figure 6. Microscope photos of ossicles from a specimen of *Neopsolidium kerguelensis* (Théel, 1886) (NMV F84997). a, multi-layered ossicle from the body wall; b, cross (bottom right) and cups from the body wall.

We judge that in Hibberd & Moore (2009, page 119) the photo of *Cucumaria* sp. nov. (HOL 14) is a photo of *Calcamariina moorea* O'Loughlin & Skarbnik-López sp. nov. And we judge that the photo of *Cucumaria kerguelensis* (HOL 19) on the same page is also a photo of *C. moorea*. TMAG types have been confirmed by direct observation of TMAG loan material. All were taken by *Southern Champion* cruise 26 and are registered in TMAG. There are probably more specimens of this new species held but not registered and not accessible in the AAD in Kingston.

As noted above for *Calcamaria hibberdi* O'Loughlin & Skarbnik-López sp. nov. the superficially similar species *Neopsolidium kerguelensis* (Théel, 1886) that also occurs on the Kerguelen Plateau is distinguished from the *Calcamariina* species by the former having narrow bare ventral inter-radii, and cups and multi-layered ossicles in the body wall (illustrated here in Figure 6).

Echinocucumis Sars, 1859

Type species (type locality; diagnostic characters). Echinocucumis hispida (Barrett, 1857) (Norway; sub-spherical body with vertically up-turned oral and anal ends, body 10 mm wide (width of U-shape), ventral tube feet prominent, dorsal tube feet inconspicuous, plates with single composite marginal spine).

Other assigned species (type localities; diagnostic characters). Echinocucumis globosa (Ohshima, 1915) (Kyushu; body spherical, 9.5 mm long, dorsal and ventral tube feet, ossicle spines reduced or absent); *E. hispida* var. *atypica* Deichmann, 1930 (Havana; spines sometimes central on plates, spines more slender and tall than *E. hispida*); *E. kirrilyae* O'Loughlin, 2009 (E Antarctica, Enderby Land; body fusiform, 6 mm long, tube feet ventral only, composite spines dendritic); *E. multipodia* Cherbonnier, 1965 (Cameroon; spherical body, 7 mm long, tube feet around body, scales lack spines); *E. paratypica* Ludwig & Heding, 1935 (Somalia; U-shaped body, 8.5 mm long, long tapered up-turned oral and anal ends); *E. sphaericum* (Sluiter, 1901) (E Indonesia; U-shaped body, 18 mm long, abundant ventral tube feet, numbers of composite spines per scale); *E. tenera* Cherbonnier, 1958 (Sierra Leone; U-shaped body, 25 mm long, dorsal and ventral tube feet).

Diagnosis. Mid-body sub-spherical, tapered non-retractile oral and anal ends, usually upturned; calcareous ring cucumariid-like, lacking posterior prolongations; tentacles 10, digitiform, unequal in size; tube feet sparse or absent, slender, restricted to ambulacra; body invested with large imbricating scales that are single-layered perforated plates, each scale with predominantly one tall spine arising near plate margin.

Remarks. Echinocucumis Sars, 1859 has been assigned to the Ypsilothuriidae Heding, 1942 in the order Dactylochirotida Pawson & Fell, 1965. Smirnov (2012) abolished the Dactylochirotida and referred all the included taxa to the Dendrochirotida. Smirnov (2012) assigned the ypsilothuriid genus *Echinocucumis* to the subfamily Cucumariinae Ludwig, 1894 (*sensu* Panning 1949) within the family Cucumariidae Ludwig, 1894. He based his decision on the work of Hansen (1988) who judged that *Echinocucumis* is similar to *Staurocucumis* Ekman, 1927 and *Psolicucumis* Heding, 1934. These two latter genera are assigned to the Cucumariinae. We accept the judgment of Smirnov (2012) based on morphology but anticipate that molecular phylogenetic evidence will challenge many such current assignments.

Echinocucumis ampla O'Loughlin & Skarbnik-López sp. nov.

Zoobank LSID. http://zoobank.org:act:7147741A-1BFE-48DC-A351-FBF5A53B8539

Tables 1, 2, 5, 6; figures 1, 7, 8.

Dactylochirotida sp. nov. (HOL 10).—Hibberd & Moore, 2009: 119, 146.

Material examined. Holotype. Southern Ocean, S Kerguelen Plateau, NE Heard Island, North-east Plateau, AAD *Southern Champion* cruise 46 haul 479, beam trawl, -50.68 74.62, 708 m, 30 Jul 2007, NMV F165735 (AAD species code: HOLO 10)

Paratypes. Holotype locality and date, NMV F198492 (2) (UF tissues sequence codes MOL AF663, 664, 665); HIMI, southern *Shell Bank*, SC26(264), -51.87 75.78, 779 m, 9 May 2003, TMAG H3431.

Other material (AAD species code: HOL 10). HIMI, southern *Shell Bank*, SC26(263), -51.80 75.50, 628 m, AAD; SC46(115), -51.81 75.98, 557 m, AAD; North-east Plateau, SC46(471), -50.38 74.54, 970 m, AAD; *Pike Bank*, SC50(016), -51.45 71.84, 756 m, AAD.

Description. Preserved body up to about 65 mm long lateral width (tentacles withdrawn), up to 30 mm high mid-body, tapered anteriorly to partly up-turned rounded oral end, prominent belly mid-body, tapered posteriorly into long up-turned tail; body wall off-white to pale brown, thin, brittle, parchment-like, completely covered with a test of imbricating spined scales, spines more dense ventrally than dorsally. Five inconspicuous anal scales, thick columnar, comprising thick mesh of branched rods, anal scales about 700 μm long. Five elongate, thin anal papillae, walls supported by rod ossicles, papillae up to about 600 μm long. Calcareous ring cucumariid-like, ring narrow, prominent anterior mid-plate radial and inter-radial prolongations, lacking posterior prolongations. Tentacles 10, digitiform, flexible, irregularly long and short. Tube feet absent from the body. Longitudinal muscles cylindrical, thin. Multiple-branching thin gonad tubules.

Body wall ossicles imbricating spined plates; plates irregularly oval in form, single-layered, thick, perforated, perforations predominantly relatively small and spaced, up to about 16 perforations across the diameter, plates up to 1.2 mm long ventrally, slightly smaller dorsally; spines variably near margin of plate to near center, long to short, thick to thin, pillars comprising dendritic branching rods, predominantly one spine per scale, rarely a cluster of up to three, spines rounded and rugose distally with short blunt spinelets; spines dorsally up to 720 μm high (fine spinous distal point frequently lost), up to 200 μm diameter mid-height; spines ventrally more coarse, more than 680 μm high (with fine spinous distal point lost), up to 280 μm diameter mid-height. Distal tail with large thick plates, not multilayered, not closely perforated, small spaced perforations variably present around margin, large central perforation, plates up to 600 μm diameter. Tentacles supported by close, transversely aligned, curved rods; rods irregular in form, variably perforated distally, variably bluntly spinous to short digiform projections laterally, rods up to 300 μm long.

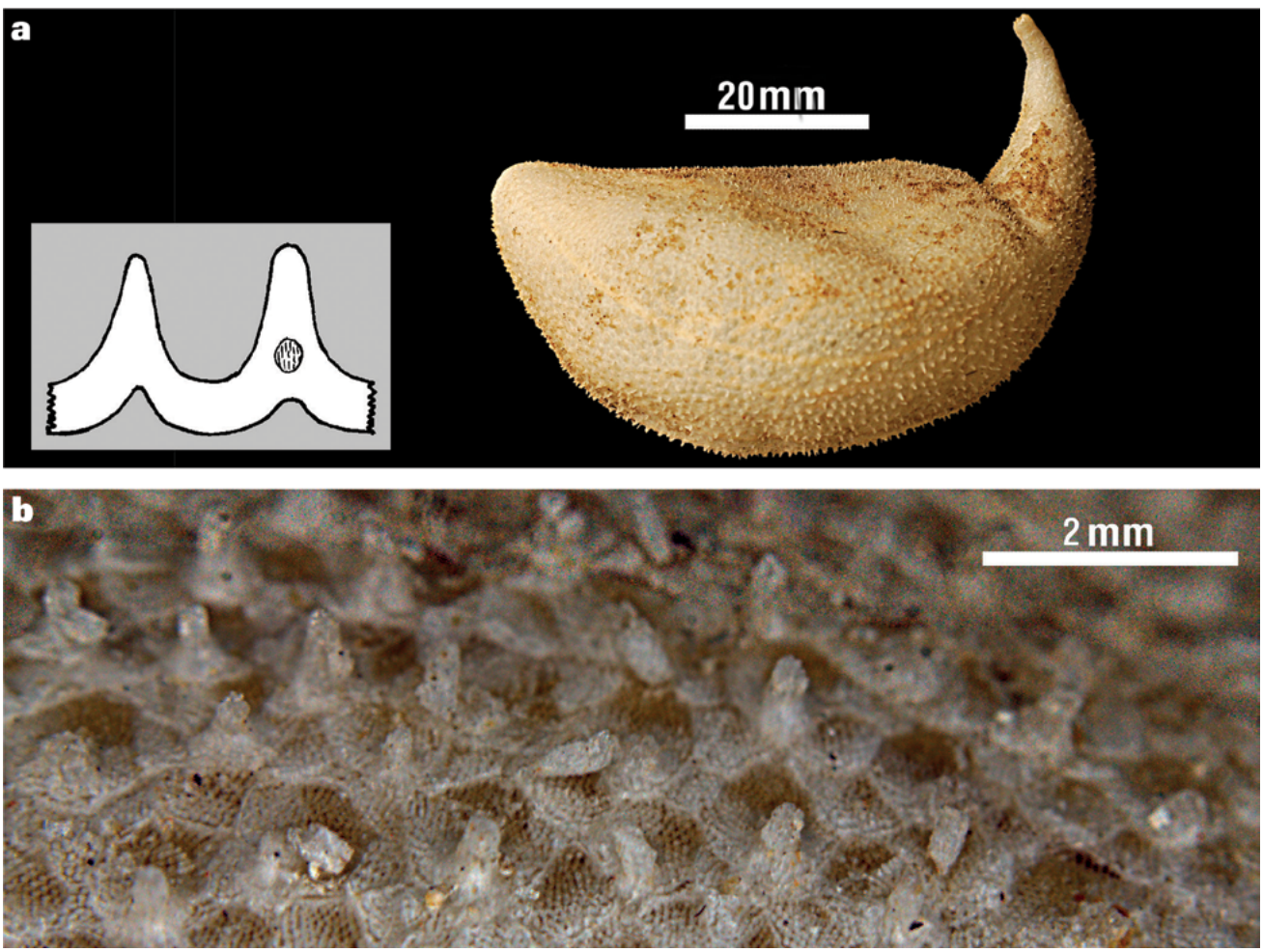

Figure 7. *Echinocucumis ampla* O'Loughlin & Skarbnik-López sp. nov. holotype photos (NMV F165735). a, left lateral view of holotype with oral end left (insert with drawing of radial (right) and inter-radial plates of the calcareous ring); b, imbricating spined plates of the body wall.

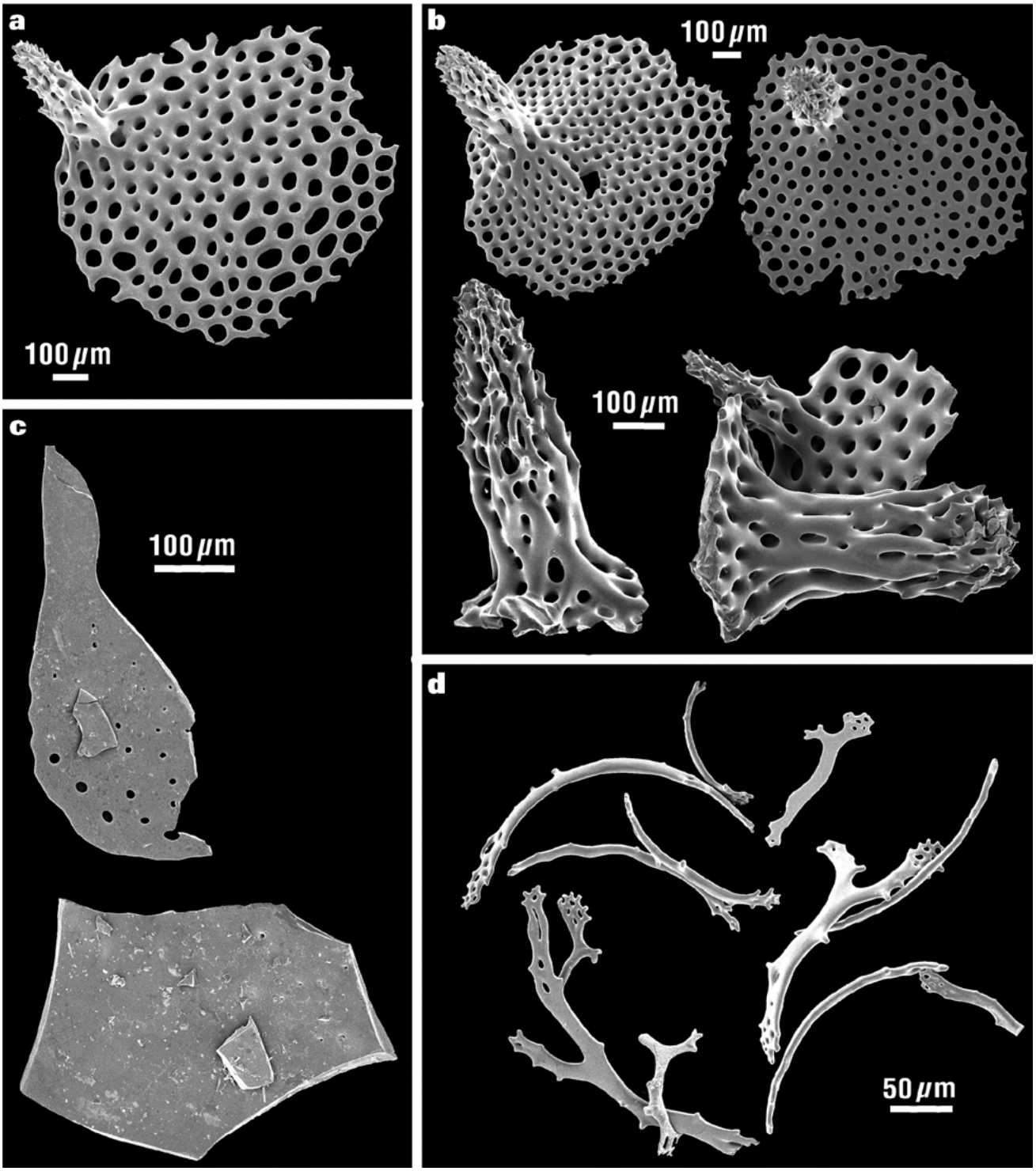

Figure 8. SEM images of ossicles from a paratype of *Echinocucumis ampla* O'Loughlin & Skarbnik-López sp. nov. (NMV F198492). a, spined plate from the mid-dorsal body wall; b, spined plates and spines from the mid-ventral body wall; c, part-perforate plate fragments from the peri-anal body wall; d, rods from a tentacle.

Distribution. Southern Ocean, S Kerguelen Plateau, N of Heard Island on North-east Plateau, *Pike Bank*, southern *Shell Bank*, 557–970 m.

Etymology. Named from the Latin *ampla* (feminine), meaning large, to indicate the relatively large size of this species.

Remarks. Type specimens were donated to NMV by the AAD. Initial preservation was by freezing, with subsequent transfer to 70% ethanol. In spite of a close examination no tube feet were detected. But in a body wall ossicle sample some small curved thin rods (up to 80 μm across) were found that were probably residual tube foot support rods. And we note the perforation in the upper left scale in Figure 8b that might be a perforation for a tube foot. *Echinocucumis ampla* O'Loughlin & Skarbnik-López sp. nov. is distinguished from all other species of *Echinocucumis* by the combination of: large size; absence of a distinctly tapered up-turned oral end; tube feet not detected; spines variably marginal to central on plates; spines comprising composite, columnar, branched rods. Pawson (1964) referred two specimens from New Zealand to *Echinocucumis hispida* (Barrett, 1857), with some reservations. The larger has a greater curvature length of only 50 mm, distinctly upturned oral and anal ends, single spines arising from the margin only of the scales, and tube feet present. Based on some differences in morphology, and the fact that very few HIMI species have been found north of the Antarctic Convergence, we judge that the New Zealand species is not *E. ampla*. The TMAG paratype has been confirmed by direct observation of TMAG loan material. "Other material" refers to lots that were identified in the AAD by comparison with voucher specimens that were identified by Mark O'Loughlin. These lots are held (unregistered) in the AAD and the determinations not confirmed by Mark O'Loughlin.

Pentactella Verrill, 1876

Pentactella Verrill, 1876a: 68, 69.

Laevocnus O'Loughlin (in O'Loughlin *et al*., 2014): 46.

Type species. *Pentactella laevigata* Verrill, 1876a, b (type locality Kerguelen Islands; initially monotypic).

Assigned species and occurrences. *Pentactella cornuta* (Cherbonnier, 1941) (Patagonia); *P. intermedia* (Théel, 1886) (HIMI and Kerguelen Is); *P. katrinae* (O'Loughlin in O'Loughlin *et al*., 2014) (Antarctica, Shag Rock); *P. laevigata* (Verrill, 1876a, b) (HIMI, Kerguelen Is, Macquarie I.)); *P. leachmani* (Davey & O'Loughlin in O'Loughlin *et al*., 2014) (Ross Sea); *P. leoninoides* (Mortensen, 1925) (New Zealand sub-antarctic islands); *P. leonina* (Semper, 1867) (Falkland Is); *L. marionensis* (Théel, 1886) (Marion I.); *P. perrieri* (Ekman, 1927) (Falkland Is, South Georgia); *P. serrata* (Théel, 1886) (HIMI).

Diagnosis (*sensu stricto; based on 14 specimens in HIMI lot NMV F85005*). Cucumariinid species; body wall thin, firm, not calcareous; body fusiform with posterior rounded taper but not tail; preserved, relaxed body up to 43 mm long (excluding tentacles); 10 equal dendritic tentacles; tube feet on radii only, radial series cross introvert, radial series on relaxed specimens single, slightly zig-zag, spaced, slightly more numerous on three ventral radii; lacking external or internal anal scales; lacking calcareous ring in all specimen sizes; three long, thin polian vesicles; lacking genital papilla, gonad tubules not branched; two, laterally paired, mid-body, mid-ventral, coelomic brood sacs, with external transverse slit openings, sacs and opening sometimes present; brood juveniles with distinct tentacle crowns may be present in brood sacs, brood juveniles up to 3 mm long. Preserved colour off-white to pale fawn.

Body wall ossicles abundant, oval to elongate, single-layered, perforated plates, typically two large lateral central perforations, typically knobbed centrally, one end of plate tapered and distally spinous, opposite end not tapered, not spinous, plates up to typically 130 μm long; lacking knobbed buttons that do not have any spinous margin. Tube feet with endplates, diameters up to 320 μm, tube foot support ossicles curved perfortated plates with outer edge spinous, plate lengths up to 140 μm. Tentacle ossicles thick, perforated plates, irregularly oval to elongate, plates up to 260 μm long; thin, irregular, convex, perforated plates, up to 100 μm across; distally perforate, bent rods, up to 120 μm long; lacking rosettes.

Remarks. Panning (1949) considered *Pentactella* Verrill, 1876 to be a junior synonym of *Stereoderma* Ayres, 1851. Pawson (1964) followed Panning (1949), reporting *Stereoderma laevigata* (Verrill, 1876). Subsequently Panning (1962) referred this species to *Pseudocnus* Panning, 1949. Pawson (1968) followed Panning (1962), reporting *Pseudocnus laevigatus* (Verrill, 1867). In describing the new genus *Laevocnus* O'Loughlin (in O'Loughlin *et al*. 2014) the authors failed to notice that their type species for *Laevocnus*, *Pentactella laevigata* Verrill, 1876, is also the type species for the monotypic *Pentactella* Verrill, 1876. *Pentactella* is here raised out of synonymy with *Stereoderma* and *Pseudocnus*, and *Laevocnus* is an objective synonym of *Pentactella*.

We recognize variations in morphological form amongst the species assigned to *Pentactella*. These variations have been included in the diagnosis for *Laevocnus* (= *Pentactella*) in O'Loughlin *et al*. 2014. The problem of a diagnosis for *Pentactella* is compounded by our recognition of the consistent presence of some knobbed buttons that lack a spinous end in specimens of *Pentactella intermedia* (Théel, 1886). Based on some supportive genetic data *P. intermedia* remains assigned to *Pentactella*. There are to date inadequate genetic data to know what morphological characters are reliable for generic diagnosis. We have thus provided above a *sensu stricto* diagnosis for *Pentactella* that is based on one lot of 14 specimens from the southern Kerguelen Plateau (NMV F85005).

The status of type material for *Pentactella laevigata* Verrill 1876 is uncertain. USNM holds a single specimen with a label: "Type, *Pentactella laevigata* Kidder, Cat. No. 3148, Locality Kerguelen Is, Coll. by Transit of Venus Expedition, Date Dec. 1876, Id. by Verrill". Obviously Verrill was the taxa author, and not the collector Dr. J. H. Kidder. Verrill (1876) gave a collection date as January 1875. This accords with the date of the *US Transit of Venus Expedition* during 1874–1875. The label date (Dec. 1876) may refer to the date of description by Verrill. Pawson (1968) noted "this may be the only extant specimen of the original type series". Verrill provided measurements for only one specimen, and did not indicate more than one type specimen. Pawson (1968) reported on the USNM specimen as a "Co-Type"

(USNM Cat. No. 3148). He judged that this specimen generally matched the description by Verrill (1876). But Pawson noted two anomalies: the presence of a calcareous ring, while Verrill explicitly stated that such plates were absent; and the presence of ventral brood pouches that Verrill did not describe. Our *sensu stricto* diagnosis above matches the descriptions by Verrill (1876) and Pawson (1968), except that we have never observed calcareous ring plates for this species. The presence of ventral brood pouches is rare. Only two specimens of the lot of 14 that we examined have brood pouches.

O'Loughlin (2009) discussed in detail *Pseudocnus intermedia* (Théel, 1886), *Pseudocnus laevigatus* (Verrill, 1876) and *Pseudocnus marionensis* (Théel, 1886), the three species subsequently referred to *Laevocnus* O'Loughlin (in O'Loughlin *et al*. 2014) (= *Pentactella* Verrill, 1876).

O'Loughlin (2009) noted some misleading captions in Théel (1886), that referred to figures of *Cladodactyla crocea* (Lesson, 1830) and *Cucumaria laevigata* (Verrill, 1876). This error misled Massin (1992) who reported *Cladodactyla crocea croceoides* (Vaney, 1908) from Marion Island, with *Cucumaria laevigata* as a junior synonym. This variety was referred to the synonymy of *Cladodactyla crocea* in O'Loughlin *et al*. 2014. Amongst the many holothuroid specimens collected from the Kerguelen Plateau no specimen of *Cladodactyla crocea* has been found.

Family **Psolidae** Burmeister, 1837

Diagnosis. Dendrochirotid species with dorsal and lateral surfaces covered by imbricating scales; ventral sole thin-walled and soft with peripheral tube feet, sometimes also in mid-ventral radial series.

Psolus Oken, 1815

Diagnosis (from Mackenzie & Whitfield 2011). Psolidae with large imbricating or contiguous dorsal and lateral scales; ventrolateral scales at margin clearly demarcated from thin sole that lacks conspicuous scales. Tube feet absent dorsally and laterally, sometimes present orally and anally. Ten dendritic tentacles, eight large and two small ventrally.

Remarks. We note again, for reasons stated in the Introduction, that *Psolus* Oken, 1815 is used provisionally.

Psolus heardi O'Loughlin & Skarbnik-López sp. nov.

Zoobank LSID. http://zoobank.org:act:FF1FB240-6E7D-44BA-9AF3-B1FADA9EE993

Psolus sp. nov. (HOL 23).—Hibberd & Moore, 2009: 120,

Tables 1–3, 6; figures 1, 9, 10.

Material examined. Holotype. Southern Ocean, S Kerguelen Plateau, NE Heard Island, NW of *Shell Bank*, ANARE *Aurora Australis*, HRD 93, stn. 71–S, epibenthic sled, -50.72 75.07, 514–528 m, coll. T. Stranks, 28 Sep 1993, NMV F84986.

Paratypes. Holotype locality and date, NMV F198493 (7).

Other material (AAD species code: HOL 23). Southern *Shell Bank*, AAD *Southern Champion* cruise 46 haul 111, beam trawl, -51.81 76.31, 247 m, AAD; southern *Shell Bank*, SC 46(114), -51.81 76.06, 410 m, AAD; southern *Shell Bank*, SC 46(115), -51.81 75.98, 557 m, AAD.

Description. Preserved body up to 12 mm long (excluding tentacles), body up to 5 mm high, body flat ventrally, domed dorsally, lacking oral and anal cones, mouth with anterior orientation, dorsal and lateral body with conspicuous imbricating scales, lacking tube feet, ventro-lateral scales projecting slightly over a soft sole. Discrete sole, lacking scales, peripheral series of large tube feet, series not continuous anteriorly, rare mid-ventral tube feet. Tentacles dendritic, 10, ventral pair small. Calcareous ring solid, cucumariid-like, digitiform anterior projection and deep posterior notch on both radial and inter-radial plates, lacking posterior prolongations. Longitudinal muscles narrow, flat. Gonad comprises 2 tufts of sac-like tubules, one on each side of the dorsal mesentery, hermaphrodite, coelomic bood-protecting.

Dorsal and lateral ossicles imbricating scales and cups; scales irregularly oval, up to about 1 mm long, scales are perforated plates with mesh-like secondary layering, finely spinous dorsal surface layer; cups irregular, shallow to deep, predominantly four perforations in cross form, sometimes small corner perforations, cups variably knobbed or with short digitiform projections, some incipiently bridged, cups typically 140 μm long. Sole with irregular, marginally knobbed, perforated, shallow, concave plates, up to about 8 perforations, up to about 360 μm long; plates inter-grade with shallow cups, similar to dorsal cups, predominantly 4 large perforations, sometimes smaller corner ones, margin knobbed, some secondary knobs and developments, cups about 140 μm long. Tentacle ossicles thick, perforated rods and plates, irregular, curved, variably knobbed and digitate margins, some surface knobs, plates and rods up to 320 μm long; small thin curved plates, about 50 μm long; rare fine irregular crosses, about 50 μm long; small rosette-like ossicles, about 100 μm long.

Distribution. Southern Ocean, Kerguelen Plateau, NE Heard Island, *Shell Bank*, 247–557 m,

Etymology. Named *heardi* with reference to Heard Island.

Remarks. We provisionally assign this new species to the currently suppressed *Psolus* Oken, 1815, pending an appeal to the ICZN (see Introduction). While *Psolus heardi* O'Loughlin & Skarbnik-López sp. nov. satisfies the general diagnostic criteria for referral to *Psolus*, we are aware that emerging phylogenetic data do not support the family Psolidae and provide evidence that the genera *Psolus* Oken and *Psolidium* Ludwig, 1887 are polyphyletic (Gustav Paulay pers. comm.). *Psolus heardi* O'Loughlin & Skarbnik-López sp. nov. differs from all other *Psolus* species by having a combination of: coelomic brood-protecting habit; poorly defined ventro-lateral margin overlapping the sole; dorsal scales that are single-layered with mesh-like secondary layering that has fine dorsal surface spines; shallow, irregular, marginally knobbed cups that are similar dorsally and in sole. "Other material" refers to lots that were identified in the AAD by comparison with voucher specimens that were identified by Mark O'Loughlin. These lots are held (unregistered) in the AAD and the determinations not confirmed by Mark O'Loughlin.

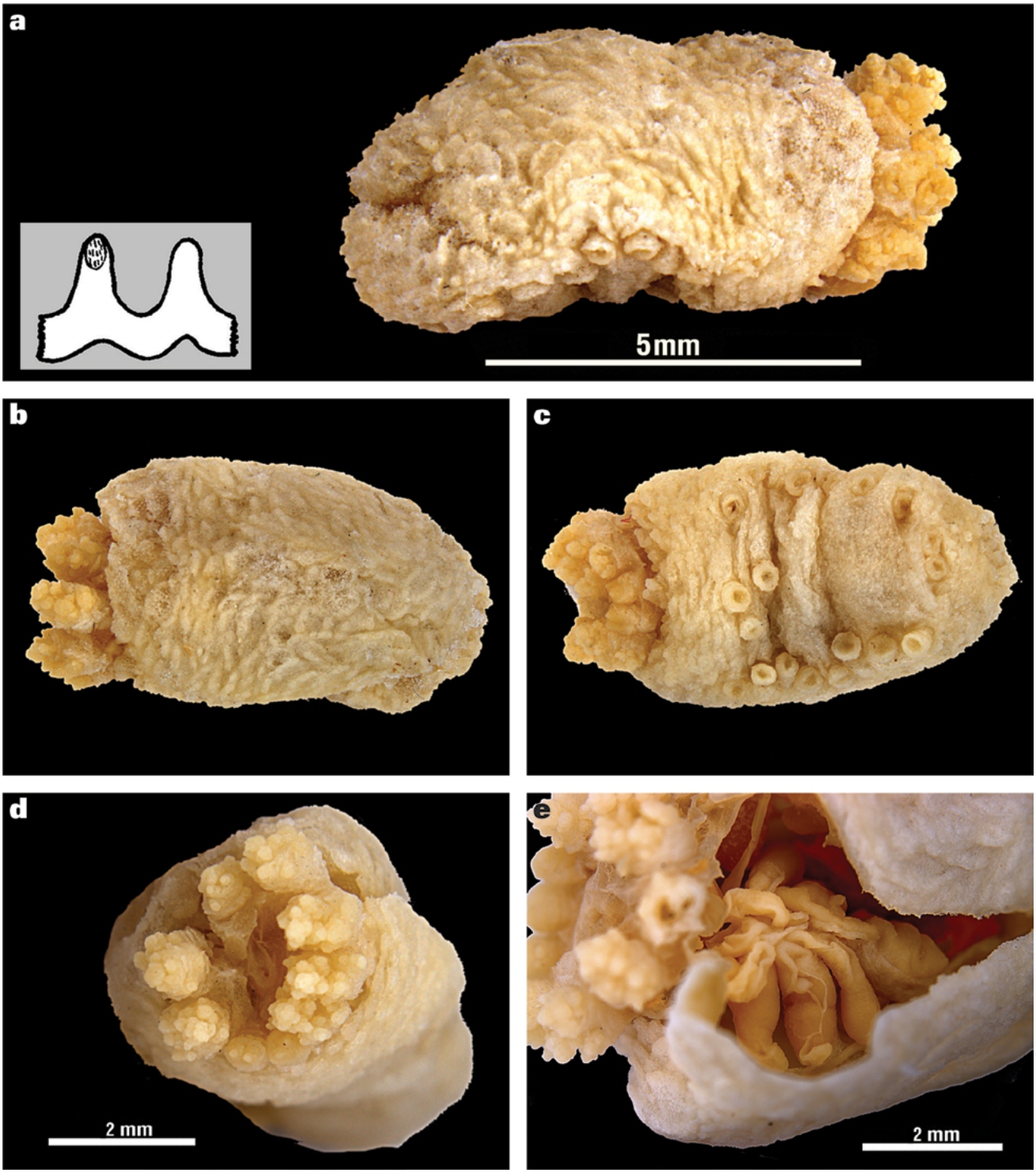

Figure 9. *Psolus heardi* O'Loughlin & Skarbnik-López sp. nov. photos (a–d of holotype NMV F84986; e of paratype NMV F198493). a, lateral view with oral end right, ventro-lateral scales slightly overhang sole (insert with drawing of radial (left) and inter-radial plates of the calcareous ring); b, dorsal view with oral end left; c, ventral view, weakly delineated sole with peripheral tube feet; d, tentacles with two small ventral ones (bottom); e, cluster of gonad tubules.

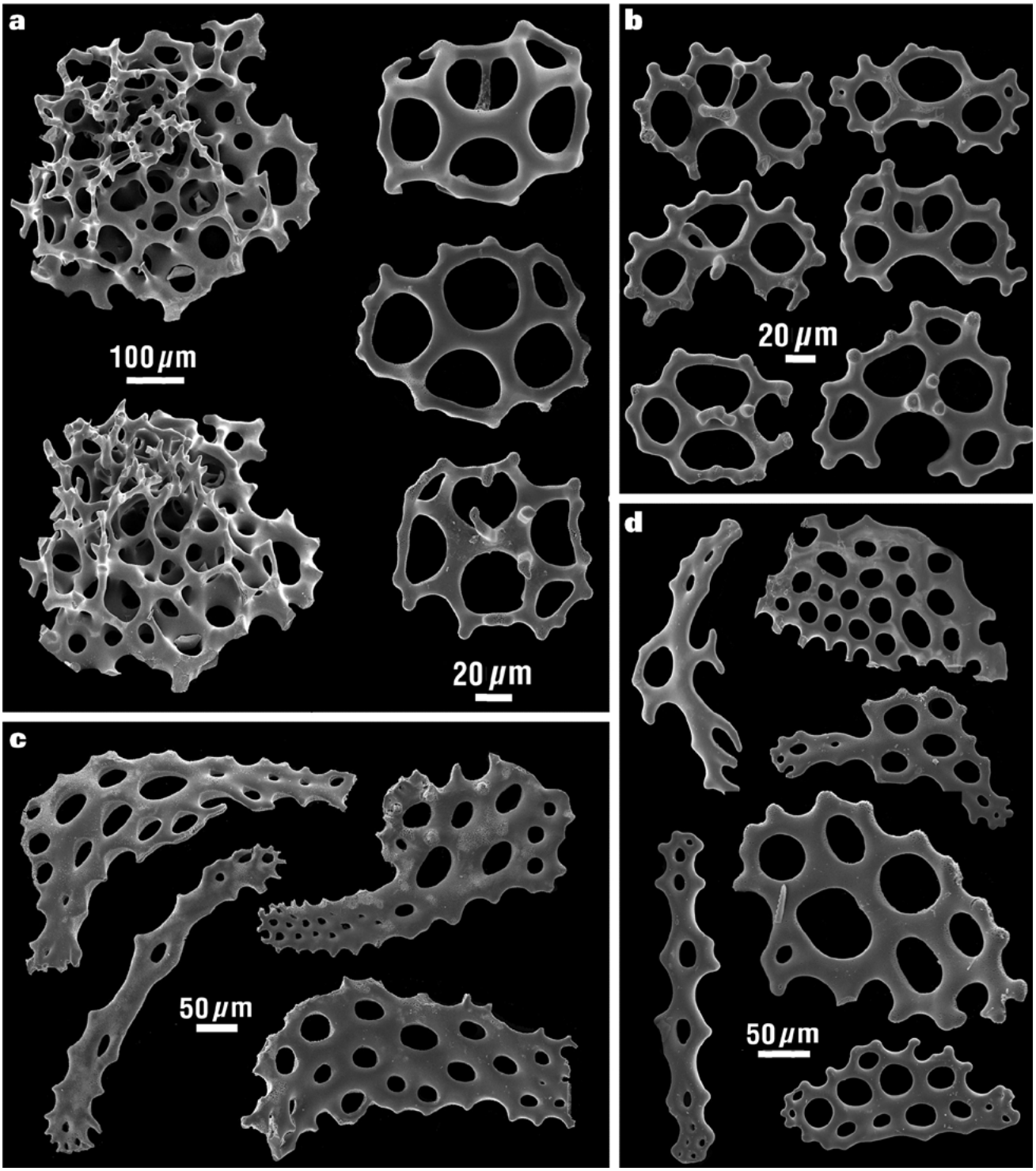

Figure 10. SEM images of ossicles from a paratype of *Psolus heardi* O'Loughlin & Skarbnik-López sp. nov. (NMV F198493). a, dorsal mid-body scales (left) and shallow cups (right); b, shallow cups from the sole; c, curved perforated rod and plates from a tentacle; d, tube foot half endplate fragment (top right), perforated rods (left), and curved knobbed perforated plates (right lower two-thirds).

Order **Molpadida** Haeckel, 1896

Diagnosis (from O'Loughlin et al. 2011). Tentacles 15, digitate; body stout, lacking tube feet, usually with an evident tail; anal papillae, tentacle ampullae and respiratory trees present; ossicles may include tables, cups, rods, perforated plates and modified anchors; phosphatic bodies often present.

Family **Caudinidae** Heding, 1931

Diagnosis (from O'Loughlin et al. 2011). Tentacles without a terminal digit, and with one or two pairs of lateral digits; tail sometimes inconspicuous; ossicles may include large tables, crossed cups, perforated plates and irregular rods; phosphatic bodies usually absent.

Paracaudina Heding, 1932

Remarks. O'Loughlin *et al*. (2011) provided a comprehensive diagnosis of *Paracaudina* Heding, 1932, listed all assigned species, and included a key to the Australian and New Zealand species. In a subsequent paper Davey & O'Loughlin (2013) discussed the caudinid species of New Zealand, described two additional species of *Paracaudina*, and provided a key to the New Zealand caudinid species.

Paracaudina championi O'Loughlin & Skarbnik-López sp. nov.

Zoobank LSID. http://zoobank.org:act:86F7DB87-F210-4732-9A77-2FC03915134B

Tables 1–3, 5, 6; figures 1, 11–13.

Molpadiidae sp. nov. (HOL 11).—Hibberd & Moore, 2009: 119, 145.

Material examined. Holotype. Southern Ocean, S Kerguelen Plateau, NE Heard Island, North-east Plateau, AAD *Southern Champion* cruise 46 haul 479, beam trawl, -50.67 74.62, 708 m, 30 Jul 2007, NMV F165736 (UF tissue sequence code MOL AF666) (AAD species code: HOL 11).

Paratypes (AAD species code: HOL 11). HIMI, Western Plateau, SC26(162), -52.44 72.67, 287 m, 30 Apr 2003, TMAG H3539 (3); SC26(165), -52.34 72.50, 462 m, 30 Apr 2003, TMAG H3434 (1).

Other material (AAD species code: HOL 11). Southern *Shell Bank*, SC26(264), -51.87 75.78, 779 m, AAD; *Shell Bank* MR, SC46(125), -51.69 76.19, 234 m, AAD; North-east Plateau, SC46(473), -50.48 74.60, 905 m, AAD; SC46(474), -50.46 74.79, 942 m, AAD.

Figure 11. *Paracaudina championi* O'Loughlin & Skarbnik-López sp. nov. holotype photo of lateral view (oral end left) (insert with drawing of radial (left) and inter-radial plates of the calcareous ring) (NMV F165736).

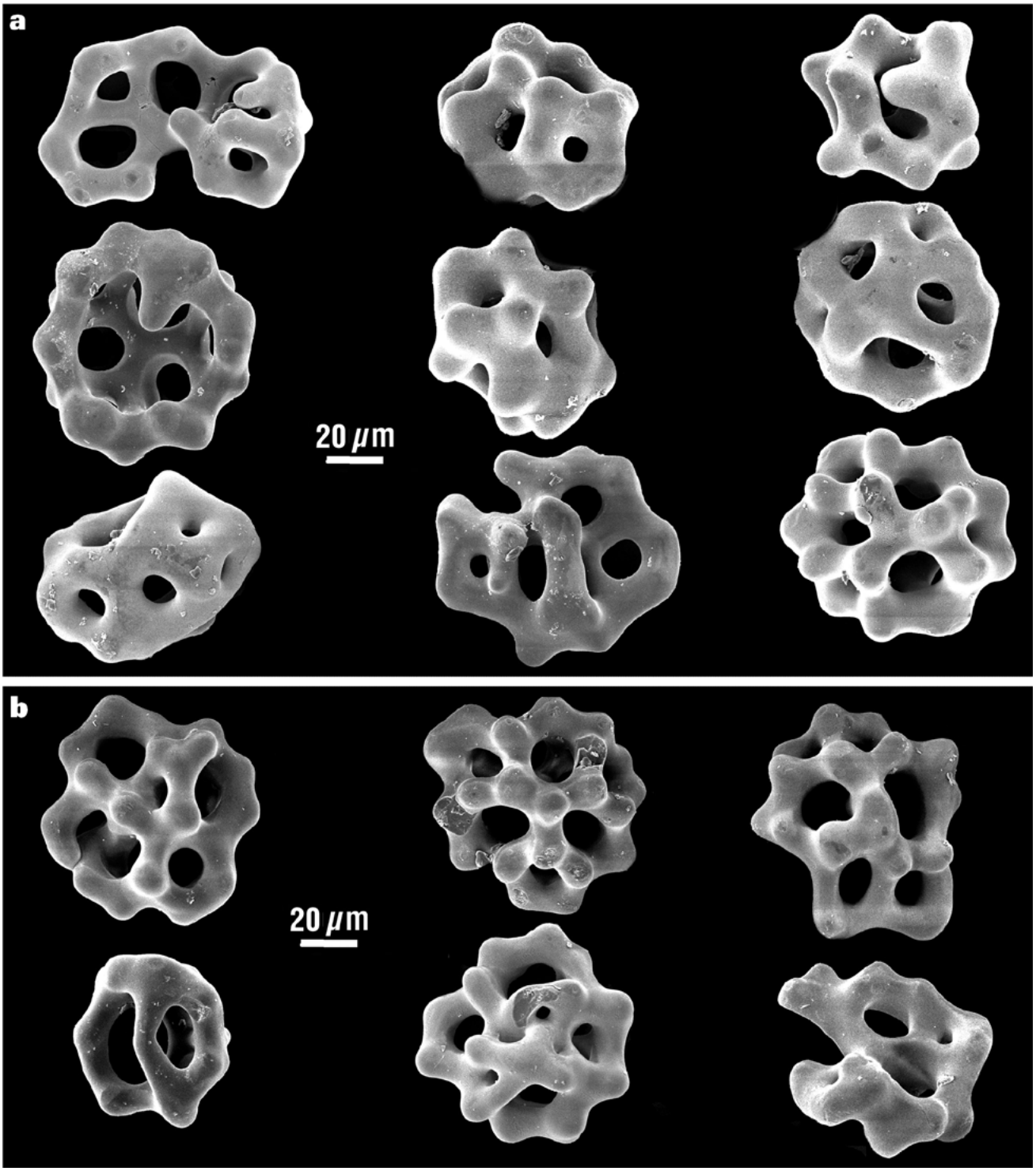

Figure 12. SEM images of ossicles from the holotype of *Paracaudina championi* O'Loughlin & Skarbnik-López sp. nov. (NMV F165736). a, irregular knobbed cup-like ossicles from the mid-body wall, with cross base evident mid-left and bottom right; b, irregular knobbed cup-like ossicles from the caudal body wall, with cross base evident upper middle and right.

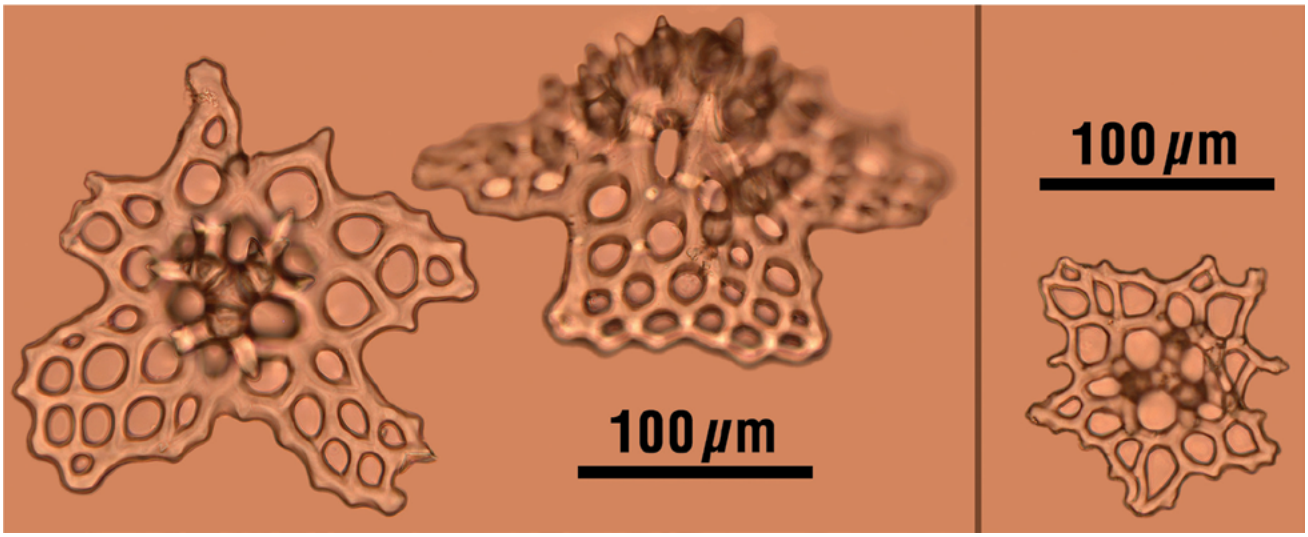

Figure 13. Microscope photos of table ossicles from the peri-anal body wall of paratypes of *Paracaudina championi* O'Loughlin & Skarbnik-López sp. nov. Two left tables from large specimen (TMAG H3434); single right table from small specimen (TMAG H3539).

Description. Preserved body up to 115 mm long (strongly contracted), tapering posterior body and tail 40 mm long, mid-body up to 30 mm diameter; body wall thick, leathery, wrinkled with transverse creases, pale brown to off-white to pale grey in colour; body form cylindrical, slight taper to blunt oral end, about one third of the body tapered to thin posterior tail (end of tail missing in holotype), tail not discretely delineated. Lacking anal scales or papillae. Tentacles 15, digitiform, lacking terminal digit or digits. Calcareous ring solid, plates fused; radial plates with two anterior projections, one with longitudinal muscle attachment and small anterior notch, separated by a bigger notch from the second lateral anterior projection, plates with tapered posterior projection with small bifid notch posteriorly; inter-radial plates with tapered anterior projection, wide rounded posterior indentation. Tentacle ampullae variable in length, up to twice the height of the ring in length. Single polian vesicle, tubular, long. Longitudinal muscles broad, flat, each divided along mid-line by narrow gap. Long, thin, unbranched gonad tubules.

Mid-body and caudal, but not peri-anal, ossicles are similar; some but not most are fairly regular, thick, knobbed cups with a basal distally-knobbed cross; most have no regular form and are thick, knobbed, often three-dimensional, and very irregular; ossicles predominantly up to 40 μm long. Peri-anal body wall with irregular knobbed cups and irregular thick tables; knobbed cups as in mid-body wall; tables in smaller specimens with predominantly 3-pillar spires, one cross-bridge, few lateral blunt spines, 3 paired blunt spines apically, spires on tables in larger specimens complex with numerous distal blunt spines, spires up to about 170 μm high; table discs indented centrally, raised marginally, irregular angular margins, predominantly 6 central perforations, 2 outer circles of irregular perforations, discs up to about 180 μm across in small specimens, up to about 250 μm across in large specimens.

Distribution. Southern Ocean, Kerguelen Plateau, N of Heard Island on North-east Plateau, *Shell Bank*, Western Plateau, 234–942 m.

Etymology. Named *championi* for the fishing trawler *Southern Champion* that was commissioned by the AAD to serve this research expedition.

Remarks. The holotype was donated to NMV by the AAD. Initial preservation was by freezing, with subsequent transfer to 70% ethanol. The presence of peri-anal 3-pillared, large, thick tables is a significant morphological addition to the diagnostic characters of *Paracaudina* Heding, 1932 that was provided by O'Loughlin *et. al*. (2011). Caudal ossicles in *Paracaudina* specimens have been discussed and illustrated by O'Loughlin *et al*. (2011). No tables were observed in the mid-body wall or caudal region. In reporting on the New Zealand Caudinidae species, Davey & O'Loughlin (2013) discussed *Hedingia* Deichmann, 1938, and the New Zealand occurrence of *Hedingia albicans* (Théel, 1886). In *H. albicans* there are abundant three-pillared tables with irregular discs in the caudal region, and rarely in the mid-body wall. *Hedingia* species lack thick, knobbed cup ossicles. The new caudinid species described here has the characteristic paracaudinid thick, knobbed cup ossicles throughout the body wall, but also has the characteristic tables of *Hedingia* in the posterior caudal region. We have provisionally assigned our new species to *Paracaudina* and await the evidence of molecular phylogenetic data for generic confirmation.

Apart from the significant diagnostic difference of presence or absence of caudal tables, *Paracaudina championi* O'Loughlin & Skarbnik-López sp. nov. is similar to *Paracaudina alta* Davey & O'Loughlin, 2013 with its very irregular ossicle forms. But the thick, knobbed cup ossicles are quite dissimilar to the more regular ossicles of all other species of *Paracaudina*. The illustration of *P. alta* body form (Fig. 1B)

in Davey & O'Loughlin (2013) indicates that most of the body is cylindrical with a relatively short discrete tail, whereas for *Paracaudina championi* about one third of the body exhibits a long caudal taper. Body wall ossicles for *P. alta* are illustrated by Davey & O'Loughlin (2013) and also by O'Loughlin *et al*. (2011) for the earlier conspecific *Paracaudina* species. We judge that amongst the very irregular ossicles of both species a basal distally-knobbed cross is sometimes evident amongst the ossicles of *P. championi* but not amongst those of *P. alta*. Their respective occurrences north and south of the Antarctic Convergence, and considerable geographical separation, also discourage us from thinking that they are conspecific. We await molecular phylogenetic data for insight into these relationships of current *Paracaudina* species. TMAG paratypes have been confirmed by direct observation of TMAG loan material. "Other material" refers to lots that were identified in the AAD by comparison with voucher specimens that were identified by Mark O'Loughlin. These lots are held (unregistered) in the AAD and the determinations not confirmed by Mark O'Loughlin.

Family **Molpadiidae** Müller, 1850

Diagnosis (Pawson 1977). Tentacles claw shaped or with terminal digits and few small lateral digits. Tentacle ampullae long or reduced. Spicules derived from tri-radiate tables with three-pillared spire. Tail with tables with round to oblong disc or long fusiform rods. Phosphatic deposits often present.

Molpadia Cuvier, 1817

Diagnosis (Pawson 1977). Calcareous deposits include tables, anchors, and rosettes of racquet-shaped plates and large fusiform rods in various combinations. Tail deposits tables or fusiform rods. Phosphatic deposits present or absent.

Type species. *Molpadia musculus* Risso, 1826 (type locality Mediterranean Sea).

Molpadia violacea Studer, 1876

Tables 1–6; figures 1, 14, 15 e, f.

Molpadia violacea Studer, 1876: 464.—Pawson, 1963: 15, pl. 3, figs 4–8.—1965: 12.

Trochostoma violaceum.—Théel, 1886: 42–43, pl. 2, fig. 4, pl. 11, fig. 1.—Lampert, 1889: 842.—Ludwig, 1894: 157–158.—1898: 64.—Perrier, 1905: 65–66.

Haplodactyla violacea.—Heding, 1931: 280.

Eumolpadia violacea.—Heding, 1935: 42, text fig. 8, figs 7–10; pl. 5 fig. 10; pl. 7, fig. 3; pl. 8, fig.4.—Ludwig & Heding, 1935: 144–145, text fig. 11.—Cherbonnier & Guille, 1975: 609.

Molpadia musculus Risso, 1826 (Antarctic).—O'Loughlin *et al*., 2009: table 1.—O'Loughlin *et al*., 2010: 269(6), tables 1, 2, 4, fig. 2 (non *Molpadia musculus* Risso, 1826).

Molpadia musculus (HOL 12).—Hibberd & Moore, 2014: 42, 119, 145 (non *Molpadia musculus* Risso, 1826).

Material examined. Holotype. Southern Ocean, N Kerguelen Plateau, SMS *Gazelle* 1874, Kerguelen Islands, 183 m, ZMB 2070.

Other material (AAD species code: HOL 12). HIMI, *Aurora Bank*, SC26(179), -52.48 71.75, 275 m, 1 May 2003, TMAG H3540 (1); SC26(193), -52.42 71.87, 264 m, AAD; Southern *Shell Bank*, SC26(263), -51.80 75.50, 628 m, TMAG H3433 (4); SC26(267), -51.82 76.02, 472 m, 10 May 2003, TMAG H3541 (1); *Shell Bank* MR, SC46(128), -51.55 75.76, 337 m, AAD; off Heard I., AD67(40), -52.95 73.34, 112 m, NMV F76842 (1); *Pike Bank*, SC50(10), -51.31 71.77, 273 m, NMV F165737 (1) (UF tissue sequence code MOL AF667).

Eastern Antarctica, Prydz Bay, AA91(84), -68.05 73.18, 680 m, NMV F71992 (1).

Western Antarctica, South Shetland Islands, AMLR 2003(71), -62.44 -61.14, 138 m, NMV F104825 (1) (UF tissue sequence code MOL AF574); South Shetland Islands, LI–AGT–3, -62.40 -61.76, 556 m, NMV F168644 (3) (UF tissue sequence code MOL AF809); South Orkney Islands, US AMLR 2009(104), -63.23 -59.46, 757–783 m, NMV F169293 (4); South Orkney Islands, US AMLR 2009(41–42), -61.82 -46.19, 450–461 m, NMV F169294 (1); South Orkney Islands, US AMLR 2009(21), -61.06 -42.84, 422–428 m, NMV F169295 (1); off Hugo I., -64.74 -65.48, 684–705 m, NMV F169353 (1); South Shetland Islands, US AMLR 2012(247), -62.38 -61.42, 344 m, NMV F193760 (5).

Description. Body up to 145 mm long, up to 25 mm diameter (preserved, NMV F169293, South Shetland Is), body form cylindrical mid-body with short anterior taper to blunt rounded end, posterior taper to short discrete thin tail, about 10% of body length, body wall firm, leathery. Tentacles 15, digitiform, each with single terminal digit. Calcareous ring solid, plates fused, radials wider than inter-radials, radials with two anterior lateral rounded projections, one with longitudinal muscle attachment and anterior notch with anterior ends of notch incurved and almost closed, tapered posterior prolongation with small bifid posterior notch; inter-radials with pointed anterior projection, broad rounded posterior indentation. Length of tentacle ampullae more than twice the height of the ring. Single polian vesicle tubular, long. Long stone canal with spiral form; madreporite attached to body wall. Longitudinal muscles broad, flat, each divided along mid-line by wide gap. Gonad tubules branched.

Ossicles tables and fusiform rods, tables and rods in main body wall, rods only caudally, in larger specimens main body tables and fusiform rods variably to completely phosphatised; tri-radiate table discs with predominantly three perforations, often a few more than three, discs frequently irregular, disc margin smooth or frequently with short to long rod-like projections from margin distal to perforations, discs variable in size, up to 190 μm across (excluding rod-like extensions from margin), solid columnar spires with blunt distal spines, spires about 70 μm high, tables phosphatize into reddish-orange bodies; long fusiform rods in mid-body and tail, rods widened centrally with elongate perforation with irregular thin bridging rods creating 2–6 irregular perforations, predominantly 3, rods variable in length, mid-body rods up to up to 1300 μm long, only rods in mid-body phosphatize, caudal fusiform rods smaller than in mid-body, up to 900 μm long, mid-body and caudal fusiform rods never with solid spire similar to tables. Inconspicuous anal scales in peri-anal body wall, irregular columnar form, comprise a dense rod network, scales up to about 360 μm long. Anchors or racquet-shaped plates not observed. Ossicles phosphatising to red, orange and yellow irregularly oval bodies or clusters of granules, sizes vary.

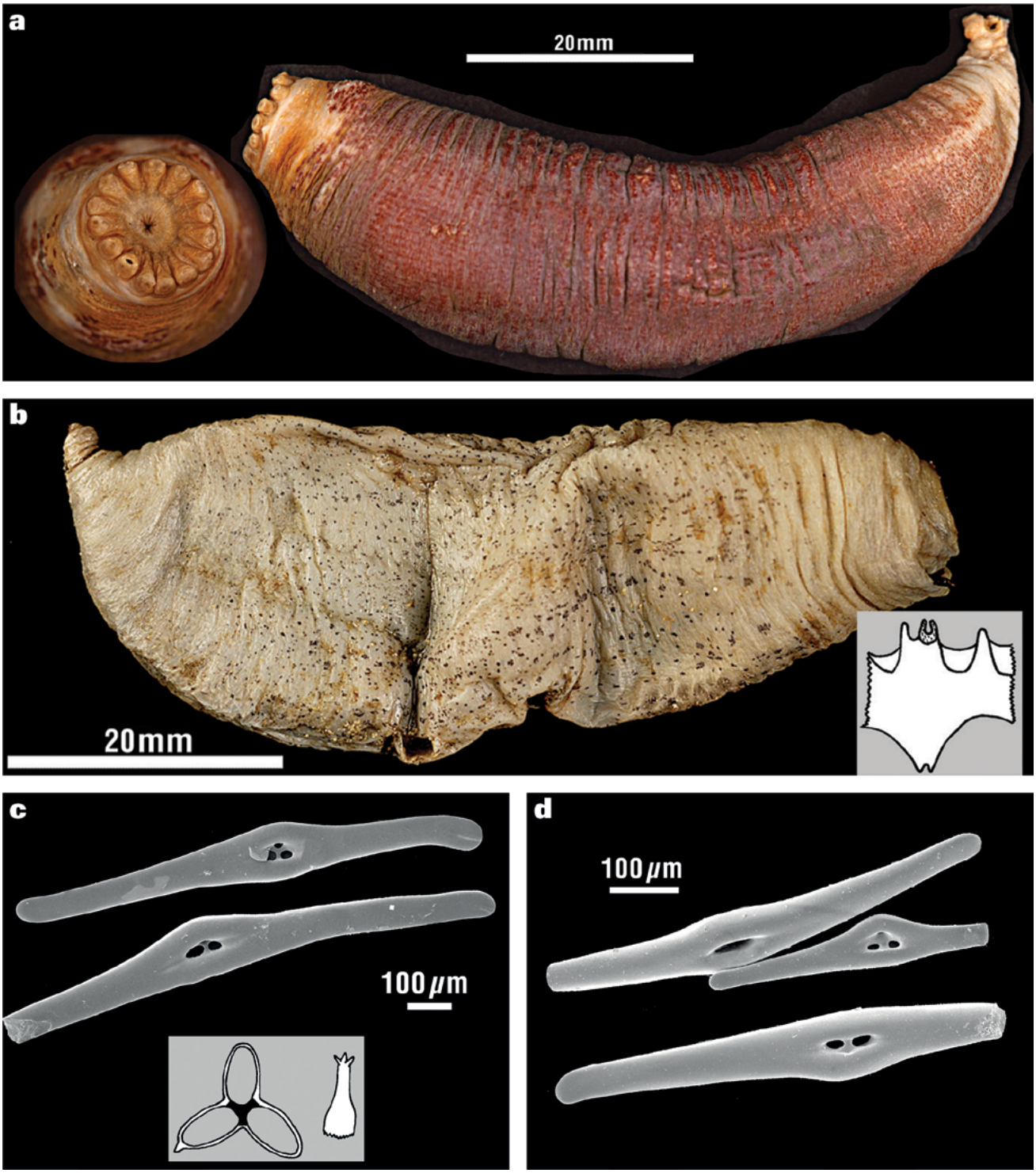

Figure 14. *Molpadia violacea* Studer, 1876 photos and SEM ossicle images. a, left lateral view of holotype (oral end left) (ZMB 2070) (bottom left insert with photo of tentacles); b, right lateral view of HIMI specimen of *Molpadia violacea* (NMV F165737) (insert with drawing of radial (left) and inter-radial plates of the calcareous ring); c, d, SEM images of fusiform rod ossicles from HIMI specimen of *Molpadia violacea* (NMV F165737); c, from mid-body wall (insert with drawings of table disc and spire); d, from caudal body wall.

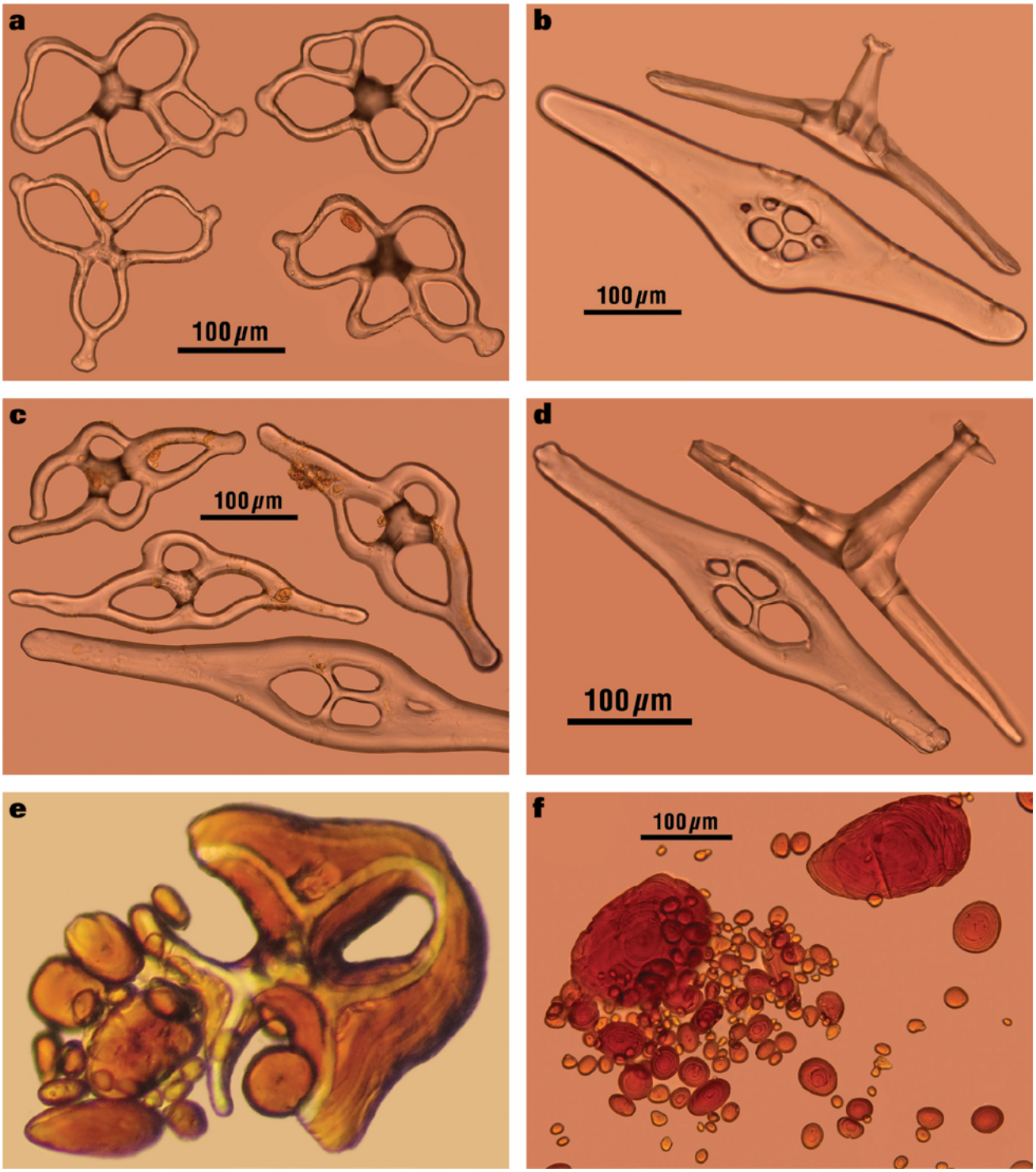

Figure 15. Microscope photos of ossicles and phosphatic bodies from specimens of *Molpadia magdae* O'Loughlin (in O'Loughlin *et al*. 2013) and *Molpadia violacea* Studer, 1876. a–d, *Molpadia magdae*. a, mid-body irregular table discs, ossicles beginning to phosphatize with small phosphatic bodies present (from NMV F197215); b, caudal fusiform rods, some only with spires (from NMV F197215); c, mid-body irregular table discs and fusiform rod, ossicles beginning to phosphatize (from NMV F68677); d, caudal fusiform rods, one with and one lacking spire (from NMV F68677); e–f, *Molpadia violacea*. e, mid-body phosphatizing table disc (disc 64 µm across; from NMV F165737); f, mid-body phosphatic bodies (from NMV F169293).

Figure 16. Photos of preserved Studer (1876) type specimens from the Kerguelen Islands. a, right lateral view of holotype of *Trachythyone muricata* Studer, 1876 (ZMB 2252); b–d, photos of holotype of *Psolidium poriferum* (Studer, 1876) (ZMB 2259, as *Cuvieria porifera*); b, lateral view with oral end left; c, dorsal view with oral end right; d, ventral view with oral end right.

Colour of preserved body variable: oral end and discrete tail frequently off-white; body off-white to blue-grey to grey with fine black to red phosphatic spots or flecks; varying to coalescing spots creating a dark red to black colour with a red-brown hue. Live holotype violet (Studer, 1876).

Distribution. Southern Ocean, Kerguelen Plateau, Kerguelen Islands, *Aurora*, *Pike*, *Shell Banks*, Heard I., 112–628 m. Antarctica, Prydz Bay, Ross Sea and vicinity of the South Orkney and South Shetland Islands.

Remarks. Clark (1908) and Deichmann (1940) were of the opinion that *Molpadia violacea* Studer, 1876 is a junior synonym of *Molpadia musculus* Risso, 1826. This opinion was discussed and upheld emphatically by Pawson (1977). After examining many specimens of *Mopadia* of different sizes, Pawson (1977) had observed the great variability of ossicle form within the same species. Pawson (1977) finally judged that *M. musculus* was cosmopolitan in distribution with a wide bathymetric range of 35–5205 m. O'Loughlin *et al*. (2010) list *Molpadia musculus* Risso, 1826 from Antarctica.

O'Loughlin *et al*. (2010) also showed that recent molecular phylogenetic data are revealing many cryptic species and they provided a phylogenetic tree for CO1 sequence data from 19 specimens judged to be *Molpadia musculus*. The specimens were collected from the Amundsen Sea, Ross Sea and South Shetland Islands in Antarctica, from Heard Island, and from Western Australia. The tree indicates the probability of five cryptic species. One of the species is Antarctic, with specimens from the Ross Sea and the South Shetland Islands, and this clade includes the specimen from Heard Island. None of the five cryptic species includes a specimen from the Mediterranean Sea, the type locality for *Molpadia musculus*. We judge from these data, and the geographical separation, that none of these specimens represents *Molpadia musculus*. We thus raise *Molpadia violacea* Studer, 1876 out of synonymy with *Molpadia musculus* Risso, 1826, and note that Antarctic *Molpadia*

specimens previously referred to *M. musculus* should in some cases now be referred to *Molpadia violacea*.

We have examined specimens of *Molpadia* from Western Antarctica that were previously thought to be *Molpadia musculus* and based on colour, ossicle form and occurrence, the phosphatising and disappearance of calcareous ossicles, the absence of spires on caudal fusiform rods, and in two cases with the support of the genetic data in O'Loughlin *et al*. (2010), we refer them to *Molpadia violacea*. These are listed above. We found only one specimen (NMV F71992) that was collected from Prydz Bay that appears to be *Molpadia violacea*. It exhibits appropriate colouration, no spires on caudal fusiform rods, and abundant phosphatic bodies in the body wall.

We have identified a number of specimens that were previously thought to be *Molpadia musculus*, from Prydz Bay in Eastern Antarctica and the Amundsen Sea in Western Antarctica, as *Molpadia magdae* O'Loughlin (in O'Loughlin *et al*. 2013): from Prydz Bay lots NMV F68058 (1), NMV F197215 (2), NMV F68677 (1), NMV F71993; and from the Amundsen Sea lot NMV F168645 (1). These specimens are characterized by: lack of colour and minimal phosphatizing; a body cover of table spires; irregular triradiate table discs that frequently have long rod-like marginal elongations; and asymmetrical fusiform rods caudally, some of which have spires and inter-grade with tables (see Figure 15 a–d). *Molpadia magdae* was described from the South Shetland Islands and this work extends its distribution to Prydz Bay in Eastern Antarctica. We have never detected spires on caudal fusiform rods in specimens of *Molpadia violacea*.

Some distributions of HIMI and Kerguelen Islands holothuroid species beyond the Kerguelen Plateau.

In addition to the holothuroid species reported here for HIMI we add two more to complete a list for the Kerguelen Plateau. *Clarkiella deichmannae* O'Loughlin, 2009 was described for BANZARE specimens taken in the Kerguelen Islands. *Pseudopsolus macquariensis* forma *gruai* Cherbonnier & Guille, 1975 was described for littoral specimens from the Kerguelen Islands. A thorough description was provided and this variety was distinguished from the Macquarie Island species *Pseudopsolus macquariensis* (Dendy, 1897) by the presence of ossicles in body parts where they were consistently reported to be absent by numbers of workers. We raise this "forma" to species status as *Pseudopsolus gruai* Cherbonnier & Guille, 1975.

O'Loughlin *et al*. (2010) provide a comprehensive list of Antarctic holothuroids. O'Hara (1998) reported on nine holothuroid species from Macquarie Island. Subsequently Davey & Whitfield (2013) reported *Psolidium marriotti* Davey & Whitfield, 2013, *Psolus antarticus* (Philippi, 1857), *Psolus macquariensis* Davey & Whitfield, 2013, *Psolus parantarcticus* Mackenzie & Whitfield, 2011 and *Psolus salottii* Mackenzie & Whitfield, 2011 from the Macquarie Ridge.

Pawson (1969) reported *Heterocucumis godeffroyi* (Semper, 1868) from southern Chile.

The type localities for *Psolus antarcticus* (Philippi, 1857) and *Trachythyone lechleri* (Lampert, 1885) are the Straits of Magellan. O'Loughlin & VandenSpiegel (2010) reported a widespread distribution of *Sigmodota contorta* (Ludwig, 1875) in Antarctica and the southern region of South America (type locality unknown).

Fifteen holothuroid species are reported here for Bouvetoya Island (list compiled from Ludwig & Heding 1935 (*Valdivia* voyage in 1898), Théel 1886 (*Challenger* voyage in 1876), and NMV specimens): *Bathyplotes bongraini* Vaney, 1914; *Bathyplotes moseleyi* (Théel 1886); *Protelpidia murrayi* (Théel 1879); *Cucamba psolidiformis* (Vaney, 1908); *Heterocucumis steineni* (Ludwig, 1898); *Psolidiella mollis* (Ludwig & Heding, 1935); *Psolicrux coatsi* (Vaney, 1908); *Psolidium whittakeri* O'Loughlin & Ahearn, 2008; *Psolus antarcticus* (Philippi, 1857); *Psolus charcoti* Vaney, 1906; *Psolus dubiosus* Ludwig & Heding, 1935; *Psolus murrayi* Théel, 1886; *Staurocucumis liouvillei* (Vaney, 1914); *Trachythyone bouvetensis* (Ludwig & Heding, 1935); *Sigmodota contorta* (Ludwig, 1875). We note that Carriol & Féral (1985) considered a paratype of *Psolus dubiosus* Ludwig & Heding, 1935 to be their *Psolus paradubiosus*. In the absence of supportive material we distrust this judgment, and think that the specimen may be the similar *Psolus antarcticus* that we have found in Bouvetoya waters.

The above reports indicate that the holothuroid fauna of the Kerguelen Plateau has eight species with distributions that are continuous with the relatively shallow fauna of the Antarctic coast, and five species that occur in the Magellanic region of South America. Two of these latter five species have not been found on the coast of Antarctica (*Heterocucumis godeffroyi* and *Trachythyone lechleri*).

Of the 15 species reported for Bouvetoya Island, 13 occur on the coast of Antarctica (no reports of *Psolus paradubiosus* or *Psolus murrayi* on the Antarctic coast). Only three are reported for the Kerguelen Plateau (*Psolus antarcticus*, *Staurocucumis liouvillei*, *Sigmodota contorta*).

Two species (*Pentactella laevigata* and *Psolus antarcticus*) reported for Macquarie Island (north of the Antarctic Convergence) occur on the Kerguelen Plateau, the northern part of which has proximity with the Antarctic Convergence. A CO1 sequence from an HIMI specimen of *Pentactella laevigata* clades with one from the Macquarie Ridge (Gustav Paulay *pers. comm*.).

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