

New cucumariid species from southern Australia (Echinodermata: Holothuroidea: Dendrochirotida: Cucumariidae)

P. MARK O'LOUGHLIN

Marine Biology Section, Museum Victoria, GPO Box 666, Melbourne, Victoria 3001, Australia (pmo@bigpond.net.au)

Abstract

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Four cucumariid species, new to science, are described for the rocky shallows and off-shore sediments of southern Australia: *Apsolidium falconerae*, *Neoamphicyclus altoffi*, *Neoamphicyclus materiae*, *Neocucumella turnerae*. *Neocucumella turnerae* sp. nov. is unique within the genus in not having table ossicles. The five syntypes of *Cucumaria mutans* Joshua are reviewed, restricted to three, and a lectotype and two paralectotypes are designated. The genus *Neoamphicyclus* Hickman is reviewed. *Cucumaria mutans* is referred to *Neoamphicyclus* Hickman. One former syntype of *Cucumaria mutans* is assigned to *Neoamphicyclus materiae* sp. nov. One former syntype of *Cucumaria mutans* has lost all ossicles and is assigned to *Neoamphicyclus* sp. A key is provided for the species of *Neoamphicyclus* Hickman.

Keywords

Echinodermata, Holothuroidea, Dendrochirotida, Cucumariidae, taxonomy, new species, key

Introduction

This paper describes new cucumariid species from the rocky shallows and off-shore sediments in the temperate waters off southern Australia. Rowe (1995) summarized our knowledge of cucumariid species occurring in Australia. A small group of species was described from tropical waters with distributions extending to the temperate southern waters of Australia: *Plesiocolochirus spinosus* (Quoy and Gaimard, 1833); *Colochirus quadrangularis* Troschel, 1846; *Cercodemus anceps* (Selenka, 1867); *Mensamaria intercedens* (Lampert, 1885); and *Plesiocolochirus dispar* (Lampert, 1889). Most of the southern Australian cucumariid species occur in temperate waters only. *Plesiocolochirus ignavus* (Ludwig, 1875) was described from South Australia, *Staurothyone inconspicua* (Bell, 1887) and *Cucumella mutans* (Joshua, 1914) from Victoria, *Staurothyone vercoi* (Joshua and Creed, 1915) from South Australia, and *Amphicyclus mortenseni* Heding and Panning, 1954 and *Neoamphicyclus lividus* Hickman, 1962 from Tasmania. O'Loughlin and O'Hara (1992) added 12 new cucumariid species for southern Australia: *Apsolidium alvei*; *A. densum*; *A. handrecki*; *Cucuvitrum rowei*; *Neocnus bimarsupiis*; *Neocucumella fracta*; *Neocucumis cauda*; *Pentocnus bursatus*; *Ocnus occiduus*; *Squamocnus aureoruber*; *Trachythyone candida*; *Trachythyone glebosa*. O'Loughlin and Alcock (2000) re-assigned *Ocnus occiduus* to their new genus *Australocnus*. O'Loughlin (2000) added the new species *Psolidiella hickmani* from south-eastern Australia and *Psolidiella maculosa* from south-western Australia, and reported the New Zealand species *Psolidiella nigra* Mortensen,

1925 from the eastern coast of southern Australia. Two new species have been distinguished here from the closely related ones *Cucumella mutans* (Joshua) and *Neoamphicyclus lividus* Hickman, and an associated generic revision has been undertaken. Two other new species are added from recently examined material.

Materials and methods

The material examined here is principally in the collections of Museum Victoria. Some specimens were borrowed from the Tasmanian and Western Australian Museums. Photography of live specimens and the preserved types was done by Leon Altoff and Audrey Falconer. Photos of ossicles and body wall mounts were taken by Mark O'Loughlin and Chris Rowley using an Olympus BX50 compound microscope and Nikon D70 digital camera, and a Leica DM5000 B compound microscope and Leica DC500 camera with montage software.

Abbreviations: NMV, Museum Victoria, registration number prefix F; TM, Tasmania Museum and Art Gallery, prefix H; WAM, Western Australian Museum, prefix Z. Throughout this paper Rowe (in Rowe and Gates, 1995) is referred to as Rowe (1995), Dr. Frank W.E. Rowe being the systematic authority in that work.

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

Cucumariidae Ludwig, 1894 (emended Pawson and Fell, 1965)

Subfamily **Colochirinae** Panning, 1949

Apsolidium O'Loughlin and O'Hara 1992

Type species. *Apsolidium handrecki* O'Loughlin and O'Hara, 1992 (original designation).

Other species. *Apsolidium alvei* O'Loughlin and O'Hara, 1992; *A. densum* O'Loughlin and O'Hara, 1992; *A. falconerae* sp. nov.

Diagnosis. See O'Loughlin and O'Hara (1992).

Distribution. Southern Australia: from Victoria (Western Port) to SW Western Australia (Trigg I.); not reported from Tasmania; 0–10 m.

Apsolidium falconerae sp. nov.

Figures 1a, 2a, 3a–d, 4a

Material examined. Holotype: Australia, Victoria, Western Port, Phillip I., Cat Bay, shallow sublittoral, covered with detrital material (held by tube feet), attached to undersurface of rock, C. Handreck, 7 Mar 1995, NMV F109375.

Description. Body length 34 mm, maximum width 15 mm (preserved; tentacles excluded, partly withdrawn); body rounded dorsally, flat ventral sole, tapering from wide high oral end to lower narrow anal end; wide dorso-anterior oral end; short dorso-posterior rounded blunt anal cone; dorsal and lateral body wall thin, densely calcareous, rough, small irregularly distributed scales evident, not overlapping; ventral body wall distinctly thin semi-translucent sole with ossicles evident, irregularly oval, tapering posteriorly, rounded not acute junction with ventro-lateral body wall, peripheral series of tube feet; 9 dendritic tentacles, 8 large, 1 small ventral; radial and interradial calcareous ring plates wide posteriorly with central deep notch, radially tapering anteriorly to blunt columnar projection, interradially to thick point, heights of plates subequal; small tube feet scattered closely over dorsal and lateral surfaces; large tube feet ventrally, continuous peripheral irregular series 5-wide, mid-ventral radial series 2–4 wide; single dorsal madreporite near vascular ring, irregular short-branched form, less than 1 mm long; single ventral polian vesicle; gonad tubules unbranched; longer respiratory tree branch extends half coelom length; longitudinal muscles thin, flat, retractor muscles branch off in mid-body.

Ossicles. Dorsal and lateral body wall and tube feet with multilayered ossicles (small scales), buttons, cups, tube foot endplates, tube foot perforated support plates: multilayered ossicles up to 896 μm long; buttons irregular, thick, knobbed, perforated, 104–192 μm long, most small, some with secondary layer developments, some intergrading with multilayered ossicles; complex bluntly spinous cups, basal cross, branching from rim to close over cup to varying extents, 112–144 μm long; small endplates, up to 184 μm diameter, smallest perforations centrally; tube foot support plates irregularly oval, perforated, denticulate on 1 margin, sometimes curved, typically 160 μm long. Ventral tube feet with endplates, support plates, narrow plates: endplates up to 280 μm diameter, small perforations centrally, large peripherally; support plates

elongate, bent or curved, perforated, denticulate on 1 margin, typically 256 μm long. Sole with plates and cups: plates perforated, thick, knobbed, single-layered, variably oval to narrowly elongate, up to 400 μm long; cups rare, 80 μm long, thin-walled, shallow, denticulate margin, denticulations slightly globose. Tentacles with rods, narrow plates, small plates, lacking rosettes: rods thick, straight or curved, large lateral perforations, small terminal perforations, up to 296 μm long (intergrade with narrow plates); narrow plates bent or curved, thick, few central and distal perforations, margin thickly denticulate, up to 200 μm long; small plates tentacle dendritic branch endplates, thin-walled, perforated, irregularly oval, cupped or curved, marginally finely denticulate, typically 56 μm long.

Colour. Live: body white dorsally and ventrally; tentacle dendritic branches yellow (pers. comm. Clarrie Handreck). Preserved: body and tentacle dendritic branches white; tentacle trunks and oral disc with dark brown flecking.

Distribution. Victoria, Western Port, Phillip I., Cat Bay; 0–1 m.

Etymology. Named for Audrey Falconer (Marine Research Group of Victoria), in appreciation of her dedication to marine invertebrate studies on the coast of Victoria, and especially for her contribution to photography in this work.

Remarks. The genus *Apsolidium* O'Loughlin and O'Hara, 1992 was described for 3 southern Australian species: *A. alvei*, *A. densum*, *A. handrecki*. *Apsolidium falconerae* sp. nov. shares the distinctive diagnostic characters of the genus. The body form and cup ossicle form distinguish *A. falconerae* from the other 3 species. None of the other 3 species has a body form that tapers distinctly from anterior to posterior, or has dorsal and lateral body wall cups with an extensively developed rim that creates variably closed cups. *A. falconerae* also lacks the tentacle rosette ossicles of each of the other 3 species. It is assumed here that the single small ventral tentacle of *A. falconerae* is exceptional and would normally be a pair.

Subfamily **Thyonidiinae** Heding and Panning, 1954

Neoamphicyclus Hickman, 1962

Neoamphicyclus Hickman, 1962: 58.—Rowe, 1995: 275.

Diagnosis (emended). Dendrochirotid holothuroid genus, up to 60 mm long with maximum diameter 25 mm (preserved; tentacles excluded); sub-cylindrical form, elongate, narrowing anteriorly, tapering posteriorly to a narrowly rounded anal cone; 25 dendritic tentacles, irregularly grouped outer ring of 15 large, 5 irregularly grouped inner pairs small, total number and sizes variable, groups not aligned with radii; lacking collar of papillae around tentacle ring; tube feet on radii only, in 5 paired single series, paired zig-zag to double series in mid-body; radial tube feet present or absent across true introvert; calcareous ring not composite, lacks posterior prolongations; radial plates sub-rectangular, variable form in same specimen, commonly asymmetrical anteriorly, deep notch above muscle

attachment, lateral shallow indentation, deep posterior notch, posterior projections not upturned; interradial plates almost as tall as radial plates, posteriorly wide with shallow indentation, tapering to point anteriorly; single dorsal stone canal and madreporite near vascular ring, rarely 2 or 3, small, madreporite with “split pea” form, less than 1 mm diameter; 1–3 ventral tubular polian vesicles; longitudinal muscles flat, undivided, retractor muscles branch from mid-body; tufts of gonad tubules on both sides of dorsal mesentery; respiratory trees extend coelom length.

Ossicles. Body wall and introvert with table disc ossicles only, with or without spires, sparse to numerous, predominantly irregular in form, pillars 2–5, predominantly 3. Tube feet with endplates, each with narrow rim of elongate perforated support plates, typically 2 large central perforations. Tentacles with irregular rods; variably with or lacking rosettes and tables. Posterior anal body wall with 5 rudimentary scale ossicles.

Type species. *Neoamphicyclus lividus* Hickman, 1962 (original designation).

Other species. *N. altoffi* sp. nov.; *N. materiae* sp. nov.; *N. mutans* (Joshua, 1914).

Distribution. Southern Australia: New South Wales (south of Bateman’s Bay), Tasmania, Victoria, South Australia, Western Australia (south of Abrolhos Is.); 0–165 m.

Remarks. In describing his species and diagnosing his monotypic genus Hickman (1962) accurately observed that the table discs always lacked spires. This has been confirmed here by extensive sampling of specimens of *Neoamphicyclus lividus* from SE Tasmania. Specimens of a superficially similar species from N Tasmania, Victoria, South Australia and Western Australia have been determined in the past as *N. lividus*. However, in all of the many specimens sampled in this work most of the otherwise similar table discs have spires. Rowe (1982) and Marsh (1991) noted these spires. This has led to the recognition of a second allopatric *Neoamphicyclus* species (*N. materiae* sp. nov. below). *Cucumaria mutans* Joshua, 1914 was reassigned to *Cucumella* Ludwig and Heding, 1935 by Heding and Panning, 1954, partly on the basis of having 20 tentacles. The syntypes and many specimens of *C. mutans* available for this study have 25 tentacles. *C. mutans* has all of the emended diagnostic characters of *Neoamphicyclus* Hickman, 1962 to which it is reassigned below. In fact one of the syntypes of *C. mutans* is *Neoamphicyclus materiae* sp. nov. (discussed below). Some specimens from across southern Australia, previously identified as *Cucumella mutans*, are recognized in this work as a 4th *Neoamphicyclus* species (*N. altoffi* sp. nov., below). In the 4 species of *Neoamphicyclus* both the “true” introvert and part of the anterior body (“pseudo” introvert) may be withdrawn by the retractor muscles. This distinction between true and pseudo introvert is made in the descriptions. Radial tube feet are present on the pseudo introvert in all *Neoamphicyclus* species, but may be present or absent on the true introvert in the various species. The 165 m depth in the distribution range is taken from H.L. Clark (1946), but the specimen is not confirmed here as *N. mutans* (Joshua, 1914) or *N. altoffi* sp. nov. (below) or *N. materiae* sp. nov. (below).

Key to the species of *Neoamphicyclus* Hickman, 1962

1. Body wall ossicles table discs, with or lacking spires, sparsely present in body wall, small, rarely up to 64 μ m wide in specimens more than 15 mm long; tentacles lacking rosette ossicles 2
 - Body wall ossicles table discs with spires, numerous in body wall, large, most more than 64 μ m wide in specimens more than 15 mm long; tentacles with rosette ossicles 3
2. All table discs lacking spires *Neoamphicyclus lividus* Hickman, 1962
 - Most table discs with spires *Neoamphicyclus materiae* sp. nov.
3. Middle and upper tentacle trunks with white lumps, rosette ossicles numerous; lacking white band across the inner (oral) tentacle base; table discs mostly irregular; table discs frequently up to 96 μ m wide *Neoamphicyclus mutans* (Joshua, 1914)
 - Middle and upper tentacle trunks lacking white lumps, ossicles irregular rods only; white band across the inner (oral) tentacle base, rosette ossicles numerous; table discs frequently regular with 3 large, 3 small perforations, 3 pillars; table discs frequently 80 μ m wide *Neoamphicyclus altoffi* sp. nov.

Neoamphicyclus altoffi sp. nov.

Figures 1c, 1d, 2c, 4b, 4c

Cucumella mutans Hickman, 1962: 55–56, text figs 38–45, pl. 1 fig. 4 (non *Cucumella mutans* (Joshua, 1914).

Material examined. Holotype: Western Australia, Fremantle, Hall Bank, C. Bryce, L. Marsh, S. Slack-Smith, 25 Jan 1980, WAM Z279-92.

Paratypes: Cockburn Sound, Woodman’s Point, *Posidonia* bed, 1 m, N. Sammy, 25 Aug 1971, WAM Z722-71 (2); B.R. Wilson, 11 Feb 1968, WAM Z721-71 (1); Cockburn Sound, south flats, A. Jones, 24 Nov 1966, WAM Z453-78 (1); Garden I., Careening Bay, Skippy Rock, 3–7 m, R. Slack-Smith, 6 Jan 1965, WAM Z729-71 (1).

Other material. Victoria, East Gippsland Scallop Survey, 38°12.3’S, 147°33’E, 26 m, 27 Feb 1971, NMV F76470 (1); Bass Strait Survey, VIMS 81-T-1, BSS stn 178, 38°43.4’S, 146°56.9’E, 26 m, 18 Nov 1981, F76623 (1); BSS stn 188, 38°38.2’S, 142°35’E, 59 m, 20 Nov 1981, F76622 (1). Tasmania, Derwent Estuary, dredged off Sandy Bay, 9–12 m, 23 Sep 1955, TM H2139 (2); Waterhouse Passage, Blizzards Landing, 26 Feb 1991, F132717 (2); Tamar R., Green’s Beach, 3 May 1986, F58459 (1). South Australia, Kangaroo I., Emu Bay, rocky shallows, algal epifauna, 17 Jan 1990, F132699 (1); Investigator Group, Topgallant I., 25 m, 21 Apr 1985, F132713 (1). Western Australia, Albany, Princess Royal Harbour, 4–13 m, 22 Jan 1988, F132704 (1); 4 m, 22 Jan 1988, F132724 (1); Geographe Bay, Forrest Beach, seagrass bed, 1 Jan 1972, WAM Z201-73 (2); Dunsborough, under stones, 0.2 m, 31 Jan 1972, WAM Z209-73 (1); SW of Bunbury, FRV *Lancelin*, 20 m, 13 Apr 1963, WAM Z764-71 (2).

Description. *Neoamphicyclus* species up to 46 mm long with maximum diameter 10 mm (preserved; tentacles excluded); perioral thin conical pointed papillae, about 0.2 mm long; radial tube feet do not cross true introvert, a few sometimes encroach onto true introvert; gonad tubules branched.

Ossicles. Body wall, introvert, with abundant table ossicles only: table discs regular and irregular in form, frequently 80 μm wide and regular with 3 large, 3 smaller perforations, 3 pillars; discs size range 40–88 μm wide, perforations 3–12, spires typically with 3 pillars, infrequently 2–5, spires 32–40 μm long; in small 6 and 13 mm-long specimens maximum table disc width was 56 μm , indicating an increase in table disc size with increase in specimen size. Tube feet with endplates up to 320 μm diameter; few elongate-perforated support plates, about 184 μm long, frequently 2 large perforations centrally. Tentacle trunks above base with irregular rods only, 64–328 μm long, small perforations distally, some short-branching, rare blunt spines. Tentacle trunk base with rosettes and tables, some intergrading: anastomosing rosettes, frequently closed peripherally, largest with central perforations with small tripod, rosettes up to 104 μm long; tables irregular, up to 80 μm long, 2–3 pillars, some with up to 15 small perforations. Oral disc and papillae with rosettes and thin rods, some intergrading: anastomosing rosettes, frequently closed peripherally, irregularly oval, up to 64 μm long; rods thin, rare lateral branching, distally few to many small perforations, up to 224 μm long. Posterior anal body wall with 5 rudimentary scales (anastomosing calcareous bodies), irregular form, up to 280 μm long.

Colour (preserved). Body and tube feet dark blue-grey to dark grey-brown to brown to pale brown to off-white; introvert brown to off-white; tentacle dendritic branches dark brown, upper trunks pale grey/translucent, lacking white patches, inner base of tentacle trunks with transverse white band; oral disc dark brown, with white patches.

Distribution. Victoria (East Gippsland), Bass Strait, SE and N Tasmania, South Australia, SW Western Australia (Perth); 0–59 m.

Etymology. Named for Leon Altoff (Marine Research Group of Victoria), in appreciation of his dedication to marine invertebrate studies on the coast of Victoria, and especially for his contribution to photography in this work.

Remarks. Most of the specimens referred hereto *Neoamphicyclus altoffi* sp. nov. have been previously determined as *Cucumella mutans* (Joshua, 1914). Hickman (1962) reported *Cucumella mutans* from SE Tasmania (Derwent estuary; TM H2139). Two specimens were re-examined here and determined as *N. altoffi* sp. nov. Marsh and Pawson (1993) determined “with some doubt” as *Cucumella mutans* (Joshua, 1914) a small specimen (7 mm long), lacking tentacles, from 30 m at Rottneest I. (SW Australia). The form of the body wall tables is illustrated, and closely resembles those of *N. altoffi*, as does the average disc diameter for a small specimen (49 μm). But tables with curved discs from tube feet are illustrated, and these have not been found here in *N. altoffi* or *C. mutans*. *N. altoffi* has not been found in the shallows of the coast of Victoria. It has been found in the shallows from NE Tasmania to near Perth in Western Australia. *N. altoffi* is distinguished from the other 3 species of *Neoamphicyclus* in the key.

Neoamphicyclus lividus Hickman, 1962

Figure 2f

Neoamphicyclus lividus Hickman, 1962: 58, text figs 53–63, pl. 1 fig. 5.—Hickman, 1978: 29–31, figs 1–14.—Dartnall, 1980: 54, map 16.—Rowe, 1982: 460, 468–469, fig. 10.34b (part).—Rowe and Vail, 1982: 222.—Materia et al., 1991: 301, 306–307 (part; SE Tasmania specimens).—O'Loughlin, 1991: 226, table 1 (part; SE Tasmania specimens).—O'Loughlin and O'Hara, 1992: 227–28, Table 1.—O'Loughlin, 1994: Table 1 (part; SE Tasmania specimens).—Rowe, 1995: 275 (part; SE Tasmania and King I. specimens), (part *Neoamphicyclus materiae* sp. nov. below; non *N. lividus* Hickman, 1962).

Type locality. SE Tasmania, Pirates Bay, Eaglehawk Neck, rocky shallows.

Material examined. SE Tasmania, Bruny I., Adventure Bay, rocky shallows, 11 Jan 1989, NMV F58700 (30); Opossum Bay, rocky shallows, 15 Nov 1982, F58698 (18+7 juveniles); F58707 (1, 5 brood juveniles); Frederick Henry Bay, Carlton Point, Red Ochre Beach, 23 Nov 1968, F132714 (3); Eaglehawk Neck, rocky shallows, 15 Feb 1991, F132711 (33); N Tasmania, King I., Gulchway, S of Surprise Bay, rocky shallows, 10 Mar 1980, F58697 (2); F58699 (5).

Description. *Neoamphicyclus* species up to 35 mm long with maximum diameter 14 mm (preserved; tentacles excluded); perioral papillae digitiform to distally sub-globular, about 0.2 mm long; radial tube feet cross true introvert; gonad tubules with single branch, extend coelom length.

Ossicles. Body wall, introvert, with table disc ossicles only: discs never with spires, irregular in form, table discs decrease in number and size with increase in specimen size; in 6-mm long specimen discs abundant, 40–104 μm wide, 3–13 perforations; in 10 mm-long specimen discs 32–72 μm wide, 3–20 perforations; in 30 mm-long specimen discs sparse, 36–48 μm wide 2–6 perforations. Tube feet with endplates up to 200 μm diameter; few elongate perforated support plates, up to 112 μm long. Tentacles with irregular rods only, perforations distally, lacking rosettes, rods up to 112 μm long. Oral disc with rods only, lacking rosettes. Posterior anal body wall with 5 rudimentary scales (anastomosing calcareous bodies), irregular form, up to 320 μm long.

Reproduction. Sexes separate; coelomic brood protection by females (Hickman, 1978; Materia et al., 1991).

Colour (preserved). Body blue-grey, slate-grey, grey-black, dark grey-brown, dark brown, brown, frequently dark anteriorly and posteriorly; tentacles darker in colour, lacking white patches.

Distribution. SE Tasmania; N Tasmania, King I.; rocky shallows.

Remarks. There are ossicle changes with change in specimen size. In a 10-mm long specimen of *N. lividus* (F132711), the disc plates have 2 forms: typical discs 32–72 μm wide 3–20 perforations; atypical thick perforated plates 96–112 μm wide 9–23 perforations. These perforated plates are not evident in larger specimens. Hickman (1978) illustrated significantly larger table discs with more perforations in coelomic juveniles than larger specimens.

Hickman (1978) and Materia et al. (1991) reported coelomic brood-protection by *N. lividus*. Only *N. lividus* specimens collected in summer months between 15 November and 19 March were reported, with few, large brood juveniles. For *Neoamphicyclus materiae* sp. nov. (below) brood release is principally in October, with a few larger brood juveniles found in females in December. A pattern of seasonal brood protection with most brood juveniles released in spring appears to be the same for *N. lividus* and *N. materiae*. Materia et al. (1991) noted the relatively larger full size of *N. lividus* specimens from SE Tasmania compared with specimens from SE mainland Australia (now *N. materiae* sp. nov. below). *N. lividus* is distinguished from the other 3 species of *Neoamphicyclus* in the key.

***Neoamphicyclus materiae* sp. nov.**

Figures 1e, 2e, 4d

Cucumaria mutans Joshua, 1914: 4, pl. 1 figs 1a–d (part).—Joshua and Creed, 1915: 18 (part).—H.L. Clark, 1938: 444–445 (part) (part non *Cucumaria mutans* Joshua, 1914).

Mensamaria thomsoni.—H.L. Clark, 1946: 406 (part, juvenile forms, non *Mensamaria thomsoni* (Hutton, 1879)).

Neoamphicyclus lividus.—Hickman, 1962: 58 (East Devonport).—Rowe, 1982: 460, 468–469, fig. 10.34b (part).—O’Loughlin, 1984: 151.—Materia et al., 1991: 301, 305–307, tables 4, 5, figs 4, 5 (part; Victoria specimens).—O’Loughlin, 1991: 226, table 1 (part; Victoria specimens).—O’Loughlin and O’Hara, 1992: 227–228, table 1 (part).—O’Loughlin, 1994: table 1 (part; Victoria specimens).—Rowe, 1995: 275 (N Tasmania, except King I., and southern Australia) (non *Neoamphicyclus lividus* Hickman, 1962).

cf. *Neoamphicyclus lividus* Hickman.—Marsh, 1991: 472–473 (non *Neoamphicyclus lividus* Hickman, 1962).

Material examined. Holotype: Victoria, Flinders ocean platforms, E of Mushroom Reef, shallow sub-littoral, under rocks and on algae, T. Megens, M. O’Loughlin, 10 Mar 1980, NMV F132722.

Paratypes: Type locality and date, F76372 (4); SE corner of Mushroom Reef, M. O’Loughlin, 12 Dec 1985, F76360 (11); E of Mushroom Reef, C. Materia, M. O’Loughlin, 9 Oct 1987, F76364 (14).

Other material. New South Wales, 12 km S of Bateman’s Bay, Pretty Point Bay, 11 Aug 1991, F132707 (2). Victoria, syntype of *Cucumaria mutans* Joshua, 1914, F132702 (1; ex F45139, non *C. mutans*); Mallacoota, 21 Jan 1981, F76422 (4); Shack Bay, VNPMS stn 27, rocky subtidal, 4–6 m, 14 Feb 1996, F146573 (1); Cape Paterson, VNPMS stn 2, rocky subtidal, 2 May 1995, F146572 (1); Phillip I., Kitty Miller Bay, 25 Oct 1987, F58590 (17); S of Apollo Bay, Marengo, Hayley Point, 11 Jan 1980, F58720 (7); Killarney, 20 Apr 1983, F76461 (1). N Tasmania, Waterhouse Passage, 26 Feb 1991, F132712 (1); F132718 (1); Lulworth, Black Rock Point, 22 Nov 1982, F132709 (3); Point Sorell, 19 Jan 1989, F58612 (12); E Devonport, 1–14 Jan 1940, TM H2141 (15); Stanley, Godfrey Beach, 30 Nov 1968, F132715 (1); Port Latta, Cowrie Beach, 1 Dec 1968, F132716 (1). South Australia, Cape Northumberland, 4 Jan 2001, F132706 (1); 6 km E of Port MacDonnell, Stoney Point, 19 Mar 1976, F132721 (2); Cape Jervis, 7 m, 21 Feb 1974, F132708 (1); Kangaroo I., Eastern Cove, 16 Jan 1990, F132705 (5); Streaky Bay, Point Westall, 15 Jan 1991, F132720 (4); Ceduna, Cape Vivonne, 14 Jan 1991, F132710 (15); NW of Thevenard, 14 Dec 1991, F66233 (20).

Description. *Neoamphicyclus* species up to 45 mm long with maximum diameter 7 mm (preserved; tentacles excluded);

perioral thick conical papillae; radial tube feet do not cross true introvert; gonad tubules unbranched.

Ossicles. Body wall, introvert, with sparse table ossicles only: table discs mostly irregular in form, rounded to angular, commonly 32–48 μm wide, rarely up to 64 μm wide, perforations commonly 3–7, rarely up to 11; spires typically with 3 pillars, sometimes 2, rarely 4, frequently absent, spires typically 24 μm long; in small 10-mm long specimens tables numerous, discs up to 88 μm wide, up to 24 perforations, indicating decrease in table disc size, number of disc perforations, and density in body wall with increase in specimen size. Tube feet with endplates up to 224 μm diameter; narrow rim of perforated support plates, elongate, frequently 2 large central perforations, about 112 μm long. Tentacles with rods only, irregular, branched or unbranched, distally with or lacking perforations, some H-shaped, rods 48–136 μm long. Oral disc and papillae with rods only, with perforated ends, lacking rosettes. Posterior anal body wall with 5 rudimentary scales (anastomosing calcareous bodies), irregular form with single-layered perforated stem, up to 400 μm long.

Reproduction. Sexes separate; seasonal reproduction; coelomic brood protection by females; up to 528 coelomic juveniles per female; brood release principally in October and November (Materia et al., 1991, as *N. lividus* from Victoria).

Colour (preserved). Body pale to dark blue-grey to grey-brown with fine speckle, dark blue-grey to grey-black anteriorly and posteriorly; introvert pale to dark grey-brown to brown; tentacle dendritic ends pale grey, trunks dark brown; oral disc dark brown.

Distribution. S New South Wales (Bateman’s Bay), Victoria, N Tasmania (excluding King I.), South Australia, S Western Australia (Princess Royal Harbour, Quaranup (Marsh, 1991)); 0–7 m.

Etymology. Named for Christine Materia in appreciation of her great contribution to echinoderm research through dedicated fieldwork and museum curation, and in particular for her contribution to our knowledge about this species.

Remarks. H. L. Clark (1938, 1946) accepted Joshua (1914) and Joshua and Creed (1915) who mistakenly thought that the common small deep blue-black holothurians on the Victorian coast, with sparse tables usually devoid of a spire, were young of *Cucumaria mutans*. These holothuroids are in fact the *Neoamphicyclus materiae* sp. nov. described here, and distinguished from the other 3 *Neoamphicyclus* species in the key. Joshua’s thinking is confirmed by the fact that one of his syntypes of *Cucumaria mutans* is the new species *N. materiae*. Hickman (1962) reported *Neoamphicyclus lividus* from Devonport. This material was examined and most discs have the characteristic spires of *N. materiae*. Marsh (1991) noted the smaller body size and presence of table spires in specimens from Princess Royal Harbour in SW Australia, and reported the material as “cf. *Neoamphicyclus lividus* Hickman”. These specimens are presumed here to be conspecific with *N. materiae* sp. nov.

Neoamphicyclus mutans (Joshua, 1914) comb. nov.

Figures 1b, 2d, 4e

Cucumaria mutans Joshua, 1914: 4, pl. 1 figs 1a–d (part).—Joshua and Creed, 1915: 18 (part).—H. L. Clark, 1938: 444–445 (part).

Mensamaria thomsoni.—H.L. Clark, 1946: 406 (adult forms; non *Mensamaria thomsoni* (Hutton, 1879).

Cucumella mutans.—Heding and Panning, 1954: 67–68.—A. M. Clark, 1966: 348–349.—Dartnall, 1980: 54, pl. 5, fig. 31, map 16.—Rowe, 1982: 460, 468, fig. 10.34a.—O'Loughlin, 1984: 151.—O'Loughlin and O'Hara, 1992: 227–29.—Rowe, 1995: 273.

Type locality. Victoria, Western Port.

Material examined. *Cucumaria mutans* Joshua, 1914. Lectotype (nominated here). Western Port, Jan 1912, NMV F45138.

Paralectotypes (nominated here): Type locality and lot, F132723 (1); Victoria, F45139 (1).

Remaining syntypes: Specimen removed from F45139 redetermined as *Neoamphicyclus materiae* sp. nov. (F132702); second specimen removed from F45139 determined as *Neoamphicyclus* sp. (F132719; ossicles completely eroded); Western Port, F45140 (microscope slide).

Other material. Victoria, Walkerville, 6 Mar 1982, F76209 (2); Shack Bay, VNPMS stn 27, 4–6 m, 14 Feb 1996, F146578 (1); Western Port, Joshua, Jan 1912, F76477 (1); Crib Point Benthic Survey, 2 m, 13 Apr 1965, F76640 (1); Shoreham, 30 Mar 1902, F76083 (1); McHaffies, 7 Feb 1970, F45246 (1); Flinders, ocean platforms, 22 Jan 1982, F76076 (2); 17 Feb 1990, F76609 (6); Port Phillip Bay, southern, 38°17' S, 144°38' E, 3–6 m, 30 Mar 1986, F136913 (3); Cheltenham beach, 20 Jul 1891, F76085 (6). N Tasmania, Waterhouse Passage, 26 Feb 1991, F146576 (9); Tamar R., Greens Beach, 3 May 1986, F146577 (8); Point Sorell, 19 Jan 1989, F146579 (2); King I., 9 Mar 1980, F146575 (2). South Australia, Victor Harbor, 9 Nov 1988, F146574 (1); Glenelg, Jul 1979, F76089 (1); Kangaroo I., NE Eastern Cove, rocky shallows, 16 Jan 1990, F136915 (1); Emu Bay, 17 Jan 1990, F136916 (1); Port Lincoln, North Shore, 14 Feb 1970, F136912 (1); dredged, Jan 1968, F136914 (1); Streaky Bay, Point Westall, Smooth Pool, 15 Jan 1991, F109315 (3). Western Australia, Perth, Cottesloe, *Sargassum* beds, 6 Feb 2007, WAM Z37473 (1).

Description. *Neoamphicyclus* species up to 60 mm long with maximum diameter 25 mm (preserved; tentacles excluded); perioral blunt to thick conical papillae; paired single radial series of tube feet usually cross true introvert, sometimes only a few present; gonad tubules not branched.

Ossicles. Body wall, introvert, with abundant table ossicles only: table discs sometimes regular (sub-triangular with 3 large 3 small perforations), mostly irregular in form, disc size range 72–136 μm wide, frequently about 112 μm wide; perforations 6–23; pillars 3–5, predominantly 3, typically 48 μm long. Tube feet with endplates up to 320 μm diameter; few elongate, irregular, perforated support plates, about 168 μm long. Tentacles with rods, rosettes both basally and distally, tables, and intergrading forms up to 184 μm long; rods plate-like, perforated, irregular in form; rosettes plate-like with small close perforations, largest with large central perforations, some with secondary layer developments, rosettes up to 136 μm long; table discs 44–88 μm wide, 4–20 perforations, 2–4 pillars. Posterior anal body wall with 5 rudimentary scales (anastomosing calcareous bodies), irregular form, up to 520 μm long.

Colour. Live: body violet-grey to blue-grey, frequently with some purple colouration, darker anteriorly and posteriorly. Preserved: body pale to dark brown, to brown-grey, to blue-grey, to violet-black, darker anteriorly and posteriorly; introvert brown to off-white; tentacle trunks pale grey, brown flecks, white lumps, lacking basal white band; tentacle dendritic branches dark brown; disc with brown markings.

Distribution (this work). Victoria, W of Wilsons Promontory (Walkerville), N Tasmania, to SW Western Australia (Perth); 0–6 m.

Remarks. H. L. Clark (1938) judged material from Bunkers Bay (Margaret River) and Cottesloe (Perth) in SW Australia to be *Cucumaria mutans* Joshua, 1914. This material was not examined here and confirmed as *N. altoffi* sp. nov. or *N. mutans* (Joshua). Subsequently H. L. Clark (1946) synonymised *Cucumaria mutans* Joshua, 1914 with *Mensamaria thomsoni* (Hutton, 1879), and referred material from the western side of the Great Australian Bight (165 m), Bunkers Bay and Perth to this species. The specimen from the Great Australian Bight was not examined here and confirmed as *N. altoffi* or *N. mutans*. H. L. Clark (1946) commented that “further study of this holothurian in New Zealand, Victoria and Western Australia may show that at least 2 and possibly 3 species are at present confused under one name”. Later Heding and Panning (1954) raised *Cucumaria mutans* Joshua, 1914 out of synonymy, and reassigned the species to *Cucumella* Ludwig and Heding, 1935. This decision was based on an erroneous assessment of tentacle number, as discussed under *Neoamphicyclus* Hickman (above), and *C. mutans* is re-assigned here to *Neoamphicyclus*.

As indicated in the material examined a lectotype and paralectotypes are nominated here. One syntype specimen is determined as *Neoamphicyclus materiae* sp. nov., and one syntype specimen with completely eroded ossicles can no longer be determined to species and remains *Neoamphicyclus* sp. Hickman (1962) reported *Cucumella mutans* from SE Tasmania (Derwent Estuary; TM H2139). The specimens were re-examined here and determined as *N. altoffi* sp. nov. (above). No specimens of *N. mutans* from southern Tasmania have been seen in this work. Marsh and Pawson (1993) determined “with some doubt” as *Cucumella mutans* (Joshua, 1914,) a small specimen (7 mm long), lacking tentacles, from 30 m at Rottne I. (SW Australia). The form of the body wall tables is illustrated, and has some resemblance to those of *N. mutans*, but the average disc diameter (49 μm) is significantly smaller. Tables with curved discs from tube feet are illustrated, and these have not been found in *N. mutans*. Many specimens from across southern Australia, previously identified as *Cucumella mutans*, are recognized in this work as a new *Neoamphicyclus* species (*N. altoffi* sp. nov., above). *N. mutans* is distinguished from the other 3 species of *Neoamphicyclus* in the key.

Neocucumella Pawson, 1962

Neocucumella Pawson, 1962: 65.—Pawson, 1963: 22.—Pawson, 1970: 31.—O'Loughlin and O'Hara, 1992: 250 —Rowe, 1995: 276.

Type species. *Pseudocucumis bicornatus* Dendy and Hindle, 1907 (originally monotypic).

Other species. *Neocucumella fracta* O'Loughlin and O'Hara, 1992; *N. turnerae* O'Loughlin, sp. nov.

Diagnosis. See emended diagnosis in O'Loughlin and O'Hara (1992).

Distribution. New Zealand (7–239 m; Pawson, 1970); SE Australia (SE Tasmania; Derwent Estuary; Bass Strait; Spencer Gulf; 10–110 m).

Neocucumella turnerae sp. nov.

Figures 1f, 2b, 4f

Material examined. Holotype: SE Tasmania, Derwent Estuary, Blackmans Bay, on beach after storm, E. Turner, 12 Jun 1988, TM H3295.

Paratypes: Type locality and date, TM H3296 (10).

Other material. Type locality and date, TM H1983 (33); SS02/2007 stn 2, 146.98°E, 43.69°S, 100–110 m, 29 Mar 2007, F136939 (1).

Description. Up to 60 mm long (preserved, tentacles partly extended), maximum diameter 8 mm; body form subcylindrical, long, thin, tapering orally and anally; ring of 20 dendritic tentacles, 5 pairs of large interradial, 5 pairs of small radial; lacking collar of papillae around tentacle ring; tube feet in 5 paired radial series, continuous across true introvert; dense collar of about 100 conspicuous pointed perioral papillae; 5 radial pairs of minute perianal papillae; ring not composite, lacks posterior prolongations; radial plates subrectangular, anterior notch, posterior notch with short projections upturned; interradial plates small, inverted V shape; dorsal twisting stone canal (1 mm long), with bean-like madreporite (1 mm long); 3 ventral long thin tubular polian vesicles up to 20 mm long; longitudinal muscles broad, flat, undivided; tufts of long, thin unbranched gonad tubules on each side of dorsal mesentery; respiratory tree weakly dendritic, extending coelom length to vascular ring.

Ossicles. Mid-body wall, introvert, lacking ossicles (except tube feet). Tube feet: endplates up to 240 μ m diameter, slightly smaller perforations centrally; few perforated support plates, typically 96 μ m long, 2 large perforations centrally, smaller perforations distally, denticulate on one side, form narrow rim around endplate; fine rods, thin, straight, perforated distally, typically 80 μ m long; rosettes in tube feet of introvert. Tentacles: smooth rods, distally perforated or bifurcate, up to 120 μ m long. Oral disc: densely branched rosettes, up to 64 μ m long, irregularly oval. Oral papillae: rosettes intergrading with unbranched and distally branched and intertwined irregular rods, variably perforated. Posterior anal body wall: 5 rudimentary scales (anastomosing calcareous bodies), irregularly oval to elongate, up to 240 μ m long; smooth distally perforated rods, up to 64 μ m long; irregular oval table-like discs, up to 48 μ m long, lacking spires.

Colour. Colour in life “pale pink” (E. Turner pers. comm.). Preserved colour of body and tube feet off-white; tentacles dark to pale brown to off-white; dark brown flecking on oral disc.

Distribution. SE Tasmania, Derwent Estuary, sediment; sublittoral to 110 m.

Etymology. Named for Mrs Elizabeth Turner, of the Tasmania Museum and Art Gallery, for her gracious assistance with loans and data over many years, and for collecting most of the specimens of this new species.

Remarks. Pawson (1962) erected the monotypic genus *Neocucumella* for the New Zealand species *Pseudocucumis bicornatus* Dendy and Hindle, 1907. O'Loughlin and O'Hara (1992) added *Neocucumella fracta* for SE Australia, and discussed the generic diagnosis. *Neocucumella turnerae* sp. nov. has the tentacle number and form, tube feet arrangement, tube feet ossicle forms, and distinctive calcareous ring of *Neocucumella*, but is unique and exceptional in completely lacking table ossicles. Such a significant diagnostic difference suggests the desirability of erecting yet another cucumariid genus, but I judge that this should not be done until appropriate molecular data is available for a revision of *Neocucumella* Pawson and related genera.

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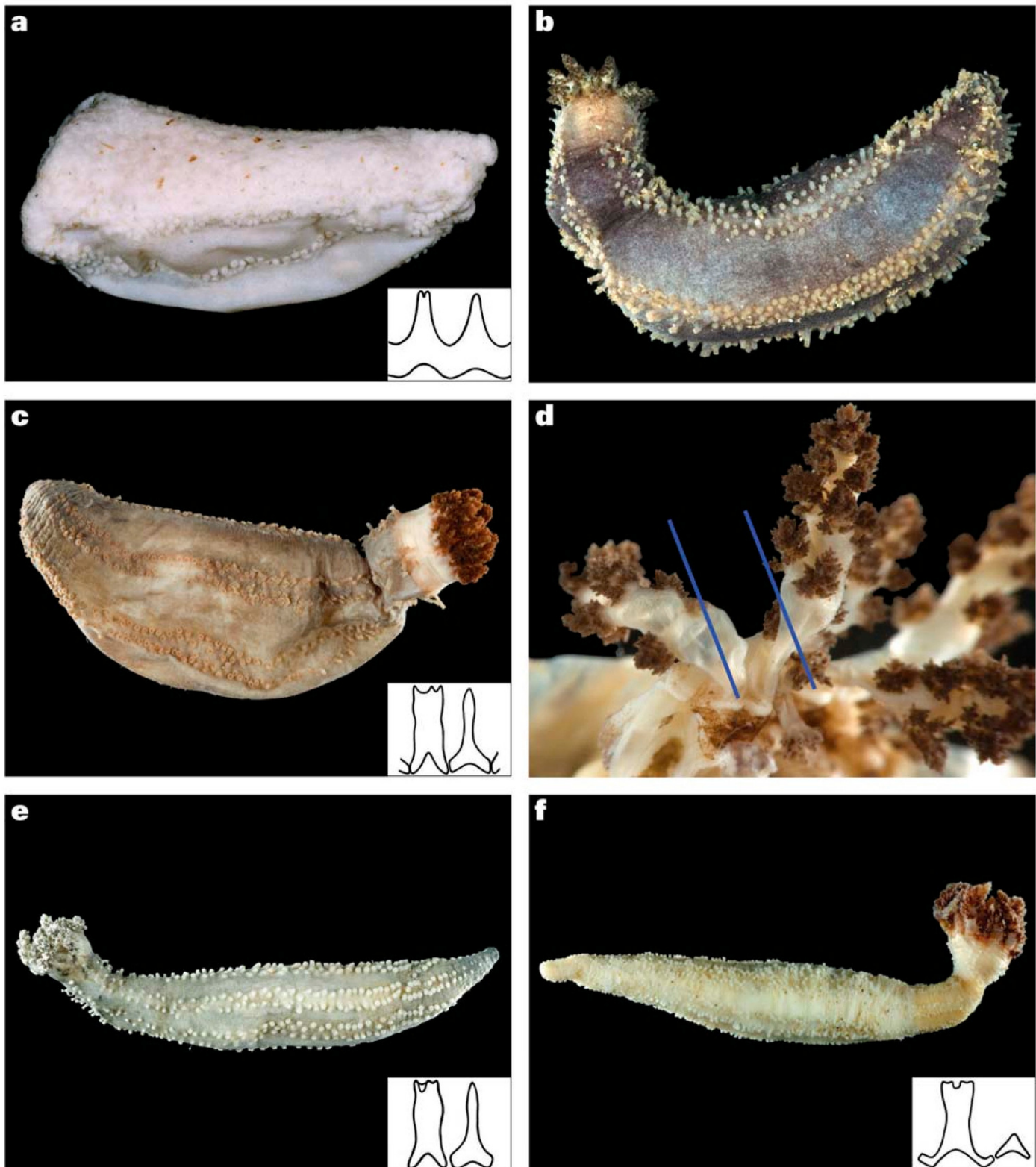


Figure 1. a, *Apsolidium falconerae* sp. nov., holotype, from Phillip I., NMV F109375, preserved, 34 mm long, lateral view showing thick calcareous dorsal and lateral body, thin-walled sole, mid-ventral radial tube feet; insert with radial (left) and interradial (right) plates of calcareous ring. b, *Neoamphicyclus mutans* (Joshua, 1914), live colour, collected by Mark O'Loughlin from Flinders ocean platforms on 13 February 2007, 60 mm long, lateral view, NMV F123862. c, *Neoamphicyclus altoffi* sp. nov., holotype, from Fremantle, WAM Z279-92, preserved, 33 mm long, dorso-lateral view; insert with radial (left) and interradial (right) plates of calcareous ring. d, *Neoamphicyclus altoffi* sp. nov., tentacles showing white calcareous band of ossicles at base, NMV F132704. e, *Neoamphicyclus materiae* sp. nov., holotype, from Flinders, NMV F132722, preserved, 35 mm long, ventral view; insert with radial (left) and interradial (right) plates of calcareous ring. f, *Neocucumella turnerae* sp. nov., holotype, from Derwent estuary, TM H3295, preserved, 46 mm long; insert with radial (left) and interradial (right) plates of calcareous ring.

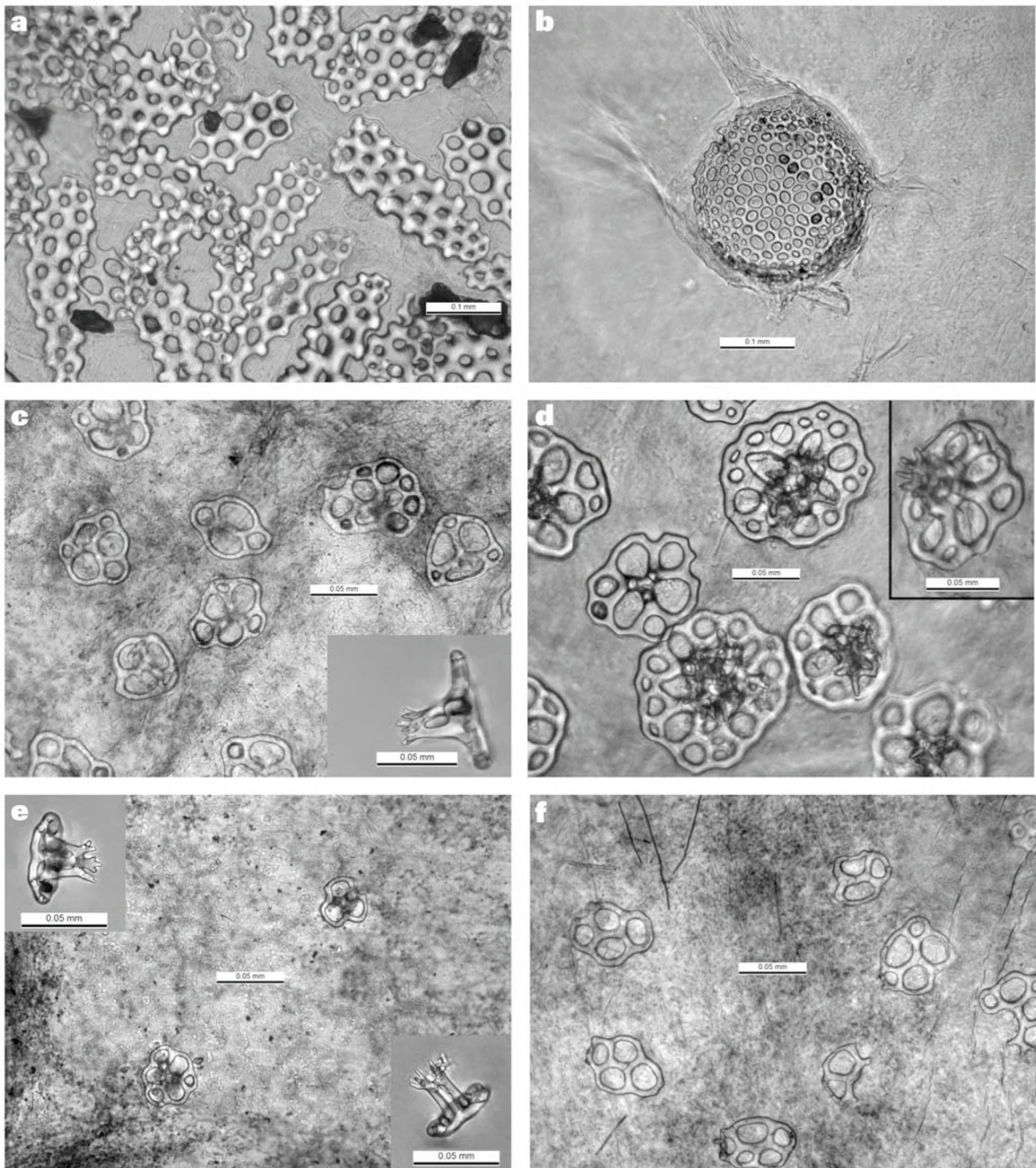


Figure 2. Body wall mounts. a, *Apsolidium falconerae* sp. nov., holotype, NMV F109375, knobbed plates in ventral body wall. b, *Neocucumella turnerae* sp. nov., paratype, TM H3296, endplate in ventral body wall; absence of other ossicles. c, *Neoamphicyclus altoffi* sp. nov., holotype, WAM Z279-92, table discs in body wall; insert with lateral view of table showing spire, NMV F132704. d, *Neoamphicyclus mutans* (Joshua, 1914), NMV F109315, table discs in body wall; insert showing table spire. e, *Neoamphicyclus materiae* sp. nov., paratype NMV F76360, table discs in body wall; inserts with lateral view of tables showing spires, paratype, NMV F76364. f, *Neoamphicyclus lividus* Hickman, 1962, table discs in body wall, NMV F58698.

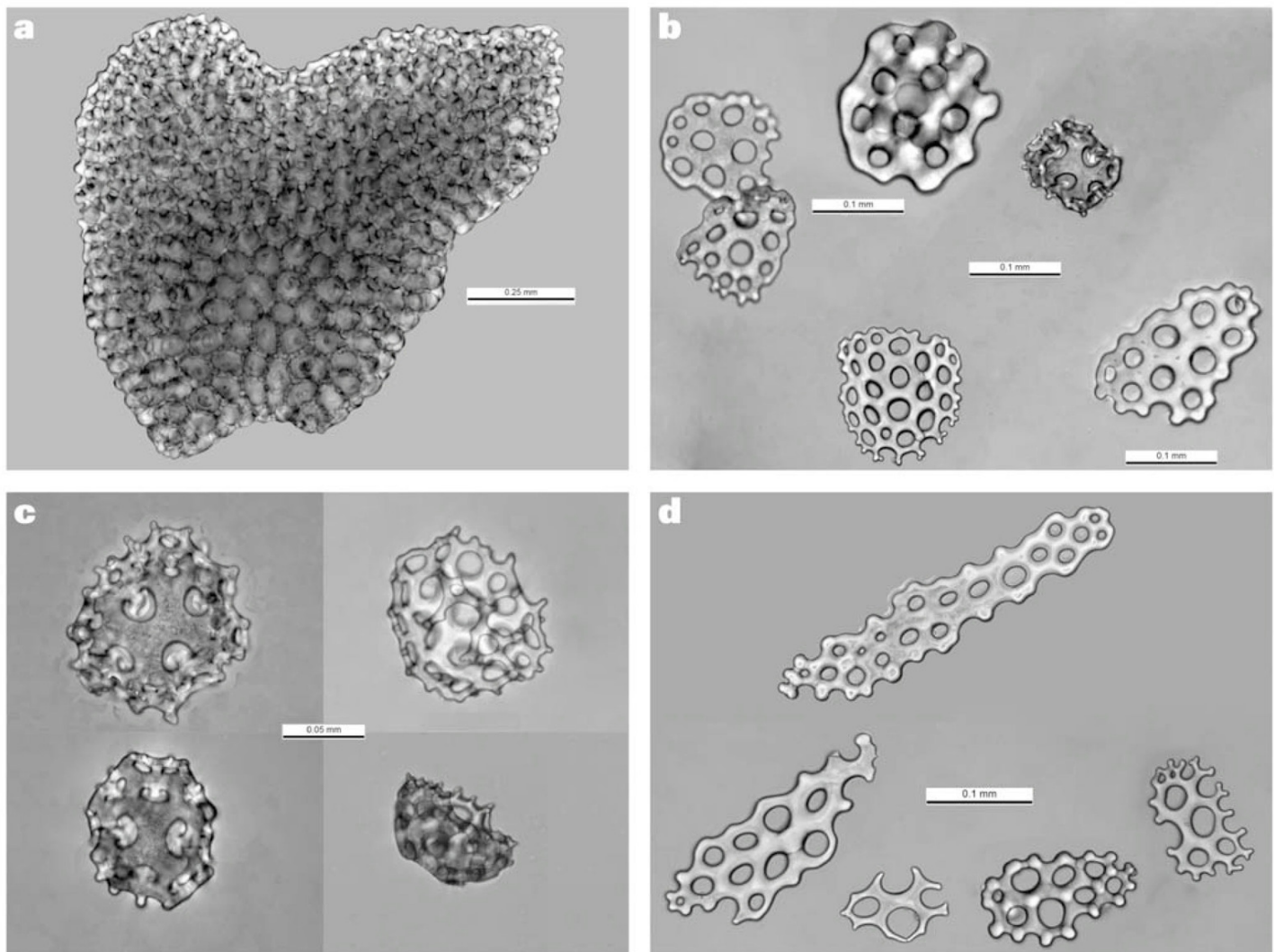


Figure 3. *Apsolidium falconerae* sp. nov., ossicles, holotype, NMV F109375. a, scale (multilayered ossicle) from dorsal body wall. b, dorsal body wall; knobbed button and cup (top right); 4 perforated tube foot support plates. c, partially “closed” cups from dorsal body wall; 2 views of cross at base of cups (left); view of partially closed top of cup (upper right); lateral view of cup (lower right). d, ventral body wall (sole); elongate knobbed plate (upper); 4 tube foot support plates (lower).

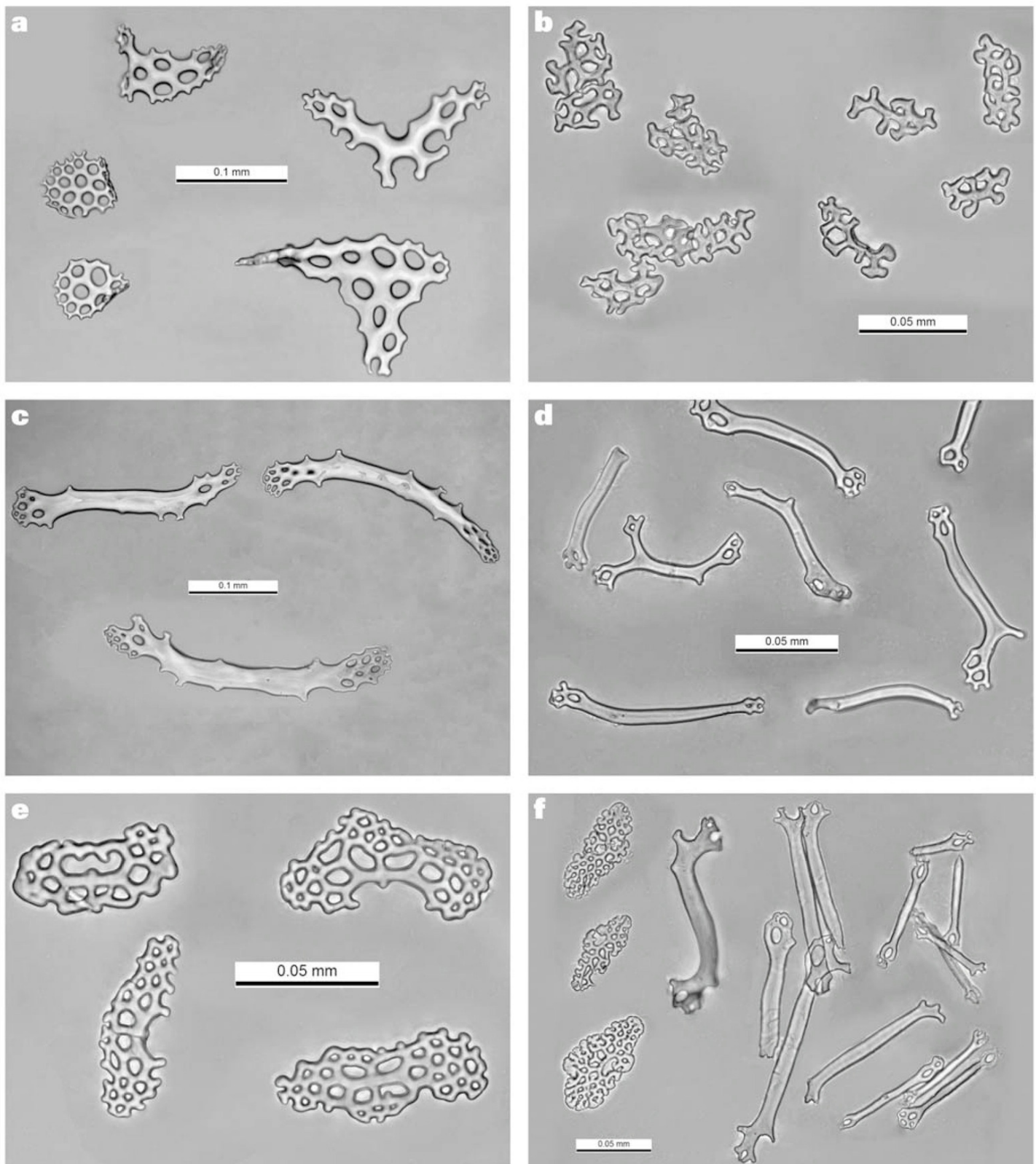


Figure 4. Tentacle ossicles. a, *Apsolidium falconerae* sp. nov., holotype, NMV F109375, perforated plates and rods. b, *Neoamphicyclus altoffi* sp. nov., rosettes from lower tentacle (base), NMV F132704. c, *Neoamphicyclus altoffi* sp. nov., rods from upper tentacle, NMV F132704. d, *Neoamphicyclus materiae* sp. nov., paratype, NMV F76364, rods. e, *Neoamphicyclus mutans* (Joshua, 1914), NMV F109315, rosettes from upper tentacle. f, *Neocucumella turnerae* sp. nov., paratype, TM H3296; rosettes from disc and oral papillae (left); rods from tentacles (right).



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