

Conchylia

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The subspecies of *Umbilia armeniaca* (VERCO, 1912) (Gastropoda: Cypraeidae)

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With 6 Text-Figs, 1 Map and 6 Plates with ## Figs

Keywords

Australia, Cypraeidae, *Umbilia armeniaca*, new subspecies, relative shell-mass.

Abstract

The Australian *Umbilia armeniaca* (VERCO, 1912) is split into four subspecies characterized by shell morphology and distribution. The nominate subspecies occurs offshore along the Great Australian Bight. *U. armeniaca andreyi* n. ssp. from the southwest is characterized by a smaller, heavier shell, with less numerous, longer and coarser columellar teeth, reduced anterior flanges, and porcelain-white instead of cream-to apricot-colored callosities. *U. armeniaca clarksoni* n. ssp. from the Esperance area is a less inflated, lightweight shell with a flattened base, and a dorsum that is covered by a darker, denser pattern. The eastern *U. armeniaca diprotodon* is larger and heavier, with a darker dorsal pattern and more distinctly tinted extremities. The two latter subspecies are found in shallow water (25 to 60 m), whereas, *a. armeniaca* and *a. andreyi* live offshore, in deep water of 100 to 200 m. The relative mass (mR) of a shell (in %) is used as a distinguishing feature of the four populations.

Zusammenfassung

Die australische *Umbilia armeniaca* (VERCO, 1912) wird auf der Grundlage von Gehäusemorphologie und Geographie in vier Unterarten aufgespalten. Die Nominat-Unterart ist vor der Küste des Great Australian Bight weit verbreitet. *U. armeniaca andreyi* n. ssp. aus dem Südwesten Australiens hat ein kleineres, schwereres Gehäuse, weniger zahlreiche, gröbere und längere Kolumellarzähne, reduzierte anteriore Seitenleisten und prozellanweiße statt creme- oder aprikosenfarbene Kallositäten. *U. armeniaca clarksoni* n. ssp. aus der Gegend um Esperance ist weniger aufgebläht und leichter, die Basis abgeflacht, der Rücken mit dunklerem, dichterem Muster. Die östliche *U. armeniaca diprotodon* ist größer und schwerer, mit dunklerem Muster und deutlicher eingefärbten Enden. Die letzteren zwei Unterarten leben in flacheren küstennahen Gewässern (25 bis 60 m) während *a. armeniaca* und *a. andreyi* auf küstenferne größere Tiefen (100 bis 200 m) begrenzt sind. Die relative Masse (mR) des Gehäuses (in %) wird als Unterscheidungsmerkmal der vier Populationen herangezogen.

Introduction

Umbilia armeniaca (VERCO, 1912), a former rarity among the cowries, has recently been found in large numbers by commercial trawlers off the Great Australian Bight. Apart from these widespread deep water (100 to 200 m) shells, two quite small, isolated populations were discovered by divers in the eastern (*U. a. diprotodon* n. ssp.) and western limits (*U. a. clarksoni* n. ssp.) bordering the *a. armeniaca* distribution. A fourth population (*U. a. andreyi* n. ssp.) is occasionally found in deep water, between Cape Naturaliste and the Rottneest Shelf in the west. The three unnamed subspecies are described and discussed in the following report.

Abbreviations and Acronyms

CLSF: CHIAPPONI LORENZ Seashell Foundation, Lecco, Italy

MAM: Collection Dr. MICHAEL A. MONT, Owings Mills, Maryland, USA

WAM: Western Australian Museum, Perth, Western Australia

Material and Methods

Only well-preserved, adult and typical specimens were used in the morphometrical analysis and as type-material: 100 *a. armeniaca*, 15 *a. andreyi* n. ssp., 15 *a. clarksoni* n. ssp. and 43 of *a. diprotodon* n. ssp. Length, width, height, and teeth-count were used to compare the shells. The results are presented in the formula created by SCHILDER & SCHILDER (1938), and modified by LORENZ (2002). The relative mass (mR) of a shell in % as an important feature of the different populations is the relation between the measured weight (mD) of a shell (in g) and the hypothetical weight of a solid block of aragonite ($\rho = 0,00293 \text{ g/mm}^3$) of the shell's dimensions (length, width and height).

$$\text{mR (\%)} = (\text{mD} / (l \cdot w \cdot h \cdot 0,00293)) \cdot 100 \%$$

t-tests made on the four sets of shells demonstrate that the differences of the relative masses are statistically significant. A comprehensive treatise

about the relative mass (M) as a morphological feature to characterize cowry populations is published separately (BRIDGES & LORENZ, 2013: this issue, pp. 27-39)

Measurements are listed length × width × height (mm), labral and columellar teeth, counted, and shell's weight (in grams). Most shells studied have been collected more than five years prior to this description so they all are in a similar state of fading to allow an objective comparison of their colors.

***Umbilia armeniaca armeniaca* (VERCO, 1912)**

Cypraea umbilicata var. *armeniaca* J. C. VERCO (1912), Trans. Roy. Soc. S. Austr., **36**: 211–215.

Characterization of the nominate subspecies

The shell is moderately large (70 to 110 mm) and heavy (mR=10.9) with a humped dorsum and a convex base. Large shells of 90 mm and more are relatively less heavy on average (mR =10.4) than shells smaller than 90 mm (mR =11.3). The anterior extremity is elongate and broadly flanged on both sides. The edge of the anterior canal is often delicately bent up. The posterior extremity is rostrate and slightly callused. The spire is large and deeply umbilicate, leaving the protoconch exposed. The aperture is curved parallel to the columella, and bent to the left at the posterior end. The labrum is slightly flattened and its margin is rounded midways and angular towards the marginal flanges. The labral teeth are numerous, short, and distinct, being slightly more pronounced towards the extremities on both ends. The columellar teeth are fine and somewhat extending towards the columella in the posterior half, and restricted to the apertural edge above the fossular area. The fossula is not projecting, but consists of a shallow, wavy ridge. There is a shallow groove dorsally above the anterior canal as a prolongation of the dorsal line.

The dorsal ground color is creamy white. The shell's interior is pale orange. The marginal and basal callosities vary in different degrees of cream, greenish-yellow (rare), orange-brown, to rich apricot color. The base is darker directly around the aperture, which is paler yellow to whitish along its edges. The labrum and the anterior flanges are of the same color as the margins. The extremities are often tinted darker brown above the lateral flanges and the canals. Usually, a paler area surrounds the shell, separating the darker margins from the colorful dorsum. The dorsal pattern consists of darker orange to olive brown patches, blotches, and fine circular spots. A paler dorsal line

of variable width is formed on the left side above the labrum. There are widely spaced, indistinct, small darker reddish brown spots along the margins on both sides. Darker colored shells tend to have finer dorsal spotting, whereas, paler orange shells are vividly mottled or blotched. Both varieties occur within the same population. A peculiarity only found in the nominate subspecies is a conspicuous circular dot of dark brown to black color situated towards the anterior half of the dorsal bulge, present in about every fifth shell.

The animal of *U. a. armeniaca* has a thin, cream-colored, yet transparent mantle with densely-placed, variably-sized dendritic papillae (class 4f after LORENZ & HUBERT, 1993). There are darker transverse dashes and circular whitish patches distributed across the mantle. The tentacles and the foot are yellow to orange.

Habitat and distribution

U. a. armeniaca is dredged in the Great Australian Bight, between Eyre and Ceduna, approximately 80 to 100 km offshore, at 100 to 200 m (Type locality: 185 m depth, 100 km offshore, 130 km southwest of Eucla).

***Umbilia armeniaca andreysi* n. ssp.**

Material

- Holotype: 68.1×43.4×38.6 (34:25) 38.0 g; Cape Mentelle, 130 to 140 m, coll. WAM S 80353
 Paratype 1: 67.6×42.6×36.2 (32:23) 43.5 g; Cape Mentelle, 135 to 140 m, coll. CLSF 14917
 Paratype 2: 66.9×42.8×38.1 (29:23) 49.0 g; Mandurah area, coll. M. BEALS
 Paratype 3: 70.2×42.4×37.2 (29:24) 45.5 g; Rottnest Shelf, 200 m, coll. CLSF 9297
 Paratype 4: 74.0×46.3×41.8 (33:25) 58.8 g; Mandurah area, coll. M. BEALS
 Paratype 5: 70.1×43.3×38.7 (32:19) 48.0 g; Mandurah area, 150 m, coll. MAM 3147
 Paratype 6: 69.4×42.6×38.5 (32:23) 45.2 g; Mandurah area, coll. J. D. DAUGHENBAUGH
 Paratype 7: 70.5×46.0×40.5 (33:22) 54.0 g; Mandurah area, coll. W. P. CARGILE
 Paratype 8: 78.1×49.1×44.0 (34:25) 55.4 g; Mandurah area, coll. M. HISCOCK
 Paratype 9: 78.1×52.2×45.5 (35:29) 57.7 g; Mandurah area, coll. M. HISCOCK
 Paratype 10: 70.8×45.0×41.0 (34:23) 57.8 g; Mandurah area, coll. M. HISCOCK
 Paratype 11: 72.0×46.0×42.0 (31:21) 51.7 g; Mandurah area, coll. J. DEPRez

Paratype 12: 82.6 × 54.4 × 48.2 (32 : 24) 102.0 g; E. of Augusta, 180 m, coll. P. IGNOTI

Paratype 13: 75.5×44.5×48.2 (31:22) 60.0 g; SSW of Rottnest Is., 180-220 m, coll. T. KANEKO

Paratype 14: 65.5×40.5×37.3 (30:25) 42.0 g; 8 miles N of Rottnest Is, 250 m, coll. F. GUARRACINO

Description

The shells are moderately small (66 to 83 mm) and heavy (mR=13.6). The dorsum is almost globular and inflated. The base is strongly callused and convex. The labrum has a strongly thickened edge along the aperture. The anterior extremity is short, tapering, and barely- or not at all flanged. The edge of the anterior canal is rather blunt. The posterior extremity is short and callused. The spire is large and slightly umbilicate, leaving the pointed protoconch exposed. The aperture is equally wide throughout, curved parallel to the columella, and bent to the left at the posterior end. The labral margin is callused and rounded, also towards the extremities. The labral teeth are numerous, short, and less distinct midways. They are slightly extending onto the lip anteriorly. The columellar teeth are coarse throughout, with narrower interstices midways. They are not extending onto the base, but somewhat into the shell. The fossula is weakly developed. Dorsally on the anterior canal, there is a wide, shallow groove.

The ground color is porcelain-white. There is a compact orange-brown zone covering the mid-portion of the dorsum. It has a few indistinct lacunae and is overlaid by whitish-blue enamel. The borders of this zone are slightly darker, especially those along the left (columellar) margin. Above the labral side, there is a similar elongate darker zone, which also has a darker border along its edges and overlaid by whitish-blue enamel. A wide, pale yellow, and white mottled dorsal line extends from the spire across the labral third of the dorsum to continue as groove above the anterior extremity. Posteriorly, it joins the unpigmented zone above the spire and along the left side. The extremities and the areas above the basal callus are pale yellow-orange, whereas, the basal callus of the labrum, the extremities and a wide area bordering the aperture are porcelain-white. The callus of the basal bulge is a pale yellow-cream.

Paratype 1 was collected three months ago. It shows a similar distribution of pattern, but they are saturated brown to orange-brown, contrasting to the plain white background color which is visible along the area of the dorsal line, scattered parts of the sides, and the basal callus on the mid-labrum

and towards the extremities on the columellar side. The labral and columellar teeth, as well as an area along the mid-section of the apertured are saturated purple.

The animal characteristics are unrecorded.

Note: The holotype is a very slightly subadult but otherwise characteristic shell in which the marginal and basal callosities have not fully formed. It is therefore excluded from the statistical analysis.

Habitat and distribution

The holotype of *Umbilia a. andreysi* n. ssp. was collected by a remote operated vehicle (ROV) at 130 to 140 m off Cape Mentelle near Margaret River, in the southwest of Western Australia. Other specimens were found west of Rottnest Is., in the northeast of Cape Naturaliste, but most shells from the western coast are labeled "off Mandurah" (BEALS, 1996). Paratype 1 was collected by ROV at 135 m, crawling on a sand, rubble and sponge bottom at night. All known specimens were collected offshore, at 100 to 220 m. Few specimens have been found outside this area. The typical specimen claimed to come from the Albany area taken at "60 m+" illustrated in WILSON & CLARKSON 2004 (pl. 368 fig. b) is in the collection of PETER IGNOTI. The correct data is "between Windy Harbour and White Point, east of Augusta, at 180 m". It is paratype 12 of *a. andreysi*. Incidentally, the shell illustrated in WILSON (1993, pl. 30 fig. 12), also claimed to come "off Albany" and was later revealed to be from the Rottnest Shelf (MORRISON, pers. comm.). It is now in the collection of the CLSF and is paratype 3 of *a. andreysi*. Whether the distribution of *a. andreysi* reaches as far east as Albany is uncertain.

Etymology

This rare subspecies is named in honor of the late ANDREY KOSTIN (1979-2011), conchologist from Moscow, Russia, and close friend of the first author. His engagement in the shell scene over the past years has contributed considerably to the study of the cowries.

Umbilia armeniaca clarksoni n. ssp.

Material

Holotype: 95.5×56.9×48.1 (41:32) 63.1 g, coll. WAM S 80352

Paratype 1: 92.7×58.7×48.3 (35:28) 59.4 g, coll. M. BEALS

Paratype 2: 98.8×58.2×48.4 (4:30) 68.2 g, coll. A. KOSTIN

Paratype 3: 92.3×55.1×45.2 (42:31) 55.7 g, coll. M. BEALS

Paratype 4: 94.6×56.4×47.3 (38:31) 58.4 g, coll. CLSF 9308

Paratype 5: 106.3×63.7×54.6 (50:30) 78.3 g, coll. M. HISCOCK

Paratype 6: 92.8×55.3×46.9 (37:27) 58.2 g, coll. CLSF 2822

Paratype 7: 97.1×57.3×47.7 (45:33) 71.8 g, coll. M. HISCOCK

Paratype 8: 95.3×57.6×48.2 (37:28) 65.1 g, coll. J. D. DAUGHENBAUGH

Paratype 9: 97.7×57.3×48.9 (41:33) 74.5 g, coll. F. GOVAERT

Paratype 10: 93.8×55.2×45.3 (37:27) 58.3 g, coll. MAM 3142

Paratype 11: 92.2×53.4×43.5 (36:29) 58.0 g, coll. MAM 4393

Paratype 12: 80.4×46.6×38.8 (34:29) 40.0 g, coll. S. WILSON

Paratype 13: 93.2×57.5×48.6 (37:29) 55.1 g, coll. MAM 3149

All from Cape Le Grande, Esperance.

Paratype 14: 79.8×51.8×44.1 (36:26) 51.1 g, coll. J. DEPPEZ

From offshore Esperance, trawled

Description

The shell is rather large (80 to 106 mm) and lightweight (mR =8.47), with a low dorsum and a flat, hardly callused base. The anterior extremity is long and delicately tapering, and slightly flanged on both sides. The edge of the anterior canal is rather thin, but not bent up. The posterior extremity is rostrate and moderately thin-walled. The spire is large and deeply umbilicate, with an exposed protoconch. The aperture is rather wide, curved parallel to the columella, and slightly bent to the left in the posterior end. The labrum is rather angular throughout and hardly callused, its base is flat. The labral teeth are numerous and equally distinct, extending onto the lip towards the anterior end. The columellar teeth are fine, less distinct midways, and barely extending towards the columella or base. In the anterior third, they are more pronounced. The fossula is weakly developed. A groove above the anterior canal is wide and shallow.

The dorsal ground color is saturated yellow-brown. The shell's interior is pale brown. The marginal and basal callosities are yellow-cream. The base and labrum are slightly darker. The extremities are stained darker brown above the lateral flanges and the canals. Along the mid-section of the shell, there is a pale blue hue between the dorsum and both

margins. The transition between the paler, indistinctly spotted margins and the dorsum is narrow. The dorsum is coated with dark brown patches and numerous small, dense dark reddish-brown to nearly black spots. These are often surrounded by paler shades of blue. A dorsal line is not discernible in the holotype. The paratypes agree with the holotype in all morphological aspects except that some specimens have a distinct, narrow paler dorsal line enhanced by rows of dark spots or a frame of darker color. The density and darkness of the dorsal pattern varies slightly: it is generally dense and fine. The grey to blue marginal zones are always present, and in some specimens bluish shades are spread across the dorsum.

The external features of the living animal (Text-Fig. 5) closely resemble those of typical *a. armeniaca*.

Habitat and distribution

Shells of *U. a. clarksoni* n. ssp. have been collected by divers at 30 to 35 m on a sandy low profile limestone reef among sponges, crawling with fully extended mantles at night, in a small area between Woody Island and Cape Le Grande, Esperance (type locality). Further specimens have been collected by scallop trawlers in the Esperance area, at 40 to 45 m (see WILSON & CLARKSON 2004 pl. 368 fig. f, WILSON (1993) pl. 30 fig. 13, and pl. 4 fig. 6 herein). Based on these findings, it is likely that the main population of *a. clarksoni* n. ssp. lives further offshore and only occasionally spreads into the area where divers collected their shells.

Etymology

We are naming this spectacular cowry in the memory of the late PETER CLARKSON († Feb. 2010), world renowned Australian shell diver, underwater photographer, book-author, and friend. PETER also donated the holotype specimen of this new subspecies.

Umbilia armeniaca diprotodon n. ssp.

Material

Holotype: 104.3×66.2×56.8 (38:31) 127.9 g, coll. WAM S 80351

Paratype 1: 109.4×65.5×56.5 (41:32) 154.1 g, coll. F. LORENZ

Paratype 2: 112.1×68.1×58.4 (39:29) 155.8 g, coll. M. BEALS

Paratype 3: 105.5×69.7×60.0 (37:26) 138.2 g, coll. MAM 3143

- Paratype 4: 100.7×61.9×55.8 (36:31) 110.0 g, coll. M. BEALS
 Paratype 5: 106.2×70.5×59.6 (40:28) 156.0 g, coll. MAM 3144
 Paratype 6: 117.5×73.6×62.0 (41:32) 184.7 g, coll. J. D. DAUGHENBAUGH
 Paratype 7: 105.9×67.5×56.6 (39:28) 149.7 g, coll. M. BEALS
 Paratype 8: 108.2×65.5×56.9 (37:32) 144.3 g, coll. MAM 3145
 Paratype 9: 103.1×65.9×55.0 (37:27) 123.2 g, coll. J. D. DAUGHENBAUGH
 Paratype 10: 110.5 × 67.4 × 58.3 (41 : 32) 156.2 g, coll. M. BEALS
 Paratype 11: 106.8×66.9×57.8 (41:35) 138.0 g, coll. CLSF 1546
 Paratype 12: 110.7×67.1×58.7 (35:31) 146.0 g, coll. MAM 3146
 Paratype 13: 117,4×72,3×60,1 (40:34) 154,0 g, coll. CLSF 1547
 Paratype 14: 103.3×65.4×55.9 (38:27) 143.0 g, coll. CLSF 9305
 Paratype 15: 105.6 × 67.9 × 57.7 (37 : 29) 128.0 g, coll. CLSF 9302-1
 Paratype 16: 108.5×66.7×56.9 (33:32) 133.0 g, coll. CLSF 9302-2
 Paratype 17: 111.7×68.8×59.4 (40:33) 152.0 g, coll. CLSF 9302-3
 Paratype 18: 113.4×66,8×57.2 (37:31) 156.0 g, coll. CLSF 9302-4
 Paratype 19: 102.7×62.1×51.3 (35:28) 109.0 g, coll. CLSF 9303-2
 Paratype 20: 101.8 × 64.6 × 53.6 (37 : 29) 127.0 g, coll. CLSF 9304
 Paratype 21: 108.5×65.5×54.8 (38:32) 144.3 g, coll. MAM
 Paratype 22: 92.8×67.8×58.4 (38:30) 133.2 g, coll. MAM
 Paratype 23: 106.2×66.0×56.5 (35:32) 157.6 g, coll. A. BENNETT
 Paratype 24: 101.3×66.5×57.0 (35:33) 148.0 g, coll. MAM 3193
 Paratype 25: 107.2×66.0×56.6 (38:31) 128.2 g, coll. J. DEPREZ
 Paratype 26: 109.1×69.7×59.8 (37:29) 144.7 g, coll. J. DEPREZ
 Paratype 27: 93.6×60.1×52.5 (-) 117.0 g, coll. P. STIMPSON
 Paratype 28: 110.0×69.4×57.8 (-) 128.0 g, coll. P. STIMPSON
 Paratype 29: 105.1×59.6×58.8 (-) 133.0 g, coll. P. STIMPSON
 Paratype 30: 116.4×74.5×63.7 (-) 184.0 g, coll. P. STIMPSON
 Paratype 31: 100.0×66.8×56.2 (-) 109.0 g, coll. P. STIMPSON
 Paratype 32: 106.8×69.8×58.2 (-) 150,5 g, coll. D. LUM
 Paratype 33: 111.5×70.0×69.4 (-) 156.0 g, coll. M. HART
 Paratype 34: 111.7×69.5×58.3 (40:31) 156.0 g, coll. M. HART
 Paratype 35: 115.5×72.5×62.4 (-) 178.7 g, coll. F. GOVAERT
 Paratype 36: 103.9×68.7×58.3 (-) 144.2 g, coll. F. GOVAERT
 Paratype 37: 106.2×69.2×57.8 (-) 144.0 g, coll. F. GOVAERT
 Paratype 38: 102.6×64.5×55.4 (-) 130.0 g, coll. F. GOVAERT
 Paratype 39: 101.7×67.6×58.2 (-) 130.7 g, coll. F. GOVAERT
 Paratype 40: 104.9×66.1×58.9 (-) 143.8 g, coll. F. GOVAERT
 Paratype 41: 99.8×65.2×59 (-) 150.0 g, coll. J. JOSEPH
 Paratype 42: 114.0×69.7×59.9 (-)145.0 g, coll. T. KANEKO
- All but no. 19 from Thorny Passage, Port Lincoln area. No. 19 from Investigator Strait, West Kangaroo Island.

Description

The shells are large (92 to 117 mm) and heavy (mR=11.7), with a humped dorsum and a slightly flat, callused base. The anterior extremity is short and solid, with thick flanges on both sides. The edge of the anterior canal is blunt. The posterior extremity is rostrate and callused. The spire is small and deeply umbilicate and the protoconch is partly exposed. the aperture is curved parallel to the columella and bent to the left at the posterior end. The labral margin is rounded and callused. The labral teeth are numerous, short, and distinct, while being more pronounced and longer towards the extremities on both ends. The columellar teeth are rather fine, short, and partially extending onto the base above the fossular area. The fossula is not projecting and hardly developed. There is a shallow groove above the anterior canal.

The dorsal ground color is pale yellow-brown. The shell's interior is pale pink. The marginal and basal callosities are a uniform cream-orange. The base and labrum are notably darker. The extremities are stained darker brown above the lateral flanges and the canals. There is a greyish to blue zone between the dorsum and the left margin. The labral margin is of the same color as the base, with crowded darker spots. The dorsum is covered with numerous, confluent brown to nearly black spots and irregular brown patches. A paler dorsal line is enhanced by a row of dark spots. The paratypes agree with the holotype in all morphological aspects. The density and distribution of the dorsal pattern varies. The grey to blue marginal zone is always discernible. Specimens from deeper water off Thistle Island and Investigator Strait tend to be

smaller and less inflated. They resemble *a. clarksoni* n. ssp. in general appearance (see WILSON & CLARKSON (2004) pl. 367 a, c).

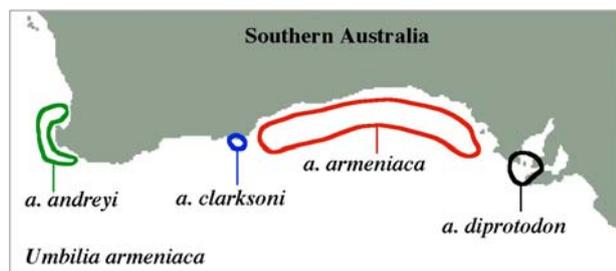
The external features of the living animal (Text-Fig. 6) agree with those of typical *a. armeniaca* and *a. clarksoni* n. ssp.

Habitat and distribution

Most known specimens of *U. a. diprotodon* n. ssp. are from Thorny Passage, near Port Lincoln (type locality, and all paratypes except No. 19), to Investigator Strait, western Kangaroo Island, South Australia (paratype 19), and off Thistle Is., Spencer Gulf. At Thorny Passage, they were collected by divers at 20 to 35 m, on a sandy bottom with sponges; specimens from the Kangaroo Island area have been trawled at 40 to 60 m.

Etymology

The *Diprotodon* was the largest known marsupial, with a height of 2 m, a length of 3 m, and an estimated weight of nearly 3 tons. It became extinct around 45,000 years ago. We thought that this would be an appropriate name for the largest and heaviest living Australian endemic cowry.



Map 1: Distribution of the subspecies of *Umbilia armeniaca*.

Historical notes

In their chapter on *Umbilia armeniaca*, WILSON & CLARKSON (2004) give a comprehensive summary of all the facts and background concerning this attractive Australian endemic species. They did not distinguish between the four populations described herein, but show numerous illustrations which can easily be attributed to the four subspecies:

U. a. armeniaca: p. 355 fig. a, b; map 21, 7 figs. in center; pl. 366 a-g; pl. 376

U. a. andreysi n. ssp.: map 21, 4 figs. on left; pl. 368 a, b;

U. a. clarksoni n. ssp.: front cover; p. vi top (living animal); pl. 18; pl. 27; pl. 37; p. 355 fig. d; map 21, 3 figs bottom left; pl. 368 c-f; Pl. 373-375

U. a. diprotodon n. ssp.: pl. 29; pl. 363; p. 355 fig. c; pl. 364; pl. 365; map 21, 4 figs. right; pl. 367 a-g; pl. 370-372

Dr. LUIGI RAYBAUDI was the first to make an attempt to subdivide *a. armeniaca* into two "geographical" variations; *westralica* and *south-stralica* (RAYBAUDI, 1980), however just a small number of shells were available at that time, and only being able to speculate on their origin made distinguishing them even more problematic. The names are taxonomically invalid and of no use, as they are based on "commercial selection" of typical variations of *a. armeniaca*. In World Shells 1, p. 15 ff., RAYBAUDI revises the species and re-defines the two varietal names. HUBERT (1992) discussed this treatise as a contradiction to the original intention of those names. Also WILSON & CLARKSON suggested to "allow them to quietly vanish" and we fully agree.

The large and dark *a. diprotodon* n. ssp. from Thorny Passage near Port Lincoln is universally known under the varietal name "*brunnea*", but it was never officially described or explicitly referred to as the eastern population. The name was first used on the back cover of the World Shells Magazine No. 4 (1993), but with no further data on origin. It is not even clear who signed as author in this case, but RAYBAUDI later cited himself as author (e.g. World Shells 11 (1994) p. 63). An earlier, but completely overlooked name (*f. hypersaturata*) given to *a. diprotodon* n. ssp. was published in the above mentioned revision in World Shells 1, but it was never used since. In World Shells 21-22 (1997) p. 107, RAYBAUDI finally abrogated *brunnea* for the eastern population by illustrating such a specimen as "*Umbilia armeniaca*" and an Esperance specimen (*a. clarksoni* n. ssp.) as *Umbilia armeniaca* f. *brunnea*.

Discussion

Study of the protoconch and egg cluster reveals that the four Australian endemic genera *Umbilia*, *Zoila*, *Austrocypraea*, and *Notocypraea* have intracapsular ("direct") larval development that puts limitations to a constant gene flow over larger distances (WILSON, 1985). In contrast to species with a planktonic veliger stage, the intracapsular developers have restrictions in horizontal as well as vertical dispersal. Their species tend to display a greater amount of conchologically distinct geographical and bathymetrical populations (LORENZ, 2002).

Taxonomists currently recognize five living species in the genus *Umbilia*: *armeniaca* (VERCO, 1912), from southern and southwestern Australia, *hesitata* (IREDALE, 1916), from Victoria and New South Wales, *oriettae* LORENZ & MASSIGLIA, 2005, from the Cape Moreton area, *capricornica*

LORENZ, 1989 and *petilirostris* DARRAGH, 2002, from Queensland. Their validity is supported by mtDNA analysis, except for that of *U. oriettae*, which has not been tested so far (MEYER, 2004 and pers. comm.).

	<i>a. armeniaca</i>	<i>a. andreysi</i> n. ssp.	<i>a. clarksoni</i> n. ssp.	<i>a. diprotodon</i> n. ssp.
Distribution and depth range	G.A.B, 100 to 200 m	WSW Australia, 100 to 200 m	Esperance area, 30 to 45 m	Pt. Lincoln area, 20 to 60 m
Formula	[87(63–55)24:19]	[72(63–57)22:17]	[94(60–50)24:19]	[107(63–54)22:18]
Size range	70 to 110 mm	66 to 78 mm	92 to 106 mm	100 to 117 mm
mR(%)	10.9	13.6	8.5	11.7
Dorsal profile	humped	humped	flattened	humped
Anterior extremity	flanged, broad, rather thin	hardly/not flanged, short, callused	hardly flanged, long, rather thin	slightly flanged, short, callused
Base	convex, callused	convex, strongly callused	flat, not callused	rather flat, callused
Teeth at columella	fine, short	coarser, longer	less distinct, short	fine, short
Color pattern	mottled or spotted, mostly pale	mottled or spotted, mostly pale	very dark and dense, blue stain	densely mottled, dark with blue stain
Color near aperture	as base, or darker	porcelain-white	pale, as base	dark, as base

Table 1: The most important differences between the four subspecies of *Umbilia armeniaca*.

Umbilia armeniaca has a wide distribution for an intracapsular developing species of Cypraeidae, reaching from the Rottneest Shelf area in Western Australia, across the Great Australian Bight, to Kangaroo Island in South Australia (map 1). It is only outdone by *Austrocypraea reevei* (SOWERBY I, 1832), whose distribution reaches a bit further to the north in Western Australia.

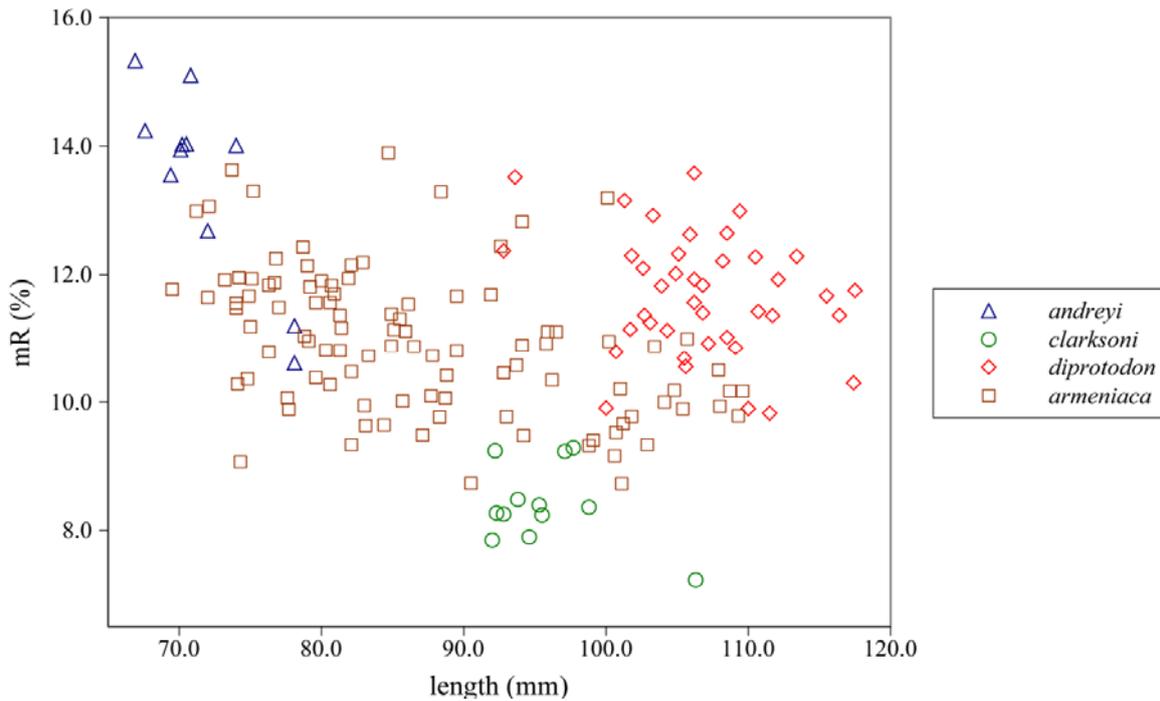
We recognize four morphologically distinct subspecies herein:

1. *U. armeniaca armeniaca* (VERCO, 1912) from deeper water off the Great Australian Bight. It has the widest distribution and shows considerable conchological variability.
2. *U. armeniaca andreysi* n. ssp. from deeper water off the West Coast displays no significant conchological variability.
3. *U. armeniaca clarksoni* n. ssp. from shallow water in the Esperance area shows very little variation. Few shells have ever been collected, and none in recent years.
4. *U. armeniaca diprotodon* n. ssp. from shallow water in the eastern limit of distribution shows little variation in most features, except the characteristics of its dorsal pattern. Approximately one-hundred specimens are estimated to have been collected by divers in the Thorny Passage area during the 1990's. As in *a. clarksoni* n. ssp., there have not been recent sightings.

The most important conchological differences between the four *U. armeniaca*-subspecies are summarized in Table 1. The shell formulae show that all subspecies of *armeniaca* have similar proportions, except *a. clarksoni* n. ssp., which is more elongate and less humped. The impression that *a. andreysi* n. ssp. is slightly more inflated and stunted is also reflected by the morphometric data. The number of teeth is remarkably similar, with the exception of *a. andreysi* n. ssp., which has fewer teeth on both sides. The size differences are considerable, especially in *a. andreysi* n. ssp., which varies less in size and is generally a dwarf compared to *a. diprotodon* n. ssp. from the far end of the species' distribution.

The relative masses (mR) confirm the subjective feeling one gets when holding these shells in one's hands: *a. andreysi* n. ssp. is the most solid and heavy, *a. clarksoni* n. ssp. a lightweight, whereas, *a. diprotodon* n. ssp. is heavier than similar sized *a. armeniaca*. Text-Fig. 1 illustrates the mR of the four *armeniaca* subspecies against the shell's length.

Of the four subspecies *a. clarksoni* n. ssp. has the lowest dorsal profile. It can be discerned that *a. diprotodon* n. ssp. tends to be less humped than *a. armeniaca*. However, it is obvious that *a. andreysi* n. ssp. is the most globular and humped (Text-Fig. 2).



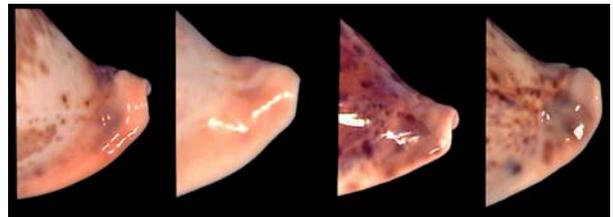
Text-Fig. 1: Relative mass (mR) against shell length.



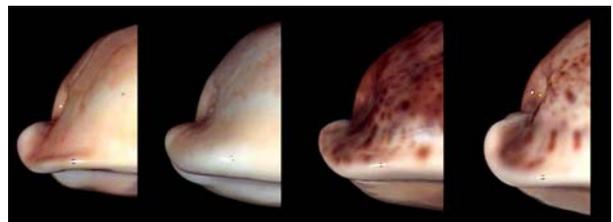
Text-Fig. 2: Shell profiles (not to scale) from left to right: *a. armeniaca*, *a. andreyi* n. ssp., *a. clarksoni* n. ssp., *a. diprotodon* n. ssp.. Note the dark spot in *a. armeniaca* on the left. These are commonly found in the nominate subspecies, usually in exactly this position, but never in the other three.

Another interesting detail is the formation of the anterior flanges left and right of the canal (Text-Fig. 3). In *a. armeniaca*, they are quite expanded and separated from the extremity by a shallow groove dorsally. In *a. diprotodon* n. ssp., the flanges are less well-defined, also because the extremity itself is a lot more callused. In *a. clarksoni* n. ssp., the opposite is the case. The extremity is not callused and the flanges are angular, yet reduced. In *a. andreyi* n. ssp., the anterior extremity is short and callused, but the flanges are even more reduced, whereas, the posterior labral side is callused and rounded instead of angular as in all other *a. armeniaca* (Text-Fig. 4).

The different outlines of the base are most apparent when the shells are viewed from the left side (Text-Fig. 2). In *a. clarksoni* n. ssp., the basal bulge is minor, in *a. andreyi* n. ssp. and *a. armeniaca*, it is prominent, and in *a. diprotodon* n. ssp., it is intermediate.



Text-Fig. 3: Anterior flanges (not to scale) from left to right: *a. armeniaca*, *a. andreyi* n. ssp., *a. clarksoni* n. ssp., *a. diprotodon* n. ssp.



Text-Fig. 4: Posterior labral flanges (not to scale) from left to right: *a. armeniaca*, *a. andreyi* n. ssp., *a. clarksoni* n. ssp., *a. diprotodon* n. ssp.

To determine the differences in the dentition requires a sharp eye. Apart from the more pronounced, less numerous and somewhat longer columellar teeth in *a. andreysi* n. ssp., it is interesting to note that due to the strong callosity of the labrum, the teeth become obsolete in the area opposite to the columella.

Color pattern plays an important role in recognizing species and subspecies. In the case of the different *armeniaca*, the differences between the two deep-water and the two shallow water subspecies are especially striking. Occasional dark spotted, fresh *a. armeniaca* can be similar to *a. diprotodon* n. ssp. It is important to note that the blue stain along the margins found in *a. diprotodon* n. ssp. and *a. clarksoni* n. ssp. is always absent in *a. armeniaca*. This coloration is caused by the microstructure of the shell, and does not fade over time as blue color pigments do. On the other hand, the circular dark spot on the dorsum, common in *a. armeniaca*, is completely lacking in the spectrum of patterns observed in the other three subspecies.

The distribution of color on the base is important for the distinction of *a. andreysi* n. ssp., in which a broad white zone encircles the aperture as well as the extremities on basal view. The fresh paratype 1 has a purple stain midway on either side of the aperture. This color is fading rapidly since obtaining the shell and we assume that it will vanish completely.

A less obvious detail in the coloration in most *a. armeniaca* and in *a. andreysi* n. ssp. is a zone above the margins in which darker pattern or spots are reduced or completely absent. This is not the case with *a. clarksoni* n. ssp. or *a. diprotodon* n. ssp., both having a far greater amount of small, crowded dark spots than their deep water relatives.

In the few specimens of *a. andreysi* n. ssp. we could study, the protoconch is larger proportionally and the spire is less umbilicate. This feature requires further specimens (juveniles in particular) and precise measurements, but may serve as an interesting subject for future research.

So far, mtDNA studies have been conducted on *a. armeniaca*, *a. clarksoni* n. ssp., and *a. diprotodon* n. ssp.. They did not reveal consistent differences in the regions tested, which is not a surprise in this group of intracapsular developers. Similar results have been found in the study of other genera with this reproductive mode, whose species and subspecies have evolved recently and more rapidly

than those of genera with planktonic dispersal mechanisms (Dr. CHRISTOPHER MEYER, pers. comm.).

The splitting of intracapsular developers, such as species of *Zoila* into geographical and even bathymetric subspecies, has been pursued comprehensively to give appropriate credit to the diversity of this genus (the works of RAYBAUDI 1978-1997, LORENZ & HUBERT 1993, 2000, CHANDLER & DUROSS 1997, LORENZ, 2001, 2002, 2011, KOSTIN, 2005, LORENZ & CHIAPPONI 2007). WILSON & CLARKSON (2004) criticized most taxonomic placements made by other authors, but used all of the "synonyms" to address the shells they illustrated. Naming the four conchologically distinct populations of *Umbilia armeniaca* is a logical consequence from the taxonomical treatment of the *Zoila*.



Text-Fig. 5: *Umbilia armeniaca clarksoni* n. ssp., living animal. Paratype 1. Esperance area. Photo PETER CLARKSON.

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available as paratypes. HUGH MORRISON, KIM BACK, and CHRISTOPHER GOUDEY supplied additional specimens. ANDREW EDINGER and JOHN CLARK provided additional data and information. JANA KRATZSCH and Dr. MICHAEL A. MONT checked and helped edit the manuscript. Many thanks also to KLAUS GROH for careful editing.



Text-Fig. 6: *Umbilia armeniaca diprotodon* n. ssp., living animal. Thorny Passage. Photo PETER CLARKSON.

References

- BEALS, M. (1996): *Umbilia armeniaca* (VERCO, 1912): A western range extension. – *World Shells*, **17**: 72-73, figs. 1-5.
- CHANDLER, J. & DUROSS, C. (1997): A new *Zoila* discovered. – *World Shells*, **20**: 65-67.
- DARRAGH, T. A. (2002): A revision of the Australian genus *Umbilia* (Gastropoda: Cypraeidae). – *Memoirs of the Museum of Victoria*, **59**: 355-392.
- HUBERT, A. (1992): *Umbilia armeniaca* VERCO, 1912. On subdividing this species. – *World Shells*, **2**: 35.
- KOSTIN, A. (2005): Naming the northern *Zoila friendii* GRAY (Mollusca: Gastropoda: Cypraeidae). – *Visaya* **1** (4): 30-39.
- LORENZ, F. (2001): Monograph of the living *Zoila*. – 187 pp., 28 figs., 54 pls.; Hackenheim, Germany (ConchBooks).
- LORENZ, F. (2002): New Worldwide Cowries. Descriptions of new taxa and revisions of selected groups of living Cypraeidae (Mollusca: Gastropoda). – *Schriften zur Malakozoologie*, **20**: 1-292, 40 pls., also appeared in hardcover ed. at ConchBooks, Hackenheim, Germany.
- LORENZ, F. (2011): A new species of *Zoila* from SW Australia (Gastropoda: Cypraeidae). – *Schriften zur Malakozoologie (Cismar)*, **26**: 11-14.
- LORENZ, F. & CHIAPPONI, M. (2007): The deep water subspecies of *Zoila friendii* GRAY 1831 (Gastropoda: Cypraeidae). – *Schriften zur Malakozoologie*, **23**: 39-44, pls. 7-8.
- LORENZ, F. & HUBERT, A. (1993): A Guide to Worldwide Cowries. – 571 pp., 124 pls.; Wiesbaden, Germany (Verlag CHRISTA HEMMEN).
- LORENZ, F. & HUBERT, A. (2000): A Guide to Worldwide Cowries, 2nd revised and enlarged edition. – 584 pp., 52 + 19 figs., 128 pls.; Hackenheim, Germany (ConchBooks).
- MEYER, C. P. (2004): Toward Comprehensiveness: Increased molecular sampling within Cypraeidae and its phylogenetic implications. – *Malacologia*, **46** (1):127-156.
- RAYBAUDI MASSILIA, L. (1980): *Umbilia (Umbilia) armeniaca* VERCO, 1912. – *La Conchiglia*, **12** (134-135):11-14, 8 unnumbered figs.
- RAYBAUDI MASSILIA, L. (1992): *Umbilia armeniaca* VERCO, 1912. – *World Shells*, **1**:15-21, figs. 1-6 + card 14.
- [RAYBAUDI MASSILIA, L.] (1993): *Umbilia armeniaca*, f. *brunnea*. – *World Shells*, **5**: inside front cover, 2 unnumbered figs. + cover.
- RAYBAUDI MASSILIA, L. & LOBETTI BODONI, F. (1994): *Umbilia armeniaca*. – *World Shells*, **11**: 63, card 14.
- VERCO, J. C. (1912): Shells from the Great Australian Bight. – *Transactions of the Royal Society of South Australia*, **36**: 206-232, pls. 10-14, 16.
- WILSON, B. R. (1985): Direct development in southern Australian cowries (Gastropoda: Cypraeidae). – *Australian Journal of Freshwater Research*, **36**:267-280, figs. 1-7.
- WILSON, B. R. (1993): Australian marine shells. Prosobranch Gastropods, Part 1. – 408 pp., numerous unnumbered figs., 44 pls.; Perth, Western Australia (Odyssey Publishing).
- WILSON, B. R. & CLARKSON, P. (2004): Australia's spectacular Cowries. A Review and Field Study of Two Endemic Genera: *Zoila* and *Umbilia*. – 396 pp., 383 pls.; El Cajon, California, USA (Odyssey Publishing).

Plate 1 on opposite p. 107

Umbilia armeniaca armeniaca (VERCO, 1912)

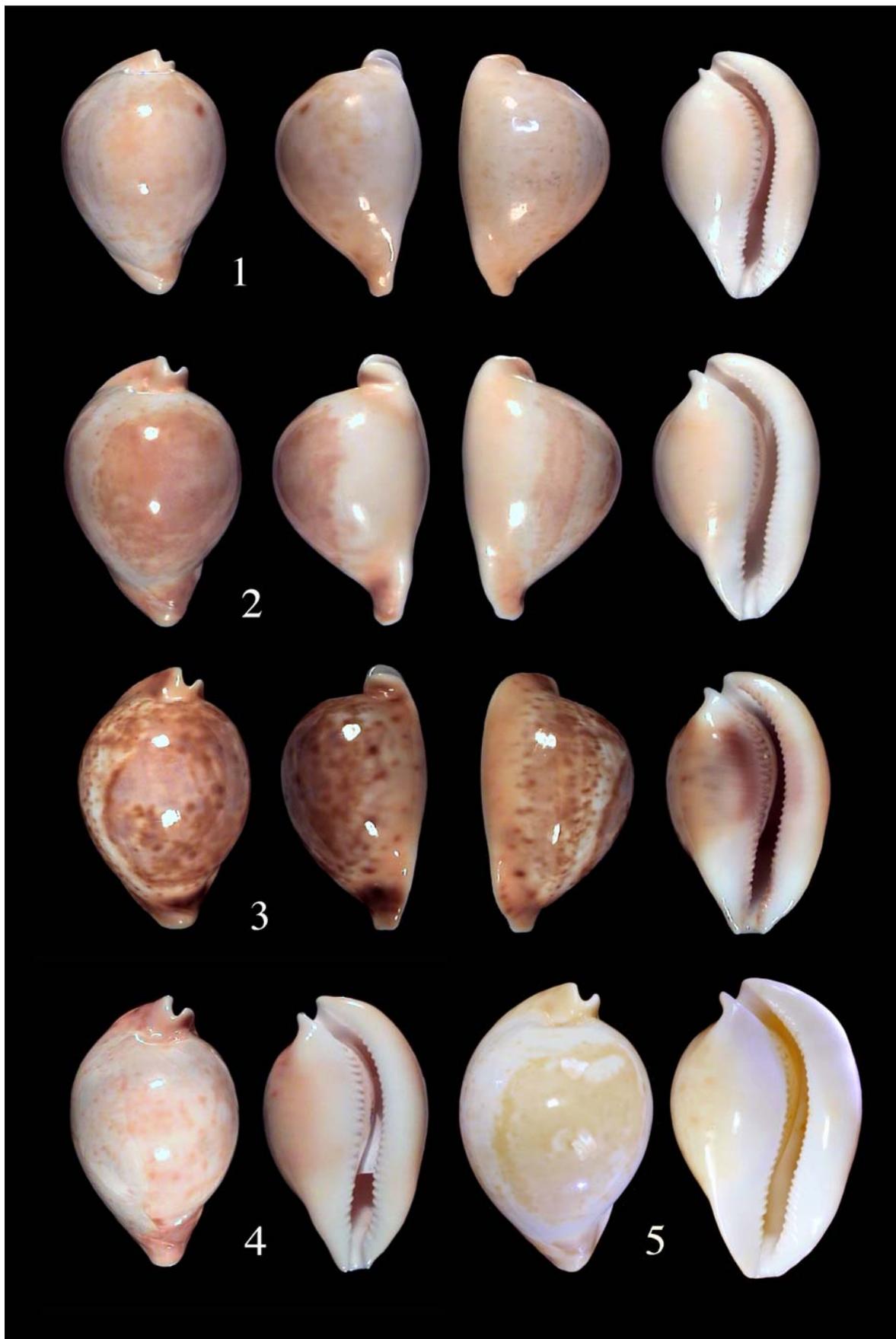
Figs 1-8: Typical variations. Largest shell 110 mm. Great Australian Bight, off 140 to 200 m

Plate 1



Explanation on p. 106

Plate 2



Explanation on p. 110

Plate 3



Explanation on p. 110

Plate 2 on p. 108

Umbilia armeniaca andreysi n. ssp.

Fig. 1: Holotype; 68 mm Cape Mentelle, Margaret River, W. Australia. Coll. WAM S 80353

Fig. 2: Paratype 5; 70 mm Mandurah area, 150 m, W. Australia. Coll. MAM 3147

Fig. 3: Paratype 1; 68 mm Cape Mentelle, Margaret River, W. Australia. Coll. CLSF 14917

Fig. 4: Paratype 3; 70 mm Rottneest Shelf, off 200 m, W: Australia. Coll. CLSF 9297

Fig. 5: Paratype 13; 76 mm SSW of Rottneest Is., 180-220 m coll. T. KANEKO

Plate 3 on p. 109

Umbilia armeniaca clarksoni n. ssp.

Fig. 1: Holotype; 96 mm Cape Le Grande, Esperance, SW Australia. Coll. WAM S41202

Fig. 2: Paratype 5; 106 mm Cape Le Grande, Esperance, SW Australia. Coll. M. HISCOCK

Fig. 3: Paratype 3; 92 mm Cape Le Grande, Esperance, SW Australia. Coll. M. BEALS

Fig. 4: Paratype 1; 92 mm Cape Le Grande, Esperance, SW Australia. Coll. M. BEALS

Plate 4 on opposite p. 111

Umbilia armeniaca clarksoni n. ssp.

Fig. 1: Paratype 6; 93 mm Cape Le Grande, Esperance, SW Australia. Coll. CLSF 2822

Fig. 2: Paratype 4; 95 mm Cape Le Grande, Esperance, SW Australia. Coll. CLSF 9308

Fig. 3: Paratype 2; 99 mm Cape Le Grande, Esperance, SW Australia. Coll. A. KOSTIN 521-1

Fig. 4: Paratype 10; 94 mm Cape Le Grande, Esperance, SW Australia. Coll. MAM 3142

Fig. 5: Esperance, SW Australia, collected by scallop trawler off 40-45 m. Coll. P. IGNOTI

Fig. 6: Paratype 14; 79 mm Esperance, SW Australia, trawled. Coll. J. DEPREZ

Plate 4



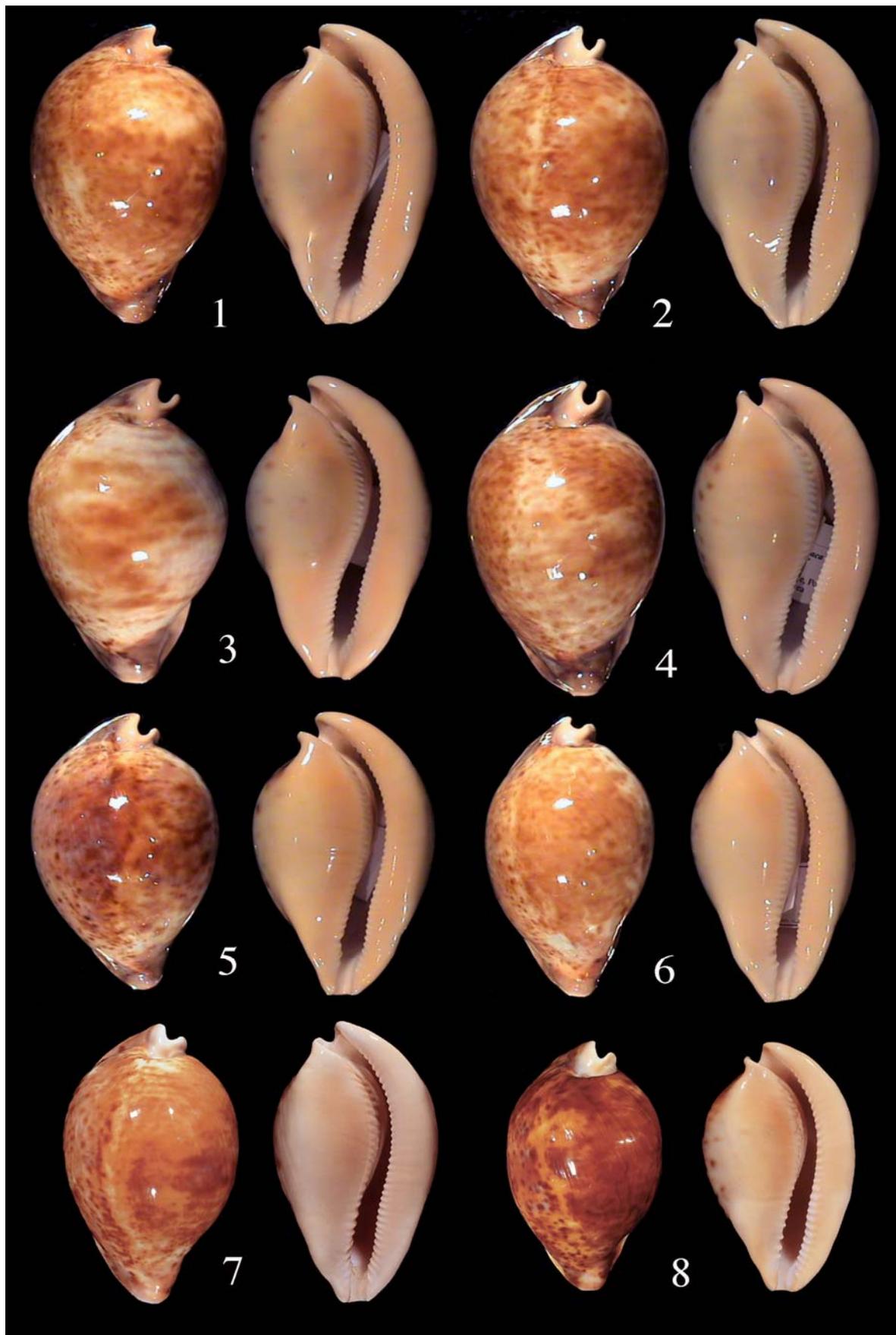
Explanation on p. 110

Plate 5



Explanation on p. 110

Plate 6



Explanation on p. 110

Plate 5 on p. 112

Umbilia armeniaca diprotodon n. ssp.

Fig. 1: Holotype; 104 mm Thorny Passage, S. Australia. Coll. WAM S 80351

Fig. 2: Paratype 5; 106 mm Thorny Passage, S. Australia. Coll. MAM 3144

Fig. 3: Paratype 8; 108 mm Thorny Passage, S. Australia. Coll. MAM 3145

Fig. 4: Paratype 12; 111 mm Thorny Passage, S. Australia. Coll. MAM789

Fig. 5: Paratype 1; 109 mm Thorny Passage, S. Australia. Coll. F. LORENZ

Fig. 6: Paratype 3; 106 mm Thorny Passage, S. Australia. Coll. MAM 3143

Plate 6 on p. 113

Umbilia armeniaca diprotodon n. ssp.

Fig. 1: Paratype 11; 107 mm Thorny Passage, S. Australia. Coll. CLSF 1546

Fig. 2: Paratype 13; 117 mm Thorny Passage, S. Australia. Coll. CLSF 1547

Fig. 3: Paratype 16; 109 mm Thorny Passage, S. Australia. Coll. CLSF 9302-2

(See also WILSON & CLARKSON pl. 367 fig. e and pl. 370 left shell for more images of this specimen)

Fig. 4: Paratype 18; 113 mm Thorny Passage, S. Australia. Coll. CLSF 9302-4

Fig. 5: Paratype 20; 102 mm Thorny Passage, S. Australia. Coll. CLSF 9304

Fig. 6: Paratype 19; 103 mm Investigator Strait, W. Kangaroo Is., S. Australia. Coll. CLSF 9303-2

Figs. 7, 8: Thistle Is., Spencer Gulf. Sizes and depository unknown.

(From WILSON & CLARKSON (2004) pl. 367 figs. a and c)