



## The Recent Pectinoidea of the New Zealand region (Mollusca: Bivalvia: Propeamussiidae, Pectinidae and Spondylidae)

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### Abstract

The Recent Pectinoidea of the New Zealand region are reviewed. Eight new species are described from the New Zealand Exclusive Economic Zone: *Parvamussium cancellorum*, *Cycloclamys austrina*, *Cc. delli*, *Cc. irregularis*, *Cc. munida*, *Cc. pileolus*, *Cyclopecten fluctuosus*, and *Catillopecten tasmani*. Nine species are new records for New Zealand: *Parvamussium retiolum* Dijkstra, 1995, *Pa. vesiculatum* Dijkstra, 1995, *Sinepecten segonzaci* Schein, 2006, *Cyclopecten fluctuatus* (Bavay, 1905), *Pseudamussium challengerii* (E.A. Smith, 1891), *Spondylus occidentis* G.B. Sowerby III, 1903, *S. proneri* Lamprell & Healy, 2001, *S. sparsispinosus* Dall, Bartsch & Rehder, 1938, and *S. jamarci* Okutani, 1983. *Cycloclamys bacata* and *Cc. wanganellica* are described from Wanganella Bank, West Norfolk Ridge, and *Cyclopecten textus* from the Lord Howe Rise. We provide new distribution records for *Catillopecten murrayi* (E.A. Smith, 1885), *Spondylus asperrimus* G.B. Sowerby II, 1847 and *S. proneri* in the south-west Pacific. *Cyclopecten aupouria* Powell, 1937 and *Cp. mestayerae* Dell, 1956 are newly referred to genus *Cycloclamys* Finlay, 1926; *Pecten challengerii* E.A. Smith, 1891 is referred to *Pseudamussium* Mörch, 1853. *Bathypecten* Schein-Fatton, 1985 is newly synonymised with *Catillopecten* Iredale, 1939; and *Chlamys consociata* E.A. Smith, 1915 is newly synonymised with *Talochlamys dichroa* (Suter, 1909). Brooding is recorded for the first time in *Cycloclamys*, and is also the first record in Propeamussiidae. Pronounced sculptural change in response to settlement of sponge on the shell is recorded in *Talochlamys dichroa* and *Zygochlamys delicatula*.

**Key words:** new taxa, new records, new synonymies, distribution, sponge-scallop mutualism

### Introduction

Since the recording of *Pecten laticostata* by Gray (1835) (= *P. novaezelandiae* Reeve, 1852) from New Zealand, the number of Pectinoidea (scallops and their relatives) known from the New Zealand region has steadily increased, particularly as a result of greatly increased sampling effort during the last four decades (Hutton 1873a, 1880; Suter, 1904; Suter 1913; Powell 1937b, 1946, 1957, 1962, 1976, 1979; Spencer and Willan 1996; Dijkstra and Marshall 1997; Spencer *et al.* 2006; Spencer *et al.* in press). In the following review of the Pectinoidea of the New Zealand Exclusive Economic Zone (NZEEZ—territory bounded at 200 miles) and adjacent waters, we record all of the 54 species known to us. These comprise 30 species of Propeamussiidae, 17 Pectinidae and seven Spondylidae. Of these, 50 species occur within the NZEEZ (27 propeamussiids, 17 pectinidae, 6 spondylids). In an earlier contribution, Dijkstra and Marshall (1997), recorded Pectinoidea of Lord Howe Island (7 pectinids), Norfolk Island (5 propeamussiids and 8 pectinids) and the Kermadec Islands (9 propeamussiids and 5 pectinids). Dijkstra and Marshall (1997) chose to omit Spondylidae, but all members of this group known to us from the region are recorded here.

Terminology of the pectinoidean shell, and classification adopted follows Waller (1986, 1991, 1993, 2006), which has been supported in a mDNA study by Matsumoto and Hayami (2000).

### Material and methods

All material at Museum of New Zealand Te Papa Tongarewa, and National Institute of water and Atmospheric Research, Wellington was examined, together with relevant type material from various museums. Height precedes width in all given dimensions. Small shells were carefully cleaned by brushing and sonication after soaking in a wetting agent (trisodium phosphate), and mounted on electrically conductive double-sided, adhesive carbon tabs together with colloidal carbon paint. Images of shells (coated with carbon and gold/palladium) were captured by a LEO 440<sup>®</sup> scanning electron microscope (SEM) and a digital camera (uncoated shells) and processed in Adobe Photoshop<sup>®</sup>.

Abbreviations and acronyms. AIM—Auckland Institute and Museum, Auckland; AMS—The Australian Museum, Sydney; BMNH—The Natural History Museum, London; CM—Canterbury Museum, Christchurch; MNHN—Muséum National d’Histoire Naturelle, Paris; NIWA—National Institute of Water and Atmospheric Research, Wellington; NMNZ—Museum of New Zealand Te Papa Tongarewa, Wellington; NZEEZ—New Zealand Exclusive Economic Zone (200 mile limit); NZGS—Institute of Geological and Nuclear Sciences, Lower Hutt; PI—prodissoconch I; PII—prodissoconch II; ZMA—Zoological Museum, Amsterdam; ZMH—Zoologisches Institut und Museum der Universität Hamburg; ZMUC—Zoological Museum, University of Copenhagen; ZSI—Zoological Survey of India, Calcutta; lv—left valve (upper valve); pr—pair of matching (articulated) valves; rv—right valve (lower

valve); v—valve(s). Unless specified, all material examined is at NMNZ (registration numbers preceded by “M.”).

## Systematics

### Superfamily PECTINOIDEA Rafinesque, 1815

#### Remarks

Formerly attributed to Wilkes (1810), but Wilkes' work is not completely binominal. We herein follow Coan *et al.* (2000: 211) and Waller and Stanley (2005: 38).

### Family PROPEAMUSSIIDAE Abbott, 1954

#### Diagnosis

Free or weakly byssate Pectinoidea with outer foliated calcitic layer on left valve and prismatic calcitic layer on main part of right valve disc. Inner layer crossed-lamellar aragonite beyond pallial line, in some species nearly to distal margins. Byssal notch without ctenolium.

### Genus *Propeamussium* de Gregorio, 1884

*Propeamussium* de Gregorio, 1884: 119. Type species (by original designation): *Pecten (Propeamussium) ceciliae* de Gregorio, 1884; Miocene, Sicily.

#### Diagnosis

Propeamussiidae with opaque or translucent, fragile, circular to subcircular shell, up to ca. 80 mm in height, laterally compressed; exterior of left valve smooth or weakly radially and/or commarginally sculptured, right valve with weak commarginal sculpture. Auricles of equal size or nearly so. Byssal notch weak, no ctenolium. Internal riblets commence in early ontogeny and extend to central or submarginal region.

#### Distribution

Jurassic to Recent. Atlantic and Pacific oceans at bathyal and abyssal depths.

### *Propeamussium investigatoris* (E.A. Smith, 1906)

Figs 1, 2A–E

*Amussium investigatoris* Smith, 1906: 255.

*Amussium margaritifera* Dautzenberg & Bavay, 1912: 36, pl. 27, figs 15–18.

*Parvamussium maorum* [sic].—Dell, 1963a: 206 (not *P. maorium* Dell, 1956).

*Propeamussium maorium*.—Dijkstra, 1995: 18, figs 11–14; Dijkstra & Marshall, 1997: 77, pl. 2, figs 1–5 (both not *P. maorium* Dell).

*Propeamussium investigatoris*.—Dijkstra & Kastoro, 1997: 248, figs 11–15; Dijkstra, 2001: 75, figs 1–4.

#### Type material

*Amussium investigatoris*: lectotype (Dijkstra and Kastoro 1997: 250) ZSI M835/1; W of Karala (Travancore), India, 08° 37'N, 75°37'E, alive, 410–519 m, 17 Oct. 1898, HMIMSS *Investigator* (stn 248). *Amussium margaritifera*: holotype ZMA Moll. 3.12.021, channel between Makjan and

Halmaheira, Moluccas [Maluku], Indonesia, 0°23.8'N, 127°29'E, alive, 472 m, 3 Aug. 1899, HM *Siboga* (stn 137).

#### Material examined

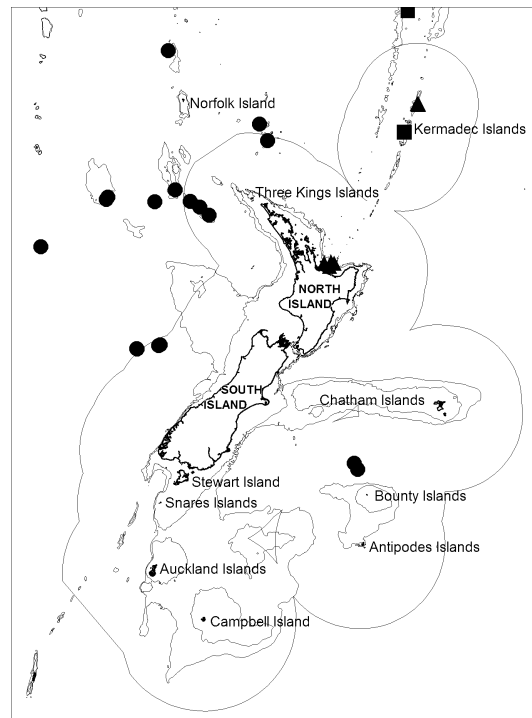
The type material (see above). Off Raoul Island, Kermadec Islands: 1.8 km NW of Napier Island, 29°13.96'S, 177°52.84'W, alive, 567–530 m (4 pr, 5 v, M.226571); SE of Chanter Islets, 29°16'S, 177°49.3'W, alive, 585–512 m (3 pr, 2 v, M.225361); SE of Chanter Islets, 29°16.5'S, 177°49.5'W, 512–549 m (6 pr, 12 v, M.225611). Rangatira Knoll, NW of White Island, 37°17.4'S, 176°53.6'E, alive, 337–292 m (3 pr, M.74790). Off Mayor Island: 37°20.6'S, 176°28.0'E, alive, 482–550 m (2 pr, 10 v, M.107566); 37°22.0'S, 176°28.5'E, alive, 448–388 m (1 pr, M.60093). Mahina Knoll, NNW of White Island, 37°21.6'S, 177°04.8'E, 418–477 m (3 v, M.59937). NE of Plate Island, 37°30'S, 176°48'E, 621–603 m (10 v, M.16282).

#### Description

Supplementary to that of Smith (1906). Prodissoconch 190 µm long, smooth, D-shaped, convex, rim narrowly flanged, sharply separated from dissoconch by fine groove. Early dissoconch of both valves with no microsculpture.

#### Distribution

Northern Indian Ocean, Indonesia, Coral Sea, New Caledonia, Loyalty Islands, Vanuatu, Norfolk Island, Kermadec Islands, and (new record) NE North Island, New Zealand, living at 176–660 m. New Zealand region specimens at 292–621 m; taken alive at 337–585 m from hard substrata (Fig. 1).



**FIGURE 1.** Map showing location of main localities in the New Zealand region (NZEEZ boundary and 500 and 1000 metre isobaths indicated), and distributions of ▲ *Propeamussium investigatoris* (E.A. Smith, 1906), ● *Propeamussium meridionale* (E.A. Smith, 1885), and ■ *Propeamussium sibogai* (Dautzenberg & Bavay, 1904).

## Remarks

The present material is similar to the type specimens from the Laccadive Sea, although the radial riblets of the left valve are more widely spaced and more variable in size, ranging from strong to very weak or almost obsolete: commarginal sculpture is also weaker. Specimens from off the Bay of Plenty consistently have weaker left valve sculpture than specimens from elsewhere in the range, though other characters are accordant.

Compared with the superficially similar species *Pr. jeffreysii* (E.A. Smith, 1885), from the Philippines, *Pr. investigatoris* differs in having more prominent regularly spaced radial lirae and commarginal lamellae (Dijkstra and Kastoro 1997: 250).

Misidentification of *Propeamussium investigatoris*

from the Bay of Plenty and the Kermadec Islands as *Parvamussium maorum* [sic] by Dell (1963a), and *Propeamussium maorium* by Dijkstra and Marshall (1997), respectively, influenced the latter authors to transfer *Pa. maorium* from *Parvamussium* to *Propeamussium*. Whereas juveniles of *Pr. investigatoris* with weak sculpture are easily confused with adult specimens of *P. maorium*, *Pr. investigatoris* attains larger size (height up to 22 mm, versus 17 mm), has a relatively smaller anterior auricle, has the two auricles more equal in size, has a much smaller byssal notch, and has the left valve strongly sculptured with prominent angular radial ribs. The left valve is orange, the right valve whitish. The two species are sympatric off the north-eastern North Island, though asyntopic.

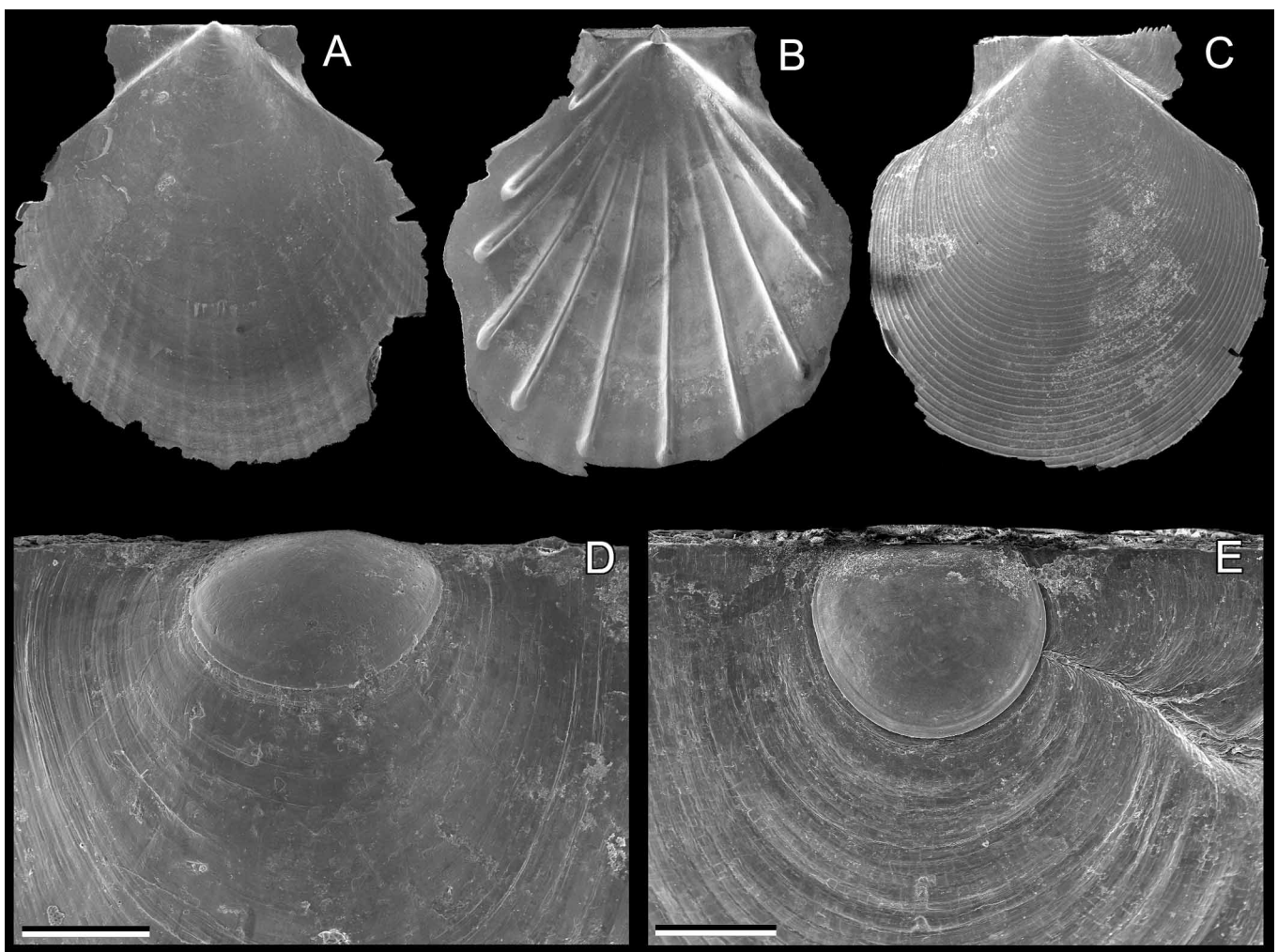


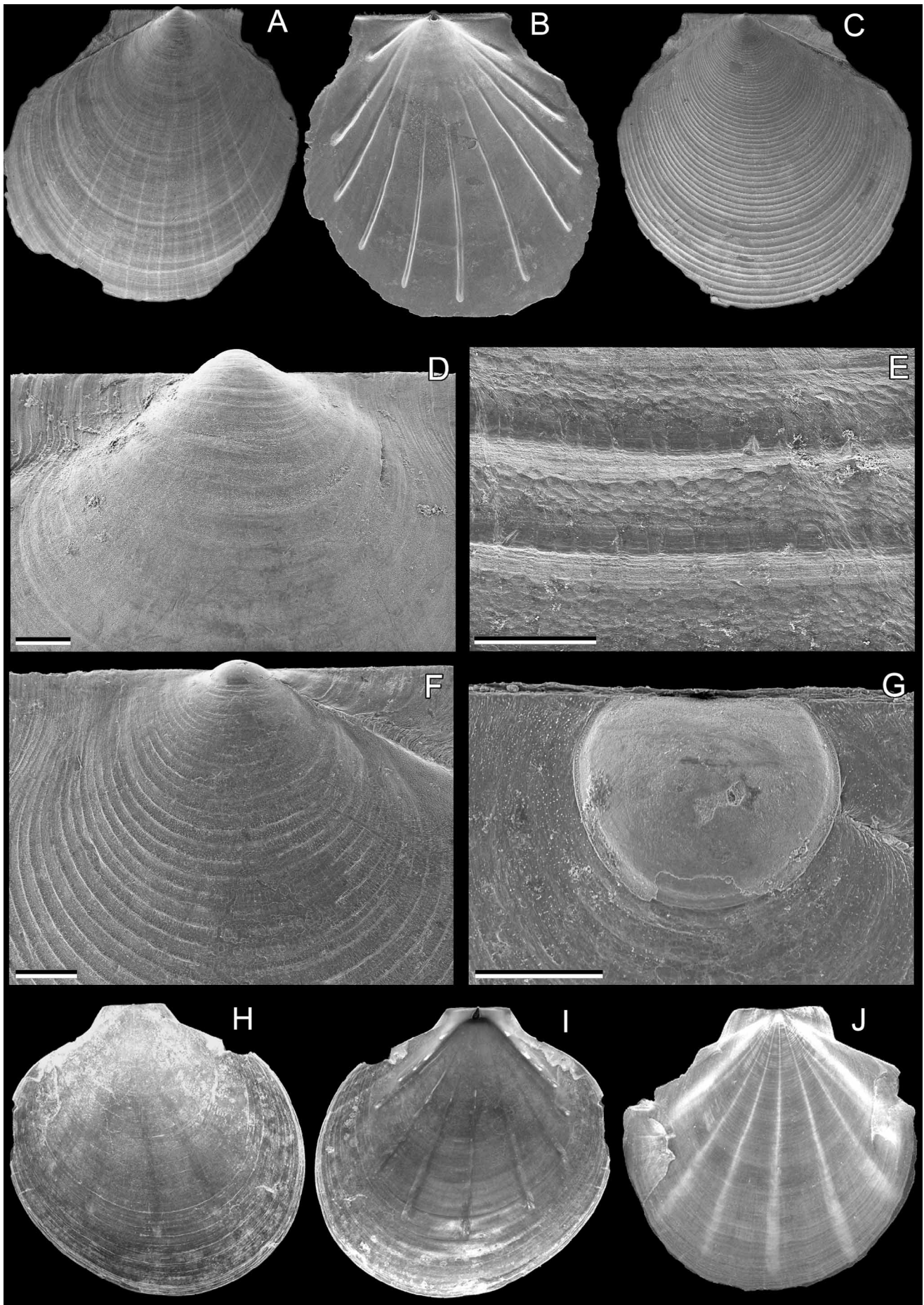
FIGURE 2. Propeamussiidae. *Propeamussium investigatoris* (E.A. Smith, 1906). **A, C.** Off Mayor Island: 482–550 m, M.107566 (**A**, lv, height 11.5 mm; **C**, rv, 12.2 mm). **B, D, E.** Off Mayor Island, 388–448 m, M.60093 (**B, D**, lv, height 12.9 mm; **E**, rv). Scale bars 100  $\mu$ m.

***Propeamussium meridionale* (E.A. Smith, 1885)**

Figs 1, 3A–G

*Amussium meridionale* Smith, 1885: 316, pl. 24, figs 1–1a.  
*Amussium meridionale*.—Knudsen, 1967: 277, pl. 1, fig. 16, textfig. 17.  
*Propeamussium meridionale*.—Grau, 1959: 12, pl. 1; Knudsen, 1970: 94 (in part = *P. malpelonium* (Dall, 1908)), pl. 12, figs 5–

9, text fig. 58; Hicks & Marshall, 1985: 227 (diet); Dell, 1990: 37; Dijkstra, 1995: 19, figs 15–18, 143–146; Dijkstra, 2001: 78; Okutani & Kawamura, 2002: 12, figs 4C, 5C.  
*Propeamussium* (*Propeamussium*) *meridionale*.—Dijkstra, 1990a: 2, 9, pl. 1, figs 1–2.  
*Varlamussium* [sic] *meridionale*.—Powell, 1960: 175.  
*Verlamussium* [sic] *meridionale*.—Clarke, 1962: 60.



**FIGURE 3.** Propeamussiidae. **A–G.** *Propeamussium meridionale* (E.A. Smith, 1885), Bounty Trough, 2780 m, M.158324 (A, D, lv, height 8.95 mm; B, lv, height 8.50 mm; C, E–G, rv, height 8.90 mm). **H–J.** *Propeamussium sibogai* (Dautzenberg & Bavay, 1904), S New Caledonia, 490–510 m, MNHN, BERYX 11 stn CP 22 (H, I, lv, height 55.1 mm; J, rv, height 43 mm). Scale bars 200  $\mu$ m (D–F) and 100  $\mu$ m (G).



## Type material

Lectotype (Dijkstra 1995: 19) BMNH 1887.2.9.3337, southern Indian Ocean, 50°01'S, 123°00'E, alive, 3292 m, 7 Mar. 1874, HMS *Challenger* (stn 158). Paralectotypes (2) BMNH 1887.2.9.3335/1–2.

## Material examined

The lectotype (see above). Norfolk Ridge, N of Norfolk Island, 26°22.8'S, 167°01.5'E, 1017–1035 m (5 v, M.171040). West Norfolk Ridge: S of Norfolk Island, 33°42.4'S, 167°27.0'E, alive, 1451–1478 m (1 pr, 1 v, M.160784); W of Cape Reinga, 34°17.8'S, 168°21.5'E, 1251–1268 m (6 v, M.171135); W of Cape Reinga, 34°34.9'S, 168°55.5'E, 1000–1150 m (many v, M.171033); WSW of Cape Reinga, 34°59.6'S, 169°28.9'E, alive, 1266–1270 m (1 pr, M.160809). Three Kings Islands Rise: 31°19.9'S, 173°05.1'E, 1563–1570 m (4 v, NIWA U601); 30°32.3'S, 172°55.3'E, 1097–1082 m (10 v, M.274120; many v, NIWA U593). Lord Howe Rise: 34°09.8'S, 163°36.7'E, 1186 m (1 v, NIWA U197); 34°12.4'S, 163°17.2'E, alive, 1076–1083 m (1 pr, M.172057); 34°31.5'S, 166°21'E, 2928–2930 m (3 v, NIWA U195). S of Lord Howe Island, 36°55.7'S, 159°31.5'E, alive, 4954–4981 m (1 pr, M.274121; 10 pr, NIWA U224). Tasman Basin: 41°20.4'S, 166°54.8'E, alive, 1760–1799 m (1 juvenile pr, 2 v, NIWA P939); 41°22.7'S, 166°44.4'E, 2092–2154 m (5 v, NIWA P940); 41°37.0'S, 165°11.0'E, alive, 4439–4441 m (1 juvenile pr, NIWA P935); 41°39.1'S, 165°13.6'E, alive, 4405–4411 m (2 pr, NIWA P934). Bounty Trough, 46°38.80'S, 178°30.03'E, alive, 2780 m (many, NIWA U2602F; 20, M.158324).

## Description

Supplementary to that of Smith (1885). Prodissoconch c. 200 µm long, smooth, D-shaped, convex, rim narrowly flanged, sharply separated from dissoconch. Early dissoconch with microsculpture of extremely minute, rather thinly dispersed granules.

## Distribution

Southern Ocean, Indian Ocean, Indonesia, New Caledonia, Wallis and Futuna, Vanuatu, Lord Howe Rise, Norfolk Ridge, West Norfolk Ridge, Kermadec Islands, Three Kings Rise, Tasman Basin, and Bounty Trough, New Zealand, living at 619–5440 m. New Zealand specimens living at 760–4981 m (Fig. 1).

## Remarks

Compared with *Propeamussium investigatoris*, which has somewhat similar sculpture and attains similar size, *Pr. meridionale* is characterised by a consistently white instead of orange-tinted left valve, and left valve sculpture of much finer radial riblets, which are typically crisp, but scarcely developed at all in some specimens. The deepest recorded occurrence for this species is 5440 m, east of Honshu, Japan (Okutani and Kawamura 2002).

***Propeamussium sibogai* (Dautzenberg & Bavay, 1904)**

Figs 1, 3H–J

- Amussium sibogai* Dautzenberg & Bavay, 1904: 207, text figs 1–4; Dautzenberg & Bavay, 1912: 31, pl. 28, figs 1–4.  
*Luteamussium sibogai*.—Oyama, 1951: 82, text fig. 1; Kira, 1955: 96, pl. 48, 14; Kira, 1962: 138, pl. 49, fig. 14; Habe & Kosuge, 1967, pl. 50, fig. 5.  
*Propeamussium sibogai*.—Knudsen, 1967: 272, pl. 1, figs 23, 24; Abbott & Dance, 1982: 303, fig.; Habe, 1977: 76, pl. 15, fig. 9; Wang, 1984: 599, text fig. 1, pl. 1, figs 1, 2; Hayami, 1988: 479, figs 2/4a–d, text fig. 3; Okutani *et al.*, 1989: 59, fig.; Dijkstra, 1990a: 9; Dijkstra, 1995: 15, figs 19–22; Rombouts, 1991: 66, pl. 27, figs 1, 1a; Matsukuma *et al.* 1991: pl. 133, fig. 5; Lamprell & Whitehead, 1992: [16], pl. 6, fig. 34; Dijkstra & Marshall, 1997: 79, p. 3, figs 1–3; Hayami, 2000: 913, pl. 454, fig. 2; Dijkstra, 2001: 81; Wang, 2002: 151, pl. 5, fig. 7.  
*Amussium cf. sibogai*.—Barnard, 1969: 655, pl. 1, figs a–d.  
*Propeamussium (Luteamussium) sibogai*.—Koyama *et al.*, 1981: 62.  
*Luteamussium sibogae* [sic].—Kosuge, 1985: 59, pl. 23, fig. 12.

## Type material

Holotype ZMA Moll. 3.04.001; Bali Sea, Indonesia, 7°15'S, 115°15.6'E, alive, 289 m, 14 Mar. 1899, HM *Siboga* (stn 12).

## Material examined

The holotype (see above). S New Caledonia, 24°44'S, 168°07'E, alive, 490–510 m (1, MNHN, BERYX 11 stn CP 22). Colville Ridge, N of Raoul Island, 24°17.7'S, 178°50.1'W, 589–591 m (1 v, NIWA P948). Off Curtis Island, Kermadec Islands: 30°31.0'S, 178°39.0'W, 710–725 m (fragment, NIWA T256); 30°45'S, 178°40'W, 300 m (1 v, M.223545).

## Distribution

South Africa, Japan, Philippines, Indonesia, Timor Sea, New Caledonia, Loyalty Islands, Wallis and Futuna, Vanuatu, Colville Ridge, and Kermadec Islands, 183–710 m; taken alive at 369–640 m (Fig. 1).

## Remarks

*Propeamussium sibogai* is distinctive among propeamussiids from the region in its large size (height up to 60 mm) and translucent, essentially smooth, yellowish shell with deeply pigmented internal ribs. The two specimens known from the New Zealand region are incomplete, so we illustrate a specimen from New Caledonia.

**Genus *Parvamussium* Sacco, 1897**

*Parvamussium* Sacco, 1897: 102. Type species (by original designation): *Pecten (Pleuronectes) duodecimlamellatus* Bronn, 1832; Late Miocene, Italy.

## Diagnosis

Propeamussiidae with opaque or translucent, fragile, circular to oblique shell, up to ca. 20 mm in height, laterally compressed; exterior surface of left valve strongly radially and/or commarginally sculptured in most species, right valve

with weak commarginal sculpture. Auricles unequal. Byssal notch well developed, no ctenolium. Internal riblets commence in late ontogeny and extend to submarginal or marginal region.

#### Distribution

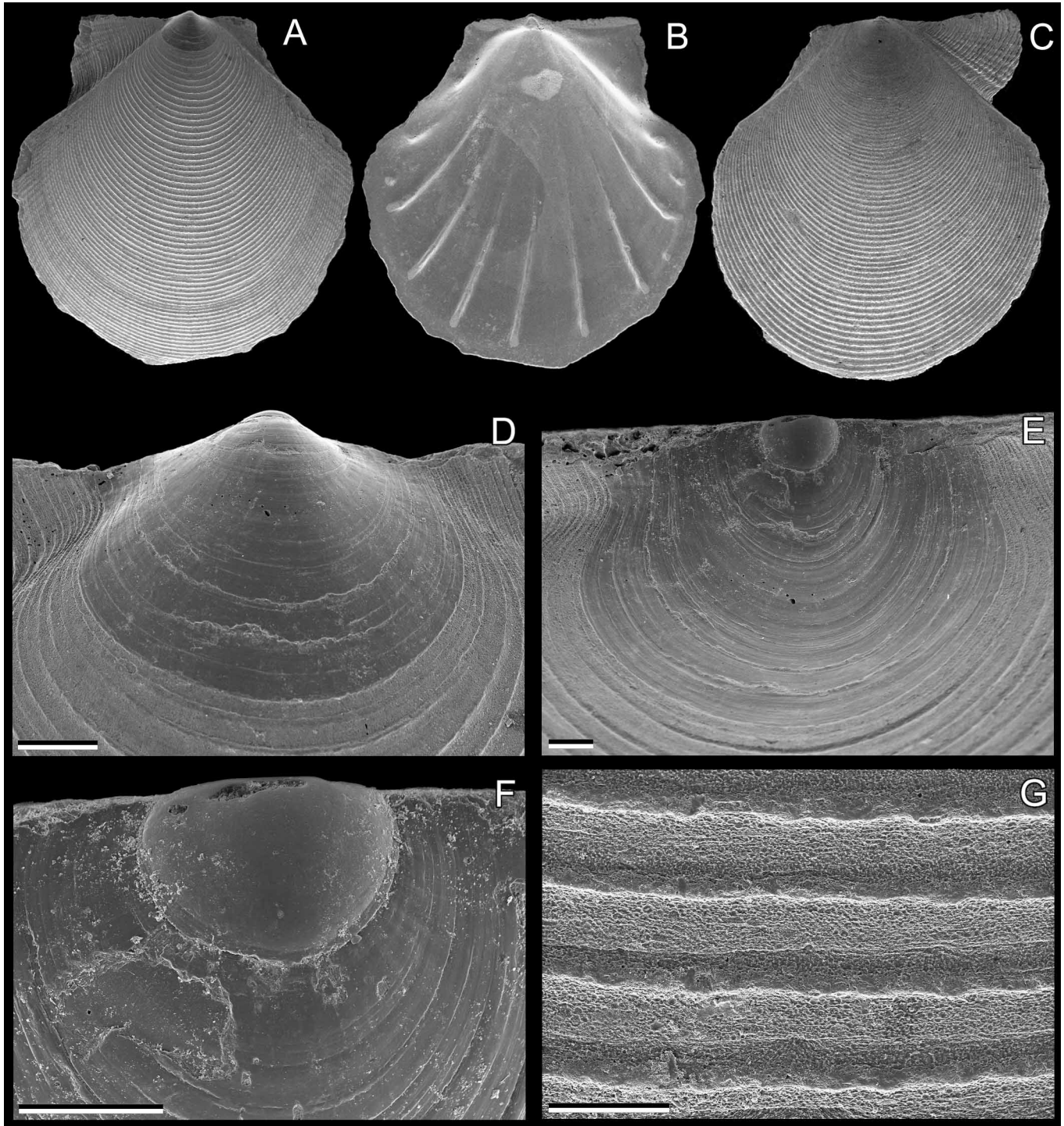
Cretaceous to Recent. Worldwide from as shallow as about 27 m to abyssal depths.

#### *Parvamussium cancellorum* n. sp.

Figs 4A–G, 5

#### Type material

Holotype NMNZ M.173000 (lv) and many paratypes (2 each AMS C.205270, MNHN, ZMA Moll. 4.07.001, rest NMNZ M.172907), southern Norfolk Ridge, NW of Cape Reinga, northern New Zealand, 33°22.61'S, 170°12.70'E, 514–540 m, 1 Jun. 2003, RV *Tangaroa*.



**FIGURE 4.** Propeamussiidae. *Parvamussium cancellorum* n. sp., southern Norfolk Ridge, NW of Cape Reinga, 514–540 m. **A, B, D–F.** Holotype, M.173000 (lv, height 6.60 mm). **C, G.** Paratype, M.172907 (rv, height 5.60 mm). Scale bars 200  $\mu$ m (D) and 100  $\mu$ m (E–G).

### Material examined

The type material (see above). West Norfolk Ridge, Wanganella Bank, 32°10.5'S, 167°21.2'E, 442–449 m (7 v, M.174027). Norfolk Ridge, N of Norfolk Island, 26°25.94'S, 167°10.87'E, 750–774 m (20 v, M.172013).

### Description

Shell up to 7 mm high, subcircular, equivalve (broad, thin ventral margin of right valve disintegrating post mortem), almost equilateral, left valve distinctly more convex than right valve, auricles dissimilar in shape, anterior auricle considerably larger than posterior one, umbonal angle c. 100°, resilifer triangular, internal ribs present 12–13 on left valve and 11 on right valve. Translucent white, typically with a few scattered, irregular opaque white and yellowish brown maculations.

Prodissoconch c. 170 µm long, D-shaped, smooth, convex, rim flanged.

Dissoconch left valve disc and auricles markedly shiny up to 800–900 µm height, smooth apart from commarginal growth lines. Subsequent disc and auricles matt due to dense microsculpture of minute pits. Disc sculptured with crisp commarginal lamellae numbering 5–10 per mm, typically 9 or 10 per mm over most of disc, closer and more numerous near adult ventral margin, few specimens commencing with c. 5 lamellae per mm, increasing to 10 or more at maturity. Low, close radial riblets finely crenulated where intersecting commarginal ribs, on anterior and posterior quarters throughout, gradually resolving near ventral margin in adults. Auricular sculpture similar to that of disc, though commarginal lamellae closer, especially posteriorly; some specimens additionally with fine, crowded riblets in 'camptonectes' pattern on posterior part of anterior auricle.

Right valve disc sculptured with crisp, rather regularly spaced commarginal ridges interspaces matt. Posterior auricle continuous with disc, sculptured with closely spaced commarginal lamellae and finer radial threads and granules; anterior auricle and byssal fasciole separated from disc by sharply incised groove, sculptured with commarginal lamellae, and 5–7 subequal radial threads on ventral half. Byssal notch shallow.

### Distribution

Norfolk Ridge and West Norfolk Ridge, 442–774 m (shells only) (Fig. 5).

### Remarks

*Parvamussium cancellorum* is superficially closely similar to *Pa. retiolum* Dijkstra, 1995, from New Caledonia, Wallis and Futuna, and Vanuatu (Dijkstra 2001: 86), but is separable by the glossy early dissoconch, which is essentially smooth until the shell is 800–900 µm high, instead of matt due to the presence of densely crowded minute threadlets and granules in *Pa. retiolum*. *Pa. cancellorum* differs further from *Pa. retiolum* in attaining smaller size (height up to 7 mm, versus 16 mm), in having finer and one or two extra internal ribs on each valve, in having finer and closer commarginal ribs on the right valve, and in the left valve

having considerably weaker radial sculpture, and more crowded commarginal sculpture. The two species are locally sympatric (see below).

### Etymology

Lattice-work (Latin), alluding to the sculpture of the left valve.

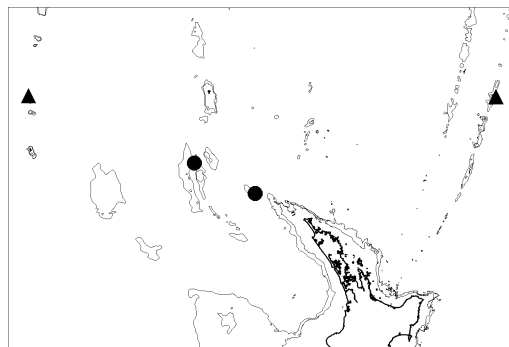


FIGURE 5. Map showing distribution of ▲ *Parvamussium cristatellum* (Dautzenberg & Bavay, 1912), and ● *Parvamussium cancellorum* n. sp.

### *Parvamussium cristatellum* (Dautzenberg & Bavay, 1912)

Figs 5, 6A–D

*Pecten* (*Amussium*) *cristatum* Bavay, 1905a: 187, pl. 17, figs 2a–c (not Bronn, 1831).

*Amussium cristatellum* Dautzenberg & Bavay, 1912: 36, pl. 28, figs 5–8 (new name for *P. cristatum* Bavay, not Bronn—preoccupied).

*Amussium texturatum*.—Barnard, 1964: 432 (not Dautzenberg & Bavay, 1912).

*Parvamussium cristatellum*.—Dijkstra, 1990a: 9; Dijkstra & Marshall, 1997: 80, pl. 3, figs 4–8, pl. 4, figs 1–2; Dijkstra & Kastoro, 1997: 261, figs 62–72; Dijkstra, 2001: 83.

### Type material

Syntypes (3) ZSI M3360/1, Masandam Islands, Andaman Islands (no other data).

### Material examined

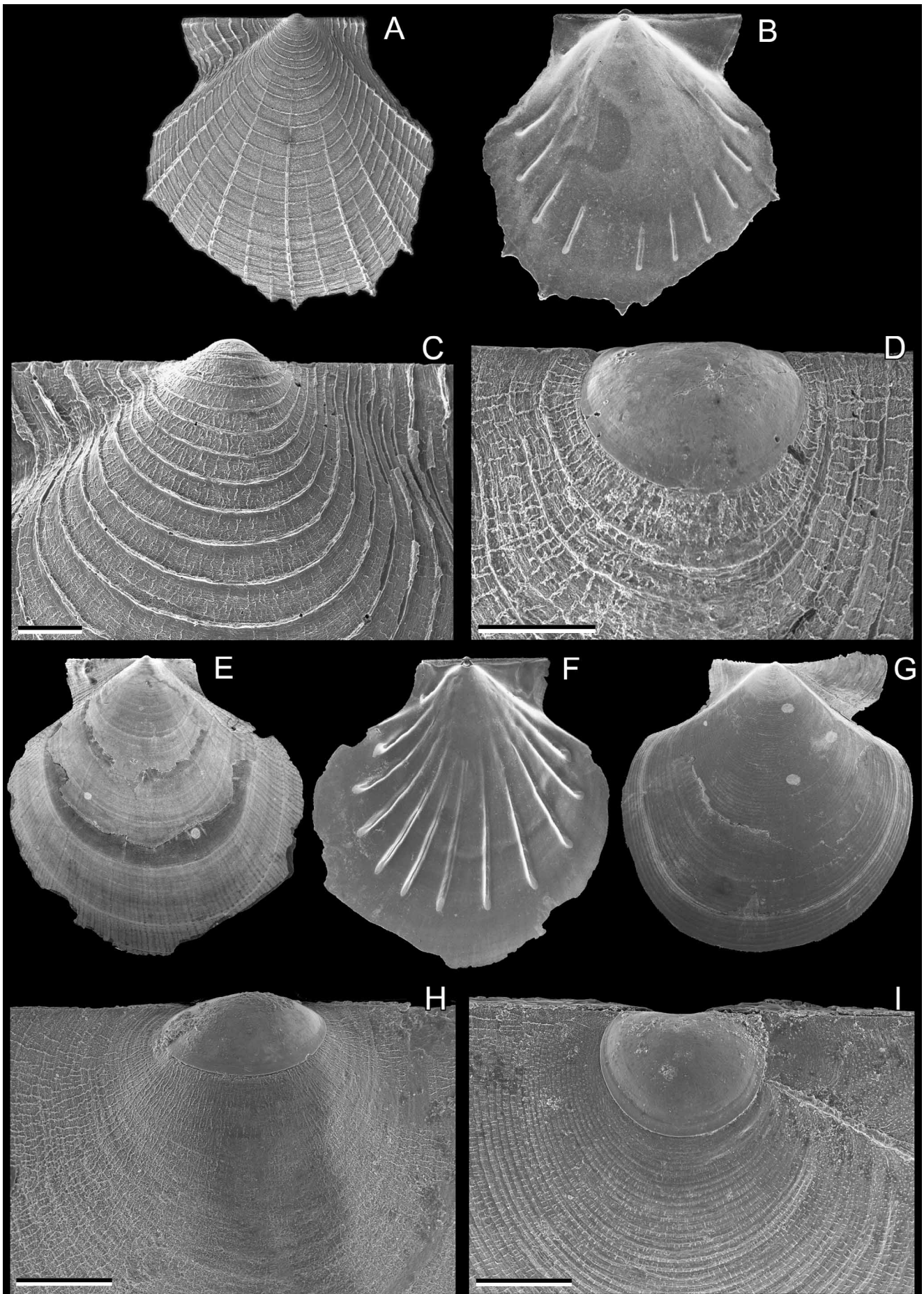
The type material (see above). Off Middleton Reef, N of Lord Howe Island, 29°12.8'S, 158°59.0'E, 505–900 m (4 v, M.171254). Off Raoul Island, Kermadec Islands: 29°15.3'S, 177°49.3'W, 348–256 m (49 v, M.225398); 29°15.5'S, 177°50'W, 402–366 m (30 v, M.225529); 29°16.5'S, 177°49.5'W, 512–549 m (1 v, M.225616).

### Description

Supplementary to that of Bavay (1905a). Prodissoconch c. 190 µm long, smooth, D-shaped, convex, rim narrowly flanged, sharply separated from dissoconch. Early left valve dissoconch with interstitial microsculpture of fine, crisp, irregularly wavy diverging and converging radial threads.

### Distribution

South-eastern Africa, Andaman Islands, Indonesian Archipelago, Wallis and Futuna, Vanuatu, New Caledonia, Lord Howe Rise, and Kermadec Ridge, 74–549 m; taken alive at 330–510 m (Fig. 5).



**FIGURE 6.** Propeamussiidae. **A–D.** *Parvamussium cristatellum* (Dautzenberg & Bavay, 1912), off Raoul Island, Kermadec Islands, 366–402 m, M.225529 (lv, height 4.95 mm). **E–I.** *Parvamussium maorium* Dell, 1956, off Mayor Island, 482–550 m, M.60227 (E, F, H, lv, height 10.8 mm; G, I, rv, height 8.80 mm). Scale bars 200  $\mu$ m (C) and 100  $\mu$ m (D, H, I).

## Remarks

*Parvamussium cristatellum* is distinctive among propeamussiids from the region in the combination of small size (height up to 7.60 mm), and left valve sculpture of crisp, widely spaced radial riblets crossed by more closely spaced, crisp commarginal lamellae.

***Parvamussium maorium* Dell, 1956**

Figs 6E–I, 7

*Parvamussium maorium* Dell, 1956: 20, pl. 4, figs 30, 31 (*P. maoria* in caption to figs 30–31); Powell, 1979: 381, figs 93/1–2 (in part = *P. investigatoris* (E.A. Smith, 1906)); Rombouts, 1991: 69.

*Parvamussium* sp.—Hicks & Marshall, 1985: 227 (diet).

*Parvamussium* sp. 1 Spencer *et al.* in press.

NOT *Parvamussium maorium* [sic].—Dell, 1963b: 206 = *P. investigatoris*.

NOT *Propeamussium maorium*.—Dijkstra, 1995: 10, figs 11–14; Dijkstra & Marshall, 1997: 77, pl. 2, figs 1–5 = *Propeamussium investigatoris*.

## Type material

Holotype (rv) NMNZ M.9171 and paratypes M.9169 (4 v); Karitane Canyon, off Otago Peninsula, New Zealand, 45°37.5'S, 171°06.0'E, 476–640 m, 28 Mar. 1954, MV *Alert*. Paratypes: SE of Pitt Island, Chatham Islands, 44°35.5'S, 176°04'W, 604 m (2 v, M.10737).

## Material examined

The type material (see above). Three Kings Rise, 31°30.7'S, 172°49.8'E, 1216–1385 m (1 v, NIWA U602). Lord Howe Rise: 34°09.8'S, 163°36.7'E, 1186 m (12 v, NIWA U197); 35°45.7'S, 165°04.1'E, alive, 950 m (1 pr, 3 v, NIWA P120). Off Three Kings Islands: 37 km SW of Great Island, 34°20.4'S, 171°48.2'E, 440 m (19 v, M.107577). Off North Cape: 34°23.0'S, 173°12.6'E, 447–357 m (1 v, M.107580); 34°25.0'S, 173°13.1'E, 327–257 m (many v, M.155385); 34°32.2'S, 173°38.0'E, alive, 349–358 m (3 pr, NIWA I348). N of Cavalli Islands, 34°47.8'S, 174°06.4'E, alive, 436 m (many, NIWA I365). Mercury Knoll, E of Mercury Islands: 36°30.27'S, 176°30.45'E, 990–1100 m (2 v, M.151368); 36°31.19'S, 176°29.54'E, 975–1190 m (1 v, M.151316). E of Aldermen Islands, 36°57.6'S, 176°17.0'E, 443–527 m (4 v, M.61147). Off Mayor Island, 37°08.8'S, 176°21.8'E, alive, 512–632 m (1 pr, 3 v, M.60067); 37°20.6'S, 176°28.0'E, alive, 482–550 m (7 pr, 12 v, M.60227); 37°22.0'S, 176°40.0'E, alive, 616–666 m (20 pr, 6 v, M.60207); 37°23.5'S, 176°45.0'E, alive, 631–666 m (1 pr, M.60181). NE of Plate Island, 37°30'S, 176°48'E, 621–603 m (6 v, M.158290). NW of White Island, 37°30'S, 177°03'E, 530 m (2 v, M.12906). SW of Manukau Harbour, 37°32.5'S, 174°05.3'E, 502 m (2 pr, 5 v, M.107573). Challenger Plateau: 40°42.8'S, 167°56.0'E, 1029 m (2 pr, many v, NIWA P929); 40°46.0'S, 167°54.9'E, alive, 1029 m (many pr, NIWA P928); 40°50.1'S, 168°14.8'E, alive, 1005–1009 m (many, NIWA P927); 41°00.6'S, 169°06.0'E, alive, 914 m (many pr, NIWA P942). Off Greymouth, 42°04.3'S, 170°12.5'E, alive, 750 m (1 pr, 11 v, NIWA Q719). Off Hokitika, 42°36.1'S, 169°34.8'E, alive, 920–935 m (1 pr, NIWA Q696). Chatham Rise, W of Chatham Islands, 43°42.7'S, 178°59.7'W, alive, 1022 m (2 pr, 1 v, NIWA

V370). Off Oamaru, 45°12'S, 171°44'E, alive, 594 m (1 pr, NIWA E413). Thompson Basin floor, Thompson Sound: 45°13.00'S, 166°57.96'E, 350 m, 2 stations (1 v, M.138860; 3 v, M.138546); 45°13.06'S, 166°58.01'E, alive, 350 m, 2 stations (7 v, M.138802; 1 pr, 12 v, M.138751); 45°14.36'S, 166°58.96'E, 319–324 m (12 v, M.150682); 45°14.38'S, 166°58.87'E, 340–362 m (30 v, M.150567). Bradshaw Basin floor, Bradshaw Sound: 45°17.27'S, 167°02.56'E, 451 m (3 v, M.150742); 45°17.27'S, 167°02.63'E, 459 m, 2 stations (1 v, M.150767; 1 v, M.150789); 45°17.3'S, 167°02.6'E, 415 m, 2 stations (2 v, M.138331; many v, M.138360). Doubtful Sound: Utah Basin floor, 45°17.9'S, 166°55.5'E, 400 m (30 v, M.138612); off point E of Joseph Point, 45°18.93'S, 166°58.36'E, 340 m (2 v, M.153638); Kellard Basin floor, 45°21.30'S, 167°03.36'E, alive, 376 m (4 pr, 28 v, M.138321). Off Taiaroa Head: head of Karitane Canyon, 45°38.5'S, 171°05.0'E, 585–530 m (3 v, M.51102); Taiaroa Canyon, 45°45.6'S, 171°05'E, 549 m (many v, M.12831); Taiaroa Canyon, 45°46'S, 171°03'E, 660 m (25 v, M.58475). Cunaris Sound, 45°56.7'S, 166°39.3'E, alive, 282–287 m (1 pr, 1 v, NIWA E805). S of Cape Saunders, 46°00'S, 171°02'E, alive, 622–768 m (7 pr, 1 v, NIWA E400). Chalky Inlet, 46°02.2'S, 166°35'E, alive, 235 m (1 pr, NIWA E806). Long Sound, 46°02.4'S, 166°47.3'E, alive, 88–168 m (3 pr, NIWA E812). Preservation Inlet, 46°07.1'S, 166°41.8'E, alive, 175 m (1 pr, 4 v, NIWA E811). Bounty Plateau: 47°40.0'S, 179°18.3'E, alive, 812 m (1 pr, NIWA I665); 47°50.8'S, 179°30.9'E, alive, 504 m (8 pr, NIWA I668); 48°00'S, 178°29.0'E, alive, 475 m (1 pr, NIWA I704); 48°10.0'S, 178°04.5'E, alive, 545 m (11 pr, NIWA I702); 48°17'S, 179°03'E, alive, 532 m (32 pr, NIWA I699); 48°20.0'S, 179°46.5'E, alive, 450 m (5 pr, 4 v, NIWA I682); 48°20.6'S, 178°31.1'E, 760 m (7 v, NIWA T51); 48°23.6'S, 179°42.6'E, 668 m (19 v, NIWA T32); 48°29.1'S, 178°16.6'E, alive, 917 m (5 pr, NIWA I697); 48°30.5'S, 179°45.0'E, alive, 710 m (many, NIWA I686). S of Bounty Islands: 48°43.7'S, 179°27.1'E, alive, 775 m (many, NIWA T36); 48°51.5'S, 178°41.5'E, alive, 608 m (18 pr, NIWA I689). N of Antipodes Islands, 49°04.6'S, 178°58.2'E, alive, 740 m (many, NIWA T38). Off Campbell Island, 53°29'S, 169°48'E, 589–594 m (1 v, M.39553).

## Description

Supplementary to that of Dell (1956). Prodissoconch c. 170 µm long, smooth, D-shaped, convex, rim narrowly flanged, sharply separated from dissoconch. Early dissoconch of both valves with microsculpture of fine, crisp, irregularly wavy diverging and converging radial threads.

## Distribution

Southern Lord Howe Rise and New Zealand, 168–1385 m, taken alive at 168–1208 m. Lives as shallow as 168 m in Fiordland where unusual hydrographic conditions prevail (Grange *et al.* 1980), but unknown living elsewhere shallower than 349 m (typically >500 m) (Fig. 7).

## Remarks

*Parvamussium maorium* ranges from almost circular in



shape to markedly posteriorly oblique, and the shell may be orange, orange-spotted, white, opaque or translucent. Unlike the glossy right valve, the left valve has a slight but distinctly matt texture, and may be essentially smooth, or (typical of East Otago), sculptured from mid to late ontogeny with radial threads that gradually enlarge to varying degrees, with or without the addition of commarginal lamellae. As already indicated, specimens of *Pr. investigatoris* have been misidentified as *Propeamussium maorium* (Dell 1963b; Dijkstra and Marshall 1997). *Propeamussium investigatoris*, which is locally sympatric (asyntopic), with *Pa. maorium* off the northern North Island has much stronger radial sculpture on the left valve, and far more conspicuous sculpture on the anterior and posterior ends of the right valve, on which, additionally, the internal radial ribs are considerably broader.

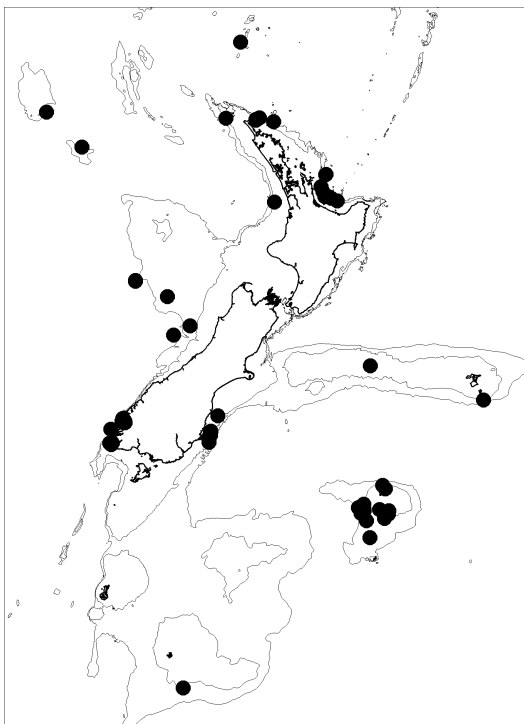


FIGURE 7. Map showing distribution of *Parvamussium maorium* Dell, 1956.

### *Parvamussium retiolum* Dijkstra, 1995

Figs 8A–G, 9

*Parvamussium retiolum* Dijkstra, 1995: 29, figs 39–42, 97; Dijkstra, 2001: 85.

*Parvamussium retiaculum*.—Dijkstra & Marshall, 1997: 81, pl. 3, figs 9–14, pl. 4, figs 3, 4. Not Dijkstra, 1995.

*Parvamussium* sp. 2 Spencer *et al.* in press.

#### Type material

Holotype MNHN; Chesterfield Reefs, Coral Sea, 19°47'S, 158°44'E, alive, 685–700 m, 19 Oct. 1986, NO *Coriolis* (MUSORSTOM 5 stn CP 363).

#### Material examined

The holotype (see above). Norfolk Ridge, N of Norfolk Island: 26°25.2'S, 167°11.2'E, 714–756 m (11 v,

M.171056); 26°25.9'S, 167°10.8'E, alive, 750–774 m (2 pr, many v, M.172011). Lord Howe Rise: off Middleton Reef, 29°12.8'S, 158°59.0'E, 505–900 m (20 v, M.171253); 34°12.4'S, 162°39.5'E, alive, 758–760 m (7 pr, M.172031). Kermadec Islands, Raoul Island, SE of Chanter Islets, 29°16.5'S, 177°49.5'W, 512–549 m (1 v, M.225615). Norfolk Ridge: S of Norfolk Island, 30°12.2'S, 167°26.8'E, 755–782 m (1 v, M.160838); NW of Cape Reinga, 33°22.61'S, 170°12.70'E, 514–540 m (7 v, M.171563); NW of Cape Reinga, 34°09.1'S, 171°27.9'E, alive, 542–554 m (1 pr, 4 v, M.160808). Kiwi Seamount, northern Three Kings Rise, 30°45'S, 173°51'E, 538–545 m (5 v, M.225311). Norfolk Ridge, S of Norfolk Island, 31°47.2'S, 167°51.6'E, 316–319 m (1 v, NIWA P14). West Norfolk Ridge: Wanganella Bank: 32°10.5'S, 167°21.2'E, 442–449 m (many v, M.174026); 32°35.3'S, 167°41.8'E, 437–422 m (27 v, M.234108); 32°40.8'S, 167°26.8'E, 660–757 m (33 v, NIWA P8); W of Cape Reinga: 34°17.1'S, 168°25.8'E, 785–800 m (many v, M.172340); 34°34.9'S, 168°55.5'E, 1000–1150 m (4 v, M.172796); 34°37.2'S, 168°57.0'E, alive, 521–539 m (1 pr, M.172054); 35°08.4'S, 169°28.4'E, alive, 867–865 m (3 pr, NIWA U568). Seamount “No. 441”, ENE of North Cape, 34°02.5'S, 174°49.0'E, alive, 792–880 m (5 pr, 6 v, KAH0204/47). Seamount WNW of Three Kings Islands, 34°06.7'S, 171°39.7'E, 394–400 m (3 pr, M.160793). South Cavalli Seamount, ENE of North Cape, 34°15.9'S, 174°06.1'E, 850–840 m (1 v, M.158250). Rumble V volcano, S Kermadec Ridge: 36°08.84'S, 178°12.24'E, 951–772 m (3 v, NIWA TAN107/225); 36°08.75'S, 178°12.11'E, alive, 924–712 m (1 pr, 18 v, NIWA TAN0107/323). Mercury Knoll, E of Mercury Islands, 36°30.38'S, 176°31.0'E, alive, 920 m (1 pr, NIWA 9907/51). Off Aldermen Islands: 36°57.3'S, 176°21.5'E, 803–846 m (1 v, M.60144); 37°04.3'S, 176°26.6'E, 807–872 m (4 v, M.107568). W of Cape Egmont, 39°20'S, 172°08'E, 500 m (10 v, M.50545). Calyptogena Bank, Ritchie Ridge, off Mahia Peninsula: 39°28.53'S, 178°25.35'E, alive, 864–867 m (3 pr, NIWA 9907/36); 39°28.56'S, 178°25.29'E, alive, 874–914 m (3 pr, 3 v, M.151282); 39°29.45'S, 178°25.05'E, alive, 980–1000 m (5 pr, 5 v, M.151305). South Ritchie Trough, seep site, 39°58.59'S, 178°14.18'E, alive, 990 m (2 pr, NIWA V466).

#### Description

Supplementary to that of Dijkstra (1995). Prodissoconch c. 170 µm long, smooth, D-shaped, convex, rim narrowly flanged, sharply separated from dissoconch. Early left valve dissoconch with microsculpture of fine, crisp, crowded, irregularly wavy diverging and converging radial threads.

#### Distribution

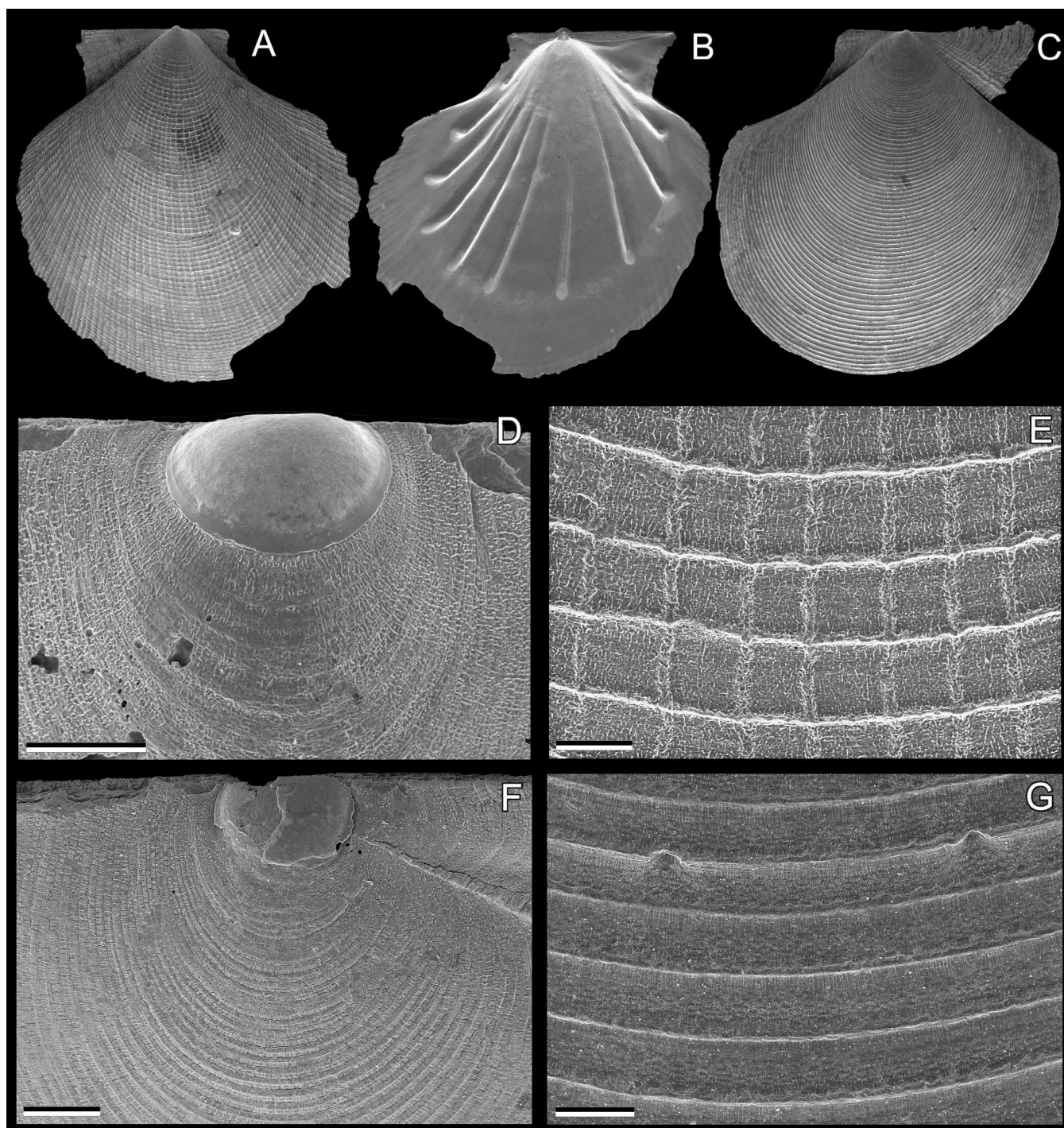
Chesterfield Reefs (Coral Sea), New Caledonia, Wallis and Futuna, and Vanuatu (Dijkstra 1995, 2001), Lord Howe Rise, West Norfolk Ridge, Kermadec Ridge, Three Kings Rise, and northern New Zealand, 316–1000 m; taken alive at 552–1000 m (Fig. 9).

## Remarks

The present specimens are accordant with type material from off the Chesterfield Reefs, although the sculpture of the left valve is more variable, ranging from coarsely to very finely reticulated, some specimens with commarginal lamellae or radial threads in late growth. Compared with the superficially similar species *Pa. thetidis* (Hedley, 1902), with which it is locally sympatric (Dijkstra 1995), *Pa. retiolum* differs in attaining larger size (height up to 16 mm, versus 10

mm), and in having more evenly reticulate sculpture on the left valve, rather than strong, irregularly spaced radial costae crossed by delicate commarginal lamellae. The presence of crisp reticulate sculpture on the left valve from early ontogeny immediately distinguishes it from sculptured (southern) forms of *Pa. maorium*, with which it is locally sympatric, though asyntopic.

*Parvamussium retiolum* is a new record for the NZEEZ.



**FIGURE 8.** Propeamussiidae. *Parvamussium retiolum* Dijkstra, 1995, NW of Cape Reinga, 542–554 m, M.160808 (A, B, D, E, lv, height 13.8 mm; C, F, G, rv, height 10.7 mm). Scale bars 100  $\mu$ m.

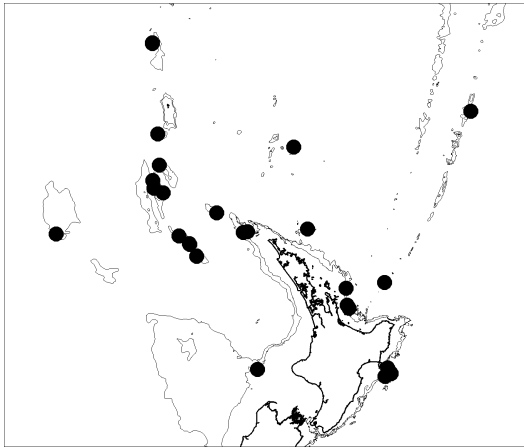


FIGURE 9. Map showing distribution of *Parvamussium retiolium* Dijkstra, 1995.

***Parvamussium squalidulum* Dijkstra, 1995**

Figs 10A–E, 11

*Parvamussium squalidulum* Dijkstra, 1995: 24, figs 47–50; Dijkstra & Marshall, 1997: 81, pl. 4, figs 5–10; Dijkstra & Kastoro, 1997: 262, figs 79–82; Dijkstra, 2001: 86.

Type material

Holotype MNHN; Kelso Bank, Coral Sea, 24°11'S, 159°35'E, alive, 270 m, 10 Oct. 1986, NO *Coriolis* (MUSORSTOM 5 stn DW277).

Material examined

The holotype (see above). ENE of Raoul Island, 28°47.8'S, 177°47.8'W, 145 m (12 v, NIWA K825). Kermadec Islands: SE of Nugent Island, 29°14.7'S, 177°49.4'W, 165–146 m (1 v, M.225679); off Curtis Island, 30°45'S, 178°40'W, alive, 302 m (1 pr, 3 v, M.224639).

Description

Supplementary to that of Dijkstra (1995). Prodissoconch c. 180 µm long, smooth, D-shaped, convex, rim narrowly flanged, sharply separated from dissoconch. Early left valve dissoconch with microsculpture of fine, crisp, crowded, irregularly wavy, diverging and converging radial threads; similar, much weaker sculpture on right valve.

Distribution

Coral Sea, Loyalty Islands, Vanuatu, Wallis and Futuna, and Kermadec Islands, 146–610 m; taken alive at 260–400 m (Fig. 11).

Remarks

*Parvamussium squalidulum* is characterised by the combination of small size (height up to 7.80 mm), narrow commarginal riblets on right valve, and left valve sculpture of crisp, widely spaced radial riblets, with prominent hollow scales set at wide intervals along them, which do not coincide with the commarginal riblets. *Parvamussium squalidulum* differs from the superficially similar species *Pa. sinense* (Wang, 1980) (East China Sea), by having weaker

and more widely spaced scaly radial sculpture on the left valve, and commarginal sculpture on the right valve (lacking in *P. sinense*) (Dijkstra 1995: 34).

***Parvamussium vesiculatum* Dijkstra, 1995**

Figs 10F–I, 11

*Parvamussium vesiculatum* Dijkstra, 1995: 37, figs 59–62, 93–96; Dijkstra & Marshall, 1997: 83, pl. 4, figs 11–16; Dijkstra & Kastoro, 1997: 265, figs 95–98; Dijkstra, 2001: 87. *Parvamussium* sp. 3 Spencer *et al.* in press.

Type material

Holotype MNHN; southeastern New Caledonia, 22°47'S, 167°14'E, alive, 440–450 m, 30 Aug. 1985, NO *Jean Charcot* (BIOCAL stn DW 44); paratypes M.268538 (2 pr).

Material examined

The holotype (see above). West Norfolk Ridge: Wanganella Bank, 32°10.5'S, 167°21.2'E, 442–449 m (12 v, NIWA P13); W of Cape Reinga, 34°17.09'S, 168°25.82'E, 785–800 m (15 v, M.172338); W of Cape Reinga, 32°40.8'S, 167°26.8'E, 660–757 m (6 v, NIWA P8). Kermadec Ridge, Seamount 130 km S of Esperance Rock, 32°28.3'S, 179°15.9'W, 538 m (12 v, M.137434). Three Kings Trough, NW of Three Kings Islands, 34°00'S, 171°55'E, 805 m (1 v, M.107605).

Description

Supplementary to that of Dijkstra (1995). Prodissoconch c. 200 µm long, smooth, D-shaped, convex, rim narrowly flanged, sharply separated from dissoconch. Earliest left valve dissoconch disc (to first commarginal lamella) glossy, with microsculpture of fine, crisp, irregular radial threadlets and elongate granules of varying length. Surface beyond first commarginal lamella matt due to very fine and dense pitting.

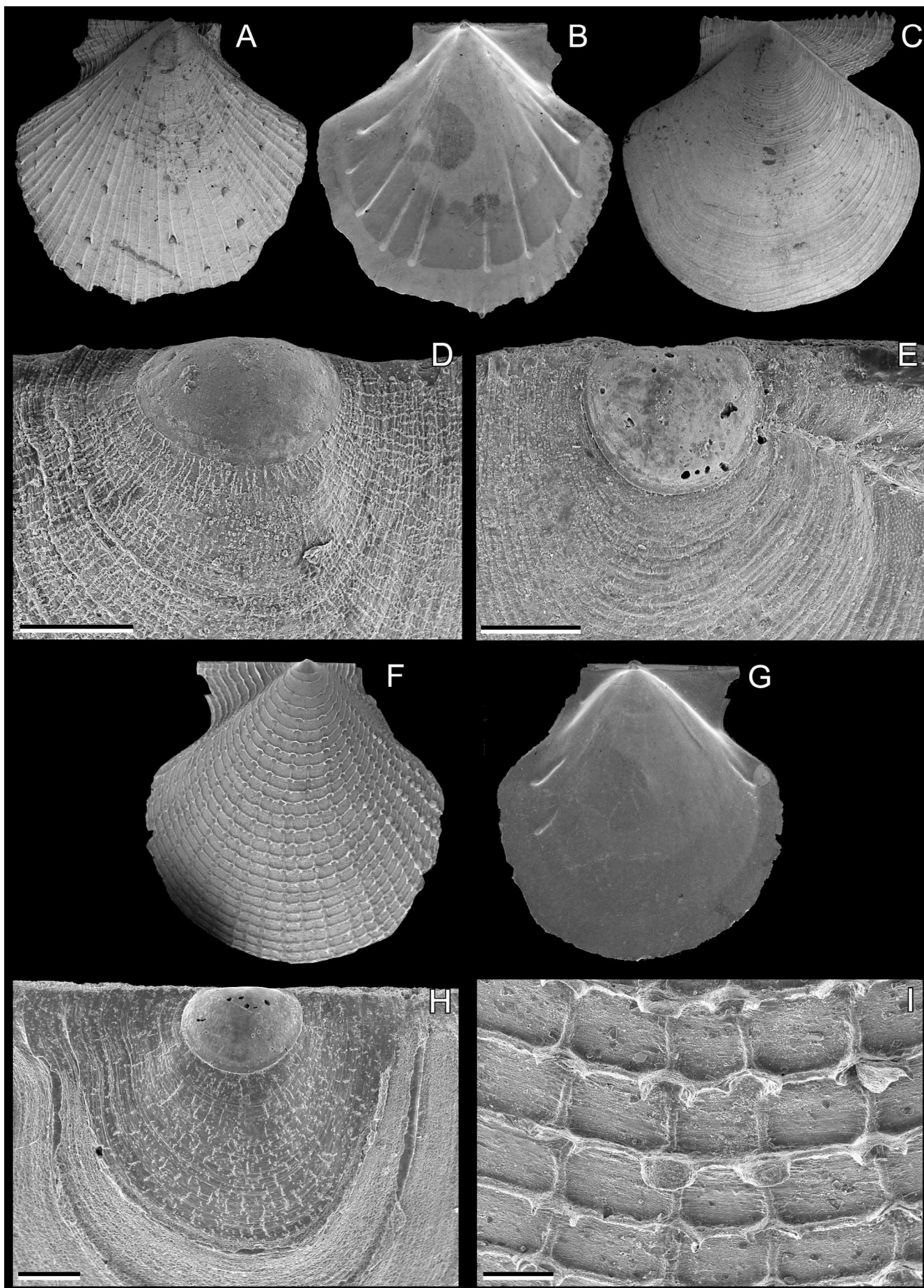
Distribution

Eastern Indonesia, New Caledonia, Loyalty Islands, Norfolk Ridge, Wallis and Futuna, Vanuatu (Dijkstra 1995, 2001); West Norfolk Ridge, southern Kermadec Ridge, and northern New Zealand, 300–805 m; taken alive at 205–650 m (Fig. 11).

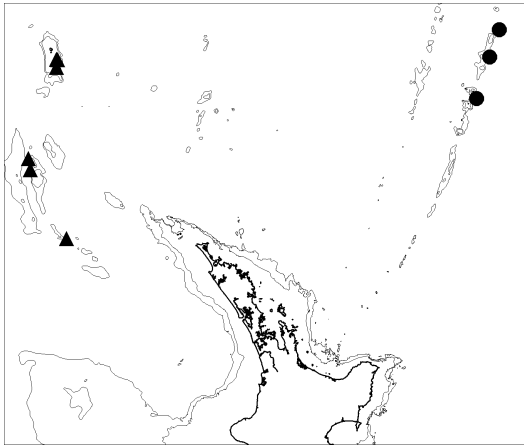
Remarks

Among *Parvamussium* species in the New Zealand region, *Pa. vesiculatum* is characterised by its small size (height up to 7.60 mm), weak internal ribs, and the presence of hollow scales on the radial riblets on the left valve (commonly broken off, but their curved bases remain). The present specimens are identical to the type material from southeastern New Caledonia.

*Parvamussium vesiculatum* is a new record for the NZEEZ.



**FIGURE 10.** Propeamussiidae. **A–E.** *Parvamussium squalidulum* Dijkstra, 1995, SE of Nugent Island, Kermadec Islands, 146–165 m, M.225679 (A, B, D, lv, height 7.70 mm; C, E, rv, height 8.00 mm). **F–I.** *Parvamussium vesiculatum* Dijkstra, 1995, seamount 130 km S of Esperance Rock, Kermadec Ridge, 538 m, M.137434 (lv, height 5.60 mm). Scale bars 100  $\mu$ m (D, E, H) and 200  $\mu$ m (I).



**FIGURE 11.** Map showing distribution of ● *Parvamussium squalidulum* Dijkstra, 1995, and ▲ *Parvamussium vesiculatum* Dijkstra, 1995.

### Genus *Cyclopecten* Verrill, 1897

*Cyclopecten* Verrill, 1897: 70. Type species (by subsequent designation of Sykes *et al.* 1898: 75): *Pecten pustulosus* Verrill, 1873; Recent, north-eastern Atlantic.

*Xenamussium* Oyama, 1944: 244. Type species (by original designation): *Pecten hoskynsi* Forbes, 1844; Turkey.

#### Diagnosis

Propeamussiidae with opaque, fragile, circular to subcircular shell, up to ca. 15 mm in height, laterally compressed; exterior surface of left valve strongly radially and/or commarginally sculptured in most species, right valve with weak commarginal sculpture. Auricles unequal. Byssal notch well developed, no ctenolium. Internal riblets lacking or rudimentary.

#### Distribution

Miocene to Recent. Worldwide from as shallow as 22 m to abyssal depths.

#### Remarks

*Cyclopecten* species are usually distinguished from *Parvamussium* species by the absence of well-formed internal ribs throughout ontogeny (Dijkstra 1995: 25, 41), as exemplified by *Cp. pustulosus* (Verrill, 1873). However, some species usually attributed to *Cyclopecten* have internal ribbing, at least in late ontogeny, and some species with well-developed internal ribbing currently referred to *Parvamussium* have external characters (e.g. vesicular sculpture) characteristic of *Cyclopecten* species. There is clearly a need for a formal phylogenetic analysis based on an extensive suite of worldwide taxa. Our allocation of species to *Parvamussium* and *Cyclopecten* is based purely on presence or absence of internal ribbing, and is thus provisional.

### *Cyclopecten fluctuosus* n. sp.

Figs 12A–D, 13

*Cyclopecten* sp. Spencer *et al.* in press.

#### Type material

Holotype (pr) NIWA and 3 paratypes (2 pr, M.173003; 1 pr, ZMA Mol. 4.02.012); Tasman Basin, 41°20.4'S, 166°54.8'E, alive, 1760–1799 m, 22 Apr. 1980, RV *Tangaroa* (NIWA P939). Paratypes: Bounty Trough, 45°21.2'S, 173°35.8'E, alive, 1386 m (2 pr, NIWA S153); 45°24.2'S, 173°59.8'E, alive, 1373 m (2 pr, NIWA S154).

#### Material examined

The type material (see above). Tasman Basin, 41°22.7'S, 166°44.4'E, 2092–2154 m (1 fragment, NIWA P940).

#### Description

Shell up to 6.55 mm high, subcircular, equivalve (relatively narrow, thin ventral margin of right valve disintegrating post mortem: thickened inner part 84% height of left valve), almost equilateral, left valve slightly more convex than right valve, auricles similar in size, umbonal angle about 120°, no internal riblets; colourless, strongly transparent.

Prodissoconch c. 150 µm long, D-shaped, smooth, sharply separated from dissoconch.

Dissoconch left valve sculptured throughout with regularly spaced commarginal lamellae (c. 10 per mm), more closely spaced on auricles. Microsculpture of minute, crisp granules throughout.

Right valve disc sculptured throughout with regularly spaced commarginal lamellae. Auricles sculptured with fine, closely spaced, commarginal lirae. Anterior auricle and byssal fasciole separated from disc by a rather deep groove, posterior auricle continuous with disc. Byssal fasciole narrow.

#### Distribution

Tasman Basin and Bounty Trough, New Zealand, 1373–2154 m, alive at 1373–1799 m (Fig. 13).

#### Remarks

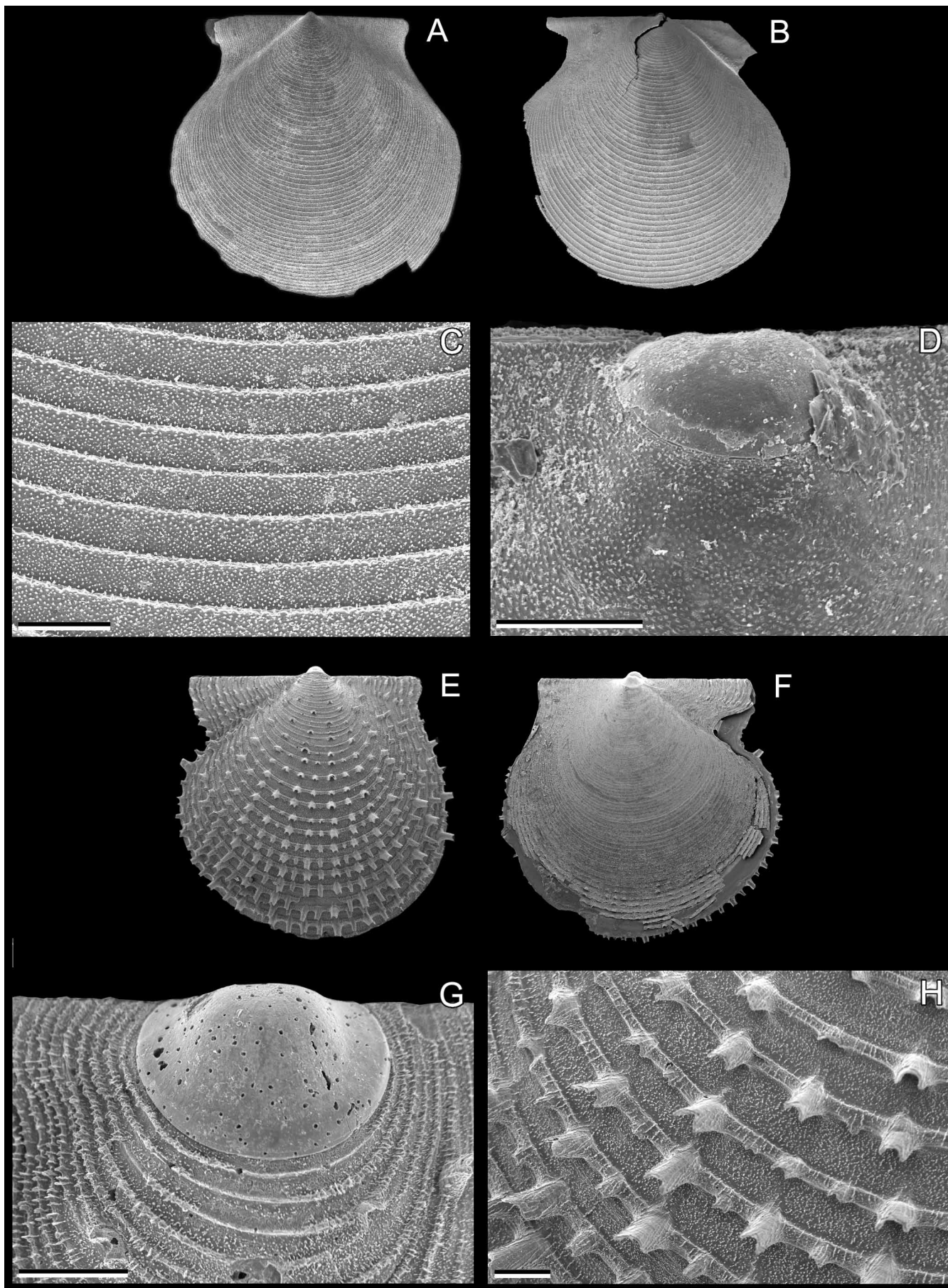
*Cyclopecten fluctuosus* resemble *Cp. kapalae* (see below) in gross facies, but differs in having more closely spaced commarginal sculpture in early ontogeny, in lacking radial sculpture on the left valve, and in having a deeper groove beside the byssal fasciole on the right valve. It is also similar to *Cp. pellucidulus* Dijkstra, 1995 (northern Norfolk Ridge, 680–700 m), but differs in being narrower and in having finer, more closely spaced commarginal lamellae.

Specimens from the Bounty Trough have slightly and distinctly more widely spaced commarginal lamellae on both valves than specimens from the Tasman Basin, but are otherwise indistinguishable.

#### Etymology

With waves (Latin), alluding to the commarginal sculpture on both valves.





**FIGURE 12.** Propeamussiidae. **A–D.** *Cyclopecten fluctuosus* n. sp., Tasman Basin, 1760–1799 m, holotype, NIWA P939 (A, C, D, lv, height 6.35 mm; B, rv, height 5.43 mm). **E–H.** *Cyclopecten horridus* Dijkstra, 1995, S of Esperance Rock, Kermadec Ridge, 538 m, M.137443 (E, G, H, lv, height 2.70 mm; F, rv, height 2.80 mm). Scale bars 200  $\mu$ m (C) and 100  $\mu$ m (D, G, H).

***Cyclopecten horridus* Dijkstra, 1995**

Figs 12E–H, 13

*Cyclopecten horridus* Dijkstra, 1995: 41, figs 63, 64, 98; Dijkstra & Marshall, 1997: 87.

## Type material

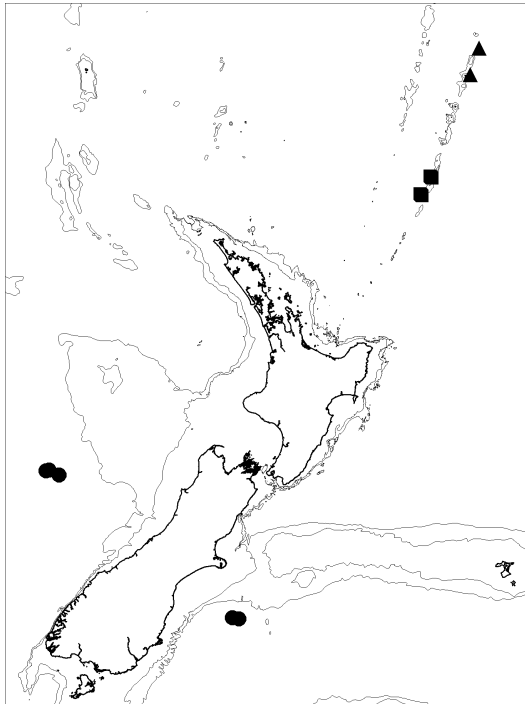
Holotype MNHN; off Loyalty Islands, 20°29'S, 166°43'E, alive, 600 m, 16 Feb. 1989, NO *Alis* (MUSORSTOM 6 stn 420).

## Material examined

The holotype (see above). S of Esperance Rock, Kermadec Ridge: 32°28.3'S, 179°15.9'W, alive, 538 m (4 pr, 4 v, M.137443); 33°02.6'S, 179°34.6'W, alive, 350 m (1 pr, NIWA K795).

## Distribution

New Caledonia, Loyalty Islands (Dijkstra 1995), and Kermadec Ridge, 350–735 m; taken alive at 350–600 m (Fig. 13).



**FIGURE 13.** Map showing distribution of ● *Cyclopecten fluctuosus* n. sp., ■ *Cyclopecten horridus* Dijkstra, 1995, and ▲ *Cyclopecten kermadecensis* (E.A. Smith, 1885).

## Remarks

*Cyclopecten horridus* is distinctive among propeamussiids from the New Zealand region in the primary sculpture of the left valve, which comprises commarginal lamellae set with numerous, prominent, hemitubular scales arranged in radial rows that multiply by intercalation. The Kermadec Ridge specimens are indistinguishable from the type material.

***Cyclopecten kapalae* Dijkstra, 1990**

Figs 14, 15A–F

*Cyclopecten kapalae* Dijkstra, 1990b: 29, figs 1–5; Dijkstra &

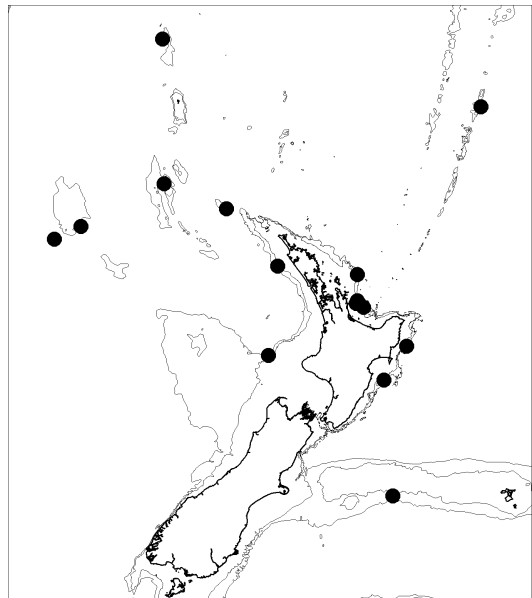
Marshall, 1997: 87, pl. 6, figs 7–12.

## Type material

Holotype (pr) AMS C.155831 and paratypes (10 v) AMS C.165060; off Sydney, New South Wales, 33°33'S, 152°07'E, alive, 907–914 m, 10 Dec. 1980, FRV *Kapala* (stn K80-20-08). Additional paratypes listed by Dijkstra (1990b).

## Material examined

The type material (see above). Norfolk Ridge, N of Norfolk Island: 26°25.9'S, 167°10.8'E, 750–774 m (30 v, M.172012). SE of Chanter Islets, Raoul Island, Kermadec Islands, 29°16.5'S, 177°49.5'W, alive, 512–549 m (2 pr, many v, M.225614). West Norfolk Ridge: Wanganella Bank, 32°40.8'S, 167°26.8'E, 660–757 m (16 v, NIWA P8); NW of Cape Reinga, 33°23.4'S, 170°11.6, 469–526 m (1 v, M.160760). Lord Howe Rise: 34°09.8'S, 163°36.7'E, 1186 m (7 v, NIWA U197); 34°59.3'S, 162°11.2'E, 1573 m (7 v, NIWA U198). Off Hokianga, 35°37.6'S, 172°36.5'E, 657 m (45 v, M.107569). E of Great Barrier Island, 35°56.8'S, 176°21.4'E, 630–645 m (25 v, M.107594). Off Aldermen Islands: 36°57.3'S, 176°21.5'E, 803–846 m (4 v, M.60147); 37°02.5'S, 176°18.1'E, 521–516 m (1 v, M.107592); 37°04.3'S, 176°26.6'E, 807–872 m (22 v, M.107612). W of White Island, 37°10.9'S, 178°38.7'E, 685–705 m (19 v, M.107604). Off Gable End Foreland, 38°38.7'S, 178°41.1'E, alive, 755–725 m (2 pr, 23 v, M.107597). Off Cape Egmont, 38°58.5'S, 172°10.2'E, 1045–1055 m (1 v, M.107608). Off Cape Kidnappers, 39°52.8'S, 177°36.5'E, alive, 785–882 m (2 pr, 23 v, M.107595). Chatham Rise, 43°56.8'S, 178°01.7'E, 680–736 m (1 v, M.107607).



**FIGURE 14.** Map showing distribution of *Cyclopecten kapalae* Dijkstra, 1990.

## Description

Supplementary to that of Dijkstra (1990b: 29). Prodissoconch c. 170 µm long, smooth, convex, sharply delineated by growth scar and change to dissoconch sculpture. Dissoconch sculpture (reticulate radial and

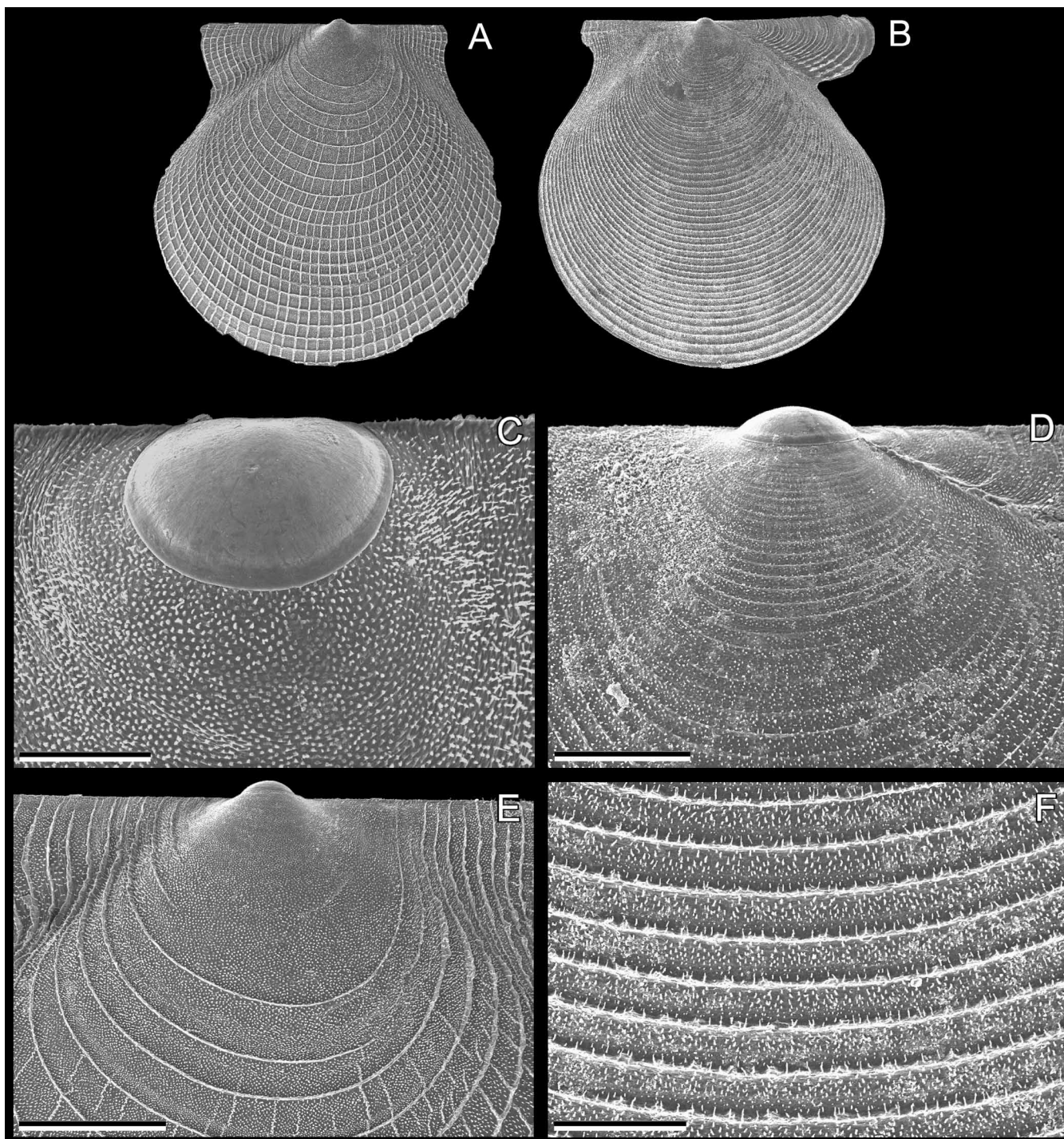
commarginal threads) additionally with interstitial microsculpture of fine, crowded spines on and near auricles of left valve to about 0.5 mm shell height, thereafter crisp, crowded granules.

#### Distribution

Southeastern Australia, Kermadec Islands, Lord Howe Rise, Norfolk Ridge, and off North Island and northern South Island, New Zealand, 512–1573 m; taken alive at 512–914 m (Fig. 14).

#### Remarks

The present material is indistinguishable from the holotype and additional specimens from eastern Australian. *Cyclopecten kapalae* closely resembles *Cp. powelli* (see below), but differs in having reticulate sculpture covering the dissoconch left valve at all stages of growth, in lacking fine, crowded, radial threads early on the right valve, and in that, after attaining about 2 mm in height, the commarginal lamellae on the right become low, rounded ridges.



**FIGURE 15.** Propeamussiidae. *Cyclopecten kapalae* Dijkstra, 1990, off Aldermen Islands, 807–872 m, M.107612 (A, C, E, lv, height 3.63 mm; B, D, F, rv, height 3.33 mm). Scale bars 100  $\mu$ m (C), 200  $\mu$ m (D–F).

***Cyclopecten kermadecensis* (E.A. Smith, 1885)**

Figs 13, 16A–F

*Pecten kermadecensis* Smith, 1885: 302, pl. 21, figs 7, 7a.  
*Cyclopecten kermadecensis*.—Dijkstra & Marshall, 1997: 88.

Type material

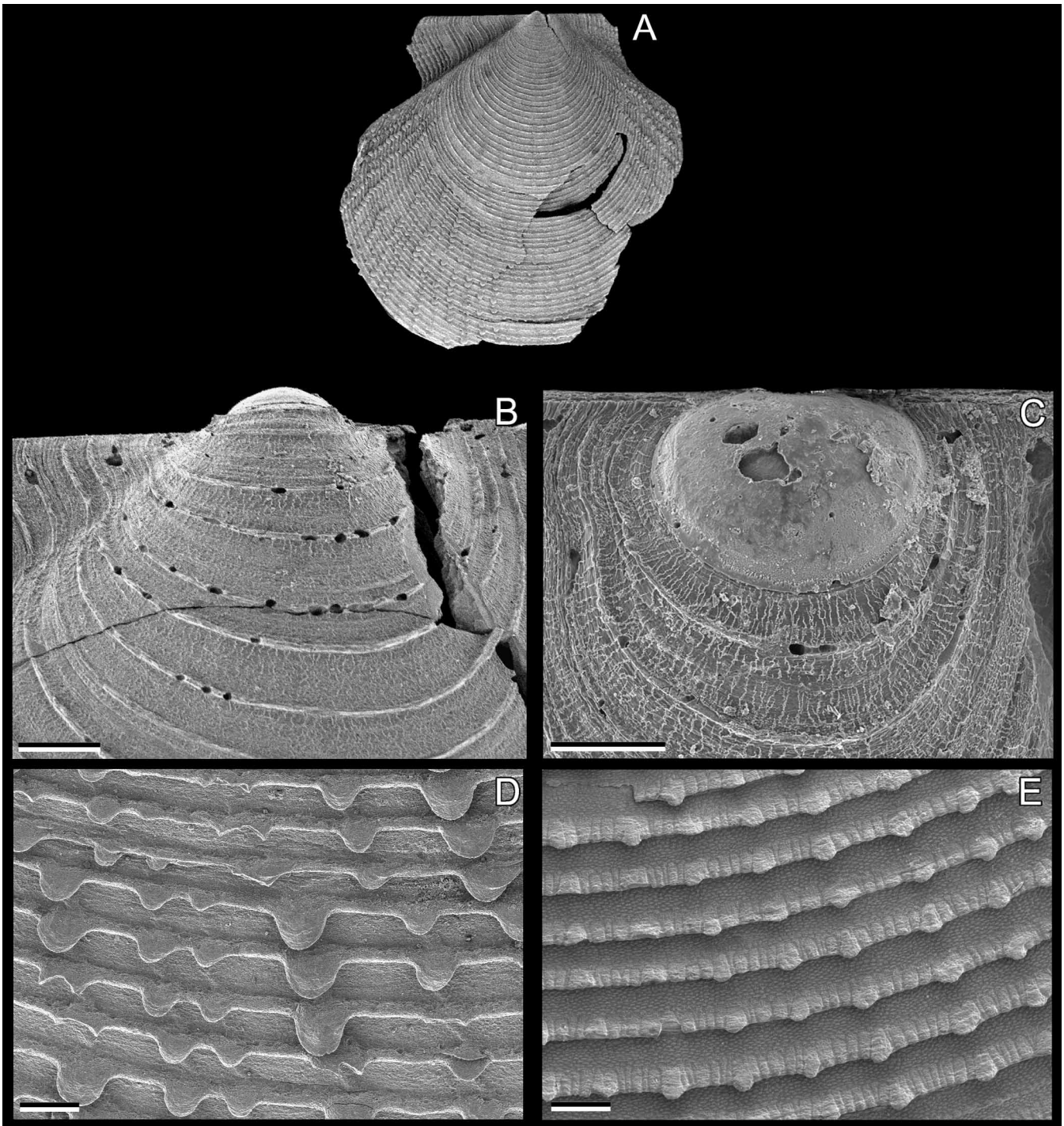
Holotype (pr) BMNH 87.2.9.3279; N of Raoul Island, Kermadec Islands, 28°33'S, 177°50'W, 1097 m, 15 Jul. 1874, HMS *Challenger* (stn 171).

Material examined

The holotype (see above). NNE of Herald Islets, Kermadec Islands, 29°12.0'S, 177°49.3'W, alive, 1188–1225 m (1 partly crushed pr, M.222131).

Description

Shell up to 7.50 mm high, compressed, subcircular, inequivalve, almost equilateral and equiconvex, auricles dissimilar in shape, anterior auricle larger than posterior one, umbonal angle c. 70°, resilifer triangular, internal ribs lacking, opaque whitish.



**FIGURE 16.** Propeamussiidae. *Cyclopecten kermadecensis* (E.A. Smith, 1885), NNE of Herald Islets, Kermadec Islands, 1188–1225 m, M.222131 (height 10 mm; A–D, lv; E, rv). Scale bars 200 µm (B,D,E), 100 µm (C).



Prodissoconch c. 250 µm long, convex, smooth, sharply separated from dissoconch by fine groove and change to dissoconch sculpture.

Dissoconch left valve immediately at first (to c. 0.5 mm shell height) sculptured with widely spaced, rounded commarginal riblets, and fine, crisp, converging and diverging, dendritic interstitial threads. Thereafter disc and auricles sculptured with rather regularly spaced, thin, outwardly sloping commarginal lamellae set with radial rows of small but prominent semicircular scales that coincide with more or less obscure radial lines. Interspaces with a dull texture though without defined microsculpture. Disc with 3 radial rows of scales that resolve on posterior fifth after 2 mm shell height; scales very gradually resolving elsewhere on disc from 3.0–5.5 mm height, suddenly enlarged after 5.5 mm height and multiplying by intercallation. Anterior auricle with about 8 rows of scales that commence after about 5 mm height; posterior auricle with about 7 rows of scales that commence after about 2 mm height.

Right valve sculptured with rather regularly spaced outwardly sloping commarginal ridges; summits finely radially grooved and with finer commarginal wrinkles, additionally, after about 5 mm height, with radial rows of low, rounded scales. Interspaces with minute, crowded, commarginally elongate, elliptical granules that impart a dull sheen.

#### Distribution

Kermadec Islands, 1097–1225 m; taken alive at 1189–1225 m (Fig. 13).

#### Remarks

The present specimen is indistinguishable from the holotype, which was taken a little further north on the Kermadec Ridge. *Cyclopecten kermadecensis* has somewhat similar sculpture to *Parvamussium thetidis* (Hedley, 1902) from eastern Australia, the Chesterfield Islands and New Hebrides, but differs in having weaker, more irregularly-spaced radial riblets that commence later, and more widely-spaced commarginal lamellae on the left valve, in having stronger commarginal sculpture on the right valve, and in lacking internal ribs.

#### *Cyclopecten powelli* Dell, 1956

Figs 17A, B, D–F, 18

*Cyclopecten powelli* Dell, 1956: 23, pl. 4, figs 34, 35; Powell, 1979: 380, figs 93/5, 6.

#### Type material

Holotype (1 v) ZMUC BIV-443 and paratypes ZMUC BIV-444 (1 v), NMNZ M.5698 (3 v); SW of Cape Foulwind, New Zealand, 42°10.0'S, 170°10.0'E, 610 m, 20 Jan. 1952, RRS *Galathea* (stn 626).

#### Material examined

The type material (see above). Challenger Plateau: 39°54.2'S, 168°14.0'E, alive, 750 m (1 pr, 5 v, M.102531); 40°33.1'S, 170°57.3'E, 570–572 m (4 v, NIWA P926);

40°42.8'S, 167°56.0'E, 1029 m (9 v, NIWA P929); 40°46.0'S, 167°54.9'E, alive, 1028–1029 m (1 pr, NIWA P928); 40°50.1'S, 168°14.8'E, 1005–1009 m (11 v, NIWA P927); 41°00.6'S, 169°06.0'E, alive, 914 m (many pr, NIWA P942). Off Westport, 41°08.1'S, 170°21.0'E, 695 m (55 v, NIWA Q699). Off Cape Foulwind, 41°15.2'S, 167°07.2'E, alive, 1457–1463 m (many pr, NIWA P941). Off Hokitika, 42°36.1'S, 169°34.8'E, 920–935 m (3 v, NIWA Q696). Off Greymouth, 42°04.3'S, 170°12.5'E, 750 m (60 v, NIWA Q719).

#### Description

Shell up to 7.50 mm high, subcircular, equivalve (broad, thin ventral margin of right valve disintegrating post mortem), almost equilateral, left valve distinctly more convex than right valve, auricles dissimilar in shape, anterior auricle larger than posterior one, umbonal angle c. 105°; resilifer broadly triangular, no internal ribs, translucent white.

Prodissoconch c. 180 µm long, smooth, convex.

Dissoconch left valve up to c. 2 mm height with dense microsculpture of crisp granules; disc with variable pattern of primary radial threads and commarginal lamellae. Commarginal lamellae typically crisp, widely and regularly spaced, and becoming obsolete when c. 2 mm high, entirely absent in some specimens. Radials resolving when c. 1 mm high, typically weakening and vanishing when c. 2 mm high, in some specimens reappearing later, in others persisting throughout. Auricular sculpture similar to that of disc, though commarginal lamellae closer, especially posteriorly.

Right valve disc sculptured with crisp, widely and regularly spaced lamellae, which transform into low, rounded, regularly spaced ridges when 2.00–2.50 mm high, these intersecting, on early dissoconch, with finer, closer radial threads in 'camptonectes' pattern. Posterior auricle continuous with disc, sculptured with closely spaced commarginal lamellae and finer radial threads and granules; anterior auricle and byssal fasciole separated from disc by sharply incised groove, sculptured with commarginal lamellae, and 3–5 radial threads on ventral half. Byssal notch shallow.

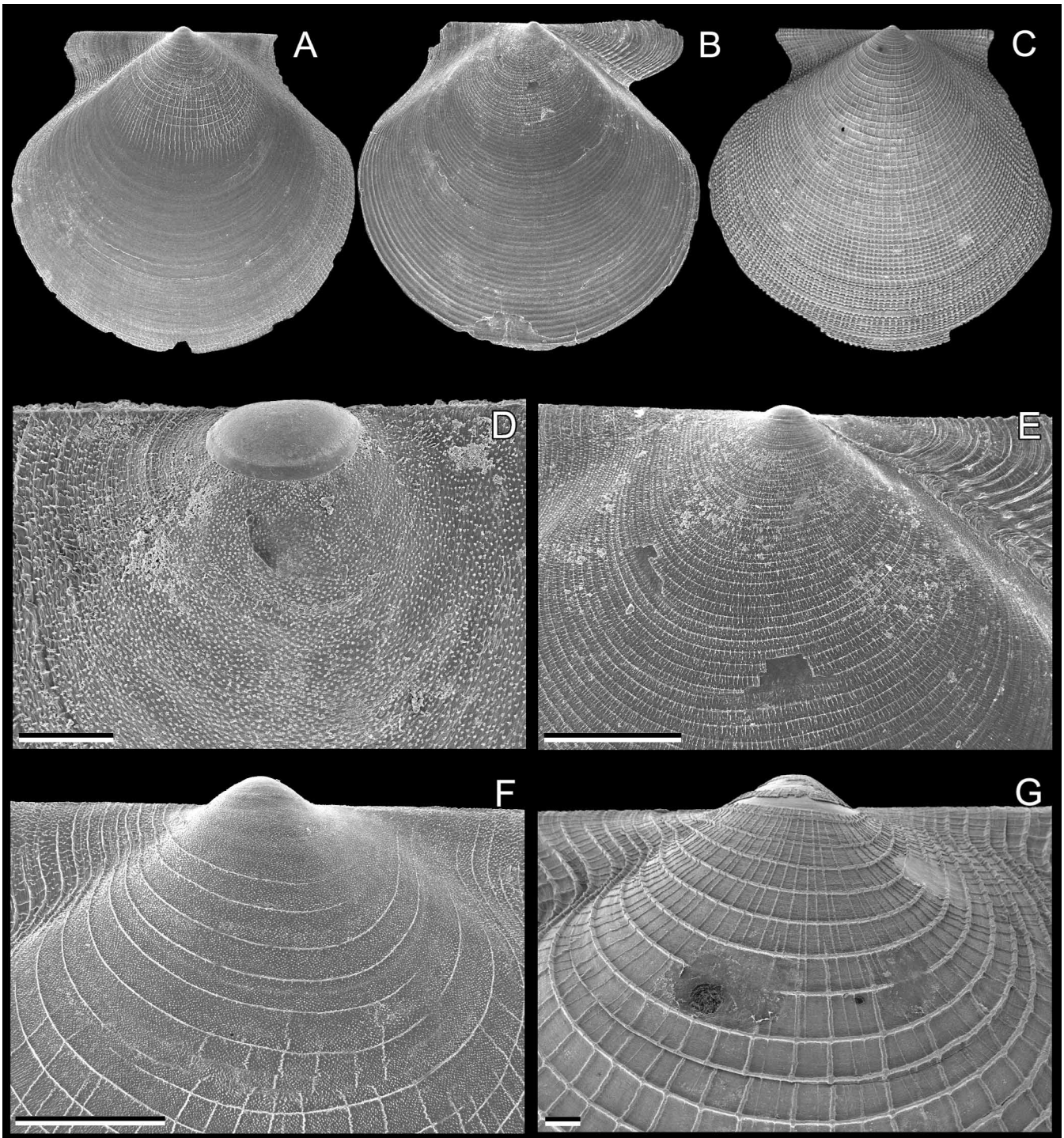
#### Distribution

Tasman Sea, New Zealand, 570–1463 m, taken alive at 750–1463 m (Fig. 18).

#### Remarks

Dell (1956: 23) and Powell (1979: 380) stated that *Cp. powelli* is "closest" to *Cc. aupouria*, because of general similarity of left valve sculpture. Their right valves, however, are entirely different, *Cc. aupouria* having commarginally elongate hexagonal prisms, *Cp. powelli* lacking these and having a sculpture of commarginal lamellae, indicating that they belong in *Cycloclamys* and *Cyclopecten* respectively. Among propeamussiids known from the New Zealand region, *Cp. powelli* most closely resembles *Cp. kapalae* (see above for distinguishing characters).





**FIGURE 17.** Propeamussiidae. **A, B, D–F.** *Cyclopecten powelli* Dell, 1956, Challenger Plateau, 750 m, M.102531 (**A, D, F**, lv, height 5.67 mm; **B, E**, rv, 4.90 mm). **C, G.** *Cyclopecten textus* n. sp., Lord Howe Rise, 2928–2930 m, holotype (lv, height 12.5 m). Scale bars 100 µm (**D**) and 500 µm (**E–G**).

***Cyclopecten secundus* (Finlay, 1926)**

Figs 18, 19A–E

*Pecten* aff. *transenna*.—Mestayer, 1919: 135, pl. 8, fig. 11 (not *Pecten transenna* Suter, 1913).

*Cycloclamys secundus* Finlay, 1926: 453.

*Pecten* (*Cyclopecten*) *hinemoa* Mestayer, 1927: 190.

*Cyclopecten* (*Cycloclamys*) *aupouria*.—Powell, 1937a: 167, pl. 47, fig. 1 (not Powell, 1937)

*Cyclopecten secundus*.—Dell, 1956: 23; Powell, 1979: 380.

NOT *Cyclopecten* (*Cycloclamys*) *secundus*.—Powell, 1937a: 167, pl. 47, fig. 3 = *Cycloclamys aupouria* (Powell, 1937).

Type material

*Cycloclamys secunda* and *Pecten* (*Cyclopecten*) *hinemoa*: holotype NMNZ M1860 (based on same specimen); N of North Cape, 34°18'S, 173°02'E, 137 m, 8 Sep. 1914, J.P. Bollons, SS *Hinemoa*. *Cyclopecten* (*Cycloclamys*) *aupouria*: paratype (BMNH 19621027; Powell 1937a, pl. 47, fig. 1); 34°13.3'S, 172°12.0'E, off Three Kings Islands, 260 m, 17 Aug. 1932, RRS *Discovery II* (not *C. aupouria* Powell, 1937).

## Material examined

The type material (see above). Off Three Kings Islands: Three Kings Trough, 34°00'S, 171°55'E, 805 m (3 v, M.17499); King Bank, 33°57.0'S, 172°19.0'E, 128 m (1 pr, M.107583); King Bank, 33°57.4'S, 172°19.4'E, alive, 128–123 m (1 pr, M.107589); 34°01'S, 172°07'E, 622 m (1 v, M.34983); Middlesex Bank, 34°02.0'S, 171°44.0'E, 246–291 m (3 v, M.107587); Middlesex Bank, 34°02.1'S, 171°45.8'E, alive, 221–206 m (2 pr, M.155425); 11 km NW of Great Island, 34°06.5'S, 172°04.7'E, 310 m (1 v, M.93793); off Northeast Island, 34°08.5'S, 172°11'E, alive, 102 m (1 pr, M.34561); submarine cave, S side of Rosemary Rock, Princes Islands, 34°10.5'S, 172°04.0'E, 20 m (1 v, M.117148); off West Island, *Elingamite* wreck, 34°11'S, 172°03'E, alive, 37 m (1 pr, M.155426); S of Great Island, 34°14.1'S, 172°09.0'E, alive, 192–202 m (1 pr, 2 v, M.107603); 34°18.8'S, 172°18.5'E, alive, 93–88 m (1 pr, M.107593). Off Whangaroa Bay, 34°54.0'S, 173°42.6'E, 83 m (1 v, M.155424). Ranfurly Bank, East Cape: 37°32.8'S, 178°48.7'E, 94 m (1 v, M.60706); 37°33.2'S, 178°50.3'E, alive, 76–71 m (13 pr, M.72687); 37°33.4'S, 178°48.3'E, alive, 106–103 m (1 pr, 2 v, M.74795); 37°35.0'S, 178°51.6'E, 39–50 m (1 v, M.60844); 37°36.3'S, 178°53.1'E, alive, 74 m (1 pr, M.60957); 37°36.7'S, 178°51.6'E, alive, 56–63 m (1 pr, M.107571).

## Description

Shell up to 3.70 mm high, subcircular, equivalve (relatively narrow, thin ventral margin of right valve disintegrating post mortem: thickened inner part c. 80% height of left valve), almost equilateral, left valve considerably more convex than weakly convex right valve, anterior auricle larger than right; some specimens with a single, incipient posterior internal radial rib on left valve; colourless, translucent.

Prodissoconch 270–300 µm long, sharply delineated, D-shaped, moderately convex, inner part very finely malleated.

Dissoconch left valve sculptured throughout with strong commarginal lamellae, and radial riblets of similar size to lamellae; strong, rounded, ventrally-projecting scales at intersections; early dissoconch with addition of very fine interstitial radial threads. Commarginal lamellae commencing immediately, number and spacing extremely variable: before appearance of radial riblets, ranging from as few as 6 with interspaces 2–3x width of each lamella, up to 25 with interspaces narrower than each lamella; after appearance of radial riblets about as widely separated as radials to less than half this width apart. Radial riblets commencing 0.40–1.00 mm from tip of prodissoconch, multiplying by intercalation, 12–15 on disc of specimens about 2 mm long, 1–4 on posterior auricle and 2–4 on anterior auricle.

Right valve disc sculptured throughout with regularly spaced commarginal riblets. Anterior auricle and byssal fasciole separated from disc by sharply incised groove, auricle sculptured with fine commarginal lamellae alone, or (typically) with 4–10 fine, weakly beaded radial threads;

posterior auricle continuous with disc, sculptured with commarginal growth lines, with or without addition of up to 3 weakly beaded radial threads. Byssal fasciole narrow.

## Distribution

Three Kings Islands, off Whangaroa, and Ranfurly Bank, East Cape, northern New Zealand, 20–622 m; taken alive at 37–221 m from comminuted bryozoan/shell substrata (Fig. 18).

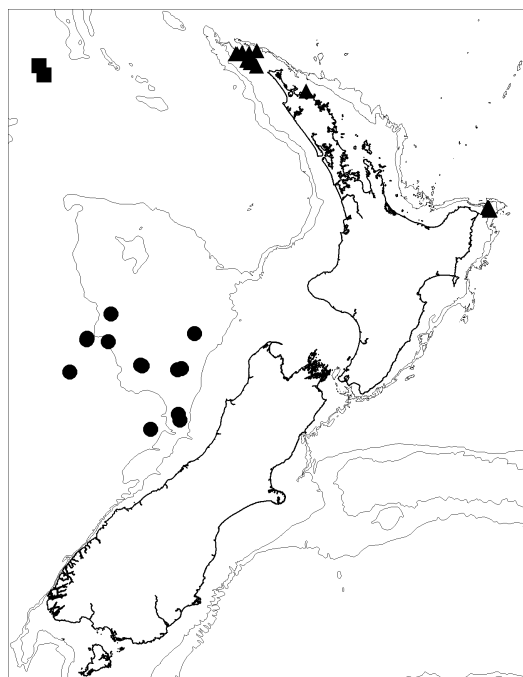


FIGURE 18. Map showing distribution of ● *Cyclopecten powelli* Dell, 1956, ▲ *Cyclopecten secundus* (Finlay, 1926), and ■ *Cyclopecten textus* n. sp.

## Remarks

*Cyclopecten secundus* is distinctive among propeamussiids from the New Zealand region in the strong reticulating commarginal and radial sculpture, with strong, rounded scales at the intersections. There is a superficial similarity to strongly sculptured forms of *Cyclochlamys transenna* with few radial ribs, but *Cp. secundus* is immediately separable by the more equilateral shape, and the sculpture of the right valve comprises commarginal threads rather than hexagonal prisms.

*Cyclopecten secundus* is closely similar to *Cp. cancellus* Dijkstra, 1991 (tropical Indo-West Pacific), in gross facies, but the latter species differs principally in lacking scales at the intersections of the primary sculptural elements.

***Cyclopecten textus* n. sp.**

Figs 17C, G, 18

## Type material

Holotype (lv) NIWA and 4 paratypes (pr, NMNZ M.155876; 3 v NIWA); Lord Howe Rise, 34°31.5'S, 166°21'E, 2928–2930 m, 23 Sep. 1982, RV *Tangaroa* (stn U195).

## Material examined

The type material (see above).

## Description

Shell up to 12.5 mm high, subcircular, equivalve (relatively narrow, thin ventral margin of right valve disintegrating post mortem), almost equilateral, left valve distinctly more convex than right valve, auricles dissimilar in shape, anterior auricle larger than posterior one, umbonal angle c. 120°, no internal riblets, resilifer broadly triangular, translucent white.

Prodissoconch unknown (etched away).

Dissoconch left valve strongly and crisply reticulately sculptured throughout by narrow radial ribs and higher commarginal lamellae; fine solid nodules at intersections, stronger on anterior and posterior end; radials and commarginals equally spaced on central part of disc, commencing immediately. Radials gradually enlarging, at first much weaker than commarginals and diverging in 'camptonectes' pattern, those on central third of disc enlarging throughout ontogeny, those on anterior and posterior thirds vanishing and replaced by normally diverging radials at about 2 mm from tip of prodissoconch, at which point radials and commarginals are similar. Commarginal lamellae strong and rather regularly spaced from initiation and throughout on central part of disc, closer after about 10 mm height and on sides. Auricular sculpture similar to that of disc.

Right valve sculptured with commarginal lirae, delicate and closely spaced (c. 14 per mm) near umbonal area, coarser and wider apart on central part of disc (c. 6 per mm). Posterior auricle continuous with disc, sculptured with fine, closely spaced commarginal lamellae, and 5 radial threads; anterior auricle and byssal fasciole separated from disc by sharply incised groove, sculptured with prominent commarginal lamellae and 10 crowded radial threads with nodular intersections. Byssal notch moderately deep, byssal fasciole small.

## Distribution

Lord Howe Rise, 2928–2930 m (very fresh shells only) (Fig. 18).

## Remarks

*Cyclopecten textus* is similar in shape and sculpture to *Cyclopecten kapalae* (see above) but differs in attaining larger size (height up to 12.5 mm, versus 6 mm), in having stronger sculpture on the left valve, and in having nodules at the intersection of the commarginal and radial sculpture. It differs from *Cp. kermadecensis* (see above) in being more rounded, with weaker commarginal lamellae and defined radial riblets, and from *Cp. cancellus* Dijkstra, 1991 (Indonesia and Vanuatu) in attaining much larger size and in having more finely reticulate sculpture.

## Etymology

Web or tissue (Latin), alluding to the sculpture of the exterior of the left valve.

Genus *Cyclochlamys* Finlay, 1926

*Cyclochlamys* Finlay, 1926: 452. Type species (by original designation): *Pecten (Pseudamysium) transenna* Suter, 1913; Recent, New Zealand.

*Chlamydella* Iredale, 1929: 164, 188. Type species (by original designation): *Cyclopecten favus* Hedley, 1902; Recent, New South Wales.

## Diagnosis

Propeamussiidae with opaque, fragile, circular to oblique shell, up to ca. 5 mm in height; exterior surface of left valve nearly smooth or radially and/or commarginally sculptured, right valve with a microstructure of elongate hexagonal elements (simple calcite prismatic outer layer). Auricles unequal. Byssal notch well developed, no ctenolium.

## Distribution

Recent. Subantarctic, South Australia and West Pacific from New Zealand to Japan at littoral (Ilot Rat, New Caledonia—new record) to bathyal depths.

## Remarks

Compared with *Cyclopecten* species, with which they are frequently confused, *Cyclochlamys* species are readily distinguishable by the presence on the the right valve disc of an outer layer of commarginally elongate, hexagonal prisms that a form broad, flexible ventral apron.

*Cyclochlamys aupouria* (Powell, 1937)

Figs 20A–G, 21

*Cyclopecten (Cyclochlamys) aupouria* Powell, 1937a: 167, pl. 47, fig. 2 only (pl. 47, fig. 1 = *Cyclopecten secundus* Finlay, 1926).

*Cyclopecten (Cyclochlamys) secundus*.—Powell, 1937a: 167, pl. 47, fig. 3 (not Finlay, 1926).

*Cyclopecten aupouria*.—Dell, 1956: 22, 165 (in part = *Cyclochlamys delli* n. sp.); Powell, 1979: 380 (in part = *C. delli* n. sp.).

## Type material

Holotype (1 v) BMNH 1962926 (but not located, K.M. Way, pers. comm., 2003); off Three Kings Islands, New Zealand, 37°13.3'S, 172°12.0'E, 260 m, 17 Aug. 1932, RRS *Discovery II* (stn 933). Paratype (BMNH 19621027) from same station = *Cyclopecten secundus* (Finlay, 1926).

## Material examined

Off Three Kings Islands: Three Kings Trough, 34°00'S, 171°55'E, 805 m (8 v, M.17526); 34°10'S, 172°12'E, alive, 252 m (1 pr, M.34216). Off Takau Bay, 35°10'S, 174°11'E, alive, 80 m (1 pr, 1 v, M.43696). SE of Aldermen Islands, 37°00.8'S, 176°12.3'E, alive, 178–248 m (30 pr, M.66622). Off Mayor Island: 37°08.7'S, 176°14.2'E, 356–380 m (3 v, M.61067); 37°09.6'S, 176°12.2'E, 293–348 m (7 v, M.61034); 37°11.5'S, 176°10.0'E, alive, 198–273 m (17 pr, 21 v M.155882); 37°12'S, 176°17'E, 256–311 m (2 v, M.35468). Mahina Knoll, NNW of White Island, 37°21.5'S, 177°05.9'E, alive, 283–308 m (7 pr, M.60138). SW of White

Island, 37°33.0'S, 176°55.6'E, alive, 442 m (1 pr, M.155459). Rungapapa Knoll, W of White Island, 37°33.8'S, 176°59.0'E, alive, 188–228 m (3 pr, M.113543). Ranfurly Bank, East Cape: 37°32.8'S, 178°48.7'E, alive, 94 m (many, M.60709); 37°33.1'S, 178°49.5'E, alive, 94–89 m (2 pr, M.74746); 37°33.4'S, 178°48.3'E, alive, 106–103 m (44 pr, M.74797). 37°37.2'S, 178°55.6'E, alive, 91–93 m (2 pr, M.107575); 37°38.4'S, 178°51.7'E, alive, 79–83 m (10 pr, 2 v, M.107602).

#### Description

Shell up to 4 mm wide, subcircular, equivalve (broad, thin ventral margin of right valve disintegrating post mortem: thickened inner part 81–83% height of left valve), left valve somewhat more convex than right valve, slightly wider than high, umbonal angle c. 107°; colourless and translucent.

Prodissoconch 340–400 µm long (brooded), bounded by second commarginal lamella after PI flange; PI D-shaped (i.e. valve margins), c. 150 µm long, essentially smooth, tip prominent and roundly coeloconoid, bounded by prominent, rounded, upturned flange; PII convex, sculpture indistinguishable from that of adjacent dissoconch, with 2 upturned, flange-like commarginal lamellae (outer bounding dissoconch), finer, crisp radial riblets, and yet finer, closer commarginal riblets.

Dissoconch left valve disc and auricle sculpture commencing immediately, crisp throughout; comprising widely spaced, high, thin, commarginal lamellae; and finer, more closely spaced radial threads that multiply by intercalation (18–21 per mm on central disc). Auricles of similar size.

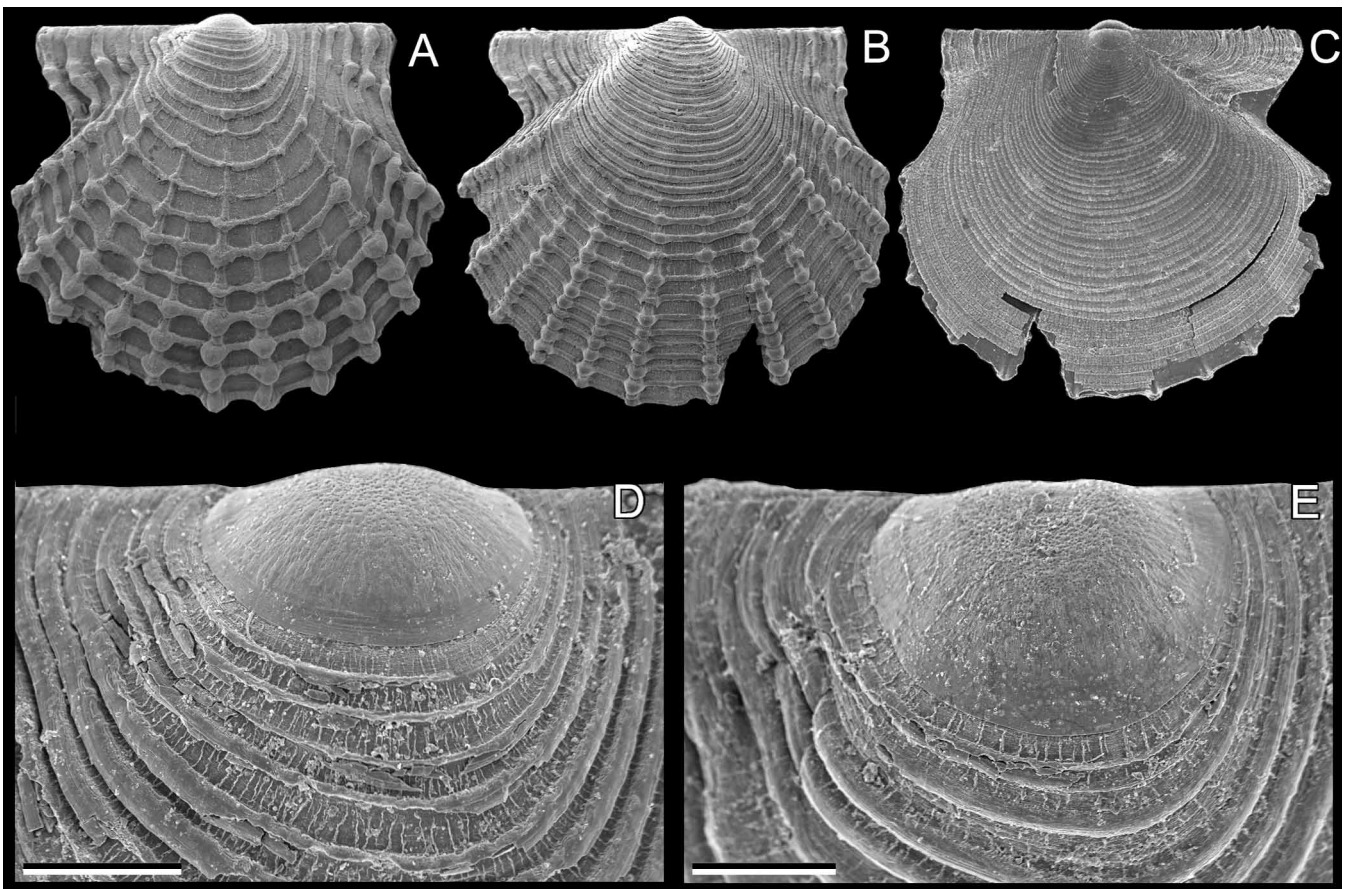
Right valve disc and all but dorsal border of posterior auricle with outer layer of commarginally elongate, hexagonal prisms that form broad, flexible ventral apron. Posterior auricle in some specimens with 1 or 2 radial threads beside dorsal margin. Anterior auricle sculptured throughout with commarginal lamellae and 4 or 5 finer radial threads. Byssal notch of moderate depth, byssal fasciole rather broad.

#### Distribution

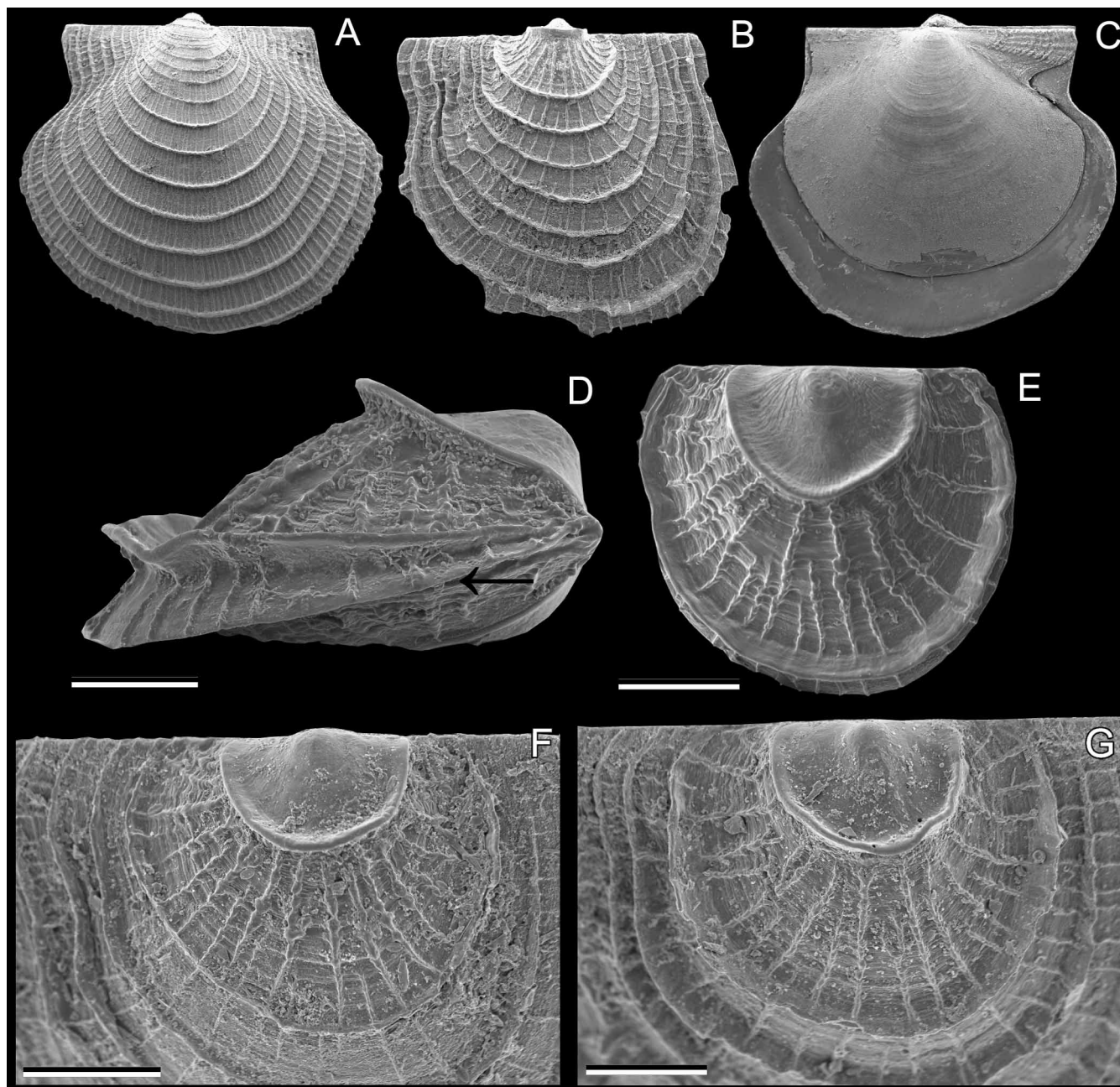
Three Kings Islands, and NE North Island, New Zealand, 79–805 m; taken alive at 79–442 m from hard substrata (Fig. 21).

#### Remarks

*Cycloclamys aupouria* broods its young. One adult specimen (height 2.4 mm) had a brood in two size classes, c.180 µm wide (10), and c.320 µm wide (6), congregated on the left and right sides respectively.



**FIGURE 19.** Propeamussiidae. *Cyclopecten secundus* (Finlay, 1926). **A, D.** S of Great Island, Three Kings Islands, 88–93 m, M.107593 (lv, height 1.85 mm). **B, C, E.** S of Great Island, 192–202 m, M.107603 (height 1.80 mm, B, E, lv; C, rv). Scale bars 100 µm.



**FIGURE 20.** Propeamussiidae. *Cyclopecten aupouria* (Powell, 1937). **A, C, D–F.** Ranfurly Bank, East Cape, 94 m, M.60709 (A, lv, height 2.40 mm, C, rv, height 2.40 mm; D, E, juveniles removed from brood (commissure arrowed and lv uppermost in D; E, lv). **B, G.** Three Kings Islands, 252 m, M.34216 (lv, height 0.95 mm). Scale bars 50 µm (D) and 100 µm (E–G).

*Cycloclamys aupouria* is superficially similar to the south-eastern Australian species *Cc. favus* (Hedley, 1902) (= *Cc. obliquus* Hedley, 1902) in sculpture, but differs in attaining smaller size (height respectively up to 3.6 mm and 4.2 mm), and in having more widely spaced commarginal lamellae and much stronger interstitial radial lirae, and in being more nearly orbicular in shape, rather than markedly posteriorly oblique as in adult specimens of *Cc. favus*. They differ further in details of prodissoconch morphology, *Cc. favus* having a prominent radial rib on the left valve (but not the right), which is absent in the New Zealand species. Similarly sculptured species are described below.

***Cycloclamys austrina* n. sp.**

Figs 21, 22A, C, D

Type material

Holotype (subadult lv) NMNZ M.155885; Bradshaw Basin floor, Bradshaw Sound, SW South Island, New Zealand, 45°17.3'S, 167°02.6'E, 415 m, 31 May 1997, RV *Munida*.

Material examined

The holotype (see above). Off Antipodes Islands, 49°40.19'S, 178°44.30'E, 113 m (1 v, M.158280).



### Description

Shell (holotype) 1.70 mm high, almost equilateral, umbonal angle c. 105°; colourless and translucent.

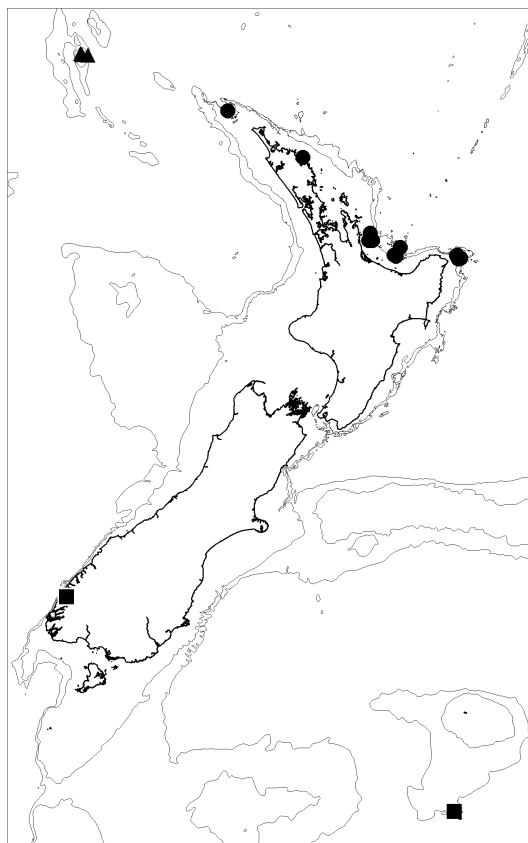
Prodissoconch c. 360 µm long, boundary unclear, but presumably first prominent, flange-like, commarginal lamella; roundly conical, surmounted by flattened; PI D-shaped (i.e. valve margins), c. 120 µm long, smooth, bounded by rounded rim; PII weakly convex, sculptured with crisp, anastomosing radial threads.

Dissoconch left valve disc and auricle sculpture commencing immediately, crisp, comprising widely and rather regularly spaced, high, thin commarginal lamellae, traversed by narrower, more closely spaced radial threads (c. 15 per mm on central disc) that multiply by intercalation, small conical nodules at intersections. Finer, more crowded, radial threads in 'camptonectes' pattern on dorsal half of posterior auricle, and on anterior and posterior quarters of disc. Posterior auricle distinctly larger than anterior auricle.

Right valve unknown.

### Distribution

Bradshaw Sound, SW South Island, and Antipodes Islands, New Zealand, 113–415 m (single valves only) (Fig. 21).



**FIGURE 21.** Map showing distribution of ● *Cycloclamys aupouria* (Powell, 1937), ■ *Cycloclamys austrina* n. sp., and ▲ *Cycloclamys bacata* n. sp.

### Remarks

*Cycloclamys austrina* resembles *Cc. irregularis* n. sp. (see below) in having anastomosing radial riblets on the prodissoconch, relatively strong, widely spaced radial riblets

on the dissoconch, and nodules where the radials cross the commarginal lamellae. *Cycloclamys austrina* differs, however, in having a flattened instead of convex PI, finer primary sculpture on the dissoconch, and in having diverging secondary radials (camptonectes pattern) on the anterior and posterior sectors of the disc. The valve from the Antipodes Islands is 2.45 mm wide, and possibly adult. In the absence of the right valve, which is diagnostic for the genus, *Cc. austrina* is referred to *Cycloclamys* because left valve morphology is more similar to that of *Cycloclamys* species than to *Cyclopecten*.

### Etymology

Southern (Latin).

### *Cycloclamys bacata* n. sp.

Figs 21, 22B, F, G

### Type material

Holotype (lv) NMNZ M.107576; Wanganella Bank, West Norfolk Ridge, summit, 32°32.6'S, 167°29.2'E, 133 m, 29 Jan. 1981, RV *Tangaroa*. Paratypes: Wanganella Bank: summit, 32°34.4'S, 167°31.0'E, 113 m (1 v, M.107599); E slope, 32°35.3'S, 167°41.8'E, 437–422 m (1 v, M.234142).

### Material examined

The type material (see above).

### Description

Shell up to 1.90 mm high, slightly posteriorly oblique, translucent white. Hinge line straight. Prodissoconch apparently 280–290 µm long, boundary poorly defined, but presumably the first sharply defined growth line; PI D-shaped (i.e. valve margins), c. 200 µm long, strongly projecting and narrowly tapered dorsally, flank surmounted by low, rounded, posteriorly-inclined ridge extending from hinge area to ventral margin, sides concave, elsewhere with scattered granules and few, weak radial threads; PII sculptured with very fine, crisp radial threads. Left valve disc and auricles sculptured with radial rows of prominent, radially elongate, ovate nodules that enlarge towards ventral margin, stronger on disc than on auricles, rows multiplying by intercalation, nodules coinciding with intersections of ill-defined radial and commarginal swellings (wear and breakage reveals nodules to be hollow).

Right valve unknown.

### Distribution

Wanganella Bank, West Norfolk Ridge, 113–437 m (shells only) (Fig. 21).

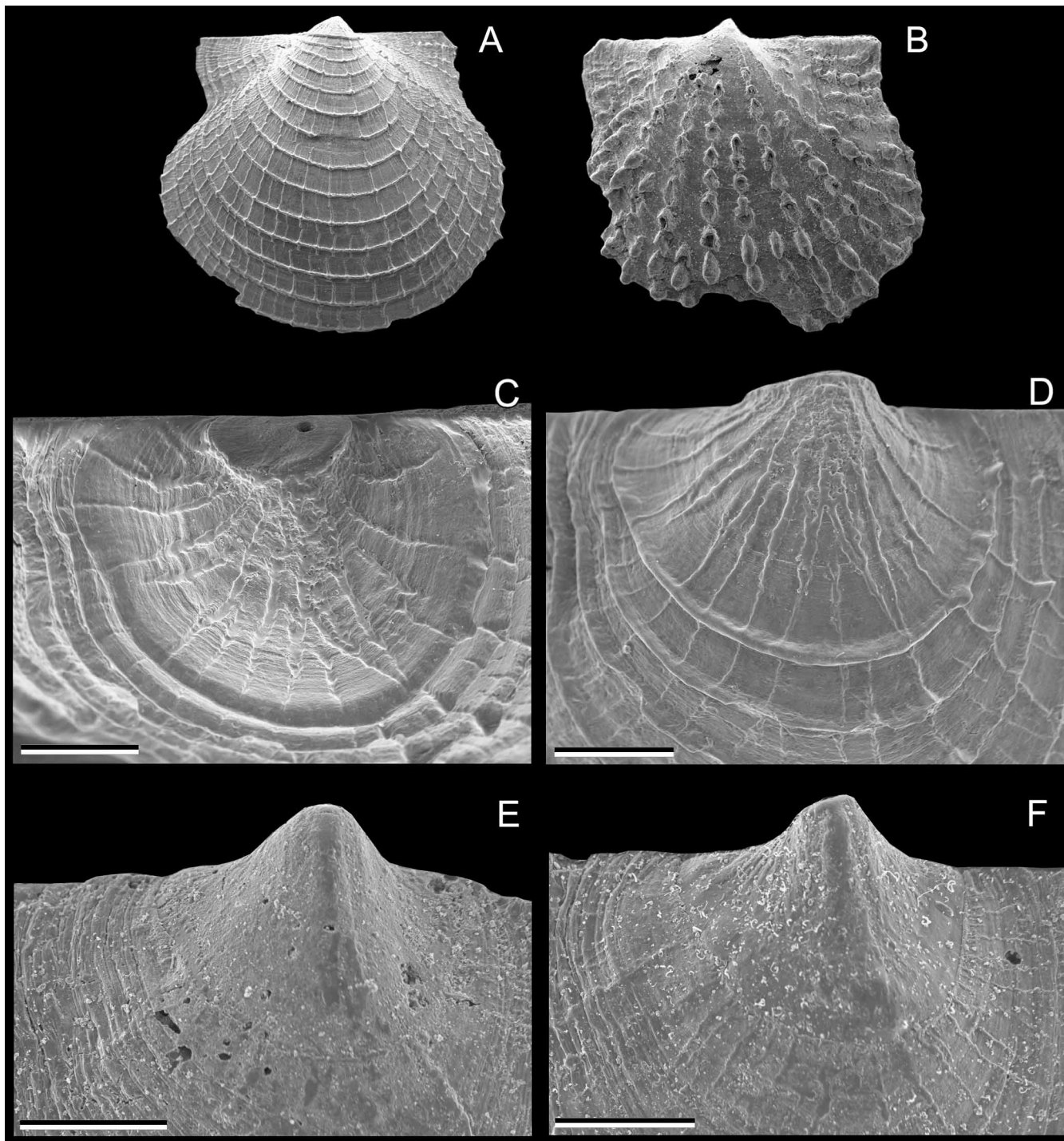
### Remarks

*Cycloclamys bacata* is distinctive among propeamussiids in the combination of very prominent PI with oblique summit ridge, and dissoconch sculpture of rows of prominent, radially elongate nodules. In the absence of the diagnostic right valve, *Cycloclamys bacata* is referred to *Cycloclamys* rather than *Cyclopecten* because of the close

similarity of its prodissoconch to that of *Cc. pileolus* n. sp. (see below), the right valve sculpture of which is characteristic of the genus.

#### Etymology

Ornamented with pearls (Latin), alluding to the vesicular sculpture of the left valve.



**FIGURE 22.** Propeamussiidae. **A, C, D.** *Cyclopecten austrina* n. sp., Bradshaw Basin floor, Bradshaw Sound, 415 m, holotype, M.155885 (lv, height 1.65 mm). **B–F.** *Cyclochlams bacata* n. sp., Wanganella Bank, West Norfolk Ridge, summit, 133 m, holotype, M.107576 (lv, height 1.55 mm). Scale bars 100  $\mu$ m.

#### *Cyclochlams delli* n. sp.

Figs 23A–F, 24

*Cyclopecten aupouria*.—Dell, 1956: 22, 165 (in part not Powell, 1937); Powell, 1979: 380 (in part not Powell, 1937).

#### Type material

Holotype NMNZ M.155920 and paratypes (many pr,

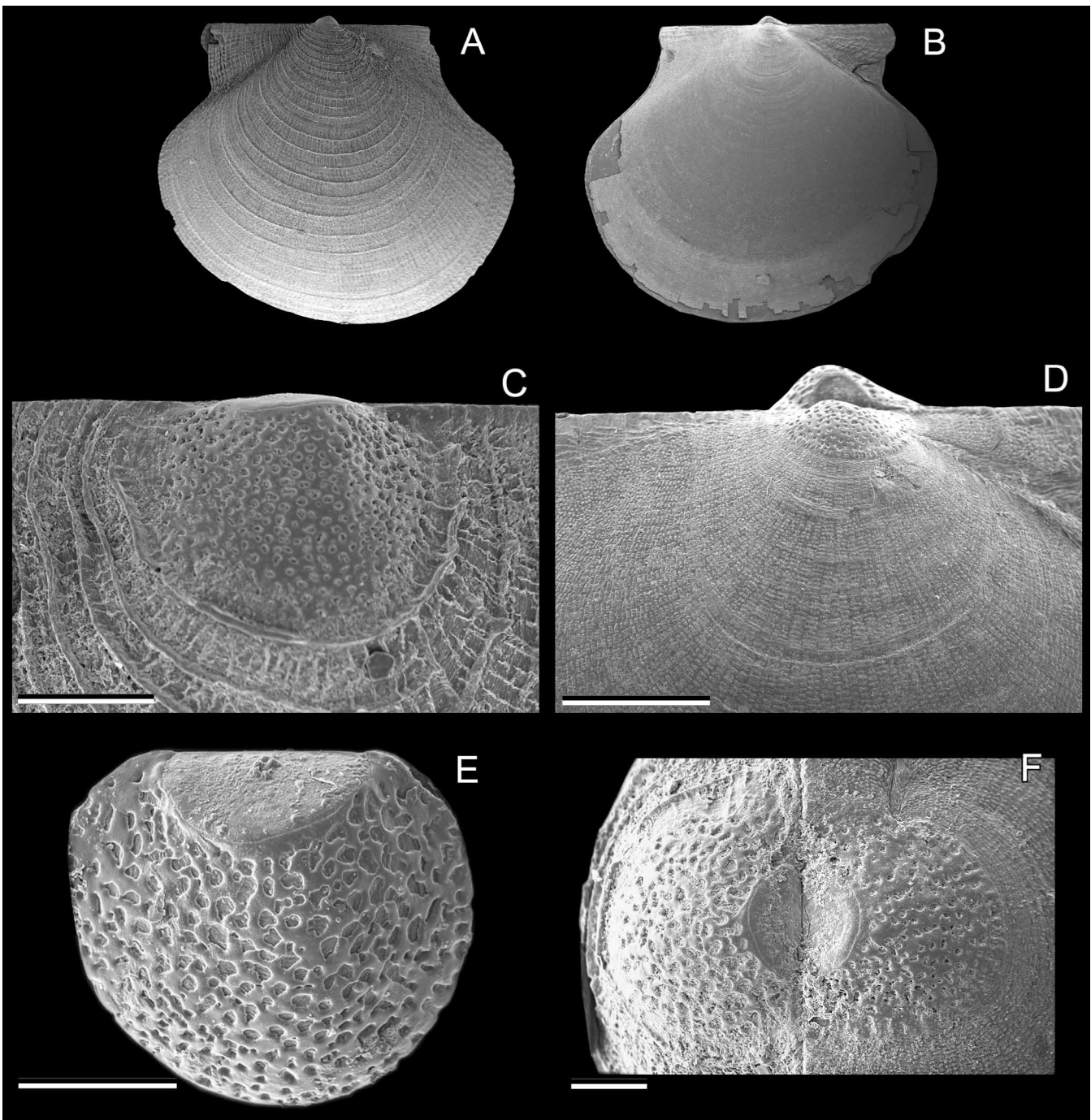
M.51155; 2 pr, ZMA Moll. 4.07.002); head of Karitane Canyon, off Otago Peninsula, south-eastern South Island, New Zealand, 45°38.5'S, 171°05.0'E, alive, 585–530 m, 19 Mar. 1976, RV *Acheron*.

#### Material examined

The type material (see above). Chatham Rise: NE of

Mernoo Bank, 42°50.8'S, 175°43.8'E, 683–703 m (3 v, M.60315); 43°14'S, 176°11'E, 366 m (3 v, M.10723); off Mernoo Bank, 43°31.17'S, 175°37.62'E, alive, 320–419 m (2 pr, M.155389); 43°32'S, 178°38'E, 549 m (2 v, M.10722). Pegasus Canyon wall, NE of Banks Peninsula, 43°14'S, 173°39'E, 1006–512 m (4 v, M.52812). Chatham Islands: NE of Kaingaroa, 43°35'S, 176°03.5'W, 220–229 m (2 v, M.10725); E of Forty Fours, 44°04'S, 175°23.5'W, 238 m (7 v, M.10727); SE of Pitt Island, 44°32'S, 176°05'W, 302 m (38 v, M.10724); SE of Pitt Island, 44°35.5'S, 176°04'W, 604 m (2 v, M.10721). Head of Waitaki Canyon, off Oamaru, 45°10'S, 171°30'E, 293–256 m (27 v, M.51336). Off Oamaru: 439 m (4 v, M.111760); 366 m (3 v, M.111720). Doubtful Sound: entrance, 45°16'S, 166°48'E, 117–128 m (1

v, M.58646); SW of Hare's Ears, 45°17.2'S, 166°49.3'E, alive, 146 m (1 pr, 2 v, M.58804). Karitane Canyon, off Otago Peninsula: 45°37.5'S, 171°03'E, 420 m (42 v, M.45529); 45°37.5'S, 171°06.0'E, 476–640 m (29 v, M.9157). Taiaroa Canyon, NE of Otago Peninsula: 45°45.4'S, 171°05'E, 549 m (40 v, M.9091); 45°45.6'S, 171°05'E, 549 m (3 v, M.12860); 45°46'S, 171°03'E, 660 m (many v, M.58533). Papanui Canyon, off Taiaroa Head: 45°51.65'S, 171°00.86'E, alive, 620–340 m (many pr, M.173009). Off Otago Peninsula, 45°50.85'S, 171°01.71'E, alive, 555–604 m (1 pr, 5 v, M.155388). Saunders Canyon, off Otago Peninsula: 45°55'S, 170°56'E, 421 m (3 v, M.26305); 45°55.2'S, 170°56.4'E, 457 m (1 v, M.9415); 45°56'S, 170°54'E, 360 m (3 v, M.48842).



**FIGURE 23.** Propeamussiidae. *Cyclopecten delli* n. sp., head of Karitane Canyon, off Otago Peninsula, 530–585 m. **A.** Holotype, M.155920 (lv, height 3.60 mm). **B–D, F.** Paratypes, M.51155 (B, D, rv, height 3.20 mm; C, lv). **E.** Left valve of juvenile removed from brood of a paratype. **F.** Dorsal view of prodissoconch of paratype: right valve on right side. Scale bars 100  $\mu$ m (C), 300  $\mu$ m (D) and 100  $\mu$ m (E, F).

### Description

Shell up to 5 mm wide, subcircular, juveniles circular, adults broader than high and slightly oblique posteriorly, equivalve (broad, thin ventral margin of right valve disintegrating post mortem: thickened inner part 76–80% height of left valve), left valve somewhat more convex than right valve, umbonal angle c. 110°; typically opaque white in umbonal area, elsewhere colourless and translucent.

Prodissoconch 310–370 µm long (brooded), D-shaped (i.e. valve margins), sharply bounded by commarginal lamella; PI c.120 µm long, D-shaped, flattened, smooth, bounded by rounded rim; PII convex, sculptured with crowded, crisp punctae, outer surface glossy, surface within pits matt.

Dissoconch left valve sculpture commencing immediately, crisp; comprising widely and somewhat irregularly spaced, thin commarginal lamellae, and much finer, more closely spaced radial threads (16–20 per mm on central disc). Commarginal sculpture progressively weakening ventrally, typically becoming obsolete after shell attains 1–2 mm in height, rarely persisting to maturity, or obsolete when as small as 0.6 mm. Radial sculpture typically persisting throughout, becoming obsolete in few specimens. Posterior auricle slightly larger than anterior; anterior auricle with closely spaced, commarginal lamellae and delicate radial lirae; posterior auricle with fine radial or reticulated sculpture.

Right valve disc and all but dorsal border of posterior auricle with outer layer of commarginally elongate, hexagonal prisms that form broad, flexible ventral apron. Posterior auricle typically with up to 5 radial threads on dorsal third. Anterior auricle reticulately sculptured throughout with crowded commarginal lamellae and finer radial threads. Byssal notch of moderate depth, byssal fasciole rather broad.

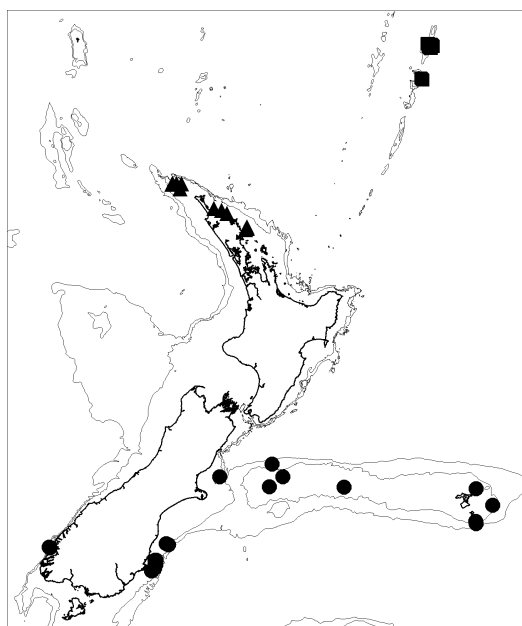
### Distribution

Eastern South Island and Chatham Rise, New Zealand, 117–1006 m; taken alive at 146–585 m from muddy substrata (Fig. 24).

### Remarks

*Cyclochlamys delli* resembles *Cc. favus* and *Cc. aupouria* in gross dissoconch morphology, differing from *Cc. favus* in being less oblique, in having weaker commarginal lamellae on the left valve that tend to obsolescence in late ontogeny, and in having stronger radial threads, and from *Cc. aupouria* in being more finely sculptured. *Cyclochlamys delli* differs most markedly from both these species, however, in size, shape and sculpture of the prodissoconch (Figs 20F, 23C).

One of the adult paratypes was opened to reveal a number of shelled young, all about 270 µm wide. These larvae had pitted sculpture throughout and none had a thickened rim. Since prodissoconchs on metamorphosed specimens are up to 370 µm wide, it would seem that there is some incremental growth prior to hatching, presumably of the narrow zone outside the pitted area, up to and including the commarginal varix (evidently the prodissoconch/dissoconch boundary).



**FIGURE 24.** Map showing distribution of ● *Cyclochlamys delli* n. sp., ▲ *Cyclochlamys irregularis* n. sp. and ■ *Cyclochlamys lemchei* (Powell, 1958).

### Etymology

In honour of the late Richard Kenneth (Dick) Dell, former malacologist of the Dominion Museum (now Museum of New Zealand Te Papa Tongarewa), Wellington.

### *Cyclochlamys irregularis* n. sp.

Figs 24, 25A–E

### Type material

Holotype (1 v) NMNZ M.183889, and paratypes (50 v, M.155423; 3 v, ZMA Moll. 4.07.003); off Whangaroa Bay, 34°54.0'S, 173°42.6'E, 83 m, 26 Jan. 1981, RV *Tangaroa*.

### Material examined

The type material (see above). Off Three Kings Islands: Middlesex Bank, 33°59.9'S, 171°45.3'E, 186–196 m (3 v, M.112824); Three Kings Trough, 34°00'S, 171°55'E, 805 m (1 v, M.155884); 34°01'S, 172°07'E, 622 m (1 v, M.34984); Middlesex Bank, 34°02.0'S, 171°44.0'E, 246–291 m (1 v, M.107600); 34°02.1'S, 171°45.8'E, alive, 221–206 m (1 pr, M.155886); submarine cave, S side of Rosemary Rock, Princes Islands, 34°10.5'S, 172°04.0'E, 20 m (10 v, M.117157); Arch Pinnacle, Princes Islands, 34°10.5'S, 172°03.0'E, 44 m (2 v, M.155419); Arch Pinnacle, 34°10.5'S, 172°03.0'E, 38 m (1 v, M.155420); off N face of Hinemoa Island, 34°10.8'S, 172°02.6'E, 23 m (1 v, M.155415). Matai Bay reef, Karikari Peninsula, 34°50'E, 173°25'S, 42 m (2 v, M.155416). Off Cavalli Islands, 91 m (1 v, M.111944). Poor Knights Islands: (5 v, M.112225; Middle Arch, Tawhiti Rahi, 35°28'S, 174°44'E, 30 m (2 v, M.119444); Northern Arch, TeAraara Point, 35°27'S, 174°44'E, 50 m (3 v, M.155421); South Harbour, Aorangi Island, 35°29'S, 174°44.5'E, 25 m (2 v, M.155422); Riko Riko Cave, Aorangi Island, 35°29'S, 174°44'E, 30 m (6 v, M.155417); off Ngoio Rock, 35°29.5'S, 174°44.2'E, 30 m (5

v, M.155418); 35°32'S, 174°41'E, 121–113 m (9 v, M.35907).

#### Description

Shell up to 3 mm wide, inequilateral, posteriorly oblique, about as wide as high, translucent white. Outline irregular, variable, and typically changing during ontogeny, commonly associated with change in spacing of commarginal lamellae and direction of radial riblets (habitat constriction).

Prodissoconch c. 300 µm long, boundary unclear, but possibly outermost of 2 earliest commarginal ridges following PI, roundly conical; PI c. 150 µm long, D-shaped (i.e. valve margins), swollen, bounded by rounded, flange-like rim with concave dorsal surface, sculptured with 5 rounded radial ridges, median strongest and gently inclined posteriorly; PII weakly convex, sculptured with fine, crisp, irregularly anastomosing radial threads.

Dissoconch left valve disc and auricle sculpture commencing immediately, crisp; comprising widely and rather irregularly spaced, high, narrow, commarginal lamellae, traversed by slightly finer radial riblets (c. 12 per mm on central disc) that multiply by intercalation, small rounded nodules at intersections; interspaces more or less as wide as those of the commarginal lamellae, widest over centre of disc. Posterior auricle distinctly larger than anterior auricle.

Right valve disc and all but dorsal border of posterior auricle with outer layer of commarginally elongate, hexagonal prisms. Anterior auricle with low commarginal ridges and up to 6 radial threads that multiply by intercalation, intersections finely nodular. Byssal notch of moderate depth, byssal fasciole rather broad.

#### Distribution

Off Three Kings Islands and NE North Island, New Zealand, 20–622 m (shells only) (Fig. 24).

#### Remarks

*Cyclochlamys irregularis* differs from the superficially similar species *Cc. aupouria*, *Cc. delli* and *Cc. wanganellica* in having more widely spaced radial riblets that form small nodules where crossing the commarginal lamellae, and in prodissoconch sculpture. *Cyclochlamys irregularis* is also somewhat similar to *Cc. transenna* (allopatric), but differs principally in being less oblique, and in having finer nodules at the intersections of the primary sculptural elements on the left valve. A somewhat similar species from Fiordland and the Antipodes Islands is *Cc. austrina* n. sp., described above. Although paired individuals of *Cc. irregularis* are unknown, there seems little doubt that dissociated right and left valves at the type locality are conspecific because left valves of no other *Cyclochlamys* (or *Cyclopecten*) species occurred with them.

#### Etymology

Irregular (Latin), alluding to the shape variation within and between specimens.

### *Cyclochlamys lemchei* (Powell, 1958)

Fig. 24, 25F–I

*Chlamydella favus lemchei* Powell, 1958: 70, pl. 9, figs 7, 8.

*Cyclochlamys lemchei*.—Dijkstra & Marshall, 1997: 85, pl. 5, figs 1–12 (discussion); Brook & Marshall, 1998: 212; Dijkstra, 2001: 88, figs 27, 28, 36–38.

#### Type material

Holotype ZMUC BIV-39; off Raoul Island, Kermadec Islands, 29°15'S, 177°05'W, 75–85 m, 3 Mar. 1952, RRS *Galathea* (stn 674).

#### Material examined

The holotype (see above), and other material listed by Dijkstra and Marshall (1997: 85).

#### Description

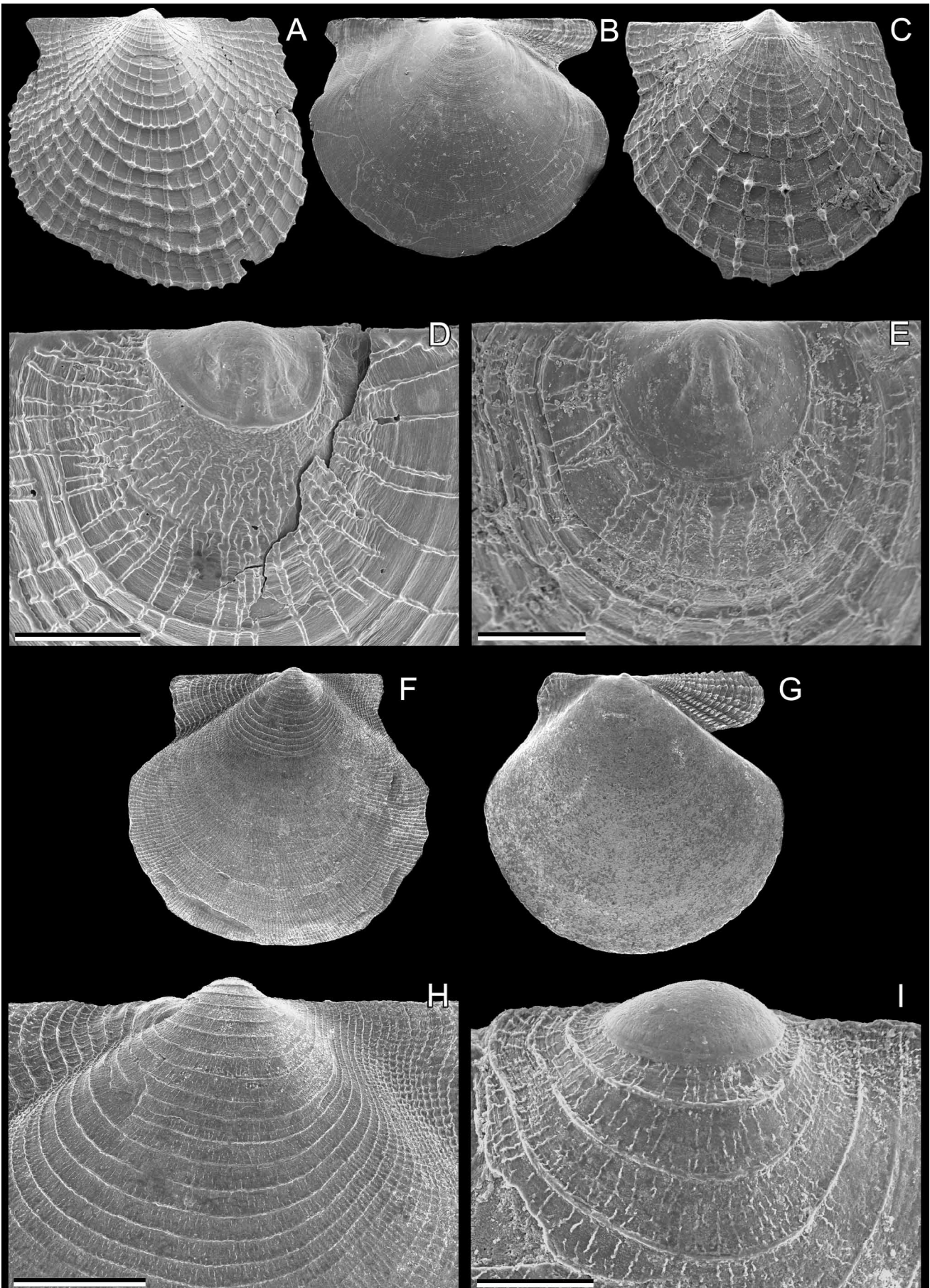
Shell up to 6.22 mm wide, about as wide as high, subcircular, equivalve (relatively narrow, thin ventral margin of right valve disintegrating post mortem: thickened inner part 93–95% height of left valve), left valve more convex than right valve. Left valve with extremely variable, highly irregular colour pattern of yellowish or reddish brown, orange, and opaque white streaks, spots, maculations and chevrons on a translucent ground; right valve translucent white. Some specimens with single internal radial rib at posterior end on one or both valves.

Prodissoconch-dissoconch boundary unclear, but probably represented by third commarginal lamella at about 300 µm length; PI smooth, convex; PII crisply sculptured with 3 commarginal growth lamellae and fine, wavy, broken radial threads.

Dissoconch left valve dissoconch disc densely covered with numerous, fine, crisp, radial threads that gradually resolve over first 1 mm shell height, multiplying by intercalation, very gradually enlarging and parting, splaying increasingly outwards with increasing shell size in 'camptonectes' pattern; early disc up to about 1.20 mm shell length additionally with crisp, widely and rather regularly spaced commarginal riblets that are stronger than intersected radial threads. Anterior auricle distinctly larger than posterior one. Anterior auricle with crisp, widely and rather regularly spaced commarginal lamellae that intersect oblique radial riblets with interspaces about as wide as those of commarginal lamellae, these superimposed on yet finer, more densely crowded radial threads. Posterior auricle with fine, crisp, crowded radial riblets, parallel to dorsal margin dorsally, oblique ventrally, intersected by crisp, broken commarginal lamellae.

Right valve disc and ventral half of posterior auricle with outer layer of commarginally elongate, hexagonal prisms that form relatively narrow, flexible ventral apron; dorsal margin serrate. Anterior auricle with rather regularly spaced commarginal lamellae, and up to 8 radial threads that multiply by intercalation, intersections with erect, rounded scales. Posterior auricle with fine, crisp, crowded radial threads covering dorsal half.





**FIGURE 25.** Propeamussiidae. **A–E.** *Cyclopecten irregularis* n. sp. **A, D.** Whangaroa Bay, 83 m, holotype (lv, height 1.80 mm). **B.** Whangaroa Bay, 83 m, paratype, M.155423 (rv, height 1.70 mm). **C, E.** Middlesex Bank, Three Kings Islands, 206–221 m, M.155886 (lv, height 1.20 mm). **F–I.** *Cycloclamys lemchei* (Powell, 1958), off Smith Bluff, Raoul Island, Kermadec Islands, 82–100 m, M.227157 (**F, H**, lv, height 3.73 mm; **G, I**, rv, height 3.40 mm). Scale bars 100  $\mu$ m (**D, E, I**) and 500  $\mu$ m (**H**).

## Distribution

Wallis and Futuna (Dijkstra 2001), and Kermadec Islands, 27–420 m; taken alive at 82–165 m. Shells locally common (Fig. 24).

## Remarks

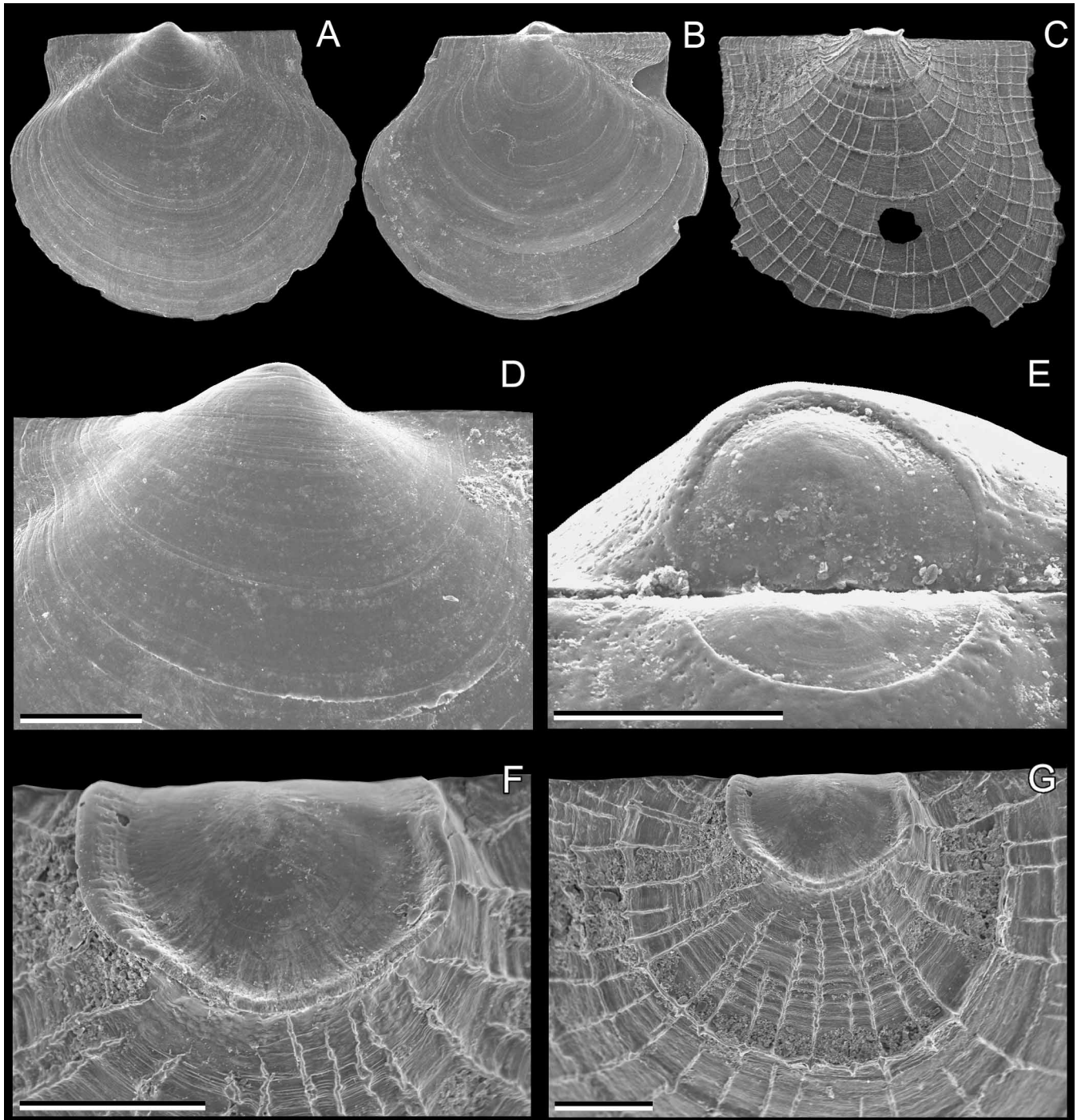
*Cycloclamys lemchei* is distinctive among known *Cycloclamys* species in the combination of relatively large size (width up to 6.22 mm) strong, variable colour pattern, sculpture of numerous fine radial threads in ‘camptonectes’ pattern, the relatively narrow flexible apron at the ventral

margin of the right valve, and in that some specimens have a single internal radial rib at the posterior end on one or both valves. Two valves from off Wallis and Futuna islands (Dijkstra 2001: 88, figs 27–28, 36–38) are indistinguishable from Kermadec Islands specimens.

***Cycloclamys mestayerae* (Dell, 1956) n. comb.**

Figs 26A, B, D, E, 27

*Cyclopecten mestayerae* Dell, 1956: 24, figs 36, 39; Powell, 1979: 380, figs 93/7, 8.



**FIGURE 26.** Propeamussiidae. A, B, D, E. *Cyclopecten mestayerae* (Dell, 1956): A, D, N of North Cape, 163–168 m, M.107585 (lv, height 2.25 mm). B, E, N of Great Island, Three Kings Islands, 155 m, M.93499 (rv, height 1.90 mm; E, rv upper). C, F, G. *Cycloclamys munida* n. sp., Bradshaw Basin floor, Bradshaw Sound, 415 m, holotype, M.138430 (lv, height 1.20 mm). Scale bars 200  $\mu$ m (D) and 100  $\mu$ m (E–G).

## Type material

Holotype (1 v) NMNZ M.9240, paratypes M.6550 (8 v); N of North Cape, 34°18'S, 173°02'E, 137 m, 8 Sep. 1914, J.P. Bollons, SS *Hinemoa*.

## Material examined

The type material (see above). Kiwi Seamount, N Three Kings Rise, 30°45'S, 173°51'E, alive, 538–545 m (2 pr, M.225338). Off Three Kings Islands: Middlesex Bank, 33°57.0'S, 171°45.4'E, NW alive, 98–103 m (2 pr, M.155391); 18 km N of Great Island, 33°59.2'S, 172°13.6'E, alive, 155 m (1 pr, M.93499); 34°01'S, 172°07'E, 622 m (1 v, M.155881); Middlesex Bank, 34°02.1'S, 171°45.8'E, alive, 221–206 m (3 pr, M.107570); off Northeast Island, 34°08.5'S, 172°11'E, alive, 102 m (1 pr, M.34562); 34°10'S, 172°12'E, alive, 252 m (3 pr, M.34217); 34°11'S, 172°10'E, alive, 91 m (1 pr, M.33811); S of Great Island, 34°14.1'S, 172°09.0'E, alive, 192–202 m (1 pr, M.107590). N of North Cape, 34°20.0'S, 173°06.6'E, alive, 163–168 m (1 pr, M.107585). E of North Cape, 34°23.0'S, 173°12.6'E, 447–357 m (1 v, M.107581); 34°25.0'S, 173°13.1'E, 327–257 m (1 v, M.107574). Off Whangaroa Bay, 34°54.0'S, 173°42.6'E, 83 m (14 v, M.155392). Off Twin Rocks, Bay of Islands, 35°10'S, 174°18'E, 46–73 m (1 v, M.42183). Off Ahipara, 35°10.4'S, 172°35.4'E, 233 m (8 v, M.107582). W of Poor Knights Islands, 35°32'S, 174°41'E, 121–113 m (many v, M.35906). SE of Aldermen Islands, 37°00.8'S, 176°12.3'E, alive, 178–248 m (many, M.66632). Off Mayor Island, 37°11.5'S, 176°10.0'E, alive, 198–273 m (2 pr, 6 v, M.66611); 37°15.2'S, 176°14.5'E, 188–193 m (2 v, M.60982). Rungapapa Knoll, W of White Island, 37°33.8'S, 176°59.0'E, alive, 188–228 m (2 pr, M.155390). NE Cape Farewell, 40°06'S, 172°12'E, 95–102 m (6 v, M.90260).

## Description

Shell up to 2.90 mm wide, subcircular, equivalve (broad, thin ventral margin of right valve disintegrating post mortem: thickened inner part 77–81% height of left valve), left valve more convex than right valve, umbonal area opaque white and commonly with irregular opaque white radial streaks, elsewhere colourless and perfectly transparent.

Prodissoconch globular, smooth apart from growth lines and a few minute punctae; tip an area c. 150 µm long bounded on left valve by thickened rim, and right valve by growth line; prodissoconch-dissoconch boundary indistinct, though possibly represented by commarginal growth line at c. 300 µm length.

Dissoconch left valve glossy throughout, smooth apart from fine commarginal growth lines and obscure radial lines. Auricles of similar size.

Right valve disc and ventral half of posterior auricle with outer layer of commarginally elongate, hexagonal prisms that form broad, flexible ventral apron. Anterior auricle with fine, close commarginal growth lines, some specimens with 2–4 weak radial rows of scales. Byssal notch of moderate depth, byssal fasciole rather broad.

## Distribution

Three Kings Islands, N North Island, and NE South Island, New Zealand, 73–447 m; taken alive at 91–252 m (Fig. 27).

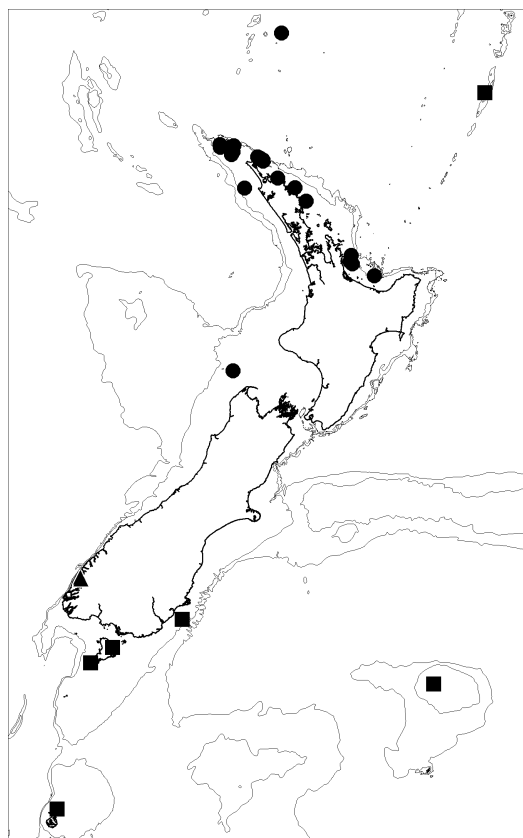


FIGURE 27. Map showing distribution of ● *Cycloclamys mestayerae* (Dell, 1956), ▲ *Cycloclamys munida* n. sp. and ■ *Cycloclamys pileolus* n. sp.

## Remarks

Although originally referred to *Cyclopecten*, *Cc. mestayerae* has the right valve microstructure characteristic of *Cycloclamys*, so we transfer it to this genus. *Cycloclamys mestayerae* is distinctive among *Cycloclamys* species from the New Zealand region in that the dissoconch left valve is smooth. A specimen from off the Three Kings Islands (M.34217) had a brood of 11 young, of which seven were about 170 µm wide, and four about 270 µm wide.

Two specimens taken alive in the Bounty Trough (NIWA S153) appear to be identical to northern specimens in shell morphology, but one is considerably larger (length 4.00 mm versus 2.90 mm), and they were living at considerably greater depth (1386 m versus 91–252 m), suggesting the possibility that they may represent a similar but distinct allopatric species.

***Cycloclamys munida* n. sp.**

Figs 26C, F, G, 27

## Type material

Holotype (1v) NMNZ M.138430; Bradshaw Basin floor, Bradshaw Sound, SW South Island, New Zealand, 45°17.3'S, 167°02.6'E, 415 m, 31 May 1997, RV *Munida*.

Paratypes: Thompson Basin floor, Thompson Sound, 45°14.38'S, 166°58.87'E, 340–362 m (2 v, M.150527).

#### Material examined

The type material (see above).

#### Description

Shell up to 2.15 mm high, slightly posteriorly oblique, about as wide as high, translucent white.

Prodissoconch 430 µm long, bounded by strong, flange-like commarginal lamella, roundly conical; PI 200 µm long, D-shaped (i.e. valve margins), smooth, weakly swollen, bounded by prominent upturned flange with rounded rim; PII sides weakly concave, reticulately sculptured with crisp radial threads, and weaker, closer, less sharply defined commarginal riblets.

Dissoconch left valve disc and auricle sculpture commencing immediately, crisp; comprising widely and rather irregularly spaced, narrow, commarginal lamellae, traversed by slightly finer radial riblets that multiply by intercalation and curve in 'camptonectes' pattern, very small rounded nodules at intersections; interspaces widest over centre of disc. Posterior auricle distinctly larger than anterior auricle.

Right valve unknown.

#### Distribution

Bradshaw Sound, New Zealand, 340–415 m, shells only (presumably living on the fjord walls, and quite likely to have been translocated down them) (Fig. 27).

#### Remarks

Compared with young specimens of *Cycloclamys aupouria* (allopatric), which it most resembles, *Cc. munida* differs in having a larger PI (width 200 µm versus 170 µm) with a broadly rounded rather than strongly projecting central area, in that PII, though of similar size, has only a single (terminal) commarginal lamella, and in that the commarginal lamellae on the dissoconch are weaker and distinctly nodular at intersections with the radial riblets and curve in a camptonectes pattern. *Cycloclamys aupouria* and *Cc. munida* (like perhaps *Cc. irregularis* and *Cc. austrina*) may be allopatric phylogenetic sister taxa.

#### Etymology

After Otago University's research vessel *Munida*, from which the type material was dredged (noun in apposition).

#### *Cycloclamys pileolus* n. sp.

Figs 27, 28

#### Type material

Holotype (pr, height 1.5 mm, width 1.4 mm, thickness 0.5 mm) NMNZ M.155879, Halfmoon Bay, Stewart Island, New Zealand, alive, 27 m, E.C. Smith, Dec. 1955. Paratypes: off Taieri, S of Dunedin, 46°15.0'S, 170°29.0'E, alive, 91 m (1 pr, M.66281); off Flat Rock, Foveaux Strait, alive, 18 m (2 pr, M.63969); off Poutama Island, Big South Cape Island, Stewart Island, 47°16'S, 167°23'E, 55 m (2 v, M.155880).

#### Material examined

The type material (see above). Seamount 130 km S of Esperance Rock, Kermadec Ridge, NE New Zealand, 32°28.3'S, 179°15.9'W, 538 m, 15 Apr. 1997, FV *Santa Maria*, coll. N. Mitchell, from foraminiferal ooze in cavities in longlined block bryozoan/shell limestone hardground (1 v, M.137540). Proclamation Island, Bounty Islands, 47°42'S, 179°05'E, 39 m (1 pr, 3 v, M.155460). Off Rose Island, Auckland Islands, 50°31.45'S, 166°15.1'E, 20 m (2 v, M.173800).

#### Description

Shell up to 1.50 mm high, suborbicular, weakly posteriorly oblique, equivalve (relatively narrow, thin ventral margin of right valve disintegrating post mortem: thickened inner part 70–77% height of left valve), inequilateral, left valve rather strongly convex, right valve weakly convex, auricles slightly equal in shape and size (anterior slightly larger), translucent white.

Prodissoconch very prominent, acutely conical, 370 µm long; PI 150 µm long, finely malleated, surmounted by prominent, rounded, median dorsal ridge; PII finely malleated, with obscure radial threads and commarginal lines, and with prominent, rounded ridge that extends posteriorly and obliquely from centre.

Dissoconch left valve disc and auricles sculptured with very strong, ventrally sloping commarginal lamellae, and weak radial riblets (6–8, including 1 on posterior auricle) that commence 0.5 mm below tip of prodissoconch and multiply by intercalation, with strong, rounded, fingernail-like scales at intersections; interspaces of commarginal ribs almost linear grooves before appearance of radials, about as wide as each rib thereafter.

Right valve disc and ventral half of posterior auricle with outer layer of commarginally elongate, hexagonal prisms that form broad, flexible ventral apron. Anterior auricle with weak commarginal near margin. Byssal notch moderately deep.

#### Distribution

SE South Island, Foveaux Strait, and Stewart, Auckland and Bounty islands, S New Zealand, taken alive at 18–91 m from clean, bryozoan/shell substrata (Fig. 27).

#### Remarks

*Cycloclamys pileolus* is distinctive in the combination of small size (height up to 1.50 mm), very strong commarginal lamellae and scales, and prominent, acutely conical prodissoconch. *Cycloclamys bacata* has a similar prodissoconch though entirely different dissoconch sculpture.

The largest of the four specimens known from the Bounty Islands (heights 0.80 mm and 0.81 mm) have no trace of radial sculpture or scales, yet are identical to Stewart Island specimens in all other respects.

The single valve from the Kermadec Ridge was among loosely consolidated calcareous material washed from cavities in a block of bryozoan/shell limestone (hardground),

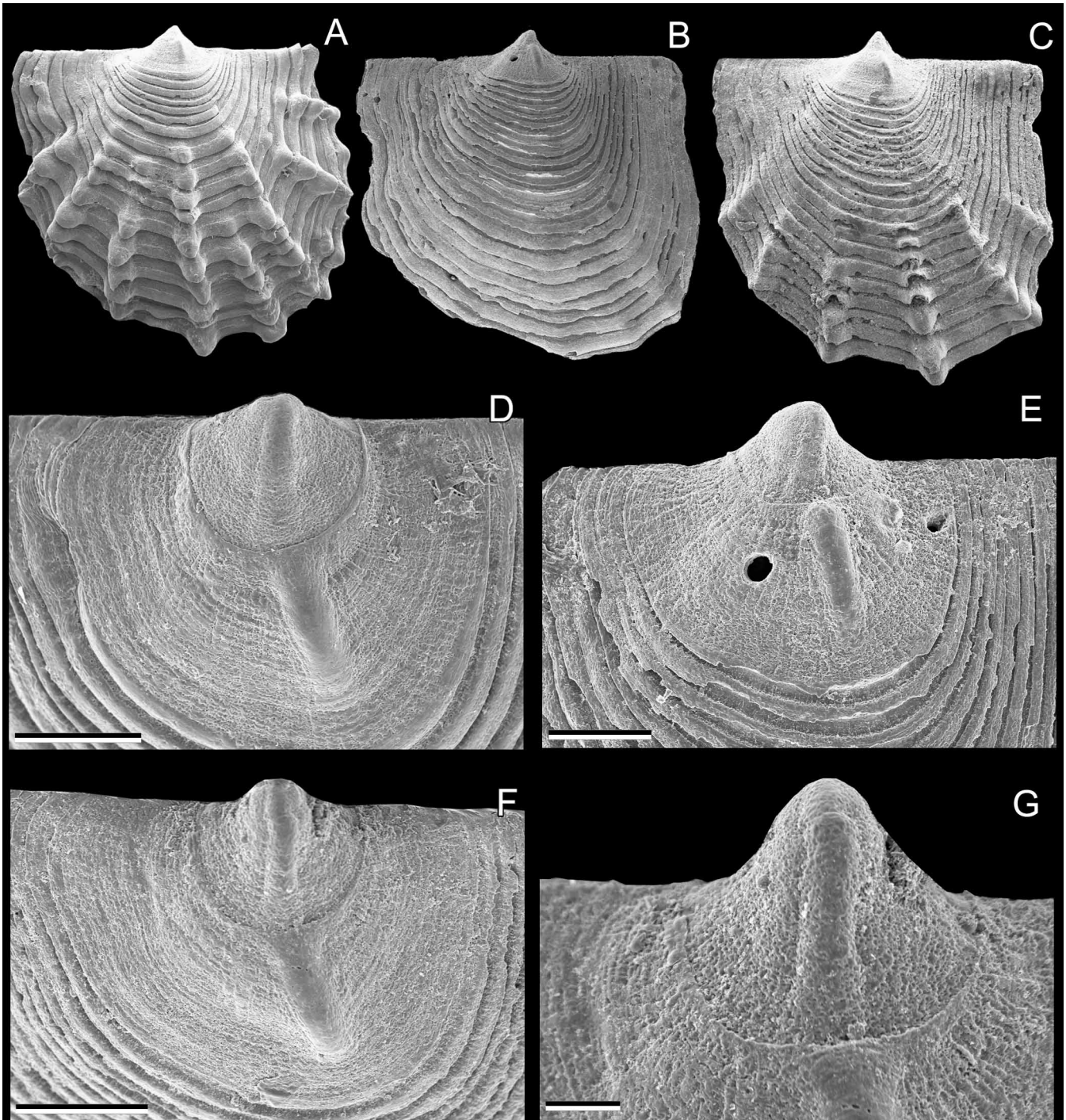


the cemented part of which includes shells of some molluscs that clearly lived at considerably shallower depths, notably *Barbatia novaezelandiae* (E.A. Smith, 1915), *Mesopeplum convexum* (Quoy & Gaimard, 1835), *Modelia granosa* (Martyn, 1784), and *Maoricolpus roseus* (Quoy & Gaimard, 1834), probably dating from a late glacial maximum. We presume that the specimen of *C. pileolus* is approximately

contemporaneous, and ranged further north than at present during glacial maxima.

#### Etymology

From the Latin *pileus* (cap), alluding to the acutely conical prodissoconch.



**FIGURE 28.** Propeamussiidae. *Cycloclamys pileolus* n. sp. **A, D.** Halfmoon Bay, Stewart Island, 27 m holotype, M.155879 (lv, height 1.5 mm). **B, E.** off Rose Island, Auckland Islands, 20 m, M.173800 (lv, height 1.20 mm). **C, F, G.** seamount 130 km S of Esperance Rock, Kermadec Ridge, 538 m, M.137540 (lv, height 1.15 mm). Scale bars 100 µm (D–F) and 30 µm (G).

#### *Cycloclamys transenna* (Suter, 1913)

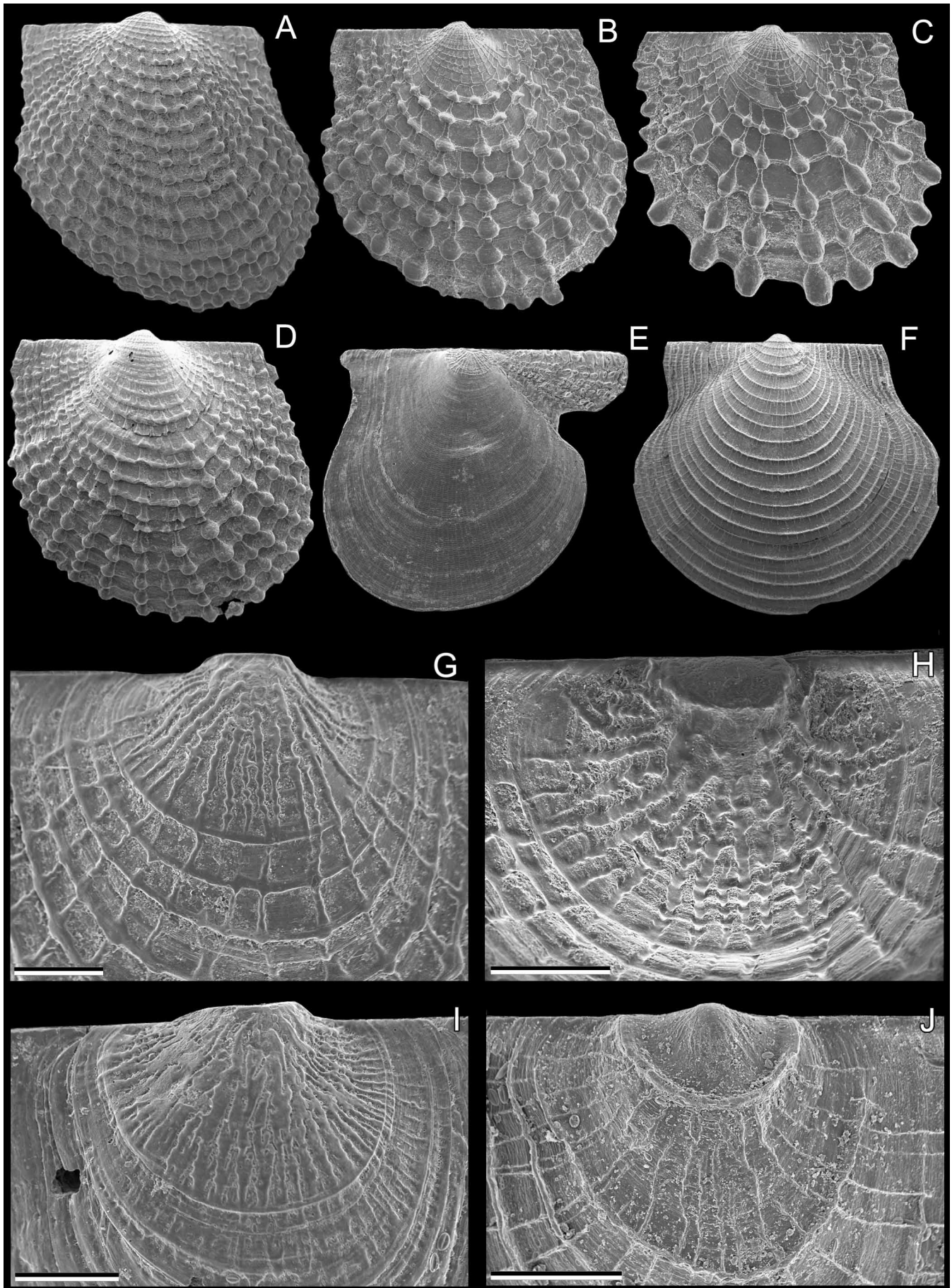
Figs 29A–E, G–I, 30

*Pecten* (*Pseudamusium*) *transenna* Suter, 1913: 881, pl. 52, fig. 3.

*Cyclopecten transenna*.—Iredale, 1915: 486; Dell, 1956: 22, pl. 4, figs 32, 33, 38; Powell, 1976: 124; Powell, 1979: 380, figs 93/3, 4.

*Cycloclamys transenna*.—Finlay, 1926: 452.





**FIGURE 29.** Propeamussiidae. **A–E, G–I.** *Cycloclamys transenna* (Suter, 1913). **A–C, E, G, H.** bay S side of Charles Sound entrance, 26 m, M.139878 (**A**, lv, height 2.35 mm; **B**, lv, height 1.55 mm; **C**, lv, height 1.50 mm; **E**, rv, height 1.48 mm). **D, I.** Ranfurly Bank, East Cape, 56–63 m, M.107588 (lv, height 1.85 mm). **F, J.** *Cycloclamys wanganellica* n. sp., Wanganella Bank summit, West Norfolk Ridge, 113 m, holotype, M.158254 (lv, height 2.05 mm). Scale bars 100  $\mu$ m.

*Cyclopecten (Cycloclamys) transenna*.—Powell, 1937b: 56.

*Cyclopecten (Cycloclamys) transennus*.—Powell, 1946: 57.

*Cyclopecten transennus*.—Boreham, 1959: 11.

#### Type material

Holotype (lv) NZGS TM.215, 8 paratypes NMNZ M.10949; near Snares Islands, New Zealand, 91 m.

#### Material examined

The type material (see above). **Fossil.** Ohope (W15/644519). Shellbeds below old reservoir in stream at foot of Ohope–Whakatane road, 1970–71, Late Pleistocene (Castleciffian). **Recent.** Off E side of Ruamahua-nui Island, Aldermen Islands, 36°57.2'S, 176°05.8'E, 38 m (1 pr, M.112761). Ranfurly Bank, East Cape: 37°36.7'S, 178°51.6'E, alive, 56–63 m (1 pr, M.107588); 37°32.8'S, 178°48.7'E, alive, 94 m (1 pr, M.60710). Lyall Bay, Wellington (many v, M.1416). Black Reef, The Steeples, off Westport, 41°43.48'S, 171°28.19'E, 1–3 m (1 v, M.152414). Chatham Islands: Kaingaroa, beach (1 v, M.12500); Ocean Bay, 43°50'S, 176°47'W, 12–15 m (1 v, M.155380). Abbey Rocks, NE of Haast, 43°41.15'S, 169°20.02'E, 7–11 m (1 v, M.152325). Akaroa Harbour entrance, 43°54'S, 172°57'E, 27 m (1 v, M.54179). NE end of Taumaka Island, Open Bay Islands, off Haast, 43°51.5'S, 168°52.5'E, 6 m (1 v, M.130389). Inner NE side of Jackson Head, 43°57.63'S 168°37.47'E, 8–12 m (2 v, M.155379). Off Seal Rocks, W of Jackson Bay, 43°59.56'S 168°31.45'E, 14–17 m (2 v, M.151829). Milford Sound: 44°34.0'S, 167°45.0'E, 81 m (7 v, M.10361); St Anne Bay, 44°34.5'S, 167°47.0'E, 10–14 m (4 v, M.142844). Bligh Sound: 44°48'S, 167°32'E, 46 m (7 v, M.10197); off Turn Round Point, 44°48.0'S, 167°32.5'E, 31 m (20 v, M.141565). Outer George Sound, 44°52'S, 167°22'E, 32 m (2 v, M.139314). Two Thumb Bay, 44°57.3'S, 167°11.0'E, 15 m (2 v, M.139268). Caswell Sound mouth, 45°00.0'S, 167°08.3'E, 37 m (3 v, M.140189). Deep bay S side of Charles Sound entrance, 45°03.5'S, 167°05.0'E, 26 m (many v, M.139878). Inside Entrance Island, Nancy Sound, 45°06.2'S, 167°01.2'E, 12 m (1 v, M.140638). Doubtful Sound: off Shelter Island No. 2, 45°17.0'S, 166°53.0'E, 27 m (30 v, M.143032); bay N side of W end of Bauza Island, 45°17.0'S, 166°54.5'E, 20 m (1 pr, 30 v, M.141749); Gaol Passage, 45°17.5'S, 166°54.0'E, 46 m (1 v, M.13756). Bradshaw Basin floor, Bradshaw Sound, 45°17.3'S, 167°02.6'E, 415 m (2 v, M.138403). Off Seventy Fathoms Point, Dags Sound, 45°25.0'S, 166°52.5'E, 20 m (1 v, M.139985). Between unnamed island and Breaksea, Breaksea Sound entrance, 45°35.2'S, 166°39.0'E, 37 m (5 v, M.13834). Wet Jacket Arm, S side of entrance, 45°40.2'S, 166°44.8'E, 42 m (1 v, M.141905). Off “30 fathom” point, inside Five Fingers Peninsula, 45°43.2'S, 166°29.5'E, 37 m (1 pr, 1 v, M.135870). “104 fathom point”, Bowen Channel, Dusky Sound, Chalky Inlet, 45°43.0'S, 166°45.0'E, 10–17 m (7 v, M.143636). Foveaux Strait: off Breaksea Island, alive, 55–64 m (6 pr, M.19843); off Fife Rock, near Ruapuke Island, 7–9 m (3 v, M.19839); fishing grounds, 37 m (2 v, M.19840). Stewart Island: off Faro Island, alive, 55 m (many pr, M.19244); Codfish Island (1 v, M.19842); Chew Tobacco

Bay, alive, 18 m (12 pr, M.16875); Smoky fishing grounds, near The Saddle, alive (6 pr, M.9822). Stewart Island: Halfmoon Bay, alive, 27 m (1 pr, M.64644); Bathing Beach (1 v, M.19841; 2 v, M.10321); Mason Bay (1 v, M.4974); Port Adventure, 46–64 m (1 pr, M.19838); Port Adventure, 95 m (1 v, M.42471); off Poutama Island, Big South Cape Island, 55 m (45 v, M.19837). Snares Islands: off “The Breaks”, 48°00.9'S, 166°36.75'E, 33–37 m (many v, M.107578); off Western Chain, 48°03'S, 166°30'E, alive, 70–110 m (5 pr, 3 v, M.135682). E side of Perpendicular head, Antipodes Islands, 19 m (3 v, M.155378). Off Bounty Islands: 73 m (1 v, M.8546); Proclamation Island, 47°42'S, 179°05'E, 39 m (1 v, M.119748). Auckland Islands: Deas Head, 50°31.52'S, 166°13.52'E, 13–18 m (9 v, M.155382); Ocean Island, 50°51.43'S, 166°15.43'E, 13–19 m (9 v, M.155381).

#### Description

Shell up to 3.50 mm high (rarely larger than 2.50 mm), adults higher than wide, vice versa, or about as high as wide, equivalve (broad, thin ventral margin of right valve disintegrating post mortem: thickened inner part 78–83% height of left valve), markedly posteriorly oblique, left valve more convex than right valve, auricles rather smoothly confluent with disc, colourless and translucent.

Prodissoconch 400–430 µm long, boundary ill-defined though apparently a growth line shortly after second or third commarginal ridge on PII; PI D-shaped (i.e. valve margins), c. 120 µm long, essentially smooth, tip weakly convex, bounded by prominent, rounded ridge; PII convex, sculpture merging smoothly with that of adjacent dissoconch, comprising fine, crisp radial threads, locally finely nodular at intersections with weak commarginal ridges, outer part with addition of 2 or 3 crisp commarginal ridges.

Left valve disc and auricle sculpture commencing immediately, crisp throughout; comprising rounded commarginal lamellae and radial threads of similar thickness, radials multiplying by intercalation, interspaces of similar width, intersections on disc with prominent, rounded, thin-walled, fingernail-like scales that strongly overhang their bases (deceptively resembling solid nodules in plan view). Rate of intercalation of radial riblets extremely variable, typically 8–22 on disc (range generally smaller within populations), scales typically larger on specimens with fewer (more widely spaced) riblets; occasional specimens (but commonly at Auckland, Antipodes and Bounty islands) eventually with up to 50 or more riblets on disc, and with few or no scales. Auricles of similar size, anterior auricle more nearly equiangular than posterior one.

Right valve disc and posterior auricle with outer layer of commarginally elongate, hexagonal prisms that form broad, flexible ventral apron. Posterior auricle typically with 1 weak radial thread close beside dorsal margin. Anterior auricle with 4 or 5 radial rows of rounded nodules. Byssal notch of moderate depth, byssal fasciole rather broad.

#### Distribution

Late Pleistocene and Recent. Aldermen Islands, East

Cape and Wellington, and South, Stewart, Snares, Bounty, Auckland and Chatham islands, New Zealand, 0–110 m; taken alive at 18–110 m (Fig. 30).

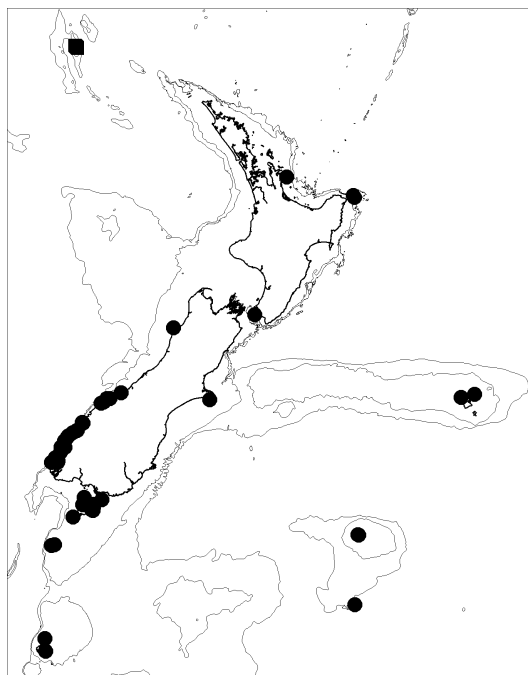


FIGURE 30. Map showing distribution of ● *Cycloclamys transenna* (Suter, 1913), and ■ *Cycloclamys wanganellica* n. sp.

#### Remarks

Typical specimens of *Cyclopecten transenna* are distinctive in the large size of the overhanging scales, where the radial riblets intersect the commarginal lamellae. Rare specimens (3) from off the Aldermen Islands and East Cape fall within the range of variation in southern populations in shell morphology, and are thus evidently conspecific. Sparse northern populations may be relict pockets dating from the last glacial maximum, when the species may have ranged further north than at present.

#### *Cycloclamys wanganellica* n. sp.

Figs 29F, J, 30

#### Type material

Holotype NMNZ M.158254 and 3 paratypes (2 pr, 1 v) M.107601; Wanganella Bank summit, West Norfolk Ridge, 32°34.4'S, 167°31.0'E, alive, 113 m, 29 Jan. 1981, RV *Tangaroa*. Paratypes: Wanganella Bank summit: 32°31.8'S, 167°29.5'E, alive, 113–118 m (2 pr, M.257182); 32°32.2'S, 167°30.7'E, alive, 113 m (3 pr, M.257273; 1 pr, ZMA Moll. 4.07.004); 32°32.6'S, 167°29.2'E, alive, 133 m (1 pr, M.107598).

#### Material examined

The type material (see above).

#### Description

Shell up to 2.55 mm wide, slightly wider than high, subcircular, equivalve (broad, thin ventral margin of right valve disintegrating post mortem: thickened inner part 84–

85% height of left valve), left valve more convex than right valve, umbonal area opaque white, few irregular, opaque white radial streaks on both valves, elsewhere colourless and translucent. Hinge line straight.

Prodissoconch 270 µm long (brooded), sharply bounded by commarginal lamella; PI c. 130 µm long, D-shaped (i.e. valve margins), weakly wrinkled, bounded by rounded rim, projecting tip roundly coeloconoid; PII convex, sculptured with crisp radial threads that are continuous with those of adjacent dissoconch.

Left valve disc and auricle sculpture commencing immediately, crisp; comprising widely and rather regularly spaced, high, thin commarginal lamellae, and much finer, more closely spaced radial threads (c. 24 per mm on central disc). Posterior auricle slightly larger than anterior one.

Right valve disc and all but dorsal border of posterior auricle with outer layer of commarginally elongate, hexagonal prisms that form broad, flexible ventral apron. Posterior auricle with low commarginal lamellae and 1 or 2 finer radial threads beside dorsal margin. Anterior auricle with low commarginal lamellae and 4 or 5 radial threads. Byssal notch of moderate depth, byssal fasciole rather broad.

#### Distribution

Wanganella Bank summit, West Norfolk Ridge, taken alive at 113–133 m from rhodolith gravel (Fig. 30).

#### Remarks

Among species with similar dissoconch facies, *Cycloclamys wanganellica* is distinctive in having a colourless, translucent shell with opaque white streaks. It differs further from *Cc. aupouria*, which has similar prodissoconch morphology, in that prodissoconch II has one rather than two commarginal lamellae, in attaining smaller size (width up to 2.55 mm versus 4.00 mm), and in having closer commarginal lamellae and finer radial sculpture on the dissoconch.

#### Etymology

After the type locality, Wanganella Bank.

#### Genus *Catillopecten* Iredale, 1939

*Catillopecten* Iredale, 1939: 347, 370. Type species (by original designation): *Pecten murrayi* E.A. Smith, 1885. Recent, Coral Sea, E of Cape York, 2561 m.

*Bathypecten* Schein-Fatton, 1985: 491. Type species (by original designation): *Bathypecten vulcani* Schein-Fatton, 1985; Recent, eastern Pacific, 2620 m.

#### Diagnosis

Propeamussiidae with translucent, fragile, subcircular shell, compressed, right valve more weakly convex than left valve; exterior surface of disc weakly undulating or even, with or without commarginal lamellae and fine radial threads. Auricles unequal, anterior auricle of right valve prominent and distinct, posterior auricle less well defined. Byssal notch deep, ctenolium absent. Outer prismatic calcite layer on right valve and foliated calcite layer on left valve.

Weak crossed-lamellar aragonite layer on interior shell surface near adductor scar.

#### Distribution

Recent. Atlantic, Indian and Pacific oceans at bathyal and abyssal depths.

#### Remarks

Schein (1988: 92; 1989: 81) distinguished *Bathypecten* from *Catillopecten* on the basis of the absence of commarginal sculpture in *B. vulcani* (which, however, is present in *C. murrayi*), and because the early dissoconch surface is gently undulating rather than more or less even as

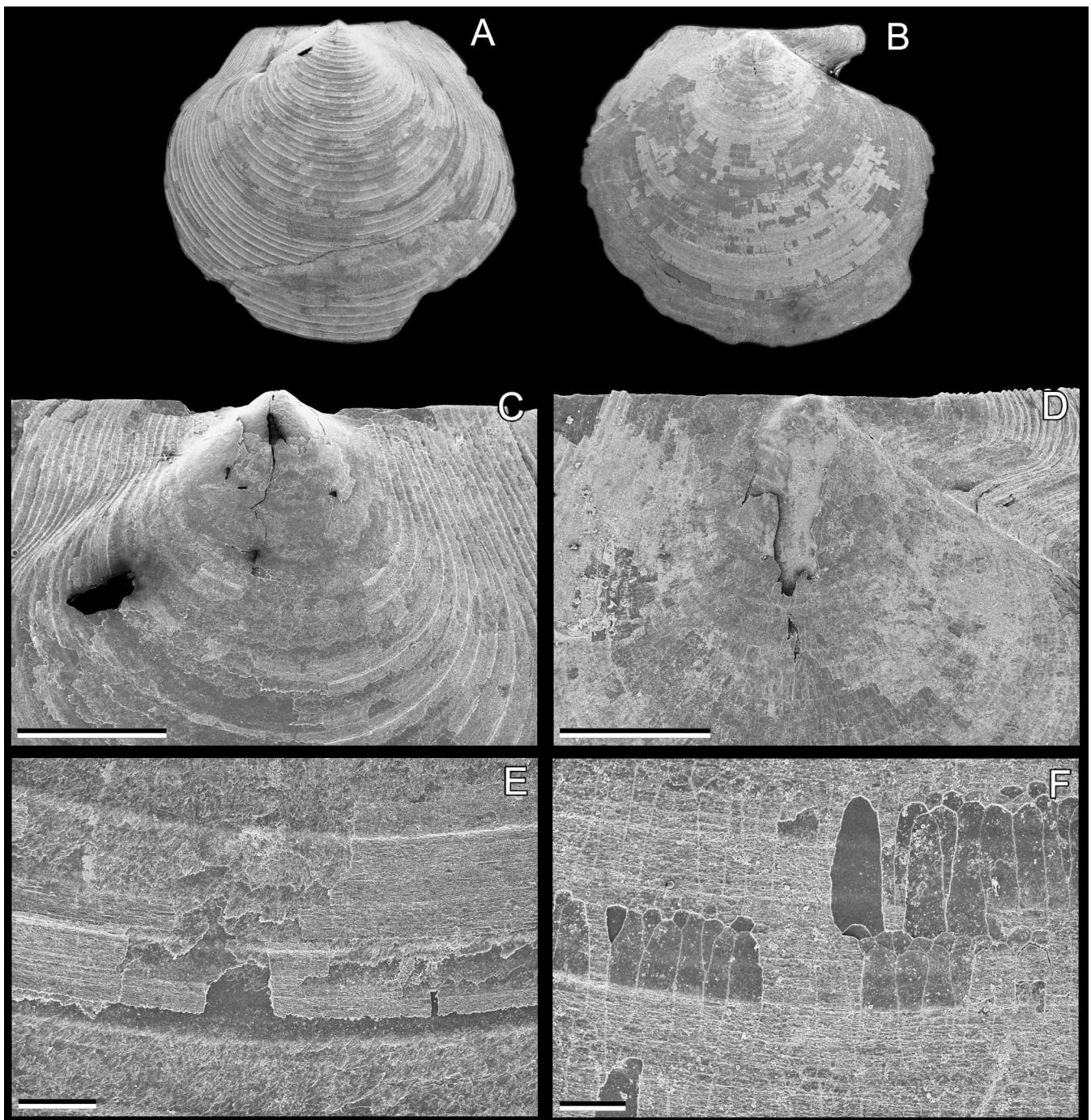
in *C. murrayi*. Both of these character states, however, are highly variable in *Catillopecten* species, based on extensive material examined (BMNH, MNHN, ZMA, ZMUC). Both type species have a distinct byssal gape on the dissoconch at all stages of growth (Waller 1984: 214), and extremely similar microsculpture. Accordingly we consider *Bathypecten* to be a synonym of *Catillopecten*.

#### *Catillopecten murrayi* (E.A. Smith, 1885)

Figs 31, 33

*Pecten murrayi* Smith, 1885: 303, pl. 22, figs 1–1a.

*Catillopecten murrayi*.—Iredale, 1939: 347, 370.



**FIGURE 31.** Pectinidae. *Catillopecten murrayi* (E.A. Smith, 1885), Lord Howe Rise, 2928–2930 m, NIWA U195 (A, C, E, lv, height 10.6 mm; B, D, F, rv, height 9.90 mm). Scale bars 1 mm (C, D), 200  $\mu$ m (E) and 100  $\mu$ m (F).



## Type material

Holotype BMNH 1887.2.9.3281; E of Cape York, N Queensland, Australia, 12°08'S, 145°10'E, alive, 2561 m, 29 Aug. 1874, HMS *Challenger* (stn 184).

## Material examined

The holotype (see above). Lord Howe Rise, 34°31.5'S, 166°21'E, 2928–2930 m (2 v, M.274123; 2 v, NIWA U195).

## Distribution

Coral Sea and Lord Howe Rise, 2561–2930 m; living at 2561 m (Fig. 33).

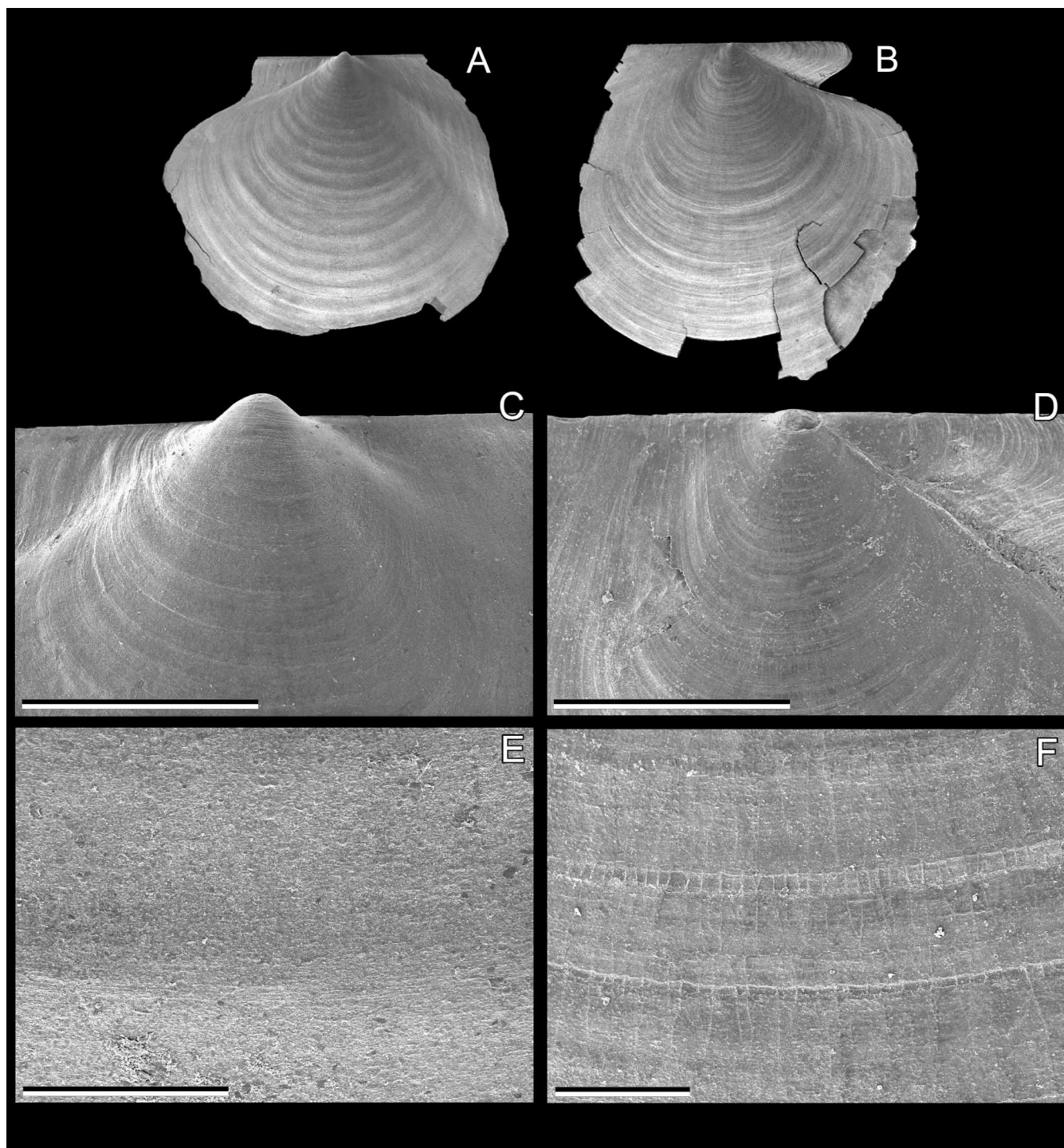
## Remarks

Specimens from the Lord Howe Rise are somewhat smaller than the holotype (height c. 10.5 mm versus c. 14.5 mm), though otherwise identical.

***Catillopecten tasmani* n. sp.**

Figs 32A–F, 33

*Catillopecten* sp. Spencer *et al.* in press.



**FIGURE 32.** Propeamussidae. *Catillopecten tasmani* n. sp., Bounty Trough, 1586 m, NIWA S151 (A, C, E, lv, height 8.40 mm; B, D, F, rv, height 9.10 mm). Scale bars 500  $\mu$ m (C–E) and 200  $\mu$ m (F).



#### Type material

Holotype (left v) NIWA S151, and paratypes (6 v, M.158279; 1 pr, 28 v NIWA; 1 pr, 4v, ZMA Moll. 4.02.013); Bounty Trough, southern New Zealand, 45°48.8'S, 174°30.5'E, alive, 1586 m, 26 Oct.1979, RV *Tangaroa*. Paratypes: Challenger Plateau, 41°15.2'S, 167°07.2'E, alive, 1457–1463 m (3 pr, NIWA P941). Bounty Trough: 45°21.2'S, 173°35.8'E, 1386 m (1 v, NIWA S153); 45°24.2'S, 173°59.8'E, alive, 1373 m (1 pr, 2 v, NIWA S154); 45°52.3'S, 174°04.9'E, alive, 1676 m (1 pr, 13 v, NIWA S152).

#### Material examined

The type material (see above).

#### Description

Shell up to c. 10 mm high, extremely thin and fragile, nearly circular, equivalve, compressed, left valve more convex than right valve, inequilateral, auricles unequal, umbonal angle c. 90°, resilifer triangular, translucent, colourless, both valves matt due to exceedingly finely granular surface texture.

Prodissoconch c. 150 µm long, convex, smooth.

Dissoconch left valve smooth apart from low, broadly rounded, commarginal undulations that commence almost immediately. Posteromarginal area of disc somewhat elevated. Auricles poorly demarcated from disc. Fine commarginal growth lines on anterior auricle, weaker growth lines on posterior auricle.

Right valve disc with weak, irregular, commarginal undulations, fine commarginal growth lines, and obscure radial lines. Posterior auricle not demarcated from disc, with fine commarginal growth lines. Anterior auricle sharply demarcated from shell disc, with fine crowded commarginal threads. Byssal gape rather deep, no byssal fasciole or ctenolium.

#### Distribution

Eastern Tasman Sea and Bounty Trough, New Zealand, taken alive at 1373–1676 m from foraminiferal ooze (Fig. 33).

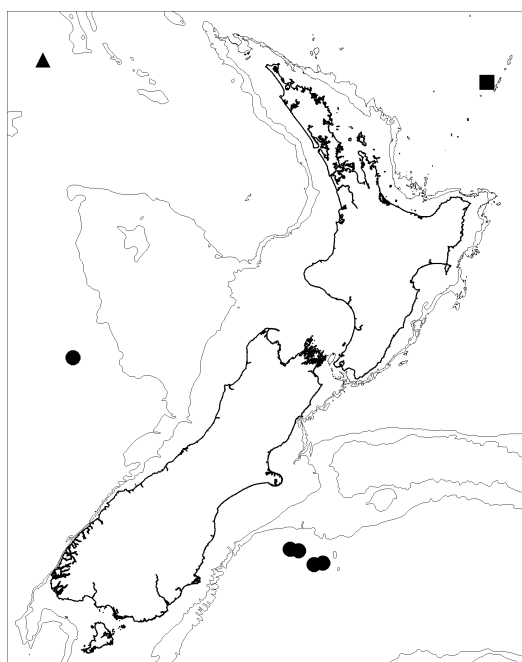
#### Remarks

*Catillopecten tasmani* most closely resembles *C. eucymatus* (Dall, 1898) (Atlantic, 1057–4829 m: see Schein 1989: 101), but differs in that the right valve is more strongly undulated and lacks commarginal striae. It differs from *C. murrayi* and *C. graui* (Knudsen, 1970) (tropical eastern Pacific, 3270–3670 m), principally in attaining smaller size (height up to 10 mm, versus c. 15 mm and 17 mm respectively), in having a weakly commarginally undulating rather than smooth disc, and in lacking commarginal lamellae. It differs from *C. translucens* (Dautzenberg & Bavay, 1912) (Indonesia, 1301 m), primarily in that the auricles are finely sculptured rather than smooth; from *C. knudseni* (Bernard, 1978) (north-eastern Pacific, 220–2900 m), in being smaller (*C. knudseni* up to ca. 18 mm high) and in lacking radial microsculpture; from *C. squamiformis*

(Bernard, 1978) (NE Pacific, 2030–2884 m), in having more regular undulations, with the left valve having fewer, more widely spaced commarginal lamellae; and from *C. vulcani* (Schein-Fatton, 1985) (tropical eastern Pacific, 2620 m), in attaining smaller size (*C. vulcani* up to 14 mm high), in being subcircular rather than elongate, and in that the left valve is more weakly undulated, and the right valve is more inflated.

#### Etymology

After Abel Janszoon Tasman (1602–1659), a Frisian mariner and explorer, who served the Dutch East India Company, and in 1642–43 made the first European discovery of Tasmania and western New Zealand.



**FIGURE 33.** Map showing distribution of ▲ *Catillopecten murrayi* (E.A. Smith, 1885), ● *Catillopecten tasmani* sp. nov., and ■ *Sinepecten segonzaci* Schein, 2006.

#### Genus *Sinepecten* Schein, 2006

*Sinepecten* Schein, 2006: 4. Type species (by original designation): *Sinepecten segonzaci* Schein, 2006, hydrothermal vent field, Manus back-arc basin, Papua-New Guinea, 1674 m.

#### Diagnosis

Propeamussiidae with opaque, fragile, subcircular shell, up to ca. 24 mm in height, compressed, left valves weakly inflated with commarginal ridges or lamellae, right valve nearly flat and interdigitated with hard substrata. Auricles continuous with disc. Byssal notch moderately deep in early growth stage, no ctenolium.

#### Distribution

Recent. Papua New Guinea and southern Kermadec Ridge at lower bathyal depths.

#### Remarks

*Sinepecten* is closely related to *Catillopecten* Iredale, 1939 and *Bathypecten* Schein-Fatton, 1985, their species

sharing similar commarginal ridges or lamellae on the left valve and a prismatic layer on the right valve. The type species of *Sinepecten* interdigitates against hard substrata, whereas *Catillopecten* species and the type species of *Bathypecten* live in soft sediments.

***Sinepecten segonzaci* Schein, 2006**

Figs 33, 34

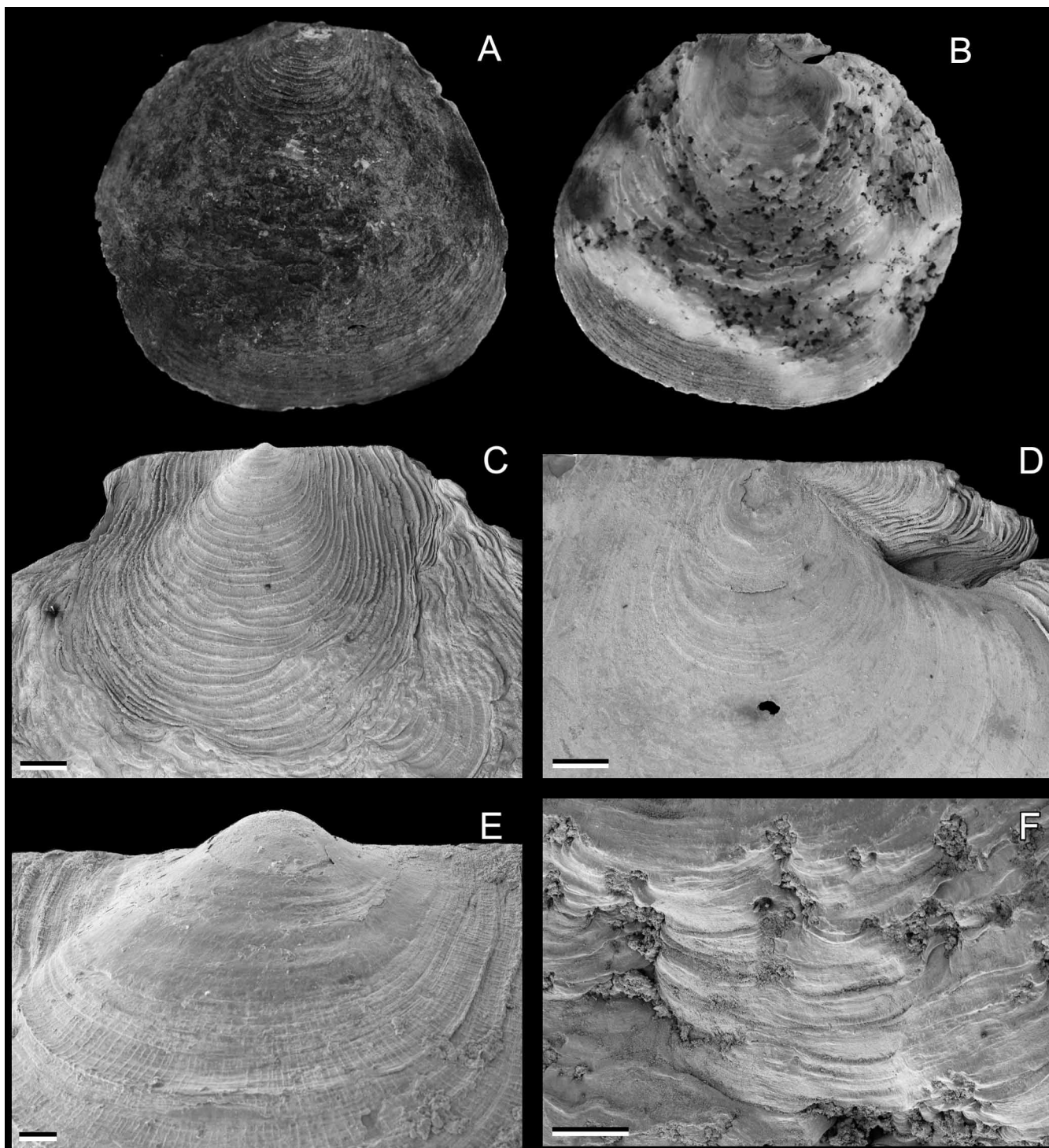
*Sinepecten segonzaci* Schein, 2006: 5, figs 2–12, 13b.

Type material

Holotype NSMT Mo-73697 and paratypes (4, NSMT Mo-73698-701), 03°43.62'S, 151°40.32'E, hydrothermal vent field, Manus back-arc basin, Papua-New Guinea, alive attached to rocks, 1674 m, 1998, submersible *Shinkai 2000*.

Material examined

34°51.14'S, 179°02.74'E, Brothers volcano, S Kermadec Ridge, 1400–1600 m, 22 May 2001, RV *Tangaroa*, attached to volcanic rocks (1 pr, M.183888; 1 pr, ZMA Moll. 146829; 2 pr, NIWA TAN107/138).



**FIGURE 34.** Propeamussiidae. *Sinepecten segonzaci* Schein, 2006, Brothers volcano, S Kermadec Ridge, 1400–1600 m, NIWA TAN107/138 (A, C, E, lv, width 22 mm, uncleaned; B, D, F, rv, 26 mm, vigorously sonicated). Note sand grains tightly enveloped and virtually cemented by shell deposition at successive margins (B, F). Scale bars 1 mm (C, D, F) and 100  $\mu$ m (E).

### Distribution

Manus back-arc basin, Papua-New Guinea, and Brothers volcano, southern Kermadec Ridge (Fig. 33).

### Remarks

The present material is morphologically identical to the type species, although the specimens from the Kermadec Ridge have coarser and more widely-spaced commarginal ridges when the shell is larger than 10 mm in length (ca. 2 versus 6 per mm).

The present specimens (height 21–24 mm: no ctenolium) were rather firmly attached to the substratum both by a weak byssus and such extremely fine and precise interdigitation of the growing margin of the right valve with the substratum that projections of the substratum are tightly enveloped and small particles are embedded in the shell (Fig. 34F). Grip on the substratum was so strong that specimens had to be carefully levered off with a knife to avoid breakage, but sufficiently weak that the specimens could be separated from it intact. The relatively weak byssus is evidently functional only in early ontogeny (height <9 mm), since grip by the dissoconch is substantially firmer. Schein (2006) suggested that irregularities in the shell were due to “damage” and suggested that it could also be a reaction to toxicity of fluids, but admitted that it was “obviously induced by its adaptation to the irregular substrate.” Schein further suggested that the high density of particles along the ventral margin reflects their density in the ambient seawater, but by contrast, we perceive their incorporation as due to the method of attachment to the substratum rather than incidental entrainment. This form of non-byssal attachment to the substratum is unique among Pectinoidea, perhaps transitional to full cementation.

### Family PECTINIDAE Rafinesque, 1815 [emend. Waller, 1978]

### Diagnosis

Byssate, cemented, or free living Pectinoidea with outer prismatic calcitic layer on right valve. Crossed-lamellar aragonite inside pallial line or entirely absent. Byssal notch with ctenolium, at least in early ontogeny.

### Subfamily unknown

### Genus *Hyalopecten* Verrill, 1897

*Hyalopecten* Verrill, 1897: 71. Type species (by original designation): *Pecten undatus* Verrill & S. Smith in Verrill, 1885 (not *Pecten undatus* Defrance, 1825—ICZN Article 23.9.5); Recent, western Atlantic.

### Dignosis

Pectinidae with opaque, fragile, oblong and/or oblique inequivalved shell, up to ca. 25 mm in height, compressed to inflated, sculptured with commarginal undulations, or with corrugations and delicate radial lirae on one or both valves. Auricles unequal. Byssal notch well developed, ctenolium present.

### Distribution

Miocene to Recent. Worldwide at bathyal to hadal depths.

### Remarks

Palazzi and Villari (1996: 270) placed *Hyalopecten* in the synonymy of *Ciclopecten* G. Seguenza, 1877, followed by Coan *et al.* (2000: 228). *Hyalopecten* species resemble *Ciclopecten* species in having commarginal undulations, but differ in lacking radial microsculpture, and in that the posterior auricles are more acute-angled, rather than obtuse and merged with the disc as in *Ciclopecten* (see also Coan *et al.* 2000: 227, and Dijkstra and Goud 2002: 47). We interpret *Hyalopecten* and *Ciclopecten* as discrete genera.

### *Hyalopecten hadalis* (Knudsen, 1970)

Figs 35, 36

*Ciclopecten* (*Hyalopecten*) *hadalis* Knudsen, 1970: 98, text-figs 61, 62, pl. 13, fig. 2.

*Hyalopecten hadalis*.—Raines & Poppe, 2006: 46, text fig. 5.

### Type material

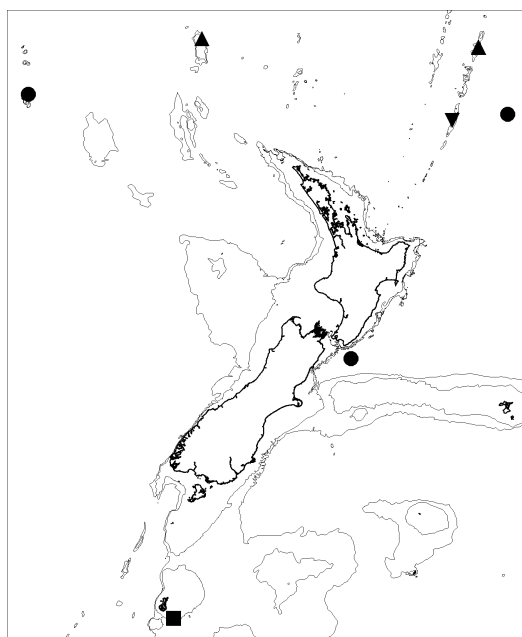
Holotype (pr) ZMUC BIV-441; Kermadec Trench, 32°20'S, 176°54'W, alive, 6620–6730 m, RRS *Galathea* (stn 650).

### Material examined

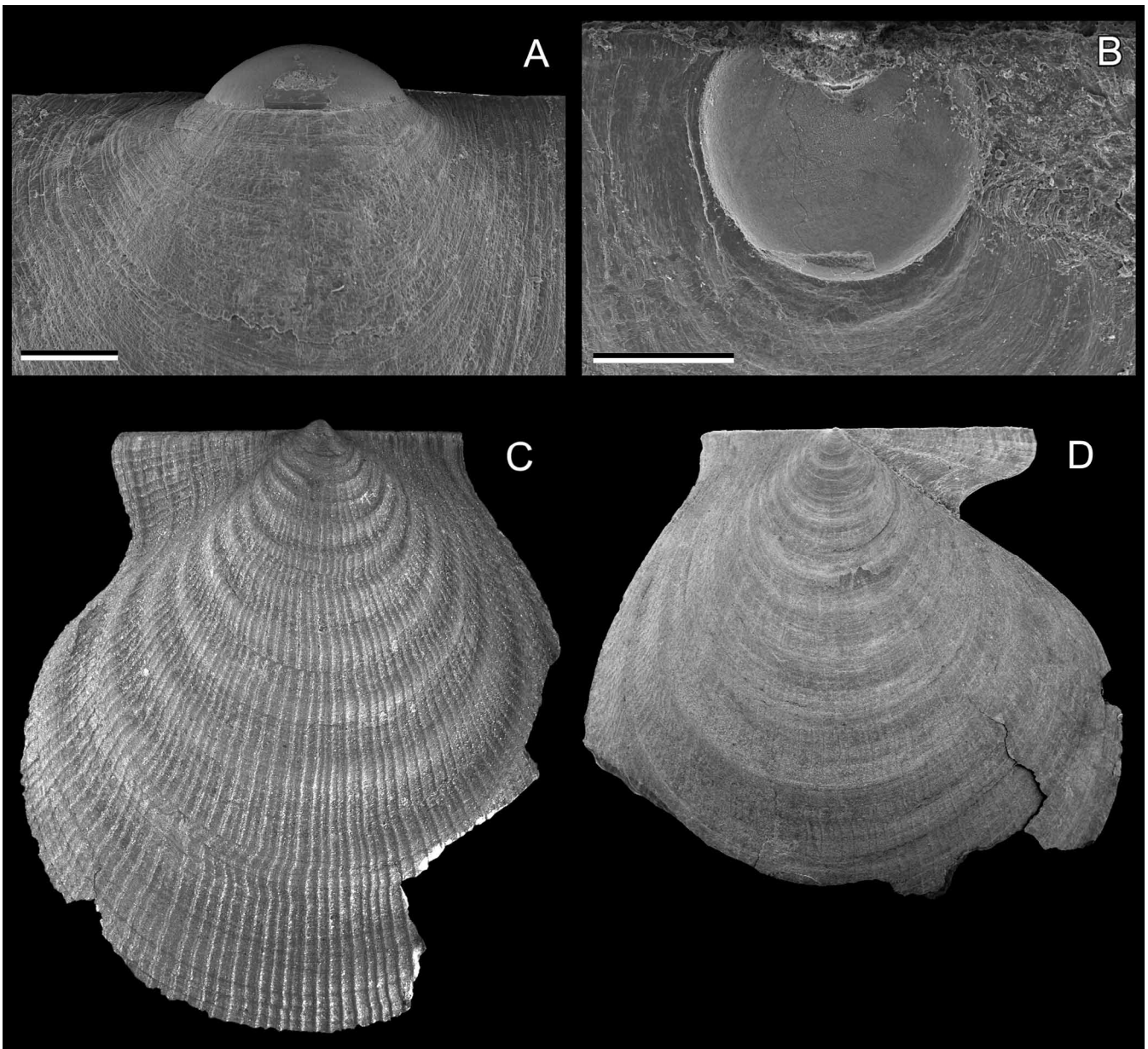
The holotype (see above). Off Lord Howe Island, 31°34'S, 159°26.5'E, 1808–1828 m (fresh fragments, NIWA 1722). Hikurangi Trench, 42°10.5'S, 175°59.4'E, alive, 2602–2677 m, 3 Nov. 1979 (2 v, M.274088; 2 pr, 3 v, several fragments, NIWA S204).

### Distribution

Off Lord Howe Island, Kermadec Trench (Knudsen 1970) and Hikurangi Trench; alive, 1808–6730 m (Fig. 35).



**FIGURE 35.** Map showing distribution of ● *Hyalopecten hadalis* (Knudsen, 1970), ▼ *Ciclopecten fluctuatus* (Bavay, 1905), ■ *Austrochlamys natans walosseki* Jonkers, 2003 and ▲ *Pascahinnites coruscans coruscans* (Hinds, 1845).



**FIGURE 36.** Pectinidae. *Hyalopecten hadalis* (Knudsen, 1970), Hikurangi Trench, 2602–2677 m, NIWA S204 (C, lv, height 13.2 mm; A, B, D, rv, height 11.2 mm). Scale bars 100  $\mu$ m.

#### Remarks

The present material is identical to the holotype. The commarginal undulations range from weak to strong, and the radial sculpture is more prominent on the left valve than on the right one. *Hyalopecten hadalis* is closely similar to *H. pudicus* (E.A. Smith, 1885) (Atlantic and south-western Indian oceans), in shape, size and sculpture, but has more delicate radial sculpture, and less regular commarginal undulations.

Although Knudsen (1970) treated *Hyalopecten* as a subgenus of *Cyclopecten*, the two groups differ markedly and indeed belong in separate families (Bernard 1983; Schein 1988, 1989; Dell 1990; Dijkstra 1991, 1995, 2001).

#### Subfamily PECTININAE Rafinesque, 1815

##### Diagnosis

Pectinidae with undivided radial costae, preradial microsculpture of left valve with weak elongate pits, internal rib carinae present, disc microsculpture with very close commarginal lamellae, hinge teeth dorsal and intermediate between resilial and dorsal tooth.

#### Tribe PECTININI Rafinesque, 1815

##### Diagnosis

Pectininae with undivided radial costae, preradial area of left valve large and smooth, internal rib carinae present,

disc microsculpture with widely spaced commarginal lamellae, hinge teeth dorsal and intermediate between resilial and dorsal tooth.

### Genus *Pecten* Müller, 1776

*Pecten* Müller, 1776: 248. Type species (by subsequent designation of Schmidt 1818: 67): *Ostrea maxima* Linnaeus, 1758; Recent, eastern Atlantic.

#### Diagnosis

Pectinidae with a sturdy, subcircular shell, up to ca. 150 mm in height, left valve flat to concave, right valve strongly convex, both valves with radial macrosculpture and commarginal microsculpture. Auricles almost equal in size. Byssal notch shallow, ctenolium weak in juvenile and lacking in adult stage.

#### Distribution

Upper Eocene to Recent. Eastern Atlantic and Indo-Pacific at sublittoral depths.

#### Remarks

For the extensive synonymy of *Pecten*, see Beu (2006).

### *Pecten novaezelandiae* Reeve, 1852

Figs 37A–D, 38

*Pecten medius*.—Deshayes, 1832a: 715; Reeve, 1852, pl. 11, fig. 44 and text; Hedley, 1902: 303; Suter, 1904: 93; Cox, 1929: 203. In part not Lamarck, 1819.

*Pecten laticostata* Gray, 1835: 310. Not Lamarck, 1819 (preoccupied).

*Pecten laticostatus*.—Gray, 1843: 260. Not Lamarck.

*Pecten novaezelandiae* Reeve, 1852: pl. 8, fig. 36 and text (but *not* pl. 8, fig. 36 = *P. fumatus* Reeve, 1852); Iredale, 1924: 193; Fleming, 1951a: 278; Powell, 1979: 377, pl. 68, figs 1, 2; Abbott & Dance, 1982: 305, fig.; Woodburn, 1990: 226; Beu & Maxwell, 1990: 335; Waller, 1991: 37, pl. 8, figs 11, 12; Beu, 2001: 120; Beu, 2006: 202, fig. 13; Raines & Poppe, 2006: 152, 153 (figs), pl. 90, fig. 2, pl. 104, figs 1–3, pl. 105, figs 1–3, pl. 106, figs 1–3.

*Vola laticostatus*.—Hutton, 1873a: 82; Hutton, 1880: 171.

*Pecten laticostatus*.—Hutton, 1873b: 30.

*Pecten (Vola) laticostatus*.—Martens, 1873: 50.

*Pecten (Euvola) novaezelandiae*.—Suter, 1913: 874, pl. 56, fig. 7.

*Notovola novaezelandiae*.—Finlay, 1926: 451.

*Notovola tainui* Finlay, 1930a: 51, pl. 4, figs 46, 56, pl. 6, fig. 81.

*Notovola marwicki* Finlay, 1930a: 52.

*Pecten (Notovola) tainui*.—Powell, 1934: 263.

*Pecten (Notovola) medius*.—Powell, 1937b: 56, pl. 15, fig. 25.

*Notovola novaezelandiae*.—Powell, 1946: 57, pl. 15, fig. 25.

*Pecten novaezelandiae* new subspecies Fleming, 1950a: 23.

*Pecten kupei* Fleming, 1951a: 278, pl. 1, fig. 1.

*Pecten toi* Fleming, 1951a: 278, pl. 1, figs 2, 5.

*Pecten marwicki*.—Fleming, 1951a: 278, pl. 1, fig. 3.

*Pecten tainui*.—Fleming, 1951a: 278, pl. 1, fig. 3; Beu & Maxwell, 1990: 335, pl. 45j.

*Pecten novaezelandiae* n. subsp. Fleming, 1951a: 278.

*Pecten tainui* n. subsp. Fleming, 1951a: 278.

*Pecten novaezelandiae novaezelandiae*.—Fleming, 1951b: 128, pl. 15, fig. 6; Fleming, 1957: 46, pl. 13, fig. 3, pl. 14, fig. 5; Boreham, 1959: 10.

*Pecten novaezelandiae rakiura* Fleming, 1951b: 130; Fleming,

1957: 44, pl. 13, figs 1, 2, pl. 14, figs 1–4.

*Palliolium fosterianum*.—Dell, 1951: 16. Not Powell, 1933.

*Pecten novaezelandiae* subsp. Fleming, 1953: 260.

*Pecten tainui aotea* Fleming, 1953: 344; Fleming, 1953: 344.

*Pecten benedictus marwicki*.—Fleming, 1957: 30, pl. 2, figs 2, 3, pl. 3, figs 1, 2, pl. 5, figs 1, 2, pl. 14, fig. 6; Fleming, 1961: pl. 4, fig. 5; Beu & Maxwell, 1990: 335, pl. 45i.

*Pecten benedictus tepungai* Fleming, 1957: 33, pl. 4, figs 1–4.

*Pecten benedictus zeehanai* Fleming, 1957: 35, pl. 3, fig. 3, pl. 5, fig. 5.

*Pecten modestus kupei*.—Fleming, 1957: 37, pl. 5, figs 3, 4, pl. 8, figs 1–4.

*Pecten jacobaeus toi*.—Fleming, 1957: 39, pl. 9, figs 1, 2, pl. 12, fig. 1, pl. 15, fig. 1.

*Pecten novaezelandiae tainui*.—Fleming, 1957: 41, pl. 10, figs 1, 2, pl. 15, fig. 2.

*Pecten novaezelandiae aotea*.—Fleming, 1957: 42, pl. 10, fig. 3, pl. 11, figs 1, 2, pl. 12, figs 2, 3.

*Pecten sulcicostatus* “var. *casa*” van Bruggen, 1961: 31, pl. 1, figs 1–3; Kilburn & Dijkstra, 1995: 278. Unavailable infrasubspecific taxon (ICZN Art 15).

*Pecten novaezelandicus* [sic].—Rombouts, 1991: 52, pl. 19, fig. 3.

#### Type material

*Pecten laticostata*: syntypes (3 v) BMNH 20020259; “New Zealand”. *P. novaezelandiae*: lectotype (Fleming 1951b: 129) BMNH 1950.2.1.2; “New Zealand; Hart”.

*Notovola marwicki*: holotype AIM70546; Castlecliff “papa”, Wanganui, New Zealand, probably Upper Castlecliff Shellbed (Late Pleistocene, Castlecliffian) (Fleming, 1957: 30).

*Notovola tainui*: holotype AIM70547; Tainui Shellbed at the Pinnacles, Castlecliff, Wanganui, Late Pleistocene (Castlecliffian).

*Pecten modestus kupei*: holotype NZGS TM.2014; thin bed at top of Kupe Formation, between Kai Iwi and Castlecliff, Wanganui, Late Pleistocene (Castlecliffian).

*Pecten toi*: holotype NZGS TM.2027; top of Pinnacle Sand Formation, Castlecliff, Wanganui, Late Pleistocene (Castlecliffian)

*Pecten novaezelandiae rakiura*: holotype NZGS TM.226; Bravo Island, Stewart Island, New Zealand.

*Pecten tainui aotea*: holotype NZGS TM.2019; Landguard Sand, lowest outcrop below road junction, Landguard Bluff, Wanganui, Late Pleistocene (Castlecliffian).

*Pecten benedictus tepungai*: holotype NZGS TM.2006; shellbed N bank of Rangitawa Stream, Rangitikei, New Zealand, Late Pleistocene (Castlecliffian).

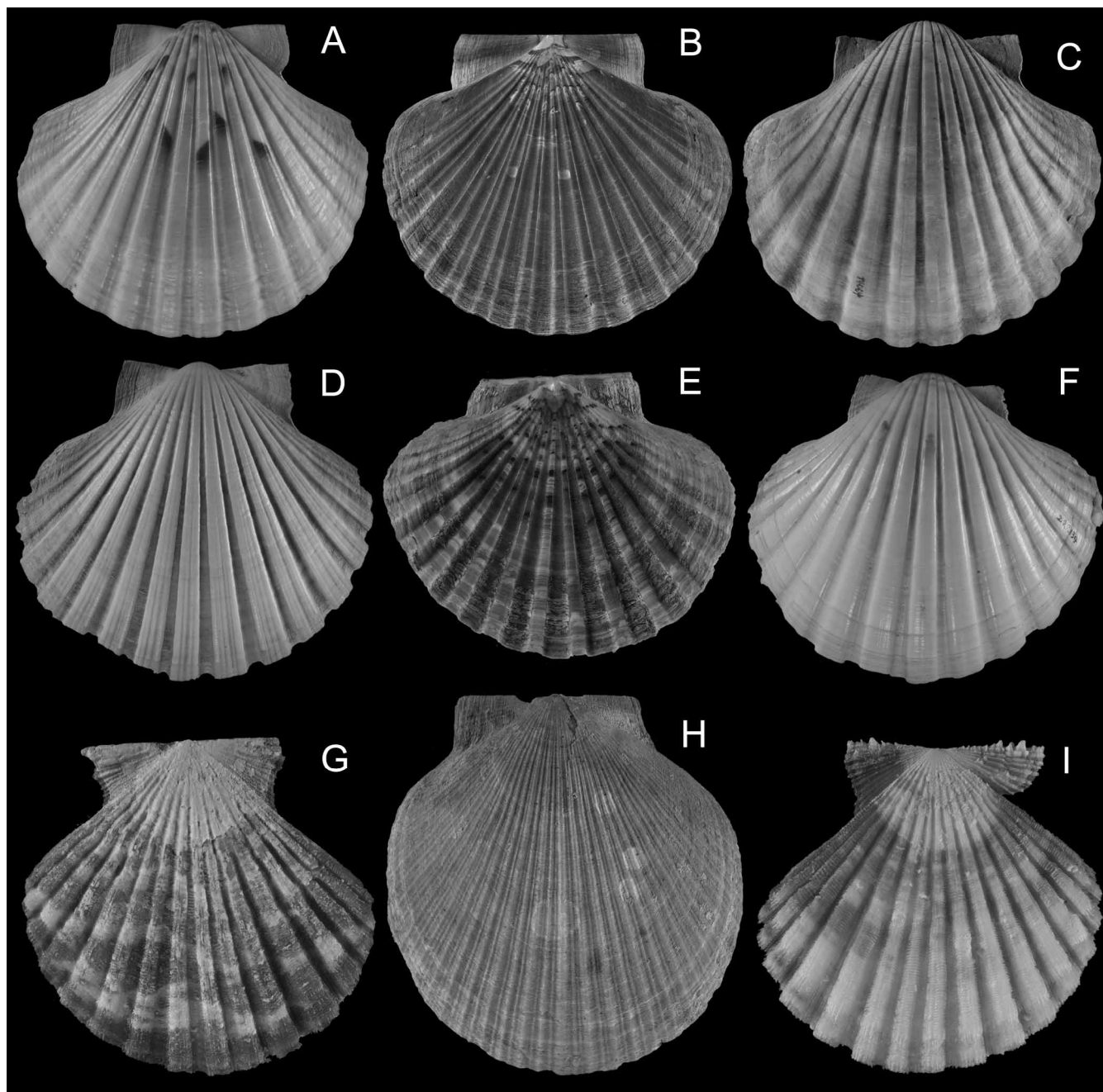
*Pecten benedictus zeehanai*: holotype NZGS TM.2025; Mount Jowett, Aramoho, SW North Island, New Zealand (Late Pleistocene).

*Pecten sulcicostatus* “var. *casa*”: original specimens Natal Museum, Pietermaritzburg B7445, B7446; said to have been “trawled alive off Port Alfred” but apparently based on mislocalised New Zealand specimens (Kilburn and Dijkstra 1995).

#### Material examined

>1000 specimens (225 lots NMNZ) from throughout the geographic and bathymetric range.





**FIGURE 37.** Pectinidae (A, C, D, F, G = lv). **A–D.** *Pecten novaezelandiae* Reeve, 1852. **A, B.** Off Little Barrier Island: form with moderately convex left valve (**A**) and more or less flat right valve characteristic of sandy substrata, M.118079 (height 90.5 mm). **C.** Off Chetwode Islands, Cook Strait, 13 m: form with strongly convex left valve with protruding dorsal end (**C**), and strongly concave right valve characteristic of very muddy substrata, M.94064 (height 98.5 mm). **D.** Doubtful Sound, Fiordland: form with well developed radial grooves in summits of radial ribs of left valve, M.118076 (height 106 mm). **E, F.** *Pecten raoulensis* Powell, 1958, off Hutchison Bluff, Raoul Island, Kermadec Islands, 110–121 m, M.222134 (height 86.5 mm). **G, I.** *Annachlamys iredalei* (Powell, 1958), off Raoul Island, 70 m, NZOI K796 (height 34 mm). **H.** *Austrochlamys natans waloszeki* Jonkers, 2003, SE of Auckland Islands, 490–510 m, M.118772 (lv, height 108 mm).

#### Distribution

Late Pleistocene-Recent. North, South, Stewart and Chatham Islands, 0–153 m; taken alive at 0–121 m. A common and commercially important species (Fig. 38).

#### Remarks

Fleming (1957) recognized seven subspecies of *Pecten* from Late Pleistocene beds in the Wanganui basin, and interpreted them as representing “at least three replacements of successive populations of *P. benedictus* by successive

populations of the *jacobaeus* group”, one of which gave rise to *P. novaezelandiae* and *P. novaezelandiae rakiura* in only the last few hundred thousand years. On the basis of much additional material, improved stratigraphic resolution, and a modern species concept, Beu & Maxwell (1990) considered it more likely that the *Pecten* sequence in the Wanganui basin was influenced by changing ecologies of the deposition sites rather than successive invasions. Their approach was conservative nevertheless, and they recognized three fossil taxa: *P. benedictus marwicki* (Finlay, 1930) (= *P. benedictus*

*tepingai* Fleming, 1957), *P. tainui* (Finlay, 1930) (= *P. tainui aotea* Fleming, 1953), and *P. kupei* Fleming, 1957. They interpreted *P. jacobaeus toi* Fleming, 1957 as a hybrid population, “preserved at the one horizon where the boundary between *P. benedictus marwicki* and *P. tainui* crossed the deposition site...”. Subsequently, Beu (2006) revisited the issue in more detail, and concluded that *P. benedictus marwicki*, *P. tainui*, *P. kupei*, *P. toi* and *P. aotea* are all ecophenotypic variants of *P. novaezealandiae*. There is fluid intergradation between typical *P. novaezealandiae* as defined by the lectotype, and the southern form named *P. novaezealandiae rakiura* by Fleming (1951b) in shell morphology, and there is mosaic intergradation between these and the various formally named Pleistocene forms, including the subrecent shells from Rungapapa Knoll, off White Island, recorded by Beu (2006, p. 208). In the Recent fauna, specimens from soft muddy substrata in sheltered conditions tend to have a markedly concave left valve and a strongly convex right valve with elevated ribs, whereas specimens from sandy substrata tend to have a more or less flat left valve, and a less convex right valve with less elevated ribs. We illustrate three Recent phenotypes (Figs 37A–D).

*Pecten novaezealandiae* is closely similar to the Tasmanian morph of the Australian species *Pecten fumatus* Reeve, 1852, although they are genetically distinct (Woodburn 1990; Beu 2006).

*Pecten novaezealandiae* has a patchy distribution in the New Zealand region, and is locally abundant yet unaccountably rare or absent over large areas of continental shelf, especially off the eastern South Island (e.g. for east coast only three specimens known from off Oamaru, and one valve from off eastern Otago: material NMNZ). The largest known specimen, localized simply “South Island” (if so, presumably Nelson-Marlborough), is a giant at 174 mm wide (M.131451, ex L. Ford collection).

### ***Pecten raoulensis* Powell, 1958**

Fig. 37E, F, 38

*Pecten medius*.—Oliver, 1915: 553. Not Lamarck, 1819.

*Pecten raoulensis* Powell, 1958: 67, pl. 10, figs 1, 2; Dijkstra & Marshall, 1997: 93; Brook & Marshall, 1998: 212; Raines & Poppe, 2006: 154, text fig. 12.

*Pecten novaezealandiae raoulensis*.—Fleming, 1962: 184.

#### Type material

Holotype ZMUC BIV-38; off Raoul Island, Kermadec Islands, 29°15'S, 177°57'W, 75–85 m, 3 Mar. 1952, RRS *Galathea* (stn 674).

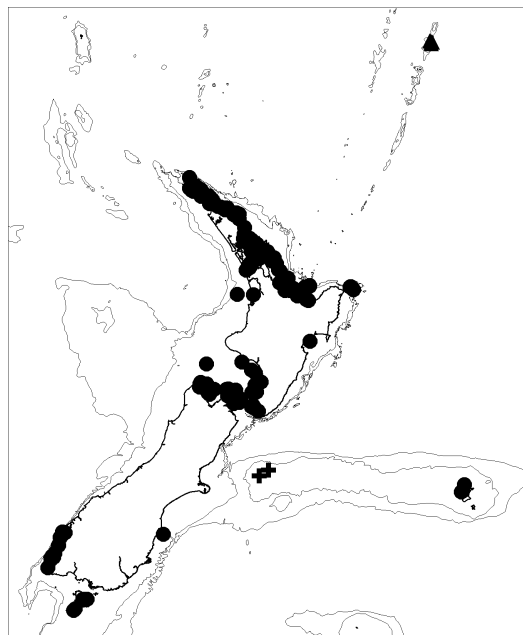
#### Material examined

Off Raoul Island, Kermadec Islands: dredged (1 pr, 1v, M.213878); 29°12.7'S, 177°55.5'W, alive, 110–146 m (1 pr, M.222099); 29°12.7'S, 177°56.1'W, NW of Fleetwood Bluff, Raoul Island, Kermadec Islands, 135 m (1 v, M.225453); 29°13.0'S, 177°55.8'W, 110–121 m (1 pr, M.222134); 29°13'S, 177°59'W, 84–113 m (7 v, M.222015);

29°13.31'S, 177°56.36'W, 95 m (1 v, NIWA K818); 29°13.24'S, 177°56.30'W, 100 m (5 v, NIWA K819); 29°13.30'S, 177°59.80'W, 95 m (5 v, NIWA K820); 29°14.6'S, 177°52.6'W, 30 m (2 v, AIM 78573); 29°16.00'S, 177°51.58'W, 42–47 m (2 v, M.226610); 29°18.5'S, 177°54.5'W, 44 m (1 v, M.225782). Off Curtis Island, Kermadec Islands, 30°33.5'S, 178°31.1'W, 125–130 m (1 v, NIWA K856).

#### Distribution

Raoul and Curtis islands, Kermadec Islands, 42–146 m; taken alive at 110–146 m (Fig. 38).



**FIGURE 38.** Map showing distribution of ● *Pecten novaezealandiae* Reeve, 1852, and ▲ *Pecten raoulensis* Powell, 1958.

#### Remarks

Dijkstra and Marshall (1997: 95) reported differences between specimens from depths greater than 50 m and those from shallower depths, and indicated that *P. raoulensis* is more similar to the Australian *P. fumatus* than to *P. novaezealandiae*, differing primarily from *P. novaezealandiae* in that the left valve extends further beyond the right valve and more strongly overhangs it, as in many specimens of *P. fumatus*. As indicated by Dijkstra and Marshall (1997), Kermadec specimens from depths greater than 50 m, including the holotype, have sculpture that falls within the limits of variation exhibited by both *P. novaezealandiae* and *P. fumatus*, whereas specimens from shallower depths more closely resemble *P. fumatus*, especially specimens from Queensland.

### **Genus *Annachlamys* Iredale, 1939**

*Annachlamys* Iredale, 1939: 358. Type species (by original designation): *Pecten leopardus* Reeve, 1853 = *Pecten flabellatus* Lamarck, 1819; Recent, Australia.

**Diagnosis**

Pectinidae with a sturdy, subcircular shell, up to ca. 80 mm in height, moderately compressed, nearly equivalve, both valves with radial macrosculpture and commarginal microsculpture. Auricles almost equal in size. Byssal notch shallow, ctenolium weak in juvenile and rudimentary or lacking in adult stage.

**Distribution**

Miocene to Recent. Indo-Pacific at sublittoral depths.

**Remarks**

*Annachlamys* is now removed from Decatopectinini and assigned to Pectinini (see Waller 2006).

***Annachlamys iredalei* (Powell, 1958)**

Figs 37G, I, 39

*Aequipecten* (*Corymbichlamys*) *iredalei* Powell, 1958: 68; pl. 11, figs 1, 2, text fig. 2.

*Annachlamys iredalei*.—Dijkstra, 1989: 19, figs; Dijkstra *et al.*, 1989: 24; Dijkstra *et al.*, 1990: 8, 10, figs; Lamprell & Whitehead, 1992: [26], pl. 11, fig. 64; Dijkstra & Marshall, 1997: 97, pl. 10, figs 1–7; Brook & Marshall, 1998: 212; Raines & Poppe, 2006: 92, 93 (fig.), pl. 28, figs 5–6.

*Corymbichlamys iredalei*.—Rombouts, 1991: 36, pl. 13, fig. 6.

**Type material**

Holotype (pr) ZMUC BIV-37; off Raoul Island, Kermadec Islands, 29°13.5'S, 177°57.0'W, 58–60 m, alive, RRS *Galathea* (stn 675).

**Material examined**

The holotype (see above). Raoul Island, Kermadec Islands—29°13.0'S, 178°00.0'W, 100 m (1 v, NIWA T233); 29°13.3'S, 177°59.8'W, 95 m (4 v, NIWA K820); off W side Meyer Island, 29°14.6'S, 177°52.6'W, 15–30 m (2 pr, 4 v, M.153361; 1 pr, AIM AK.78572); 29°15.0'S, 177°50.9'W, between Dayrell and Chanter Islets, Raoul Island, 31–45 m (1 pr, 2 v, M.227103); 29°15.0'S, 177°52.0'W, 58–60 m (2 v, AMS C.81779); 29°18.5'S, 177°54.5'W, SE of D'Arcy Point, 44 m (3 v, M.225783); 29°18.9'S, 177°56.4'W, SE of Smith Bluff, 82–100 m (4 v, M.226585); 31°20.8'S, 178°49.0'W, alive, 70 m (1 pr, 1 v, NIWA K796); 31°20.8'S, 178°49.2'W, 55–70 m (6 v, NIWA K797).

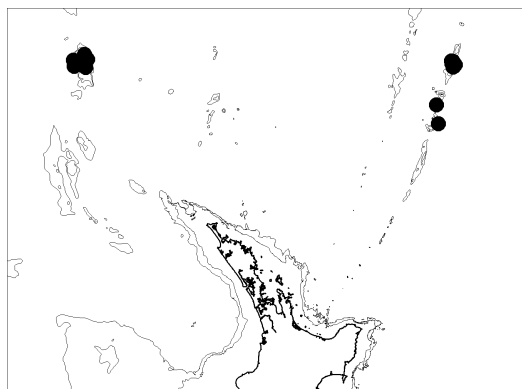
**Distribution**

Coral Sea, New Caledonia, Lord Howe Island, Norfolk Island, and Kermadec Islands, 15–183 m; taken alive at 15–70 m (Fig. 39).

**Remarks**

Like its congener *Annachlamys reevei* (A. Adams & Reeve, 1850) (Philippines), *A. iredalei* lives solitary and free (byssally unattached) amongst coral rubble on sand. By contrast, the other two congeners *A. flabellata* (Lamarck, 1819) (eastern and western Australia), and *A. striatula* (Linnaeus, 1758) (tropical south-western Pacific) live in colonies on soft sediments (HD, pers. obs.). All species of

*Annachlamys* have a reduced ctenolium or lose it in the adult stage.



**FIGURE 39.** Map showing distribution of *Annachlamys iredalei* (Powell, 1958).

**Subfamily CAMPTONECTINAE Habe, 1977****Diagnosis**

Pectinidae with anterodorsal margin of disc distinctly concave in lateral view. Exterior surface with antimarginal microsculpture, a few species smooth. Fine radial macrosculpture present in some species. Most species with commarginal undulations on left valve that underlie sculptural elements. Auricles with prominent antimarginal microsculpture and commarginal flanges. Hinge with weak dorsal and resilial teeth.

**Genus *Ciclopecten* G. Seguenza, 1877**

*Ciclopecten* G. Seguenza, 1877: 362. Type species (by original designation): *Ciclopecten peloritanus* G. Seguenza, 1877; Pliocene, Italy.

**Diagnosis**

Pectinidae with commarginally undulated, weakly inflated valves; fragile, slightly oblong, prominent radial and weak commarginal sculpture, radial microsculpture throughout; byssal notch moderately deep, byssal fasciole distinct, functional ctenolium present.

**Distribution**

Pliocene (Italy) to Recent (bathyal tropical Indo-West Pacific).

**Remarks**

The phylogenetic relationship between *Ciclopecten*, *Hyalopecten* and *Delectopecten* Stewart, 1930 is not well understood and *Ciclopecten* is here provisionally placed between *Hyalopecten* and *Delectopecten*, based on such similarities as undulated shell surface similar to that in *Hyalopecten*, shape and radial microsculpture similar to that in *Delectopecten*, and a reticulate macrosculpture similar to that in both genera. Byssal notch and functional ctenolium are well-developed in all three genera.

***Ciclopecten fluctuatus* (Bavay, 1905)**

Figs 35, 40C, G

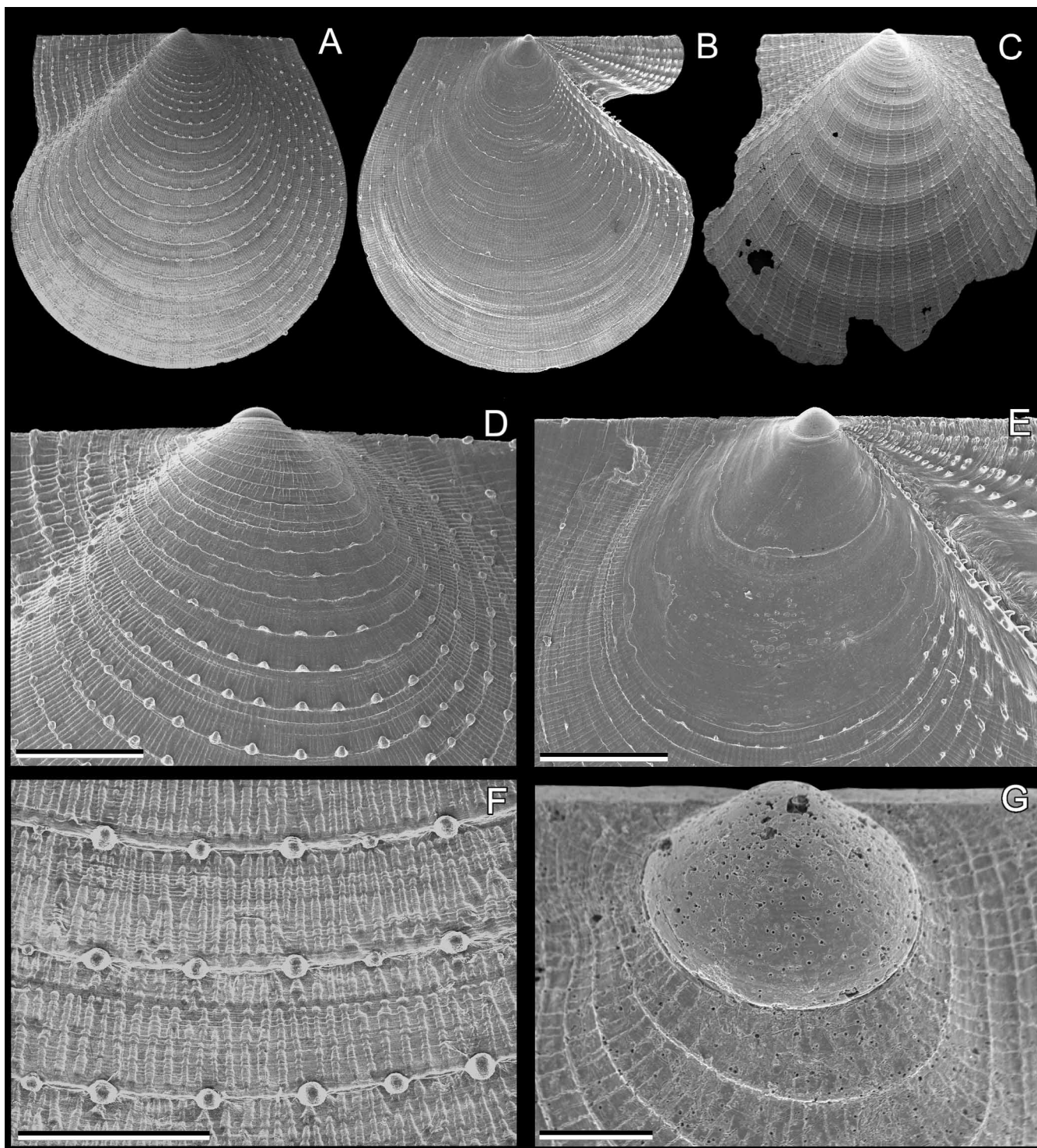
*Pecten* (*Chlamys*) *fluctuatus* Bavay, 1905: 188, pl. 17, figs 3a–b.  
*Delectopecten fluctuatus* (Bavay). Dijkstra, 1995: 51, figs 83–86;  
 Dijkstra & Kastoro, 1997: 266, figs 109–113; Dijkstra, 2001:  
 91.  
*Ciclopecten fluctuatus*.—Palazzi & Villari, 1996: 270; Raines &  
 Poppe, 2006: 64, 67 (figs), pl. 4, fig. 1.

## Type material

Holotype ZSI M3359/1; Andaman Sea.

## Material examined

The holotype (see above). Seamount 130 km S of  
 Esperance Rock, Kermadec Ridge, 32°28.3'S, 179°15.9'W,  
 538 m (1 v, M.137495).



**FIGURE 40.** Pectinidae. **A, B, D–F.** *Delectopecten fosterianus* (Powell, 1933), off Chatham Islands, 804–863 m, M.127389 (**A, D, F**, lv, height 10.6 mm; **B, E**, rv, height 10.5 mm). **C, G.** *Ciclopecten fluctuatus* (Bavay, 1905), seamount 130 km S of Esperance Rock, Kermadec Ridge, 538 m, M.137495 (lv, height 5.45 mm). Scale bars 1 mm (**D–F**) and 100  $\mu$ m (**G**).

## Distribution

Andaman Sea, Indonesia, Vanuatu, Loyalty Islands, and (new record) Kermadec Ridge, living at 225–566 m (Fig. 35).

## Remarks

Similar sized specimens of the Japanese species *Delectopecten macrocheiricolus* (Habe, 1951), are superficially similar, but *C. fluctuatus* differs markedly in having prominent radial sculpture, which is lacking in *D. macrocheiricolus*.

This is a new record for the New Zealand region.

**Genus *Delectopecten* Stewart, 1930**

*Delectopecten* Stewart, 1930: 118. Type species (by original designation): *Pecten* (*Pseudamusium* [sic]) *vancouverensis* Whiteaves, 1893; Recent, off Maryland, 2603 m.

## Diagnosis

Pectinidae with opaque or translucent, fragile, subcircular shell, up to ca. 30 mm in height, valves inequivalve and equilateral, smooth or sculptured with commarginal rows of scales or vesicles, spinose radial ridges and/or delicate antimarginal striae. Auricles unequal in size. Byssal notch moderately deep, functional ctenolium prominent.

## Distribution

Early Cretaceous to Recent. Worldwide at sublittoral to abyssal depths.

## Remarks

For discussion see Dijkstra (1995: 50), and Coan *et al.* (2000: 227).

***Delectopecten fosterianus* (Powell, 1933)**

Figs 40A, B, D–F, 41

*Palliolium fosterianum* Powell, 1933: 370, pl. 40, figs 6, 7; Powell, 1937b: 56, pl. 15, fig. 26; Powell, 1946: 57, pl. 15, fig. 26; Powell, 1957: 77, pl. 15, fig. 26; Powell, 1962: 118, pl. 15, fig. 26.

*Delectopecten fosterianus*.—Beu, 1970: 117; Powell, 1979: 379, pl. 73, fig. 3; Dell, 1990: 36; Beu, 1995: 11; Raines & Poppe, 2006: 56, 57 (figs), pl. 2, figs 5, 7, 8.

*Delectopecten fosterianum*.—Powell, 1976: 124, pl. 22, fig. 26.

*Cyclopecten* (*Delectopecten*) *fosterianus*.—Rombouts, 1991: 77.

NOT *Palliolium fosterianum*.—Dell, 1951: 16 = *Pecten novaezelandiae* Reeve, 1852.

## Type material

Holotype AIM 70582; 644 km W of New Plymouth, New Zealand, 1097–1280 m, attached to a cable, CS Recorder, W. Foster.

## Material examined

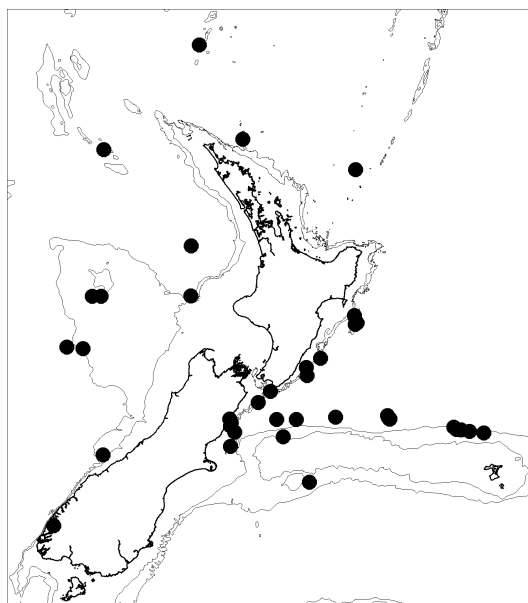
The holotype (see above). N Three Kings Rise, 31°30.7'S, 172°49.8'E, 1216–1385 m (2 v, NIWA U602). South Cavalli Seamount, ENE of North Cape, 34°15.9'S, 174°06.2'E, 850–840 m (2 v, M.158249). West Norfolk

Ridge, W of Cape Reinga, 34°34.9'S, 168°55.5'E, 1000–1150 m (3 v, M.172746). Rumble II (West) volcano, Kermadec Ridge, 35°21'S, 178°32'E, alive, 1357–1423 m (1 pr, NIWA X655). Aotea Seamount, 37°30.56'S, 172°10.75'E, 910 m (3 v, M.155386). Off Cape Egmont, 38°58.5'S, 172°10.2'E, alive, 1045–1055 m (1 pr, M.86835). W of New Plymouth, 39°00'S, 168°50'E, alive, 1097–1280 m (4 pr, 2 v, M.3152; 1 pr, M.84116). Off Mahia, 39°32.8'S, 178°16.5'E, alive, 857–880 m (1 pr, M.100336); 39°45.6'S, 178°21.8'E, alive, 642 m (2 pr, 5 v, M.100713); 39°47.9'S, 178°17.9'E, alive, 788–832 m (2 pr, 1 v, M.100833). Challenger Plateau: 40°46.0'S, 167°54.9'E, alive, 1029 m (1 pr, NIWA P928); 40°50.1'S, 168°14.8'E, alive, 1005–1009 m (1 pr, 2 v, NIWA P927). Off Castlepoint: 40°46.2'S, 177°00.5'E, alive, 1020–1040 m (many juvenile pr, M.74968); 41°01.7'S, 176°28.4'E, alive, 410 m (5 pr, M.119164). Uruti High, off Cape Palliser, 41°15.5'S, 176°31'E, alive, 1200 m (2 pr, M.107609). Valerie Guyot, Louisville Ridge, 41°27'S, 164°08'W, 950–1000 m (2 v, M.119197). Off Palliser Bay, 41°42.3'S, 175°09.0'E, 1006 m (2 v, M.11122). SE of Cape Campbell, 42°00.8'S, 174°41.0'E, 939–1019 m (4 v, M.60435). Conway Rise, off Kaikoura, 400 m (1 v, M.107611). Upper Kaikoura Canyon, 42°29'S, 173°37'E, 1097–1006 m (1 pr, 4 v, M.51010). Hikurangi Trench, S side NE of Mernoo Bank, Chatham Rise, 42°29.2'S, 176°06.3'E, alive, 1568 m (4 pr, M.59629). S of Kaikoura Peninsula, 42°35'S, 173°41'E, alive, 640 m (2 pr, 1 v, M.53668). Chatham Rise: 42°37.86'S, 179°51.66'W, alive, 1037–1205 m (4 pr, NIWA Z9787); 42°42.2'S, 177°57.2'E, alive, 958–961 m (1 pr, NIWA Z10925); 42°43.49'S, 179°55.46'W, alive, 1055–1110 m (1 pr, NIWA Z9793); 42°43.79'S, 179°53.42'W, 1130–1000 m (2 pr, NIWA Z10713); 42°47.17'S, 179°59.12'W, alive, 993–900 m (1 pr, NIWA Z10698); 42°47.73'S, 179°59.23'E, alive, 1009–928 m (2 pr, NIWA Z10737); 42°47.84'S, 179°58.91'E, alive, 1013–922 m (6 pr, NIWA Z10707); 42°49.27'S, 175°37.49'W, alive, 1097–1106 m (3 pr, NIWA X535); 42°58.0'S, 175°37.0'E, alive, 513 m (1 pr, 1 v, M.150815); 44°19.8'S, 176°59.9'E, alive, 1086 m (1 pr, NIWA V385). Off Chatham Islands: 42°42'S, 178°01'W, alive, 1025–1055 m (9 pr, M.100711); 42°45.4'S, 177°54.6'W, alive, 954–968 m (30 juvenile pr, M.107610); 42°46.2'S, 177°44.6'W, alive, 988–993 m (2 pr, M.155384); 42°49.2'S, 177°25.4'W, alive, 855 m (1 pr, M.137790); 42°51.44'S, 176°53.73'W, alive, 804–863 m (many, M.127389). Off Kaikoura, 42°49.9'S, 173°48.4'E, alive, 927–995 m (2 pr, M.155383). Wall of Pegasus Canyon, NE of Banks Peninsula, 43°14'S, 173°39'E, 512–1006 m (8 v, M.52851). Moeraki Canyon, off Jackson Bay, 43°26.8'S, 168°54.2'E, alive, 833–891 m (2 pr, M.107586). Kellard Basin floor, Doubtful Sound, 45°21.30'S, 167°03.36'E, alive, 376 m (2 pr, M.138326).

## Distribution

Eastern and southern Australia (Dijkstra, unpubl. data), Pacific-Antarctic Ridge (Dell 1990), West Norfolk Ridge, Kermadec Ridge, and New Zealand, 376–1568 m; taken alive at 376–1568 m from hard substrata. Locally common (Fig. 41).





**FIGURE 41.** Map showing distribution of *Delectopecten fosterianus* (Powell, 1933).

#### Remarks

The present specimens are indistinguishable from the type material. Commarginal and radial sculpture in *D. fosterianus* ranges from prominent to very weak, or may even be absent. The minimum in Dell's (1956) stated bathymetric range "25–700 fathoms" (repeated in metres by Dell 1990) is based on a misidentified juvenile *Pecten novaezelandiae* from Queen Charlotte Sound (M.6592) (Dell 1951: 16).

#### Subfamily CHLAMYDINAE Teppner, 1922

#### Diagnosis

Chlamydoid Pectinidae having a persistent byssal notch with ctenolium, most species with radial costae or plicae that crenulate shell margin. Internal carinae lacking. Dentition simple, of dorsal and resilial teeth.

#### Tribe CHLAMYDINI Teppner, 1922

#### Diagnosis

Chlamydinae with subdivided and intercalated radial costae. Left valve with preradial antimarginal ridgelets. Internal rib carinae lacking except in *Notochlamys* and *Equichlamys*. Disc with antimarginal and shagreen microsculpture. Dorsal and resilial teeth present.

#### Genus *Austrochlamys* Jonkers, 2003

*Austrochlamys* Jonkers, 2003: 59. Type species (by original designation): *Pecten natans* Philippi, 1845; Recent, southern South America and southern New Zealand.

#### Diagnosis

Pectinidae with sturdy, oblong to subcircular, chlamydoid, prosocline shells, up to ca. 100 mm in height, surface of valves with radial costae that multiply by

intercalation and fission, prominent commarginal lamellae in rib interspaces, antimarginal microsculpture on pre-radial stage of left valve. Auricles unequal in size. Byssal notch moderately deep, functional ctenolium prominent.

#### Distribution

Oligocene to Recent. Antarctica, southern South America and sub-Antarctic New Zealand at sublittoral to bathyal depths.

#### *Austrochlamys natans walosseki* Jonkers, 2003

Figs 35, 37H

*Austrochlamys natans walosseki* Jonkers, 2003: 61, pl. 14, figs a–e.

#### Type material

Holotype (lv) ZMH 2909; off Argentina, 40°27.8'S, 56°31.8'E, 164 m, 27 Jun. 1978, RV *Walther Herwig* (not seen).

#### Material examined

SE of Auckland Islands, 51°10.0'S, 166°51.0'E, 490–510 m (2 v, M.118772).

#### Distribution

South-eastern South America and off Auckland Islands, southern New Zealand, 125–960 m (shells only) (Fig. 35).

#### Remarks

The two valves from off the Auckland Islands were trawled together with a quantity of similarly bleached, old-looking shells and presumably date from the last glacial maximum.

#### Genus *Paschinnites* Dijkstra & Raines, 1999

*Paschinnites* Dijkstra & Raines, 1999: 200. Type species (by original designation): *Pecten (Chlamys) pasca* Dall, 1908; Recent, Easter Island.

#### Diagnosis

Pectinidae with subcircular chlamydoid shells, byssate in juvenile stage and cemented with right valve to hard substrate in adult stage, up to ca. 20 mm in height, external prismatic layer lacking in early right dissoconch, antimarginal microsculpture in pre-radial stage, hexagonal or quadrangular microsculpture and radial macrosculpture throughout, commarginal sculpture lacking. Auricles unequal in size. Byssal notch and functional ctenolium prominent in juvenile stage, no function in adult (cemented) stage.

#### Distribution

Recent. Tropical and temperate Indo-and Central Pacific, Kermadec Islands and Easter Island at sublittoral depths.

***Paschinnites coruscans coruscans* (Hinds, 1845)**

Figs 35, 48A, D

- Pecten coruscans* Hinds, 1845: 61, pl. 17, fig 3.  
*Pecten cuneolus* Reeve, 1853: pl. 29, fig. 131 and text.  
*Pecten schmeltzii* Dunker in Küster & Kobelt, 1888: 272, pl. 71, figs 5–6.  
*Pecten sulphureus* Dunker in Küster & Kobelt, 1888: 276, pl. 72, figs 5–6 (not Gmelin, 1791—preoccupied)  
*Chlamys cellularis* Oliver, 1915: 554, pl. 12, fig. 46  
*Pecten eucosmia* Turton, 1932: 222, pl. 57, fig. 1549.  
*Chlamys coruscans coruscans*.—Dijkstra & Marshall, 1997: 99, pl. 8, figs 7–10.  
*Chlamys coruscans*.—Brook & Marshall, 1998: 212.  
*Bractechlamys* [sic] *coruscans*—Hayami, 2000: 905, pl. 450, fig. 41, unnumbered figs pp 904, 905.  
*Semipallium coruscans coruscans*.—Dijkstra & Kilburn, 2001: 294, figs 31–32 (further references to synonyms); Raines & Poppe, 2006: 236, 237 (figs), pl. 186, figs 1, 4–6, 8–9.  
*Bractechlamys coruscans coruscans*.—Wang, 2002: 193, pl. 5, fig. 1.

## Type material

See Dijkstra and Marshall (1997: 99) and Dijkstra and Kilburn (2001).

## Material examined

Raoul Island, Kermadec Islands—(2 pr, M.202881; 4 v, M.214629; 9 v, M.153478; 3 v, AIM AK.78582; 9 v, AIM AK.79528; 9 v, AMS C.300125).

## Distribution

Tropical and subtropical Indo-West Pacific, including Kermadec Islands, 0–82 m; taken alive intertidally to 24 m (Fig. 35).

## Remarks

For comments on the present species see Dijkstra and Marshall (1997: 101), and Dijkstra and Kilburn (2001: 296). *Paschinnites coruscans* is distinctive among Recent Pectinoidea in having a primary tripartite radial sculpture, flanked with one or two intercostal radial riblets, and a reticulate microsculpture. Unlike *P. pasca* (Dall, 1908), from Easter Island, *P. coruscans* lives attached to the substratum by byssus rather than cementation with the right valve. *Paschinnites coruscans* was formerly placed in *Chlamys*, *Semipallium* and *Bractechlamys*, but recently assigned to *Paschinnites*, based on the lack of an external prismatic layer in the early right dissoconch stage (Paulay 2003).

**Genus *Talochlamys* Iredale, 1929**

*Talochlamys* Iredale, 1929: 164. Type species (by original designation): *Chlamys famigerator* Iredale, 1925 (= *Pecten pulleineanus* Tate, 1887); Recent, southern Australia.

## Diagnosis

Pectinidae with rather inflated, weakly convex, sturdy to fragile, oblong shell, up to ca. 40 mm in height; valves with irregularly spaced, primary radial squamous costae, delicate secondary radial riblets commonly in late growth

stage, antimarginal microsculpture and intercalated, widely spaced, prominent commarginal lamellae; shagreen microsculpture commonly lacking. Auricles unequal in size. Byssal notch deep, functional ctenolium prominent.

## Distribution

Oligocene to Recent. Eastern Atlantic and Indo-West Pacific at littoral to bathyal depths.

## Remarks

The Australian type species of *Talochlamys* (*Pecten pulleineanus* Tate, 1887) and the New Zealand *Pecten dichrous* Suter, 1909 have similar shell morphology, and both have two extreme but intergrading forms, which are represented in the New Zealand species by the type material of *P. dichrous* and *Chlamys taiaroa* Powell, 1952 (Beu 1995; Beu and Darragh 2001; herein). Waller (1991) referred *P. dichrous* and *C. taiaroa* (which he maintained as distinct species) to *Zygochlamys*, because their microsculpture is closely similar to that in *Zygochlamys delicatula*, the principal difference being differential rate of sculpture transition during ontogeny. Waller (1991) did not discuss *Talochlamys*, or its type species. Beu (1995) reasoned that *Talochlamys* and *Zygochlamys* are distinct genera because *Zygochlamys* “is a South American group that reached New Zealand during earliest Pliocene time”, whereas *Talochlamys* species of the species group that includes *P. dichrous* had been in the New Zealand region since the Eocene. Poorly preserved fossils from a sparse early Pliocene faunule from Campbell Island identified as *Chlamys* aff. *delicatula* by Fleming (1950b), were re-examined by Beu (1985b) and identified as a species belonging to the same group as *C. gemmulata* (i.e. *Talochlamys*). *Zygochlamys* is absent from a sparse mid-late Miocene faunule from the Auckland Islands (Fleming 1968; Beu 1985a).

***Talochlamys dichroa* (Suter, 1909)**

Figs 42–45

- Pecten* (*Chlamys*) *dichrous* Suter, 1909: 264, pl. 11, fig. 31; Suter, 1913: 875, pl. 52, fig. 1.  
*Chlamys consociata* Smith, 1915: 89, pl. 2, figs 3, 8; Dell, 1963a: 172, pl. 1, figs 5–8; Powell, 1976: 124; Powell, 1979: 377. New synonymy.  
*Chlamys dichrous*.—Powell, 1937b: 56.  
*Chlamys* (*Mimachlamys*) *dichroa*.—Powell, 1946: 57.  
*Chlamys* (*Mimachlamys*) *consociata*.—Powell, 1946: 57.  
*Chlamys radiata consociata*.—Powell, 1950: 75.  
*Chlamys gemmulata consociata*.—Fleming, 1951b: 133.  
*Chlamys* (*Mimachlamys*) *taiaroa* Powell, 1952: 169, pl. 35, fig. 1.  
*Chlamys* (*Zygochlamys*) *delicatula*.—Dell, 1956: 19 (Mernoo Bank record only, not Hutton, 1873).  
*Chlamys dichroa*.—Boreham, 1959: 10; Powell, 1976: 124; Powell, 1979: 378, pl. 68, fig. 6; Abbott & Dance, 1982: 313, fig. 77.  
*Chlamys* (*Mimachlamys*) *gemmulata consociata*.—Powell, 1957: 77.  
*Chlamys taiaroa*.—Powell, 1976: 124; Powell, 1979: 378, pl. 68, fig. 7.  
*Zygochlamys dichroa*.—Waller, 1991: 29.  
*Zygochlamys taiaroa*.—Waller, 1991: 29, pl. 3, figs 1–3.  
*Talochlamys dichroa*.—Beu, 1995: 17, figs 3 e–h; Jonkers, 2003:

56, pl. 11, figs h–k; Raines & Poppe, 2006: 284, 285 (figs), pl. 235, figs 1–6.

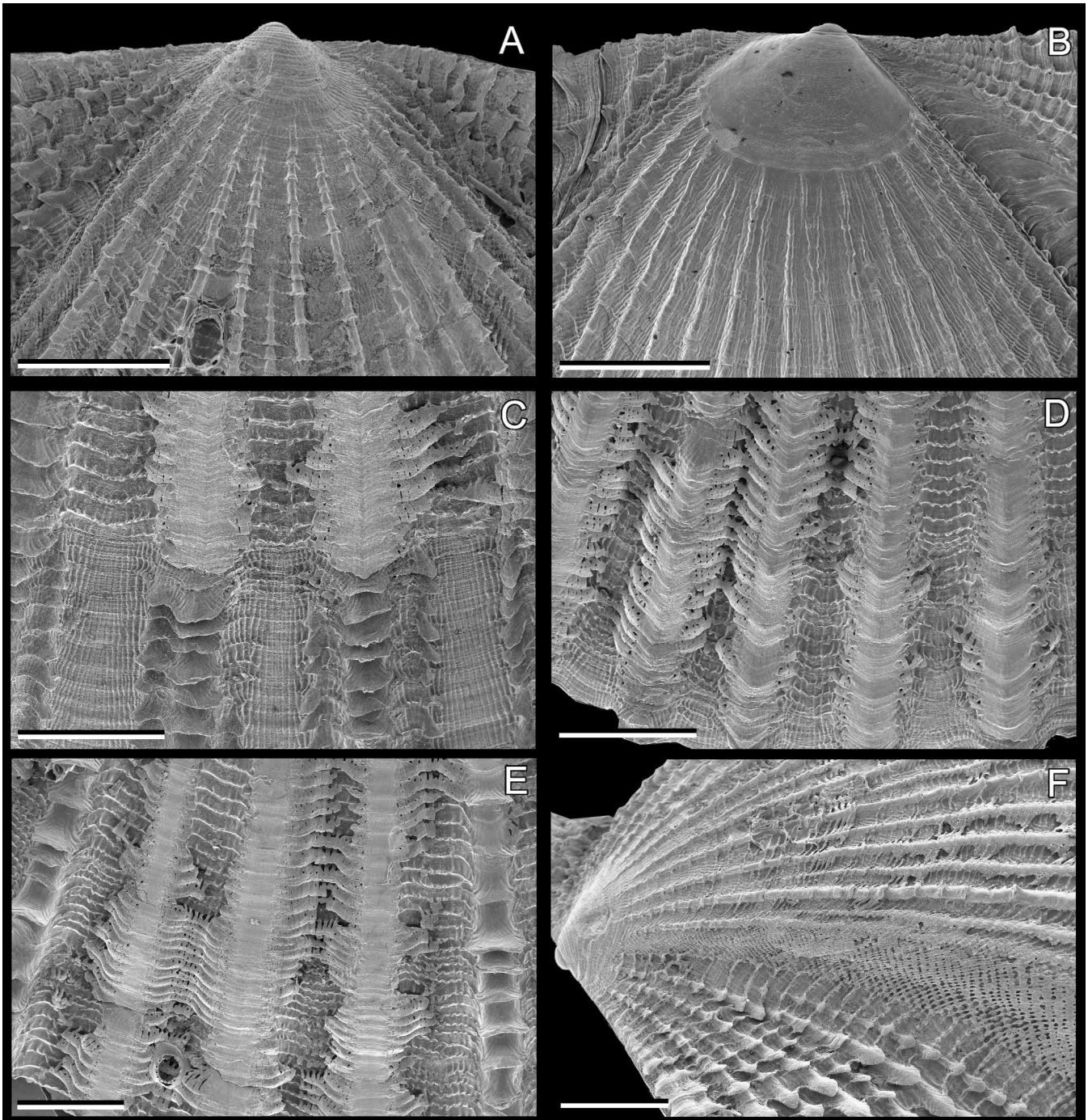
*Talochlamys* sp. cf. *pulleineana*.—Dijkstra & Marshall, 1997: 104 (not Tate, 1887).

#### Type material

*Pecten* (*Chlamys*) *dichrous*: lectotype (Boreham 1959: 10) NZGS TM 209, paralectotypes NMNZ M.10967 (1 pr, 1 v); Port Pegasus, Stewart Island, New Zealand, cod guts.

*Chlamys consociata*: syntypes (2) BMNH 1915.4.18.260 (Smith 1915, pl. 2, figs 3, 8; Dell 1963a, pl. 1, figs 5–8), S of Great Island, Three Kings Islands, 183 m, 25 Jul. 1911, HMS *Terra Nova* (stn 90); BMNH 1915.4.18.261, E of North Cape, 128 m, 3 Aug. 1911, HMS *Terra Nova* (stn 96).

*Chlamys* (*Mimachlamys*) *taiaroa*: holotype AIM 71183, off Otago, New Zealand, 91–128 m.



**FIGURE 42.** Pectinidae. *Talochlamys dichroa* (Suter, 1909). **A, C, E, F.** Tairaroa Canyon, off Otago Peninsula, 80 m (2 cleaned specimens), abrupt change to (*taiaroa*) sculpture following sponge-settlement clearly visible on C, and near valve margin on D, M.130698 (lv). **B, D.** Pegasus Canyon, NE of Banks Peninsula, 256–293 m, M.74877 (rv). Scale bars 1 mm.

#### Material examined

The type material (see above). Wanganella Bank, West Norfolk Ridge—32°10.5'S, 167°21.2'E, 442–449 m (1 old v,

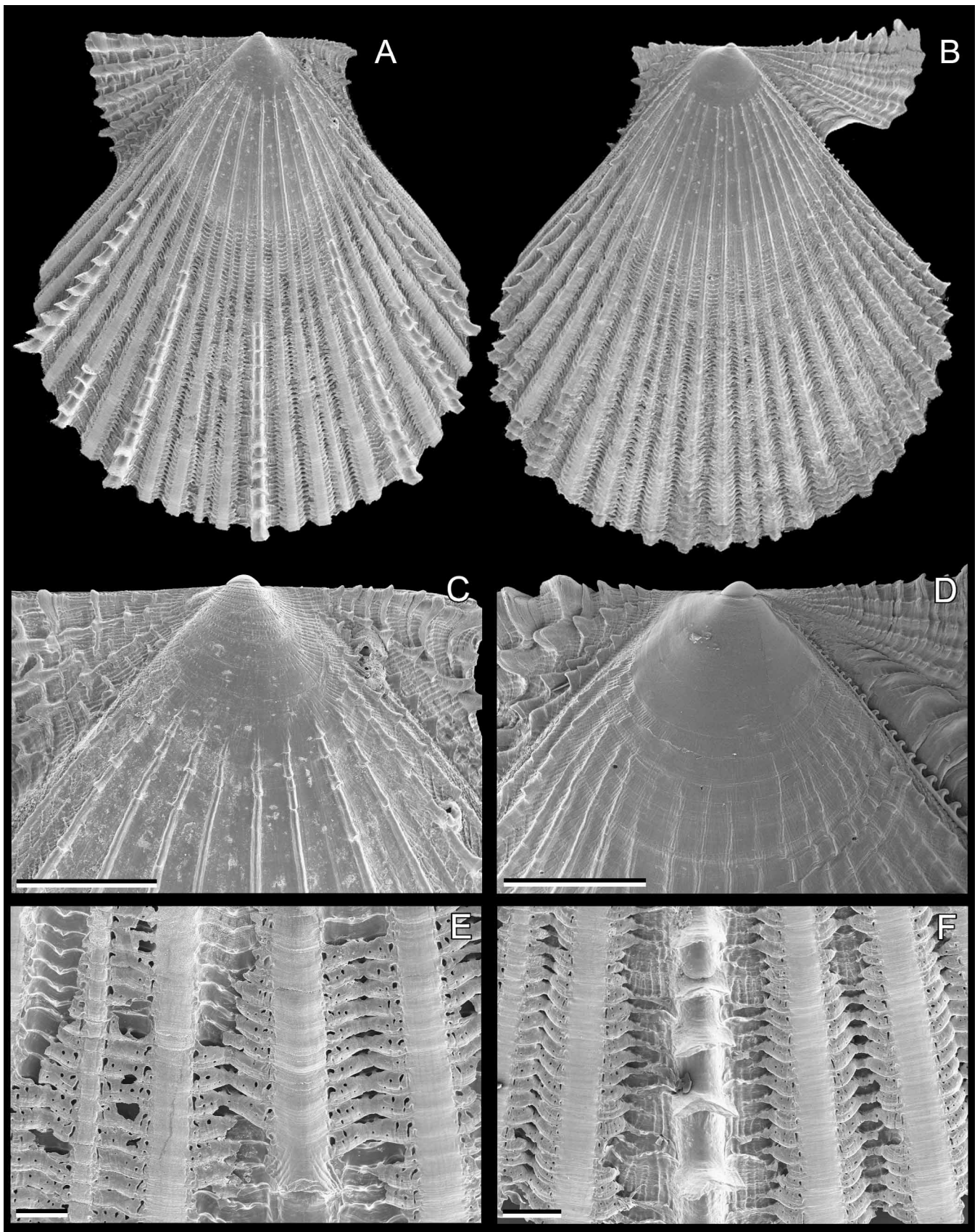
NIWA P13); 32°31.8'S, 167°29.5'E, 113–118 m (1 old v, M.257168); 32°39.2'S, 167°31.7'E, 133 m (3 v, M.243282). Middlesex Bank, NW of Three Kings Islands: 33°57.0'S,

171°45.4'E, 98–103 m (26 v, M.81180); 33°59.8'S, 171°46.8'E, alive, 143–163 m (2 pr, many v, M.155352); 33°59.9'S, 171°45.3'E, 186–196 m (many v, M.155345); 34°00.9'S, 171°44.7'E, alive, 201–216 m (1 pr, many v, M.155341); 34°01.2'S, 171°44.4'E, alive, 206–211 m (10 pr, many v, M.155348); 34°01.4'S, 171°45.2'E, alive, 201–216 m (4 pr, 22 v, M.107528); 34°02.0'S, 171°44.0'E, 246–291 m (many v, M.155288); 34°02.1'S, 171°45.8'E, alive, 221–206 m (3 pr, many v, M.155346). King Bank, N of Three Kings Islands—33°57.0'S, 172°19.0'E, 128 m (many v, M.155327); 33°57.4'S, 172°19.4'E, alive, 128–123 m (7 pr, many v, M.155343). Off Three Kings Islands: 37 km NE of Great Island, 33°58.0'S, 172°30.6'E, 550 m (30 v, M.155362); 18 km N of Great Island, 33°59.2'S, 172°13.6'E, 155 m (20 v, M.155360); Three Kings Trough, 34°00'S, 171°55'E, 805 m (many v, M.155333); N of Great Island, 34°01'S, 172°07'E, 622 m (30 v, M.34973); 13 km N of Great Island, 34°01.8'S, 172°12.0'E, 508 m (40 v, M.155461); 37 km NW of Great Island, 34°02.0'S, 171°48.4'E, 188 m (many v, M.155361); 22 km ENE of Great Island, 34°05.0'S, 172°24.6'E, 200 m (30 v, M.81238); 24 km NW of Great Island, 34°05.9'S, 171°55.1'E, 710 m (many v, M.81256); 11 km NW of Great Island, 34°06.5'S, 172°04.7'E, 310 m (30 v, M.155326); off Northeast Island, 34°08.5'S, 172°11'E, alive, 102 m (1 pr, many v, M.34582); 34°10'S, 172°12'E, alive, 252 m (1 pr, 40 v, M.34182); between Palmer Rocks and Southeast Island, 34°10'S, 172°08'E, 82 m (3 v, M.35459); E of Great Island, 34°10.5'S, 172°11.4'E, 153 m (5 v, M.155329); N side of Princes Islands, 34°10.7'S, 172°02.5'E, 20 m (1 v, M.117434); 34°11'S, 172°10'E, 91 m (3 v, M.35425); submarine cave, S side of Rosemary Rock, Princes Islands, 34°10.5'S, 172°04.0'E, 20 m (4 v, M.117287); 34°11'S, 172°10'E, 91 m (14 v, M.33791); 34°13.0'S, 172°11.5'E, alive, 256 m (12 pr, 14 v, M.155356); S of Great Island, 34°14.1'S, 172°09.0'E, alive, 192–202 m (11 pr, many v, M.155344); 34°14.2'S, 172°32.4'E, 100 m (11 v, M.155358); SE of Great Island, 34°14.8'S, 172°13.6'E, alive, 173–178 m (10 pr, many v, M.155351); SE of Great Island, alive, 34°16.4'S, 172°15.4'E, 138–143 m (1 pr, 2 v, M.155316); 39 km SW of Great Island, 34°17.6'S, 171°45.3'E, 427 m (9 v, M.155357); SE of Great Island, 34°18.8'S, 172°18.5'E, alive, 93–88 m (2 pr, many v, M.81133); SE of Great Island, 34°20.2'S, 172°21.8'E, alive, 121 m (1 pr, many v, M.155330); 37 km SW of Great Island, 34°20.4'S, 171°48.2'E, 440 m (7 v, M.155355); 28 km S of Great Island, 34°24.0'S, 172°16.8'E, 120 m (many v, M.155328). NW of Cape Maria van Diemen, 34°20.0'S, 172°30.0'E, 100 m (2 v, M.155324). Off Spirits Bay, 34°18.36'S, 172°49.39'E, 68 m (4 v, M.155377). N of North Cape, 34°20.0'S, 173°06.6'E, 163–168 m (2 v, M.158287). Off Cape Reinga: 34°21'S, 172°37'E, alive, 88 m (4 pr, M.36038); 34°22.8'S, 172°24.6'E, 121 m (many v, M.155353); 34°25.0'S, 172°27.8'E, 78 m (4 v, M.155331). Northern Arch, TeAraara Point, Poor Knights Islands, 35°27'S, 174°44'E, 50 m (1 v, M.155337). Rungapapa Knoll, W of White Island, 37°33.2'S, 176°58.7'E, 134–174 m (1 v, M.59942); 37°33.8'S, 176°59.0'E, 188–228 m, 20

January 1979, RV *Tangaroa* (associated *Pecten* valves dated at up to 28400 YBP) (2 v, M.158286). Ranfurly Bank, East Cape: 37°32.8'S, 178°48.7'E, 94 m (14 v, M.155332); 37°33.1'S, 178°49.5'E, 94–89 m (many v, M.155349); 37°33.2'S, 178°50.3'E, 76–71 m (2 v, M.155338); 37°33.4'S, 178°48.3'E, 106–103 m (5 v, M.155335); 37°36.7'S, 178°51.6'E, 56–63 m (1 v, M.155359); 37°38.4'S, 178°51.7'E, alive, 79–83 m (1 pr, 21 v, M.155347); 37°32.8'S, 178°48.7'E, 94 m (15 v, M.155332). Pegasus Canyon NE of Banks Peninsula: 43°25.0'S, 173°26.0'E, alive, 329–183 m (5 pr, 13 v, M.64680); 43°29.5'S, 173°30.5'E, 402–338 m (2 v, M.155350); 43°31.0'S, 173°30.5'E, alive, 256–293 m (11 pr, 27 v, M.74877). Off Oamaru, alive (18 pr, M.102574; 1 pr, M.155458). Between Moeraki and Oamaru, alive, 73–110 m (1 pr, M.6580). Off Otago Peninsula: 45°32'S, 170°56'E, alive, 130 m (7 pr, M.155334); Karitane Canyon, 45°38.5'S, 171°01'E, 200 m (1 v, M.155340); 45°41.85'S, 170°58.72'E, alive, 100–97 m (1 pr, M.112323); 45°38.5'S, 171°02'E, Karitane Canyon, 220 m (1 v, M.8955); 45°44'S, 171°02'E, alive, 137 m (1 pr, M.11084); 45°45.4'S, 171°05'E, Taiaroa Canyon, 549 m (2 v, M.9054); 45°47'S, 171°07'E, Taiaroa Canyon, alive, 457–549 m (9 pr, 2 v, M.8868); 45°48'S, 170°53'E, alive, 80 m (5 pr, 4 v, M.130698); 45°48'S, 170°52'E, alive, 70 m (2 pr, M.130588); 45°49'S, 170°54'E, alive, 90 m (20 pr, M.130537); 45°50'S, 170°56'E, 105 m (8 v, M.45323); 45°50'S, 170°59'E, alive, 220 m (1 pr, 5 v, M.155339); 45°50.85'S, 171°01.71'E, 555–604 m (2 v, M.130660); 45°51'S, 170°54'E, alive, 110 m (11 pr, 1 v, M.130501); Papanui Canyon, 45°51'S, 171°00'E, alive, 348–220 m (2 pr, 2 v, M.94634); Saunders Canyon, 45°56'S, 170°54'E, 360 m (3 v, M.48942). Off Taieri, S of Dunedin: 46°07.0'S, 170°39.0'E, alive, 87 m (2 pr, 7 v, M.155283); 46°09.0'S, 170°27.0'E, 60 m (1 v, M.155342); 46°12.0'S, 170°41.5'E, 150 m (13 v, M.65834); 46°15.0'S, 170°29.0'E, alive, 91 m (2 pr, 23 v, M.155336). Chatham Islands: (5 v, M.6582; 1 v, M.6589); SE of Pitt Island, 44°35.5'S, 176°04'W, 604 m (1 v, M.16208); E of Forty Fours, 44°04'S, 175°23.5'W, 238 m (6 v, M.16214). Stewart Island: off Halfmoon Bay (3 pr, M.19357); off Port Pegasus (2 pr, M.13481; 7 pr, M.19356). Off Western Chain, Snares Islands, 48°03'S, 166°30'E, alive, 70–110 m (5 pr, 4 v, M.135673). Off Auckland Islands, 50°55.9'S, 166°01.5'E, 95 m (12 v, NIWA D75). Campbell Plateau, 52°23'S, 170°02'E, alive, 160–244 m (2 pr, M.58235).

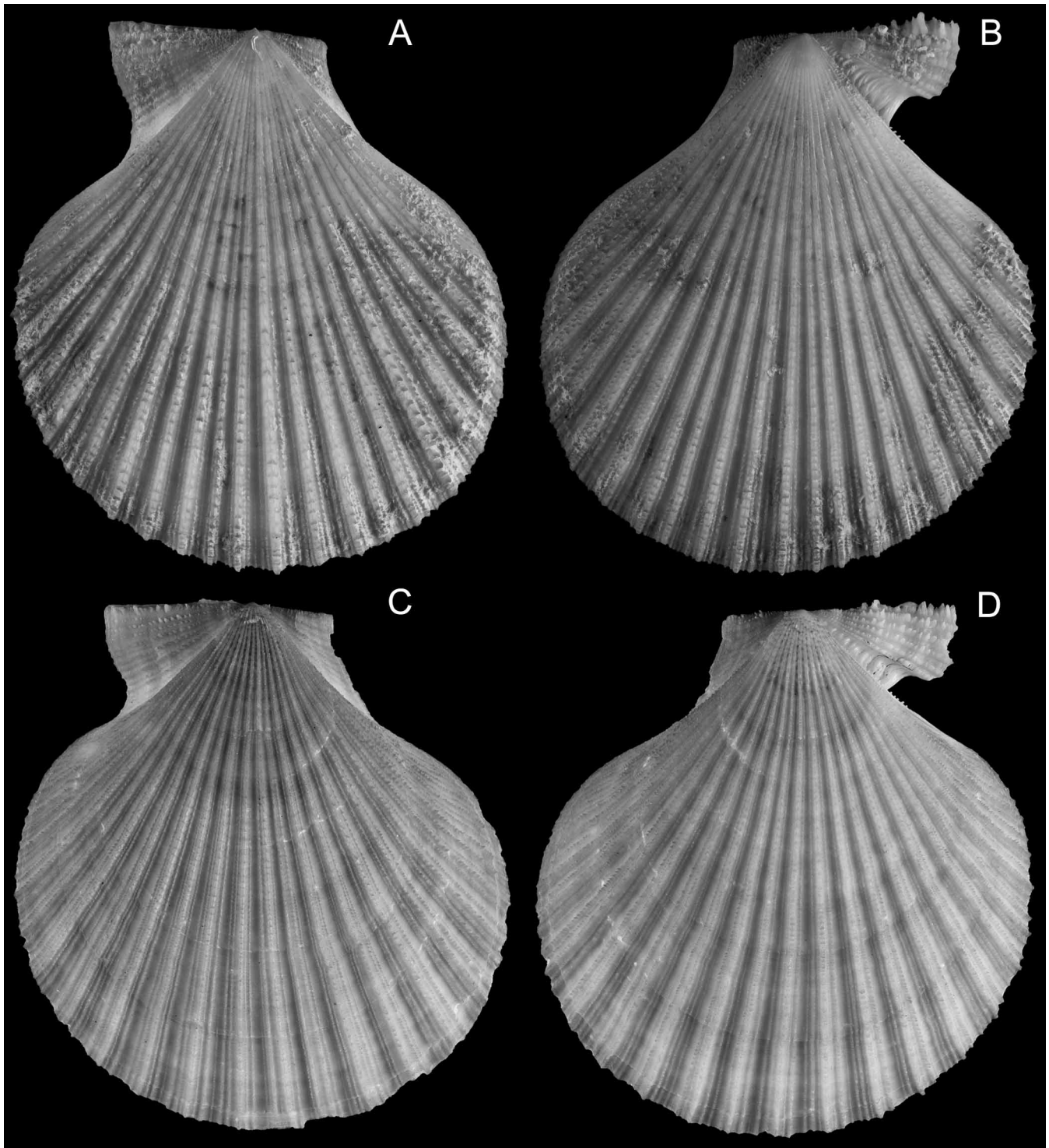
#### Distribution

Wanganella Bank, Three Kings Islands, Poor Knights Islands, seamounts off White Island (subfossil), East Cape, E South Island, Chatham Rise, Chatham Islands, Auckland Islands, and Campbell Plateau, New Zealand, 20–805 m, taken alive at 70–549 m. *Talochlamys dichroa* has only twice been taken shallower than 50 m, and the four valves taken at 20 m (by scuba diving), off the Three Kings Islands, may well have been transported up-slope by fishes: the minimum depth for the living animal seems likely to be about 70 m. Locally common (Fig. 45).



**FIGURE 43.** Pectinidae. *Talochlamys dichroa* (Suter, 1909). Typical *dichroa* morphotype, naturally free of encrusting sponge. Off Three Kings Islands, 256 m, M.155356 (height 10 mm: A, C, E, lv; B, D, F, rv). Scale bars 1 mm (C, D), 200  $\mu$ m (E) and 300  $\mu$ m (F).





**FIGURE 44.** Pectinidae (A, C = lv). *Talochlamys dichroa* (Suter, 1909). Typical *taiaroa* morphotypes with thinly encrusting sponge removed. **A, B.** virtual topotype of *Chlamys taiaroa* Powell, 1952, off Oamaru, M.102574 (height 43 mm). **C, D.** virtual topotype of *Chlamys consociata* E.A. Smith, 1915, off Three Kings Islands, 102 m, M.34582 (height 34 mm).

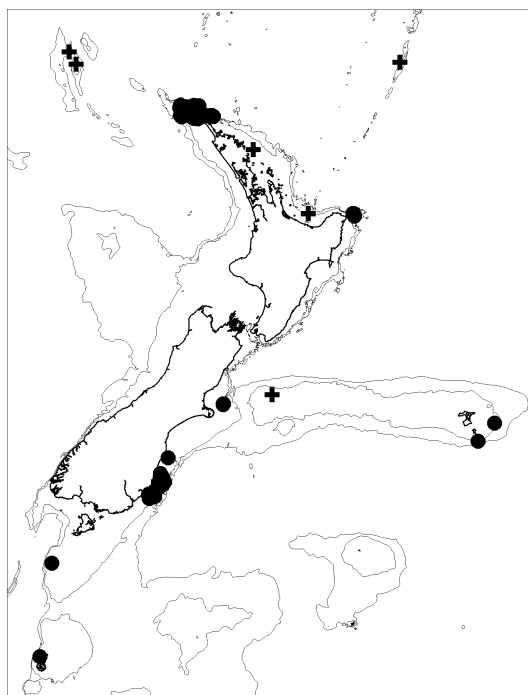
#### Remarks

Until now, *T. dichroa* has generally been regarded as a scarce southern species, though in fact a form morphologically identical to southern specimens is common and the dominant pectinid off the Three Kings Islands, and on Ranfurly Bank, East Cape, where it appears to replace *T. gemmulata*. Although having a wider north-south distribution than both *T. gemmulata* and *T. zelandiae*, *T. dichroa* is evidently a stenothermal, cool-adapted species,

and northern populations are probably able to thrive where they do because of local upwelling (Marshall 1998: 120). Upwelling may explain its presence on Wanganella Bank, though whether or not it still lives there remains to be established (only 5 valves known).

*Chlamys taiaroa* and *Pecten dichrous* are based on two forms in which sculpture diverges strongly after the shell attains about three mm in height. In the typical *dichroa* morph (Fig. 42, 43) the radial ribs become broader than high

from an early stage of growth, with broadly rounded summits. On the left valve, the summits of generally each third rib are set with imbricating scales, while on the right valve few or all ribs develop typically closely-spaced, imbricating scales, the interspaces on both valves having thin, commarginal lamellae and finer radial threads. The commarginal lamellae range from low and simple, to high with summits that lean ventrally to contact the next lamella, so that a secondary exterior surface is formed over the interspaces (typically more or less incomplete, however, because of extreme fragility of the lamellae—which sonication will destroy). In the typical *taiaroa* morph (Fig. 44A–D) the radial ribs remain angulate in section throughout, a secondary rib may or may not appear on one or both sides of each primary, the radials have rather widely-spaced scales, and interstitial commarginal lamellae may be prominent or obsolete, typically vanishing when the shell attains a height of about five millimetres. Both morphs occur off the Three Kings Islands, and patchily off the north-eastern North Island, where the *taiaroa* morph includes the type material of *C. consociata*. Whereas most individuals tend to be distinctly one form or the other, intermediates exist, not only in series, but also as occasional individuals in which sculpture changes abruptly from characteristically *dichroa* to *taiaroa* (Fig. 42C, D) (never *vice versa*). All specimens of the *taiaroa* morph are thinly encrusted with sponge, whereas, all specimens of the *dichroa* morph are naturally sponge-free and either clean or partly covered with living bryozoans. As discussed with respect to *Zygochlamys delicatula* (see below), the transition is evidently a response to settlement of sponge on the shell. We presume that settlement by sponge is advantageous to these bivalves by reducing predation (see Marin and López Belluga 2005).



**FIGURE 45.** Map showing distribution of *Talochlamys dichroa* (Suter, 1909):

● living specimens; + shells only.

Since there is fluid intergradation in shell morphology within and between northern and southern populations, it seems clear to us that a single highly variable species is involved. The southern Australia *T. pulleineana* (Tate, 1887), which shows similar variation, differs markedly in having much weaker sculpture on the early dissoconch (Beu and Darragh 2001: 95, figs 29A–I).

Whereas the nominal form of *dichroa* is distinctive, the *taiaroa* form is superficially similar to *T. gemmulata*, from which it differs in that radial ribs are more narrowly and sharply angulate in section, with considerably more prominent and sharper scales at equivalent stages of growth, in that the secondary ribs that appear beside the primary ribs remain markedly weaker than the adjacent primaries (enlarging to resemble primaries in *T. gemmulata*), and in that the spaces between adjacent secondaries are considerably broader. Populations of *T. dichroa* occur within the geographic and bathymetric ranges of *T. gemmulata* (sympatric), though they have never been taken living together, and even shells are rarely found together (asyntopic).

Some forms of *Z. delicatula* have very similar sculpture (especially up to about 10 mm height—Figs 53, 54). However *T. dichroa* differs in these characteristics: lighter build, less inflated, less highly arched in the middle and less oblique, smaller resilium, narrower hinge, and with radial undulations typically more deeply concave. Moreover, the summits of the primary radial ribs are typically smooth in *Z. delicatula*, but develop sharp spines in the *taiaroa* and *consociata* forms of *T. dichroa*.

#### ***Talochlamys gemmulata* (Reeve, 1853)**

Figs 46, 47, 48B, E

*Pecten gemmulatus* Reeve, 1853: pl. 27, fig. 111 and text; Küster & Kobelt, 1887: 206, pl. 55, figs 5, 6; Iredale, 1939: 354.

*Pecten gemmeus* Reeve, 1853: pl. 35, fig. 175 and text [see errata].

#### **New synonymy**

*Pecten radiatus* Hutton, 1873a: 82; Hutton, 1878: 55; Hutton, 1880: 171; Hutton, 1884: 532; Küster & Kobelt, 1888: 281; Suter, 1904: 93. Not Gmelin, 1791, nor Bosc, 1801 (preoccupied).

*Pecten australis*.—Hutton, 1878: 54; Hutton, 1880: 171 (not Reeve, 1853)

*Pecten asperrimus*.—Hutton, 1884: 531 (not Lamarck, 1819).

*Pecten dieffenbachi*.—Küster & Kobelt, 1887: 162, pl. 45, figs 3, 4 (not Reeve, 1853).

*Pecten zelandiae* var. *gemmulata*.—Suter, 1904: 93.

*Chlamys radiatus*.—Iredale, 1915: 486.

*Pecten (Chlamys) suteri* Hertlein, 1933: 63—replacement name for *P. radiatus* Hutton, 1873 not Gmelin, 1791, nor Bosc, 1801 (preoccupied).

*Chlamys (Mimachlamys) radiata*.—Powell, 1946: 57.

*Chlamys (Mimachlamys) gemmulata*.—Powell, 1946: 57.

*Chlamys radiata*.—Powell, 1950: 75.

*Chlamys gemmulata gemmulata*.—Fleming, 1951b: 132, pl. 19, figs 4, 5; Pantin, 1963: 508, fig. 3a; Dell, 1963a: 172, pl. 1, fig. 1.

*Chlamys gemmulata radiata*.—Fleming, 1951b: 133.

*Chlamys (Mimachlamys) gemmulata gemmulata*.—Powell, 1957: 77.

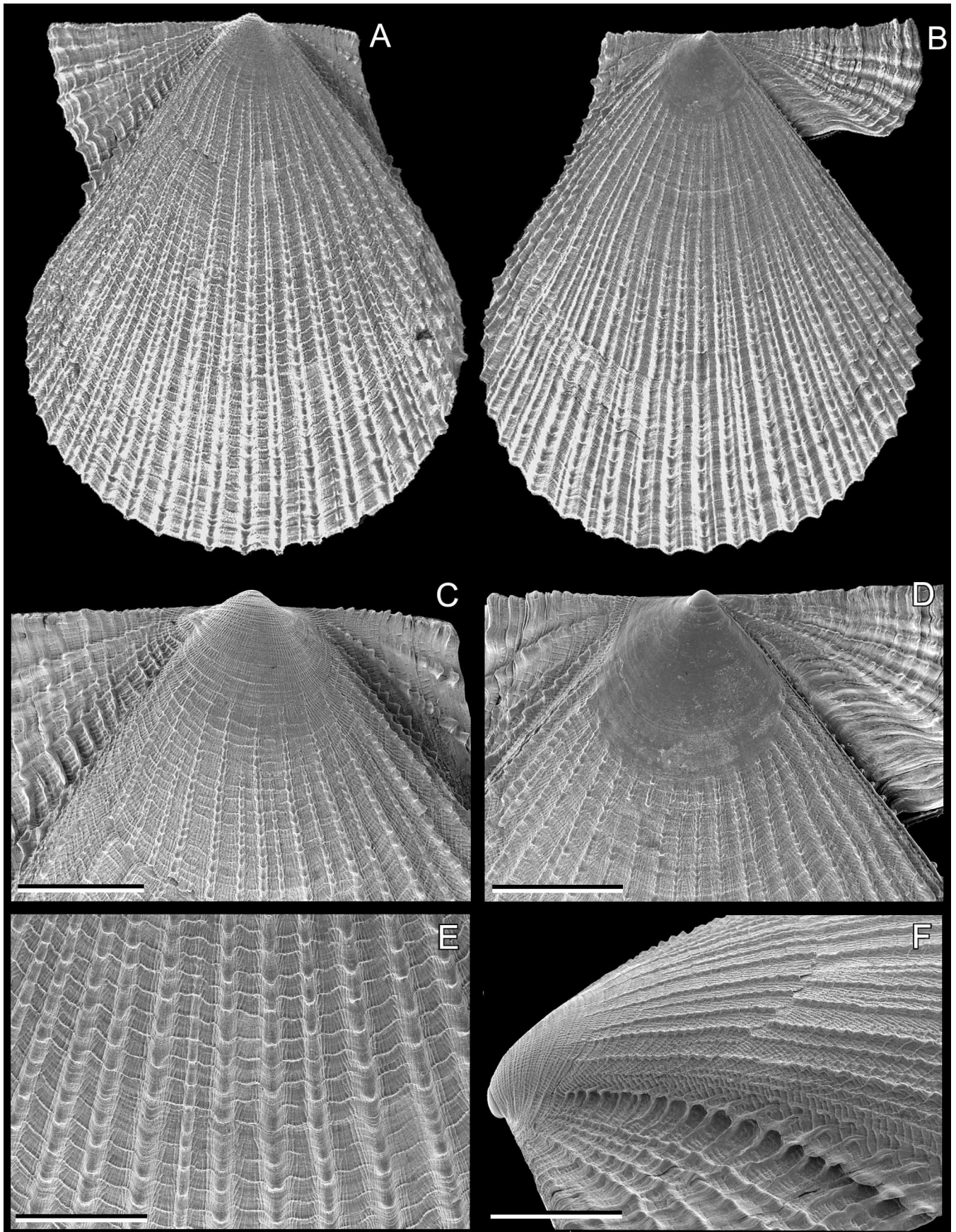
*Chlamys (Mimachlamys) gemmulata radiata*.—Powell, 1957: 77.

*Chlamys gemmulata suteri*.—Fleming, 1976: 28.

*Chlamys gemmulata*.—Powell, 1950: 75; Powell, 1976: 124;

Powell, 1979: 378, pl. 68, fig. 8; Abbott & Dance, 1982: 313, fig.; Beu & Maxwell, 1990: 336, 395, pl. 44, figs j, k.  
*Talochlamys* (?) *gemmulata*.—Beu, 1995: 19, figs 4 e–h.

*Talochlamys gemmulata*.—Raines & Poppe, 2006: 284, 285 (figs), pl. 236, figs 1–7, pl. 237, figs 1–5.



**FIGURE 46.** Pectinidae. *Talochlamys gemmulata* (Reeve, 1853), Colville Channel, Hauraki Gulf, 51 m, M.183890 (height 8.50 mm, A, C, E, F, lv; B, D, rv. Scale bars 1 mm.

NOT *Pecten gemmulatus*.—Hutton, 1873a: 81 = *C. zelandiae* (Gray, 1843).

NOT *Chlamys zelandiae gemmulatus*.—Suter, 1913: 878 = *C. zelandiae*.

#### Type material

*Pecten gemmulatus*: lectotype (Fleming 1951b: 132) BMNH 20020114/1 (Reeve, 1853, pl. 27, fig. 111; Fleming, 1951b, pl. 19, figs 4, 5; paralectotypes BMNH 20020114/2 (“syntype” Dell 1963, pl. 1, fig. 1) and BMNH 20020114/3; “New Zealand”).

*Pecten gemmeus*: holotype (pr) BMNH 20030057; “locality unknown” = New Zealand.

*Pecten radiatus* = *P. suteri*: syntypes (3) NMNZ M.350; Stewart Island, 24 m.

#### Material examined

The type material (see above). Several thousand specimens (270 lots NMNZ) from throughout the stratigraphic, bathymetric and geographic range.

#### Distribution

Pliocene (Opoitian) to Recent. North, South, Stewart, Snares and Chatham Islands, 0–805 m; taken alive at 20–293 m. Common (Fig. 47).

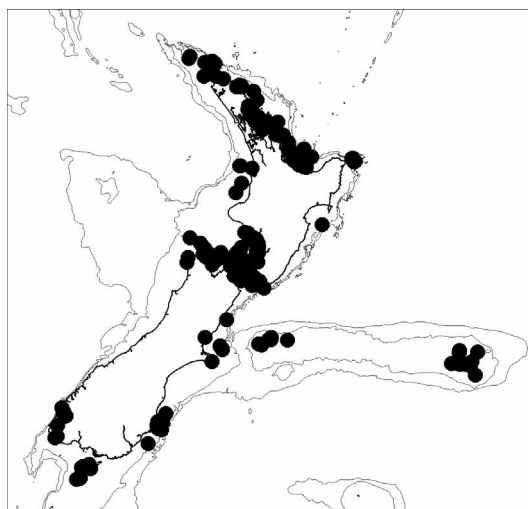


FIGURE 47. Map showing distribution of *Talochlamys gemmulata* (Reeve, 1853).

#### Remarks

*Talochlamys gemmulata* attains larger size in the south of its range (*radiatus* = *suteri* form) than in the north, notably at Stewart Island (height up to 68 mm, M.19561): the largest living specimen seen from north of East Otago is 46 mm high (Cook Strait, M.7792). Whereas no living North Island specimen seen is higher than 37 mm (off Bream Bay, M.155225), old-looking (bleached or stained) specimens up to 59 mm high, indistinguishable from the southern *suteri* form, have been dredged with accumulations of similarly preserved shells from off Te Arai Point, Northland (suction-dredged sand from 38–40 m depth used for beach formation at Mission Bay, Auckland; valves up to 49 mm high, M.138177), Rangatira and Rungapapa knolls, off White

Island (188–235 m, up to 56 mm high, M.60055; and 188–228 m, up to 58 mm high, M.64846 respectively), the south-eastern slope of Ranfurly Bank, East Cape (143–153 m, up to 62.5 mm high, M.76071), and from west of Kapiti Island (148 m, up to 58 mm high, M.7800). The sample from Rungapapa Knoll included numerous valves of a distinctive form of *Pecten novaezelandiae*, the oldest of which yielded <sup>14</sup>C dates of up 28,400 YBP. The Ranfurly Bank dredging included abundant *Zeacolpus* cf. *symmetricus* (Hutton, 1873) (Turritellidae), which is unknown living north of East Otago, and numerous well preserved valves of the southern South Island-Foveaux Strait form of *Ostrea chilensis* Philippi in Küster, 1844 (Ostreidae). Evidently, therefore, the large *suteri* form is a response (directly or indirectly) to low sea temperature, and was expressed further north than at present during glacial maxima. Although common throughout most of its geographic range, *T. gemmulata* is rare off the northern tip of Northland (Cape Maria van Diemen to North Cape), entirely replaced by *T. dichroa* off the Three Kings Islands, and rare at Ranfurly Bank, where *T. dichroa* is the dominant *Talochlamys* species (see above).

#### *Talochlamys zelandiae* (Gray, 1843)

Figs 48C, F, 49, 50

*Pecten zelandiae* Gray, 1843: 260; Smith, 1874: 7, pl. 3, fig. 7; Suter, 1904: 93.

*Pecten laetus* Gould, 1850: 345; Gould, 1852: 456, pl. 42, figs 571, a, b.

*Pecten dieffenbachii* Reeve, 1853: pl. 22, figs 88a, b and text.

*Pecten zelandiae* [sic].—Hutton, 1873a: 81; Hutton, 1880: 170.

*Pecten gemmulatus*.—Hutton, 1873a: 81, Hutton, 1880: 170 (not Reeve, 1853).

*Pecten dieffenbachii* [sic].—Hutton, 1873a: 82

*Pecten neozelanica* [sic, i.e. *zelandiae*].—Hutton, 1884: 531

*Pecten imparicostatus* Bavay, 1905b: 23, pl. 2, figs 6, 7. Not Bittner, 1895 (preoccupied).

*Pecten (Chlamys) imparicostatus* [sic].—Suter, 1913: 876, pl. 58, figs 9, a.

*Pecten imparicostatus* [sic].—Suter, 1906: 316.

*Pecten (Chlamys) zelandiae*.—Suter, 1913: 878, pl. 58, fig. 10

*Pecten zelandiae gemmulatus*.—Suter, 1913: 878 (not Reeve).

*Chlamys zelandiae*.—Iredale, 1915: 486; Powell, 1937b: 56, pl. 1, fig. 5; Dell, 1963a: 172, pl. 1, fig. 2; Powell, 1976: 124; Powell, 1979: 379, pl. 68, fig. 4; Abbott & Dance, 1982: 313, fig.; Beu & Maxwell, 1990: 338, 395.

*Chlamys imparicostatus*.—Iredale, 1915: 486.

*Chlamys celator* Finlay, 1928: 268, pl. 42, figs 49, 50;

*Chlamys suprasilis* Finlay, 1928: 269, pl. 43, figs 52–55;

*Pecten zealandonus* Hertlein, 1931: 369—replacement name for *P. imparicostatus* Bavay, 1905, not Bittner, 1895 (preoccupied).

*Chlamys zeelandonus*.—Powell, 1937b: 56.

*Chlamys (Mimachlamys) zelandiae*.—Powell, 1946: 57, pl. 1, fig. 5; Powell, 1957, pl. 1, fig. 5.

*Chlamys (Mimachlamys) suprasilis*.—Powell, 1946: 57.

*Chlamys (Mimachlamys) celator*.—Powell, 1946: 57; Shikama, 1964: pl. 28, fig. 1.

*Chlamys (Mimachlamys) zeelandona*.—Powell, 1946: 57.

*Chlamys suprasilis crepusculi* Fleming, 1948: 77, pl. 7, figs 1–3.

*Chlamys (Mimachlamys) cf. suprasilis*.—Powell, 1955: 24.

*Chlamys (Mimachlamys) cf. celator*.—Powell, 1955: 25.

*Chlamys (Mimachlamys) suprasilis suprasilis*.—Powell, 1957: 77.

*Chlamys (Mimachlamys) suprasilis crepusculi*.—Powell, 1957: 77.

*Chlamys dieffenbachi*.—Dell, 1963a: 172, pl. 1, fig. 3; Powell, 1976: 124; Beu, 1965: 93, pl. 1, figs 1–10; Powell, 1979: 378, pl. 73, fig. 1; Abbott & Dance, 1982: 311, fig.

*Talochlamys (?) zelandiae*.—Beu, 1995: 19, figs 4 a–d.

*Talochlamys zelandiae*.—Raines & Poppe, 2006: 290, 291 (figs), pl. 241, figs 1–8, pl. 242, figs 1–6.

NOT *Pecten dieffenbachi*.—Küster & Kobelt, 1887: 162, pl. 45, figs 3, 4 = *T. gemmulata* (Reeve, 1853)

#### Type material

*Pecten zelandiae*: 2 syntypes—BMNH 1842.11.16.145/1 (Smith 1874, pl. 3, fig. 7), BMNH 1842.11.16.145/2 (Dell 1963, pl. 1, fig. 2); “New Zealand”.

*Pecten laetus*: holotype USNM 5956; “New Zealand”.

*Pecten dieffenbachi*: lectotype (Dell 1963a: 172) BMNH 20020113/1 (Reeve 1853, fig. 88a), paralectotypes BMNH 20020113/2 (Reeve 1853, fig. 88b; Dell 1963a, pl. 1,

fig. 3) and BMNH 20020113/3; “New Zealand”.

*Pecten imparicostatus* = *P. zeelandonus*: holotype BMNH 52.3.13.241; “Novae Zelandiae mare” (Bavay 1905), and “don. Captain Stokes, HMS *Acheron*, leg. Dr. Gall” (label).

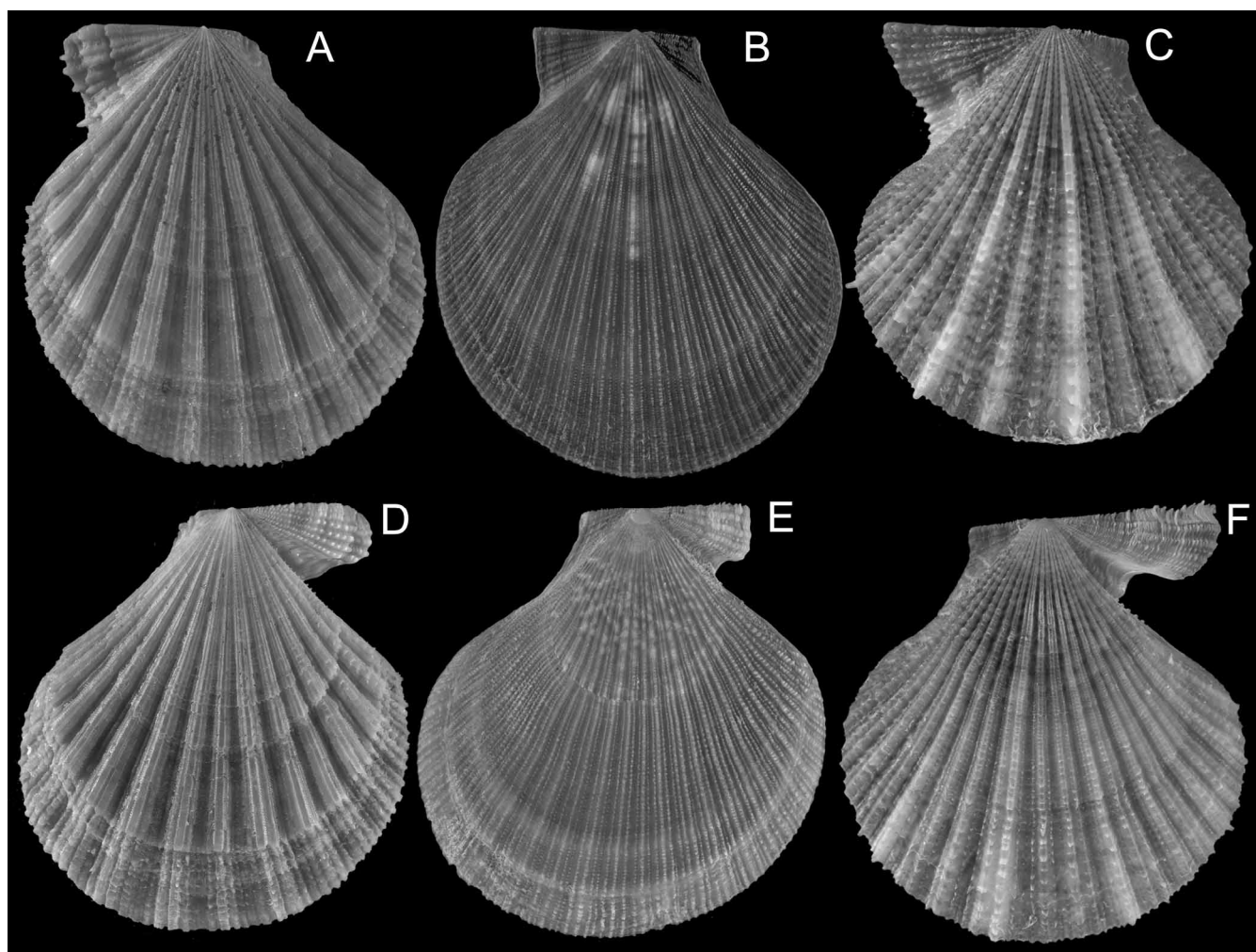
*Chlamys celator*: holotype AIM70166; Stewart Island.

*Chlamys suprasilis*: holotype AIM70168; Port Chalmers, Dunedin.

*Chlamys suprasilis crepusculi*: holotype NZGS TM.206; Facile Harbour, Dusky Sound, 22 m.

#### Material examined

The type material (see above). Several thousand specimens (383 lots NMNZ) from throughout the stratigraphic, bathymetric and geographic range.



**FIGURE 48.** Pectinidae (A–C = lv). **A, D.** *Paschahinnites coruscans coruscans* (Hinds, 1845), Raoul Island, Kermadec Islands, M.202881 (height 21 mm). **B, E.** *Talochlamys gemmulata* (Reeve, 1853), off Palliser Bay, 183 m, M.7611 (height 37 mm). **C, F.** *Talochlamys zelandiae* (Gray, 1843), off Barrett Reef, Wellington Harbour, M.29111 (height 31 mm).

#### Distribution

Late Pliocene (Mangapanian) to Recent. Three Kings, North, South, Stewart, Snares, Auckland and Chatham islands, 0–1006 m; taken alive intertidally to 549 m. Common (Fig. 50).

#### Remarks

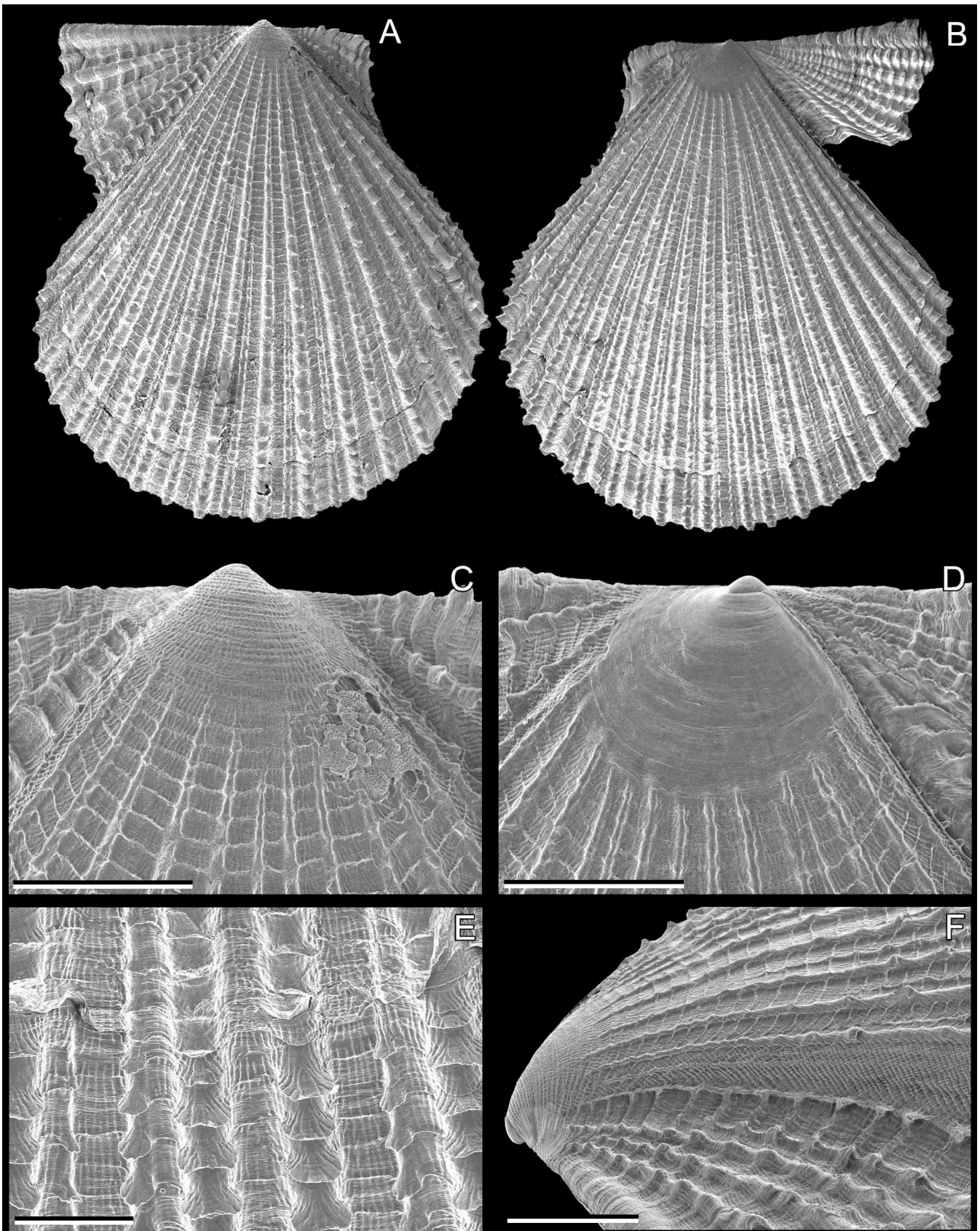
Dell (1963a: 172) unequivocally chose the syntype (of 2) illustrated by Reeve (1953, fig. 88a) as “lectotype”, yet unaccountably illustrated the syntype (i.e. paralectotype) illustrated by Reeve (1853, fig. 88b) as “type” (Dell 1963a, pl. 1, caption). *Talochlamys zelandiae* is common throughout



its geographic range, and locally sympatric with *T. gemmulata* (see below), which is more finely sculptured.

Hutton (1873a: 82, 1880: 171) suggested that *Pecten multicostatus* Reeve, 1853 (not Nilsson, 1827—preoccupied)

may be synonymous with *P. zelandiae* [sic], but from examination (HD) of the holotype (BMNH 1950.11.14.47), it is a form of *Mimachlamys varia* (Linnaeus, 1758).



**FIGURE 49.** Pectinidae. *Talochlamys zelandiae* (Gray, 1843), Colville Channel, Hauraki Gulf, 51 m, M.155258 (height 10 mm, A, C, E, F, lv; B, D, rv. Scale bars 1 mm (C, D, F) and 500  $\mu$ m (E).

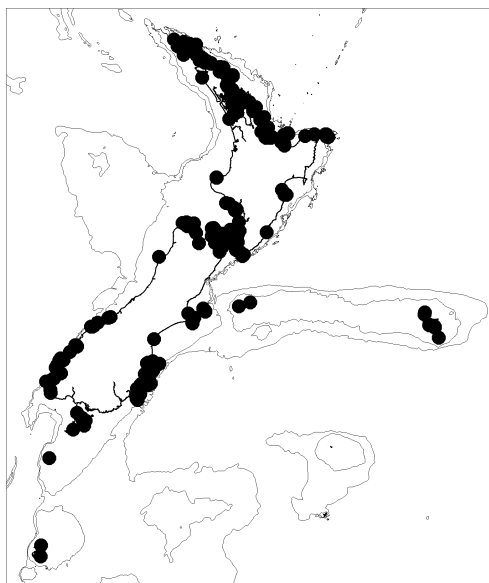


FIGURE 50. Map showing distribution of *Talochlamys zelandiae* (Gray, 1843).

### Genus *Veprichlamys* Iredale, 1929

*Veprichlamys* Iredale, 1929: 164, 188. Type species (by original designation): *Chlamys perillustris* Iredale, 1925; Recent, south-eastern Australia.

#### Diagnosis

Pectinidae with rather inflated, weakly convex, fragile, oblong shell, up to ca. 40 mm in height; valves with preradial antimarginal microsculpture, squamous primary and secondary intercalated (commonly in late growth stage) radial macrosculpture, and interstitial antimarginal microsculpture (rarely reticulate). Auricles unequal in size. Byssal notch deep, functional ctenolium prominent.

#### Distribution

Recent. Pacific from as shallow as 50 metres to bathyal depths.

#### Remarks

For discussion see Dijkstra (1995: 57).

### *Veprichlamys kiwaensis* (Powell, 1933)

Figs 51, 52

*Chlamys kiwaensis* Powell, 1933: 371, pl. 40, figs 1–5; Powell, 1979: 378, pl. 72, fig. 14.

*Chlamys (Mimachlamys) kiwaensis*.—Beu and Climo, 1974: 309.

*Chlamys (Chlamys) kiwaensis*.—Rombouts, 1991: 15, pl. 6, fig. 7.

*Veprichlamys kiwaensis*.—Beu, 1995: 19; Dijkstra, 1995: 58, figs 119–120; Raines & Poppe, 2006: 252, 253 (figs), pl. 199, figs 1, 4–6.

#### Description

Supplementary to those of Powell (1933, 1979). Prodissoconch smooth, 370–400 µm wide.

#### Type material

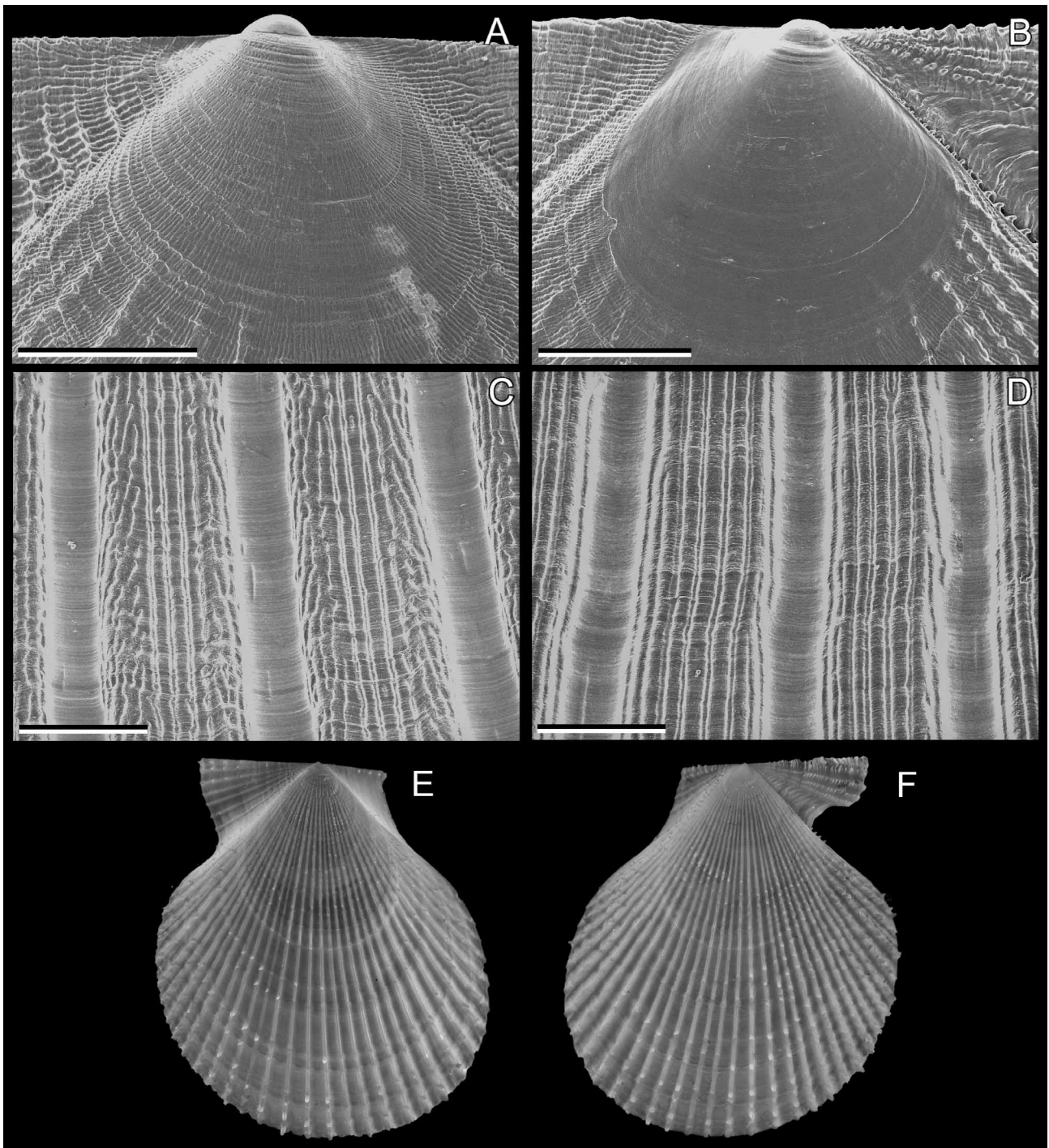
Holotype AIM AK 70167; 640 km W of New Plymouth, New Zealand, 39°00'S, 168°50'E, alive, 1097–1280 m, CS *Recorder*, W. Foster.

#### Material examined

The holotype (see above). Wanganella Bank, West Norfolk Ridge, 32°10.5'S, 167°21.2'E, 442–449 m (3 v, NIWA P13). Three Kings Trough, N of Three Kings Islands, 34°00'S, 171°55'E, 805 m (4 old v, M.155368). E of Great Barrier Island, 36°12.0'S, 176°19.4'E, 486–655 m (1 v, M.155364). Off Kaipara Harbour, 36°28.7'S, 173°43.8'E, 547–587 m (1 v, M.74634). ESE of Mayor Island, 37°22.0'S, 176°28.5'E, alive, 448–388 m (3 pr, 1 v, M.60094). Off Mahia, 39°45.6'S, 178°21.8'E, alive, 642 m (5 pr, M.100714). Challenger Plateau, 40°33.1'S, 170°57.3'E, 570–572 m (1 v, NIWA P926). Off Castlepoint, 41°01.71'S, 176°28.46'E, alive, 410 m (many pr, M.119165). Nicholson Canyon, off Turakirae Head, Cook Strait, 41°30.5'S, 174°54.0'E, alive, 640–658 m (3 pr, M.29129). Turakirae Trench, 41°30.7'S, 174°58.4'E, alive, 448–512 m (10 pr, 10 v, M.29148). Off Turakirae Head, 41°31.4'S, 174°52.6'E, alive, 533–225 m (1 pr, M.64930). Off Palliser Bay, 41°35'S, 174°53'E, alive, 366–549 m (4 pr, 8 v, M.9850). SE of Cape Campbell: 41°55.8'S, 174°40.7'E, alive, 434–446 m (many pr & v, M.60407); 41°55.9'S, 174°43.2'E, alive, 454–424 m (many pr & v, M.59679); 42°01.8'S, 174°26.5'E, alive, 885–969 m (3 pr, 3 v, NIWA E756). Conway Rise, off Kaikoura, alive, 400 m (15 pr, M.76106). S of Kaikoura Peninsula, 42°35'S, 173°41'E, alive, 640 m (5 pr, 2 v, M.53676). Slope N of Mernoo Bank, Chatham Rise, 42°38.2'S, 175°58.4'E, alive, 1040–1130 m (2 pr, M.147038). Off Mernoo Bank: 42°58.0'S, 175°37.0'E, 513 m (1 v, M.150814); 43°31.17'S, 175°37.62'E, alive, 320–419 m (1 pr, M.155367). Pegasus Canyon, NE of Banks Peninsula: 43°14'S, 173°39'E, alive, 1006–512 m (many pr & v, M.52769); 43°30'S, 173°31'E, 446 m (1 pr, 1 v, M.158289). Chatham Rise: 42°45.89'S, 179°59.16'W, Graveyard Seamount, alive, 800–757 m (2 pr, NIWA TAN104/289); 42°45.93'S, 179°59.34'W, Graveyard Seamount, alive, 875–757 m (1 pr, NIWA TAN104/02); 43°20.18'S, 178°58.8'E, 415–418 m (5 v, NIWA V372); 43°21.6'S, 179°30.3'E, alive, 394 m (1 pr, NIWA H947); 43°21.69'S, 178°39.03'W, alive, 412–420 m (1 pr, M.155366); 43°26.4'S, 179°34.9'E, alive, 395 m (4 pr, NIWA H636); 43°26.8'S, 179°16.7'E, alive, 396 m (2 pr, NIWA H950); 43°31'S, 179°36'E, alive, 410 m (1 pr, NIWA G232); 43°31.0'S, 179°09.5'E, alive, 512 m (4 pr, NIWA J58); 43°36'S, 175°31'E, 375 m (1 v, M.16213); 43°34.8'S, 179°00.0'E, alive, 392 m (3 pr, NIWA V373); 43°38'S, 178°32'E, alive, 424 m (1 pr, NIWA G364); 43°40'S, 179°01'E, alive, 327 m (3 pr, NIWA G290); 43°42'S, 179°55'E, 512 m (2 v, M.10755); 43°44.8'S, 178°59.7'W, alive, 397 m (4 pr, 16 v, NIWA V365); 43°50.2'S, 179°05.8'E, alive, 375 m (2 pr, NIWA I661); 43°51.0'S, 179°25.0'E, alive, 309 m (15 pr, 5 v, NIWA J59); 43°54'S, 179°44'E, 395 m (4 v, NIWA G200); 43°56.8'S, 178°01.7'E, alive, 680–736 m (2 pr, M.107606); 44°05.5'S, 176°12.0'E, alive, 198 m (2 pr, 1 v, NIWA J55); 44°07'S, 179°13'E, alive, 402 m (7 pr, NIWA G307A); 44°22.07'S, 176°01.64'E, alive, 263 m (2 pr, M.155365). Thompson Basin floor, Thompson Sound: 45°13.00'S, 166°57.96'E, 350 m (1 v, M.138503); 45°13.06'S, 166°58.01'E, 350 m, 2 stations (5 v, M.138752; 5 v, M.138815); 45°14.38'S, 166°58.87'E, 340–362 m (8 v,

M.150579). Off point E of Joseph Point, Doubtful Sound, 45°18.93'S, 166°58.36'E, 340 m (1 v, M.153640). Kellard Basin floor, Doubtful Sound, 45°21.30'S, 167°03.36'E, alive, 376 m (2 pr, 23 v, M.138306). Off Oamaru: alive, 293 m (1 pr, M.102571); alive, 366 m (1 pr, M.111768); alive, 508 m (1 pr, M.111762). Off Otago Peninsula: Karitane Canyon, 45°37.5'S, 171°06.0'E, 476–640 m (1 v, M.9138); Taiaroa Canyon, 45°45.6'S, 171°05'E, 549 m (2 v, M.12827); Papanui Canyon, 45°46.1'S, 171°05.0'E, alive, 720–530 m (1 pr, 8 v, M.137637); 45°50.85'S, 171°01.71'E, 555–604 m (5 v, M.130661); 45°51.05'S, 171°00.90'E, 500–589 m (1 v, M.135702). Bounty Plateau: 47°20.6'S, 179°30.0'E, alive, 552 m (5 pr, NIWA I707); 47°30.0'S, 178°45.0'E, 390 m (5

v, NIWA I705); 48°02.0'S, 179°44.0'E, alive, 380 m (1 pr, NIWA I672); 48°10.0'S, 180°00'E, alive, 327 m (2 pr, NIWA I679); 48°19.5'S, 179°29.5'E, 722 m (1 v, frags, NIWA I685); 48°20.5'S, 179°31.8'E, alive, 389 m (1 pr, NIWA I681). Off Auckland Islands: 49°35.76'S, 166°32.73'E, alive, 456–519 m (1 pr, M.117993); 50°39.0'S, 167°39.6'E, alive, 400 m (2 pr, NIWA S22); 50°41.0'S, 167°40.8'E, alive, 265 m (3 pr, NIWA S30); 50°41.8'S, 167°40.6'E, alive, 339 m (3 pr, NIWA S25); 51°10'S, 166°37'E, alive, 490–510 m (1 pr, M.118768). Off Campbell Island: 51°29.12'S, 169°37.44'E, 448–462 m (2 pr, M.118009); 53°00.7'S, 172°59.9'E, alive, 450 m (12 pr, 30 v, NIWA S53).



**FIGURE 51.** Pectinidae. *Veprichlamys kiwaensis* (Powell, 1933). **A–D.** off Castlepoint, 410 m, M.119165 (**A, C**, lv; **B, D**, rv). **E, F.** S of Kaikoura Peninsula, 640 m, M.53676 (height 30 mm). Scale bars 1 mm (**A, B**) and 500  $\mu$ m (**C, D**).

### Distribution

Southern New Caledonia (Dijkstra, 1995) and New Zealand, living at 263–1130 m byssally attached to corals and hexactinellid sponges. Locally common (Fig. 52).

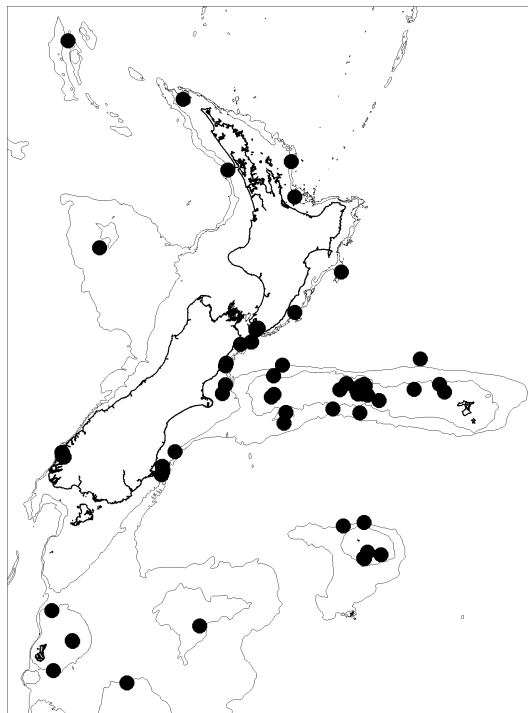


FIGURE 52. Map showing distribution of *Veprichlamys kiwaensis* (Powell, 1933).

### Remarks

*Veprichlamys kiwaensis* is distinctive among pectinids from the NZEEZ in having pink radial ribs on a paler or white ground, and crisp, crowded radial sculpture in interspaces of all radial ribs. The rather weak, widely spaced scales on the radial ribs appear later on the centre of the disc than on the sides, typically when the shell is more than 15–18 mm high.

### Genus *Zygochlamys* Ihering, 1907

*Zygochlamys* Ihering, 1907: 250. Type species (by original designation): *Pecten geminatus* G.B. Sowerby II, 1846; Late Eocene or Early Oligocene, Argentina.

*Psychrochlamys* Jonkers, 2003: 43. Type species (by original designation): *Pecten patagonicus* King & Broderip, 1832; Recent, southern South America.

### Diagnosis

Pectinidae with rather inflated, weakly convex, sturdy, chlamydoid, oblong (juvenile stage) to subcircular (adult stage) shell, up to ca. 100 mm in height; macrosculpture of disc broadly undulated plicae bearing scaly costae, with secondary costellae in interspaces of fasciculate riblets. Shagreen microsculpture throughout. Auricles unequal in size. Byssal notch deep, functional ctenolium prominent.

### Distribution

Late Eocene to Recent. Southern South America,

southeastern Australia and New Zealand at sublittoral to bathyal depths.

### Remarks

Jonkers (2003) introduced *Psychrochlamys* for taxa that differ from *Zygochlamys* species primarily as follows: smaller size, mostly opisthocline shape, shorter outer ligament, shallower byssal notch, complete lack of shagreen sculpture, and in that all species undergo a marked transformation in shell shape during ontogeny from a chlamydoid to an essentially aequipectinoid shape. Certainly all species referred by Jonkers to *Psychrochlamys* transform from chlamydoid to aequipectinoid shape, but the type species of *Zygochlamys* itself undergoes a similar transformation, the change being less pronounced in other *Zygochlamys* species. Jonkers reported that shagreen sculpture completely covers the disc in some *Zygochlamys* species, but that it occurs to a variable extent in early ontogeny in *Z. geminata*.

It seems clear to us that all of these differences are simply grades, none of which are of great magnitude (see Jonkers 2003, figs 30, 34). Accordingly we interpret *Psychrochlamys* as a synonym of *Zygochlamys*.

### *Zygochlamys delicatula* (Hutton, 1873)

Figs 53, 54, 55A, B, D, E, 56

*Pecten delicatula* Hutton, 1873b: 30.

*Chlamys asperrimus* [sic].—Hedley & May, 1908: 113. Not Lamarck, 1819.

*Chlamys antiaustralis*.—Hedley, 1911: 96 (Cape Pillar record only); May, 1912: 44; May, 1921: 10; May, 1923, pl. 3, fig. 8; May & Macpherson, 1958: pl. 3, fig. 8. Not Tate, 1886.

*Pecten (Patinopecten) delicatulus*.—Suter, 1914: 42, pl. 9, fig. 4 only (in part = *Sectipecten difffluxus* (Hutton, 1873)).

*Chlamys subantarctica* Hedley, 1916: 23, pl. 2, figs 14, 15; Tomlin, 1948: 230.

*Pecten delicatulus*.—Thomson, 1919a: 480; Thomson, 1919b: 282.

*Chlamys campbellicus* [sic] Odhner, 1924: 61, pl. 2, fig. 36 only (in part = *Talochlamys dichroa* (Suter, 1909)); Powell, 1939: 222, pl. 50, figs 10–14; Fleming, 1943: 193.

*Chlamys instar* Iredale, 1925: 251, pl. 41, figs 5–7.

*Chlamys titirangiensis* Marwick, 1928: 458, fig. 28.

*Chlamys delicatula*.—Marwick, 1928: 453; King, 1933: 353; Fleming, 1943: 193; Fleming, 1944: 210; Boreham, 1963: 3; Beu, 1969: 643; Beu, 1977: 199; Fleming, 1979: 72, figs 72c, d; Fleming, 1980: 20, fig. 5; Waloszek, 1984: 227, pl. 4, fig. 6.

*Chlamys campbellica*.—Fleming, 1944: 209.

*Chlamys (Zygochlamys) delicatula*.—Powell, 1950: 76; Powell, 1955: 25 (in part = *Sectipecten difffluxus*); Dell, 1956: 19 (in part: Mernoo Bank record = *T. dichroa*); Fleming, 1957, fig. 1E; Fleming & Boreham in Pantin, 1957: 788, figs 1, 2; Powell, 1960: 175; Fleming, 1961: pl. 4, fig. 8; Pantin, 1963: 507, figs 1, 3, 4; Dell, 1964: 180 (in part = *S. difffluxus*); Shikama, 1964: pl. 32, fig. 1; Boreham, 1963: 22, pl. 5, figs 8–10; Beu *et al.* 1977: 217, figs 3–6; Powell, 1979: 379, pl. 68, fig. 3 (in part = *S. difffluxus*); Beu *et al.* 1981: 127.

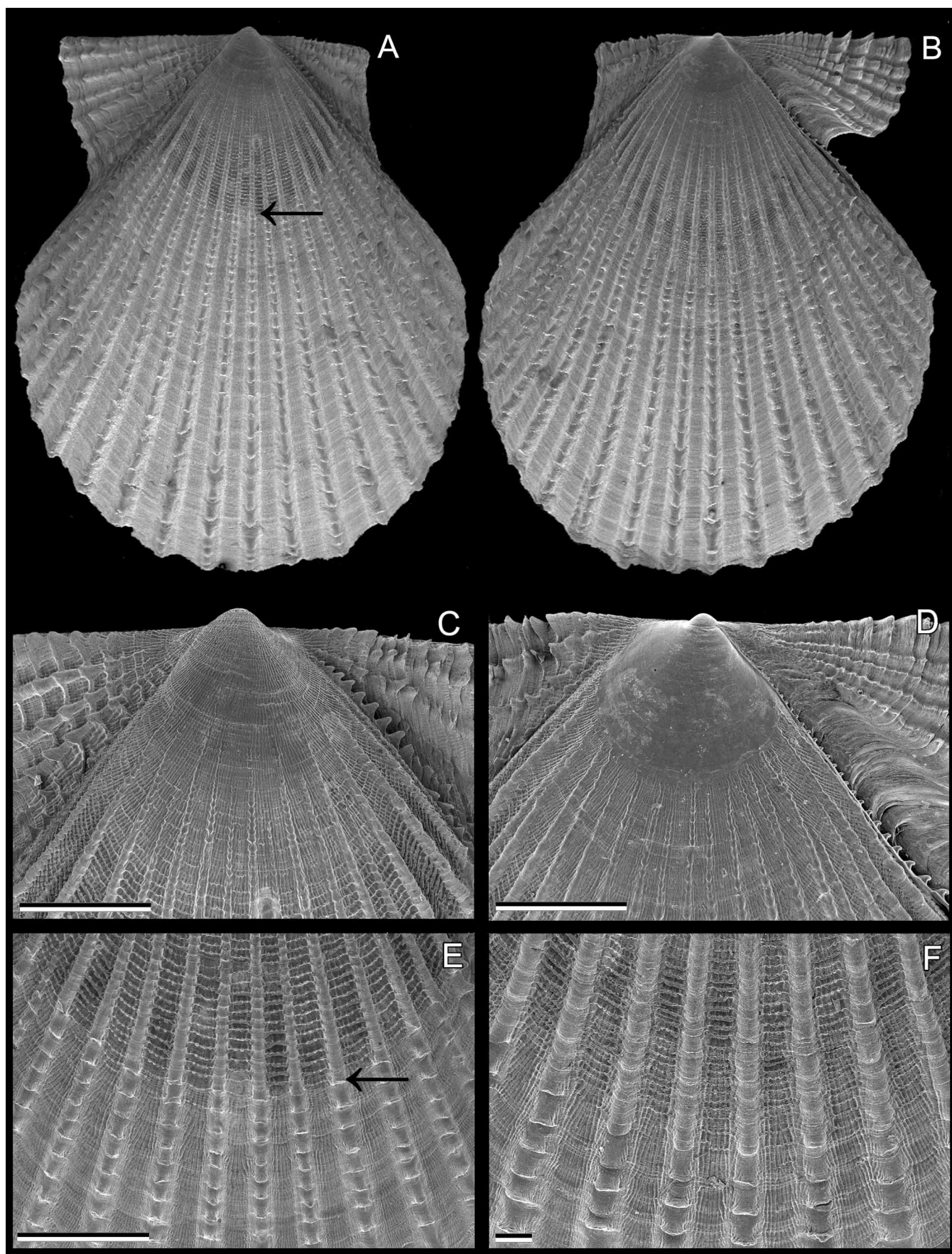
*Mimachlamys instar*.—Kershaw, 1955: 294.

*Chlamys (Zygochlamys) instar*.—Dell, 1964: 180.

*Chlamys patagonica delicatula*.—Beu, 1985b: 4, pl. 1, figs 5–9, pl. 2, figs 1–5; Beu & Maxwell, 1990: 308, pl. 38, fig. j; Lamprell & Whitehead, 1992: [22], pl. 9, fig. 48.

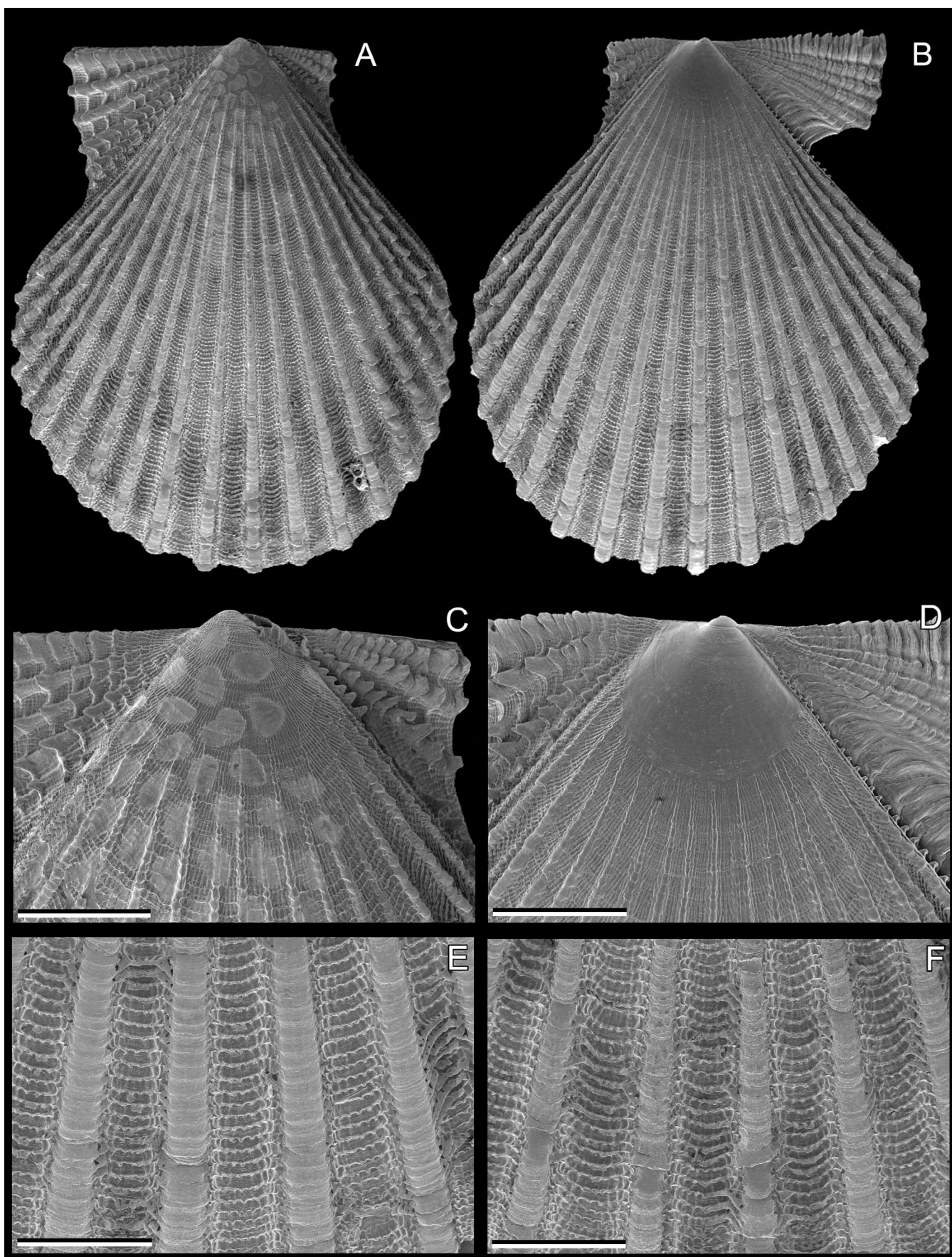
*Chlamys (Mimachlamys) instar*.—Rombouts, 1991: 29.





**FIGURE 53.** Pectinidae. *Zygochlamys delicatula* (Hutton, 1873), Pukaki Rise, 160–186 m, juvenile cleaned of thinly encrusting sponge, sculptural change triggered by sponge settlement indicated, M.58912 (height 10.5 mm: A, C, E, lv; B, D, F, rv.). Scale bars 1 mm (C–E) and 200  $\mu$ m.





**FIGURE 54.** Pectinidae. *Zygochlamys delicatula* (Hutton, 1873), Pukaki Rise, 160–186 m, juvenile naturally free of encrusting sponge, M.58912 (height 9.95 mm: A, C, E, lv; B, D, F, rv). Scale bars 1 mm.

*Zygochlamys delicatula*.—Waller, 1991: 28, pl. 2, figs 15, 16, pl. 3, fig. 4; Beu, 1995: 15, figs 3a–d, 23b, c, e; Beu, 1999: 543, figs 4–7; Beu, 2001: 120; Beu & Darragh, 2002: 118, figs 41A–G.

*Psychrochlamys delicatula subantarctica*.—Jonkers, 2003: 48, pl. 1, fig. b, pl. 9, figs a–d, pl. 11, figs d–g.

*Psychrochlamys delicatula instar*.—Jonkers, 2003: 51, pl. 11, figs a–c.

*Psychrochlamys delicatula*.—Raines & Poppe, 2006: 224, 227 (figs), pl. 172, figs 1–4.

#### Type material

*Pecten delicatula*: lectotype (Boreham 1965: 22) NZGS TM2835; Castlepoint, eastern Wairarapa, New Zealand, Late Pliocene (early Nukumaruan).

*Chlamys subantarctica*: holotype AMS C.47411; Lusitania Bay, Macquarie Island, 25 m, 4 Dec. 1913, Australasian Antarctic Expedition.

*Chlamys campbellicus*: lectotype (Beu 1995: 17) ZMUC BIV-413; Perseverance Harbour, Campbell Island, New Zealand, 37 m, 10 Dec. 1914, Mortensen's Pacific Expedition (stn 45).

*Chlamys instar*: holotype (1 v) AMS C.53769, and paratypes AMS C.29103 (7 v), C.105646 (1 v); 11 km E of Cape Pillar, Tasmania, c. 180 m.

*Chlamys titirangiensis*: holotype NZGS TM4207 and 2 paratypes; Titirangi Point, Chatham Island, New Zealand, Late Pliocene or Early Pleistocene (Nukumaruan).

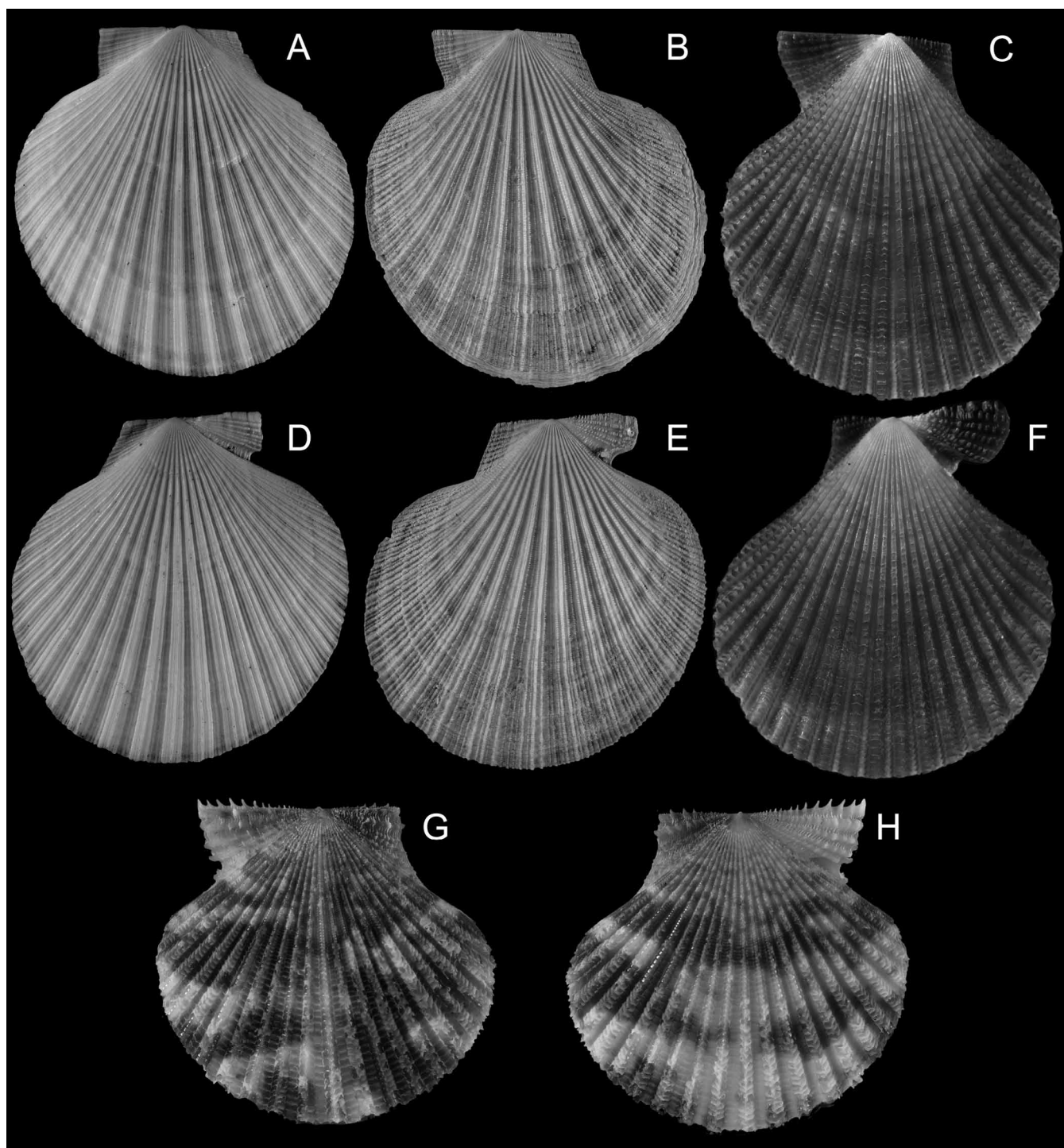
#### Material examined (\* = spiny, thin-shelled morphotype)

Cook Strait, W of Sinclair Head, 41°21.2'S, 174°31.7'E, alive, 256 m (1 pr, NIWA A444b). Off Palliser Bay, 41°38.0'S, 175°21.0'E, alive, 132 m (1 pr, 2 v, NIWA A140). NE of Banks Peninsula: 42°58.0'S, 173°30.0'E, alive, 110–128 m (1 pr, NIWA G156); 43°02.0'S, 173°38.0'E, alive, 146 m (2 pr, NIWA G159); 43°25.0'S, 173°26.0'E, alive, 183–329 m (3 pr, 2 v, M.64675); 43°31.0'S, 173°30.5'E, alive, 256–293 m (40 pr, 10 v, M.64712); 43°29.5'S, 173°30.5'E, alive, 402–338 m (1 pr, 5 v, M.67359); 43°30'S, 173°31'E, alive, 446 m (28 pr, 8 v, M.53917). W of Chatham Islands: 43°54.0'S, 179°14.0'W, 202 m & 222 m (10 old v, NIWA D907; 7 old v, NIWA D906); 43°56.0'S, 179°15.0'W, 203 m (2 old v, NIWA A917); 43°56.4'S, 179°25.1'W, 296–303 m (6 old v, M.90024). Veryan Bank, W Chatham Rise: 44°05.5'S, 176°12.0'E, alive, 198 m (1 subadult pr, NIWA J55); 44°07.3'S, 175°55.2'E, 140 m (1 v, NIWA I719). Head of Waitaki Canyon, off Oamaru, 45°10'S, 171°30'E, alive, 256–293 m (1 pr, 1 v, M.51331). Off Oamaru, alive, 128 m (many pr, M.102577, M.102573); alive, 366 m (1 pr, M.111494). Off Otago Peninsula: alive, 200 m (7 pr, M.155916); 45°32'S, 170°56'E, alive, 130 m (6 pr, M.130775); Karitane Canyon, 45°38.5'S, 171°01'E, 200 m (5 v, M.155940); Karitane Canyon, 45°38.5'S, 171°02'E, 220 m (1 v, M.8953); 45°41.85'S, 170°58.72'E, alive, 97–100 m (5 pr, M.100820); 45°44'S, 171°02'E, alive, 137 m (9 pr, M.11074); Taiaroa Canyon, 45°47'S, 171°07'E, alive, 457–549 m (9 pr, M.8869); 45°48'S, 170°52'E, alive, 70 m (12 pr, M.130589); 45°48'S, 170°51'E, alive, 60 m (2 pr, M.131437); 45°48'S, 170°53'E, alive, 80 m (3 pr,

M.130714); 45°48.0'S, 170°57.0'E, alive, 108 m (15 pr, NIWA G684); 45°49'S, 170°54'E, alive, 90 m (40 pr, M.130548); 45°50'S, 170°59'E, 220 m (7 v, M.155939); 45°51'S, 170°54'E, alive (18 pr, M.130506); 45°51'S, 170°59'E, alive, 220 m (8 pr, M.131300); Papanui Canyon, 45°51'S, 171°00'E, alive, 220–348 m (4 pr, 18 v, M.74846). Off Taieri, S of Dunedin: 45°59.8'S, 170°59.2'E, alive, 346 m (16 pr, NIWA B566); 46°07.0'S, 170°39.0'E, alive, 87 m (3 pr, 8 v, M.58910); 46°09.0'S, 170°48.0'E, alive, 133 m (many pr, NIWA G689); 46°12.0'S, 170°41.5'E, alive, 150 m (26 pr, 39 v, M.58608); 46°15.0'S, 170°29.0'E, 91 m (10 v, M.155941); 46°17.0'S, 170°32.0'E, alive, 180 m (19 pr, 16 v, M.59514). Off Puysegur Point, 46°28.7'S, 166°14.3'E, 164 m (30 v, NIWA B488). Off Nugget Point: 46°40'S, 170°00'E, alive, 140 m (14 pr, 15 v, M.65918); 46°45.8'S, 169°56.0'E, alive, 205–218 m (5 pr, M.58988). SW of Stewart Island, 47°33.0'S, 166°48.0'E, alive, 222–327 m (2 pr, M.58346). Off Bounty Islands: 47°20.3'S, 178°59.3'E, 195 m (4 v, NIWA I706\*); 47°30.0'S, 179°30.0'E, alive, 159 m (1 pr, M.274130; 2 pr, 6 v, NIWA A746\*); 47°40.0'S, 179°30.0'E, alive, 155 m (8 pr, NIWA I708\*); 47°40.9'S, 179°03.1'E, 113 m (12 v, NIWA A747\*); 47°41.0'S, 179°23.0'E, 159 m (17 v, NIWA A701\*); 47°50.0'S, 179°15.0'E, 139 m (24 v, NIWA I711\*); 47°55.0'S, 179°04.0'E, alive, 205 m (38 pr, NIWA A717\*); 48°00.1'S, 179°30.1'E, alive, 129 m (1 pr, 6 v, NIWA I712). Off Snares Islands: 48°00.2'S, 166°39.0'E, alive, 155 m (3 pr, NIWA B587); 48°02.0'S, 167°03.0'E, alive, 132 m (50 pr NIWA D131\*); 48°02.0'S, 166°36.0'E, alive, 161 m (3 pr, NIWA D100); 48°13.2'S, 166°52.3'E, alive, 147–150 m (2 pr, M.100586); 48°44'S, 166°30'E, alive, 187 m (2 pr, NIWA B589); alive, 146 m (5 pr, M.48815). Off Antipodes Islands, 49°36.7'S, 178°48.1'E, 360 m (5 old v, NIWA A744); 49°37.9'S, 178°52.4'E, 150 m (6 v, NIWA A742\*); 49°39.0'S, 178°55.0'E, 109 m (6 v, M.39554\*); 49°39.5'S, 178°53.0'E, 132 m (3 v, NIWA A721\*); 49°40.0'S, 178°53.0'E, alive 103 m (1 pr, 1 v, M.39452\*); 49°40.0'S, 178°52.0'E, alive, 86–95 m (3 pr, M.81418\*); 49°40.1'S, 178°44.3'E, 113 m (28 v, NIWA A739\*); 49°42.0'S, 178°44.3'E, alive, 150 m (6 pr, 8 v, NIWA A734\*); 49°42.0'S, 178°50.3'E, alive, 123 m (1 pr, NIWA A723); 49°43.3'S, 178°45.3'E, alive, 121 m (1 pr, 2 v, NIWA A733\*); 49°45.6'S, 178°48.0'E, alive, 163–210 m (4 pr, M.13454\*). Off Auckland Islands: 50°24.0'S, 166°14.0'E, alive, 141 m (1 pr, 13 v, NIWA D198); 50°55.9'S, 166°01.5'E, 95 m (2 v, NIWA D75). Off Campbell Island: 52°33.0'S, 169°10.8'E, alive, “6 m”, taken by scuba diver (1 pr, M.117492); 52°56.4'S, 169°33.0'E, alive, 188 m (28 pr, NIWA D35). Off Macquarie Island: 54°24.0'S, 159°01.0'E, alive, 79–83 m (10 pr, 2 v, M.59344); 54°25.0'S, 159°02.0'E, alive, 104 m (30 pr, NIWA C733); 54°31.0'S, 159°00.0'E, alive, 110 m (7 v, M.39551; 2 pr, 1 v, M.59343); 54°29.5'S, 158°58.5'E, alive, 22 m (10 pr, NIWA C732); 54°32.0'S, 159°02.0'E, alive, 86–101 m (4 pr, M.39555); 54°32.0'S, 159°02.0'E, alive, 92–113 m (8 pr, M.59342); 54°33.0'S, 158°58.0'E, alive, 91 m (10 pr, NIWA B339); 54°36.4'S, 158°57.0'E, alive, 91 m (6 pr, NIWA A695); 54°37.7'S, 158°57.0'E, alive, 433 m (30 pr, NIWA A696); 54°40.95'S, 158°54.8'E, alive, 95 m (4 pr, NIWA

A694); 54°41.0'S, 158°55.0'E, alive, 148 m (50 pr, NIWA E228); 54°51.0'S, 158°38.0'E, alive, 155 m (20 pr, NIWA E237); 54°52.0'S, 158°39.0'E, alive, 141 m (1 pr, NIWA D8); 54°52.0'S, 158°50.0'E, alive, 113 m (2 pr, NIWA D9);

54°55.0'S, 158°47.0'E, alive, 110 m (6 pr, NIWA C730); 54°59.7'S, 158°36.4'E, alive, 155–198 m (20 pr, NIWA E236); 55°01.0'S, 158°42.5'E, alive, 357 m (1 pr, NIWA E235).



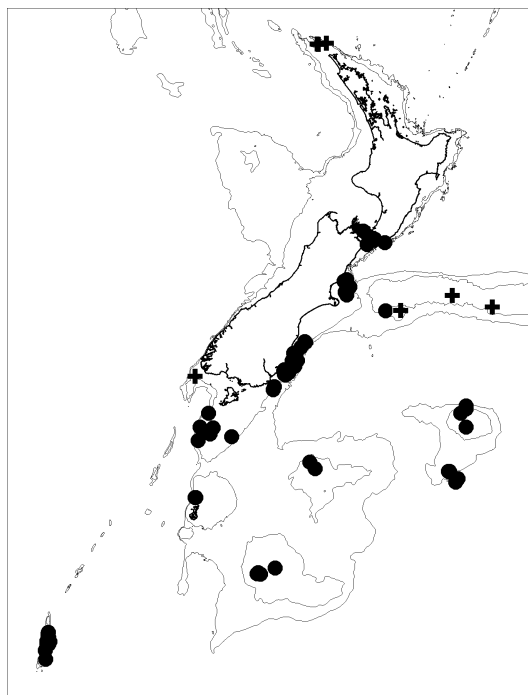
**FIGURE 55.** Pectinidae (A, B, C, G = lv). **A, B, D, E.** *Zygochlamys delicatula* (Hutton, 1873). **A, D.** off Cape Saunders, 130–150 m, thick, spineless form naturally without sponge encrustation, M.117266 (height 72 mm). **B, E.** off Antipodes Islands, 86–95 m, thin, spiny form, encrusting sponge removed, M.81418 (height 65 mm). **C, F.** *Mimachlamys sanguinea* (Linnaeus, 1758), off Norfolk Island, 65 m, NZOI I84 (height 32 mm). **G, H.** *Cryptopecten bullatus* (Dautzenberg & Bavay, 1912), off Raoul Island, Kermadec Islands, 82–100 m, M.227159 (height 15 mm).

#### Distribution

Late Pliocene (Early Nukumaruan) to Recent. Tasmania (presumed extinct—Beu 1985b) and southern New South Wales (AMS: presumed extinct—A.G. Beu, pers. comm.).

Eastern South Island, Veryan Bank, W of Chatham Islands (subrecent), Auckland, Bounty and Campbell islands, Antipodes Islands (subrecent), and Macquarie Island, 60–644 m; taken alive at 60–549 m. Living considerably

shallower than 60 m at Campbell Island, and possibly as shallow as 6 m (shells from anchor mud from Tucker Cove, Perseverance Harbour, and Northeast Harbour NMNZ). A locally common, commercially-harvested species (Fig. 56).



**FIGURE 56.** Map showing distribution of *Zygochlamys delicatula* (Hutton, 1873): ● living specimens; + old shells.

#### Remarks

*Chlamys/Zygochlamys delicatula* has generally been interpreted as a variable species ranging from Late Pliocene to Recent (Dell 1964; Powell 1979; Waller 1991; Beu 1995, 1999; Beu and Darragh 2002), and for a time it was interpreted as a geographic subspecies of the southern South American *Z. patagonica* (King & Broderip, 1832) (Beu 1985b; Beu and Maxwell 1990). In the most recent study of the group, Jonkers (2003) introduced *Psychrochlamys* for *Pecten patagonicus*, and recognised two chronosubspecies of the Late Pliocene *P. delicatula delicatula*: *P. delicatula subantarctica* (Hedley, 1916) for the living forms, and *P. delicatula instar* (Iredale, 1925) for some subrecent valves from Cook Strait and off the Snares Islands ( $^{14}\text{C}$ : 19,000 YBP; 18,850 6 650 YBP; 14,319 6 86 YBP) and Tasmania. Jonkers (2003, figs 34, 38) provided extensive statistical data showing differences between Recent specimens and the lectotype and other Late Pliocene specimens of *P. delicatula* that include smaller size (mean valve height 58.9 mm and 71.1 mm respectively), less symmetrical valves, less convex left valve, relatively shorter outer ligament, much lower auricular symmetry, angle between free margin of left valve anterior auricle and hinge  $<90^\circ$  (versus  $>90^\circ$ ), much higher angle between free margin of posterior auricle and hinge (about  $120^\circ$  and  $110^\circ$  respectively), deeper byssal notch, and higher number of functional byssal teeth. Jonkers admitted that the New Zealand species identified as *P. delicatula instar* were morphologically intermediate between *P. delicatula delicatula* and *P. delicatula subantarctica*, but differed in

that both valves are less inflated than in either *P. delicatula delicatula* or *P. delicatula subantarctica*. It seems clear to us that Recent and subrecent forms are forms of a single species in which various shell parameters have undergone random drift over time. We prefer to interpret these subrecent shells as simply forms of *Zygochlamys delicatula* rather than chronosubspecies, being influenced by the extreme variation between living populations.

In this connection, we draw attention to the fact that most of the local recent populations of *Zygochlamys delicatula* have distinctive combinations of shell sculpture, suggesting that the aggregations are largely self recruiting (in the absence of imperial data, Michael and Cranfield (2001) used data from “similar” pectinid species to infer length of larval life as 40–50 days for *Z. delicatula*).

Specimens from Pukaki Rise (Figs 53, 54), all live-taken specimens from Antipodes Islands (Fig. 55B, E), all live-taken specimens from the Bounty Plateau with the exception of material from NIWA stations I712 (no sponge and normally sculptured) and A717 (1 spiny, sponge covered specimen among 37 ‘normally’ sculptured, unencrusted specimens in station A717), and one lot from off the Snares Islands (station D131), are particularly distinctive in having an unusually thin shell, with prominent, sharp spines on all of the radial ribs, including (and particularly) the summits of the primaries. As with *Talochlamys dichroa* (see above), many individuals tend to be distinctly one form or the other, but individuals commonly occur in which sculpture changes abruptly from spineless to spiny (Fig. 53E, F) (but not *vice versa*), the transition evidently being a response to settlement of sponge on the shell.

Specimens without encrusting sponges from or adjacent to these stations are considerably thicker and spineless (Fig. 55A, D). The summits of the primary radial ribs are typically smooth in populations from elsewhere, whether or not there is sponge encrustation (Fig. 53E, F). This particular sponge (A717, D131) was identified as an undescribed species of *Esperiopsis* (Demospongiae: Poecilosclerida: Esperiopsidae) by Michelle Kelly (NIWA, Auckland). The thin, spiny form is almost indistinguishable from the *consociata* morph of *Talochlamys dichroa* (Suter, 1909) from off the Three Kings Islands, yet large size (height up to 79.5 mm), and the narrow outline of juveniles clearly indicates that they are forms of *Z. delicatula* rather than *Z. dichroa* (see below). This appears to be the first record of geographic variation in scallop dimorphism in response to sponge encrustation. Other examples of sponge-scallop mutualism have been discussed by Beu (1965), Forester (1979), Chernoff (1987), Pitcher and Butler (1987), and Pond (1992). The sponge will be discussed elsewhere by Michelle Kelly (in prep.). Recently, Marin and López Belluga (2005) have provided evidence that sponge coating on the bivalve *Arca noae* significantly reduces predation, and this seems likely to pertain in pectinids.

Since both extremes of sculpture may occur on a single individual, and there is fluid intergradation in shell morphology within and between populations, it seems clear to us that a single highly variable species is involved.

**Tribe AEQUIPECTININI Nordsieck, 1969****Diagnosis**

Chlamydiae with undivided radial costae, pitted preradial microsculpture, internal rib carinae and enlarged resilial hinge teeth.

**Genus *Cryptopecten* Dall, Bartsch & Rehder, 1938**

*Cryptopecten* Dall, Bartsch & Rehder, 1938: 93. Type species (by original designation): *Cryptopecten alli* Dall, Bartsch & Rehder, 1938 = *Pecten (Chlamys) bullatus* Dautzenberg & Bavay, 1912; Recent, Indo-Pacific.

*Corymbichlamys* Iredale, 1939: 367. Type species (by original designation): *Chlamys corymbiatus* Hedley, 1909; Recent, Queensland.

**Diagnosis**

Pectinidae with strong, variable inflated, sturdy, subcircular to circular shell, up to ca. 30 mm in height, valves with lamellose radial costae, interspaces with delicate imbricated scales. Auricles unequal in size. Byssal notch moderately deep, functional ctenolium well developed.

**Distribution**

Lower Miocene to Recent. Western Atlantic and Indo-Pacific at sublittoral to bathyal depths.

***Cryptopecten bullatus* (Dautzenberg & Bavay, 1912)**

Figs 55, 57

*Pecten (Chlamys) bullatus* Dautzenberg & Bavay, 1912: 17, pl. 27, figs 1–2.

*Chlamys (Aequipecten) tissotii*.—Kuroda, 1932: app. 95 (not Bernardi, 1861).

*Cryptopecten alli* Dall, Bartsch & Rehder, 1938: 93, pl. 23, figs 1–4, 7; Poutiers, 1981: 332; Abbott & Dance, 1982: 308, fig.; Dijkstra, 1987: 8, fig.

*Chlamys bullatus*.—Barnard, 1964: 429, fig. 14c.

*Cryptopecten tissotii*.—Habe, 1951: 77; Habe, 1961: 118, pl. 53, fig. 8; Habe, 1964: 174, pl. 53, fig. 8; Okutani, 1972: 113, fig. 62; Habe, 1977: 84; Koyama *et al.* 1981: 67. Not Bernardi, 1861.

*Chlamys alli*.—Kay, 1979: 524, fig. 168A; Earle, 1985: 1, figs.

*Cryptopecten complanus* Wang, 1983: 402, figs 1/1–7.

*Cryptopecten bullatus*.—Hayami, 1984: 96, pl. 1, figs 1–6, pl. 2, figs 1–3, pl. 9, fig. 1, pl. 10, fig. 3, pl. 11, fig. 3; Wagner, 1989: 60, figs 14–16; Dijkstra, 1991: 4, 35; Dijkstra, 1992: 26, figs; Dijkstra, 1995: 51, figs 115–118; Dijkstra & Marshall, 1997: 105, pl. 12, figs 1–5; Hayami, 2000: 905, pl. 450, fig. 39; Dijkstra, 2001: 92; Dijkstra & Kilburn, 2001: 309, fig. 49; Wang, 2002: 210, fig. 90.1–7; Raines & Poppe, 2006: 312, 315 (figs), pl. 275, figs 1–7.

*Chlamys (Cryptopecten) bullatus*.—Rombouts, 1991: 23, pl. 23, fig. 6.

**Type material**

*Pecten bullatus*: holotype ZMA Moll.3.12.006; Sulu Archipelago, 06°08'N, 121°19'E, 275 m, 4 Jul. 1899, HM *Siboga* (stn 105).

*Cryptopecten alli*: holotype USNM 173194; off S coast of Oahu, Hawai'i, 435–461 m, 27 Mar. 1902, RV *Albatross*

(stn 3811).

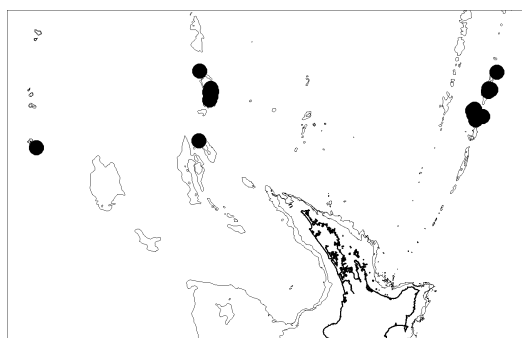
*Cryptopecten complanus*: holotype IOAS M11072; East China Sea, 31°05'N, 128°00'E, 147 m, 30 May 1978.

**Material examined**

The type material (see above). Norfolk Ridge, S of Norfolk Island, 29°41.8'S, 168°02.6'E, 322–337 m (3 v, M.171104). Macauley Cone, Kermadec Ridge, 30°10.1'S, 178°34.3'W, 287–328 m (1 v, NIWA TAN205/64). Off Lord Howe Island, 31°45.7'S, 159°20.9'E, 565–960 m (2 v, M.171159). West Norfolk Ridge, Wanganella Bank, 31°47.2'S, 167°51.6'E, 316–319 m (3 v, NIWA P14).

**Distribution**

SW Indian Ocean, SE Africa, Japan, East China Sea, Philippines, Indonesia, E Australia, New Caledonia, Wallis and Futuna, Vanuatu, Hawaiian Islands, Lord Howe Island, Norfolk Ridge, West Norfolk Ridge, and Kermadec Islands, 64–608 m; taken alive at 82–460 (Fig. 57).



**FIGURE 57.** Map showing distribution of *Cryptopecten bullatus* (Dautzenberg & Bavay, 1912).

**Remarks**

*Cryptopecten bullatus* differs from its locally sympatric living congener *C. nux* by having a thinner shell, a more weakly inflated right valve, and more delicate intercalary commarginal sculpture. The present material slightly differs from the holotype in having a sturdier, more inflated shell, and more prominent sculpture. Specimens from eastern Australia (AMS) eastwards to the Kermadec Islands are generally larger (height up to ca. 30 mm) than specimens from Indonesia and the Philippines (height up to ca. 20 mm, ZMA).

The Wanganella Bank specimens are the southernmost record for *C. bullatus*.

**Tribe MIMACHLAMYDINI Waller, 1993****Diagnosis**

Chlamydiae with undivided radial costae, shallow pitted preradial microsculpture, herringbone-like disc microsculpture, and dorsal and resilial hinge teeth. Internal rib carinae present in most species.

**Genus *Mimachlamys* Iredale, 1929**

*Mimachlamys* Iredale, 1929: 162. Type species (by original designation): *Pecten asperrimus* Lamarck, 1819; Recent, Australia.



### Diagnosis

Mimachlamyдини with rather inflated to compressed, sturdy, oblong to subcircular shell, up to ca. 100 mm in height, valves with preradial granulated microsculpture, radial macrosculpture typically of regularly spaced, solid radial spinose costae, flanked by secondary costellae, and antimarginal and/or divaricating interstitial microsculpture. Auricles strongly unequal in size. Byssal notch deep, functional ctenolium prominent.

### Distribution

Eocene to Recent. Eastern Atlantic, Indo-West Pacific and temperate Australasian waters at littoral to upper bathyal depths.

### *Mimachlamys sanguinea* (Linnaeus, 1758)

Figs 55C, F, 58

*Ostrea sanguinea* Linnaeus, 1758: 698; Dijkstra, 1999: 413, figs 4A–B.

*Pallium senatoris* Chemnitz, 1784: 320, pl. 65, fig. 617 (not binomial).

*Pallium porphyreum* Chemnitz, 1784: 330, pl. 66, fig. 632 (not binomial).

*Ostrea senatoria* Gmelin, 1791: 3327 (based on Chemnitz 1784: 320, pl. 65, fig. 617).

*Ostrea porphyrea* Gmelin, 1791: 3328 (based on Chemnitz 1784: 330, pl. 66, fig. 632).

*Pecten aurantius* Lamarck, 1819: 175.

*Pecten florens* Lamarck, 1819: 175.

*Pecten indicus* Deshayes, 1832b: 410, pl. 3, fig. 5.

*Pecten pseudolimea* Sowerby, 1842: 78, pl. 20, fig. 235.

*Pecten layardi* Reeve, 1853: pl. 21, figs 80 a, b and text.

*Pecten fricatus* Reeve, 1853: pl. 34, fig. 161 and text.

*Pecten blandus* Reeve, 1853: pl. 34, figs 162 a, b and text.

*Pecten raffrayi* Jousseau, 1886: 221, text fig.

*Mimachlamys ellochena* Iredale, 1939: 349, pl. 5, fig. 24.

*Chlamys* (*Mimachlamys*) *asperrimoides* Powell, 1958: 70, pl. 11, figs 3–4, text fig.

*Mimachlamys senatoria*.—Dijkstra & Marshall, 1997: 101, pl. 9, figs 1–4; Dijkstra & Knudsen, 1998: 83, pl. 4, fig. 16 (further references to synonyms); Hayami, 2000: 903, pl. 448, fig. 24. Wang, 2002: 188, fig. 79.

*Mimachlamys sanguinea*.—Dijkstra & Kilburn, 2001: 305, figs 44–45; Raines & Poppe, 2006: 274, 275 (figs), pl. 221, figs 1–5, pl. 222, figs 1–5, pl. 223, figs 1–5, pl. 224, figs 1–8.

### Type material

See Dijkstra and Knudsen (1998) and Dijkstra (1999).

### Material examined

Off Raoul Island, Kermadec Islands—29°13.0'S, 177°52.4'W, 610 m (1 v, NIWA K829); 29°13.1'S, 177°53.5'W, 472 m (fragment, NIWA T225).

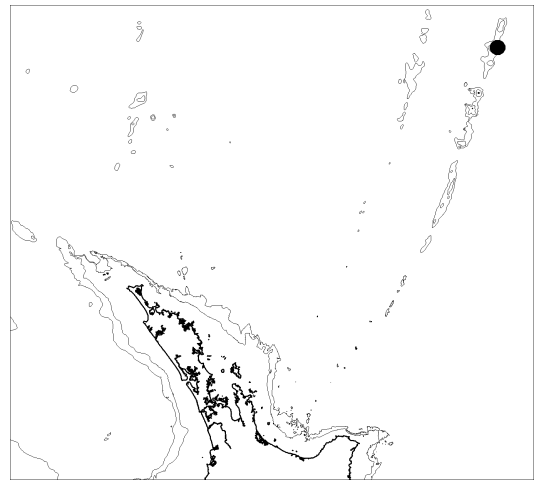
### Distribution

Red Sea and tropical and subtropical Indo-West Pacific, including Norfolk Island (common) and Kermadec Islands (rare), 0–610 m; taken alive at 0.6–74 m (Fig. 58).

### Remarks

*Mimachlamys sanguinea* is a polymorphic and

polychromatic species widespread in the tropical Indo-Pacific that is still under study (HD). For further comments see Dijkstra and Marshall (1997: 104) and Dijkstra and Kilburn (2001: 306).



**FIGURE 58.** Map showing distribution of *Mimachlamys sanguinea* (Linnaeus, 1758).

### Subfamily PALLIOLINAE Korobkov in Eberzin, 1960

#### Diagnosis

Pallioline Pectinidae with an inner shell surface microstructure of irregularly foliated calcite.

#### Remarks

For phylogenetic observations on this subfamily see Waller (2006: 10).

### Tribe PALLIOLINI Korobkov in Eberzin, 1960

#### Diagnosis

Palliolineae with undivided radial costae, preradial microsculpture of commarginal and antimarginal ridgelets, inner rib carinae, dorsal hinge teeth, and disc microsculpture of widely spaced commarginal lamellae.

### Genus *Pseudamussium* Mörch, 1853

*Pseudamussium* Mörch, 1853: 59. Type species (ICZN Opinion 714, 1964): *Pecten septemradiatus* O.F. Müller, 1776 = *Ostrea peslutrae* Linnaeus, 1771 (Dijkstra 1999: 427). Recent, eastern Atlantic.

#### Diagnosis

Palliolini with weakly inflated, fragile to sturdy, subcircular to circular shell, up to ca. 50 mm in height; valves with plicae or costae, sculptured with delicate to rather prominent radial ridges and/or radial striae, and antimarginal microsculpture. Auricles somewhat unequal in size. Byssal notch shallow, functional ctenolium weak.

#### Distribution

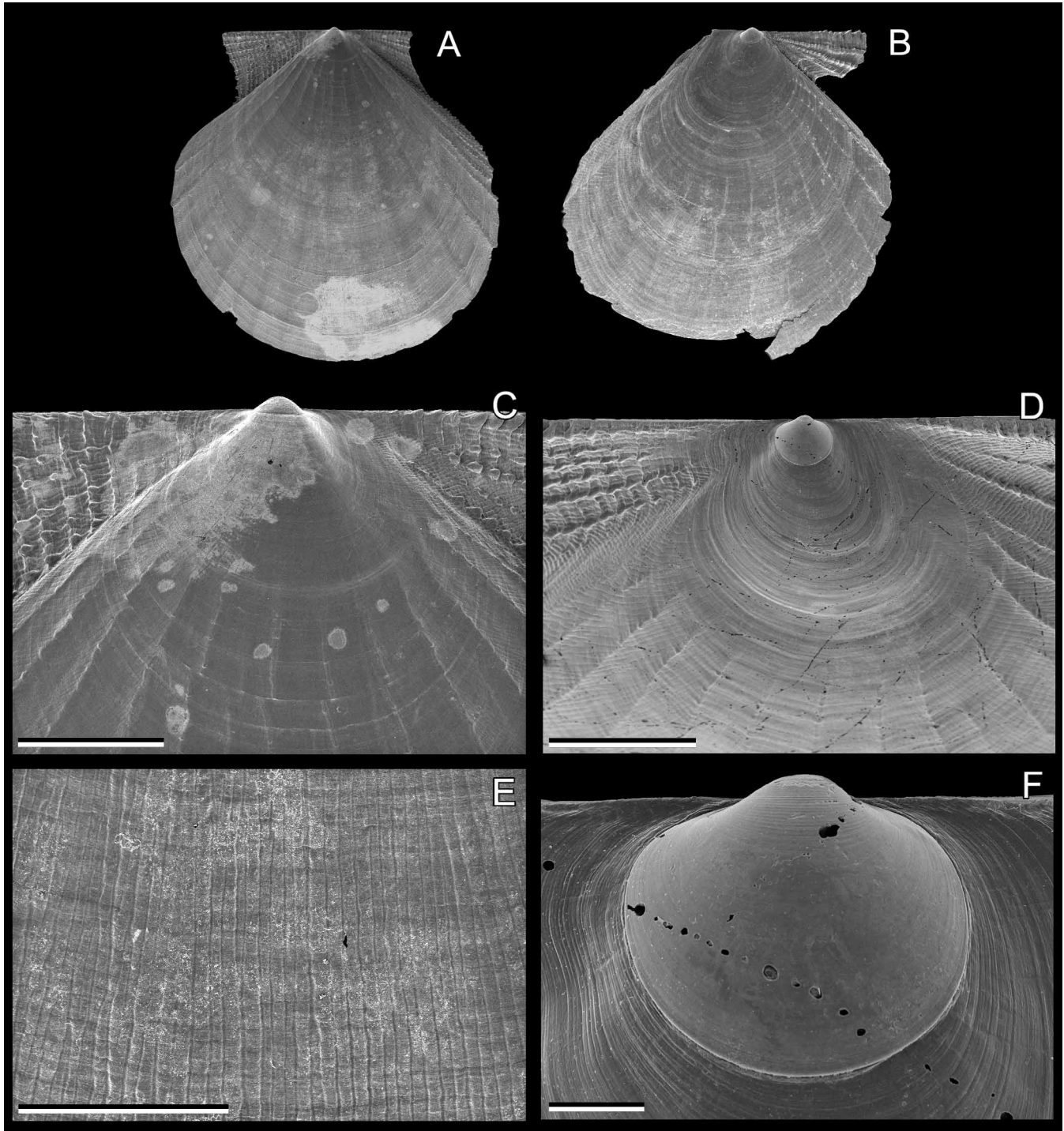
Miocene to Recent. Eastern Atlantic and southeastern Australia at sublittoral to bathyal depths.

***Pseudamussium challengeri* (E.A. Smith, 1891) n. comb.**

Figs 59, 60

*Pecten challengeri* Smith, 1891: 443, pl. 35, fig. 25; Iredale & McMichael, 1962: 4.*Chlamys* (*Veprichlamys*) *challengeri*.—Rombouts, 1991: 34.*Chlamys* (*Chlamys*) *challengeri*.—Lamprell & Whitehead, 1992: [20], pl. 8, fig. 46.*Veprichlamys* sp. Spencer *et al.* in press.*Veprichlamys challengeri*.—Raines & Poppe, 2006: 248, 249 (figs), pl. 197, fig. 4.

## Type material

Syntypes (1 pr, 1 rv) BMNH 1889.2.13.1–2; off New South Wales, Australia, 34°13'S, 151°38'E, alive, 750 m, 13 Jun. 1874, HMS *Challenger* (stn 164B).

**FIGURE 59.** Pectinidae. *Pseudamussium challengeri* (E.A. Smith, 1891), Challenger Plateau, 914 m, NIWA P942 (A, C, E, lv, height 8.10 mm; B, D, F, rv, height 5.75 mm). Scale bars 1 mm (C–E) and 100  $\mu$ m (F).

## Material examined

The type material (see above). Off Hokianga, 35°37.6'S, 172°36.5'E, alive, 657 m (1 pr, 2 v, M.74962).

Rumble V volcano, S Kermadec Ridge, 36°08.84'S, 178°12.24'E, 951–772 m (1 v, NIWA TAN0107/225). W of White Island, 37°10.9'S, 178°38.7'E, 685–705 m (1 v,

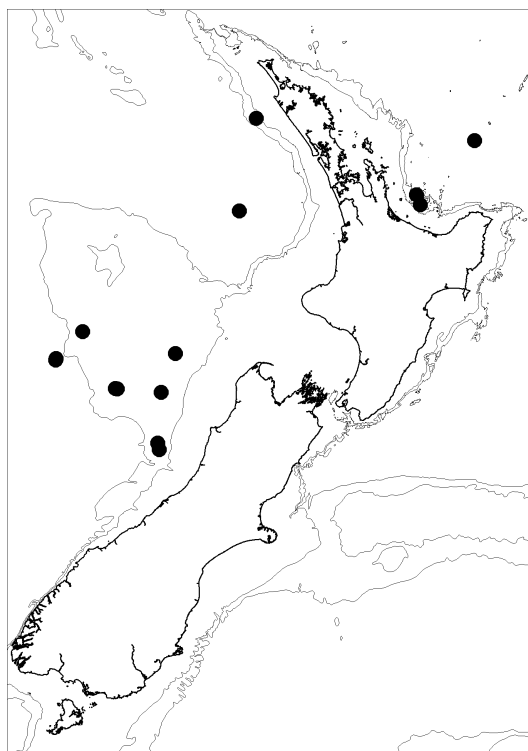
M.107591). E of Mayor Island, 37°23.5'S, 176°45.0'E, alive, 631–666 m (1 pr, 1 v, M.60183). Aotea Seamount, 37°30.56'S, 172°10.75'E, 910 m (fragments, M.155387). Challenger Plateau: 39°54.2'S, 168°14.0'E, 750 m (1 v, M.102507); 40°33.1'S, 170°57.3'E, 570–572 m (10 v, NIWA P926); 40°42.8'S, 167°56.0'E, 1029 m (9 v, NIWA P929); 40°46.0'S, 167°54.9'E, 1029 m (10 v, NIWA P928); 40°50.1'S, 168°14.8'E, alive, 1005–1009 m (1 pr, 32 v, NIWA P927); 41°00.6'S, 169°06.0'E, 914 m (many v, NIWA P942; 4 v, M.155877). Off Westport, 41°08.1'S, 170°21.0'E, 695 m (17 v, Q699). Off Greymouth, 42°04.3'S, 170°12.5'E (22 v, NIWA Q719). SW of Cape Foulwind, 42°10.0'S, 170°10.0'E, 610 m (2 v, M.5697).

#### Description

Supplementary to that of Smith (1891). Prodissoconch pale buff, subcircular, PI c. 100 µm long, PII sharply delineated, about 370 µm long, sculptured with fine commarginal wrinkles to about 150µm width, thereafter smooth.

#### Distribution

Southeastern Australia, Tasman Sea, and New Zealand (new record), 570–1029 m; taken alive at 631–1009 m from mud and foraminiferal ooze (Fig. 60).



**FIGURE 60.** Map showing distribution of *Pseudamussium challengerii* (E.A. Smith, 1891).

#### Remarks

*Pseudamussium challengerii* is similar to the southern African species *P. gilchristi* (Sowerby, 1904), in gross facies, but differs by having radial microsculpture throughout ontogeny. The macrosculpture of both species is extremely variable: ranging from smooth undulated radial lirae,

characteristic of the New Zealand morph of *P. challengerii*, to a more complicated sculpture of primary radial lirae and secondary intercalated riblets, which are covered with spoon-shaped lamellae.

Rombouts (1991) referred *P. challengerii* to *Veprichlamys*, presumably because the radial microsculpture is similar to that in *Veprichlamys* species, whereas Lamprell and Whitehead (1992) placed it in *Chlamys*, though it lacks the shagreen microsculpture characteristic of that group. In fact, *P. challengerii* more closely resembles the type species of *Pseudamussium* in shape and convexity, in having radial sculpture, and in lacking commarginal sculpture, at least in late ontogeny.

New record for the NZEEZ.

#### Tribe MESOPEPLINI Waller, 2006

#### Diagnosis

Palliolinae with clustered radial costae in broad radial folds, posterior auricles with a distinctive concave posterior margin, commarginal lirae in costal interspaces, inner rib carinae, and reduction in depth of byssal notch.

#### Genus *Mesopeplum* Iredale, 1929

*Mesopeplum* Iredale, 1929: 162. Type species (by original designation): *Mesopeplum caroli* Iredale, 1929; Recent, southern and eastern Australia.

*Dendopeecten* Hertlein, 1936: 26. Type species (by original designation): *Pecten dendyi* Hutton, 1902; Early Pliocene (basal Opoitian), Chatham Islands.

#### Diagnosis

Mesopeplini with inflated to compressed, right valve in most species more convex than left valve, sturdy, subcircular to oblique shell, up to ca. 100 mm in height, valves with few prominent radial plicae, covered by weakly subdivided costae, internal rib carinae around the ventral margin, microsculpture of delicate commarginal lamellae throughout. Auricles rather unequal in size. Byssal moderately deep, functional ctenolium present.

#### Distribution

Early Pliocene to Recent. Southern Australia and New Zealand at sublittoral to bathyal depths.

#### Remarks

Beu (1978) has introduced *Borehamia* (type species *Pecten crawfordi* Hutton, 1873) as a subgenus of *Mesopeplum* for a group of very large species from the New Zealand Cenozoic.

#### *Mesopeplum* (*Mesopeplum*) *convexum* (Quoy & Gaimard, 1835)

Figs 61, 62

*Pecten convexus* Quoy & Gaimard, 1835: 443, pl. 76, figs 1–3; Hutton, 1878: 55; Suter, 1904: 93; Finlay, 1930b: 251.

*Pecten roseopunctatus* Reeve, 1853, pl. 22, fig. 84 and text; Küster & Kobelt, 1887: 213, pl. 57, fig. 4.

*Pecten (Dentipecten) vellicatus* Hutton, 1873a: 82; Hutton, 1873b: 32; Hutton, 1880: 171.

*Pecten (Pallium) convexus*.—Suter, 1913: 879, pl. 56, figs 8, a.

*Pecten (Pallium) burnetti*.—Suter, 1914: 42, pl. 9, fig. 3, pl. 16, figs 1a, b (not Zittel, 1865).

*Pallium (Felipes) convexus*.—Marwick, 1928: 454.

*Pallium kapitiensis* Mestayer, 1929: 249, figs 18, 19.

*Pallium (Mesopeplum) convexus*.—Powell, 1937b: 56, pl. 1, fig. 6.

*Pallium (Mesopeplum) convexus*.—Powell, 1938: 160; Powell, 1946: 57, pl. 1, fig. 6; Powell, 1957: 77, pl. 1, fig. 6; Powell, 1962: 118, pl. 1, fig. 6.

*Mesopeplum convexus*.—Powell, 1976: 124, pl. 1, fig. 6; Powell, 1979: 377, pl. 68, fig. 5; Abbott & Dance, 1982: 306, fig.; Beu & Maxwell, 1990: 338, pl. 44g; Raines & Poppe, 2006: 84, 85

(figs), pl. 21, figs 1–7, pl. 22, figs 1–6.

*Mesopeplum (Mesopeplum) convexus*.—Beu, 1977: 259; Beu, 1995: 52.

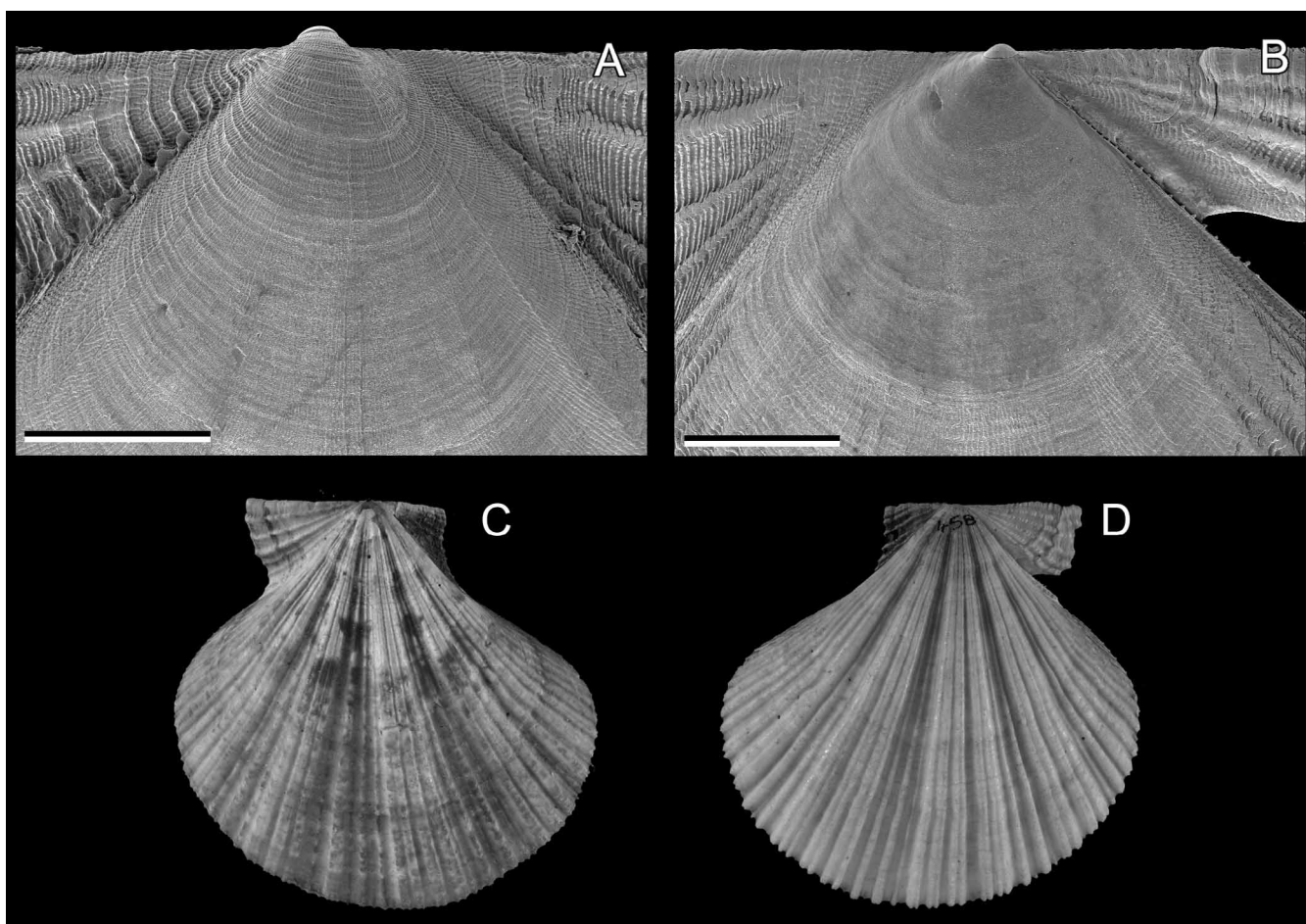
#### Type material

*Pecten convexus*: 2 syntypes MNHN.

*Pecten roseopunctatus*: type material apparently lost—not at BMNH; “Moluccas” = New Zealand.

*Pecten vellicatus*: type material lost (Marshall 1996: 46); type locality not specified (= New Zealand, Recent).

*Pallium kapitiensis*: holotype NMNZ M.1254; off Kapiti Island, New Zealand, from stomach of blue cod taken at c. 6 m.



**FIGURE 61.** Pectinidae. *Mesopeplum convexus* (Quoy & Gaimard, 1835). **A, B.** off Plate Island, 39 m, M.64900 (G, lv; H, rv). **C, D.** Stewart Island, M.155905 (height 59.5 mm). Scale bars 1 mm.

#### Material examined

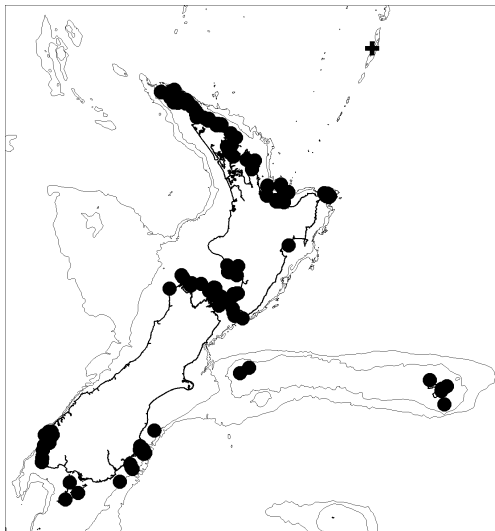
The holotype of *Pallium kapitiensis* (see above). Several thousand specimens (188 lots NMNZ) from throughout the geographic and bathymetric range.

#### Distribution

Pliocene to Recent. Living off Three Kings, North, South, Stewart and Chatham islands, 0–274 m; taken alive at 15–202 m from hard substrata. Subrecent on Kermadec Ridge and Mernoo Bank (Fig. 62).

#### Remarks

*Mesopeplum convexus* is locally common off the four main islands of New Zealand, where it lives byssally attached on rock and bryozoan/shell substrata. The species attains exceptional size off Stewart Island, Foveaux Strait, and especially Fiordland, the largest seen being from Milford Sound (width 69 mm, M.155904). Raines and Poppe (2006, p. 85) illustrated several specimens of *M. convexus* reputedly trawled at 700 metres depth off the Auckland Islands. Since the species has not otherwise been recorded this deep or far south, it is likely their specimens were provided by a shell dealer with fabricated locality data.



**FIGURE 62.** Map showing distribution of *Mesopeplum (Mesopeplum) convexum* (Quoy & Gaimard, 1835): ● living specimens; + Holocene.

### Family SPONDYLIDAE Gray, 1826

#### Diagnosis

Most species inaequivalve, auriculate, radially ribbed, with spines of irregular shape and size, right (cemented) valve with external triangular area at apical end; monomyarian with posterior adductor muscle; ligament alivincular, resilium deep in triangular pit; adult hinge with two isodont crura in each valve, those on lower valve adjoining resilium.

#### Remarks

Extant members of the genus have been recently monographed by Lamprell (1987, 2006).

### Genus *Spondylus* Linnaeus, 1758

*Spondylus* Linnaeus, 1758: 690. Type species (by subsequent designation of Schmidt, 1818): *Spondylus gaederopus* Linnaeus, 1758; Recent, Mediterranean. See Hertlein and Cox (1969) for extensive synonymy.

#### Diagnosis

Most species inaequivalve, auriculate, radially ribbed, with spines of irregular shape and size, right (cemented) valve with external triangular area at apical end; monomyarian with posterior adductor muscle; ligament alivincular, resilium deep in triangular pit; adult hinge with two isodont crura in each valve, those on lower valve adjoining resilium.

#### Distribution

Worldwide in tropical, subtropical and (locally) temperate seas, at intertidal to bathyal depths.

### *Spondylus asperrimus* G.B. Sowerby II, 1847

Figs 63, 64A

*Spondylus asperrimus* Sowerby, 1847a: 87; Sowerby, 1847b: 421,

pl. 87, fig. 38; Lamprell, 1992: 192; Lamprell & Healy, 2001: 140, figs 9A, B; Lamprell, 2006: 48, pl. 12, figs A–G.

*Spondylus gloriosus* Dall, Bartsch & Rehder, 1938: 102, pl. 26, figs 8, 10 (not figs 9, 11–13, which are of holotype of *S. kauaiensis* Dall, Bartsch & Rehder, 1938.

*Spondylus mimus* Dall, Bartsch & Rehder, 1938: 102, pl. 26, figs 6, 7.

*Spondylus kauaiensis* Dall, Bartsch & Rehder, 1938: 103, pl. 26, figs 12, 13.

*Spondylus linguaefelis* form *asperrimus*.—Lamprell, 1987: 20, fig. 1.

#### Type material

*Spondylus asperrimus*: holotype BMNH 1996040, H. Cuming, locality unknown.

*Spondylus gloriosus*: holotype USNM 190435, off Penguin Bank, Oahu, Hawai'i, 49–51 m, USBFS *Albatross*.

*Spondylus mimus*: holotype USNM 337509, entrance to Honolulu Harbour, Oahu, Hawai'i, 24 m, D. Thaanum.

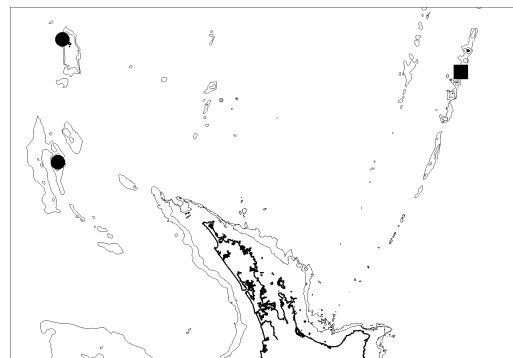
*Spondylus kauaiensis*: holotype USNM 335638, off Kauai, Hawai'i, 426–439 m, USBFS *Albatross*.

#### Material examined

Norfolk Island, 28°54.39'S, 167°41.05'E, alive, 111–115 m (3 pr, 1 v, M.160868); 29°19'S, 168°07'E, 110 m (2 v, M.224976); 29°20'S, 168°09'E, 201 m (4 v, M.224744). Wanganella Bank, West Norfolk Ridge, summit, 32°39.2'S, 167°31.7'E, 133 m (1 v, M.173016).

#### Distribution

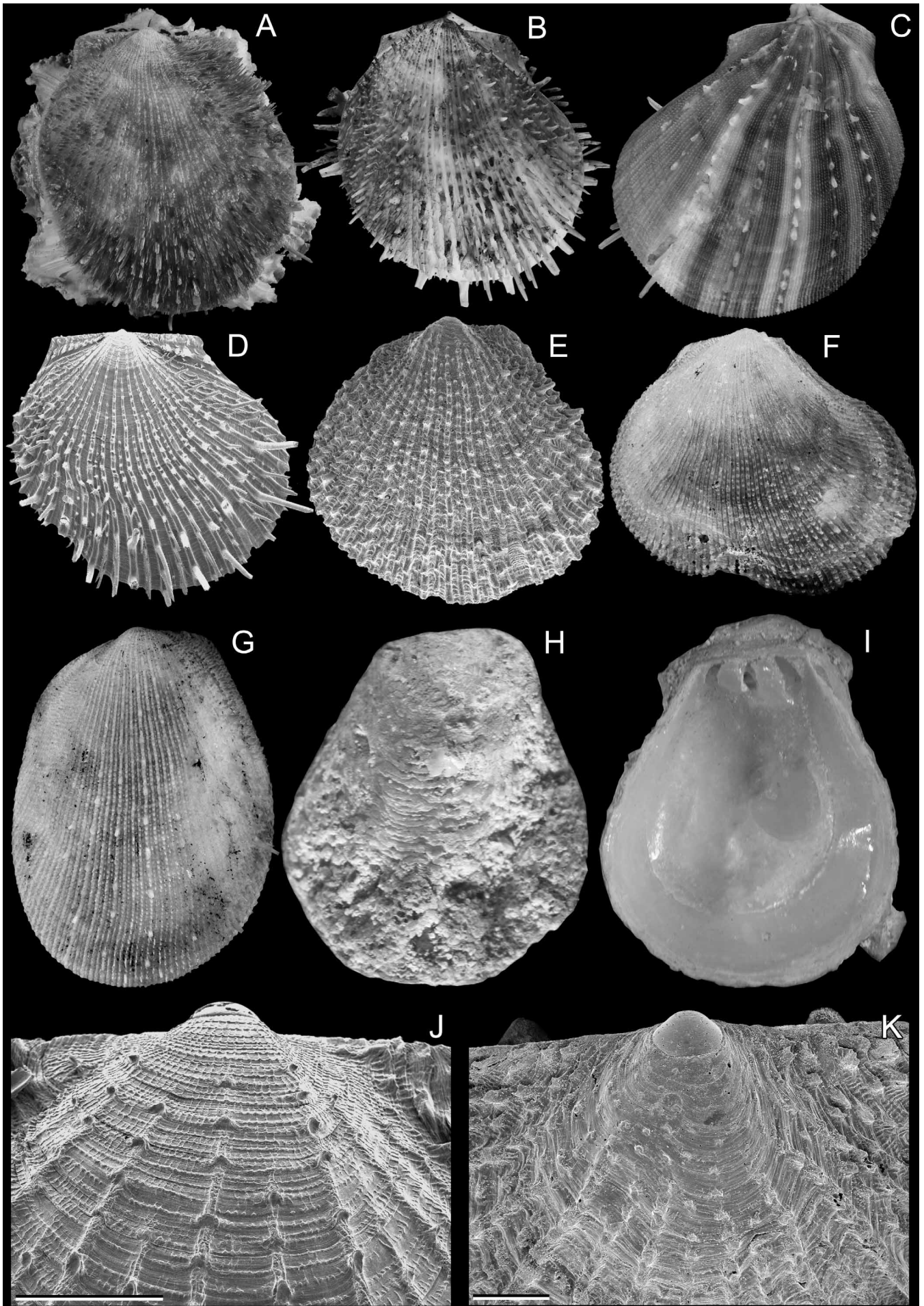
Hawaii, Norfolk Ridge and West Norfolk Ridge, 49–133 m; taken alive at 111–115 m (Fig. 63).



**FIGURE 63.** Map showing distribution of ● *Spondylus asperrimus* G.B. Sowerby II, 1847 and ■ *Spondylus ostreoides* E.A. Smith, 1885.

**FIGURE 64.** Spondylidae. **A.** *Spondylus asperrimus* G.B. Sowerby II, 1847, Norfolk Island, 111–115 m, M.160868 (height less spines 48 mm). **B.** *Spondylus jamarci* Okutani, 1983, NW of Fleetwood Bluff, Raoul Island, Kermadec Islands, 154 m, M.225408 (height less spine 60 mm). **C, D, J.** *Spondylus occidentens* G.B. Sowerby III, 1903. **C.** Off Bell's Flat, Raoul Island, 165–220 m, M.226362 (height 56 mm). **D, J, E** of Dayrell Islet, 135–146 m, juvenile, M.226625 (height less spines 8.80 mm). **E–G, K.** *Spondylus proneri* Lamprell & Healy, 2001. **E, K,** E of Norfolk Island, 201 m, juvenile, M.273202 (height 4.0 mm). **F,** Off Macauley Island, Kermadec Islands, 30°17.6'S, 398 m, NIWA K840 (height 12 mm). **G.** Off Middleton Reef, N of Lord Howe Island, 740–800 m, M.160824 (height 27 mm). **H, I.** *Spondylus ostreoides* E.A. Smith, 1885, S of Raoul Island, Kermadec Islands, 950 m, holotype, BMNH 1887.2.9.3359 (height 13.8 mm). Scale bars 500 µm (J) and 200 µm (K).





## Remarks

We follow Lamprell (1992) (and Lamprell and Healy 2001), who considered that short-spined *S. asperrimus* is not conspecific with long-spined *S. linguafelis*, as asserted by Lamprell (1987). *Spondylus asperrimus* is distinctive in having extremely dense, hair-like spines on the antero- and posterodorsal areas of the free (left) valve. The species illustrated as *Spondylus electus* Fulton, 1915 by Lamprell and Healy (1998, fig. 280) is possibly also conspecific with the present material. We have insufficient comparative material to enable firmer resolution of these issues. Our uncritical synonymy follows Lamprell and Healy (2001).

***Spondylus jamarci* Okutani, 1983**

Figs 64, 65

*Spondylus occidentens*.—Lamprell, 1987: 36, figs 1a, b. Not G.B. Sowerby III, 1903.

*Spondylus jamarci* Okutani, 1983a: 22, figs 8–9; Okutani, 1983b: 328, text fig.; Matsukuma *et al.*, 1991, pl. 139, fig. 4; Okutani, 1991: 165; Lamprell & Healy, 1998: 126, fig. 314.

*Spondylus occidentens*.—Lamprell, 2006: 96, pl. 36, figs D–H (in part not Sowerby, 1903)

*Spondylus* sp. 2 Spencer *et al.* in press.

## Type material

Holotype NSMT Mo.61202, “11°03'N, 61°01'W, off Surinam” (error—see Bouchet and Bail 1991) = Saya de Malha Bank, Indian Ocean, 11°03'S, 61°01'E, 128 m.

## Material examined

Norfolk Island: 28°54.39'S, 167°41.05'E, 111–115 m (3 v, M.273203). Raoul Island, Kermadec Islands: NW of Fleetwood Bluff, 29°11.9'S, 177°56.2'W, alive, 154 m (2 pr, 3 v, M.225408); between Bell's Flat and Hutchison Bluff, 29°12.6'S, 177°56.8'W, alive, 155–165 m (8 pr, 4 v, M.222115); between Met. Station and Hutchison Bluff, 29°12.7'S, 177°55.5'W, alive, 110–146 m (2 pr, 3 v, M.222106); off NW end, 29°13.0'S, 177°59.8'W, alive, 201–146 m (3 pr, 3 v, M.222119); SE of Nugent Island, 29°14.7'S, 177°49.4'W, 165–146 m (1 v, M.225725); E of Dayrell Islet, 29°14.73'S, 177°50.34'W, alive, 135–146 m (1 pr, 3 v, M.226625); off Bell's Flat, 29°12.5'S, 177°56.0'W, alive, 220–165 m (1 pr, 6 v, M.226363); NW of Fleetwood Bluff, 29°12.7'S, 177°56.1'W, alive, 135 m (1 pr, M.225426). Off Macauley Island, Kermadec Islands: “Volcano L”, 30°02.2'S, 178°42.6'W, alive, 166 m (1 pr, NIWA NZAPLUME II stn 10).

## Distribution

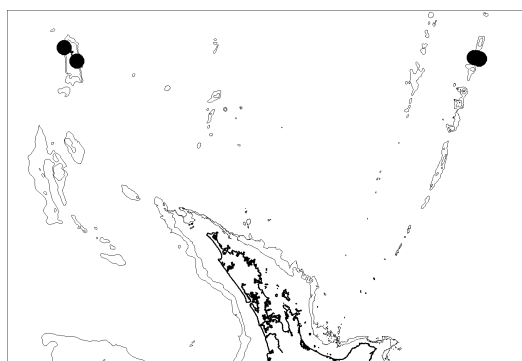
Saya de Malha Bank (Indian Ocean), Queensland, Norfolk Island, Kermadec Ridge, 111–220 m; taken alive at 128–166 m (Fig. 65).

## Remarks

The present specimens are similar to the holotype and paratype of *Spondylus jamarci* Okutani, 1983, as described and illustrated by Okutani (1983a). The type material was stated to be from off Surinam, but evidently originated from

Saya de Malha Bank in the Indian Ocean (Bouchet and Bail 1991; Okutani 1991).

*Spondylus jamarci* resembles *S. occidentens* G.B. Sowerby III, 1903 (see below), in size, shape, colour and colour pattern, but differs in having fewer radial ribs, prominent spines on almost all of the radial ribs instead about seven or fewer of them; in having slender, curved secondary spines with lateral spinelets (both absent in all specimens of *S. occidentens* seen), and in having a more deeply crenulated ventral margin. We thus consider that Lamprell (1987, 2006) and Lamprell and Healy (2001) were mistaken in interpreting *S. jamarci* as a synonym of *S. occidentens*. Both species occur sympatrically off northern New Zealand.



**FIGURE 65.** Map showing distribution of *Spondylus jamarci* Okutani, 1983.

***Spondylus occidentens* G.B. Sowerby III, 1903**

Figs 64C, D, J, 66

*Spondylus occidentens* Sowerby, 1903: 77, fig. 9; Matsukuma *et al.* 1991: pl. 140, fig. 6; Lamprell & Healy, 1998: 120, fig. 297; Lamprell & Healy, 2001: 123, figs 4a–d; Higo *et al.*, 2001, fig. B528; Lamprell, 2006: 96, pl. 36, figs A–C (in part = *S. jamarci* Okutani, 1991)

*Spondylus anacanthus*.—Kira, 1962: 142, pl. 51, fig. 1; Okutani, 1963: 86, fig. 18; Kuroda *et al.* 1971: 361, pl. 80, figs 5, 6; Okutani, 1972: 109, pl. 2, fig. 9; Lamprell, 1987: 36, figs 1a, 1b, 3; Hayami, 2000, 919, pl. 457, fig. 11. Not Mawe, 1823.

*Spondylus* sp. Bondarev & Röckel, 1992: 34, fig. 5.

## Type material

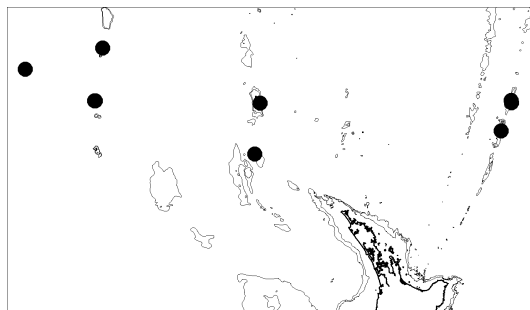
Holotype BMNH 1903.11.5.9; Moluccas, Indonesia.

## Material examined

Japan: off Tosa, 73–91 m (2 pr, M.262392); off Kii, 91 m (1 pr, M.273204). Seamount N of Lord Howe Island, 26°38.2'S, 159°25'2'E, 285 m (3 v, NIWA Z2091). Queensland Guyot, off Queensland, 27°41.2'S, 155°08.8'E, 412–521 m (2 v, NIWA Z2092). Raoul Island, Kermadec Islands: off Bell's Flat, 29°12.5'S, 177°56.0'W, alive, 165–220 m (1 pr, M.226362); SE of D'Arcy Point, 29°18.80'S, 177°54.20'W, 219–274 m (4 v, M.226603). Off Curtis Island, 30°40.4'S, 178°29.9'W, 247 m (3 v, NIWA T213). Norfolk Ridge, S of Norfolk Island, 31°47.2'S, 167°51.6'E, 319–316 m (5 v, NIWA P14).

## Distribution

Saya de Malha Bank (Indian Ocean), Japan, Indonesia, Queensland, New Caledonia, Vanuatu, West Norfolk Ridge, and Kermadec Islands, 73–319 m; bathymetric range of living specimens uncertain, though certainly in the range 165–220 m (Fig. 66).



**FIGURE 66.** Map showing distribution of *Spondylus occidens* G.B. Sowerby III, 1903.

## Remarks

The present specimens are accordant with the original description and illustration of the holotype of *S. occidens* (G.B. Sowerby III, 1903), and Japanese material that is evidently conspecific. *Spondylus occidens* is distinctive in having reddish and whitish radial bands, up to about seven rows of spines of moderate size or a few scattered primary spines separated by rows of short spines. It is compared with the similar species *S. jamarci* above.

This is a new record for the New Zealand region.

***Spondylus ostreoides* E.A. Smith, 1885**

Figs 63, 64H, I

*Spondylus ostreoides* Smith, 1885: 302, text figs 1, 2; Oliver, 1915: 553; Lamprell & Healy, 2001: 117; Lamprell, 2006: 100, figs F, G.

## Type material

Holotype (pr) BMNH 1887.2.9.3359; S of Raoul Island, Kermadec Islands, 29°55'S, 178°14'W, 950 m, 14 Jul. 1874, HMS *Challenger* (stn 170). Incorrectly cited by Smith (1885) as being from "178°14'E", and "north of the Kermadec Islands" (see Murray 1895: 611). Cemented valve length 13.8 mm, upper valve length 12.5 mm.

## Material examined

The holotype (see above).

## Distribution

Off Raoul Island, Kermadec Islands, 950 m (Fig. 63).

## Remarks

*Spondylus ostreoides* is unusual among spondylids in having commarginal rather than radial sculpture. The holotype remains the only known specimen.

***Spondylus proneri* Lamprell & Healy, 2001**

Figs 63E–G, 67

*Spondylus proneri* Lamprell & Healy, 2001: 126, figs 5A–G, 15H; Lamprell, 2006: 102, figs A–D.

## Type material

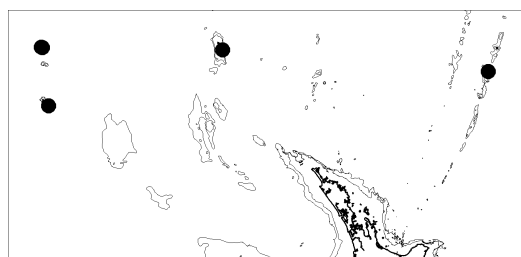
Holotype MNHN; Vanuatu, 22°26'S, 171°46'E, 620–700 m (not seen).

## Material examined

29°20'S, 168°09'E, E of Norfolk Island, 201 m (1 v, M.273202). Off Middleton Reef, N of Lord Howe Island: 29°12.88'S, 158°59.05'E, 505–900 m (10 v, M.171244); 29°13.61'S, 159°02.49'E, 740–800 m (1 v, M.160824). Off Lord Howe Island, 31°45.73'S, 159°20.93'E, 565–960 m (1 v, M.171146). Off Macauley Island, Kermadec Islands, 30°17.6'S, 178°25.3'W, alive, 398 m (2, NIWA K840).

## Distribution

Coral Sea, New Caledonia, Loyalty Ridge, Vanuatu and (new records) Middleton Reef, Lord Howe Island, Norfolk Island and Macauley Island, Kermadec Islands, 210–960 m; taken alive at 210–620 m (Fig. 67).



**FIGURE 67.** Map showing distribution of *Spondylus proneri* Lamprell & Healy, 2001.

## Remarks

The specimens from Middleton Reef, Lord Howe Island and Norfolk Island are perfectly accordant with the original description and illustration of this distinctively sculptured species.

This is a new record for the NZEEZ.

***Spondylus raoulensis* Oliver, 1915**

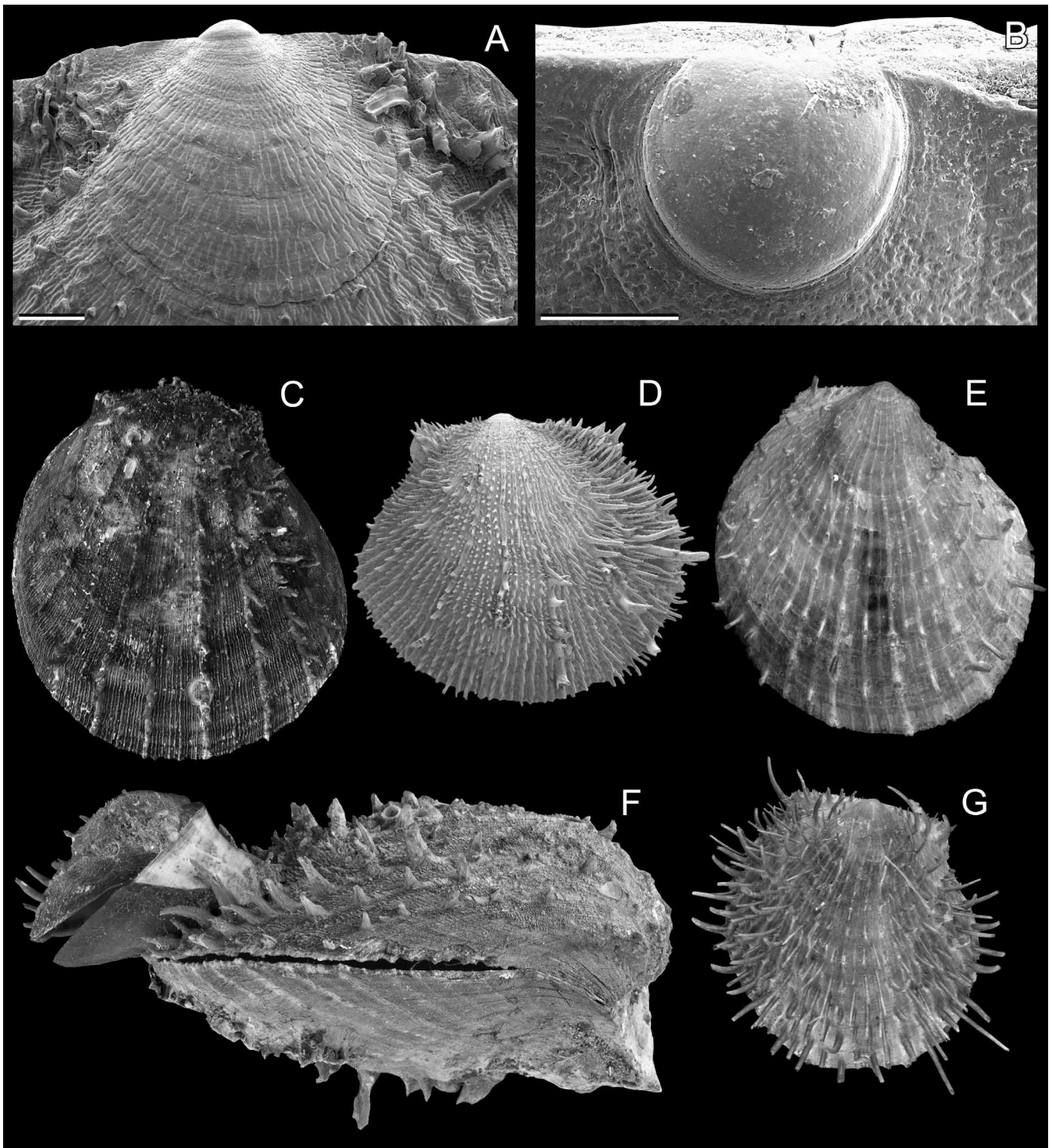
Figs 68A–D, F, 69

*Spondylus raoulensis* Oliver, 1915 (12 July): 553, fig. 49; Lamprell, 1992: 193; Freeman *et al.* 1997: 33; Brook & Marshall, 1998: 212; Lamprell, 2006: 34, pl. 5, figs H, I. *Spondylus iredalei* Fulton, 1915 (October): 358; Lamprell, 1987: 76, pl. 29, fig. 4.

## Type material

*Spondylus raoulensis*: holotype CM M668; Raoul Island, Kermadec Islands.

*Spondylus iredalei*: holotype AMS C.90375; [Raoul Island] Kermadec Islands.



**FIGURE 68.** Spondylidae. **A–D, F.** *Spondylus raoulensis* Oliver, 1915. **A, B, D.** Raoul Island, 22 m, juveniles, M.214532 (**D**, height 8.65 mm). **C, F.** W side of Meyer Island, 15–30 m, M.153340 (**C**, height 108 mm; **F**, combined height 132 mm). **E, G.** *Spondylus sparsispinosus* Dall, Bartsch & Rehder, 1938. **E.** Off Middleton Reef, N of Lord Howe Island, 740–800 m, M.160823 (height 31 mm). **G.** Off Curtis Island, Kermadec Islands, 710–725 m, NIWA T256 (height 43 mm). Scale bars 200  $\mu$ m (**A**) and 100  $\mu$ m (**B**).

#### Material examined

Raoul Island, Kermadec Islands: off Hutchison Bluff, 29°13'S, 177°59'W, 84–113 m (1 v, M.222018); W side of Meyer Island, alive, 15–30 m (5 pr, 3 v, M.153340); off Meyer Island, 29°14.7'S, 177°52.7'W, 27–22 m (2 v, M.225793); NE corner reef, alive, 20 m (1 pr, M.257071); Milne Islets, base of rock wall, alive, 15 m (1 pr, M.153344);

alive, 22 m (1 pr, M.214532); beach (2 v, M.200976; 2 v, M.212800; 9 v, M.212801; 1 v, 202896; 5 v, M.202893; 3 v, M.202892); East Anchorage, 29°16.00'S, 177°51.58'W, 42–47 m (1 v, M.226604); SE of D'Arcy Point, 29°19.1'S, 177°54.6'W, 70 m (5 v, M.225762); E end of Denham Bay, 29°17.20'S, 177°57.20'W, 27–29 m (5 v, M.226962); SE of Smith Bluff, 29°18.90'S, 177°56.40'W, 82–100 m (1 v,

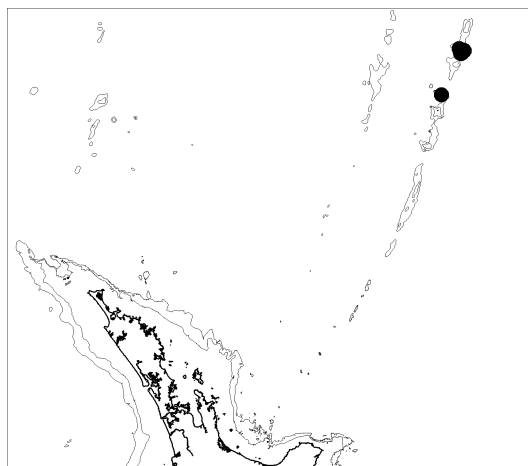
M.226582). Macauley Island, alive in crevice in vertical rock wall, 30 m (2 pr, M.153814).

#### Description

Supplementary to that of Oliver (1915). Prodissoconch 230 µm long, ovate, hinge line straight, moderately inflated, smooth.

#### Distribution

Raoul and Macauley islands, Kermadec Islands, 0–113 m; taken alive at 15–30 m (Fig. 69).



**FIGURE 69.** Map showing distribution of *Spondylus raoulensis* Oliver, 1915.

#### Remarks

*Spondylus raoulensis* is common at the Kermadec Islands, where it appears to be a restricted endemic. Attaining 130 mm in height, it is the largest spondylid in the New Zealand region.

#### *Spondylus sparsispinosus* Dall, Bartsch & Rehder, 1938

Figs 68E,G, 70

*Spondylus sparsispinosus* Dall, Bartsch & Rehder, 1938: 98, pl. 26, figs 1–5; Beu & Maxwell, 1990: 90.

?*Spondylus erectospinosus* Habe, 1973: 37, figs 1, 2; Lamprell, 1987: 34, pl. 10, fig. 4; Higo *et al.* 2001: fig. B551.

*Spondylus erectospinosus* [sic].—Lamprell & Healy, 2001: 145, figs 10e, 14b–d. Lamprell, 2006: 96, pl. 36, figs I–L.

*Spondylus* sp. 1 Spencer *et al.* in press.

#### Type material

*Spondylus sparsispinosus*: holotype USNM 190436; Pailolo Channel, Hawaiian Islands, 238–274 m.

*Spondylus erectospinosus*: holotype NSMT Mo.42037; South China Sea, c. 200 m.

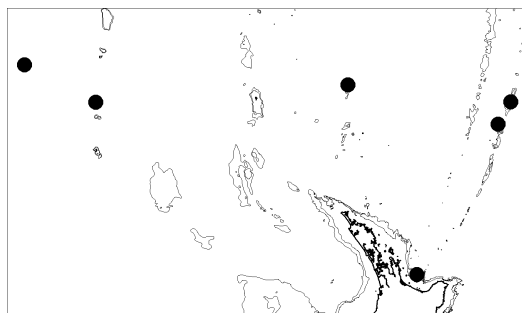
#### Material examined

The holotype of *S. sparsispinosus* (see above). Queensland Guyot, off Queensland, 27°41.2'S, 155°08.8'E, 412–521 m (2 v, NIWA Z2092). Off Middleton Reef, N of Lord Howe Island, 740–800 m (1 v, M.160823). Three Kings Rise, 28°39.5'S, 173°01'E, 850 m (19 v, NIWA Z2098).

Kermadec Islands—between Bell's Flat and Hutchison Bluff, Raoul Island, 29°12.6'S, 177°56.8'W, alive, 155–165 m (2 v, M.272653); off Curtis Island, 30°31.0'S, 178°39.0'W, 710–725 m (5 v, NIWA T256). Rangatira Knoll, NW of White Island, 37°14.6'S, 176°51.0'E, 407–162 m (fragments, M.74594).

#### Distribution

South China Sea, Queensland, Loyalty Ridge, northern Lord Howe Rise, northern Three Kings Rise, Kermadec Ridge and off White Island, north-eastern North Island, 155–841 m (shells only) (Fig. 70).



**FIGURE 70.** Map showing distribution of *Spondylus sparsispinosus* Dall, Bartsch & Rehder, 1938.

#### Remarks

The holotypes of *S. sparsispinosus* and *S. erectospinosus* are essentially similar, and we agree with Beu and Maxwell (1990) that they may be conspecific.

Compared with other spiny *Spondylus* species occurring off Raoul Island, *S. sparsispinosus* differs in having far fewer, more widely spaced radial ribs, all of which are set with long, upright spines. Shell colour in the present specimens is orange with two or three yellow radial bands.

This is a new record for the NZEEZ: Beu and Maxwell (1990: 90) recorded *Spondylus sparsispinosus* from “deep water off northern New Zealand”, but omitted locality data placing it unequivocally within the Zone.

#### Discussion

Both the high proportion of species in *Parvamussium* (6 species) and *Propeamussium* (3) that are sympatric in various combinations, and the large number of pectinid genera with only a single species (12 of the 14), reflect high dispersal ability in the larval stage, since all of the species involved are widely distributed in the western Pacific and presumably have planktotrophic development, or lecithotrophic larvae with a drifting period of long duration. By contrast the large number of *Cycloclamys* (11) and *Cyclopecten* (7) species, most of which are allopatric, is presumably associated with more limited dispersal ability. Three of the *Cycloclamys* species brood their young, suggesting that direct development or short-period lecithotrophic development may prove to be a characteristic of these genera, at least *Cycloclamys*, most species of which



have larger prodissoconchs than *Cyclopecten* species (length range 150–300 µm, mean 208 µm, SD 50; versus 270–430 µm, mean 340 µm, SD 53). Two of the *Cyclopecten* and one of the *Cycloclamys* species, however, clearly have planktonic larval-stages of sufficient duration to cross wide stretches of unfavourable depths: i.e. *Cyclopecten horridus*, *Cp. kapalae* and *Cycloclamys lemchei*. Limited dispersal ability in the brooders probably enhances potential for speciation.

Our finding that settlement by sponges triggers dramatic, characteristic and irreversible sculptural changes in *Talochlamys dichroa* and *Zygochlamys delicatula* has implications for interpretation of pectinid morphospecies in general, since the condition may well occur in other species from elsewhere, including fossils.

Of the 50 species from the NZEEZ, 23 (46%) are restricted endemics—Propeamussiidae: 15 species (55.5%), Pectinidae: six species (35%), Spondylidae: two species (33%). Two *Cycloclamys* species from Wanganella Bank, close to the NZEEZ boundary are also restricted endemics (*Cc. bacata* n. sp. and *Cc. wanganellica* n. sp.). The non-endemic species show affinities variously with south-eastern Australia (*Cyclopecten kapalae*, *Delectopecten fosterianus*, *Zygochlamys delicatula* (extinct?) and *Pseudamussium challengerii*), the south-western Pacific (*Parvamussium retiolium*, *Pa. squalidulum*, *Pa. vesiculatum*, *Cyclopecten horridus*, *Cycloclamys lemchei*, *Catillopecten murrayi*, *Sinepecten segonzaci*, *Hyalopecten hadalis*, *Annachlamys iredalei*, *Spondylus proneri* and *S. sparsispinosus*), and the tropical and subtropical Indo-Pacific (*Propeamussium investigatoris*, *Pr. meridionale*, *Pr. sibogai*, *Parvamussium cristatellum*, *Cyclopecten fluctuatus*, *Pascahinnites coruscans coruscans*, *Cryptopecten bullatus*, *Mimachlamys sanguinea*, *Spondylus jamarci* and *S. occidentis*).

In the 'New Zealand Species 2000' checklist (Spencer *et al.* in press), 683 species of marine bivalves are recorded from the NZEEZ, of which 227 species (33%) are listed as undescribed or new records. The present contribution suggests that this was an underestimate. Of the 17 species here described as new species or new records from the zone, only seven (i.e. 41%) were recorded as new or undescribed in the checklist. Note that an eighth new record by Spencer *et al.* is not accepted here (*Parvamussium* sp. 1 = *P. maorium*). Several pectinid genera occurring off New Caledonia and Queensland do not extend into the temperate waters of northern New Zealand. These include *Anguipecten* Dall, Bartsch & Rehder, 1938 (type species *Anguipecten gregoryi* Dall, Bartsch & Rehder, 1938), *Coralichlamys* Iredale, 1939 (*Coralichlamys acroporicola* Iredale, 1939), *Decatopecten* G.B. Sowerby II, 1839 (*Ostrea plica* Linnaeus, 1758), *Excellichlamys* Iredale, 1939 (*Pecten spectabilis* Reeve, 1853), *Glorichlamys* Dijkstra, 1991 (*Pecten elegantissimus* Deshayes, 1863), *Gloripallium* Iredale, 1939 (*Ostrea pallium* Linnaeus, 1758), *Laevichlamys* Waller, 1993 (*Pecten multisquamatus* Dunker, 1864), *Juxtamusium* Iredale, 1939 (*Juxtamusium oblectatum* Iredale, 1939), *Mirapecten* Dall, Bartsch & Rehder, 1938 (*Mirapecten thaanumi* Dall, Bartsch & Rehder, 1938), *Pedum* Lamarck, 1799 (*Ostrea*

*sponyloidea* Gmelin, 1791), *Scaeoclamys* Iredale, 1929 (*Pecten lividus* Lamarck, 1819) and *Semipallium* Jousseaume, 1928 (*Pecten tigrinus* Lamarck, 1819).

It is remarkable that *Cryptopecten nux* does not occur off Norfolk Island and the Kermadec Islands, as it is commonly sympatric with *C. bullatus* elsewhere in subtropical (and tropical) waters.

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### About the authors

**Hendrik (Henk) Dijkstra** took early retirement from being a primary school teacher in 1980. He has specialised in studies on the nomenclature, taxonomy and zoogeography of the worldwide living scallops (Pectinidae) and glass-scallops (Propeamussiidae). In 1988 he was appointed honorary research associate at the Malacology Department of the Zoological Museum, University of Amsterdam. He has since revised the pectinoidean collections in the major zoological museums in Europe and Australia. A major focus of his research has been to determine the identity and relationships of bathyal pectinoideans, particularly those collected by French cruises to the tropical Indo-Pacific, and this work has resulted in several publications. He also developed a webpage of Pectinidae and Propeamussiidae ([www.scallop.nl](http://www.scallop.nl)), aimed at both amateur and professional malacologists. His second interest is in historical malacology, and he has published two papers in this area, one on Lamarck and the other on Linnaeus. He is a member of several malacological societies and Unitas Malacologica.

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