

Callucina and *Pseudolucinisca* (Mollusca: Bivalvia: Lucinidae) from Australia: revision of genera and description of three new species

Emily A. Glover and John D. Taylor

Department of Zoology, The Natural History Museum, London SW7 5BD,
United Kingdom. Email: emilyglover@mac.com; j.taylor@nhm.ac.uk

Abstract – Three new species of lucinid bivalves are described from Australia. Two of these are assigned to the genus *Callucina*, previously known living only from the Western Atlantic Ocean. In Western Australia, *Callucina linnaei* ranges from the Houtman Abrolhos Islands northwards to the Dampier Archipelago. *Callucina brittoni* is recorded from islands on the Great Barrier Reef, Queensland. Another Indian Ocean species, *C. winckworthi* (Viader 1951) is recognized from Mauritius. The third new species, *Pseudolucinisca wami*, was previously confounded with the South and Western Australian endemic species, *P. lacteola*. *Pseudolucinisca wami* is distributed from Geographe Bay to Port Hedland while the more southerly range of *P. lacteola* extends from western Victoria to Cape Leeuwin, Western Australia. Revised descriptions are given for the genera *Callucina* and *Pseudolucinisca*. *Callucina* species have a fossil history in the Cenozoic of Europe and North America and the living Australian and Mauritian species may be relicts from a wider distribution in the Cenozoic Tethyan Ocean.

INTRODUCTION

The discovery of chemosymbiosis in lucinid bivalves in the mid 1980s stimulated renewed interest in the systematics of the previously rather neglected family Lucinidae, with 57 new species and 28 new genera described in the last ten years. Within Australia, Lamprell and Whitehead (1992) and Lamprell and Healy (1998) list 33 species of Lucinidae. Since then several unusual taxa have been described from Western Australia including *Rasta thiophila*, *Cardiolucina australopilula*, *Plicolucina flabellata*, *Lamellolucina pilbara* and *Pillucina australis* Taylor and Glover (1997a, 1997b, 2002), Glover and Taylor (2001); Glover, Taylor and Slack-Smith (2003). Additionally, new species and new records of *Anodontia* have been recorded from tropical eastern Australia (Taylor and Glover 2005).

In this paper we describe two new Australian species of *Callucina* Dall 1901, a genus previously known living only in the Western Atlantic, and also a recognise a new species of *Pseudolucinisca* Chavan 1959, previously confounded with *Pseudolucinisca lacteola* (Tate 1897), a species endemic to south and southwestern Australia. *Pseudolucinisca* was hitherto a monospecific genus, usually classified as a subgenus of *Callucina* (Chavan 1969; Lamprell and Whitehead 1992). It is unfortunate that only dead-collected shell material is available for these new species, likewise for the western Atlantic *Callucina keenae*, precluding any anatomical observations or molecular analysis.

As neither *Callucina* nor *Pseudolucinisca* are well-defined genera, we provide new descriptions and

illustrations of the type species. Some confusion exists because in the most recent comprehensive generic revision Chavan (1969, figures E3.10) unfortunately figured an Eocene fossil, "*Callucina*" *hoernesii* (Deshayes 1857), as the example of *Callucina*. But this has characters (e.g. both anterior and posterior lateral teeth) not present in the type species which he did not illustrate.

The phylogenetic positions of these genera are interesting; in the case of *Pseudolucinisca*, based on *P. lacteola*, molecular analysis (Williams *et al.* 2004) indicated it was in a basal clade, sister to the *Anodontia* group and quite distinct from the majority of shallow water lucinids, such as *Codakia*, *Ctena*, *Lucina* and *Loripes*. Earlier, from morphological evidence, Bretsky (1976: 258) suggested that *Callucina* and *Parvilucina* were closely related and derived from a common ancestor in the late Cretaceous or early Cenozoic. Unfortunately, this hypothesis has not been tested by molecular techniques because no *Callucina* specimens have been available for analysis.

Lucinids assigned to *Callucina* have a putative fossil history into the Early Cretaceous (Chavan 1969) but all these records need re-evaluation. Nevertheless, Eocene fossils such as *Callucina papyracea* (Lea 1833) from the southern USA are similar to the type species, *C. keenae*. *Callucina*-like lucinids were present in the Eocene of Europe but by the Miocene were represented only in the Americas (Chavan 1959; Bretsky 1976).

From Australia, *Pseudolucinisca lacteola* has been

recorded from the Late Pliocene of southwestern Australia (Ludbrook 1978). Additionally Ludbrook (1955) plate 2, figure 10) illustrates *Callucina balcombica* (Cossmann 1912) also from Pliocene of Adelaide and Gippsland, Victoria. Although this species resembles *Callucina* in external shell form, Chavan (1961) classified it within the new genus *Callucinella* on the basis of hinge teeth.

MATERIALS AND METHODS

The specimens examined for this study are lodged in the following institutions: Australian Museum, Sydney (AMS); Academy of Natural Sciences, Philadelphia (ANSP); The Natural History Museum, London (BMNH); Museum Victoria, Melbourne (MV); South Australian Museum, Adelaide (SAM); Western Australian Museum, Perth (WAM).

Shells were examined by conventional optical microscopy. Tissue samples of ctenidia and posterior apertures of a single specimen of *Pseudolucinisca lacteola* collected at Esperance Western Australia were fixed in a 2.5% glutaraldehyde solution in phosphate buffer, critical point dried through an ascending acetone series, sputter coated with gold and examined by scanning electron microscopy.

The following abbreviations were used throughout the text: H – shell height; L – shell length; LV – left valve; RV – right valve; T – tumidity of single valve, m – metre. All measurements of specimens in mm.

SYSTEMATICS

Superfamily Lucinoidea Fleming 1828

Family Lucinidae Fleming 1828

Callucina Dall 1901

Phacoides (*Callucina*) Dall 1901: 806.

Lucina (*Callucina*): Chavan 1938: 220; Bretsky 1976: 257.

Callucina: Chavan 1969: N494.

Type species

Lucina radians Conrad 1841, by original designation (junior homonym of *L. radians* Bory de St Vincent 1824; replacement name *Callucina keenae* (Chavan in Cox *et al.* 1971: N1215). Holotype, 1 right valve (ANSP 30603) from near Magnolia, Natural Well, Duplin County North Carolina, USA. Pliocene.

Diagnosis

Subcircular, sculpture of closely spaced commarginal lamellae, fine radial striations particularly at anterior and posterior. Lateral teeth absent, 2 cardinal teeth in LV; single cardinal in

RV; adductor muscle scar detached ventrally from pallial line for 1/5 to 1/2 of length, inner shell margin finely denticulate.

Because of some confusion concerning the characters of *Callucina* we describe the type species below (Figures 1, 2, A–D, 3A).

Callucina keenae, shell small to medium size (H to 23.0, L to 22.4) subcircular, usually slightly longer than high, H/L mean 0.97, moderately inflated, T/L mean 0.26). Umbones prominent, central. Sculpture of closely spaced, regular, low commarginal lamellae. Interspaces narrower than ridges. Growth halts prominent. Radial sculpture of faint striations, particularly at anterior and posterior parts of shell. Sulci or demarcated dorsal areas absent. Ligament broad, set in shallow nymph. Lunule heart-shaped, impressed, slightly asymmetric, wider in RV, overlying LV. Hinge with lateral teeth absent, RV with one large, posterior, bifid cardinal tooth, separated by a large socket from projecting lunule. LV with large, slightly bifid, anterior cardinal, separated by a socket from thin, posterior cardinal at margin of hinge plate. Anterior adductor scar moderately long, broad, ventrally detached from pallial line for half of length (Figure 3A). Anterior pedal muscle scar separate from adductor; posterior adductor scar subovate. Pallial line irregularly lobate dorsally, almost discontinuous. Inner shell margin finely denticulate. Inner shell between edge and pallial line with fine radial grooves. Shell white, internal margin glossy outside of pallial line.

Remarks

Because of previous misunderstanding we have taken a more restricted concept of *Callucina* than used by previous authors (e.g. Chavan 1937–1938, 1969), for example, excluding species with lateral teeth. The type species was described from a Pliocene fossil but the shells are morphologically inseparable from living bivalves referred to this species from the southern USA and Caribbean. Chavan (1969 figures E2, 9ab) confusingly illustrated *Callucina hoernesii* (Deshayes) from the Eocene of France as an example of *Callucina* but this species has characters not found in the type species, such as the presence of both anterior and posterior lateral teeth and an elongate anterior adductor scar, ventrally detached from the pallial line for about 3/4 of length.

Callucina keenae ranges in the Western Atlantic from North Carolina to Brazil at depths from the shallow subtidal to 183 m (Britton 1970) and is generally thought to be the only living species of *Callucina*. Britton (1970) included *Callucina bermudensis* Dall 1901 (plate 39, figure 5) from Bermuda, introduced as a new name for *Lucina lenticula* Reeve 1850 (non *L. lenticula* Gould 1850)

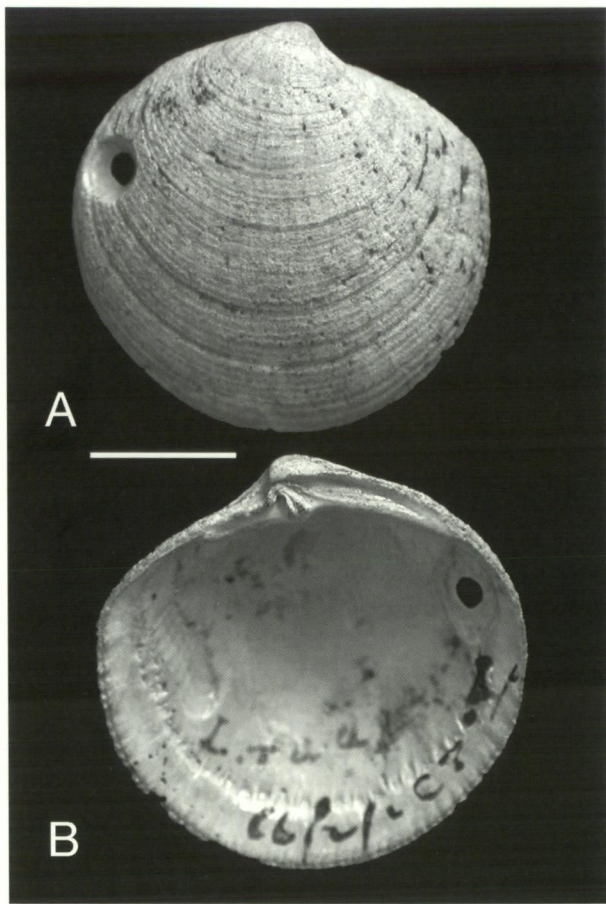


Figure 1 Holotype of *Lucina radians* Conrad 1841, the type species of *Callucina* (ANSP 30603), Pliocene, near Magnolia, Duplin County, North Carolina, U.S.A. Scale bar = 5 mm.

but Dall writes that his specimens were encrusted with sediment and that no living specimens had come to his attention. However, these shells (USNM 41339) differ from *C. keenae* in sculpture, hinge teeth, characters of the anterior adductor scar and lack of marginal denticles. At least one of the two syntypes of *L. lenticula* (BMNH 1963171-2) appears live-collected (no locality given) and has characters of a small *Lucinoma*. *Cavilinga lampra* (Dall 1901) from the eastern Pacific has sometimes been placed in *Callucina* but this species possesses both anterior and posterior lateral teeth (see discussion in Bretsky 1976: 271).

Most fossil species assigned to *Callucina* need re-evaluation in relation to the type species. *Lucina papyracea* Lea 1833 from the Middle Eocene of Alabama (see Bretsky 1976, plate 27 figures 5-7) closely resembles the type species and may be regarded as an early *Callucina*. A number of other species from the Paleocene and Eocene included in *Callucina* by Chavan (1938: 253) possess lateral teeth and elongate, detached adductor muscle scars and can be excluded.

Callucina linnaei sp. nov.

Figures 2E-L, 3B, 4

Material examined

Holotype

Australia: Western Australia: 1 shell (H 26.5, L 28.8, T 8.0), Dampier Archipelago, Lady Nora Island, 20°28'S, 116°40'E, December 1971, B.R. Wilson (WAM S13402).

Paratypes

Australia: Western Australia: 4 shells, 1 valve (H 27.4, L 28.9; H 26.3, L 27.1; H 19.7, L 21.3; H 21.7, L 24.3; H 22.2, L 24.1), Montebello Islands, east side Hermite Island, 20°31'35"S, 115°33'03"E, 4 m, August 1993, S. Slack-Smith (WAM S12506).

Other material examined

Australia: Western Australia: 2 shells, Goss Passage, Beacon Island, Houtman Abrolhos Islands, 28°28'29"S, 113°46'46"E, 25 m, April 1978 (WAM S12507); 1 shell, Middle Channel, Easter Group, Houtman Abrolhos Islands, 28°35'S, 113°45'E, 38 m, March 1963 (WAM S13404); 5 valves, NE of Leos Island, Easter Group, Houtman Abrolhos Islands 28°40'05"S, 113°54'E, 42 m, August 1977 (WAM S13405); 1 valve, N. Muiron Island, North West Cape, 21°39'19"S, 114°42'27"E, 6-13 m, 24 August 1995, (WAM S13403); 1 valve, lagoon, S.W. of Hermite Island, Montebello Islands, 20°30'09"S, 115°29'59"E, 3 m, August 1993 (WAM S13406).

Diagnosis

Compared to *C. keenae*, *C. linnaei* is larger, with broader, more widely spaced commarginal lamellae and fewer radial striations between them. The anterior adductor muscle scar is less ventrally detached from the continuous pallial line. *Callucina linnaei* differs from *C. brittoni* (see below) from Queensland in its larger size, less inflated shell and much coarser commarginal lamellae.

Description

Shell medium-sized, thick-shelled, H to 27.4 mm, L to 28.9 mm, subcircular, slightly longer than high, H/L mean 0.93 range 0.89-0.97; moderately inflated, T/L mean 0.27, range 0.24-0.30. Ventral, anterior and posterior margins rounded. Umbones slightly anterior of mid-line, prosogyrate, prominent. Sculpture of numerous low, rounded closely spaced, commarginal lamellae with prominent growth halts. Lamellae divide and anastomose to the anterior and posterior. Commarginal lamellae crossed by faint radial striations, particularly to anterior and

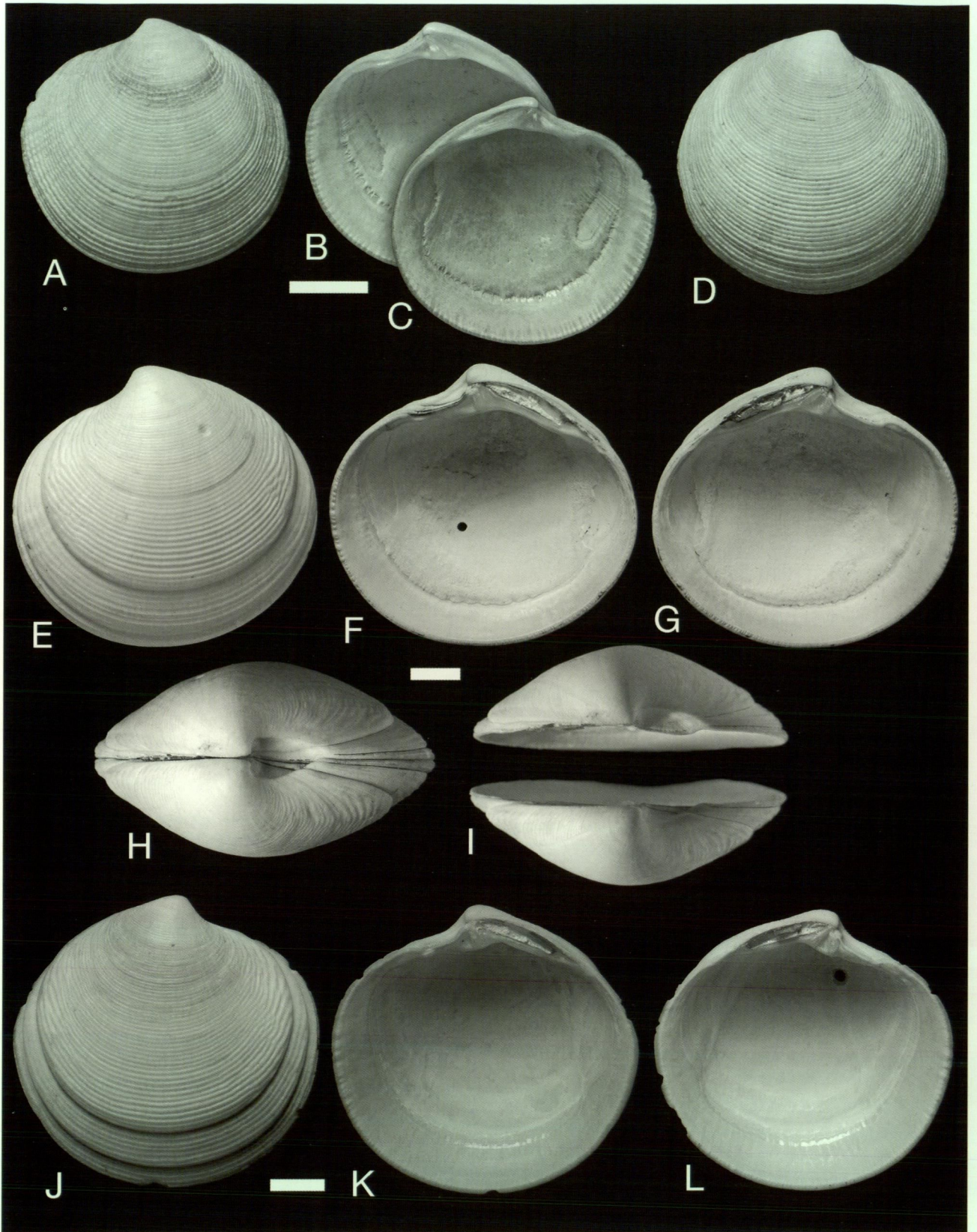


Figure 2 A–D, *Callucina keanae* Chavan 1971 West Indies, Carpenter Collection (BMNH 65.1.27.4); E–L, *Callucina linnaei* new species: E–I, holotype (WAM S12506), Lady Nora Island, Dampier Archipelago, Western Australia; E, exterior of left valve; F, G, valve interiors; H, dorsal view with valves closed; I, dorsal view, valves parted; J–L, paratype (WAM S12506) Hermite Island, Monte Bello Islands, Western Australia; J, exterior of right valve; K, L, valve interiors. Scale bars = 5 mm

posterior and, in some specimens, by low rounded ribs at anterior. Dorsal areas not demarcated except by slight thickening and anastomosing of commarginal lamellae. Lunule impressed, narrow, heart-shaped, asymmetrical, smaller in RV but overlies LV. Ligament large, lying in deep nymph, not protruding above dorsal margin. Hinge plate thick, RV with single, large, bifid cardinal tooth, LV with two cardinal teeth, the posterior larger and slightly bifid, the anterior smaller. Lateral teeth absent in both valves. Anterior adductor muscle scar short, ventrally detached from pallial line for only 1/5 of length (Figure 3B). Pallial line entire, but lobate dorsally. Inner shell margin very finely denticulate. Exterior colour white, interior hinge area and margin outside pallial line often yellowish.

Distribution

The species has been found in Western Australia from the Houtman Abrolhos Islands to Dampier Archipelago (Figure 4).

Etymology

The species is named in honour of Carl Linnaeus.

Callucina brittoni sp. nov.

Figures 3C, 4, 5

Material examined

Holotype

Australia: Queensland: 1 shell (H 14.9, L 15.6, T 4.8), northern Great Barrier Reef, Lizard Island, South Island, 14°42'S, 145°27'E, 3–18 m on coral and rubble on southern face of fringing reef, December 1974, W.F. Ponder, P.H. Colman and I. Loch (AMS C 360666).

Paratypes

Australia: Queensland: 33 valves, northern Great Barrier Reef, Michaelmas Cay, 16°36'S, 145°59'E, GBR Boring Expedition, May–June 1926, T. Iredale and G.P. Whitley (AMS C053648); 39 valves, same locality (AMS C053649). Measurements of selected shells (H 16.1, L 17.0; H 15.1, L 16.0; H 15.5 L 16.4; H 14.7, L 15.6).

Other material examined

Australia: Queensland: 2 valves, 3 km NE. of Bylund Cay, Swain Reefs, Great Barrier Reef, 21°42'S, 152°26'E, 64–73 m, 1962 (AMS C360665).

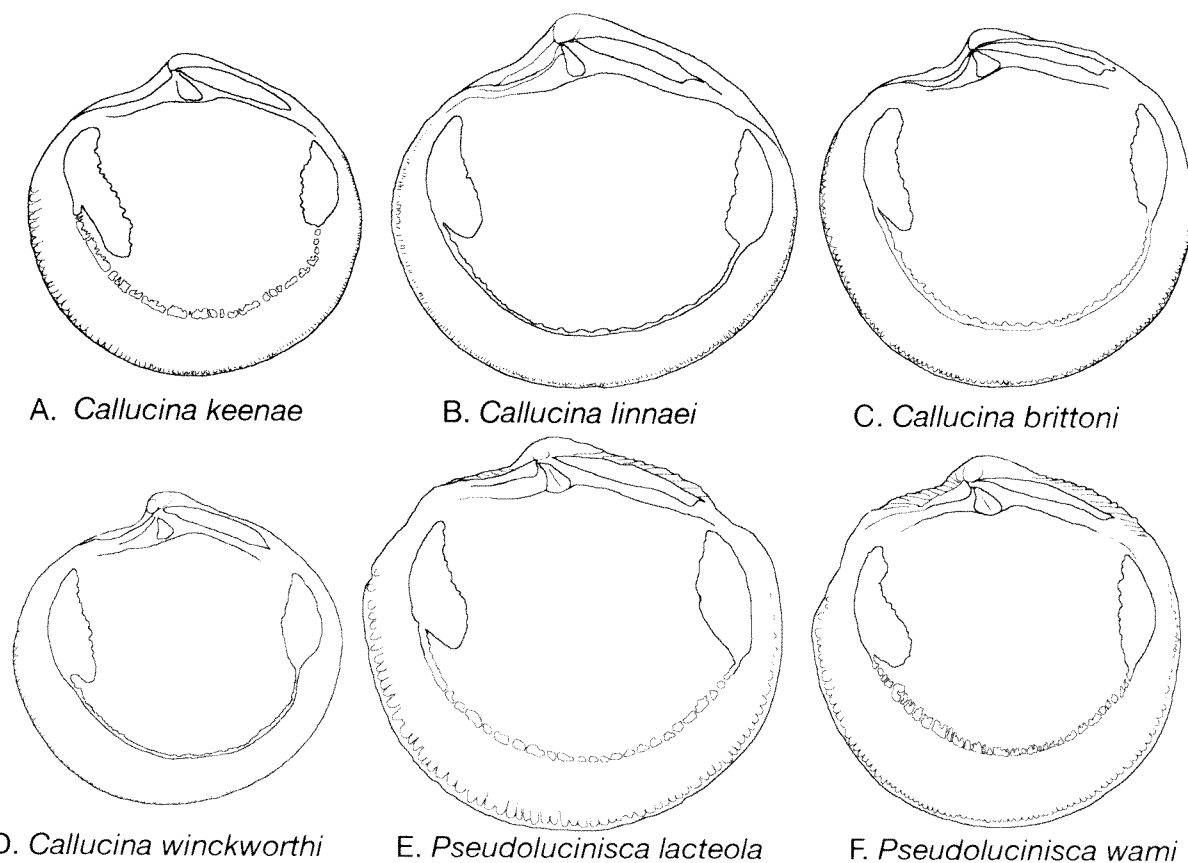


Figure 3 Outline drawings of interiors of right valves of *Callucina* and *Pseudolucinisca* species. Not to scale.

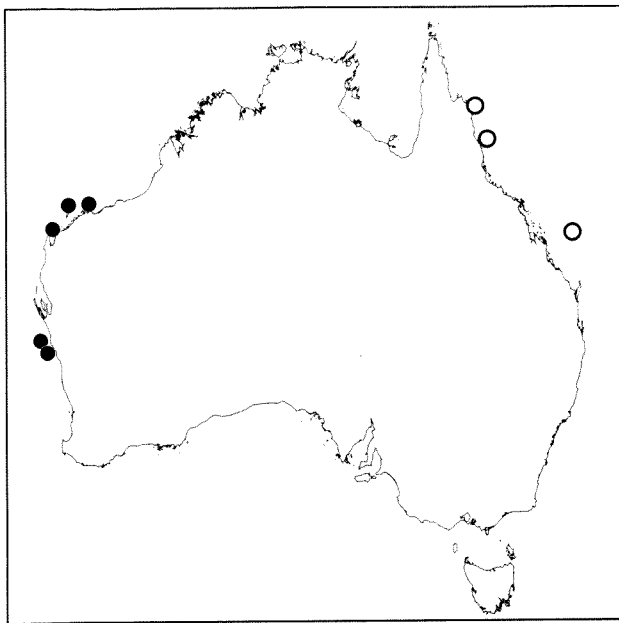


Figure 4 Map showing distribution of *Callucina* species. *Callucina linnaei* (●), *C. brittoni* (○).

Diagnosis

Compared with *Callucina linnaei*, *C. brittoni* is smaller, thinner shelled, slightly more inflated, with lower, narrower and more abundant commarginal lamellae. In both species, the asymmetry of the lunule is variable.

Description

Shell small, H to 17.0, L to 17.4, subcircular, H/L mean 0.95, range 0.92–1.01, moderately inflated, T/L mean 0.33, range 0.29–0.34. Ventral, anterior and posterior margins rounded. Umbones at mid-line, prosogyrate, prominent. Dorsal areas not demarcated. Sculpture of numerous fine, rounded, closely spaced, commarginal lamellae, with growth halts prominent. Commarginal lamellae crossed by faint radial striations, particularly in anterior and posterior areas. Lunule impressed, short, asymmetric, wider RV overlies longer LV (Figure 5D, K). Ligament robust, in shallow nymph. Hinge, RV with single, large cardinal tooth; LV with two cardinal teeth, the anterior smaller. Lateral teeth absent in both valves (Figure 5E, F). Anterior adductor muscle scar short, ventrally detached from pallial line for 1/4 of length (Figure 3C), posterior adductor scar ovoid. Pallial line entire, with slightly lobate dorsal margin. Inner shell margin finely denticulate with radial grooves. Exterior colour white, interior of shell often glossy, pale yellow.

Distribution

This species has been found only in the Great Barrier Reef, Queensland (Figure 4).

Etymology

This species is named for the late Joseph (Joe) Britton who wrote a fine but unpublished Ph.D. thesis on taxonomy of Lucinidae (Britton 1970).

Callucina winckworthi (Viader 1951)

Figures 3D, 6

Lucina (*Phacoides*) *winckworthi* Viader 1951: 135, plate 4, figures 1–3.

Material examined

Mauritius: One shell (Figure 6) and three valves sent by R. Viader to R. Winckworth (BMNH 20080324). Four valves, Cassis, collected by R. Viader 1950 (BMNH 20080323). 9 valves, Flic en Flac (BMNH 20080322). Three valves, Biggs Collection (BMNH 20080325).

Description

Shell small, H to 13.5 mm, L to 13.8 mm, subcircular, H/L mean 0.98, range 0.96–1.00, moderately inflated, T/L mean 0.33, range 0.32–0.36. Ventral, anterior and posterior margins rounded. Umbones at mid-line, prosogyrate, prominent, protruding. Dorsal areas not demarcated. Sculpture of numerous, rounded, closely spaced, commarginal lamellae, with growth halts prominent. Commarginal lamellae crossed by faint radial striations. Lunule short, heart-shaped, impressed, asymmetric, wider in RV. Ligament short, robust, in shallow nymph. Hinge, RV with single, large cardinal tooth; LV with two cardinal teeth, the anterior larger. Lateral teeth absent in both valves. Anterior adductor muscle scar short, ventrally detached from pallial line for 1/5 of length, posterior adductor scar ovoid. Pallial line entire. Inner shell margin finely denticulate. Exterior colour white to yellow, interior white, sometimes pale yellow-orange on hinge and shell margin outside pallial line.

Distribution

Known only from Mauritius.

Remarks

Apart from the two new Australian species this is the only *Callucina* species known from the Indo-West Pacific Province. Compared to *C. linnaei* and *C. brittoni* it is much smaller, relatively higher than long, with more irregular commarginal lamellae.

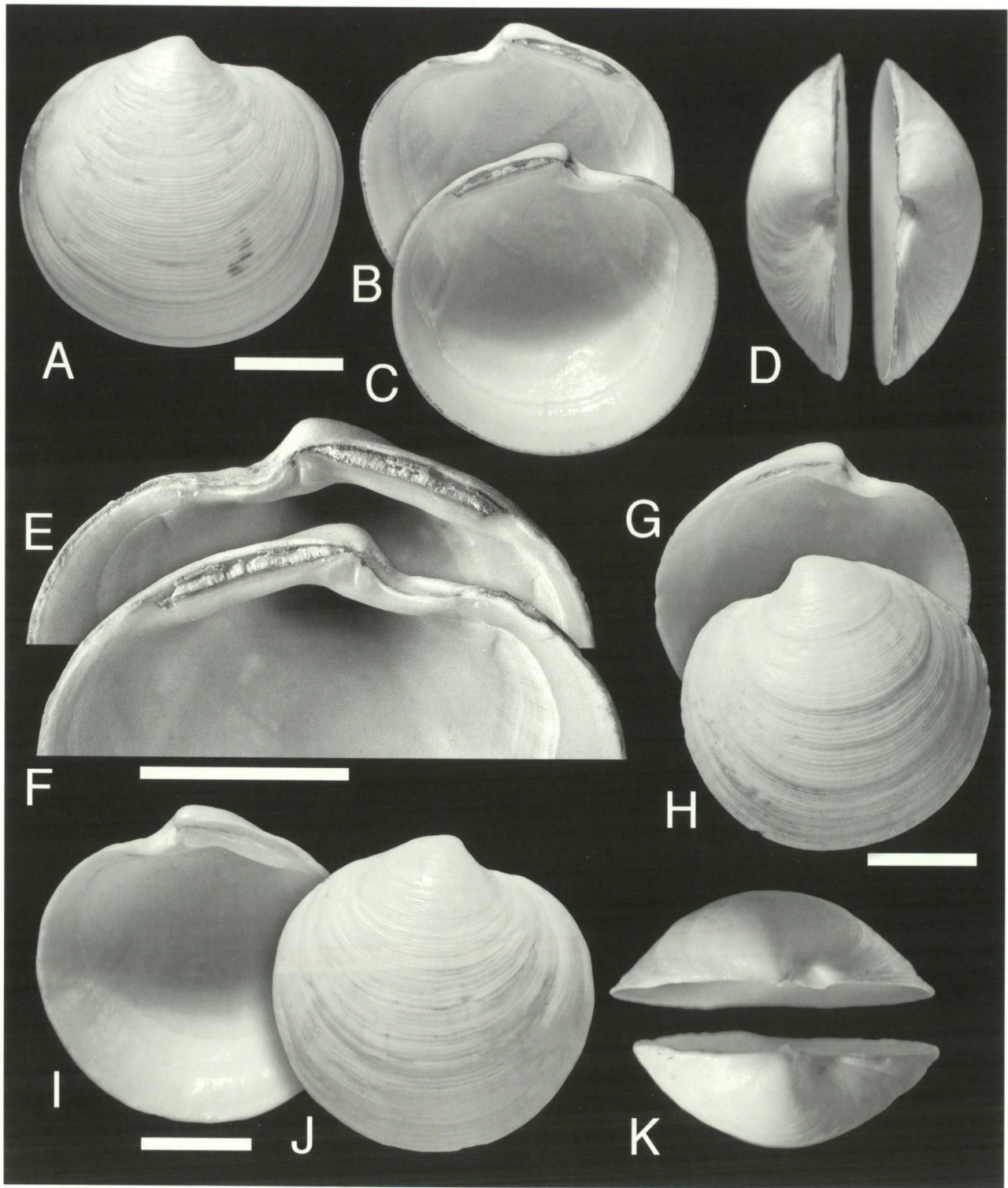


Figure 5 *Callucina brittoni* sp. nov. A-F. Holotype (AMS C 360666), South Island, Lizard Island, Great Barrier Reef, Queensland, Australia; A, exterior right valve; B,C, interior of both valves; D, dorsal view with valves parted; E,F, details of hinge of both valves; G-K, paratypes (AMS C 053648) Michaelmas Cay, Great Barrier Reef, Queensland; G, H, exterior and interior of left valve; I-J, paratype (AMS C 053648), interior and exterior of right valve; K, dorsal view of G and J. Scale bars = 5 mm.

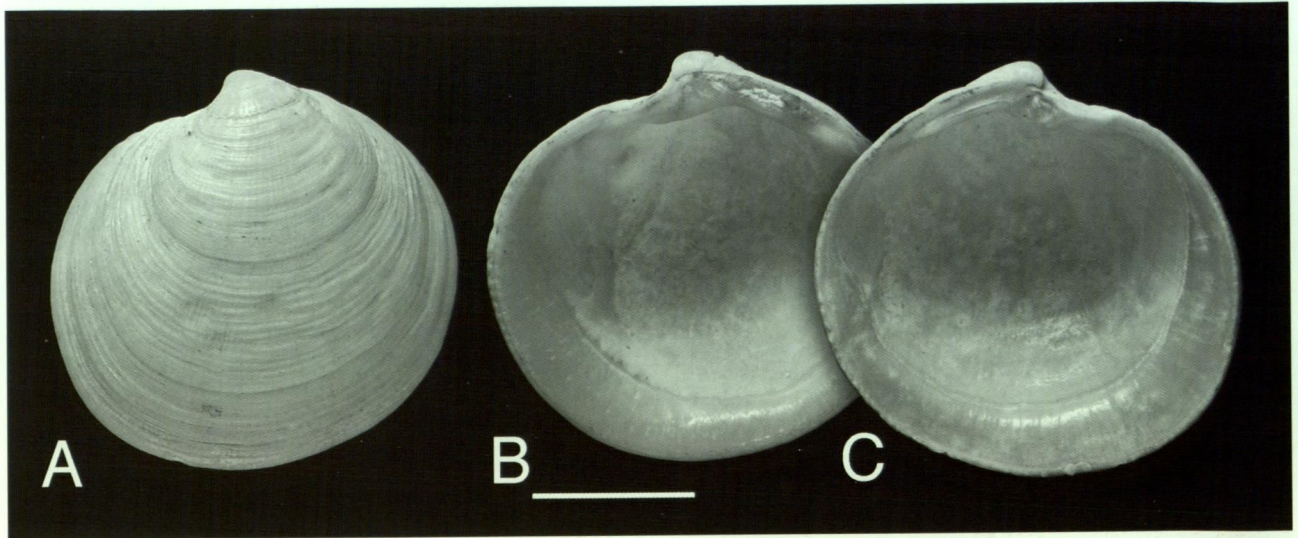


Figure 6 *Callucina winkworthi* (Viader 1951), Mauritius (BMNH 20080324). A Exterior of left valve, B, C, interior of right and left valves. Scale bar = 5 mm.

Pseudolucinisca Chavan 1959

Callucina (*Pseudolucinisca*) Chavan 1959: 516.

Type species

Lucina lacteola Tate 1897 (= *L. lactea* Adams 1855 non Lamarck 1818; *Lucina concentrica* Adams and Angas 1863, non Lamarck 1806), by original designation.

Diagnosis

Subcircular in outline, sculpture of narrow, regularly spaced commarginal lamellae; lunule highly asymmetric, with arcuate flange projecting entirely from LV; lateral teeth absent, RV with single, large, bifid cardinal tooth; LV with posterior cardinal and vestigial anterior cardinal abutting lunule extension. Pallial line discontinuous, divided into irregular blocks. Shell margin denticulate.

Remarks

Although *Pseudolucinisca* is usually treated as a subgenus of *Callucina* it is uncertain if the two genera are related and here we treat the taxa as separate, distinct genera. Molecular data are published for *Pseudolucinisca* (Williams *et al.* 2004), but none are yet available for *Callucina*.

Chavan (1959) assigned the two Miocene species *Lucina strigosa* Michelotti, 1861 and *L. michelotti* Mayer, 1858 to *Pseudolucinisca*. Illustrations of these species (Sacco 1901: plate 20, figures 18–21; Cossmann and Peyrot 1909–1912: plate 28, figures 47–50) show lucinids with marked dorsal areas and prominent anterior lateral teeth, unlike the type, but they have large lunules, although from the figures it is impossible to say whether these are strongly asymmetrical.

Pseudolucinisca lacteola (Tate 1897)

Figures 3E, 7, 8, 10, 11

Lucina lactea A. Adams 1855: 225 (junior primary homonym of *Lucina lactea* Lamarck 1818).

Lucina concentrica A. Adams and Angas 1865: 426, plate 37, figure 19 (non *L. concentrica* Lamarck 1806).

Lucina lacteola Tate 1897: 48 (replacement name for *L. lactea* A. Adams).

Loripes lacteola (Tate 1897): Hedley 1916: 161.

Codakia lacteola (Tate): May 1921: 18; Cotton and Godfrey 1938: 206, figure 219; Cotton 1961: 219, figure 226.

Callucina lacteola (Tate): May revised by Macpherson 1958: plate 7, figure 16; Ludbrook 1978: 51.

Callucina (*Pseudolucinisca*) *lacteola* (Tate): Chavan 1959: 516; Lamprell and Whitehead 1992: figure 116.

Material examined

Syntypes of *Lucina lactea*

Australia: Western Australia: 3 shells (H 21.4–23.8, L 22.4–24.0), Swan River and New Zealand (error), (BMNH 1963555/1-3).

Syntypes of *Lucina concentrica*

Australia: South Australia: 3 shells (H 19.6–20.8, L 21.5–21.7), St Vincent Gulf (BMNH 1870.10.26.33).

Other material examined

Australia: Victoria: Portland, West Victoria (AMS). **South Australia:** St Kilda, Adelaide

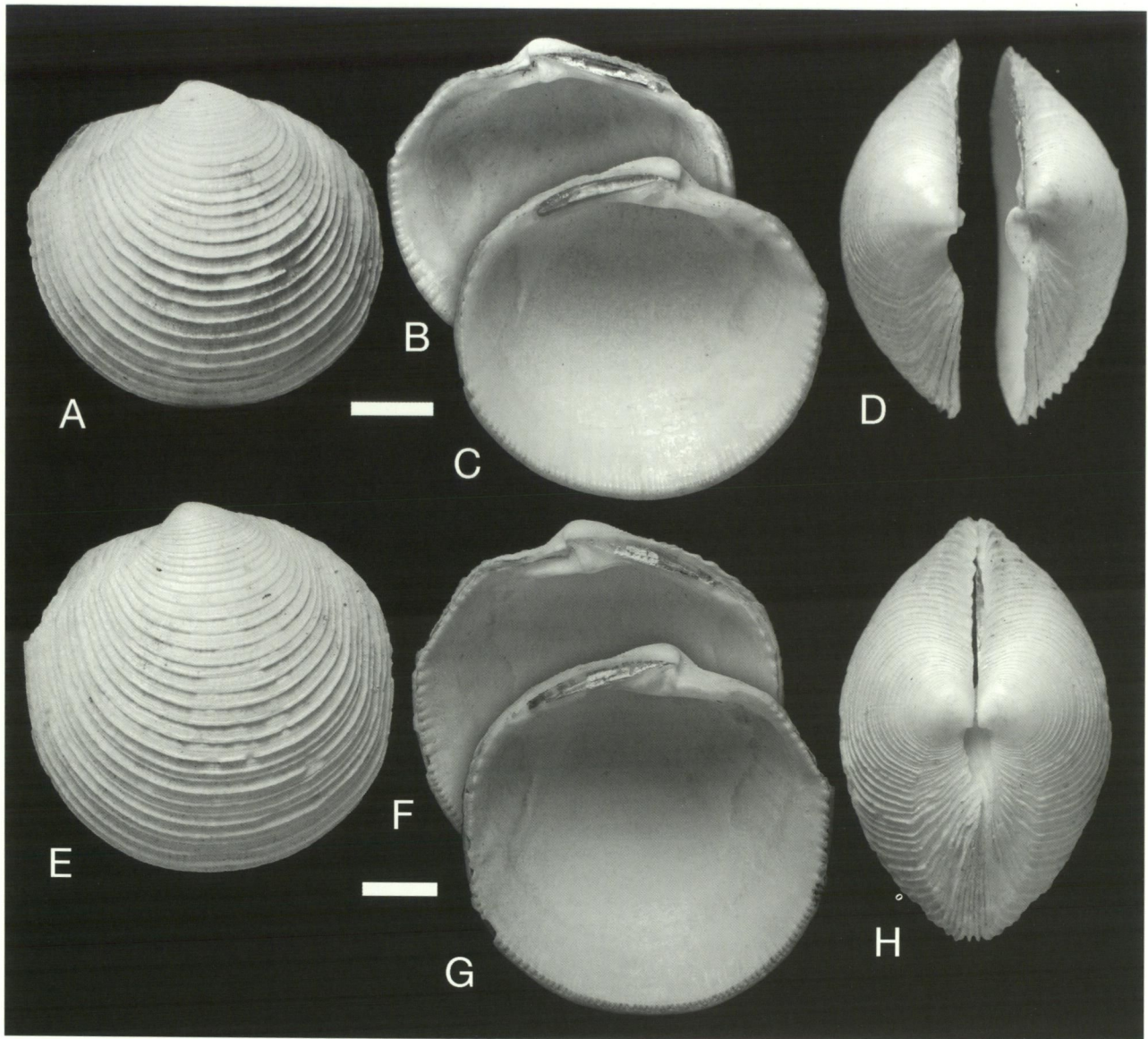


Figure 7 *Pseudolucinisca lacteola* (Tate 1897): A–D, syntype of *Lucina lactea* (BMNH 1963555/1-3): A, exterior left valve; B, C, interior of both valves; D, dorsal view of parted valves; E–H, syntype of *L. concentrica* Reeve, 1850 (BMNH 1870.10.26.33): E, exterior left valve; F, G, interior of both valves; H, dorsal view. Scale bars = 5 mm.

(BMNH); Holdfast Bay (AMS C39180); Normanville (AMS); West Beach (AMS C75726); St Vincent Gulf (AMS C 13784); Safety Bay (NMV), Largs Bay (NMV), Heydon Beach (NMV), Grange (NMV); Henley Beach (SAM), West Franklin Island, (SAM); Willunga (SAM); Scales Bay (SAM); Semaphore Beach, Adelaide (SAM); Outer Harbour (SAM); Kingston Park (SAM); Edithburgh, Yorke Peninsula (SAM); Port Lincoln. (NMV). **Western Australia:** between Eucla and Esperance, 79–147 m (AMS); North Twin Island and Middle Island, Recherche Archipelago (NMV); Duke of Orleans Bay (AMS); Mississippi Bay, Esperance (AMS); Lucky Bay, Cape le Grand (BMNH); Esperance Beach (BMNH); Two Peoples Bay, Albany (AMS); Shoal Bay, Albany (BMNH); Oyster Harbour,

Albany (WAM); Princess Royal Harbour, Albany (AMS); Emu Point, Albany (AMS); Torbay, Albany (WAM); Duke Head, Augusta (BMNH).

Description

Shell medium sized, H to 27.2, L to 29.0, subcircular, H/L mean 0.96 range 0.91–0.99, inflated, T/L mean 0.34, range 0.29–0.39. Umbones rounded, central, low. Sculpture of regularly spaced, low, thin commarginal lamellae (6–8 lamellae per 5 mm shell height); with fine, radial lines in interspaces, mainly in posterior part of shell. Lunule, lanceolate, impressed, highly asymmetrical, with strong, arcuate flange of LV projecting into RV (Figure 7D). Anterior dorsal area demarcated by a low ridge and posterior area

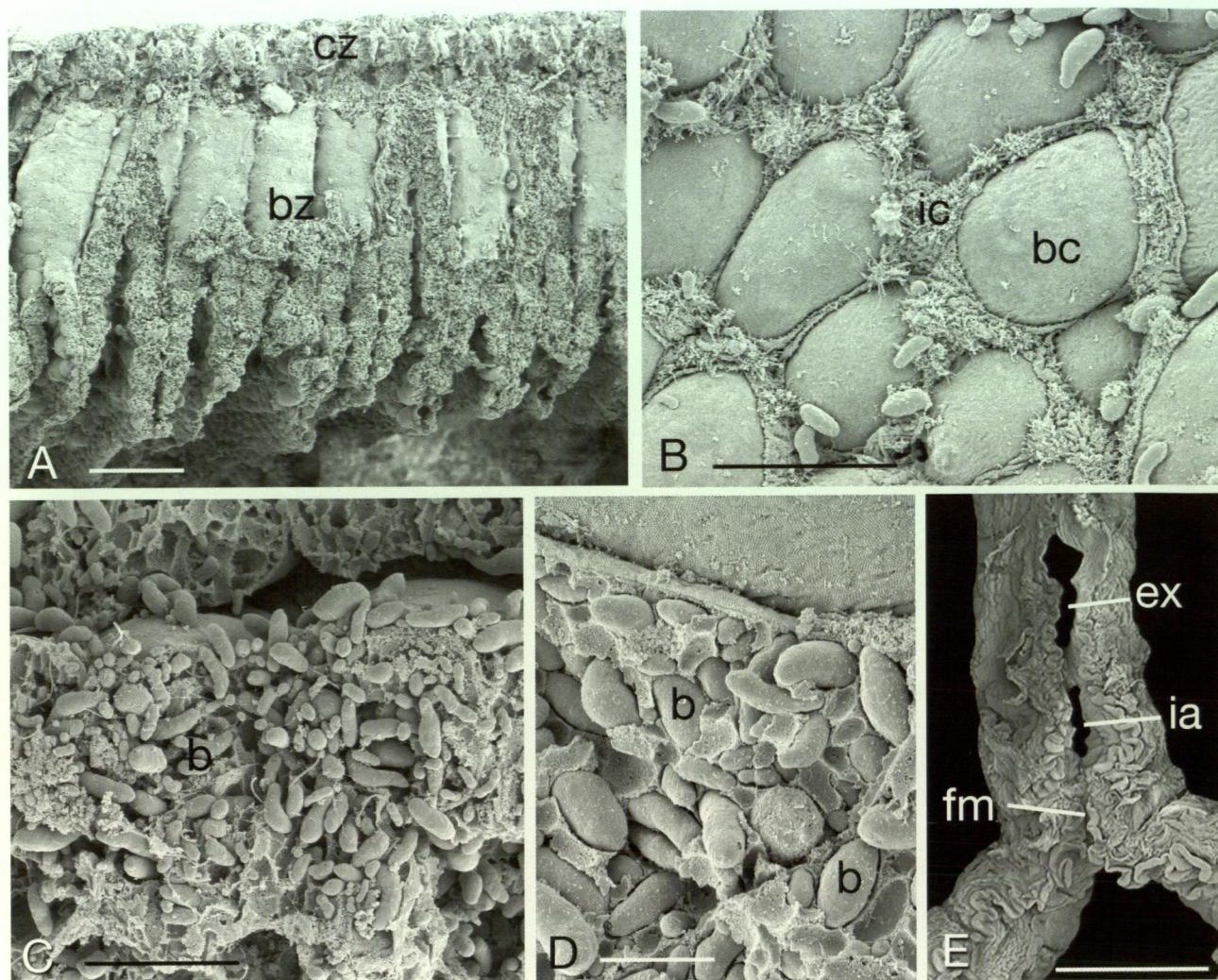


Figure 8 Bacteriocytes and posterior apertures of *Pseudolucinisca lacteola*, Esperance, Western Australia. SEMs of critical point dried preparations from glutaraldehyde - fixed tissue: A, section of ctenidial demibranch showing extensive abfrontal thickening of the bacteriocyte zone; B, surface of bacteriocytes with surrounding intercalary cells; C, section of bacteriocytes containing abundant bacteria; D, bacteria in apical part of bacteriocyte; E, posterior apertures. Scale bars A = 100 μm ; B = 20 μm ; C = 10 μm ; D = 5 μm ; E = 2 μm . Abbreviations: b = bacteria; bc = bacteriocytes; bz = bacteriocyte zone; cz = ciliated zone; ex = exhalant aperture, fm = fused mantle; ia = inhalant aperture; ic = intercalary cells.

by an indistinct sulcus. Hinge plate narrow, LV with two cardinal teeth, smaller anterior tooth, not always present, abuts against projecting lunule. RV with a single cardinal. Lateral teeth absent in both valves. Ligament long, narrow, set in shallow groove. Anterior adductor scar short, fairly broad, detached from pallial line for 1/3 of length (Figure 3D), posterior adductor scar ovate. Pedal muscle scars strongly visible and separate from adductor scars. Pallial line discontinuous, divided into small blocks. Inner surface of shell dull, ventral margin finely denticulate with beaded appearance. Shell white to grayish white.

Anatomy

A single live-collected specimen from Esperance, Western Australia, was available for observations on gills and bacteriocytes. As in all

studied Lucinidae (Taylor and Glover 2006), the ctenidia have single demibranchs with broad, closely spaced filaments. In section, there is a narrow, distal ciliated zone and a long, lateral zone comprising sheets of bacteriocytes, about 15–20 μm in diameter (Figures 8A, B). These bacteriocytes are capped with short, uniform microvilli and separated by intercalary cells with spiky apical extensions (Figure 8B). The bacteriocytes are packed with short, rod-shaped bacteria 5–7 μm long and 2 μm wide (Figures 8C, D). These observations confirm the presence of bacteria in the ctenidia and the likely nutritional dependence on chemosymbiosis for *P. lacteola*.

The form of the posterior apertures and amount of mantle fusion ventral to the inhalant aperture have some potential in systematic studies of

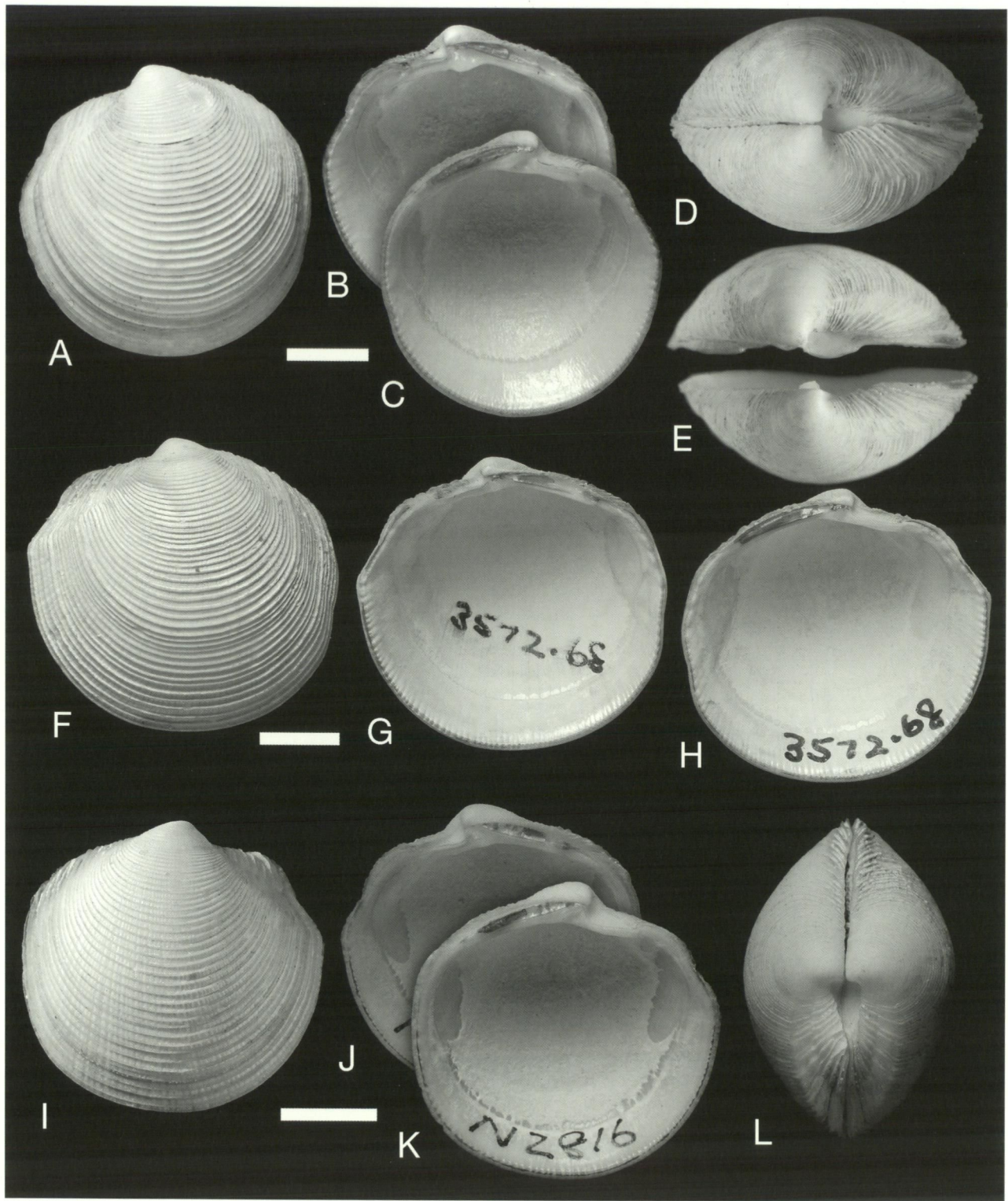


Figure 9 *Pseudolucinisca wami* new species. A-E, holotype (WAM S13399) Cockburn Sound, Fremantle, Western Australia: A, exterior left valve; B,C, interior of both valves; D, dorsal view; E, dorsal view with parted valves to show asymmetry of lunule; F-H, paratype (WAM S13400), Dunsborough, Geographe Bay, Western Australia: F, exterior of left valve; G, interior of right valve; H, interior of left valve; I-L, paratype (WAM S13396), Middle Channel, Houtman Abrolhos Islands: I, exterior of right valve; J, K, interiors of left and right valves; L, dorsal view. Scale bars = 5 mm.

Lucinidae (Taylor and Glover 2006). The posterior apertures of *Pseudolucinisca lacteola* are shown in (Figure 8E); the inhalant aperture lacks papillae and there is a medium length of mantle fusion (fusion index 0.52; for method see Taylor and Glover 2002) compared to the highly fused *Phacoides pectinatus* (Gmelin 1791) at 0.78 and the short fusion of *Codakia orbicularis* (Linnaeus 1758) at 0.20 (Taylor and Glover 2006).

Distribution

This species is found from Portland, Victoria, and South Australia to Cape Leeuwin, Western Australia (Figure 11). Shells of *P. lacteola* recorded from beaches on Rottnest Island, off Fremantle, are probably derived from the late Quaternary deposits outcropping along the shores (see Hickman and Barnes 1999).

Remarks

See below for comparison with new species.

Pseudolucinisca wami new species

Figures 3F, 9, 10, 11

Callucina lacteola (Tate 1897): Slack-Smith 1990: 148.

Callucina (Pseudolucinisca) lacteola (Tate 1897): Taylor and Glover 2004: 262.

Material examined

Holotype

Australia: Western Australia: 1 shell with dried body (H 18.3, L 18.2, T 6.1), Fremantle, Cockburn Sound, 32°11'S, 115°43'E, 29 November 1972, L. Marsh (WAM S13399).

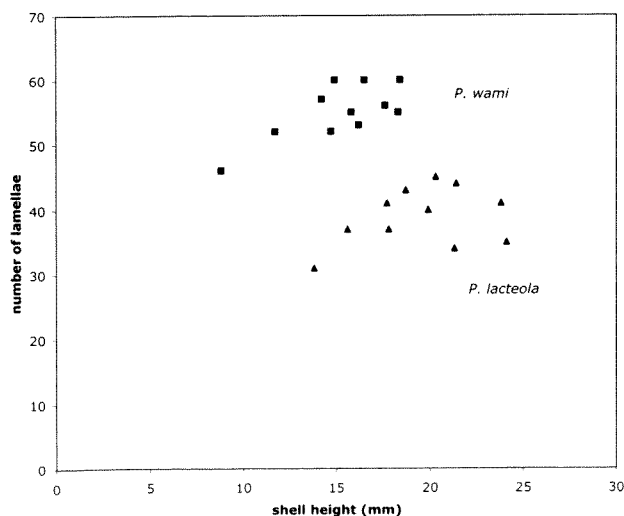


Figure 10 Scatter plot of number of commarginal lamellae against shell length for *Pseudolucinisca lacteola* and *P. wami*.

Paratypes

Australia: Western Australia: 1 shell (H 18.4 mm, L 19.7, T 6.0), Geographe Bay, Dunsborough, 33°36'S, 115°06'E, December 1965, B.R. Wilson (WAM S13400); 1 shell (H 14.7, L 15.4, T 4.9), Abrolhos Islands, Middle Channel, 28°35'S, 113°46'E, March 1963, J. Seabrook, 03.1963 (WAM S13396).

Other material examined

Australia: Western Australia: Geographe Bay, 9 m (WAM); 3 miles (4.8 km) off Dunsborough, 54 ft (16.5 m) (WAM); Eagle Bay, Geographe Bay (WAM); Busselton Beach (BMNH); Palm Beach, Rockingham (WAM); Warnboro Sound (WAM); Cockburn Sound (WAM); west of Rottnest, 110 m (WAM); off northeast Rottnest Island, 22 m (BMNH); Green Island, off Grey (WAM); Cervantes, North Terin Bank (WAM); Jurien (WAM); Geraldton, Bluff Point. (WAM); Zeewyck Channel, Houtman Abrolhos Islands, 21 fathoms (38 m) (WAM); SW face of Beacon Island, Wallabi Group, Houtman Abrolhos Islands (WAM); E. side Wooded Island, Easter Group, Houtman Abrolhos Islands, 24 fathoms (44 m) (WAM); Middle Channel, Easter Group, Houtman Abrolhos Islands 21 fathoms (38m) (WAM); Bernier Island, Shark Bay (WAM); Boat Harbour, Carnarvon (BMNH); Exmouth (AMS); Dampier Archipelago, 32–43 m (BMNH); 78 miles (125.5 km) NNE. of Port Hedland, 19°4.4'S, 119°4.4'E, 82 m (AMS).

Diagnosis

This species is very similar in general morphology to *P. lacteola* but differs in being smaller, with more densely-spaced commarginal lamellae (Figure 10) and more prominent radial striations in the interspaces between the lamellae.

Description

Shell small, H to 18.4, L to 19.7, subcircular (H/L mean 0.96 range 0.94 – 1.01), solid, inflated (T/L mean 0.33 range 0.30–0.35) Umbones rounded, central, low. Sculpture of regularly spaced, low, narrow, commarginal lamellae (11–13 lamellae per 5 mm); fine radial lines in interspaces over all shell. Anterior dorsal area demarcated by a low ridge and posterior area by a shallow sulcus. Lunule small, impressed, lanceolate, strongly asymmetrical, large arcuate flange of LV projecting into slot in RV (Figure 9E). Hinge plate narrow, LV with one larger posterior cardinal tooth and a deep socket, with a tiny anterior cardinal on lunular margin; lateral teeth absent; RV with single large cardinal, sometimes bifid, and no laterals. Ligament long, narrow, set in shallow groove. Anterior adductor muscle scar short, fairly broad, detached from pallial line for

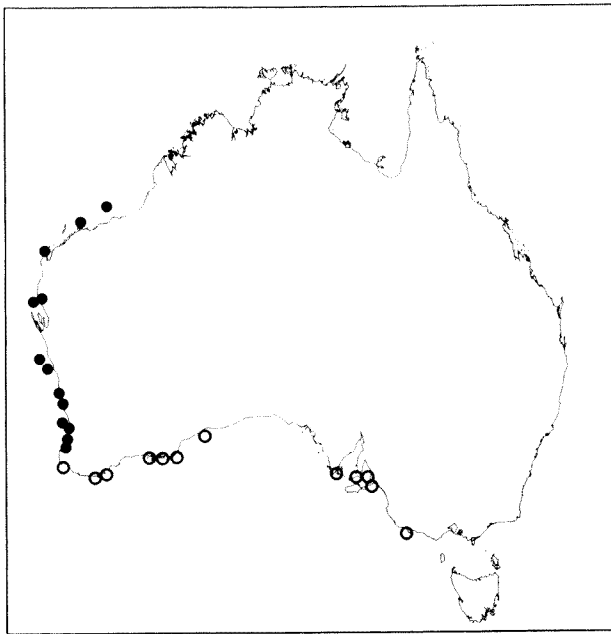


Figure 11 Map showing distribution of *Pseudolucinisca* species: *Pseudolucinisca lacteola* (○), *P. wami* (●).

one-third of length (Figure 3F); posterior scar ovate. Pedal muscle scars strongly visible and separate. Pallial line discontinuous, divided into small irregular blocks. Shell inner surface dull, glossy outside pallial line with fine radial grooves and marginal denticulations. Colour grey-white.

Distribution

This species is found in Western Australia from Geographe Bay to the North-West Shelf near Port Hedland (Figure 11).

Remarks

Pseudolucinisca wami and *P. lacteola* have contiguous ranges; *P. lacteola* is distributed from western Victoria to Cape Leeuwin and *P. wami* northwards from Geographe Bay to near Port Hedland. Bivalves from the southern parts of the range are generally larger than those from the north. Slack-Smith (1990: 148) remarked that specimens of *Callucina lacteola* (i.e. the new species, *P. wami*) from Shark Bay were generally smaller than those from more southerly localities.

Etymology

This species is named in recognition of the Western Australian Museum. The name is to be treated as a noun in apposition.

DISCUSSION

There is considerable misunderstanding in the generic assignments of small to medium sized Lucinidae that are subcircular in shape, with a sculpture of low, closely spaced commarginal

lamellae and an absence of well-defined sulci or dorsal areas. A number of genera including *Callucina*, *Callucinella*, *Callucinopsis* and *Epilucina* have similar external morphology but differ in hinge, adductor muscle scar and other internal characters. For this reason, we have used in this paper a more narrowly defined concept of *Callucina*, based on characters of the type species, thereby excluding some of the fossils often assigned to *Callucina* but possessing lateral teeth. *Pseudolucinisca* is usually regarded as a subgenus of *Callucina* but there is no firm evidence that they are related, so we treat them as two distinct genera.

Although *Callucina* s.l. has been claimed as an ancient genus, older Mesozoic lucinids referred to *Callucina* (Chavan 1937–1938, 1959) all need re-evaluation and most can be considered as doubtful assignments, for instance *Callucina olea* (Vokes 1946: 46, plate 7, figures 14–17) from the Cretaceous (Aptian) of Lebanon has sculpture (coarse, sharp lamellae) and dentition (robust, posterior lateral tooth) unlike *Callucina keena*. The small *Lucina ripleyana* Wade (1926: 82 plate 25 figures 19–21) from the Campanian Ripley Formation was assigned to *Callucina* by Chavan (1959) but has large anterior and posterior lateral teeth. Similarly, *Lucina calmoni* Pervinquier 1912 from the Maastrichtian of Tunisia, included in *Callucina* by Chavan (1938: 220), possesses two cardinal teeth in each valve and both anterior and posterior lateral teeth. Chavan (1959) subsequently placed this species in his new genus *Callucinopsis*.

From shell characters Bretsky (1976: 235 and figure 3) claimed a close relationship of *Callucina* with *Parvilucina* and placed *Callucina* as a stem group of a clade comprising *Parvilucina*, *Lucinisca*, *Pleurolocina* and *Callucina*. This proposal is yet to be tested by molecular methods. The usual inclusion of *Pseudolucinisca* as a subgenus of *Callucina* implies a close relationship. However, molecular results for *Pseudolucinisca lacteola* shows that it aligns near to the *Anodontia* clade and not with *Lucinisca* and many other shallow water lucinids (Williams *et al.* 2004; Taylor, Glover and Williams unpublished data). This result is incongruent with the classification of Chavan (1969) who placed *Callucina* and *C. (Pseudolucinisca)* within the subfamily *Lucininae* and the *Anodontia* group in the Milthinae.

The distribution of *Pseudolucinisca* is restricted to southern and western Australia with two living species. For *Callucina* s.s. there are three living species from the Indo-West Pacific province, *C. winckworthi* from Mauritius and the two new Australian taxa described here. On shell characters, the new Australian *Callucina* are

closely similar to the western Atlantic *Callucina keenae* and it is reasonable, without other evidence, to group them in the same genus.

Western Australia is known to harbour populations of invertebrates regarded as relicts of the Cenozoic Tethyan Ocean, notably stygobiont fish and copepods (Knott 1993; Humphreys 1999; Jaume *et al.* 2001). Amongst marine molluscan examples (Beesley *et al.* 1998) are *Campanile symbolicum* (Iredale 1917), *Neotrigonia* spp. and *Diastoma melanioides* (Reeve 1849). *Callucina* species are known from the Palaeogene of Europe and North America and the Neogene of eastern North America (Bretsky 1976) and the Australian and Mauritius species may be a remnant of a former, wider distributional range. However, there is no known fossil record of the genus in the Indo-West Pacific. Similarly, fossil lucinids with shells superficially similar to *Pseudolucinisca* are known from the Miocene of southern France and Italy (Chavan 1959), although these all need critical reassessment.

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