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A REVISION OF THE AUSTRALIAN GENUS *UMBILIA* (GASTROPODA: CYPRAEIDAE)

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Abstract

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Umbilia, an endemic Australian genus of cool-water cowry, comprises 11 species ranging in age from Late Oligocene to Recent, of which four species are known only in the living fauna. Fossil species occur in the Eucla, St Vincent, Murray, Otway, Bass and Gippsland Basins, and living species range from Western Australia to central Queensland. Species of the genus probably have no free-swimming larval stage, so that there is considerable morphological variability which has led to the creation of many synonyms. Two subgenera are recognised here, *Umbilia* (*Umbilia*), with ten species, *U. prosila* sp. nov., *U. leptorhyncha*, *U. petilirostris* sp. nov., *U. platyrhyncha*, *U. angustior*, *U. eximia* (= *brevis, maccoyi, frankstonensis, montismarthae* and *sphaerodoma*), *U. hesitata* (= *beddomei, cera, howelli* and *tatei*?), *U. siphonata* (= *breviplicata*), *U. armeniaca* and *U. capricornica*, and *U.* (*Palliocypraea*) with one species, *U.*(*P.*) *gastroplax*. A possible ancestor of *Umbilia*, *Palaeocypraea*? *eripnides*, from the Upper Paleocene–Lower Eocene, of the Chatham Is, New Zealand, is newly described. *Rhynchocypraea* Cossmann, 1898 (type species *Cypraea leptorhyncha* McCoy) is synonymised with *Umbilia*.

Introduction

Umbilia is an endemic Australian genus of cowry. Living species are found in deep water from the southern coast of Western Australia and along the east coast to the Capricorn Channel area of Queensland. Fossil species are known from the Eucla, St Vincent, Murray, Otway, Bass, and Gippsland Basins in rocks ranging in age from Late Oligocene to Late Pliocene. In general, fossil specimens are not common except in the Middle Miocene Fyansford and Gellibrand Formations of the Otway Basin. One of the extant species (*U. hesitata*) also has fossil records (Miocene-Pliocene).

Umbilia is a member of an endemic group of Australian cowries that includes *Notocypraea, Austrocypraea* and *Zoila* (Wilson, 1985). The present paper reports results of part of a wider, comprehensive study of all the Australian fossil cowries.

Previous work. The first fossil species of *Umbilia* to be described, *Cypraea eximia* G. B. Sowerby I, 1845, was based on a specimen collected by P. E. Strzelecki allegedly from Tasmania. McCoy (1867a, 1875, 1876) described another species, *Cypraea* (*Aricia*) *platyrhyncha* from Torquay as well as illustrating Victorian examples of Sowerby's species and describing a new variety of it, *Cypraea* (*Aricia*) *eximia* var. *brevis*. He also described *Cypraea gastroplax* (McCoy, 1867a), now included in the subgenus *Umbilia* (*Palliocypraea*) and *Cypraea* (*Luponia*) *leptorhyncha* (McCoy, 1877) herein regarded as an *Umbilia*. Tate (1890) listed previously described species, recorded new occurrences and described two new taxa, *Cypraea sphaerodoma* and *C. amygdalina*, the latter renamed *C. tatei* by Cossmann (1903) owing to preoccupation of Tate's original name. Tate also noted a general resemblance of *Cypraea eximia* to the living *C. umbilicata* G. B. Sowerby I (= *hesitata* Iredale), type species of *Umbilia* Jousseaume, 1884.

Pritchard (1896) described a new variety of McCoy's species, *Cypraea platyrhyncha* var. *angustior* from northern Tasmania, that is here elevated to specific rank. Harris (1897) placed *C. eximia* and *C. sphaerodoma* in *Umbilia*, which he regarded as a subgenus of *Cypraea*. Cossmann (1898) erected *Rhynchocypraea* for *Cypraea leptorhyncha*. This is synonymised with *Umbilia* (*Umbilia*) in this paper. In 1906 Cossmann erected *Palliocypraea* as a subgenus of his genus *Rhynchocypraea*, with type species *Cypraea*

gastroplax McCoy. Chapman (1922) described *Cypraea siphonata* from near Waikerie, South Australia, a species now included in *Umbilia*. In 1926, Schilder named *Gisortia breviplicata* based on Tate's (1890) description of *C. sphaerodoma* var. In 1932, Schilder listed all previously described taxa under the genus *Umbilia* and erected *U.* (*U.*) *eximia maccoyi* based on McCoy's figures (McCoy, 1876) of *Cypraea eximia*.

In 1935, Schilder revised all the Tertiary cowries from Australia, describing many new taxa based on material (much with poor locality data) in European collections. *U.* (*U.*) *brevis montismarthae* and *U.* (*U.*) *brevis frankstonensis* were the new taxa of *Umbilia* so erected. He had little idea of the variability of the taxa owing to the relatively small number of specimens available to him (18 specimens of *Umbilia*) and he had no idea of their stratigraphic positions. Schilder regarded both *Rhynchocypraea* and *Palliocypraea* as subgenera of *Umbilia*, maintaining *Rhynchocyprea* as a montotypic subgenus and assigning *Gisortia breviplicata* and *Cypraea siphonata* to *Palliocypraea*. The last fossil species to be erected, *U. cera*, was described by Cotton (1947) from the Dry Creek Sands of the St. Vincent Basin, South Australia.

There are four known living species of *Umbilia*: *U.* (*U.*) *armeniaca* (Verco, 1912) from southern Western Australia and South Australia; *U.* (*U.*) *hesitata* (Iredale, 1916) widely distributed from South Australia to southern Queensland; and *U.* (*U.*) *capricornica* Lorenz, 1989 and *U.* (*U.*) *petilirostris* sp. nov. from south-central Queensland. Of these, only *U.* (*U.*) *hesitata* is known from the fossil record.

Generic status. There has been considerable debate as to the worth of many of the genera within the family that were erected on the basis of shell morphology, particularly as anatomical studies of several species show that the anatomical features of many of these "genera" are very similar to one another and do not support their separation on shell characters (Kay, 1960). This applies particularly to the Indo-Pacific tropical cowry genera. In the case of *Umbilia*, however, there does seem to be sufficient grounds for recognising the group, either at generic or subgeneric level. These grounds are essentially its unique geological history, its geographic and stratigraphic isolation from other cowry groups, and its paucispiral protoconch. Most of the tropical cowries have pelagic larval stages, which accounts for their widespread distribution. These tropical species have multispiral protoconchs (Ranson, 1967).

Molluscs with paucispiral protoconchs usually do not have a pelagic larval stage but hatch directly from the egg as crawling juveniles. Though nothing is known yet of the mode of reproduction of species of *Umbilia*, the distribution and fossil history of the genus also suggest that there was no pelagic larval stage. Ranson (1967) illustrated the protoconchs of specimens of *Umbilia hesitata* and showed these as being paucispiral. Sections made by me of two fossil species, *U.* (*U.*) *angustior* (Pritchard) and *U.* (*U.*) *eximia* (Sowerby) (Figs 1A–B), show that these also have paucispiral protoconchs, so it seems likely that all species of *Umbilia*, living and extinct, feature direct development rather than pelagic larval stages. Wilson (1985) has shown that species of the other endemic genera, *Zoila, Austrocypraea* and *Notocypraea*, feature direct development.

Direct development in molluscs leads to extensive infraspecific variation (Wilson, 1993). Species of *Umbilia*, both living and fossils show considerable infraspecific variation in shell morphology and colour. This variation has led inevitably to the erection of a considerable number of specific and subspecific names for both colour and morphological varieties which the present work seeks to rectify.

Fossil history. The earliest fossil records of *Umbilia* are from the Late Oligocene, by which time it seems that direct development in the genus had been established. It is suggested here that *Umbilia* may have been derived from an ancestor such as *Palaeocypraea*? *eripnides* sp. nov., from the Paleocene of New Zealand, which has a multispiral protoconch suggesting a pelagic larval stage in its development. Another possible ancestor occurs in the Eocene of Western Australia, *Cypraeorbis* sp., which could have given rise to the Late Oligocene *U. prosila* sp. nov. The fossil record of *Umbilia* shows two possible species lineages, both beginning in the Late Oligocene and continuing through to the Recent: *U. platyrhyncha* – *U. angustior* – *U. eximia* – leading to the living *U. hesitata* and *U. prosila* sp. nov. – *U. leptorhyncha* leading to the the living *U. petilirostris* sp. nov. There are also two other species in the Middle Miocene which on present knowledge do not seem closely related to these lineages and have no known descendants. One of these is sufficiently distinct to justify subgeneric status, *Palliocypraea*. It is possible that the genus *Umbilia* as recognised here is polyphyletic, but until mollecular studies have been undertaken on living representatives, the question must remain unresolved.

Rhynchocypraea Cossmann, 1898 (type species *Cypraea leptorhyncha* McCoy) is synonymised with *Umbilia* (*Umbilia*) in this paper.

Species are described here in groups according to their affinity with one another, and within these groups in stratigraphic order.

Terminology. Measurements in millimetres are given as follows: L, total length of shell; W, width of shell; H, height of shell. Tooth counts are cited as LT, labial teeth and CT, columellar teeth. The terms left and right refer to the animal's true left and right sides respectively.

All material used in this study, unless otherwise stated, is held in the collections of Museum Victoria, registration numbers with prefixes P (Invertebrate Palaeontology collection) and F (living mollusca collection). Localities are cited where possible using the Museum Victoria fossil locality register with prefix PL. The full locality data for these numbers has been published in Darragh (1989, 1991) and Beu and Darragh (2001). Museum acronyms are as follows: BMNH, Natural History Museum, London; TM, Type mollusca collection, New Zealand Institute of Geological and Nuclear Sciences, Wellington; SAM T, Tate Collection, South Australian Museum, Adelaide; AM, Australian Museum, Sydney, New South Wales.

All specimens figured were coated with ammonium chloride for photography, unless stated otherwise.

Class **Gastropoda**

Cypraeidae

Palaeocypraea Schilder, 1928

Palaeocypraea Schilder, 1928: 17.

Type species. Cypraeacites spirata Schlotheim, 1820 by original designation (Danian, Denmark).

?Palaeocypraea eripnides sp. nov.

Figure 2A–D

Cypraea (*Zoila*) n. sp. Beu and Maxwell, 1990: 96, pl. 4j, k.

Type material. Holotype TM8124, paratype TM8125, P.A. Maxwell, 1977.

Type locality. CH/f471, Wave-cut platform below 'The Bluff' homestead, Pitt I., Chatham Is, New Zealand. Pitt I. 713236. Red Bluff Tuff, Late Teurian–late Waipawan, Late Paleocene–Early Eocene.

Occurrence. Type locality only (2 specimens).

Description. Shell of large size for genus, smooth, elongate, pyriform, tapering gently anteriorly. Protoconch multispiral, not distinguished from teleoconch whorls. Spire conical, projecting, covered with thin glaze.

Posterior canal short, inner lip sharp, curved towards and attached to spire. Anterior canal short. Aperture slightly sinuous; outer lip with 12–14 teeth present on anterior two-thirds to half of lip; columella with 8–11 teeth present on anterior two-thirds to half. No terminal ridge. Fossula wide and shallow.

Dimensions	L	W	H	LT	CT
Holotype TM8124	44	22	18	12	8
Paratype TM8125	51	27	27	14	11

Time range. Late Teurian–late Waipawan, Late Paleocene–Early Eocene.

Remarks. Beu and Maxwell (1990) placed this taxon in *Zoila*; however, the fossula is wide and shallow, quite different from the well developed spoon shaped fossula which in all species of *Zoila* is bounded anteriorly by a ridge. Of the Southern Hemisphere cowries, it comes closest to *Umbilia*, but possesses a conical spire and multispiral protoconch in contrast to the umbilicate spire and paucispiral protoconch of *Umbilia*. However, it may well be ancestral to it as discussed below. This species is referred to *Palaeocypraea* with considerable doubt, since the shell is very elongate when compared with other taxa referred to the genus and the fossula is relatively poorly developed, whereas in *Palaeocypraea spirata* the fossula is broad and concave with a distinct notch on the smooth inner border. Owing to the preservation of the specimens, it has not been possible to determine whether this species has fenestrate sculpture on the early whorls of the spire as in other species of the genus.

This is one of the oldest cowries known from the Southern Hemisphere and is included here as a possible ancestor of the southern Australian *Umbilia*, the earliest species of which is known from the Late Oligocene.

Umbilia Jousseaume, 1884

Umbilia Jousseaume, 1884a: 414.—Jousseaume, 1884b: 90; Schilder, 1935: 342.—Schilder, 1939: 186.—Wenz, 1941: 995.

Type species. Cypraea umbilicata Sowerby, 1825 (*non* Dillwyn, 1823 = *C. hesitata* Iredale, 1916) by monotypy. Recent, south-eastern Australia.

Diagnosis. Shell highly glazed, of medium to large size for the family, pyriform with umbilicate

spire. Anteriorly and posteriorly rostrate, the anterior rostrum generally larger and bearing 2 dorsal tubercles. Rostra supported by flanges that may be weakly or strongly developed or extend around the base of the last whorl. Aperture sinuous with weakly or strongly developed teeth. Fossula weakly developed or absent.

Remarks. The monotypic subgenus *Palliocypraea* from the Miocene is characterised by the development of a thin, wide, flat flange extending around the base. Species of *Umbilia* lacking this feature are all placed in the subgenus *Umbilia* sensu stricto.

***Umbilia* (*Umbilia*)** Jousseaume, 1884

Umbilia Jousseaume, 1884a: 414.—Jousseaume, 1884b: 90.—Schilder, 1926: 378.—Thiele, 1929: 275.—Schilder and Schilder, 1939: 145.

Cypraea (*Umbilia*).—Harris, 1897: 209.—Cossmann, 1903: 160.—Wilson, 1993: 191.

Rhynchocypraea Cossmann, 1898: 17, type species (original designation) *Cypraea* (*Luponia*) *leptorhyncha* McCoy, 1877.—Wenz, 1941: 994.

Rhynchocypraea.—Cossmann, 1903: 174, in part; not of Cossmann, 1898.

Umbilia (*Umbilia)*.—Schilder, 1935: 342.—Schilder, 1939: 186.—Wenz, 1941: 995.

Umbilia (*Rhynchocypraea*).—Schilder, 1935: 342.—Schilder, 1939: 186.

Diagnosis. Shell solid, highly glazed, of medium to large size for the family, elongate to subglobosely pyriform, generally somewhat more ventricose posteriorly. Anteriorly and posteriorly rostrate; anterior rostrum elongate to very elongate in some species, flattened ventrally, bearing 2 weakly to well developed dorsal tubercles separated by sinuous groove. Posterior rostrum deeply notched. Rostra supported by triangular extensions of base (extensions poorly developed on species with short rostra). Anterior and posterior canals incised into anterior and posterior rostra. Dorsal surface of shell generally smooth, somewhat granular on some specimens.

Spire depressed below last whorl, early teleoconch and protoconch covered with thin glaze, in most species spire whorls and protoconch visible on slightly decorticated specimens. Protoconch of 3 or 4 smooth dome-shaped whorls, tilted at about 10˚ to axis of teleoconch. Teleoconch of 3–4 whorls.

Aperture sinuous. Labial teeth well to poorly developed, on some specimens covering whole length of lip, on others fading on posterior half; columella teeth variable in expression, on one species developed into a series of prominent elongate ridges separated by deep grooves; teeth and ridges variable in number, on some species fading on posterior half of columella. Terminal ridges of aperture, variable in strength and number, from one to three. Fossula on most species weakly developed, absent on some specimens.

Time range. Janjukian (Late Oligocene) to Recent.

Distribution. Southern Western Australia (Pliocene, Recent); South Australia (Middle Miocene–Late Miocene, Recent); Victoria (Late Oligocene–Late Miocene, Recent); Tasmania (Early Miocene, Late Pliocene, Recent); New South Wales (Recent); southern Queensland (Recent).

Remarks. The well developed anterior rostrum is the most characteristic feature of this subgenus. The posterior rostrum is generally much less developed and varies between species from being greatly extended to a short stump.

Cossmann erected *Rhynchocypraea* in 1898, with type species, *Cypraea* (*Luponia*) *leptorhyncha* McCoy for Australian fossil species having rostral extensions of the aperture. In 1903, he either overlooked or ignored his previous designation and cited *C. loxorhyncha* Tate (an error for *toxorhyncha*) as type species instead. He placed *C. leptorhyncha* in his newly erected *Austrocypraea* (type species *C. contusa* McCoy). *C. toxorhyncha* is a junior synonym of *Zoila platypyga* (McCoy). Vredenberg (1927) accepted Cossmann's 1903 interpretation, unaware of Cossmann's original designation of a type species for *Rhynchocypraea* but synonymised both *Umbilia* and *Rhynchocypraea* with *Gisortia* from the *Paleogene* of Europe.

In 1930, Schilder regarded *C. leptorhyncha* as an *Umbilia*, stating that numerous identical specimens seemed to exclude their being juveniles of *U. eximia* and that the species connected the rostrate *Umbilia* with *Austrocypraea pyrulata* (Tate). In 1935, however, Schilder maintained *Rhynchocypraea* as a subgenus of *Umbilia*, stating that it was related to *Umbilia* (*Palliocypraea*) and also that it was closely related to some species of his new genus, *Notoluponia*, (presumably *pyrulata*). Schilder separated *Rhynchocypraea* from *Umbilia* by the presence of a shallow rather than deeply notched posterior outlet and by the fact that it was not rostrate. In 1939, Schilder stated that *Rhynchocypraea* was more pear shaped, more gibbous, with a more slender anterior end, wider mouth and narrower siphonal canal. These differences are quite insignificant, *leptorhyncha*

is just as anteriorly rostrate as *hesitata*, if not more so and the posterior outlet and width of aperture and canals vary in degree of development from species to species. As I can find no consistent character which can justify separation of *leptorhyncha* from *hesitata* at the generic level, I regard *Rhynchocypraea* as a synonym of *Umbilia* (*Umbilia*).

Wilson (1993) suggested that *Umbilia* (*U.*) *hesitata* fed on bryozoans. Bryozoans are a common element in the fossil assemblages of the formations in which fossil species of *Umbilia* have been found. Lorenz (1988) reported finding the remains of sponges in the stomachs of specimens of *U.* (*U.*) *capricornica* and Wilson (1998) reported divers taking *U.* (*U.*) *armeniaca* crawling on sponges. Species of *Zoila* are known to feed on sponges (Wilson and McComb, 1967). The anatomy of only one living species of *Umbilia* is known. Lorenz (1988) briefly described and illustrated the broad features of *U. capricornica*, comparing it to *Cypraeovula fuscorubra* and *Cypraea cruikshanki* from southern Africa. Judging from Lorenz's figures the anatomy of *U. capricornica* is somewhat similar to that of *Zoila friendii* described and illustrated by Wilson and McComb (1967), particularly in the presence of a bursa copulatrix in the female genital system.

The origin of the genus is not known. There is nothing quite like it known from the Southern Hemisphere, except possibly ?*Palaeocypraea eripnides* sp. nov., Late Paleocene–Early Eocene, Chatham Islands, New Zealand and an undescribed species of *Cypraeorbis* from the Late Eocene of Western Australia. The New Zealand species seems to have a multispiral protoconch, as in other species of *Palaeocypraea*, suggesting a planktonic larval stage, whereas species of *Umbilia* have paucispiral protoconchs more consistant with direct development. If *Umbilia* is descended from this or some similar taxon, there is adequate time between the Paleocene and Late Oligocene for a switch to direct development to have taken place. Other changes would involve an elongation of the anterior canal. Otherwise the overall morphology of ?*Palaeocypraea eripnides* sp. nov. is not dissimilar from that of small specimens of the Late Oligocene, *Umbilia platyrhyncha*, and from specimens of the Early Miocene, *U. angustior*. In contrast to this suggestion, the Western Australian species of *Cypraeorbis* is closer to the Late Oligocene *U. prosila* sp. nov. in overall shell shape but has a much shorter anterior canal and deeper fossula.

Umbilia* (*Umbilia*) *platyrhyncha (McCoy, 1876)

Figures 2E–F, H–K; 3A–F

Cypraea (Aricia) platyrhyncha McCoy, 1876: 40: 30, figs 2–2c.

Umbilia (Umbilia) platyrhyncha.—Schilder, 1935: 343.

Type and figured material. Holotype P12138.

Figured specimens. P59169, Richard Daintree, Geological Survey of Victoria, Jul–Aug 1861. P302697, C.W. Mallett, 15 Oct 1972. P302784, G.B. Pritchard Collection.

Type locality. Geological Survey of Victoria locality Ad24 (PL3024 Cliff section opposite Bird Rock, below Bird Rock cap, Torquay, Victoria, Torquay 642518). Jan Juc Formation, Late Oligocene, Janjukian.

Occurrence and material. Type locality only (17 specimens).

Description. Shell of medium size for genus, pyriform, maximum convexity close to posterior, tapering anteriorly and produced into broad, flattened rostrum with 2 weak dorsal tubercles present on some specimens. Transverse section of last whorl subcircular. Spire barely if at all visible, on most specimens covered with thick glaze. Protoconch of 4 smooth dome-shaped whorls, tilted at about 10° to axis of teleoconch whorls.

Posterior canal very short, twisted dorsally toward spire; margins thickened, outer margin more so and produced beyond inner margin. Anterior canal elongate, deeply incised into rostrum. Aperture only very slightly sinuous; outer lip with 15–20 teeth present on about half lip to midpoint of aperture. Columella with about 12 weak teeth, fading in strength posteriorly; slight trace of ridge extending from posterior teeth along columella to left side of posterior canal. Terminal ridge absent. Fossula broad, very gently concave, merging imperceptibly into columella margin. Dorsal surface smooth, shining.

Dimensions	L	W	H	LT	CT
Holotype P12138	95	46	38	12	15
Figured specimen P302697	79	37	33	15	8
Figured specimen P302784	86	39	33	13	12
				very faint	
Figured specimen P59169	40	32	12+	20+	87

Time range. Janjukian, Late Oligocene.

Remarks. This is the one of the two oldest known species of the genus recorded, and the rarest of the fossil species. Most specimens are slightly decorticated, slightly distorted, or broken. The

species is characterised by weakly developed teeth, an elongate shape, lack of an umbilicus, concealed spire, weakly developed dorsal tubercles and massive flat anterior rostrum and heavy posterior canal.

This species bears some resemblance to ?*Palaeocypraea eripnides* sp. nov., Pitt I., New Zealand (Fig. 2A–D), but it is much more massive, about twice the size, has a relatively longer anterior rostrum and a paucispiral rather than a multispiral protoconch. *P. eripnides* has slightly stronger developed teeth that extend almost to the end of the anterior canal. The fossulae of both are similar. *P. eripnides* has a prominent conical exert spire, whereas the spire in *Umbilia* (*U.*) *platyrhyncha* is depressed and covered with a thick callus deposit.

Umbilia* (*Umbilia*) *angustior (Pritchard, 1896)

Figures 1A; 2G; 3G–I; 4A–I

Cypraea platyrhyncha angustior Pritchard, 1896: 107: 4, figs 8, 9;

Umbilia (Umbilia) platyrhyncha angustior.—Schilder, 1935: 343.

Umbilia sp.—Burgess, 1989: 11, fig D.—Lorenz, 1989: fig. 5.

Type and figured material. Holotype P2671, E.D. Atkinson Collection.

Figured specimens. P302785, F.A. Cudmore Collection. P302688, T.A. Darragh, 15 Nov 1984. P302703, T.A. Darragh 30 Nov 1972.

Type locality. Table Cape. The matrix indicates that the holotype came from the lower bed, i.e. PL3028 Lower bed in cliff between Fossil Bluff and l.5 km NW towards Table Cape, Wynyard, Tasmania, Table Cape 930630. Freestone Cove Sandstone, Early Miocene, early Longfordian.

Occurrence and material. Freestone Cove Sandstone: PL3028 Lower bed, Table Cape (25 specimens). Fossil Bluff Sandstone: PL3029 Upper bed, Table Cape (5). Puebla Formation: PL3032 Jan Juc Beach (2). Fishing Point Marl: PL3037 Camping Reserve, Hordern Vale (2); "Picnic bed", Red Hill district, Hordern Vale (2); Fischers Point, Hordern Vale (2); Cutting on road to Hordern Vale camping reserve (1).Gellibrand Formation: PL3033 Birregurra (2).

Description. Shell of small size for genus, pyriform, maximum convexity close to posterior, tapering rapidly to anterior, produced into a rapidly narrowing rostrum bearing 2 low tubercles. Transverse section of last whorl subcircular. Spire covered with thick glaze, slight trace of umbilicus on some specimens. Posterior canal relatively short, twisted back dorsally towards spire, margins produced, thin. Anterior canal long, deeply immersed in rostrum.

Aperture somewhat sinuous, outer lip with 8–22 teeth, on most specimens fading about midpoint of aperture, inner lip with 8–20 teeth on most specimens, fading about midpoint of aperture; slight trace of ridge extending from teeth to side of posterior canal margin. Terminal ridge absent. Fossula narrow, flattened, merging imperceptibly into columella. Dorsal surface smooth.

Dimensions	L	W	H	LT	CT
Holotype P2671	68	34	27	13	16
Figured specimen P302785	71	33	26	9	13
Figured specimen P302688	67	37	32	12	24 PL3032
Figured specimen P302703	56	28	23	23	27 PL3037

Time range. Longfordian, Early Miocene.

Remarks. As pointed out by Pritchard (1896), this species differs from *Umbilia* (*U.*) *platyrhyncha* (McCoy) by its smaller size, more rapidly tapering anterior rostrum, more strongly developed dorsal tubercles and the relatively thin sides of the posterior canal. Although Pritchard considered *angustior* merely to be a variety of *U.* (*U.*) *platyrhyncha*, the material before me, though showing some variation, does not in fact overlap in morphology with the latter and therefore I accept *angustior* as a full species. It seems most likely to have evolved from *U.* (*U.*) *platyrhyncha* and to have probably given rise to *U.* (*U.*) *eximia*. Some specimens are rather tumid, approaching *U.* (*U.*) *eximia* in whorl shape (Figs 2G-H), but lacking the prominent rostra of *U.* (*U.*) *eximia*.

Umbilia* (*Umbilia*) *eximia
(G.B. Sowerby I, 1845)

Figures 1B; 5A–H; 6A–H; 7B–I; 8A–H

Cypraea eximia G.B. Sowerby I, 1845: 296, pl. 19 figs 1–3.—Tate, 1890: 209.

Cypraea (Aricia) eximia.—McCoy, 1876: 35, pls. 27–28 figs 2–2b. All figures reversed in lithographing.

Cypraea (Aricia) eximia var. *brevis* McCoy, 1876: 36.

Cypraea sphaerodoma Tate, 1890: 209.—Tate, 1892: pl. 8 fig. 5.—Harris: 1897: 211.

Cypraea (Umbilia) eximia.—Harris, 1897: 210.

Rhynchocypraea eximia.—Cossmann, 1903: pl. 6 fig. 11.

Rhynchocypraea loxorhyncha Tate.—Cossmann, 1903: pl. 8 fig. 5 (error for *toxorhyncha*) not *toxorhyncha* of Tate, 1890.

Gisortia eximia.—Vredenburg, 1927: 50, pl. 3 fig. 5 (copy of Cossmann, 1903: pl. 6 fig. 11).

Umbilia (Umbilia) eximia maccoyi Schilder, 1932: 183.—Schilder, 1935: 344.

Umbilia (Umbilia) montis-marthae Schilder, 1935: 344, fig. 29.

Umbilia (Umbilia) brevis brevis.—Schilder, 1935: 344.

Umbilia (Umbilia) brevis frankstonensis Schilder, 1935: 344.

Umbilia (Umbilia) eximia eximia.—Schilder, 1935: 345.

Umbilia sphaerodoma (Tate).—Lorenz, 1989, fig. 5.

Type and figured material. Holotype BMNH G9694, P.E. Strzelecki Collection. The specimen bears a paper label inside the shell bearing the number 215.

Syntypes of *Cypraea (Aricia) eximia* var. *brevis* NMV P5296, Geological Survey of Victoria, Geological Survey of Victoria locality Aw 9, 3 miles W of the mouth of the Gellibrand River; NMV P12136, Geological Survey of Victoria, between Mount Eliza and Mount Martha. The colour and preservation of P12136 suggests that the specimen probably came from the Fyansford Formation at Fossil Beach, Balcombe Bay. This specimen is chosen as lectotype of *brevis*.

Holotype of *Umbilia (U.) brevis frankstonensis* BMNH G40069, E.O Teale Collection presented Jan 1926. This specimen is labelled 'Grices Creek, Frankston, Mornington' on a printed label. Another handwritten label bears the locality 'Mornington'. The light colour of the specimen and matrix (Fyansford Formation) suggest that Grices Creek is correct.

Holotype of *U. (U.) brevis montismarthae* BMNH 70406, purchased Bryce M. Wright, 90 Great Russell St., London. This specimen bears a printed dealer's label with the handwritten number 17 and locality 'Mount Martha, Victoria'. This specimen is abraded and has fragments of hard dried clay inside the aperture. It is typical in matrix, colour and condition of those specimens washed out from the clay (Fyansford Formation) and picked up on the surface at Fossil Beach, S of Mornington.

Syntypes of *Umbilia (U.) eximia maccoyi* NMV P12135 (McCoy, 1876, figs 2, 2b), P16171 (McCoy, 1876, fig. 2a) Geological Survey of Victoria, between Mount Eliza and Mount Martha. The original labels with these specimens are missing. The original drawings for McCoy's plate were undertaken by Arthur Bartholomew in Jun and Jul 1861, which indicates that the specimens were collected before then and so almost certainly by Alfred Selwyn during his survey of the Mornington Peninsula in 1854. The complete specimen, P12135, is chosen as lectotype of *Umbilia (U.) eximia maccoyi*. The colour of the matrix, light grey, and the light colour of the shells suggest that they were collected from outcrops of the Fyansford Formation at Grices Creek or nearby Manyung Rocks.

Lectotype of *Cypraea sphaerodoma* Tate SAM T821, R. Tate Collection, 'Eocene, River Murray Cliffs, near Morgan' i.e., PL 3084 Small gully 4.8 km S of Morgan Ferry–Cadell road on left bank of Murray River opposite Brenda Park Homestead, South Australia. Morgan 790280. Morgan Limestone, Cadell Marl Lens, Middle Miocene, Balcombian. This is the original of Tate, 1892, pl 8 fig. 5, which is chosen as lectotype.

Figured specimens. P302779, F.A. Cudmore Collection. P302712, E.D. Gill, 27 Apr 1956. P302716, presented H.J. Hauschildt, 30 Jul 1906. P302782, T.A. Darragh, 4 May 1996.

Type locality. The holotype described by Sowerby was obtained by P.E. Strezelecki during his visit to Australia in 1839–1843. According to the original description given in Strezelecki (1845), the holotype was 'Found in a muddy sand, in sinking a well to 140 feet in depth, at Franklin's Village, Van Diemen's Land, about 15 miles from the sea'. There are two Franklin's Villages in Tasmania. The better known of the two is now an outer suburb of Launceston on the Hobart Road about 5 km south of the centre of the city and thus nowhere near '15 miles from the sea'. It is situated in the Tamar Graben which is filled with non-marine sediments. The possibility that the specimen could have come from here is considered to be so remote as to be virtually impossible. The other place bearing this name is on the coast at the west end of Cape Barren I. in the Furneaux Group, Bass Strait. At this locality, which I visited in February 1969, there is a thin sequence of Tertiary bryozoal calcarenite sitting on granite within a kilometre of the sea. Again it is most unlikely that the specimen could have come from here, though Strzelecki is known to have visited the Furneaux Group. This species has never been recorded from Tasmania, only from South Australia and Victoria. Strzelecki (1845) does not mention this fossil in his book at all, whereas virtually all the other fossils described by Lonsdale, Morris and Sowerby are mentioned either in Strzelecki's discussion of the geology of the country or under fossil fauna, in some cases in both places. The two species of land snail, *Bulimus gunni* and *Helix tasmaniensis*, illustrated on the same plate as *Cypraea eximia* are mentioned by Strzelecki twice, but neither *C. eximia* nor *Terebratula compta*, a brachiopod from Port Fairy, Victoria, also figured on the plate, are mentioned at all. Strzelecki does not even record the genus *Cypraea* anywhere in the book, though he mentions other genera of gastropods as occurring in the Tertiary of Tasmania. This suggests that there is an error in the locality.

There is some matrix still adhering to the specimen and also present inside the shell. The specimen is light in colour with traces of yellow grey silt adhering to it. Inside the shell were some polished shell fragments as well as pieces of the grey silt. Of the Victorian occurrences of the species, the area which contains sediments which best matches the matrix is Geelong. The Fyansford Formation in the Geelong district, for example at Red Hill, Shelford, is slightly weathered to a yellow grey colour and has similar texture to that in and on the type specimen. It is also pertinent to note that some specimens from the Fyansford Formation around Geelong seem to have the posterior canal twisted to the right almost as in the holotype, a feature not so common in specimens from other areas.

Strzelecki was in Melbourne and could have received the specimen there or even in Tasmania, because many

of the Port Phillip settlers came from Tasmania and travelled back and forth. Sowerby described *Terebratula compta* from Port Fairy, Victoria, following his description of *Cypraea eximia* which shows that Strzelecki did have access to Victorian specimens, even though he did not travel to Geelong or Port Fairy.

The weight of the evidence, though circumstantial, seems to indicate that the true type locality was in Victoria, probably some source within the Fyansford Formation in the Port Phillip Embayment of the Otway Basin.

Occurrence and material. Batesfordian. Fishing Point Marl: Fishing (= Fischers) Point, Hordern Vale (1 fragment). Gellibrand Formation: PL3043 Kennedy Creek cutting (2 specimens). Wuk Wuk Marl: PL3054 Skinners (1 fragmentary specimen).

Balcombian. Muddy Creek Formation: PL3082 Clifton Bank (27 specimens); Muddy Creek, Hamilton (24); Miocene, Hamilton (2); Grange Burn Gorge 3. Fyansford Formation: PL3069 Red Hill, Shelford (5); PL3071W of Glen Leigh (1); PL3072 Fyansford (5); PL3077 Altona Bay Coalhaft (4 and 3 fragments); PL3074 Dingleyhaft (2 and 3 fragments; PL3078 Fossil Beach, Balcombe Bay (35); PL3079 lower beds, Grices Creek (5); Old Quarries, Batesford (2); Overburden, Batesford Limestone Quarry (5); Native Hut Creek (upper) (1); Mornington (6); south-eastern trunk sewer spoil dump, Carrum (2); Braeside Tunnel spoil (1); Shelford (3). Cadell Marl: River Murray cliffs, 4 miles south of Morgan (1 and 2 fragments). Morgan Limestone: Broken Cliffs opposite Waikerie, River Murray, South Australia (selenite replacement, AM P29732).

Bairnsdalian. Gellibrand Formation: PL3087 Lake Bullenmerri (3 and 3 fragments); Lake Gnotuk (1); PL3088 east of Glenample Steps (2); Cowleys Creek (1); Between Gibsons Beach and Point Ronald (10). Rutledges Creek Member of Port Campbell Limestone: PL3093 Rutledges Beach (1). Fyansford Formation: PL3098 Native Hut Creek (3 fragmentary); PL3100 Murgheboluc 4A (7); PL3102 Warrambine Creek (2); PL3103 downstream Grices Creek (1); PL3104 Manyung Rocks (15); Grices Creek (36); Leigh River at Shelford (1); Inverleigh (1 and 1 fragment); Mount Eliza (1); Mouth of Grices Creek (1). Bookpurnong Beds: PL3298 Wookool (3 and 2 fragments).

Description. Shell globosely pyriform, with maximum convexity about two-thirds length of shell from anterior end; tapering rapidly anteriorly to form long narrow, rounded anterior rostrum; rostrum supported by 2 strong lateral elongate subtriangular extensions of base and bearing 2 prominent dorsal tubercles. Transverse section of last whorl subcircular. Spire covered with thin glaze, all whorls visible.

Posterior canal long to short, posterior end slightly reflexed dorsally, twisted to left or right, on most specimens to left; canal supported by short flattened triangular extensions of base. Anterior canal elongate, embraced by rostrum. Aperture sinuous, outer lip with 23–40 teeth, on most specimens present along entire length, on some specimens fading at posterior third; columella bearing 23–37 prominent teeth, extending along length of aperture, on some specimens very short, on most, extended into long ridges across base away from aperture, sometimes bifurcating; teeth encroaching on fossula on many specimens. Fossula very narrow if at all present.

Dorsal surface on most specimens smooth, shining, showing traces of mantle edges running as shallow sulcus from end of posterior canal across left side of spire umbilicus across dorsum between dorsal tubercles and onto anterior rostrum; some specimens with very shallow depressions over shell.

Dimensions	L	W	H	LT	CT
Holotype BMNH G9694	82	40	31	34	34
BMNH G40069	99	51	43	31	23
BMNH 70406	70	43	36	32	29
P5296	77	42	34	37	25
P12136	82	43	36	29	23
SAM T821	84	49	39	29	25
P12135	103	51	42	38	25
P16171	99	47	39	34	30
Figured specimen P302779	87	43	34	23	24 PL3079
Figured specimen P302712	69	37	31	30	25 PL3087
Figured specimen P302716	76	49	32	crushed, Rose Hill	
Figured specimen P302682	89	44	33	26	20 PL3298

Time range. Batesfordian–Bairnsdalian, Early Miocene–Middle Miocene.

Remarks. This species was the first Tertiary mollusc to be described from Australia. It is the most common species of the larger cowries and one of the most highly variable in morphology. The variation is random through time and across the geographic distribution of the species. This variability was not taken into account either by Tate, or Schilder in particular, when erecting new taxa, so that it probably has more synonyms than any other Australian Tertiary mollusc. McCoy remarked how variable the species was in the degree of development of the anterior canal and erected a variety *brevis* based on two small specimens with particularly short canals but without illustrating them. This name was elevated to the status of species by Schilder (1935), who did not see the specimens. There is every variation in size

of specimens and degree of development of the canals in the one population from Grices Creek and from other localities, e.g., Muddy Creek, consequently *brevis* is not recognised here as a valid taxon.

Tate distinguished his species C*ypraea sphaerodoma* from *C. eximia* by its globose body whorl, the abrupt sinistral curvature of the posterior half of the aperture, and the strong torsion of the posterior canal. Specimens of similar shape can be found intergrading with other forms in populations from Fossil Beach (Fyansford Formation) and Muddy Creek (Muddy Creek Formation), so that this name may be regarded as a synonym of *Umbilia eximia*.

The holotype of *U. eximia*, which matches most other specimens in its general morphology, has the distal end of the posterior canal twisted prominently to the left when viewed from the dorsal side, whereas most other specimens have a posterior canal which is straight or has the distal end twisted slightly to the right. However, there are all variations between the condition shown by the holotype and that shown by the specimens figured by McCoy (1876), in which the canal is bent slightly to the right in dorsal view. This feature was used by Schilder (1932) to differentiate between *U.* (*U.*) *eximia* and his new species, *U.* (*U.*) *eximia maccoyi* (based on McCoy's figured specimens), but given the variability in populations, the distinction cannot be sustained and *maccoyi* is also placed in synonymy with *U.* (*U.*) *eximia*.

Other features used by Schilder in differentiating his other new taxa, *U.* (*U.*) *brevis frankstonensis* and *U.* (*U.*) *brevis montismarthae*, are also variable. The columellar teeth, which are produced into prominent ridges extending across the base in the holotype and most other specimens, can be considerably reduced to ridges extending across half the base or merely to the edge of the columella. These ridges commonly extend onto the fossula, such as it is; that is, they commonly extend well into the aperture. The dorsal tubercles are strongly developed in most specimens, but can be quite weak in others from the same population. The holotype of *U.* (*U.*) *brevis montismarthae* is water-worn, with extremities that are broken and not 'extremely short' as maintained by Schilder. The sulcus connecting the spire and dorsal side of the posterior canal, cited as a differentiating feature of *montismarthae*, is present to a greater or lesser extent on all specimens examined, including the lectotype of *U.* (*U.*) *brevis brevis*. The dorsal tubercles present on the holotype of *U.* (*U.*) *brevis frankstonensis* are no weaker than those found on other specimens with prominent ridgelike teeth from the same locality. There are all degrees of variation in specimens from Grices Creek. For these reasons, both Schilder's names are also placed in synonymy with *Umbilia eximia*.

Only two undoubted specimens of *U.* (*U.*) *eximia* are known from the Gippsland Basin, though internal moulds probably of this species are common in the Bairnsdale Limestone. The two specimens come from PL3054, Skinners, on the Mitchell River (Batesfordian) and Rose Hill (no other locality data), near Bairnsdale. The Rose Hill specimen (Fig. 7F–G) does not have matrix typical of the Tambo River Formation at that locality and may have come from the top of the underlying Bairnsdale Limestone. Specimens of *U.* (*U.*) *hesitata* occur in the Tambo River Formation at Rose Hill, so if the Rose Hill specimen of *U.* (*U.*) *eximia* does come from there, it would make an ancestor/descendent relationship between these two species unlikely. Both *U.* (*U.*) *hesitata* and *U.* (*U.*) *eximia* also occurr in the Bookpurnong Beds at Loxton, though as yet not recorded from the same localities within the formation.

Umbilia* (*Umbilia*) *hesitata (Iredale, 1916)

Figures 7A; 9A–H; 10A–I; 11A–H; 12A, C, F–H; 13D–E; 14A–C; 19C

Cypraea umbilicata Sowerby, 1825, appendix: xxx, pl. non Dilwyn, 1823.—Beddome, 1898: 564 (with discussion on early literature).—Verco, 1912: 211 (with synonymy).

? *Cypraea amygdalina* Tate, 1890: 209.—Tate, 1892, pl. 6, fig. 8, non Grateloup, 1847.

? *Cypraea tatei* Cossmann, 1903: 160, pl. 7 figs 4, 6, nomen novum for *Cypraea amygdalina* Tate, 1890.

Cypraea hesitata Iredale, 1916: 93, nomen novum for *Cypraea umbilicata* Sowerby, 1825.

Umbilia hesitata beddomei Schilder, 1930: 77.

Umbilia hesitata howelli Iredale, 1931: 220–224, figs 1–2.

Umbilia cera Cotton, 1947: 667, pl. 21, figs 1–3.—Ludbrook, 1958: 45.

Cypraea tatei Cossmann.—Ludbrook, 1973, pl. 27 figs 87–88.

Cypraea (Umbilia) hesitata.—Wilson, 1993: 192, pl. 30 figs 7, 9–11.

Type and figured material. Lectotype BMNH 1950.8.28.22, Broderip Collection (Sowerby's figured specimen chosen as lectotype here).

Holotype of *U. cera* Cotton, SAM P8339, donated H.S. Pratt, 1925.

Syntypes of *Cypraea amygdalina* Tate (= *tatei*

Cossmann), SAM T812A, B, Ralph Tate Collection. T812A Tate's figured specimen chosen as lectotype here. Matrix associated with the two specimens is a carbonate rich glauconitic sand. The type locality cited was a well sinking in the Murray Desert. Tate had material from wells at Tareena in southwestern New South Wales and Mindarie in South Australia and it is not known from which place the type specimens came, since Tate (1899: 104) recorded his species from both. Whatever the origin, the shells seem to have come from the Bookpurnong Beds.

Holotype of *Umbilia hesitata beddomei* Schilder, 1930, Schilder collection no. 821, Zoologisches Institut, Humboldt Museum, Berlin (locality unkown), purchased Fulton.

Holotype of *Umbilia hesitata howelli* Iredale, 1931, AM C57762.

Figured specimens. P302717– P302718, John Dennant Collection. Figured specimen P302720, G.B. Pritchard Collection. P302780, collected and presented J.M. Warren. P302770, T.A. Darragh, D.M. Shanks and H.E. Wilkinson, 8 Feb 1969. P302781, T.A. Darragh, D.M. Shanks and H.E. Wilkinson, 11 Feb 1969. F4526, J.H. Macpherson, 6-11 Jun 1948. F23166, presented T.A. Garrard. Figured specimens WAM 89.636a–b, G.W. Kendrick, 27–30 Oct 1988. Geological Survey of South Australia M1335, M.J. Paul (figured Ludbrook, 1973).

Occurrence and material. Bairnsdalian. ? Dry Creek Sands: Abattoirs Bore (fragmentary specimens). Bookpurnong Beds: 1.5–3 m below bed of River Murray, Loxton, South Australia.

Mitchellian. Tambo River Formation: Rose Hill Farm near Bairnsdale (2 specimens).

Cheltenhamian. Black Rock Sandstone: Beaumaris (3). Jemmys Point Formation: PL3115 Lake Bunga Crossing (2 fragmentary specimens); PL3123 Ferndale Parade (2 fragmentary specimens).

Pliocene. Jemmys Point Formation: PL3275 Gosnells Point (1 specimen). Cameron Inlet Formation: PL1250 (2), PL1258 (3), PL1261 (1), PL1264 (17), PL1265 (2), PL1287 (2), PL1296 (1). West end of North Memana Drain, Memana, Flinders I. (3); Flinders I. (1); South side of Nelson Lagoon Drain, Flinders I. 018588 (1); Land Settlement Division Drain, Flinders I. (3). Roe Calcarenite: PL3166 2.5 km N Hampton Tower (4), PL3165 16 km S of Madura (1), Pl3167 1.5 km N Hampton Tower (1), PL3172 Hampton Tower (2).

Records of living species are from north-east of Cape Morton, Queensland to Robe, South Australia, including northern and western Tasmania as far south as Port Davey, 70–400 m. Pliocene records from the Roe Calcarenite lie outside of the recorded modern distribution.

Description. Shell of small to average size for genus, highly glazed, subpyriform, tapering gently anteriorly and produced into short rounded rostrum bearing traces of 2 dorsal tubercles, slightly rostrate posteriorly. Spire umbilicate, covered with glaze, about 5 whorls visible.

Posterior canal very short, margins thickened, twisted to left in ventral view. Anterior canal short, embraced by rostrum, supported by very weak lateral flanges. Aperture sinuous, outer lip with 30–40 teeth; inner lip with 28–37 teeth which become slightly weaker on posterior half of columella. Fossula very narrow, very slightly depressed. On some specimens slight trace of sulcus running from left side of posterior canal across dorsum onto anterior rostrum between tubercles.

Colour white with irregular sized brown spots over dorsum and large brown patches on anterior rostrum and on most specimens on either side of posterior canal; ventral surface white. Some specimens almost entirely white.

Time range. Bairnsdalian?, Mitchellian-Recent, Middle Miocene?, Late Miocene–Recent.

Remarks. This species may be descended from *Umbilia* (*U.*) *eximia* but, as noted above, there could be an overlap in the time ranges of the two species in the Middle to Late Miocene. *U.* (*U.*)

Dimensions	L	W	H	LT	CT	
Lectotype BMNH 1950.8.28.22	96	58	–	33	31	
Figured specimen P302781	88	51	42	31	27	
Figured specimen P302780	85	45	35	32	31	
Figured specimen P302770	62	38	30	28	28	off Botany Bay
Figured specimen F4526	103	58	48	34	35	
Figured specimen F23116	65	41	41	29	25	*beddomei* form
AM C57762	111	64	53	38	31	holotype of *U. howelli* Iredale.
SAM P8339	55	36	29	26	22	holotype of *U. cera* Cotton
Figured specimen SAM T812A	56	37	29	22	29	lectotype of *Cypraea tatei* Cossmann.
Figured specimen P302717	86	49	40	–	30	
Figured specimen P302718	55	36	26	24	22	
Figured specimen P302720	62	36	29	29	23	
Figured specimen WAM 89.636a	83	50	40	33	30	
Figured specimen WAM 89.636b	87	53	42	36	30	

hesitata differs from *U.* (*U.*) *eximia* in having less prominent columellar teeth and a less prominent anterior rostrum and posterior canal. The dorsal tubercles on the anterior rostrum are also weakly developed and the lateral flanges supporting the rostrum are obsolete in *U. hesitata*. The differences between *U. hesitata* and the other southern Australian living species, *U. armeniaca*, are not great. *U. hesitata* tends to be slightly less tumid than *U. armeniaca* and has a slightly longer anterior rostrum. On our present knowledge of the distributions of both taxa, there is a considerable gap between the range extremities of both species.

The type specimens of both *Cypraea tatei* Cossmann (probably Bookpurnong Beds at Tareena or Mindarie) and *Umbilia cera* Cotton (Dry Creek Sands) are both small and fragmentary. They seem to be similar if not identical to small specimens of *U. hesitata*, but until a range of material from the Bookpurnong Beds and Dry Creek Sands is available, it is not possible to be certain of the identity of *Cypraea tatei* in particular, since the apertures on the specimens look immature. For this reason I have included the name with a query in the synonymy above, at the same time preserving the stability of the name of the well known common living species, *Umbilia hesitata*. Since both *tatei* and *cera* seem to come from Middle Miocene strata, there is also a possibility that they are small specimens of *U. eximia*. This seems unlikely, but the anterior rostra on all specimens are broken, so there is doubt about their identity.

Late Miocene and Early Pliocene specimens of *U. hesitata* are not common and most are fragmentary or poorly preserved; however, there is sufficient well preserved material available to be confident of the identification.

Umbilia hesitata beddomei was based on a small form, with somewhat brighter coloured dorsum, base with less callus and whiter. The holotype is from an unknown locality (Dr Matthias Glaubrecht pers. comm. January 2000), but Schilder cited Port Stephens, New South Wales as a locality based on Beddome's (1898) description and figure of a similar specimen. Such small specimens (Figs 12A, C) are found throughout the geographic range of the species as well as in the fossil record (Figs 9G–H, 10A–C) and intergrade with larger specimens from the same locality. For these reasons *Umbilia hesitata beddomei* is regarded as a synonym of *hesitata* and cannot be accepted as a geographic subspecies.

Umbilia hesitata howelli was erected by Iredale (1931) as a new subspecies ((type locality 164–274 m, off Cape Everard (Point Hicks), Bass Strait, Victoria) for a large, pure white variety previously called variety *alba* Cox, 1879 (non Blainville, 1826, nec Sowerby, 1832). Apart from its colour, it cannot be distinguished from other specimens of *hesitata* and is regarded as a mere colour form and therefore synonymised.

Umbilia* (*Umbilia*) *prosila sp. nov.

Figures 15A–C, E, H

Type material. Holotype P308716, Paratype P308717, F.A. Cudmore collection.

Type locality. Ledge, Bird Rock Cliffs, Torquay, Victoria. Jan Juc Formation, Janjukian, Late Oligocene.

Occurrence and material. Jan Juc Formation. Ledge, Bird Rock, Torquay (9 specimens); Spring Creek, Torquay (8); Bird Rock cliffs, Torquay (2); below Bird Rock cap between Fishermans Steps and Bird Rock, Torquay (1); Geological Survey of Victoria locality Ad24, Bird Rock (1) and Ad23, Bird Rock (1).

Description. Shell very small for genus, delicate, highly glazed, umbilicate posteriorly, very globose with short, very narrow anterior rostrum; rostrum supported by very weak extensions of base. Spire depressed, covered with thin callus, of 3 teleoconch whorls. Protoconch 3.5 smooth whorls, axis tilted slightly from axis of shell.

Posterior canal very short, strongly bent to left, bounded on columellar side by prominent blunt ridge. Anterior canal short, deeply sunk into rostrum. Aperture virtually crescent shaped, narrowest medially; outer lip with 20–26 relatively thick, elongate teeth, extending along entire lip; inner lip with 16–22 well developed, short teeth, extending along entire lip, almost nodulate on anterior half, more elongate posteriorly. Fossula wide, flat to slightly concave, slightly notched anteriorly on interior side and bounded anteriorly by weak ridge.

Dimensions	L	W	H	LT	CT
Holotype P308716	39	27	21	26	20
Paratype P308717	39	30	24	24	24

Time range. Janjukian, Late Oligocene.

Remarks. Specimens of this species are not common. This is the smallest species of the genus and seems to be ancestral to *Umbilia* (*U.*) *leptorhyncha* (McCoy). It differs from *U.* (*U.*) *leptorhyncha* by its smaller size, being nearly half the length, by having a relatively short anterior rostrum, and by having relatively thicker teeth. The anterior flanges supporting the rostrum present in *leptorhyncha* are scarcely developed in this species. The species shows little resemblence to the putative ancestor of

Umbilia, ?*Palaeocypraea eripnides* sp. nov., or to the other species of *Umbilia* found at the same horizon, *U.* (*U.*) *platyrhyncha*. It may have developed from an undescribed species of *Cypraeorbis* from the Late Eocene of Western Australia by weakening of the fossula and extension of the anterior canal. *Cypraeorbis* sp. has a short anterior canal and a deep concave fossula bounded on the anterior by a thick ridge and with a notch in the interior margin immediately behind the ridge.

Umbilia* (*Umbilia*) *leptorhyncha (McCoy, 1877)

Figures 16A–H

Cypraea (Luponia) leptorhyncha McCoy, 1877: 35, pl. 49 fig. 1, 1a–c.—Harris, 1897: 207.

Cypraea leptorhyncha.—Tate, 1890: 208.

Gisortia leptorhyncha.—Vredenburg, 1927: 42.

Umbilia (Rhynchocypraea) leptorhyncha.—Schilder, 1935: 343, fig. 27.

Rhynchocypraea leptorhyncha.—Lorenz, 1989: 7, fig.

Type material. Lectotype P12133, McCoy's figured specimen chosen herein. Paralectotypes P308726–P308729. Origin unknown (possibly J. Kershaw, 1875).

Type locality. "Near foot of Mount Eliza and Mount Martha, Mornington". The paralectotypes are labelled near Mount Martha. The matrix on the lectotype indicates that it was collected at Fossil Beach, i.e. PL3078 Shore platform at Fossil Beach, 3 km S of Mornington, Victoria. AMG Western Port 273653. Fyansford Formation, Balcombian, Middle Miocene.

Occurrence and material. Batesfordian. Gellibrand Formation: PL3043 Kennedys Creek cutting (2 specimens); Fyansford Formation: Curlewis (2).

Balcombian. Fyansford Formation: PL3078 Fossil Beach (16 specimens); Balcombe Bay (29); near Mount Martha (4); Mornington (6); Schnapper Point (2); PL3069 Red Hill (1); PL3072 Orphanage Hill (1); PL3077 Altona Bay Coal Shaft (1); Shelford (1). Muddy Creek Formation: PL3082 Clifton Bank (25); Muddy Creek (6); Hamilton (3). Cadell Marl: Murray River cliff, 4 miles downstream from Morgan, South Australia.

Bairnsdalian. Fyansford Formation: Grices Creek (4 specimens); Lower beds, Grices Creek (2); Mount Eliza (1); PL3104 S of Manyung Rocks; PL3097 Murgheboluc 2B (2); PL3100 Murgheboluc 4A (1 and 1 fragment); Inverleigh (1 fragment); Overburden, Batesford Limestone Quarry (1).

Description. Shell of medium size for genus, thin shelled, delicate, highly glazed, umbilicate posteriorly, globosely pyriform, tapering abruptly to narrow anterior rostrum; rostrum supported by narrow triangular extensions of base. On some specimens, rostrum bearing deep oblique groove on dorsal surface formed by anterior end of dorsal line (mantle margins). Spire depressed, covered with thin callus; 5 teleoconch whorls. Protoconch of 2.5 smooth whorls with axis slightly tilted from axis of teleoconch whorls.

Posterior canal, very short, strongly bent to left, bounded on columellar side by low sharp ridge. Anterior canal short, deeply sunk into rostrum. Aperture very sinuous, narrowest medially, widest posteriorly; outer lip with 35–39 thin, well developed, well spaced teeth, extending along entire lip; inner lip with 32–34 well developed, thin, widely spaced teeth, extending along entire lip; teeth longer in middle section, with some short teeth intercalated, becoming very short posteriorly and extending onto posterior canal wall; teeth almost lamellar on some specimens. Fossula moderately developed, rather elongate, narrow, depressed, inner border slightly thickened and weakly indented. Base and portion of sides covered with very thin callus.

Dimensions	L	W	H	LT	CT
Lectotype P12133	63	40	33	39	33
Paralectotype P308726	59	39	32	33	29
Paralectotype P308728	50	34	28	35	28

Time range. Batesfordian–Bairnsdalian, Middle Miocene.

Remarks. The geographic distribution of this species is probably much wider than that given above and it is more common than the numbers would suggest, because specimens are generally so fragile that they have not survived intact at many localities. The specimens from Curlewis and Kennedys Creek have the columellar side of the posterior canal very well developed when compared to specimens from younger horizons. The apertural teeth are also not so well developed and look more like those of *U.* (*U.*) *prosila* sp. nov.

Umbilia petilirostris sp. nov.

Figures 13A–C, 15D, F–G

Umbilia capricornica Lorenz, 1989: 2, pl. 2 (part, deep water variants).

Cypraea capricornica.—Wilson, 1993: 192, pl. 30, fig. 6 (part).

Type material. Holotype F86962, paratypes F86963, F86967, presented Alan Limpus, 30 Jun 1997.

Type locality. Capricorn Channel, off Lady Musgrave I., Queensland, 264–252 m.

Occurrence. Capricorn Channel, Queensland – type locality; off Fitzroy Reef, 249 m; off One Tree I.; off Swains Reef, 188–201 m.

Description. Shell of medium to large size for genus, thin shelled, highly glazed, posteriorly umbilicate, very globose, tapering abruptly to short anterior rostrum; rostrum supported by very narrow, thin extensions of the base and bearing 2 very weakly developed tubercles, separated on some specimens by wide, shallow, oblique groove. Spire depressed, covered with thin callus; teleoconch whorls 3; protoconch of 2.5 smooth whorls, axis tilted slightly from axis of teleoconch.

Posterior canal very short, strongly bent to left, bounded on columellar side by thin high wall. Anterior canal relatively wide, deeply immersed in rostrum. Aperture sinuous; outer lip with 24–34 short, well developed teeth, extending along entire lip; inner lip with 20–32 short, well developed teeth, extending along entire lip and on some specimens extending onto posterior canal wall; teeth more elongated posteriorly and almost nodulate anteriorly above fossula. Fossula relatively long and wide, concave with weak depression on inner border.

Dorsum grey brown with brown spots particularly near base. Base white with dark brown patch on columellar side.

Dimensions.	L	W	H	LT	CT	
Holotype F86962	76	49	40	34	32	
Paratype F86963	67	47	38	28	28	off Fitzroy Reef
Paratype F86967	53	34	28	29	24	off Swains Reef

Remarks. This species has been confused with *Umbilia* (*U.*) *capricornica* Lorenz, but differs by its more globose shape, more weakly developed posterior rostrum, and by having the columellar side of the posterior rostrum developed as a thin wall. It seems to be the living descendent of *U.* (*U.*) *leptorhyncha* from which it differs by its much larger size, the presence of a seemingly relatively larger fossula, and by having the posterior canal as a prominent thin wall on the columellar side, whereas *U.* (*U.*) *leptorhyncha* has a low ridge. The two species are very similar in shape though perhaps U. (*U.*) *petilirostris* is even more globose and with shorter labial teeth than *U.* (*U.*) *leptorhyncha*.

Umbilia* (*Umbilia*) *siphonata Chapman, 1922

Figures 17A–E; 18A–F; 19A–B

Cypraea sphaerodoma var. ? Tate, 1890: 210.
Cypraea siphonata Chapman, 1922: 12, pl. 3 fig. 16.
Gisortia breviplicata Schilder 1926: 361, 373.
Umbilia (Palliocypraea) breviplicata Schilder, 1935: 345, fig. 30.
Umbilia sp.— Burgess, 1989: 11, fig. C.—Lorenz, 1989: fig. 5.

Type and figured material. Holotype P13243, F.A. Cudmore, presented 8 Oct 1920.

Holotype of *Gisortia breviplicata* P26904, John Dennant Collection. There are two specimens in the Dennant Collection from Muddy Creek labelled *Cypraea sphaerodoma*. One is near complete (P302803), but lacks the anterior canal and so could not be that referred to by Tate. It is also too small. The other specimen was found in fragments. This shell is very fragile, the dorsum having had been subjected to boring organisms (a common feature on many specimens of larger cowries) and at some stage it had been broken. This specimen was repaired to enable measurements to be taken, and on repair it was found that Tate's measurements fitted it.

Figured specimens. P12569, purchased R.H. Annear, 23 Jan 1912. P302803, John Dennant Collection. P14835, Noel J. Shaw, 13 Mar 1950.

Type locality. 'Below Overland Corner (left bank), and second cliff showing strata, below Waikerie, Murray River, South Australia. From upper part of the cliff below the Kalimnan beds'.

Occurrence and material. Balcombian. Muddy Creek Formation: PL3082 Clifton Bank (1 specimen); Muddy Creek (6 and 11 fragments). Fyansford Formation: PL3069 Red Hill, Shelford (1 and 2 fragments); Orphanage Hill, Fyansford (1 fragmentary specimen). PL3074 Heatherton test shaft. Morgan Limestone: Broken Cliffs opposite Waikerie, River Murray cliffs, South Australia (selenite replacement, 1 fragmentary specimen, SAM P35237).

Bairnsdalian. Bairnsdale Limestone: 1 mile from Bairnsdale (1 natural internal mould)?; Nicholson River (1 specimen with remains of shell). Fyansford Formation: PL3097 Murgheboluc 2B (2 specimens); PL3098 Native Hut Creek, S of Hamilton Highway (1 fragment); PL3102 Warrenbine Creek (1); PL3104 Manyung Rocks (1 and 1 fragment); Grices Creek (2). Gellibrand Formation: PL3087 Lake Bullen Merri (1 and several fragments). Bookpurnong Beds: PL3133 Wookool Bend (1); PL3298 Wookool Homestead (1 fragment). PL6667 NW of Wookool Homestead (2 fragmentary specimens).

Description. Shell large for genus, subhemispherical, tapering rapidly anteriorly to form narrow canal; prominently rostrate posteriorly. Transverse section of last whorl oval. Spire umbilicate, covered with glaze, whorls scarcely visible. Protoconch of 3.5 smooth, dome-shaped whorls, tilted at an angle to teleoconch whorls. Teleoconch of about 3 whorls.

Posterior canal extremely elongate, reflexed dorsally on most specimens, on others straight; weak longitudinal sulcus present on left dorsal side extending from end of canal into umbilicus; base of canal supported by lateral extensions of

base; left extension triangular, prominent; right extension elongate, narrow. Anterior canal moderately short (much shorter than posterior canal), reflexed dorsally on some specimens (extremely so on 1 specimen), almost straight on others, sometimes bearing 2 very weak dorsal tubercles; dorsal surface of canal bearing long sulcus, obsolete on some specimens; base of canal supported by narrow elongate extensions of the base, right extension longer than left.

Aperture sinuous; outer lip wide, slightly concave close to inner edge of lip, convex towards periphery of base, bearing 30–34 relatively thin but prominent teeth, well separated by interspaces about twice width of teeth; teeth fading posteriorly; inner lip with 26–28 teeth slightly wider than labial teeth, very short anteriorly, longer and slightly weaker posteriorly. Fossula broad, very slightly depressed.

Base on columellar side slightly swollen in middle and concave posteriorly and anteriorly towards canals.

Dimensions	L	W	H	LT	LT
Holotype P13243	135	63	50	–	–
P26904	133	76	58	30	28
Figured specimen P12569	144	83	65	34	27
Figured specimen P302803	111	70	56	30	28
Figured specimen P14835	168	85	65	30	26

Time range. Balcombian–Bairnsdalian, Middle Miocene.

Remarks. This is the second largest species of Australian fossil cowry, exceed only by specimens of *Zoila gigas* (McCoy). The species was recorded as a questionable and unnamed variety of *Cypraea sphaerodoma* by Tate (1890), based on a specimen from Muddy Creek in the collection of John Dennant. In 1922 Chapman named *C. siphonata* based on a natural mould in limestone from the Murray River near Waikerie and compared it with *C sphaerodoma*. Chapman confused anterior and posterior canals in his description. Schilder (1926) recognised that Tate's variety was a new species and formally named it, based on Tate's description and material. Later Schilder (1935) stated that *C. siphonata* was 'allied' to *C. breviplicata*, including both species in the subgenus *Palliocypraea* on the basis of their basal extremities being much expanded. In fact, the extensions of the base on these two are no different from those of any other of the fossil species included in *Umbilia* (*Umbilia*) and for this reason, the two species are placed in this subgenus.

The holotype of *C. siphonata* has sufficient characters preserved to show that *breviplicata* is a synonym. The long posterior canal is the same as that on a specimen of *breviplicata* from Grices Creek and the whorl profile is also identical in shape. A rubber cast taken from the holotype mould shows teeth identical to those on specimens of *breviplicata* and the base has the same slight swelling in the middle of the columella side.

This species is rare in the Fyansford Formation but not uncommon in the Muddy Creek Formation. The occurrence of both this species and *Umbilia eximia* in the Bookpurnong Beds of the Murray Basin suggests that this formation is probably Bairnsdalian, that is Middle Miocene, rather than Late Miocene in age.

Of the two specimens from the Bairnsdale Limestone, one is an internal mould. It is recorded with a query but the size of the specimen and the elongated anterior canal seems to indicate that it is probably this species. The other specimen is incomplete but has significant remnants of original shell preserved, so that the identification seems certain. It has the typical oval outline of the dorsum and teeth typical of *U. siphonata*.

Umbilia* (*Umbilia*) *armeniaca Verco, 1912

Figure 12B, D–E

Cypraea umbilicata var. armeniaca Verco, 1912: 211, 213, pl. 10 figs 1–3.

Cypraea (Umbilia) armeniaca.—Wilson, 1993: 191, pl. 30 figs 12–16.

Type and figured material. Type stated to be in J.C. Verco collection. Verco presented his collection to the South Australian Museum, but the holotype cannot be located there (T. Laperousaz, Collection Manager, Marine Invertebrates, pers. comm., 12 Oct 1999).

Paratype AM C35583 (ex E3842), Verco's 'slightly older specimen'. Paratype AM 121153 (ex E3843), Verco's 'youngest example'. The holotype is not in the Australian Museum collection.

Figured specimen. F27194, C.J. Gabriel collection, presented 29 Aug 1963.

Type locality. '100 fathoms, Great Australian Bight, 60 miles from shore, 80 miles west of Eucla'.

Description. Shell solid, globular, pyriform, of large size for the genus, tapering abruptly anteriorly and produced into a very short rostrum. Spire deeply umbilicate, covered with glaze, 2 whorls visible.

Posterior canal very short, margins thickened, twisted to left. Anterior canal very short, embraced by rostrum, supported by weak lateral flanges. Aperture sinuous, outer lip with 32–40 teeth, inner lip with 26–31 teeth, which become slightly weaker posteriorly. Fossula on some specimens wide, distinctly depressed.

Colour variable; apricot, orange, cream to almost lilac blotches on white to grey ground, darker patches on anterior and posterior rostra. Ventral surface very pale, with many specimens having dark patch in centre of base.

Dimensions	L	W	H	LT	CT
Figured Specimen F27194	89	57	51	39	31

Distribution. Albany, Western Australia to Port Lincoln, South Australia, 30–200 metres.

Remarks. To date, this species has not been found as a fossil. This may be accounted for by its inhabiting deep water over most of its known range and there being no outcrops of deep water sediments of appropriate age, though specimens of *U.* (*U.*) *armeniaca* have been collected by divers in Thorny Passage near Port Lincoln and at Esperance in 30 metres (C. Goudey collection).

Umbilia* (*Umbilia*) *capricornica Lorenz, 1989

Figure 14D–H

*Umbilia capricornica L*orenz, 1989: 2–8, pl. 2 (part), figs 3–4.

Cypraea (Umbilia) capricornica.—Wilson, 1993: 192, pl. 30 figs 1–5, 8.

Type and figured material. Haus der Natur-Cismar, Germany. Holotype HNC 22453.

Figured specimens F85329, F85330, presented Alan Limpus, 30 Jun 1997.

Type locality. Swains Reef, 120–125 fm, trawled Feb 1989.

Description. Shell somewhat small for genus, pyriform, tapering relatively abruptly anteriorly to form a moderately developed rostrum bearing 2 moderately developed dorsal tubercles; somewhat rostrate posteriorly. Spire umbilicate, covered with thick glaze

Posterior canal short, margins thickened, twisted to left. Anterior canal embraced by rostrum supported by weak lateral flanges. Aperture sinuous, outer lip with 28–34 teeth; inner lip with 22–29 teeth. Fossula well developed, rather wide, concave, projecting slightly into body of shell. On some specimens slight trace of sulcus running from left side of posterior canal across dorsum on to anterior rostrum between tubercles.

Colour cream to white with irregular brown spots and patches on anterior rostrum and on either side of posterior canal; ventral surface brown to white.

Dimensions	H	W	H	LT	CT
Figured specimen F85329	82	45	39	29	29
Figured specimen F85330	60	36	29	30	22

Distribution. Swains Reefs, 165–420 m; Capricorn Channel, off Lady Musgrave I., 220 m.

Remarks. Lorenz (1989) distinguished this species from *Umbilia* (*U.*) *hesitata* by the presence of well developed tubercles on the anterior rostrum, the coarser apertural dentition and by the presence of a visible fossula margin. The general colour and colour pattern of *U.* (*U.*) *capricornica* are very similar to those of *U.* (*U.*) *hesitata*, the posterior rostrum is very similar, the anterior rostrum is more slightly produced and the dorsal tubercles are more strongly developed; however, the overall morphology of *U.* (*U.*) *capricornica*, including the apertural dentition, is not very different from that of northern specimens of *U.* (*U.*) *hesitata*. Even the fossula in some specimens of *U.* (*U.*) *hesitata* has a slight resemblance to that in *U.* (*U.*) *capricornica*. Nevertheless, there do seem to be sufficient differences between them to maintain specific separation of the two taxa.

Lorenz stated that the *U.* (*U.*) *capricornica* was more closely allied with the fossils *U.* (*U.*) *eximia* and *U.* (*Palliocypraea*) *gastroplax* than with the other living species; however, as noted above, *U.* (*U.*) *capricornica* is not greatly different from *U.* (*U.*) *hesitata*. The resemblance to *U.* (*U.*) *eximia* is not so great, but both *U.* (*U.*) *hesitata* and *U.* (*U.*) *capricornica* are probably descended from *U.* (*U.*) *eximia*.

***Umbilia* (*Palliocypraea*)** Cossmann, 1906

Rhynchocypraea (Palliocypraea) Cossmann, 1906: 239

Gisortia (Palliocypraea).—Vredenburg, 1927: 26, 60

Umbilia (Palliocypraea) Schilder, 1935: 342.—Schilder, 1939: 186.

Type species. Cypraea gastroplax McCoy, 1867 by original designation; Miocene, Victoria.

Diagnosis. Shell relatively thin, of medium size for the family, body of shell pyriform with prominent thin flat flange extending around periphery of body to give a circular outline. Rostra and siphonal canals incor-porated into flange. Other shell features similar to *Umbilia*.

Time range. Batesfordian-Balcombian, Early Miocene to Middle Miocene.

Distribution. Victoria

Remarks. The overall shell morphology of the only species assigned to the subgenus is very similar to that of *Umbilia* sensu stricto, with the exception of the prominent lateral flange encircling the body of the shell. This flange can be envisaged as an extensive development of the triangular basal extensions that support the rostra in species of *Umbilia* sensu stricto. As mentioned above, *U. siphonata*, included in this subgenus by Schilder (1935), has basal flanges similar to those of other species of *Umbila* (*Umbilia*), and is placed in the latter subgenus.

Umbilia* (*Palliocypraea*) *gastroplax
(McCoy, 1867)

Figures 19D–E; 20A–D; 21A–D

Cypraea gastroplax McCoy, 1867a: 18.—McCoy, 1867b: 194.

Cypraea (Aricia) gastroplax McCoy, 1875: 20, pl. 16 figs 1–1a, pls 17–18 figs 2–2a. Figures reversed in lithography.

Rhynchocypraea (Palliocypraea) gastroplax.—Cossmann, 1906: 239, pl. 9 figs 10–11.

Palliocypraea gastroplax.—Chapman, 1929: 202–205, pls 19–20.—Lorenz, 1989: fig. 5.

Umbilia (Palliocypraea) gastroplax.—Schilder, 1935: 342, 345.

Type and figured material. Holotype P12140. The original drawings for McCoy's plate are dated Jul 1861 which proves that the specimens were collected before then and so almost certainly by Alfred Selwyn, Geological Survey of Victoria, during his survey of the Mornington Peninsula in 1854. The specimen was originally registered under number 8060 (registered in 1861) under the old registration system, but the entry has no further information beyond the locality 'Mt. Eliza to Mount Martha'.

Figured specimens. P13373, presented by Walter Greed 3 Mar 1924. P24869, G.B. Pritchard Collection. P302852, T.A. Darragh 23 Oct 1971. P302854, Nielson Collection, presented Mrs W.A. Nielson, 1 May 1985.

Type locality. 'Tertiary limestone of the tract between Mount Eliza and Mount Martha'. The preservation of the holotype in a block of septarian limestone indicates that it came from PL3078 Fossil Beach.

Occurrence and material. Batesfordian. Gellibrand Formation: PL3048 Boornong Rd cutting (2 fragments).

Balcombian. Muddy Creek Formation: PL3082 Clifton Bank (2 specimens and 2 fragments). Fyansford Formation: PL3077 Altona Bay Coal Shaft (1 fragment); PL3078 Fossil Beach (4 specimens and 2 fragments); Overburden, Batesford Limestone Quarry (1 specimen and 2 fragmentary specimens).

Description. Shell of average size for genus; last whorl pyriform, tapering gently anteriorly with prominent wide flange extending around periphery of whorl; flange width about half width of last whorl, flange thickness about 1 mm. Transverse section of last whorl subtriangular. Spire umbilicate; spire whorls scarcely visible, covered with glaze.

Posterior canal incorporated into shell flange, slightly reflexed dorsally, subcylindrical, almost tubelike anteriorly, almost closed on some specimens, closed on others; weak longitudinal sulcus present on left dorsal side of posterior canal and extending from middle of canal into umbilicus and across dorsum to posterior canal on some specimens. Anterior canal subcylindrical incorporated into shell flange; dorsal surface of canal bearing very weak sulcus. Aperture narrow, sinuous; with 30–39 labial teeth; teeth prominent, thin, short, tooth interspaces about twice width of teeth; inner lip with 24–30 short thin teeth about half width of interspaces; teeth set on narrow rounded ridge running from anterior canal to posterior canal. Fossula elongate, narrow, slightly depressed. Ventral surface on both sides of aperture uniformly convex.

Dimensions	L	W	H	LT	CT
Holotype P12140	96	52	38	–	–
Figured specimen P24869	102	55	41	39	30
Figured specimen P13373	97	52	37	30	36+
Figured specimen P302852	88	41	33	30	24
Figured specimen P302854	121	51	39	30	28

Time range. Batesfordian–Balcombian, Early Miocene–Middle Miocene.

Remarks. Chapman (1929) suggested that the flange was an adaptation to enable the animal to creep over 'an even-surfaced oozy sea-bed'. The specimens from PL3048, Boornong Rd. cutting, consist of fragments of the flange. It is assumed that they belong to this species, though the locality is of Batesfordian age, whereas all the other specimens have been recorded only from localities of Balcombian age.

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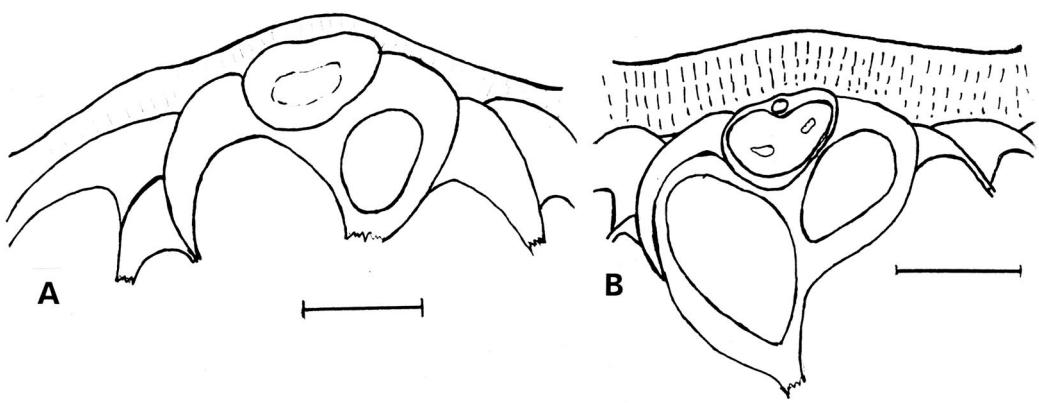

Figure 1. Sections through protoconchs. Bar scale 1 mm. A, *Umbilia (U.) angustior* (Pritchard), P304357, Picnic bed, Hordern Vale. B, *Umbilia (U.) eximia* (Sowerby), P304355, PL3078, Fossil Beach.

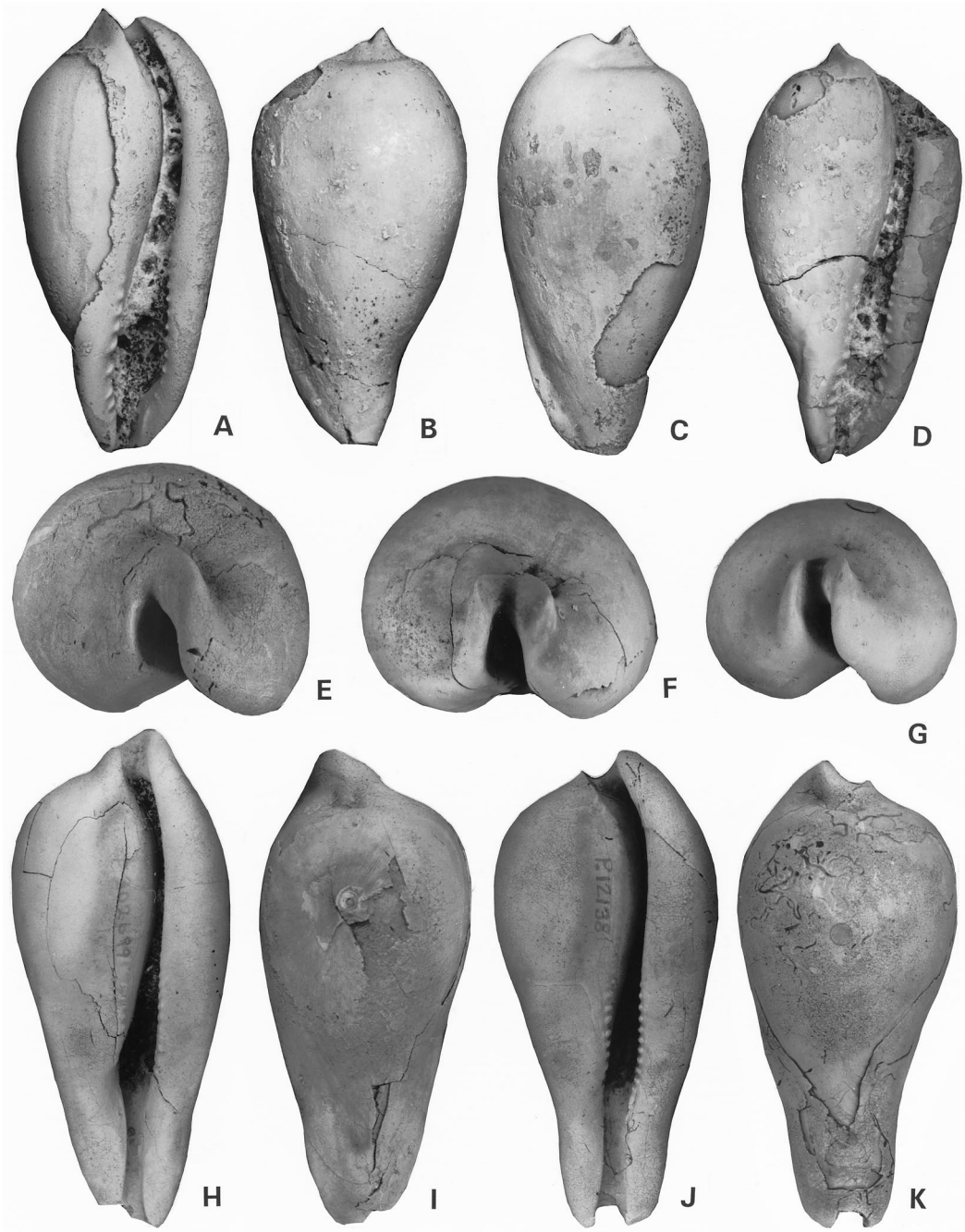

Figure 2. A–D, ?P*alaeocypraea eripnides* sp. nov. A, C, NZGNS TM 8124, holotype, Pitt I., New Zealand, x 1.5. B, D, NZGNS TM 8125, paratype, Pitt I., New Zealand, x 1.2. E–F, H–K, *Umbilia (U.) platyrhyncha* (McCoy). E, P12138, holotype, Ad 22, Bird Rock cliffs, x 1.0. F, P59169, Ad 22, Bird Rock cliffs, x 1.1. H–I, P302784, Bird Rock cliffs, x 0.9, x 0.8. J–K, P12138, holotype, Ad 22, Bird Rock cliffs, x 0.7. G, *Umbilia (U.) angustior* (Pritchard), P2671, holotype, Table Cape, Tasmania, x 1.1.

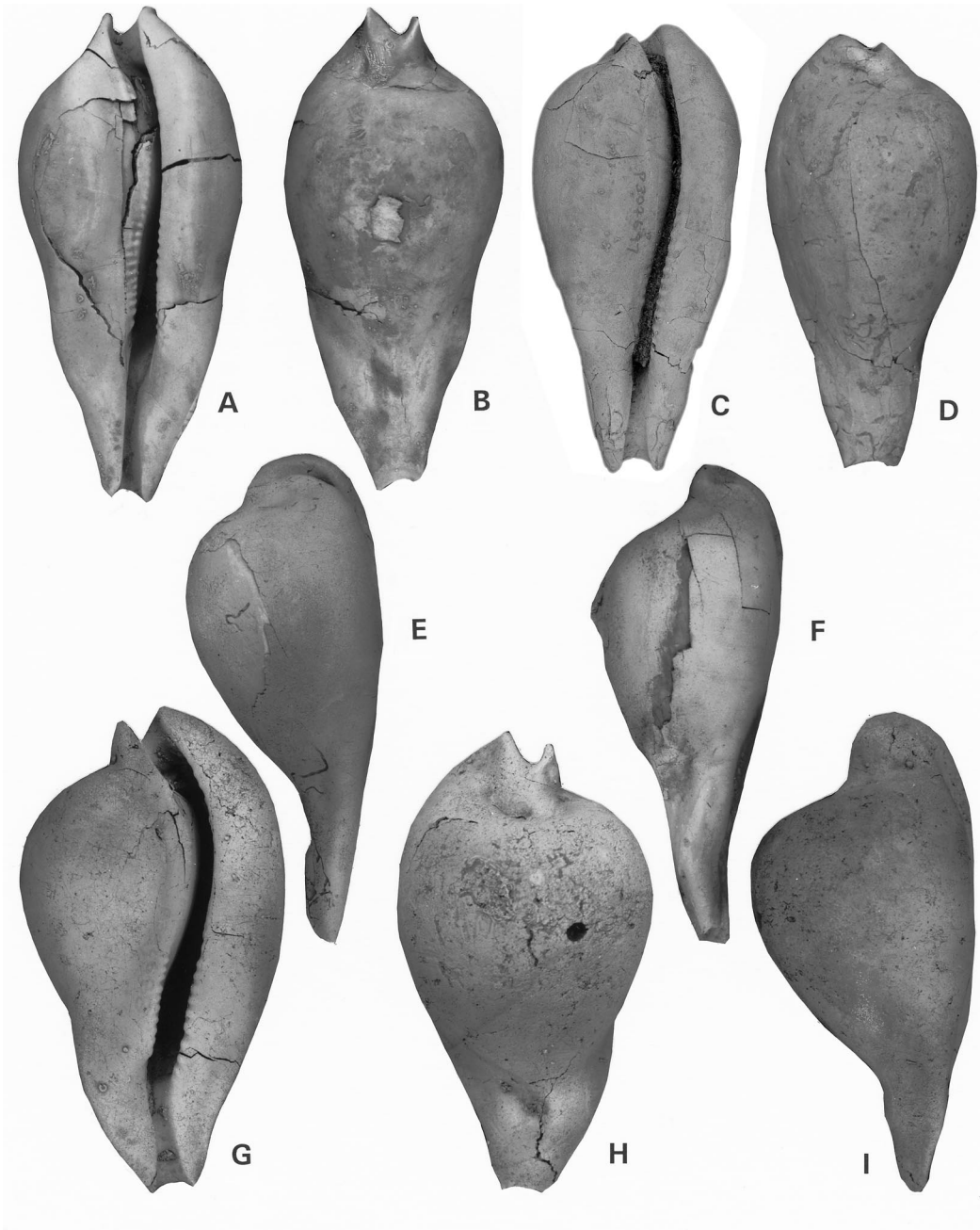

Figure 3. A–F, *Umbilia (U.) platyrhyncha* (McCoy). A–B, P59169, Ad 22, Bird Rock cliffs, x 0.8. C–D, P302697, cliffs west of Bird Rock, x 0.8. E, P12138, holotype, Ad 22, Bird Rock cliffs, x 0.75. F, P302784, Bird Rock cliffs, x 0.8. G–I, *Umbilia (U.) angustior* (Pritchard), P302688, PL3032, x 1.0.

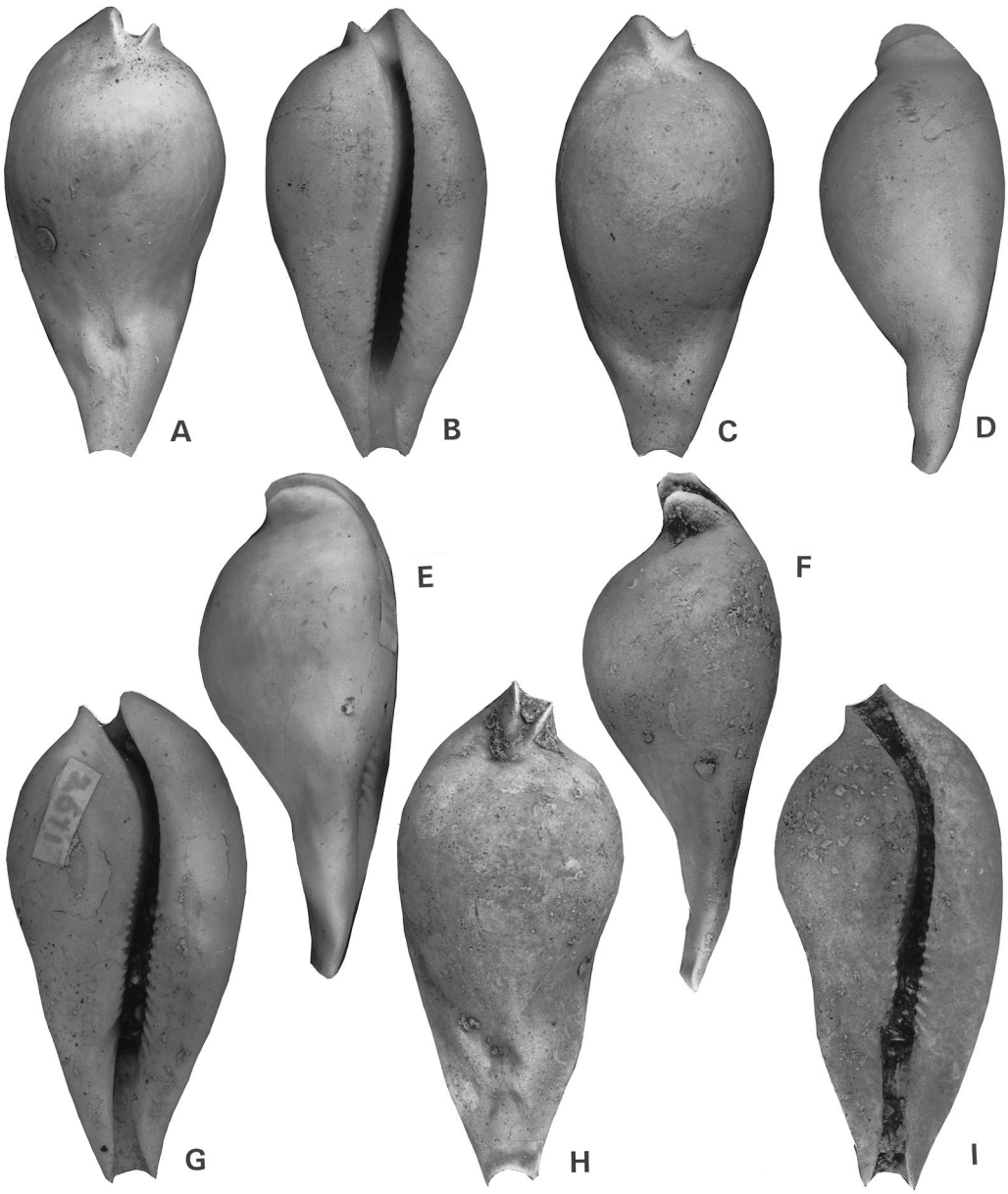

Figure 4. A–I, *Umbilia (U.) angustior* (Pritchard). A, E, G, P2671, holotype, Table Cape, Tasmania, x 0.9, x 1.0, x 1.0. B–D, P302703, PL3037, Hordern Vale, x 1.1. F, H–I, P302785, Table Cape, Tasmania, x 1.0.

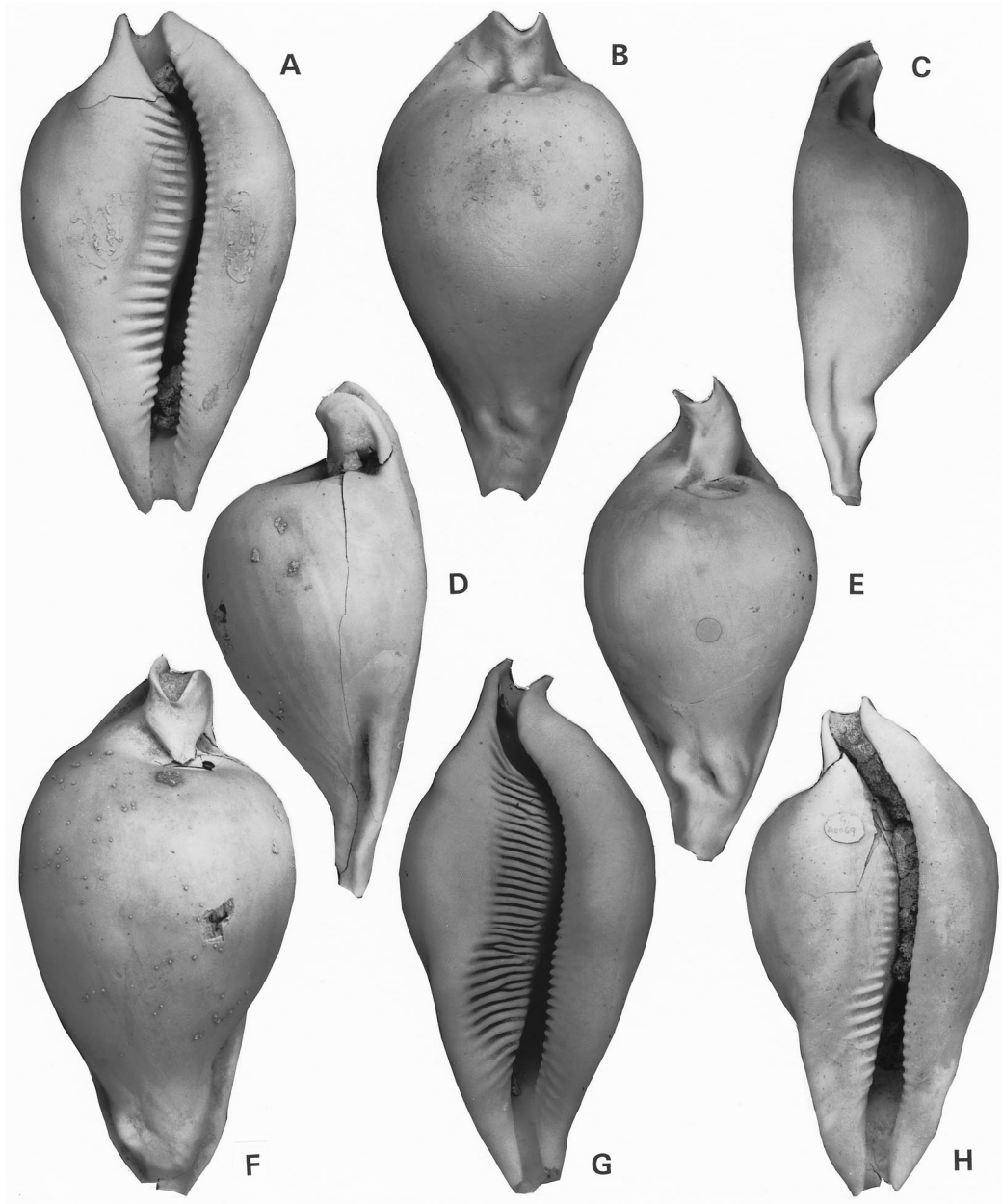

Figure 5. A–H, *Umbilia (U.) eximia* (Sowerby). A–B, P5296, syntype of *Cypraea eximia brevis* McCoy, Aw 9, Gellibrand River, x 0.9. C, E, G, BMNH G9694, holotype, Franklin Village, Tasmania, x 0.8, x 0.8, x 0.9. D, F, H, BMNH G40069, holotype of *Umbilia (U.) brevis frankstonensis* Schilder, Grices Creek, x 0.7, x 0.8, x 0.7.

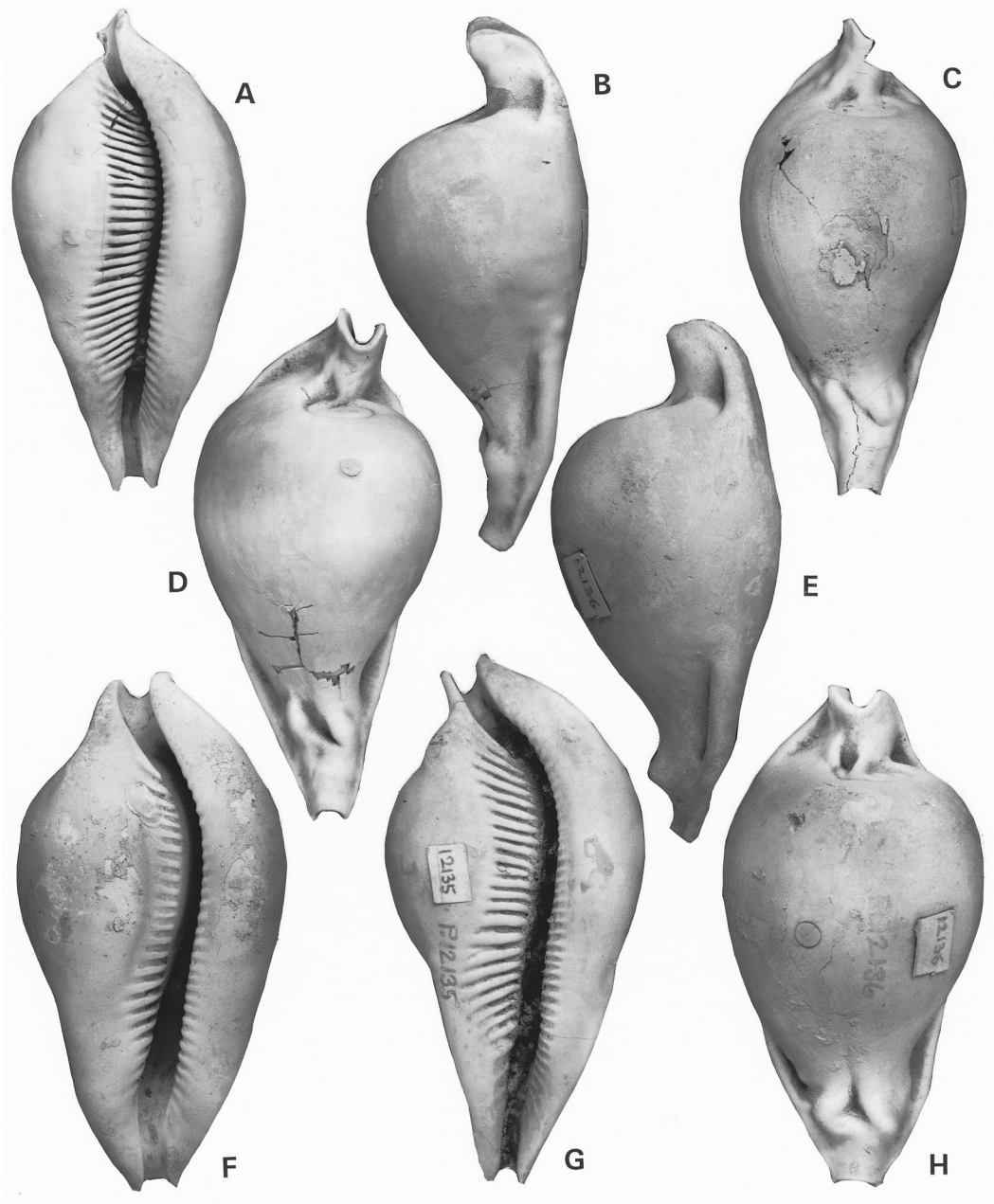

Figure 6. A–H, *Umbilia (U.) eximia* (Sowerby). A, C, P16171, syntype of *Umbilia (U.) eximia maccoyi* Schilder, between Mt Eliza and Mt Martha, x 0.7. B, D, G, P12135, lectotype of *Umbilia (U.) eximia maccoyi* Schilder, between Mt Eliza and Mt Martha, x 0.7. E–F, H, P12136, lectotype of *Cypraea eximia brevis* McCoy, between Mt Eliza and Mt Martha, x 0.9.

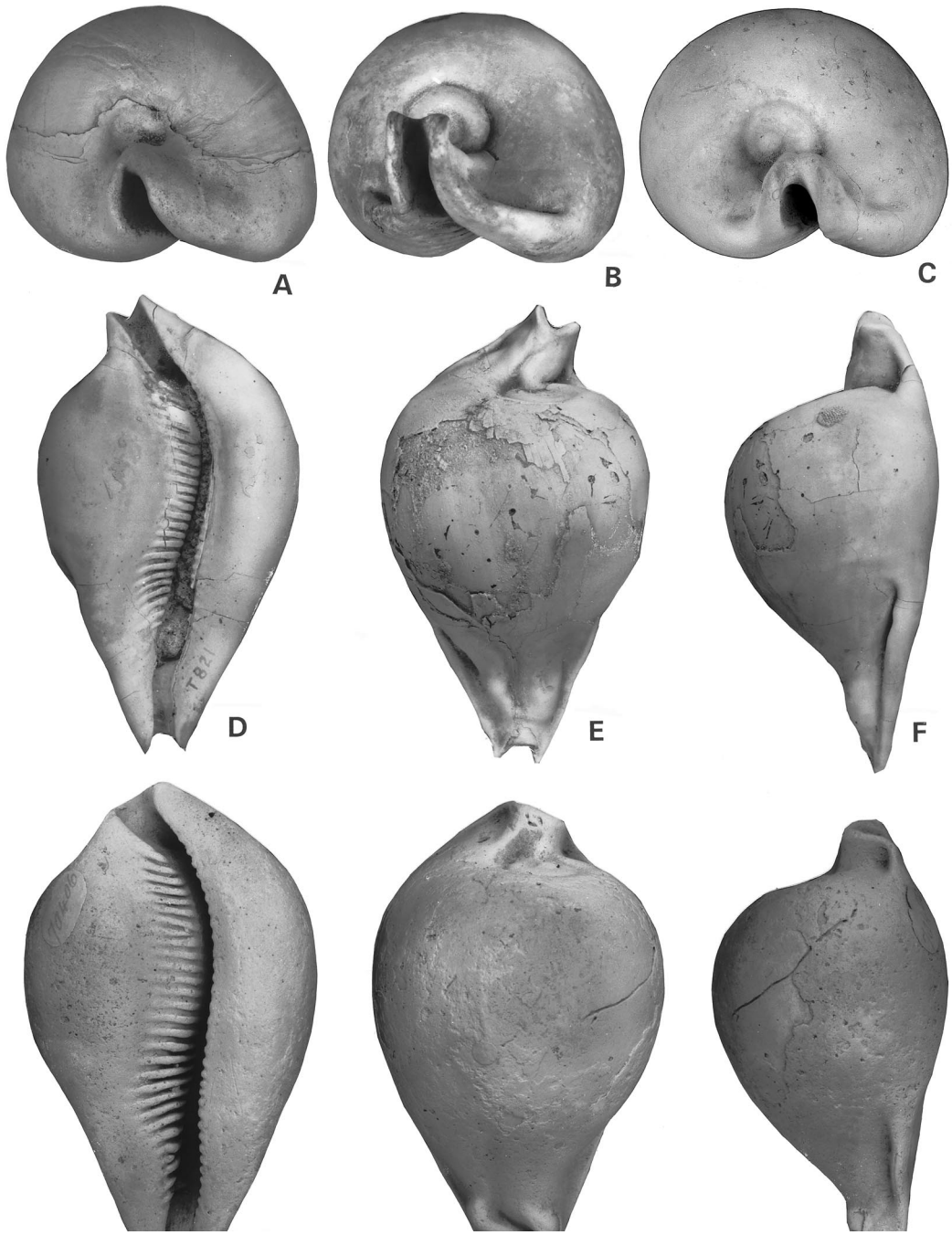

Figure 7. A, *Umbilia (U.) hesitata* (Iredale), P302781, PL1264, Flinders I., x 0.75. B–I *Umbilia (U.) eximia* (Sowerby). B, P12135, lectotype of *Umbilia (U.) eximia maccoyi* Schilder, between Mt Eliza and Mt Martha, x 0.9. C, P5296, syntype of *Cypraea eximia brevis* McCoy, Aw 9, Gellibrand River, x 1.1. D–F, SAM T821, holotype of *Cypraea sphaerodoma* Tate, near Morgan, South Australia, x 0.8. G–I, BMNH 70406, holotype of *Umbilia (U.) brevis montismarthae* Schilder, Mount Martha, x 1.0.

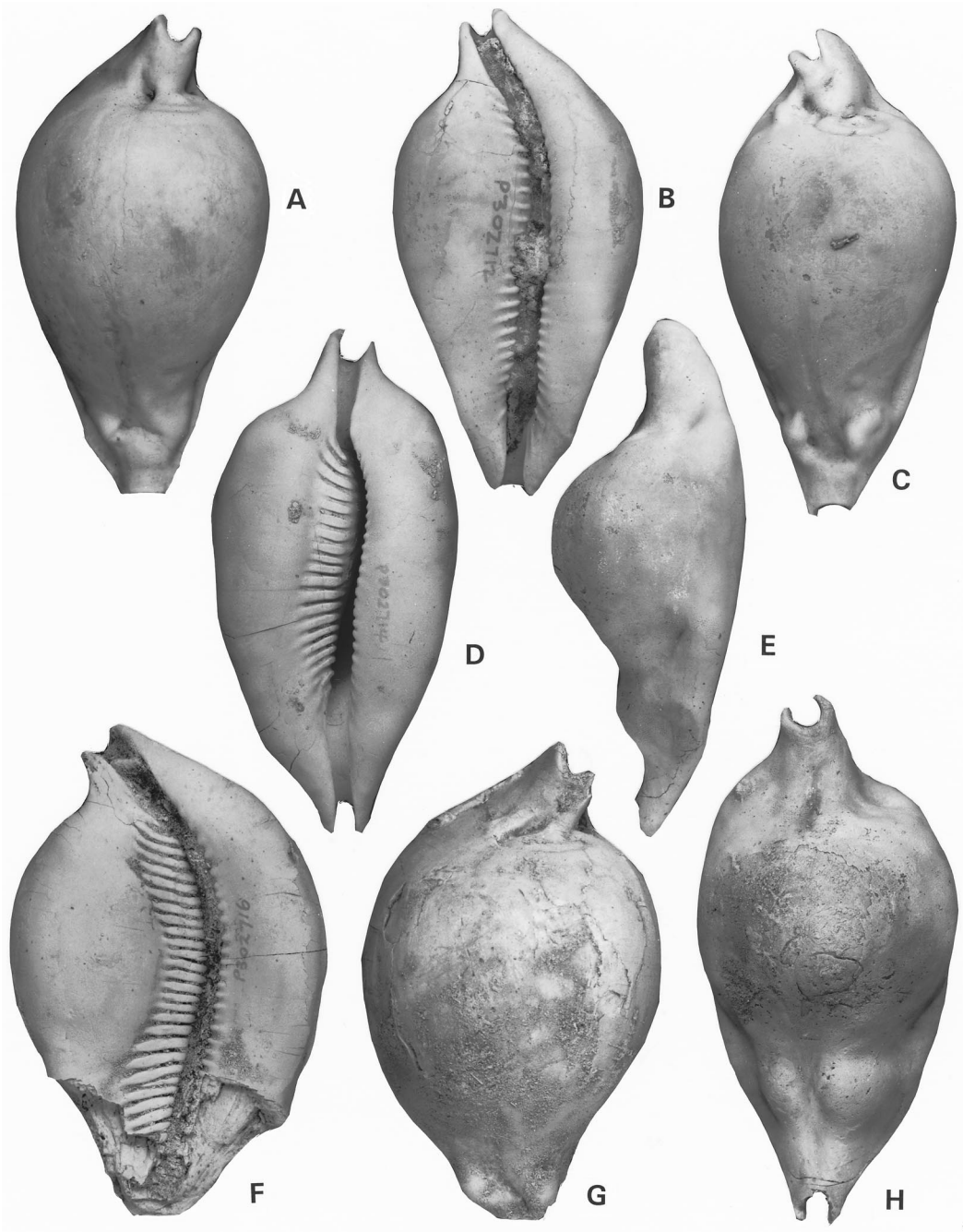

Figure 8. A–H, *Umbilia (U.) eximia* (Sowerby). A–B, P302712, Lake Bullenmerri, x 1.0. C, P302779, lower beds, Grices Creek, x 0.8. D–E, H, P302782, PL3298, x 0.8, x 0.9, x 0.9. F–G, P302716, Rose Hill, x 1.0, x 0.9.

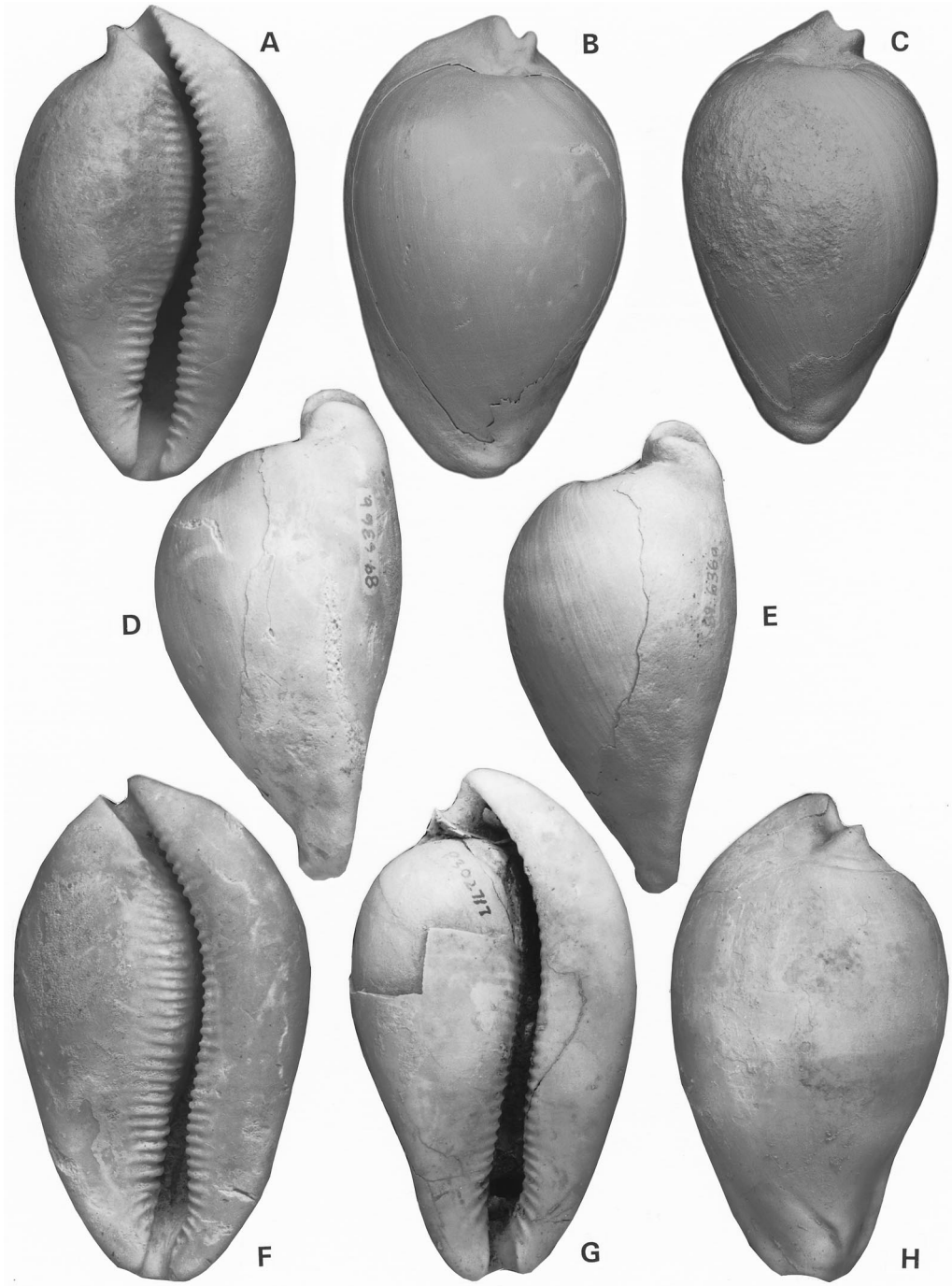

Figure 9. A–H, *Umbilia (U.) hesitata* (Iredale). A, C, E, WAM 89.636a, 2.5 km N of Hampton Tower, Roe Plains, Western Australia, x 0.9, x 0.8, x 0.9. B, D, F, WAM 89.636b, 2.5 km N of Hampton Tower, Roe Plains, Western Australia, x 0.8, x 0.9, x 0.9. G–H, P302717, Rose Hill, x 0.9, x 0.8.

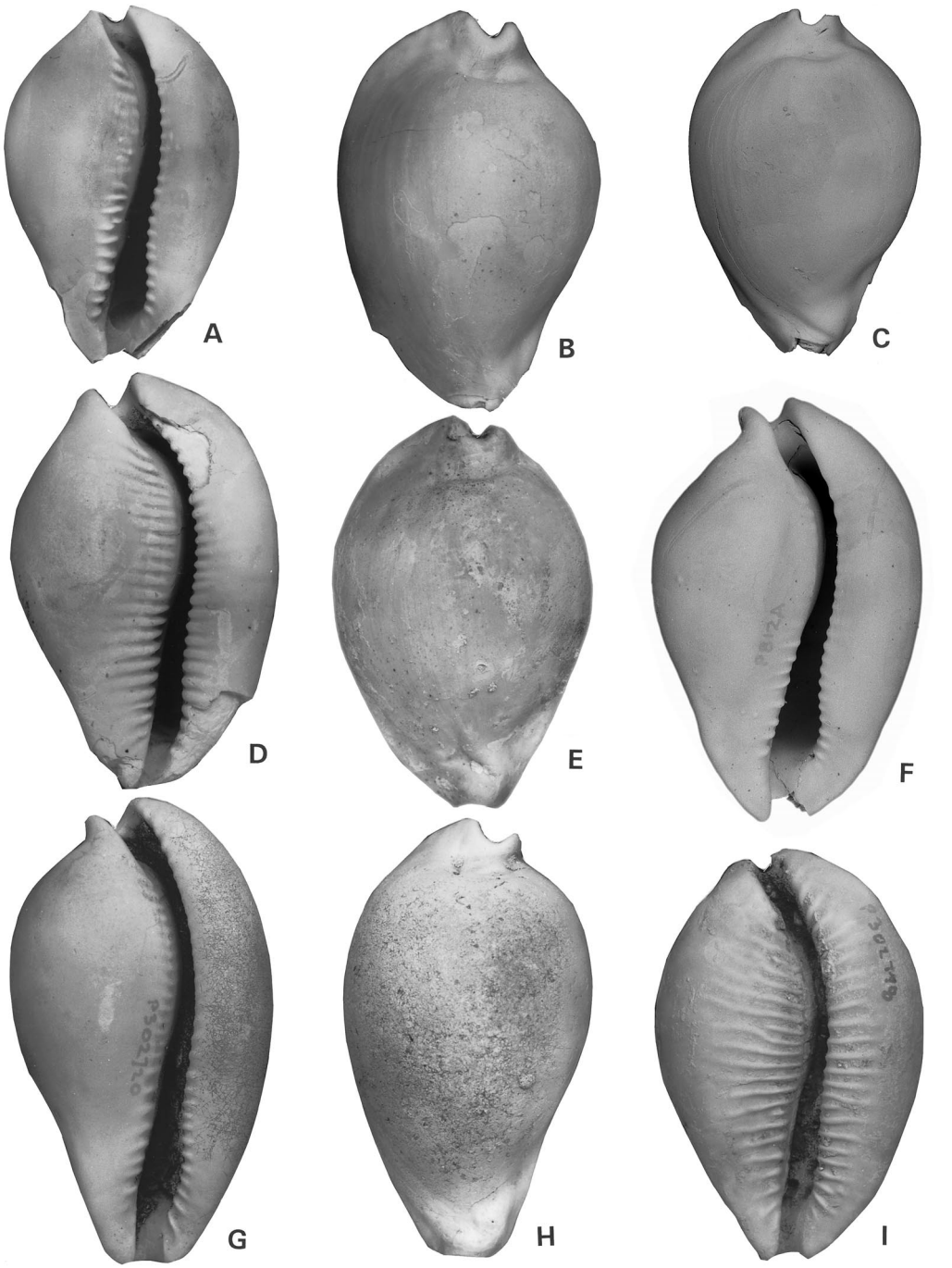

Figure 10. A–I, *Umbilia (U.) hesitata* (Iredale). A, C, SAM T812B, syntype of *Cypraea tatei* Cossmann, Murray Desert, x 1.1. B, D, SAM P8339, holotype of *Umbilia cera* Cotton, Abattoirs Bore, South Australia, x 1.1. E, I, P302718, Rose Hill, x 1.1. F, SAM T812A, lectotype of *Cypraea tatei* Cossmann, Murray Desert, x 1.1. G–H, P302720, Beaumaris, x 1.1.

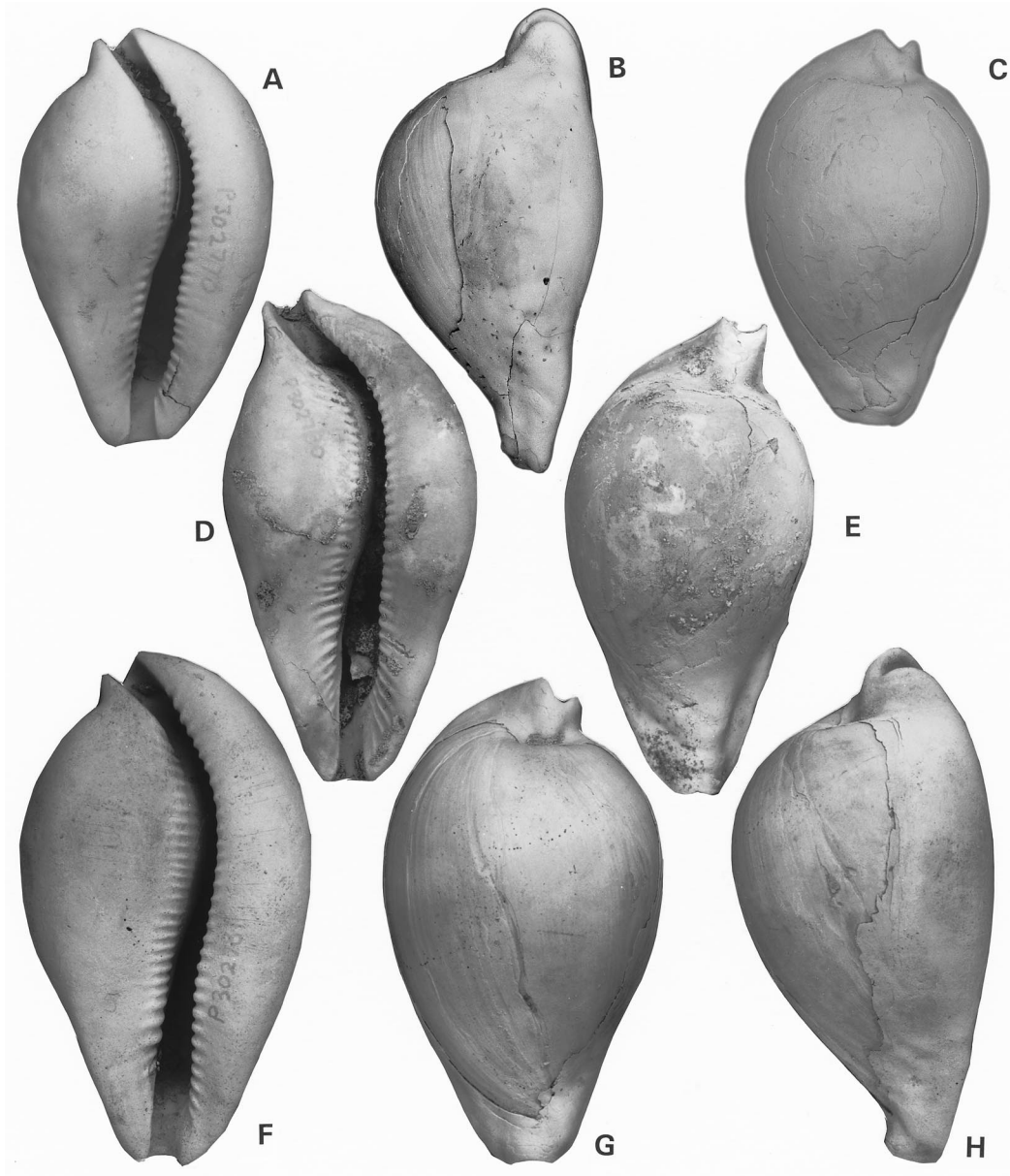

Figure 11. A–H, *Umbilia (U.) hesitata* (Iredale). A–C, P302770, PL 1250, Flinders Is, Tasmania, x 1, x 1.1, x 0.9. D–E, P302780, North Memana Drain, Flinders I., Tasmania, x 0.8. F–H, P302781, PL1264, Flinders Is, Tasmania, x 0.8.

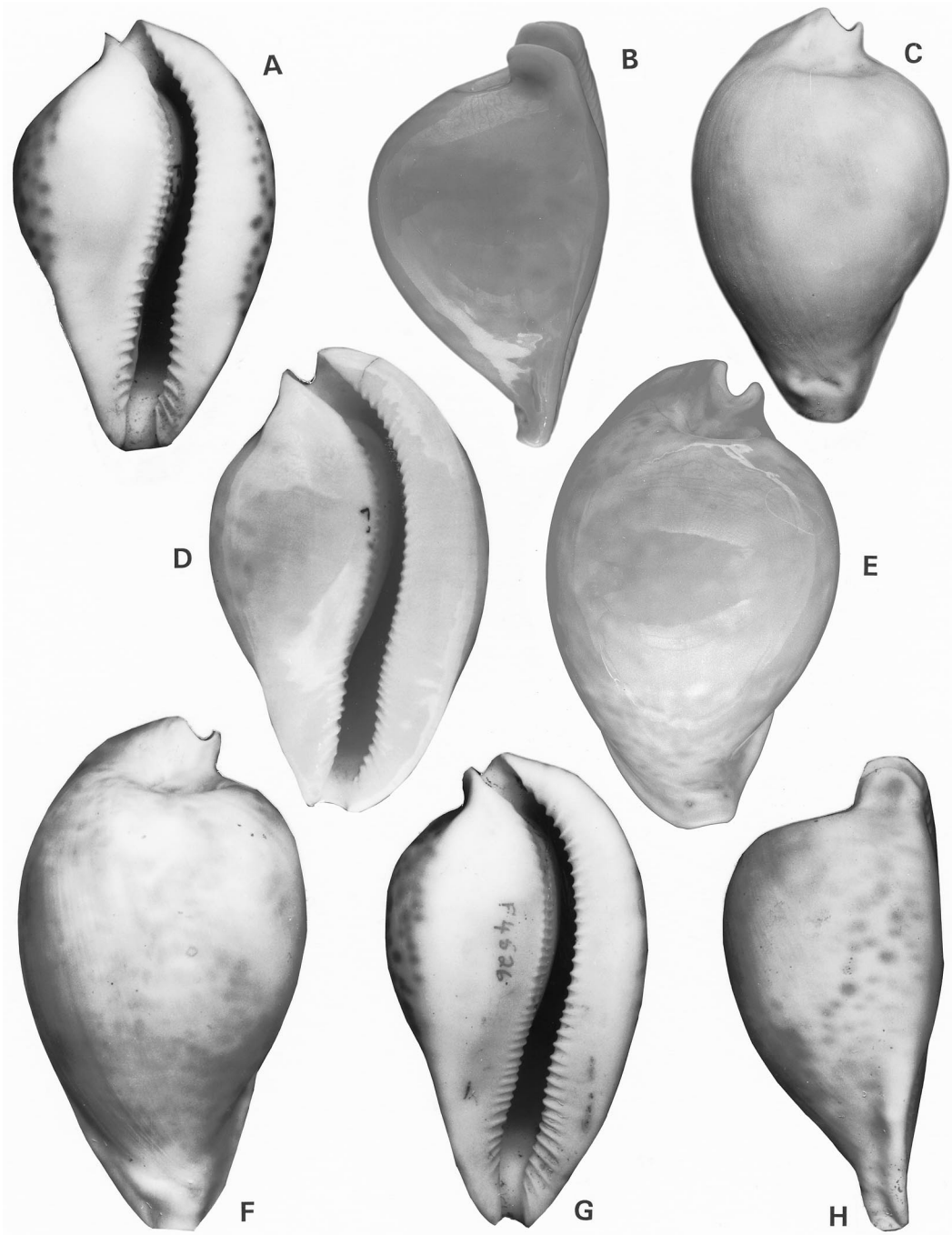

Figure 12. A, C, *Umbilia (U.) hesitata* (Iredale), 'beddomei' form, F23116, 50 fm, off Botany Bay, New South Wales, x 1.0, x 0.9. B, D–E, *Umbilia (U.) armeniaca* (Verco), F27194, Great Australian Bight, uncoated, x 0.7, x 0.8, x 0.8. F–H, *Umbilia (U.) hesitata* (Iredale), F4526, off Lakes Entrance, Victoria, x 0.8, x 0.7, x 0.7.

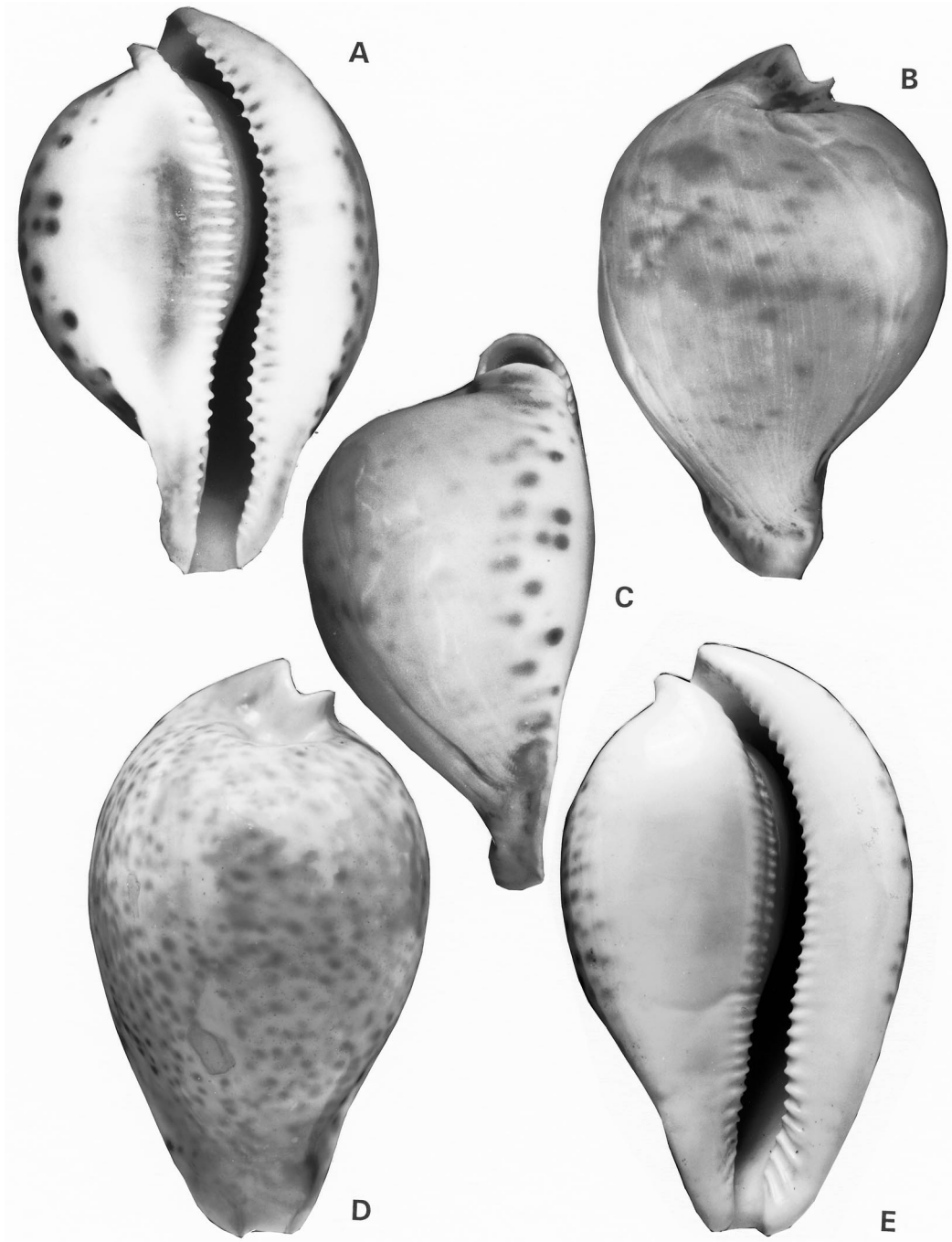

Figure 13. A–C, *Umbilia (U.) petilirostris* sp. nov., F86962, holotype, Capricorn Channel, off Lady Musgrave I., Queensland, 264–252 metres, A, C x 1.1, D x 1.0. D–E, *Umbilia (U.) hesitata* (Iredale), BMNH 1950.8.28.22, lectotype, x 0.9.

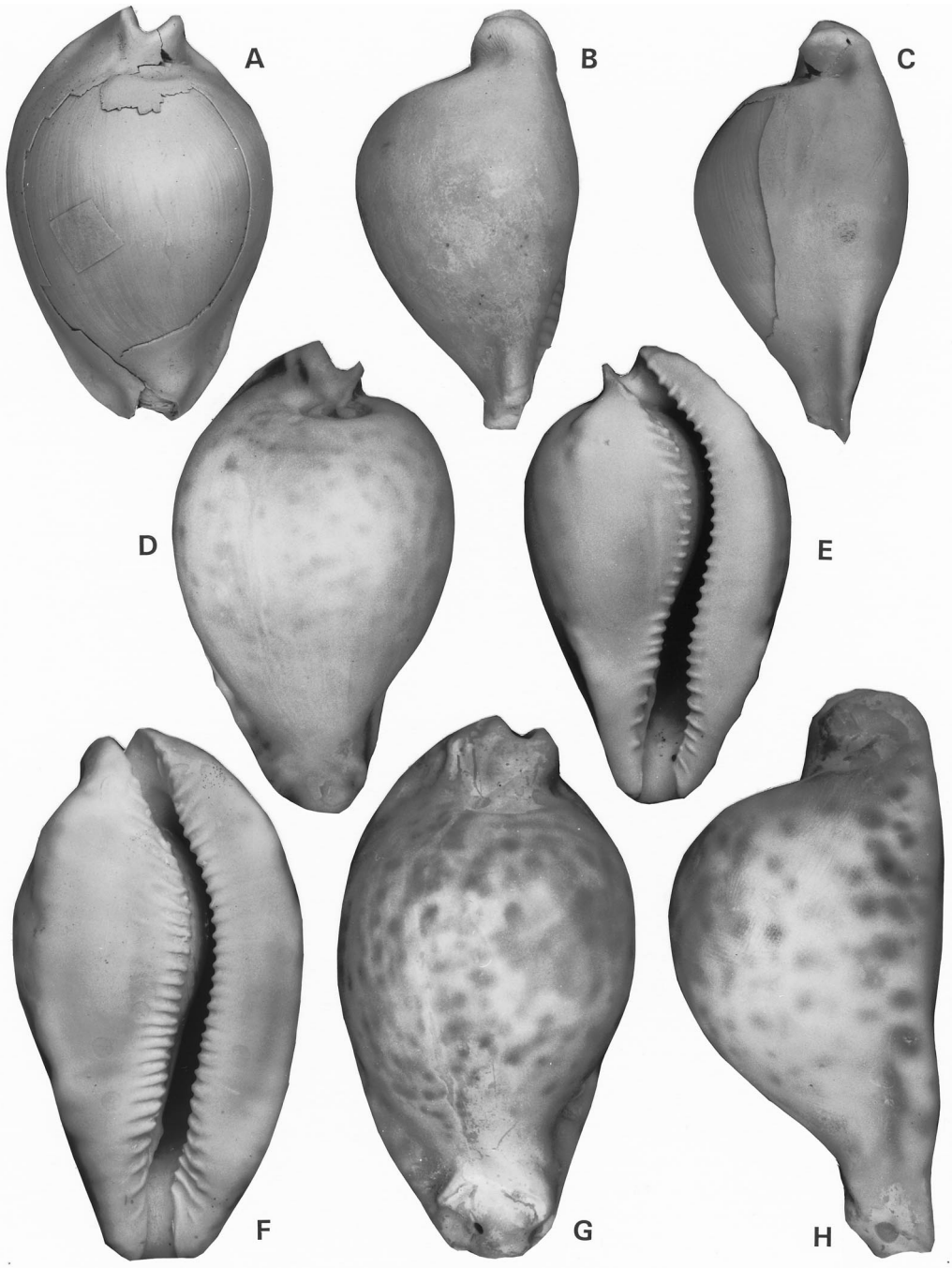

Figure 14. A–C, *Umbilia (U.) hesitata* (Iredale). A, C, SAM T812A, lectotype of *Cypraea tatei* Cossmann, Murray Desert, x 1.1. B, SAM P8339, holotype of *Umbilia cera* Cotton, Abattoirs Bore, x 1.1. D–H, *Umbilia (U.) capricornica* Lorenz, D–E, F85330, 108–110 fm, Swains Reef, Queensland, x 1.2. F–G, F85329, 103–105 fm, Swains Reef, Queensland, x 1.0.

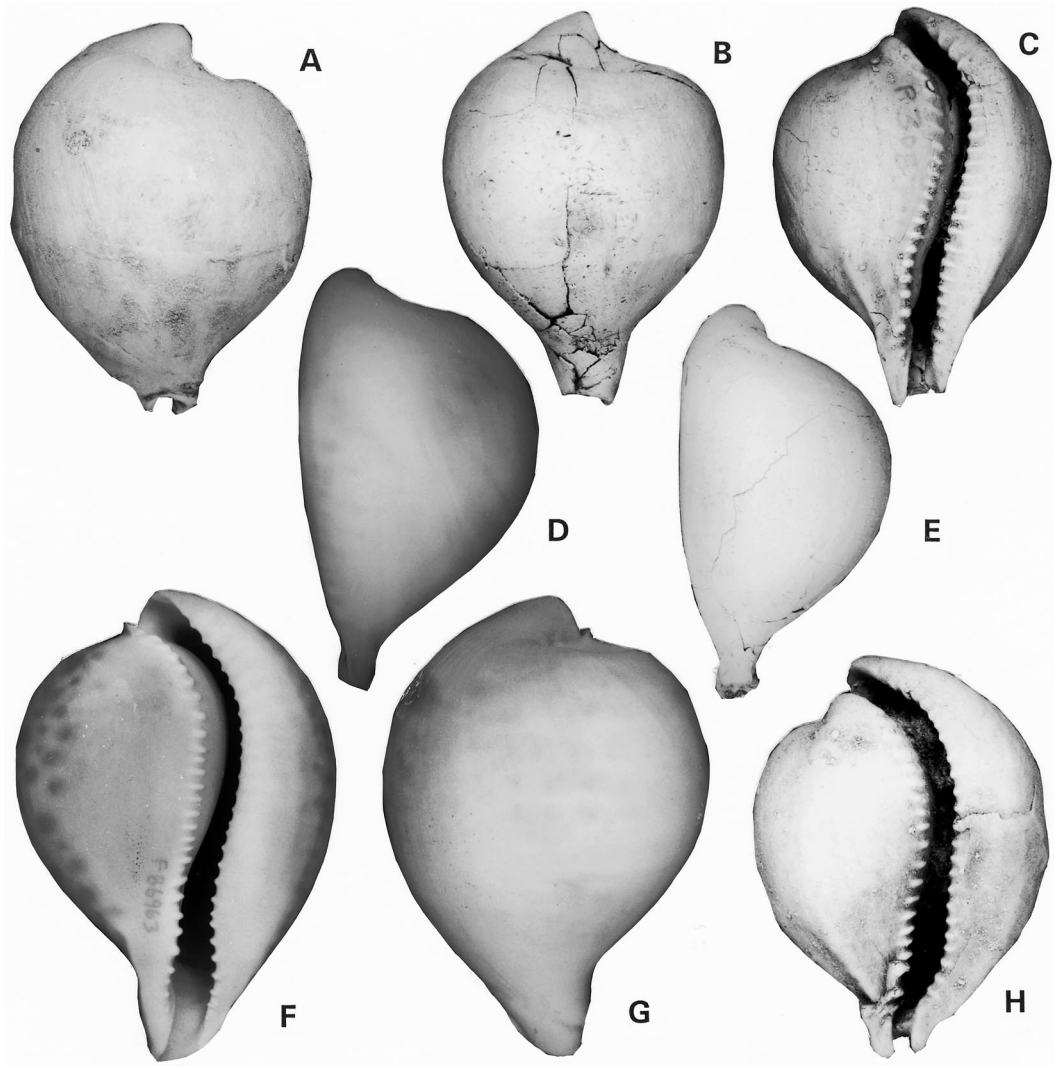

Figure 15. A–C, E, H, *Umbilia (U.) prosila* sp. nov. A, H, P308717, paratype, Bird Rock cliffs, Torquay, x 1.4. B–C, E, P308716, holotype, Bird Rock cliffs, Torquay, x 1.4. D, F–G, *Umbilia (U.) petilirostris* sp. nov. F86963, paratype, 249 m, off Fiztroy Reef, D x 0.8, F–G x 0.9.

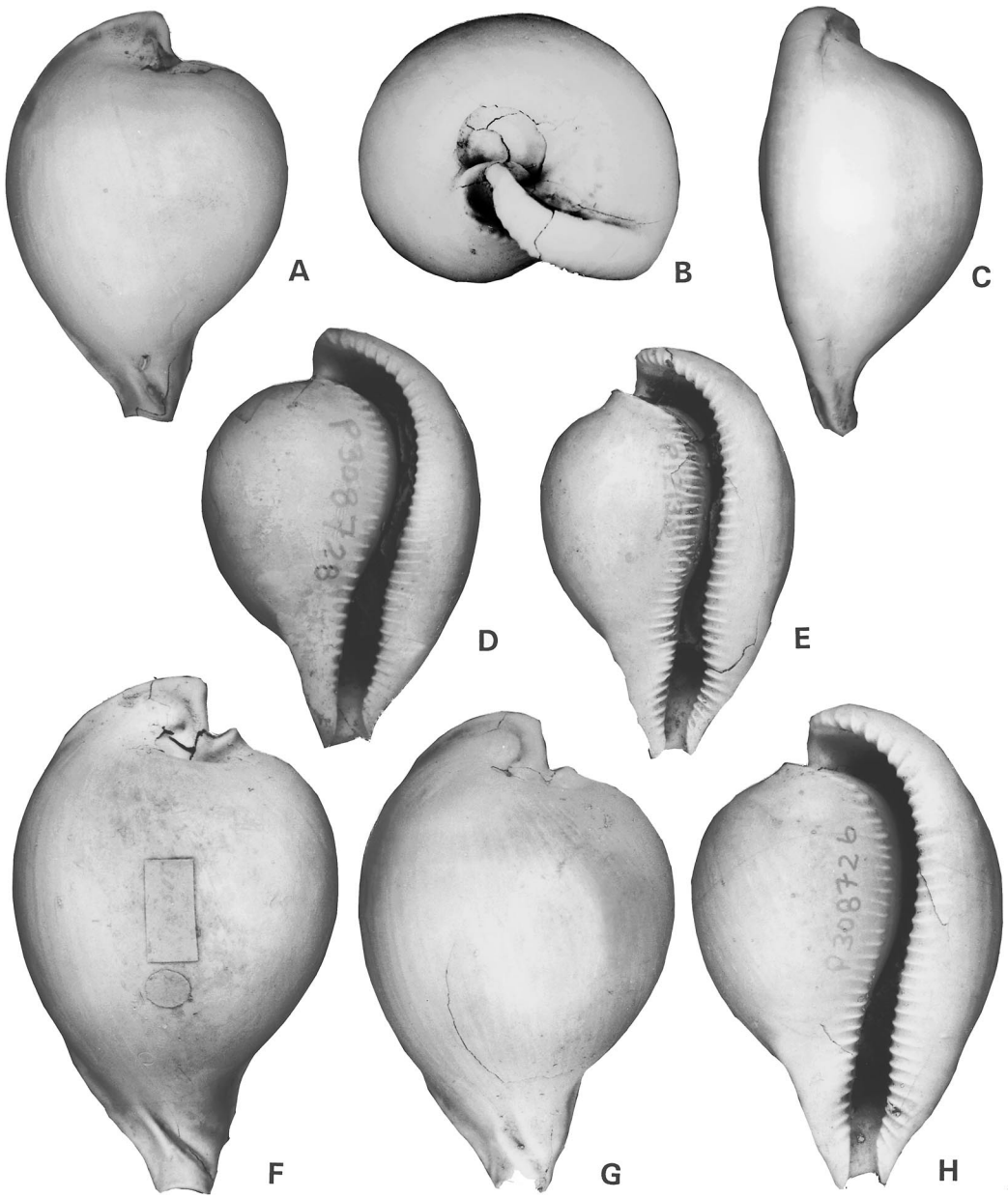

Figure 16. A–H, *Umbilia (U.) leptorhyncha* (McCoy). A, D, P308728, paralectotype, near Mount Martha, x 1.2. B–C, E–F, P12133, lectotype, B x 1.1, C x 1.0, E x 0.9, F x 1.2. G–H, P308726, paralectotype, near Mount Martha, x 1.2.

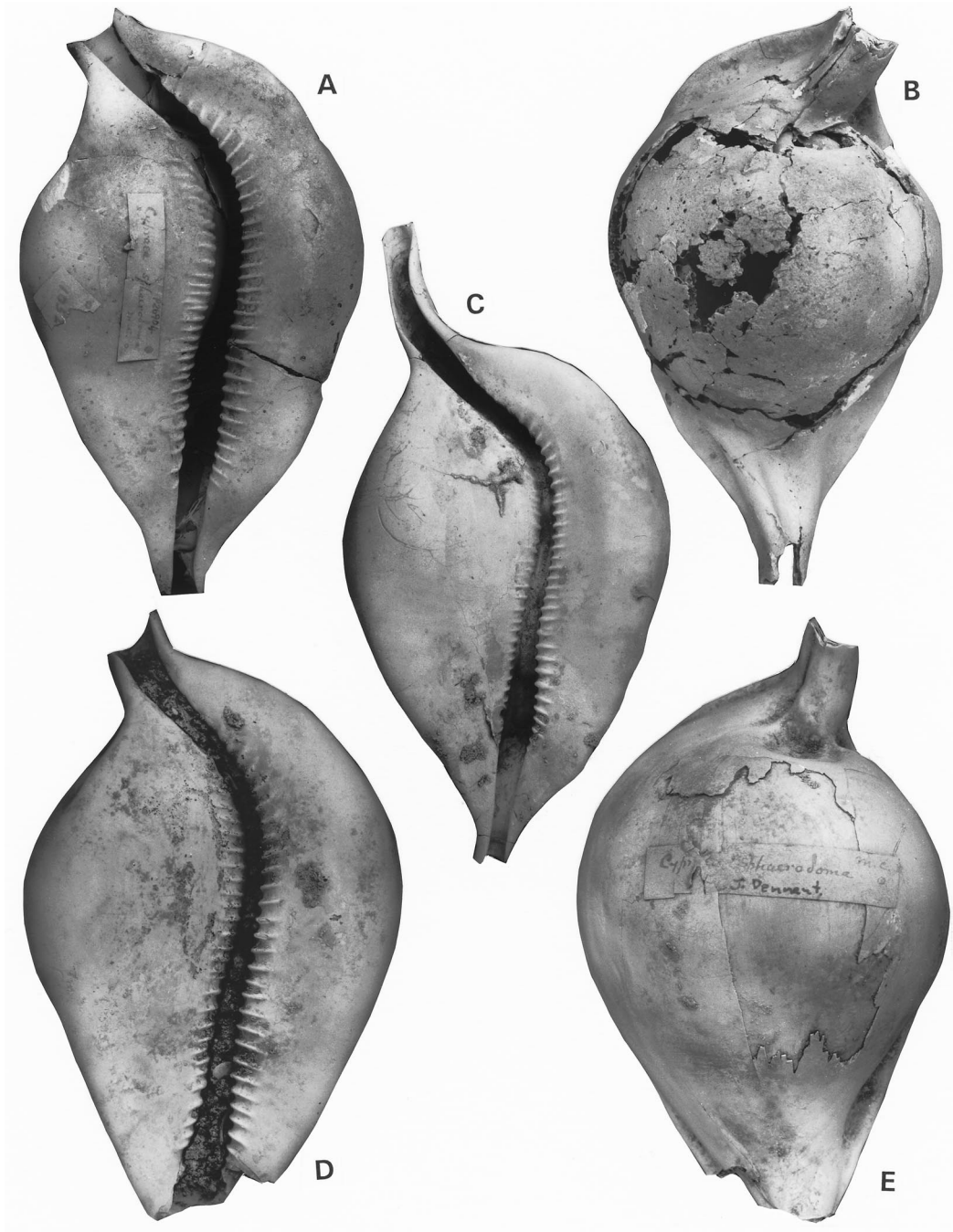

Figure 17. A–E, *Umbilia (U.) siphonata* (Chapman). A–B, P26904, holotype of *Gisortia breviplicata* Schilder, Muddy Creek, x 0. 6. C, P14835, Grices Creek, x 0.6. D–E, P302803, Muddy Creek, x 0.8.

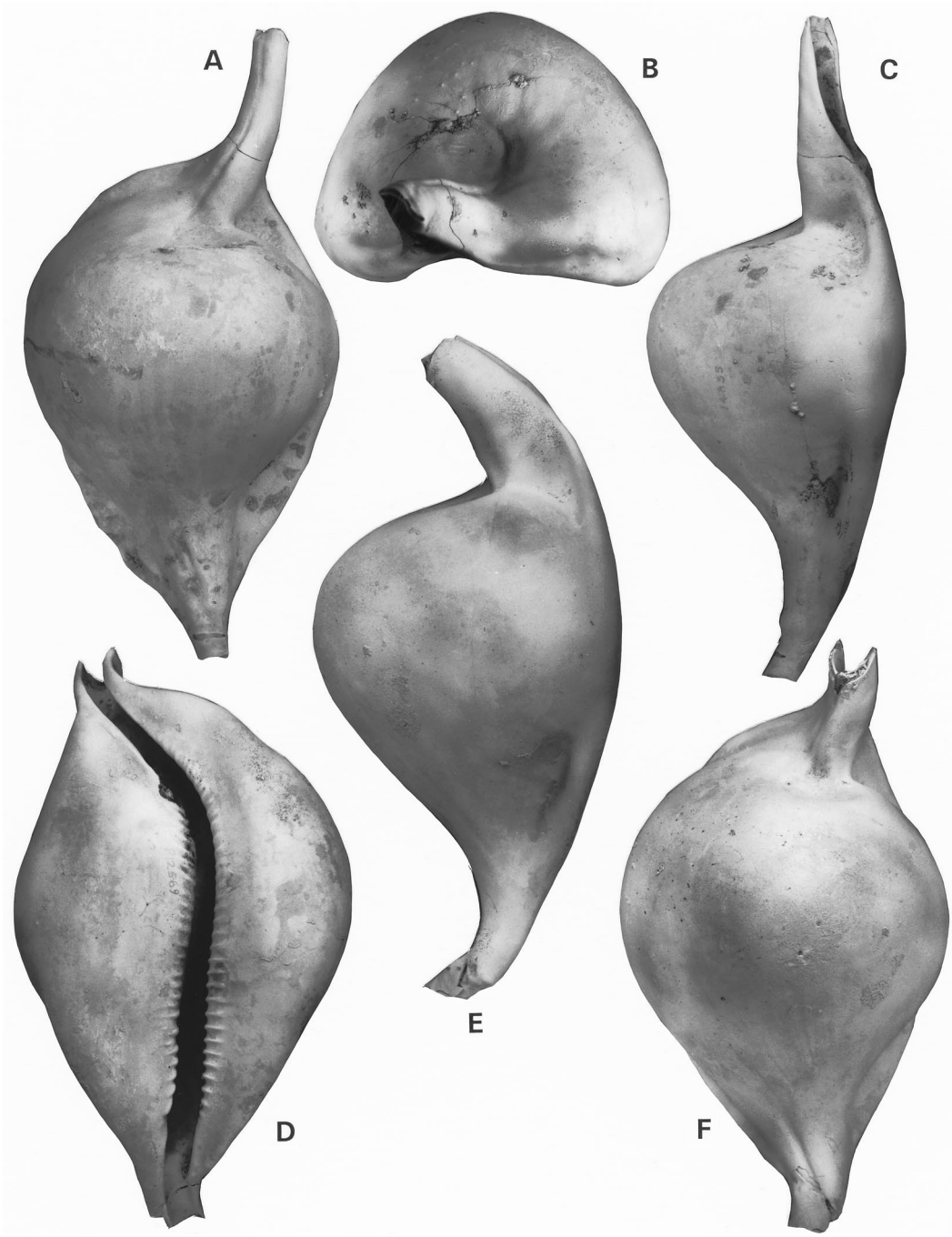

Figure 18. A–F, *Umbilia (U.) siphonata* (Chapman). A–C, P14835, Grices Creek, x 0.6. D–F, P12569, Muddy Creek, x 0.6, x 0.7, x 0.6.

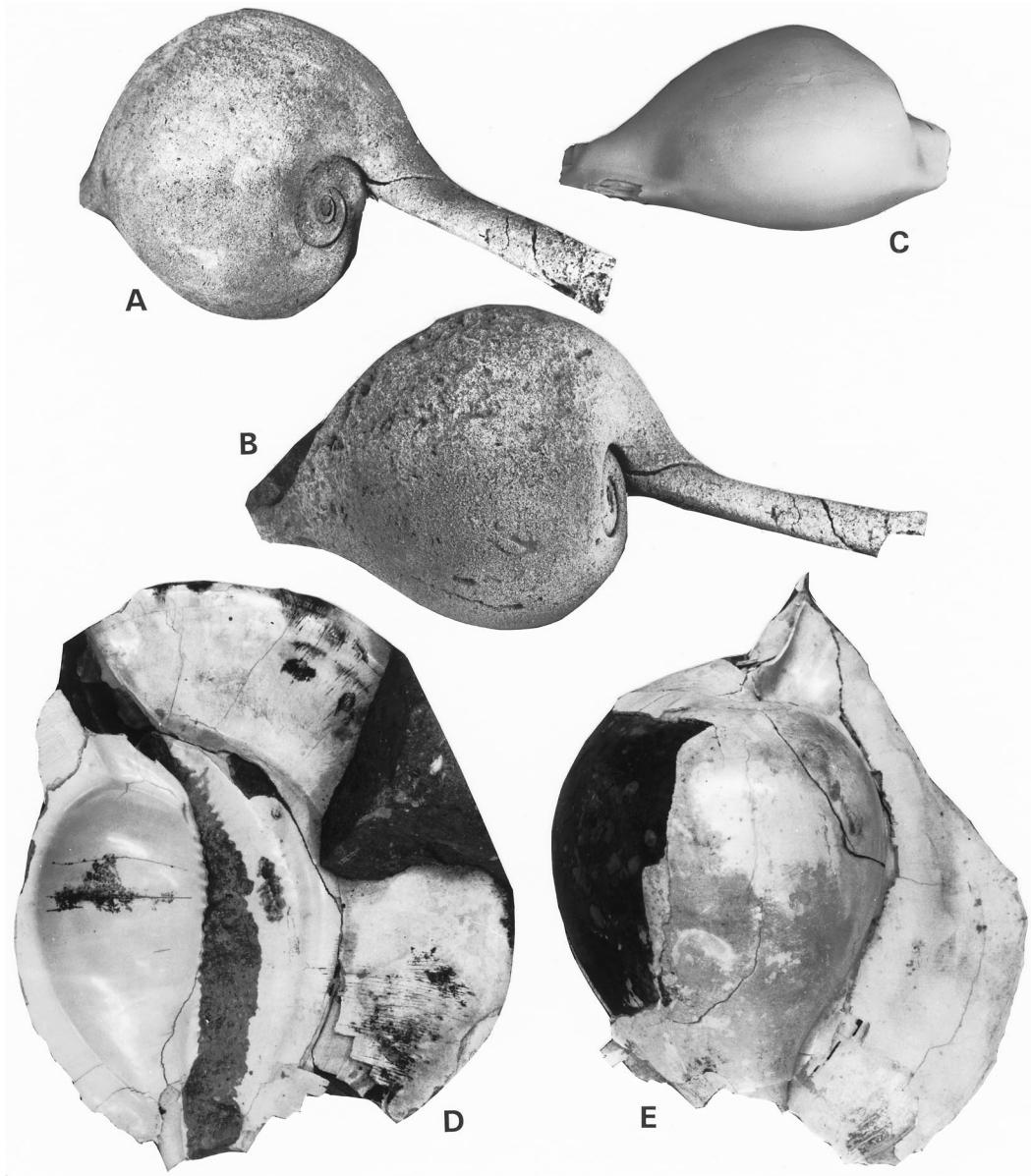

Figure 19. A–B, *Umbilia (U.) siphonata* (Chapman), P13243, holotype, Murray River cliffs near Waikerie, South Australia, x 0.7. C, *Umbilia (U.) hesitata* (Iredale), SAM T812B, syntype of *Cypraea tatei* Cossmann, Murray Desert, x 1.1. D–E, *Umbilia (Palliocypraea) gastroplax* (McCoy), P12140, holotype, between Mt Eliza and Mt Martha, x 0.8.

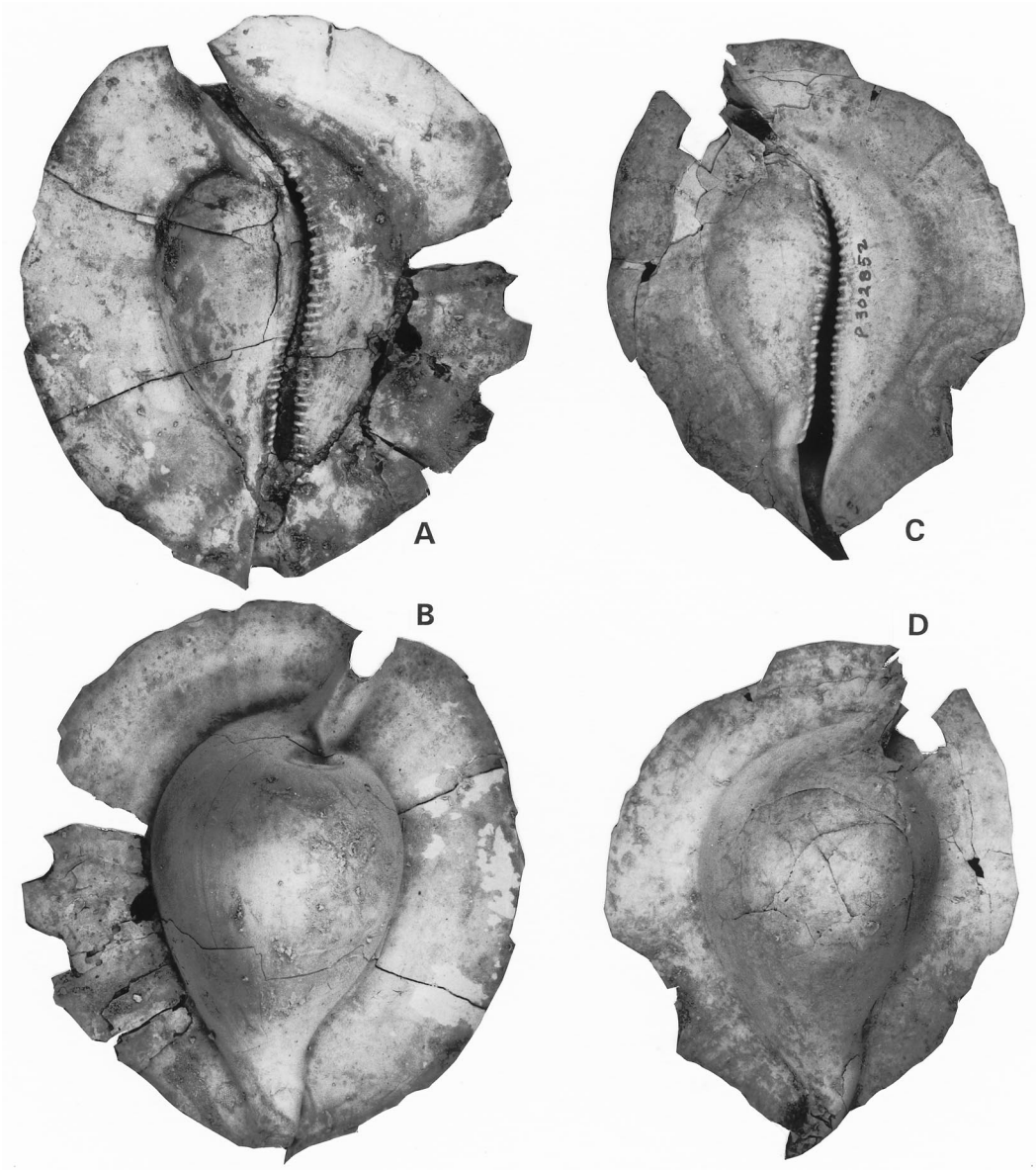

Figure 20. A–D, *Umbilia (Palliocypraea) gastroplax* (McCoy). A–B, P302854, Balcombe Bay, x 0.7. C–D, P302852, Clifton Bank, x 0.8.

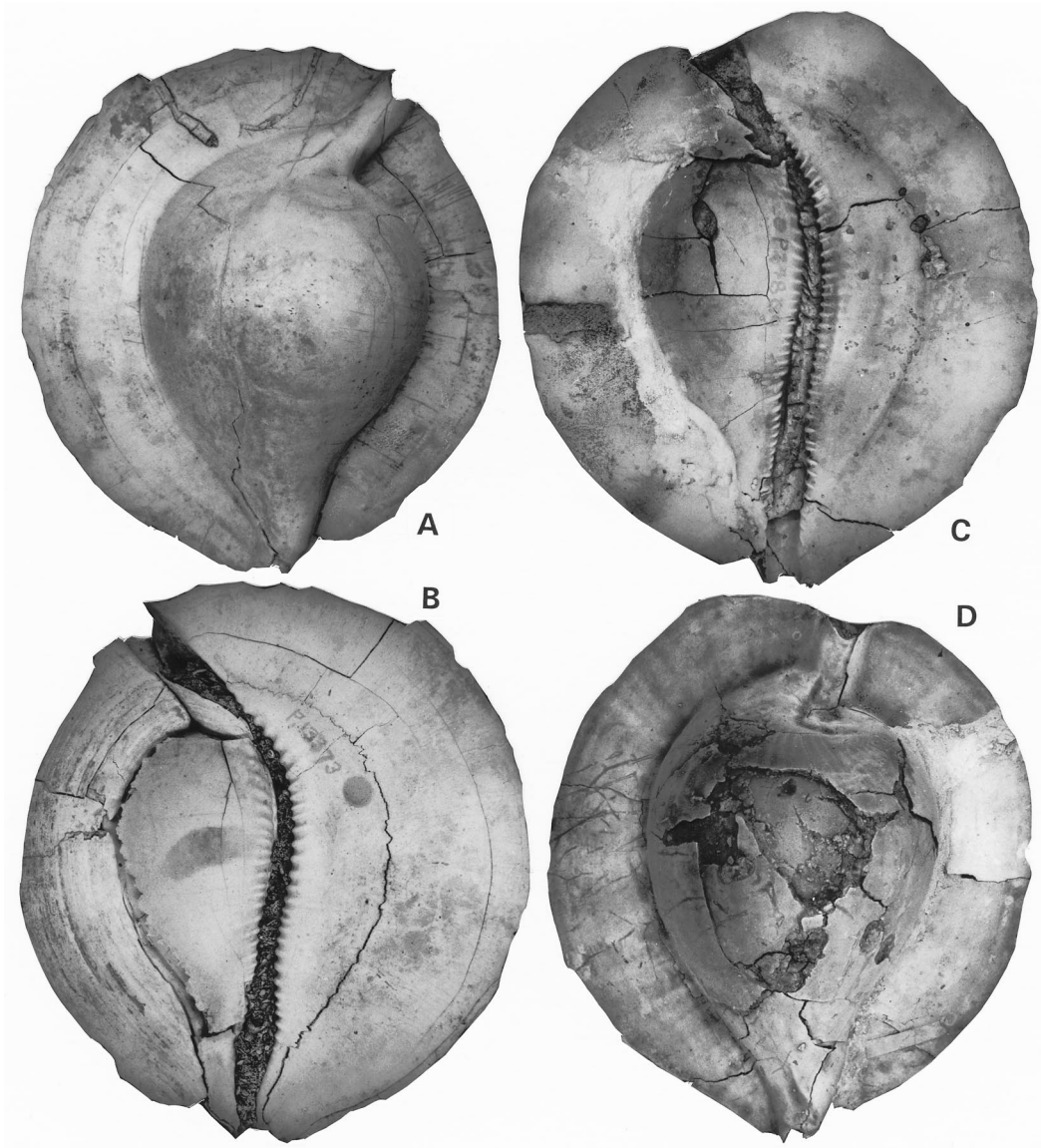

Figure 21. A–D, *Umbilia (Palliocypraea) gastroplax* (McCoy). A–B, P13373, Clifton Bank, x 0.8, C–D, P24869, Balcombe Bay, x 0.8, x 0.7.