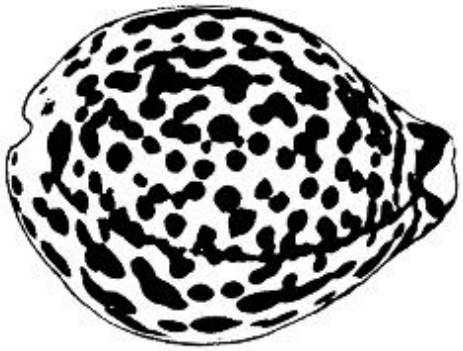
New taxa of Cowries (Gastropoda: Cypraeidae)



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Foreword

This issue of Acta Conchyliorum contains nine works describing fifteen new subspecies of living, as well as one new species of fossil cowries, with different approaches to their characterization. The first paper addresses those members whose molecular data gives strong support for their distinction, although the shells of some of them are quite difficult to separate. The taxonomy of the *Erronea caurica* complex is revised, and the Philippine population of *Mauritia maculifera* is finally given a name. The group of attractive and popular allies of *Bistolida stolida* from the Australian coast is given a closer look, and a new member from Queensland is named. Based on molecular analysis and statistical comparisons, the Marquesan population of "Tiger Cowries" yields a surprise. The Philippine population of *Austrasiatica langfordi* is found to be separable from its relatives. A new bathymetric subspecies of *Austrocypraea reevei* is recognized, and a new subspecies of *Purpuradusta minoridens* from the Indian Ocean. Last but not least, a cowry "dinosaur" is described and illustrated for the first time. It was probably the most impressive member of the family that ever lived.

As the overlap among the cited references is considerable, a cumulative list applicable to all contributions will be given at the end of this volume.

Methods

For shell measurement comparisons, the revised formula to characterize cowry shells (BRIDGES & LORENZ 2013) was used. Dimensions enumerated are: L × W × H in mm (counted labral : columellar teeth) [weight in grams].

The formula contains these elements: (L (W/L - H/L - H/W) LTnl : CTnl [mR].

Abbreviations

CTnl	columellar teeth normalized
CLSF	CHIAPPONI-LORENZ Seashell Foundation, Lecco, Italy
H	height (mm)
HNC	Haus der Natur, Cismar, Germany.
L	length (mm)
LTnl	labral teeth, normalized
MNHN	Museum National d'Histoire Naturelle, Paris, France.
mR	relative mass
MSF	Molluscan Science Foundation, Inc., Owings Mills MD, USA.
NCBI	National Center for Biotechnology Information, Bethesda MD, USA.
NMNH	National Museum of Natural History, Washington DC, USA.
SMF	Forschungsinstitut und Naturmuseum Senckenberg, Frankfurt a. M., Germany.
USNM	United States National Museum – Smithsonian Institution, Washington DC, USA.
WAM	Western Australian Museum, Perth, Western Australia.
W	width (mm)

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Descriptions of new subspecies of cowries (Gastropoda: Cypraeidae)

By CHRISTOPHER P. MEYER & FELIX LORENZ

With 7 Text-Figures, 4 Maps, 5 Tables and 60 Figs on Plates 1-6

Keywords

Cypraeidae, new subspecies, genetic differences.

Abstract

Eight new subspecies of cowries (Cypraeidae) are described. They are characterized mainly by genetic data, but also in most cases, rather subtle conchological differences. *Lyncina ventriculus johnclarki* n. ssp. from Christmas Island differs by an average COI pairwise difference of 2.05 % from the nominate Pacific subspecies. The shell of the new subspecies is broader and higher, the distribution of basal callus differs. *Palmadusta ziczac yzac* n. ssp. from Thailand has a characteristic finer y-shaped zig-zag-pattern and apart from other subtle features, its average COI pairwise difference from other populations of the species is 8.4 %. *Bistolida ursellus jomi* n. ssp. from the eastern Indian Ocean has more numerous teeth, and a 7.1 % average COI pairwise difference separating it from the nominate Pacific subspecies. *Ransionella punctata bridgesi* n. ssp. and *R. p. conleyi* n. ssp. closely resemble other populations of the species conchologically, but their average COI pairwise differences of 9.3 % and 3.3 % respectively, support their recognition as separate subspecies. *Cribrarula abaliena erypersica* n. ssp. from the northwestern Indian Ocean has an average COI pairwise difference of 2.1 % from its sister lineages. The shells resemble *a. ganteri* and differ only in subtle details. *Purpuradusta fimbriata insolita* n. ssp. from Cocos Keeling and Christmas Islands differs from its sister lineages by subtle features of the dorsal banding, the aperture, the formation of the anterior columellar teeth and an average COI pairwise difference of 3.2 %. The name *Mauritia scurra occidua* n. ssp. replaces the improper usage of *scurra* for Indian Ocean populations. It differs from its Pacific sisters by a more inflated shell, narrower netting, denser marginal spots and a different structure of the extremities. The average COI pairwise difference from the nominate *scurra* (12.8 %) is exceptionally high.

Zusammenfassung

Acht neue Unterarten von Kauris (Cypraeidae) werden beschrieben. Sie sind vor allem durch genetische Unterschiede gekennzeichnet, und in den meisten Fällen, subtile morphologische Merkmale. *Lyncina ventriculus johnclarki* n. ssp. von Christmas Island hat ein breiteres, höheres Gehäuse mit andersartiger Verteilung von basalem Kallus und einem durchschnittlichen COI Unterschied von 2.05 % zur Pazifischen Nominatform. *Palmadusta ziczac yzac* n. ssp. aus Thailand trägt ein feineres y-förmiges Streifenmuster, und abgesehen von weitern subtilen Gehäusemerkmales beträgt der durchschnittliche COI Unterschied zu anderen Populationen 8.4 %. *Bistolida ursellus jomi* n. ssp. aus dem östlichen Indischen Ozean besitzt mehr Zähne und einen COI Unterschied von 7.1 % zur Pazifischen *u. ursellus*. *Ransionella punctata bridgesi* n. ssp. aus dem östlichen und *R. p. conleyi* n. ssp. aus dem nordwestlichen indischen Ozean sind den übrigen *punctata*-Unterarten conchologisch sehr ähnlich, haben aber durchschnittliche COI Unterschiede von 9.3 % bzw. 3.3 %, was ihren Status als separate Unterarten untermauert. *Cribrarula abaliena erypersica* n. ssp. aus dem nordwestlichen Indischen Ozean hat einen durchschnittlichen COI Unterschied von 2.1 % zu ihren Schwesterlinien. Das Gehäuse zeigt nur geringfügige Unterschiede gegenüber *a. ganteri*. *Purpuradusta fimbriata insolita* n. ssp. von Cocos Keeling und Christmas Island unterscheidet sich von den anderen Unterarten durch Merkmale in der dorsalen Bänderung, der Apertur und der Zähnung im vorderen Abschnitt, sowie durch einen durchschnittlichen COI Unterschied von 3.2 %. Der Name *Mauritia scurra occidua* n. ssp. korrigiert die Fehlinterpretation von *scurra* für Populationen des Indischen Ozeans. Sie unterscheidet sich von den Pazifischen Schwestern durch ein aufgeblähteres Gehäuse, schmaleres Netzmuster, dichtere Seitenpunkte und andersartig strukturierte Extremitäten. Der COI Unterschied zu *scurra* beträgt ungewöhnlich hohe 12.8 %.

Introduction

It has been more than ten years since a comprehensive treatise on molecular barcoding of the family Cypraeidae was published by the first author (2003, 2004). With the help of these data, the second author has described several taxa of cowries (LORENZ 2002). These descriptions dealt with those species and subspecies whose conchological analysis also supported separation. In addition, numerous evolutionary significant

units have been identified by the first author, but could not be described yet, for various reasons. On one hand, the available comparative material seemed too scarce, and, on the other hand, insufficient morphological differences could be found to support the establishment of new taxa.

Since that time, we have accrued additional material, and also herein confirm the status of several genetically defined subspecies with otherwise minimal conchological differences. In some cases, a thorough revision revealed that the past usage of names was incorrect. The following provides new names for universally accepted subspecies, and adds names for those evolutionary significant units that are largely characterized by genetic, rather than morphological, differences.

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For loan and supply of material, information and support we wish to thank Dr. MARCO CHIAPPONI, HARRY CONLEY †, ERIC LE COURT DE BILLOT, TIM MCDONALD, SVEN KAHLBROCK, IAN MACKIE, Dr. MICHAEL A. MONT, HUGH MORRISON, GRAHAM RYAN, Dr. RICCARDO SCIAKY.

1 An isolated population of *Lyncina ventriculus* (LAMARCK 1810)

The geographic isolation of Cocos Keeling and Christmas Islands in the eastern Indian Ocean supports the formation of local endemism. The most famous example is probably *Turbo lajonkairii* (DESHAYES 1839), a large and distinctive member of the family Turbinidae. Molecular analysis reveals that many populations of cowries found in these islands actually represent the adjacent Pacific subspecies, and not a subspecies of the Indian Ocean. Two cowry lineages show striking molecular differences to any other population and need to be recognized as separate, endemic subspecies. These lineages would fulfill criteria 1 (geographic distinction and allopatry) and 2 (significant genetic distance from the sister group) established by MEYER (2004) to recognize taxa. One of them, *Purpuradusta fimbriata insolita*, is also conchologically distinct and described later in this paper. On the other hand, the only population of *Lyncina ventriculus* (LAMARCK 1810) found in the Indian Ocean barely differs from its Pacific relatives conchologically, but new additional comparative sequence data confirm a significant separation. It is here described as

Lyncina ventriculus johnclarki n. ssp.

(Plate 1 Figs 2-7)

Etymology

In honor of JOHN CLARK of Esperance, Western Australia, who made several specimens available to us.

Material

Holotype: 52.6 × 39.8 × 28.0 (20:21) [42.1], Christmas Island, DNA #CPM_5591, coll. WAM S79749.

Paratype 1: 52.2 × 38.1 × 27.3 (20:18) [39.3], Christmas Is.; Paratype 2: 50.9 × 37.8 × 27.1 (19:20) [38.7]; Paratype 3: 49.0 × 34.7 × 25.5 (19:18) [31.3]; Paratype 4: 47.0 × 35.6 × 25.5 (18:18) [31.3]; Paratype 5: 49.9 × 35.9 × 25.5 (19:20) [33.7]; Paratype 6: 57.9 × 42.1 × 30.2 (21:20) [51.5]; Paratype 7: 49.9 × 34.7 × 25.6 (19:20) [29.1]; Paratype 8: 51.4 × 36.9 × 26.1 (20:21) [35.3], Christmas Island, DNA # CPM_5592, coll. USNM 1422340; Paratype 9: 54.5 × 41.4 × 29.4 (20:21) [44.4], Christmas Island, coll. USNM 1422341; Paratype 10: 47.5 × 33.2 × 25.1 (20:21), Christmas Island, DNA Voucher XmaxIO_956, coll. USNM 1422334; and five further paratypes in the collections JOHN CLARK, TIM MCDONALD, GRAHAM RYAN, and IAN MACKIE.

Description

The shell is rather large and very solid. The shape is oval to rhomboidal, with a slightly pointed posterior extremity. The margins are low, slightly angular and strongly calloused. The base is convex, with an irregular accumulation of callus on its lowest point. The aperture is narrow, sloping, and curved behind. The teeth are coarse, thickened, rather restricted to the aperture, forming a distinctly denticulate fossula and columellar sulcus. The ground color is pink with four narrow, slightly darker reddish transverse bands. The margins are dark brown above, framing the dorsal window, gradually becoming paler towards the marginal edge. They show regular whitish hairlines. The base is pale brown, whitish along the aperture. The animal characteristics are similar to its Pacific sister subspecies, with greyish white sometimes branching papillae emerging from a similar ground color on a predominantly dark blue/black mantle with occasional white small protuberances sprinkled throughout (MEYER pers. observ.).

Distribution

Only known from Christmas Island, Indian Ocean.

Occurrence, habitat

Rare. In deep crevices of coastal rocks and waveswept reef, in turbulent water.

Discussion

This subspecies seems to be endemic to Christmas Is. and Cocos Keeling (WELLS 1994) and is the only population of *ventriculus* in the Indian Ocean. Its main difference from the Pacific populations lies in the DNA, which reveals a significant period of isolation in *johnclarki*. The conchological differences are subtle, and may also be found in occasional specimens of the nominate *ventriculus*. The general coloration is very similar. The darker dorsal bands in *johnclarki* tend to be narrower than in *ventriculus*. The combination of the following structural features may help to distinguish the shell of *johnclarki*: The posterior extremity is more pointed and the aperture and canals narrower than in *ventriculus*. The base is more calloused, with a more prominent accumulation of callus in its midsection (Plate 1 Figs 2-7).

v. ventriculus, Samar, Philippines:
53 (65 - 47 - 72) 17 : 17 [23.9]
v. johnclarki, Christmas Is.:
50 (72 - 53 - 73) 16 : 16 [24.2]

The formulae show that *johnclarki* is broader on average, and significantly higher in proportion. More material is needed to better understand this interesting taxon. We had to wait and enquire for more than ten years before additional specimens could be obtained that corroborated the data derived from a single sample discussed in MEYER (2004 p. 137). The average COI pairwise difference between individuals from *v. johnclarki* and *v. ventriculus* is 2.05 % (see Pl. 6 Fig. 1).

2 Four new subspecies from Thailand and the northwestern Indian Ocean

The Indian Ocean coast of Thailand, the Andaman Sea, and the east of India and Sri Lanka bear a number of characteristic cowry species which are easily recognized by their shells, with ranges that are quite restricted to this general area (e.g. *Callistocypraea nivosa* (BRODERIP 1827), *Ovatipsa coloba* (MELVILL 1888), *Bistolida stolida rubiginosa* (GMELIN 1791)). Molecular analyses revealed several other lineages which had not been recognized by their shells alone. These populations do not always differ conchologically from their Indian Ocean or Pacific relatives, or the differences are concealed by individual variability. One is certainly *Palmadusta clandestina clandestina* (LINNAEUS 1767), whose molecules separate it from the western *passerina* (MELVILL 1888) and the Pacific *candida* (PEASE 1865) significantly (MEYER 2003, 2004).

Another species in the genus, the variable and widespread *Palmadusta ziczac* (LINNAEUS 1758), has a subspecies confined to this area. Its conchological features set it apart from any other population, and we were not surprised that the molecular data strongly support its status as separate subspecies, which we propose to call

Palmadusta ziczac yzac n. ssp.

(Plate 3 Figs. 11-13)

Etymology

With y-shaped zig-zag lines.

Material

Holotype: 14.2 × 8.0 × 6.8 (19:18), DNA sample #5579, coll. USNM 1422335.

Paratype 1: 15.5 × 9.1 × 7.7 (18:17) [0.52]; Paratype 2: 14.3 × 7.8 × 6.6 (18:18) [0.4]; Paratype 3: 14.9 × 8.7 × 6.9 (18:18) [0.4]; Paratype 4: 13.2 × 7.5 × 6.1 (17:17) [0.31]; Paratype 5: 14.5 × 8.3 × 7.0 (20:17) [0.44]; Paratype 6: 15.3 × 8.5 × 7.1 (19:17) [0.5]; Paratype 7: 15.7 × 8.9 × 7.3 (18:19) [0.49]; Paratype 8: 13.9 × 7.7 × 6.5 (15:17) [0.4]; Paratype 9: 15 × 8.7 × 7.1 (17:20) [0.54]; Paratype 10: 12.7 × 7.6 × 6.3 (17:15) [0.34] plus 28 additional paratypes. All from Raya Is., Western Thailand.

Description

The small shell is narrowly pyriform. The extremities are slightly rostrated and delicately margined. The spire is deeply umbilicate and half exposed. The aperture is narrow throughout and evenly curved to the left in the posterior third. The teeth are short on the columellar side, gradually becoming stronger anteriorly. The fossula is flat with two faint denticles. The labral teeth are coarse and extend across the lip, almost

reaching the margin. The basal callosities are pale yellowish brown, with large, sparse black spots, some of which are associated with a labral tooth. Along the marginal edge on the labral side, the spotting is considerably smaller. The dorsal ground color is invariably greenish tan, grey in old faded shells. There are three transverse primary bands consisting of white zic-zag lines which are very narrow and fine, usually forming waves with several peaks. Above the extremities there is a band of widely spaced black spots. The extremities show large dark terminal spots.

The animal has a bright red mantle with small whitish areas bearing tiny branched papillae of white or red color. Foot, proboscis, and eye-stalks are of the same bright red color. The tentacles are yellow.

Occurrence, habitat

Uncommon. Shallow water to 40 m, on muddy, sandy bottom.

Distribution

Phuket Island on the west coast of Thailand, to the eastern Andaman Sea. Conchologically similar specimens are known from the Maldives and India. These are tentatively included in the concept of *yzac*, whose distribution pattern hence agrees with that of its congener *clandestina*, and *Bistolida ursellus jomi* described in the following.

Discussion

The shell of *yzak* is more slender and the extremities more rostrate than in other populations of *ziczac* and its western subspecies *misella*. The dorsal markings of *yzac* are consistently different from all other populations of *ziczac* in being narrower, sharply angular, with several pointed peaks often forming the shape of the letters w and y. Table 1 summarizes the distinguishing conchological features. Shells from India and the Maldives can be nearly white dorsally, with barely discernible banding but similar prominent basal spotting. DNA samples from the Maldives or Sri Lanka are not available so far. The population of *ziczac* from Western Australia belongs to the nominate subspecies whose distribution is predominantly Pacific. Further DNA analyses are required to confirm the relationships among *zizac* lineages. The average COI pairwise difference between individuals from *z. yzac* and all other *ziczac* subspecies is 8.4 % (see Pl. 6 Fig. 2).

Table 1: Comparison of the subspecies of *Palmadusta ziczac*.

Palmadusta	***z. ziczac***	***z. misella***	***z. yzac***
distribution	Pacific & W Australia	Western Indian Ocean	India to Thailand
shape	oval to pyriform	pyriform	elongated, rostrate
ground color	whitish to orange	greenish to brownish	grey to greenish tan
zig-zac bands	broad, often connected	broad, well separated	narrow, often connected
zig-zag-pattern	coarse, usually with one peak		much finer, often 2 or more peaks
marginal spots	small, distant	larger, denser	large, distant
terminal spots	small, discrete	small, distinct	prominent, distinct
dark spots above spire	small, distant	larger, densely set	large, distant

z. ziczac, Cebu, Philippines:
15 (59 - 49 - 83) 20 : 19 [17.5]
z. misella, Zanzibar Is., Tanzania:
19 (62 - 49 - 79) 18 : 18 [18.7]
z. yzac, Phuket Is., Thailand:
15 (57 - 47 - 83) 21 : 21 [17.9]

The shell formulae show that *yzac* is the most slender of the three subspecies, with a slightly greater number of teeth (normalized).

Bistolida ursellus jomi n. ssp.

(Text-Figure 1, Plate 2 Figs 1-5)

Etymology

In honor of JOM PATAMAKANTHIN of Phuket, Thailand. JOM was of great help in obtaining an additional sample of this rare cowry for DNA analysis.

Material

Holotype: 11.6 × 6.7 × 5.7 (21:19) DNA # 1613, coll. USNM 1422336, Bon Is., Phuket, Thailand.

Paratype 1: 9.9 × 5,8 × 4,8 (20:21) [0.17]; Paratype 2: 11,5 × 6,6 × 5,6 (19:20) [0.18]; Paratype 3: 9.5 × 5.4 × 4.6 (19:18) [0.12], all from Bon Is., Phuket, Thailand; Paratype 4: 14.8 × 9 × 7.5 (21:21) [0.51]; Paratype 5: 13.9 × 8.9 × 7.1 (20:21); Paratype 6: 15.0 × 9.4 × 7.5 (20:20) [0.43]; Paratype 7: 11.7 × 7.3 × 5.7 (20:19); Paratype 8: 12.6 × 7.7 × 6.1 (20:19); Paratype 9: 17.0 × 9.6 × 8.3 (18:20); Paratype 10: 11.0 × 6.6 × 5.2 (21:19) [0.23]; Paratype 11: 8 × 4.6 × 3.7 (18:19); Paratype 12: 11.5 × 7.1 × 5.7 (20:20); Paratype 13: 14.0 × 8.5 × 7 (19:19) all from Weligama, S Sri Lanka.

Description

The very small shell is inflated, pyriform, with a rostrate anterior extremity and a produced, distinctly ribbed posterior extremity. These ribs are prolongations of the fine, narrowly set teeth, which extend across the base and the labrum, reaching both margins. The ground color is white, and there are three darker zones of bluish-green color dorsally. The median zone has the shape of a square with two lateral extensions in the posterior end and an indentation at its anterior end. The paler zone situated towards the anterior has a characteristic shape resembling a stretched w. In young adults, three brown interrupted bands are discernible at least basally. The tips are distinctly blotched darker. The marginal spotting is fine and sparse. The dorsal spotting is sparse, none of the shells studied has a darker blotch.

The animal has a greyish brown mantle with short, dendritic white papillae. The foot is transparent white. The eye-stalks are dark grey, the tentacles yellow (Text-Fig. 1).

Text-Fig. 1: *Bistolida ursellus jomi*, Paratype 1, living animal.

Occurrence, habitat

Very rare (in any condition). Lives deep inside coral conglomerate, at 5-25 m.

Distribution

Western coast of Thailand to Sri Lanka and the Maldives.

Discussion

The molecular data of *ursellus* reveal that the population from Thailand shows significant separation from the Pacific *ursellus* that is comparable to the difference between *ursellus* and *kieneri*. The average COI pairwise difference between individuals from *u. jomi* and *u. ursellus* subspecies is 7.1 % (see Pl. 6 Fig. 3). However, the shells of the new subspecies and typical *ursellus* are difficult to distinguish. The main difference is the higher number of teeth in *jomi* compared to *ursellus* from the Philippines. Usually, the counted number of teeth varies between 18 and 21 on both sides, which translates to a normalized number of 25 to 26 in the formulae, depending on the length of the shell:

u. ursellus, Mindanao, Philippines:
13 (57 - 48 - 83) 23 : 21 [19.1]
u. jomi, Bon Is., Phuket, Thailand:
10 (58 - 49 - 85) 26 : 27 [15.9]
u. jomi, Sri Lanka:
13 (61 - 49 - 81) 25 : 25 [11.1]

RAYBAUDI (1992) listed the taxonomically invalid varietal name "*maldiviensis*" with a barely recognizable illustration and no further explanation. The name has never been used afterwards.

Ransoniella punctata bridgesi n. ssp.

(Text-Fig. 2, Plate 4 figs. 14-19)

Etymology

In honor of RANDALL J. BRIDGES, malacologist from Phoenix, Arizona, USA.

Material

Holotype: 10.2 × 5.5 × 4.8 (19:19), DNA # 1621, coll. USNM 1422337.

Paratype 1: 11.8 × 6.2 × 5.3 (18:17) [0.21]; Paratype 2: 11.1 × 6.4 × 5.4 (19:20) [0.2]; Paratype 3: 9.7 × 5.5 × 4.6 (17:17) [0.12]; Paratype 4: 11.3 × 6.6 × 5.3 (19:18) [0.2]; Paratype 5: 12.3 × 7.1 × 5.8 (17:19) [0.26]; Paratype 6: 9.9 × 5.9 × 4.9 (17:16) [0.14]; all from Bon Is., Phuket Is., W Thailand.

Description

The very small shell is slightly inflated, pyriform, with a calloused posterior and a narrow, slightly rostrated, and finely margined anterior extremity. There is a discrete, indistinct but faintly ribbed callus accumulation above the labral side of the posterior extremity dorsally. The teeth are fine, stained red, and extend across the labrum. On the columellar side, their staining extends onto the base, but the teeth are restricted to the aperture. The fossula area is coarsely denticulate, the sulcus shows fine denticles which become obsolete posteriorly. The ground color is pale tan, the callosities white. There are large, sparse and distinct dorsal spots. The marginal spots are smaller. The terminal spots are small but distinct. The spire is umbilicate, covered with a thin layer of callus, through which the black protoconch is clearly visible.

The animal has a bright red mantle with minute white, branched papillae. The foot is reddish on top, transparent whitish along its edges. The siphon is finely fringed, and of transparent red color. The tentacles are paler orange (Text-Fig. 2).

Text-Fig. 2: *Ransoniella punctata bridgesi*, Bon Is., Phuket Is., Thailand.

Occurrence, habitat

Rare. In coral rubble at 3 to 20 m.

Distribution

Western coast of Thailand, possibly to Sri Lanka and the Maldives.

Ransoniella punctata conleyi n. ssp.

(Text-Fig. 3, Plate 2 Figs 10-12)

Etymology

In honor of the late HARRY CONLEY, from Guam, who supplied numerous specimens for scientific studies, including the type material for this subspecies. An avid collector, HARRY had a keen sense for cowries and incredible knowledge of their habits and habitats.

Material

Holotype: 11.3 × 6.9 × 5.6 (16:16), DNA # CPM_1260, Praslin, Seychelles, coll. USNM 1422345

Paratype 1: 13.8 × 7.9 × 6.5 (17:19), DNA # CPM_5500, Hurghada, Egypt, coll. USNM 1422346; Paratype 2: 14.5 × 8.0 × 6.8 (18:17) [0.41] Abu Ramada Plateau, Hurghada, Egypt; Paratype 3: 15.8 × 9.0 × 7.4 (19:18) [0.51] Hurghada, Egypt; Paratype 4: 14.3 × 8.2 × 6.9 (17:21) [0.39] Hurghada, Egypt; Paratype 5: 13.7 × 8.2 × 6.5 (17:16) [0.40] Ras Zeit, Gulf of Suez, Egypt; plus seven additonal paratypes in the second author's collection.

Description

The small shell is quite inflated, oval, with a broadly produced posterior extremity. The anterior extremity is rather short, broad and distinctly margined on both sides. There is a prominent, distinct and irregular callus accumulation above the labral side of the posterior extremity dorsally. The teeth are rather coarse, stained red, and extend onto the midsection of the the labrum. On the columellar side, their staining extends slightly onto the base, but the teeth are restricted to the aperture. The fossula is slightly projecting and coarsely denticulate, the sulcus shows fine denticles which become obsolete posteriorly. The ground color is pale tan, with two broad, indistinct transverse areas. There are numerous distinct dorsal spots of variable size. The marginal spots are quite large and sparse. The terminal spots are distinct and large posteriorly. The spire is partly covered by callus.

Shells from the Red Sea tend to be slender, with a more rostrated posterior extremity and a coarsely denticulate columellar sulcus. The animal has a bright red mantle evenly covered with prominent paler pustules and with a few, evenly distributed

transparent papillae which may have short branches. The siphon is purplish red with prominent siphonal papillae along its edge. The tentacles are the same red color as the mantle (Text-Fig. 3).

Text-Fig. 3: *Ransoniella punctata conleyi*, Hurghada area, Red Sea. Photo SVEN KAHLBROCK.

Occurrence, habitat

Locally abundant. In coral rubble at 20 m in the Red Sea. In living *Pavona clavus* corals at 2 m, along the fringing reef in Tanzania. At 1 m in dead coral rubble on St. Brandon.

Distribution

Red Sea, Somalia, Seychelles, St. Brandon, Tanzania (cfr. Map 1).

Map 1: Distribution of *Ransoniella punctata* and its subspecies.

Discussion

R. p. bridgesi is a distant relative of the other *punctata* lineages, the Pacific *punctata* (LINNAEUS 1758) and *trizonata* (SOWERBY 1870), and the western Indian Ocean *berinii* (DAUTZENBERG 1906) and *conleyi* n. ssp. The shell morphology of *bridgesi* resembles that of the nominate *punctata*, and no consistent conchological differences could be found to support recognition of empty shells. The range of *bridgesi* in the eastern Indian Ocean is uncertain, as all samples analyzed came from Phuket Is. in Thailand. The populations from India, Sri Lanka and the Maldives could not be sampled so far, and their assignment to *bridgesi* is tentative and based on the general zoogeographic ties between western Thailand and that general area (Map 3).

The molecular data shows that *conleyi* is a sister to *berinii*. The conchological characteristics of *R. p. conleyi* are difficult to summarize as that subspecies varies considerably throughout its wide range. It differs from *berinii* by its more inflated, usually more calloused shell, by having a more produced posterior extremity and a more distinct posterior callosity. It has been collected and sampled from the northern Red Sea, the Seychelles, Zanzibar Is. and St. Brandon. In Tanzania, it has been found together with the northernmost populations of *berinii*. The dimorphism between the large, solid shells of *berinii* and the smaller, more rostrate and often heavily calloused shells of *conleyi* has already been noted by the second author (1998), who reported that "large, cylindrical shells" (*berinii*) are found in intertidal habitats, whereas "smaller,

calloused" shells (*conleyi*) are usually found in deeper reef areas.

The spotted shell of *punctata* and its subspecies is conserved, so that recognizable conchological modifications do not occur, despite significant geographic and reproductive separation. This phenomenon has been discussed for the genus *Pustularia* (LORENZ 2014), but also accounts for the members of the genus *Cribrarula*, whose pattern concept is the same in all of its species. The average COI pairwise difference between individuals from *p. bridgesi* and all other *punctata* subspecies is 9.3 % (see Pl. 6 Fig. 4), that of *conleyi* to *berinii* is 3.3 %.

Table 2: Comparison of the subspecies of *Ransoniella punctata*.

Ransoniella	***p. punctata***	***p. trizonata***	***p. berinii***	***p. conleyi***	***p. bridgesi***
Distribution	Pacific	Tahiti, Tuamotu	SW Indian Ocean	NW Indian Ocean, Red Sea	Thailand, ? India, ? Maldives
Shape	pyriform, inflated	elongate, oval	elongate, depressed	oval, inflated, calloused	pyriform, inflated, not calloused
Posterior extremity	swollen, or rostrate	slightly produced	rather blunt	produced, calloused	slightly rostrate
Posterior callus accumulation	irregular, ribbed	small, smooth	indistinct, smooth	distinct, irregular	indistinct, ribbed
Aperture	rather straight				curved
Terminal spots	small	small	large	discrete	indistinct
Teeth	bright red	unstained, shorter	bright	pale orange	bright red
Paler banding	broad, indistinct	narrow, distinct	broad, indistinct to absent		narrow, indistinct

More comprehensive sampling of the members of *Ransionella* is urgently required to clarify the status of some morphologically striking groups, including all those species proposed by DOLIN (2007) for *punctata*-like members from the Philippines, whose descriptions were based exclusively on qualitative, non-statistical shell features.

3 A fourth subspecies of *Cribrarula abaliena* LORENZ 1989

The following describes another subspecies of *Cribrarula abaliena* LORENZ 1989 restricted to the Red Sea and the northwestern Indian Ocean:

Cribrarula abaliena erypersica n. ssp.

(Text-Fig. 4, Plate 3 Figs 5-10)

Etymology

From Erythrea and Persia.

Material

Holotype: 19.7 × 11.6 × 9.4 (16:14) Bajun Is., S Somalia, DNA # CPM_5312, coll. USNM 1422338.

Paratype 1: 28.1 × 18.2 × 13.7 (17:19) [3.87] Giftun Is., Egypt; Paratype 2: 26.6 × 15.6 × 12 (19:20) [1.75] Giftun Is., Egypt; Paratype 3: 27.8 × 16.7 × 13.1 (18:20) [2.11] Hurghada, Egypt; Paratype 4: 23.1 × 14.8 × 11.5 (15:15) [1.72] Abu Ramada Plateau, Egypt; Paratype 5: 18.4 × 10.1 × 7.9 (18:17) [0.65] Erg Camel, Hurghada, Egypt; Paratype 6: 13.6 × 8.2 × 6.3 (13:13) [0.34] Bajun Is., S Somalia; Paratype 7: 14.4 × 8.2 × 6.6 (14:14) [0.38] Bajun Is., S Somalia; Paratype 8: 20.2 × 12.0 × 9.6 (16:17), Hurghada, Egypt, DNA voucher #CPM_5501, coll. USNM 1422339.

Description

The small to medium sized shell is depressed and pyriform. The labral margin is slightly produced and separated from the dorsum by a shallow groove. The left margin is calloused in the holotype, but may be rather thin. The posterior extremity is tapering, calloused in the holotype, with a pointed left tip. The anterior extremity is pointed and distinctly margined along its outer edge. The aperture is rather wide throughout, and slightly curved. The teeth are restricted to the aperture on the columellar side, the first anterior tooth is swollen. The anterior gap between that tooth and the broad terminal ridge is narrow. The fossula is somewhat projecting and coarsely

denticulate, the columellar sulcus is denticulate and weakly pronounced. The ground color of the dorsum is yellow to orange, the callosities are plain white. The margins are usually spotted with red or brown near the extremities, sometimes throughout, and on both sides of the shell. This spotting does not extend onto the base but is restricted to the margins and the groove above the labral callosities. The dorsal lacunae are large and densely set, the orange to saturate reddish brown pattern in between them narrow or dissolving. Usually there is a narrow dorsal line without an area of overlap of darker color. The paratypes from the Red Sea are often larger and more inflated, with less development of callus, compared to the shells from Somalia and Oman.

Text-Fig. 4: *Cribrarula abaliena erypersica*, Giftun Is., Hurghada area, Egypt, at 20 m. Living animal of paratype 8. Photo SVEN KAHLBROCK.

The animal is bright red with a thick mantle covered with minute warts, larger unbranched beaded papillae and transversally oriented dashes of white color which are formed by numerous minute glandular structures. There are fine black reticulated lines which correlate to the darker pattern of the shell (they are absent in areas where the mantle covers the lacunae). The foot, siphon, and tentacles are of the same red color (Text-Fig. 4).

Occurrence, habitat

Rare. In coral reef, in association with red sponges, intertidally to 25 m.

Distribution

Masirah Is., Oman, Persian Gulf, the eastern coast of Somalia, and the Red Sea (Map 1).

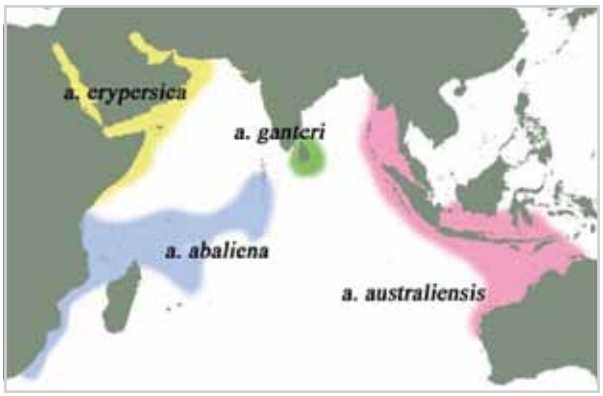
Discussion

The shell of this subspecies is most similar to that of *abaliena ganteri* LORENZ 1998 on account of its marginal spotting, which is usually absent in *abaliena australiensis* LORENZ 2002 and the nominate *abaliena* LORENZ 1989. Molecular data taken from specimens from the Oman and the Red Sea support the position suggested by the shell: distinct from *abaliena*, and basal to *ganteri* and *australiensis*. In comparison to *ganteri*, the shell is usually less solid. Table 3 summarizes the conchological differences between the subspecies of *abaliena*. The average COI pairwise difference between individuals from *a. erypersica* and its sister lineages is 2.1 % (see Pl. 6 Fig. 5).

The most readily available specimens are from the northern coast of Somalia. Few specimens have been collected in the northern Red Sea, the Persian Gulf (SHARABATI 1981 p. 99 "*esontropia*"), and Oman. Additional molecular sampling of both, *ganteri* and *erypersica*, is required to verify their systematic position within the *abaliena* clade.

Table 3: Comparison of the subspecies of *Cribrarula abaliena*.

Cribrarula	***a. abaliena***	***a. ganteri***	***a. erypersica***	***a. australiensis***
distribution	East Africa, Central Indian Ocean	Sri Lanka	Red Sea, Somalia, Oman, Persian Gulf	Thailand to Western Australia
shape	oval	oval to cylindrical	oval to pyriform	pyriform
posterior extremity	rostrate, pointed	calloused, short	rostrate, pointed	rather short, broad
fossula	steep, few swollen denticles	projecting, densely denticulate		steep, few denticles
marginal spotting	absent	sparse, indistinct	denser, distinct	absent
dorsal coat	paler orange	orange to reddish	dark reddish	orange to brown
lacunae	large, dense	smaller, less dense	large, less dense	comparatively smaller, rather dense



Map 2: Distribution of *Cribrarula abaliena* and its subspecies.

4 A new subspecies of *Purpuradusta fimbriata* (GMELIN 1791)

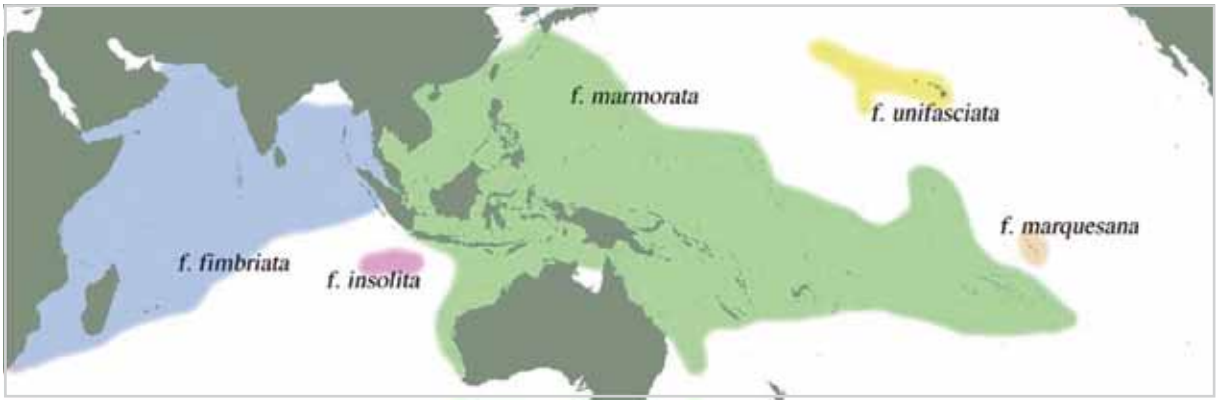
The Indo-Pacific *Purpuradusta fimbriata* is subdivided in several geographic subspecies that are difficult to identify because of their small size, and individual variability. Molecular data shows that the populations from the western and NE Indian Ocean (*fimbriata*) must have been isolated from those of the Pacific for a considerable while. The Pacific population split into an eastern group, *marquesana* LORENZ 2002, and *unifasciata* (MIGHELS 1845), and a western to central Pacific clade (*marmorata* (SCHRÖTER 1804)). An isolate, distinct population is confined to Christmas and Cocos Keeling Islands in the eastern Indian Ocean (*insolita* n. ssp.). Occasionally, gene flow from the Central Pacific (*marmorata*) and the Marquesas (*marquesana*) to the Tuamotus (*marmorata*) has been recorded, but not in the opposite direction. The population from Hawaii (*unifasciata*) has not had any recent contact with the rest of Polynesia and the Central Pacific, despite conchological similarity to the population from the Tuamotus.

To identify empty shells, the structure of the anterior columellar teeth is important: the number of teeth that are markedly thickened, and the width of the aperture in that section of the shell. The width and formation of the transverse dorsal band and the size and density of the dorsal spotting are further features that have to be compared. As in the other species of the genus, the features characterizing the subspecies may have to be evaluated on comparing larger series of shells.

The nominate Indian Ocean subspecies of *fimbriata* differs from its Pacific relatives by having less developed columellar teeth, which are barely visible posteriorly, and less thickened anteriorly. The dorsal banding is always well-developed and dark, composed of irregular interrupted transverse and longitudinal lines. Marginal spotting is usually present, but rare to absent in the other subspecies.

The description of *fimbriata* and its references to illustrations barely allow a recognition, not even on species level. SOWERBY (1837) designated Mauritius as type locality, which was adopted by SCHILDER (1965). DNA data places all western Indian Ocean populations into the same general subspecies. Therefore, *durbanensis* (SCHILDER & SCHILDER 1938) becomes a junior synonym of *fimbriata*, whereas the status of the calloused *quasigracilis* LORENZ 1989 from Zanzibar Island remains uncertain. The shells can be remarkably different in shape, callosity and coloration compared to any other taxon found within the species. Unfortunately, no finds of *quasigracilis* have been made since the 1970s and molecular data is not available.

The average shell length of populations of *marmorata* gradually decreases eastward. In Micronesia and Polynesia, they are narrow and cylindrical. The extremities are short, finely margined anteriorly, and somewhat rostrate posteriorly. The spire is large, slightly projecting, with an exposed protoconch. The aperture is straight, narrow posteriorly, somewhat widening anteriorly. The teeth are restricted to the apertural area. The first three anterior columellar teeth are distinctly thickened and extend onto the flat fossula area, the following ones are gradually smaller. The tips are tinted rich purple. The dorsal ground color is purple to grey. An interrupted darker transverse band is distinct and visible also through thick callus of the base. The margins are unspotted. The dorsal spots are dense, rather regular and large. These populations were formerly considered a separate subspecies, listed under the name *unifasciata*. Herein, they are combined with the western Pacific *marmorata*, as consistent molecular differences have not been found. As the name *unifasciata* is based on a shell from Hawaii, it constitutes an earlier name for *waikikiensis* SCHILDER 1933, but is not available for the Tuamotu/Tahiti populations. Should additional studies give support to the rather variable shell differences between western *marmorata* and the eastern populations, then a new name would be needed to distinguish them.



Map 3: Distribution of *Purpuradusta fimbriata* and its subspecies.

Purpuradusta fimbriata insolita n. ssp.

(Pl. 4 Figs. 15-19)

Etymology

Isolated *fimbriata.*

Material

Holotype: 10.2 × 5.2 × 4.2 (15:14) DNA # 2117, coll. WAM S79750. Type locality cfr. "Distribution".

Paratype 1: 10.4 × 5.4 × 4.4 (15:16) [0.08] coll. CLSF 6982a; Paratype 2: 9.0 × 4.5 × 3.8 (15:16) [0.06] coll. CLSF 6982b; Paratype 3: 12.6 × 6.2 × 5.1 (16:18) [0.15] coll. CLSF 6982c; Paratype 4: 9.2 × 4.7 × 3.7 (15:16) [0.08]; Paratype 5: 10.4 × 5.7 × 4.3 (15:17) [0.15]; Paratype 6: 11.0 × 5.7 × 4.6 (16:16) [0.15]; Paratype 7: 12.4 × 6.4 × 5.2 (18:18) [0.19]; Paratype 8: 13.4 × 6.6 × 5.1 (18:20) [0.22]; Paratype 9: 12.6 × 6.4 × 4.9 (17:19) [0.19]; Paratype 10: 11.6 × 5.9 × 4.8 (19:20) [0.14]; Paratype 11: 8.3 × 4.3 × 3.4 (15:15) [0.06]; Paratypes 8-11 coll. JOHN CLARK.

Description

The very small shell is cylindrical, with short extremities. The spire is slightly projecting, the expose protoconch conspicuous. The anterior extremity is slightly margined. The aperture is rather wide and straight, and widens considerably in the anterior end. The first three anterior columellar teeth are conspicuously thickened, the posterior columellar teeth are barely discernible. The base does not have any callus. The dorsal ground color is orange to grey. The tips are rather discretely tinted with pink. The margins are unspotted. The transverse banding is weak to nearly absent. The dorsal spots are rather large and dense.

The animal characteristics are unrecorded.

Occurrence, habitat

Rare. In coral reef in crevices, in shallow water.

Distribution

Christmas and Cocos Keeling Islands, Eastern Indian Ocean.

Discussion

This new subspecies is hardly known, as it is endemic to Cocos Keeling and Christmas Islands, where shell collecting is banned without a permit. DNA data places *insolita* as a sister to the eastern Pacific *marmorata* population, and the subspecies *marquesana*, and *unifasciata*, but not to the other populations from the Indian Ocean as one would expect. This suggests that its lineage is quite ancient. The more conspicuously widening aperture, the contrast between the coarsely thickened anterior and almost indiscernible posterior columellar teeth, and the near absence of dorsal banding make the shell well-recognizable on direct comparison (Table 4). The average COI pairwise difference between individuals from *f. insolita* and its sister lineages is 3.2 % (see Pl. 6 Fig. 6).

Table 4: Comparison of the subspecies of *Purpuradusta fimbriata*.

Purpuradusta	*f. fimbriata*	*f. marmorata*	*f. unifasciata*	*f. insolita*	*f. marquesana*
distribution	Indian Ocean	Pacific to Tuamotu, Tahiti, Cook Is.	Hawaii	Christmas & Cocos Keel. Id.	Marquesas
shape	elongate oval			narrow cylindrical	elongate oval depressed
aperture	rather narrow throughout			very wide anteriorly	
thickened ant. col. teeth	4	3	4	3	2
basal callus	mostly well developed			absent	less developed

Shell formulae taken from series of shells from different localities help to differentiate between subspecies and sample populations:

f. fimbriata, Mauritius
10 (56 - 44 - 79) 17 : 19 [17.7]
f. fimbriata, Tanzania
16 (58 - 47 - 80) 18 : 20 [18.2]
f. marmorata, Philippines
12 (55 - 44 - 81) 18 : 18 [18.6]
f. marmorata, Marshall Is.
10 (53 - 43 - 81) 18 : 19 [17.8]
f. marmorata, Tuamotu
10 (52 - 43 - 82) 21 : 21 [16.5]
f. marmorata, Tahiti
11 (52 - 43 - 82) 21 : 21 [16.8]
f. unifasciata, Hawaii
11 (55 - 43 - 79) 20 : 23 [17.3]
f. marquesana, Marquesas
10 (54 - 43 - 79) 19 : 20 [18.7]
f. insolita, Christmas Is.
11 (50 - 42 - 83) 20 : 22 [12.4]

The W/L ratio of 50 shows that *insolita* from Christmas Island and Cocos Keeling Is. is the most narrow of the *fimbriata* subspecies. Those anterior columellar teeth that are distinctly thickened are less numerous in *marmorata* than in *unifasciata*, and more numerous than in *marquesana*. The normalized toothcount of *marmorata* from Tuamotu, as well as Tahiti, is [21:21], which reveals that the columellar teeth are less numerous than in the Hawaiian *unifasciata*. On the other hand, *marquesana* has coarser labral teeth [19:20], which is also reflected by this morphometric element. Even though the differences seem minimal, they are perceivable under magnification as "coarser" or "finer". The blotching of the tips in *marmorata* is less dark and more confluent than in *marquesana*, which is also more depressed and broader (w/l = 54 opposed to 52 in eastern *marmorata*). The differences in coloration of the dorsum and the interior of the shell make these neighbouring taxa rather easily separable, whereas a separation of *marmorata* from the Hawaiian *unifasciata* may require careful comparison of the anterior columellar teeth.

5 A new name for the western *Mauritia scurra* (GMELIN 1791)

The common assignment of the taxon *scurra scurra* to the East African subspecies is based on the treatment in "DAUTZENBERG's Collection" by SCHILDER & SCHILDER (1952) and repeated in SCHILDER (1965). In their "Guide", LORENZ & HUBERT (1993) had already hinted at the rather arbitrary usage of the name *scurra*, but they did not draw taxonomic conclusions. The original description of *scurra* merely quotes "Indian Ocean" as type locality. It refers to an illustration in MARTINI (1769), which shows easily recognizable images of the more cylindrical, sparsely spotted Pacific subspecies (Text-Fig. 5a). The dorsal line is wide, and the tips are calloused and blotched. GMELIN described also *indica*, referring to a picture in RUMPHIUS (1705), whose shells originated from Indonesia (Text-Fig. 5b). This figure shows a dorsal aspect that seems to be of the same subspecies, and the name is either a synonym of *scurra*, or a nomen dubium. The more inflated, densely spotted subspecies from the western Indian Ocean, however, has never been named. It is described as.

Mauritia scurra occidua n. ssp.

(Text-Fig. 6a, Pl. 5 Figs 5-8)

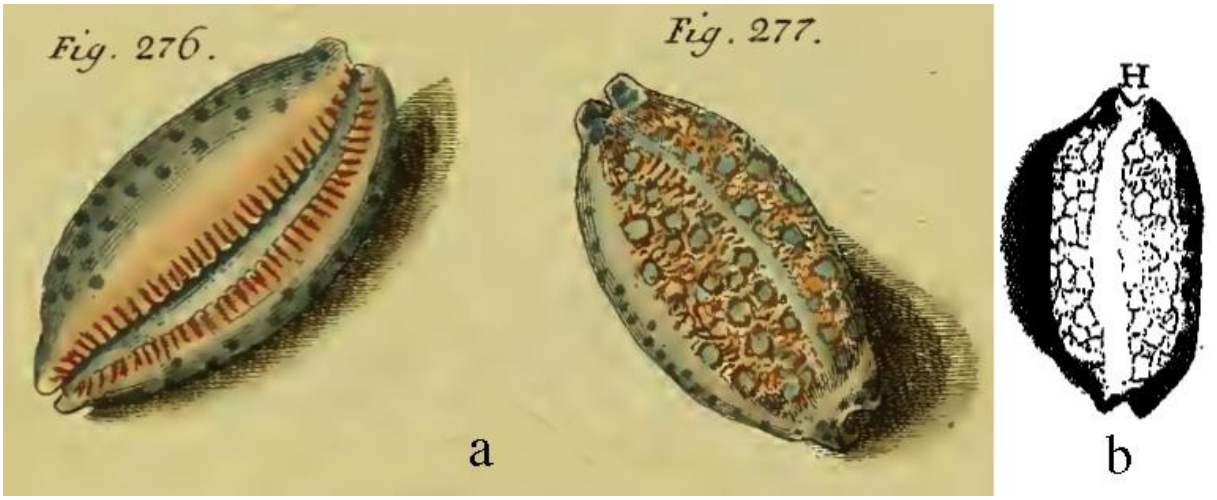
Etymology

Westerly Jester Cowry

Material

Holotype: 39.2 × 23.2 × 18.0 (31:27) [8.04] Coll. MNHN IM-2000-32670

Paratype 1: 39.8 × 21.9 × 17.3 (32:31) [7.13]; Paratype 2: 49.8 × 29.4 × 22.6 (36:27) [14.19]; Paratype 3: 46.3 × 25.8 × 20.2 (31:28) [11.12]; Paratype 4: 36.8 × 20.1 × 16.4 (31:27) [5.9]; Paratype 5: 30.1 × 16.1 × 12.6 (30:26) [3.22]; Paratype 6: 48.5 × 26.5 × 21.3 (35:29) [13.73]; Paratype 7: 39.1 × 22.3 × 18.4 (29:26) [7.49]; Paratype 8: 44.7 × 25.5 × 19.8 (31:30) [10.47]; Paratype 9: 40.5 × 21.9 × 17.7 (34:32) [7.62]; Paratype 10: 37.0 × 19.9 × 16.0 (32:28) [5.96]; Paratype 11: 37.8 × 20.8 × 16.4 (31:29) [6.3]; Paratype 12: 39.7 × 22.4 × 17.7 (31:29) [7.22]; Paratype 13: 33.5 × 18.4 × 14.4 (32:26) [4.16]; Paratype 14: 39.3 × 22.0 × 17.1 (31:31) [7.27]; Paratype 15: 46.2 × 25.3 × 19.1 (37:31) [11.03]; Paratype 16: 33.5 × 17.9 × 14.0 (29:27) [4.86]; Paratype 17: 37.4 × 19.7 × 15.7 (33:28) [6.05]; Paratype 18: 40.7 × 23.0 × 18.8 (34:29) [7.96]; Paratype 19: 36.3 × 20.3 × 16.1 (30:28) [5.25], plus 100 additional paratypes in the second author's collection. All from Nungwi, Northern Zanzibar Is., Tanzania. Also, numerous specimens from Sri Lanka, the Maldives, Mozambique, and Mauritius were available.



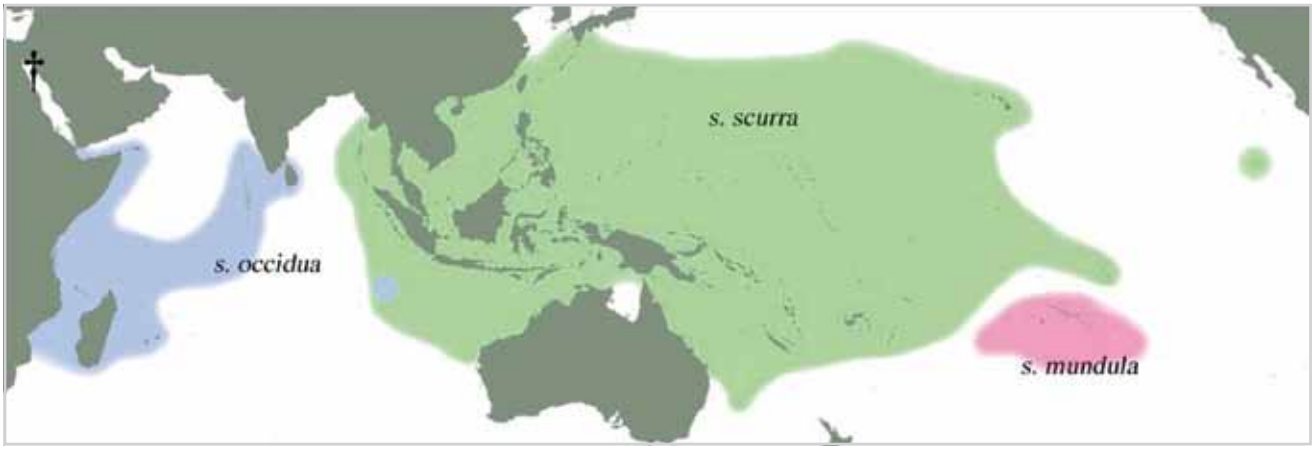
Text-Fig. 5: Types figures: a) type figure of *scurra* from MARTINI 1769 pl. 27, and b) *indica* after RUMPHIUS (1705). Explanations in the text.

Description

The medium sized shell is elongate-oval, and slightly inflated. The marginal callosities are barely developed. The base is convex, without a notable step along the margins. The aperture is narrow, nearly straight, constricted at the posterior canal, and slightly widening in front. The fossula is concave, projecting, with coarse denticles that are thickened along the fossular edge. The teeth are rather fine, extending only slightly, distinctly stained dark brown. The extremities are not calloused, faintly blotched, rounded anteriorly. The dorsum is covered with a fine brown netting forming densely set lacunae and a narrow dorsal line. The margins are covered with dense spotting which extends far onto the base.

The animal has a brownish, semi-transparent mantle with numerous, densely set, narrow and pointed, unbranched papillae. These are connected with a clearly discernible network of vessels. The foot is greyish brown, reddish in front. The tentacles are transparent brown, the eye-stalks contrasting cream colored (Text-Fig. 6).

Text-Fig. 6: Living animals. a) *M. scurra occidua*, Mautitius; photo ERIC LE COURT DE BILLOT. b) *M. scurra scurra*, Hawaii; photo SCOTT & JEANNETTE JOHNSON. c) *M. scurra scurra* var. *mundula*, Tahiti; photo PATRICK MARTI. Note the different structures and densities of the papillae.



Map 4: Distribution of *Mauritia scurra* and its subspecies.

Distribution

Western to Central Indian Ocean (Map 4): along the coast of East Africa, from Somalia to central Mozambique, Madagascar, the Mascarenes, the Seychelles, the Maldives, India, Sri Lanka, and Christmas Is. off Western Australia. A Pleistocene specimen from the vicinity of Hurghada suggests that the distribution might include the Red Sea, but no ascertained finds of living specimens from that area are available. It apparently inhabited this area in the Pleistocene but might have become extinct since (indicated by the dagger in Map 4).

Habitat

Locally common. In coral reefs, usually dug in coral rubble, just below the low tide level to 25 m.

Discussion

As mentioned above, the usage of the name *scurra* needed to be changed to the eastern Indian Ocean to Pacific subspecies formerly called *indica*, leaving the western subspecies without a valid name. The conchological differences between *occidua* to *scurra* and its French Polynesian variation *mundula* LORENZ 2002[1] are summarized in table 5. They are rather subtle but constant. The most important features are the less cylindrical shape, and the finer marginal spotting in *occidua*. Anteriorly there are indentations above a distinct margin bordering the extremity (Text-Fig. 7).

[1] The name *mundula* was introduced for an eastern Polynesian subspecies of *scurra*. However, molecular data does not support this status (see MEYER 2004). To be consistent with the criteria used throughout this paper we decided to list it merely at the level of a local variation.

Text-Fig. 7: Anterior extremity. Left: *M. scurra scurra*, right: *M. scurra occidua*. Note also the difference in density and distribution of the spotting.

The tips are rounded and not pointed as in *scurra* and its eastern variation *mundula*. The differences in dentition and fossula are apparent on comparing larger series of shells. In most *occidua*, the dorsal pattern forms more numerous, but less circular lacunae, and the dorsal line is mostly narrower and less distinct. The density and shape of the mantle papillae differ considerably (Text-Fig. 6).

The shell formulae show that *scurra* and var. *mundula* have a fairly constant number of teeth throughout their ranges, whereas, the teeth of *occidua* are less numerous on both sides of the aperture. The shell of *occidua* is broader and more humped relative to its length than *scurra* and var. *mundula*, which is the narrowest and flattest of all.

s. occidua, Tanzania:
40 (55 - 44 - 79) 27 : 24 [16.7]
s. occidua, Mauritius:
37 (54 - 42 - 76) 27 : 23 [17.4]
s. scurra, Philippines:
43 (51 - 42 - 82) 31 : 28 [17.1]
s. scurra, Solomons:
44 (51 - 41 - 80) 32 : 27 [18.1]
s. scurra, Marshall Is.:
34 (51 - 41 - 80) 30 : 26 [17.6]
s. scurra, Hawaii:
44 (51 - 41 - 81) 32 : 27 [18.7]
s. scurra, Marquesas:
44 (49 - 40 - 81) 31 : 28 [14.5]
s. scurra var. *mundula*, Tahiti:
31 (48 - 39 - 80) 31 : 27 [18.7]
s. scurra var. *mundula*, Tuamotu:
27 (48 - 39 - 81) 31 : 26 [20.5]

The DNA analysis shows a considerable difference between *scurra* and *occidua* of 12.8 %, which is comparable even to the distance between valid species in the genus, e.g. *Mauritia eglantina* (DULCOS 1833) and *Mauritia histrio* (GMELIN 1791) (see Pl. 6 Fig. 7). The ranges of *scurra* and *occidua* overlap at Christmas Island, but conchologically intermediate shells have not been found among the material studied.

Table 5: Comparison of the subspecies of *Mauritia scurra*. Explanations in the text.

Mauritia	***s. scurra***	***s. scurra* var. *mundula***	***s. occidua***
distribution	Eastern Indian Ocean to eastern Pacific	French Polynesia	Western and Central Indian Ocean
shape	cylindrical, calloused	cylindrical, narrower	oval, inflated
teeth	short, numerous		longer, less numerous
extremities	calloused, pointed anteriorly		less calloused, blunt
terminal blotches	large and distinct		smaller, less distinct
netting	rather coarse	coarse	narrow, finer
lacunae	circular, dense, slightly framed	circular, less dense, distinctly framed	irregular, very dense, reticulated, not framed
marginal spots	large, sparse	smaller, less sparse	small, dense
dorsal banding	faint	more distinct	faint to absent
papillae	broad at the base, pointed, dense	broad at the base, pointed, less dense	narrow at their base, finer and much denser

Plate 1 (on opposite page)

Fig. 1: *Lyncina ventriculus ventriculus* (50.9 mm) Suluan Is., Samar, Philippines. Note distribution of basal callus compared to Fig. 2.

Fig. 2: *Lyncina ventriculus johnclarki* (52.2 mm) Christmas Is. Paratype 1.
Fig. 3: *Lyncina ventriculus johnclarki* (49.0 mm) Christmas Is. Paratype 3.
Fig. 4: *Lyncina ventriculus johnclarki* (47.0 mm) Christmas Is. Paratype 4.
Fig. 5: *Lyncina ventriculus johnclarki* (49.9 mm) Christmas Is. Paratype 7.
Fig. 6: *Lyncina ventriculus johnclarki* (49.9 mm) Christmas Is. Paratype 5.
Fig. 7: *Lyncina ventriculus johnclarki* (52.6 mm) Christmas Is. Holotype. WAM S79749.

Plate 2 (on p. 22)

Fig. 1: *Bistolida ursellus jomi* (11.6 mm) Bon Is., Phuket, Thailand. Holotype. USNM 1422336.
Fig. 2: *Bistolida ursellus jomi* (9.8 mm) Bon Is., Phuket, Thailand. Paratype 1.
Fig. 3: *Bistolida ursellus jomi* (11.6 mm) Bon Is., Phuket, Thailand. Paratype 2.
Fig. 4: *Bistolida ursellus jomi* (9.5 mm) Bon Is., Phuket, Thailand. Paratype 3.
Fig. 5: *Bistolida ursellus jomi* (15.0 mm) Weligama, S Sri Lanka. Paratype 6.

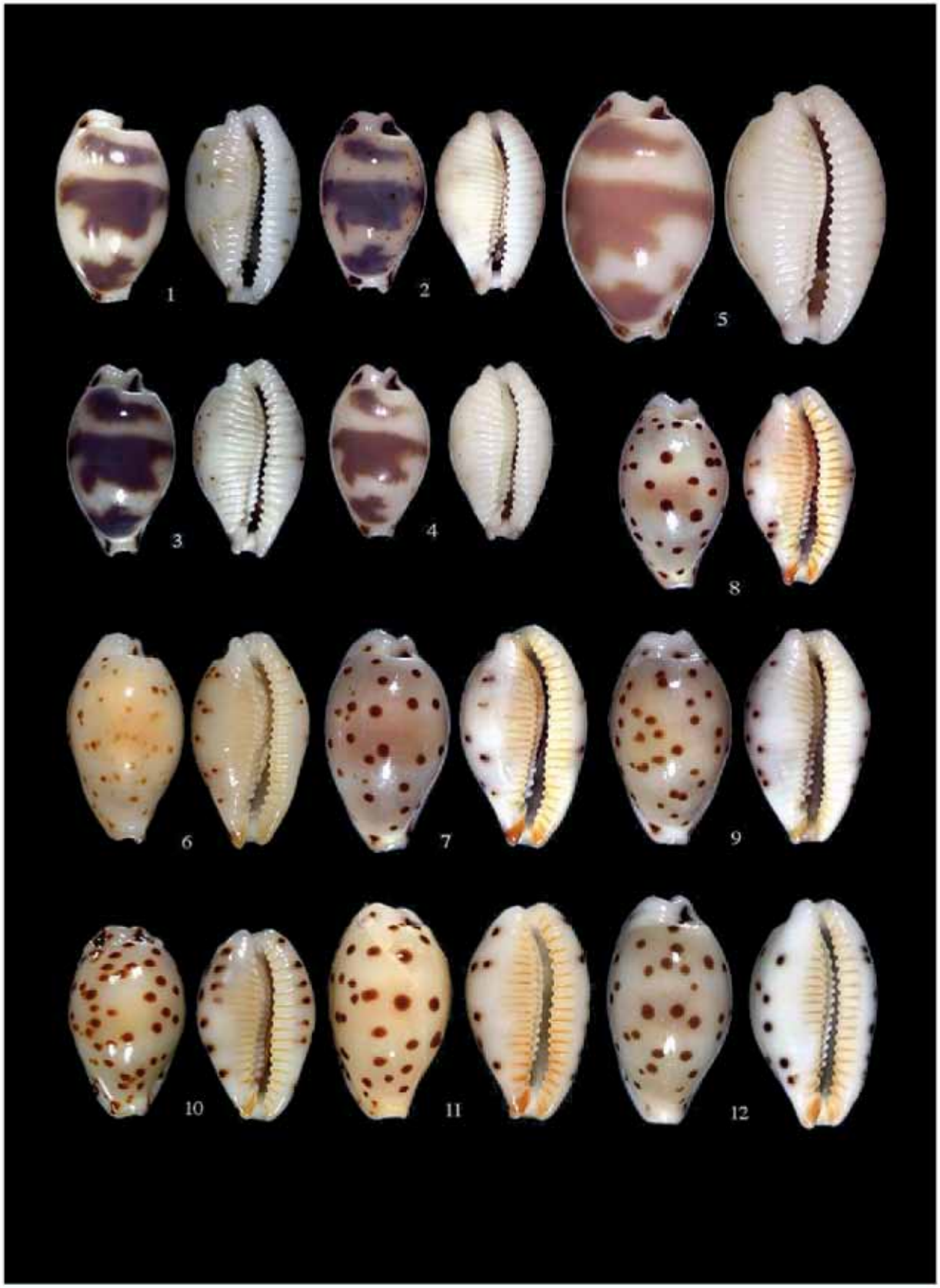
Fig. 6: *Ransoniella punctata bridgesi* (10.2 mm) Bon Is., Phuket, Thailand. Holotype. USNM 1422337.
Fig. 7: *Ransoniella punctata bridgesi* (11.1 mm) Bon Is., Phuket, Thailand. Paratype 2.
Fig. 8: *Ransoniella punctata bridgesi* (9.7 mm) Bon Is., Phuket, Thailand. Paratype 3.
Fig. 9: *Ransoniella punctata bridgesi* (11.3 mm) Bon Is., Phuket, Thailand. Paratype 4.

Fig. 10: *Ransoniella punctata conleyi* (11.3 mm) Seychelles. Holotype. USNM 1422345.
Fig. 11: *Ransoniella punctata conleyi* (13.8 mm) Seychelles. Paratype 1. USNM 1422346.
Fig. 12: *Ransoniella punctata conleyi* (14.5 mm) Hurghada, Egypt. Paratype 2.

Plate 1

Explanation on opposite p.

Plate 2



Explanation on p. 20

Plate 3 (on p. 24)

Fig. 1: *Cribrarula abaliena abaliena* (12 mm) Tumbatu Is., NW Zanzibar, Tanzania.
Fig. 2: *Cribrarula abaliena abaliena* (approx. 12 mm) Seychelles. Coll. USNM – Smithsonian.
Figs 3, 4: *Cribrarula abaliena ganteri* (28-30 mm) SW Sri Lanka. Coll. CLSF 7681.

Fig. 5: *Cribrarula abaliena erypersica* (19.7 mm) Bajun Is., S Somalia. Holotype. USNM 1422338.
Fig. 6: *Cribrarula abaliena erypersica*, Oman
Fig. 7: *Cribrarula abaliena erypersica* (24 mm) Bajun Is., S Somalia. Coll. CLSF 12257.
Fig. 8: *Cribrarula abaliena erypersica* (14.4 mm) Bajun Is., S Somalia. Paratype 7.
Fig. 9: *Cribrarula abaliena erypersica* (28.1 mm) Giftun Is., Egypt. Paratype 1.
Fig. 10: *Cribrarula abaliena erypersica* (13.6 mm) Bajun Is., S Somalia. Paratype 6.

Fig. 11: *Palmadusta ziczac yzac* (14.2 mm) Raya Is., Thailand. Holotype. USNM 1422335.
Fig. 12: *Palmadusta ziczac yzac* (15.5 mm) Raya Is., Thailand. Paratype 1.
Fig. 13: *Palmadusta ziczac yzac* (14.3 mm) Raya Is., Thailand. Paratype 2.

Plate 4 (on p. 25)

Fig. 1: *Purpuradusta fimbriata fimbriata* (14 mm) S Sri Lanka.
Fig. 2: *Purpuradusta fimbriata fimbriata* (11 mm) S Mauritius.
Fig. 3: *Purpuradusta fimbriata fimbriata* var. *quasigracilis* (15 mm) Tumbatu Is., Zanzibar, Tanzania.

Fig. 4: *Purpuradusta fimbriata marmorata* (11.4 mm) Misool Is., Raya Ampat, Irian Jaya, Indonesia.
Fig. 5: *Purpuradusta fimbriata marmorata* (14 mm) Balicasag Is., Bohol, Philippines.
Fig. 6: *Purpuradusta fimbriata marmorata* (8.8 mm) New Ireland, Papua New Guinea.
Figs 7-10: *Purpuradusta fimbriata marmorata* (10-11 mm) Rangiroa Atoll, Tuamotus.
Fig. 11: *Purpuradusta fimbriata marmorata* (11.1 mm) Taiarapu, Tahiti.

Fig. 12: *Purpuradusta fimbriata unifasciata* (13.5 mm) Kam Reef, Oahu, Hawaii.
Fig. 13: *Purpuradusta fimbriata marquesana* (14 mm) Nuku Hiva, Marquesas.
Fig. 14: *Purpuradusta fimbriata insolita* (13.5 mm) Cocos Keeling Is., Indian Ocean.

Fig. 15: *Purpuradusta fimbriata insolita* (10.8 mm) Christmas Is., Indian Ocean.
Fig. 16: *Purpuradusta fimbriata insolita* (10.2 mm) Christmas Is. Holotype. Coll. WAM S79750.
Fig. 17: *Purpuradusta fimbriata insolita* (10.4 mm) Christmas Is. Paratype 1.
Fig. 18: *Purpuradusta fimbriata insolita* (12.6 mm) Christmas Is. Paratype 3.
Fig. 19: *Purpuradusta fimbriata insolita* (9.0 mm) Christmas Is. Paratype 2.

Plate 5 (on p. 26)

Fig. 1: *Mauritia scurra scurra* (43.2 mm) Samar, Philippines.
Fig. 2: *Mauritia scurra scurra* (45.0 mm) Marau Sound Is., Guadalcanal, Solomons.
Fig. 3: *Mauritia scurra scurra* (41.2 mm) S Nuku Hiva, Marquesas.

Fig. 4: *Mauritia scurra scurra* var. *mundula* (30.4 mm) Taiarapu, Tahiti.
Fig. 5: *Mauritia scurra occidua* (39.2 mm) Nungwi, N Zanzibar, Tanzania. Holotype.

Fig. 6: *Mauritia scurra occidua* (39.8 mm) Nungwi, N Zanzibar, Tanzania. Paratype 1.
Fig. 7: *Mauritia scurra occidua* (46.3 mm) Nungwi, N Zanzibar, Tanzania. Paratype 3.
Fig. 8: *Mauritia scurra occidua* (36.2 mm) Trou d'Eau Douce, E Mauritius.

Plate 3

Explanation on p. 23

Plate 4

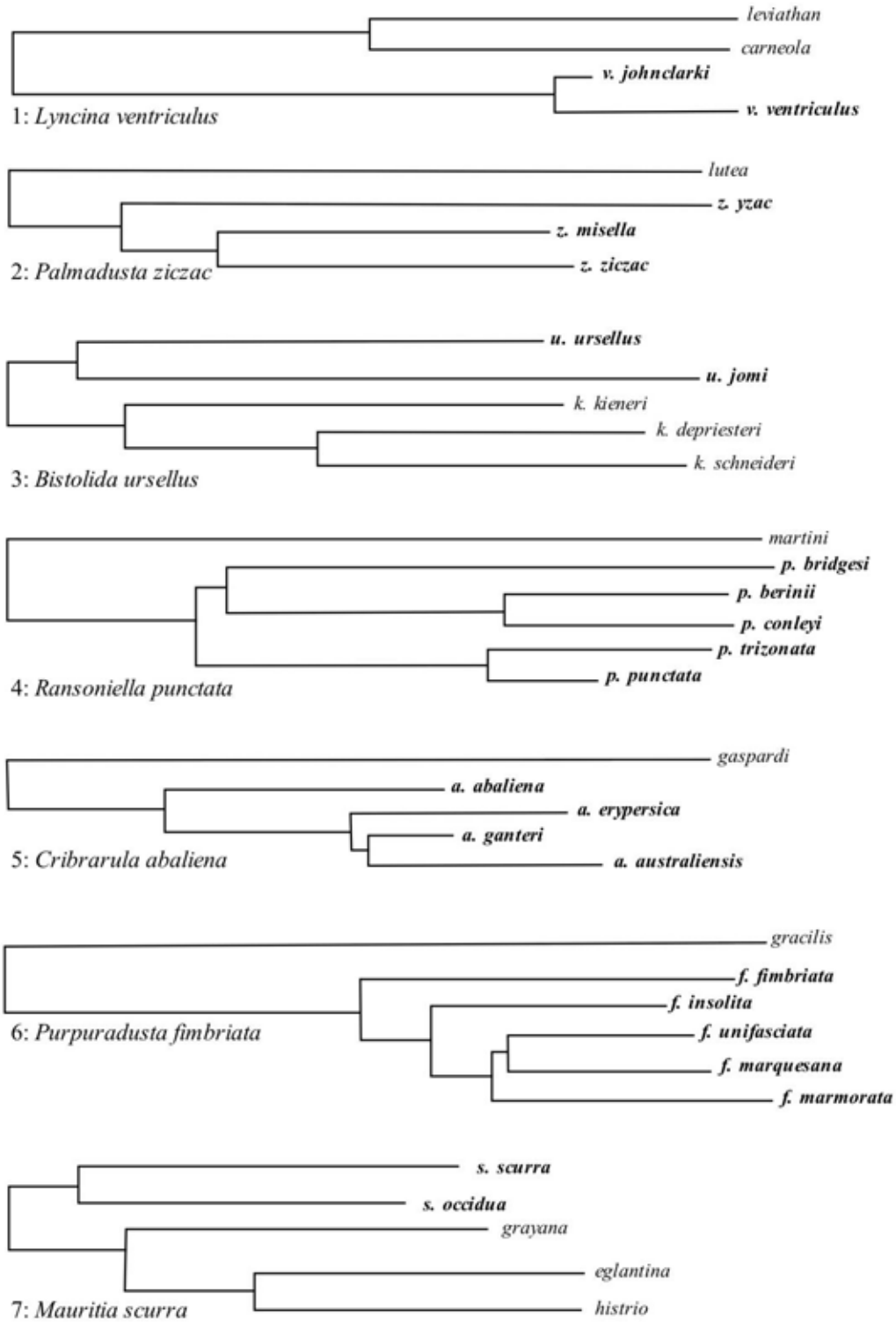
Explanation on p. 23

Plate 5

Explanation on p. 23

Plate 6

CO1 phylograms



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A new subspecies of *Erronea caurica* (LINNAEUS 1758) from West Thailand (Gastropoda: Cypraeidae)

By FELIX LORENZ

With 3 Text-Figures, 1 Table and 27 Figs on Plates 1-2

Keywords

Cypraeidae, *Erronea caurica chrismeyeri* n. ssp., western Thailand.

Abstract

Erronea caurica chrismeyeri n. ssp. is described from the western coast of Thailand. It differs from its relatives by a finer dorsal pattern, the lack of a dorsal blotch, and thick, partly extending columellar teeth, apart from considerable genetic differences. The *Erronea caurica* (LINNAEUS 1758)-complex is revised.

Zusammenfassung

Erronea caurica chrismeyeri n. ssp. von der Westküste Thailands unterscheidet sich von ihren Verwandten durch das Fehlen eines Dorsalfecks, feinere Musterung, teilweise verlängerte Kolumellarzähne und erhebliche genetische Merkmale. Der *Erronea caurica* (LINNAEUS 1758)-Komplex wird revidiert.

Introduction

The Indo-Pacific *Erronea caurica* comprises numerous geographically and conchologically defined populations recognized as subspecies and supported by molecular data. The differentiating shell features may be obscured by exceptional development of marginal callus or other local or individual variations, and larger series of shells may be necessary to safely assign a population to a subspecies. Several of the frequently used names are based on incorrectly identified type material or poor illustrations without an existing holotype. The following describes a subspecies whose range is restricted to the western coast of Thailand:

Erronea caurica chrismeyeri n. ssp.

Material

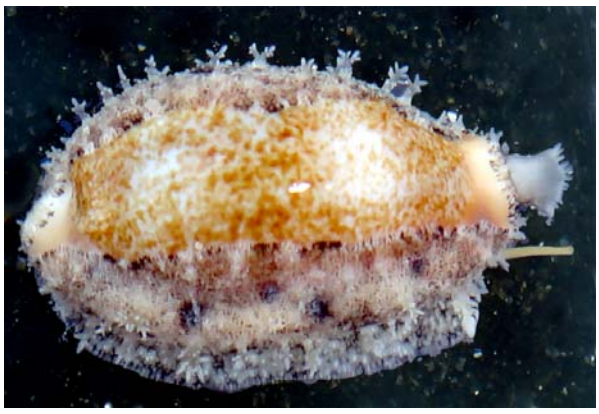
Holotype: 37.2 × 19.4 × 14.2 (15:15) coll. USNM 1422342. Paratype 1: 37.4 × 20.7 × 16.1 (14:17) [6.76]; Paratype 2: 35.4 × 19.6 × 15.0 (15:18) [5.89]; Paratype 3: 25.8 × 13.8 × 10.6 (12:14); Paratype 4: 24.5 × 14.3 × 10.6 (10:15) [2.21]; Paratype 5: 35.9 × 21.2 × 15.2 (13:18) [6.64]; Paratype 6: 24.5 × 13.1 × 10.3 (12:14) [1.84]; Paratype 7: 23.3 × 13.0 × 10.0 (12:15) [1.98]; Paratype 8: 23.9 × 13.5 × 10.3 (13:15) [2.18]; Paratype 9: 23.7 × 12.9 × 10 (11:15) [1.77]; Paratype 10: 25.5 × 14.1 × 10.8 (12:14) [2.39]; Paratype 11: 22.8 × 12.3 × 9.8 (11:13) [1.48] coll. HNC No. 92745; Paratype 12: 21.9 × 12.2 × 9.4 (11:12) [1.61]; Paratype 13: 24.7 × 13.7 × 10.4 (12:13) [2.18] coll. SMF 349033; Paratype 14: 24.9 × 13.2 × 10 (11:13) [2.09] coll. CLSF 16419; Paratype 15: 23.9 × 13.3 × 10.1 (10:12) [1.88]; Paratype 16: 38.8 × 21.5 × 16.3 (14:19) [7.71]; Paratype 17: 25.2 × 13.9 × 10.4 (12:13) [2.13] coll. Phuket Seashell Museum; Paratype 18: 26.1 × 14.2 × 10.8 (13:13) [2.48] coll. MNHN IM-2014-6081; Paratype 19: 31.7 × 18.6 × 13.7 (12:14) [4.74] coll. SMF 349034; Paratype 20: 36.9 × 20.7 × 15.6 (14:16) [6.36] coll. CLSF 16420; Paratype 21: 39.8 × 21.4 × 16.5 (13:16) [8.06]; Paratype 22: 36.0 × 20.5 × 15.2 (13:15) [6.88] coll. CLSF 16421; Paratype 23: 36.5 × 20.5 × 14.7 (13:16) [7.1]; Paratype 24: 38.6 × 19.9 × 15.9 (14:18) [5.63]; Paratype 25: 31.4 × 18.5 × 14.1 (13:17) [5] coll. MNHN IM-2014-6081; Paratype 26: 31.1 × 18.7 × 13.5 (12:17) [5.05]; Paratype 27: 28.0 × 16.2 × 11.8 (12:14) [3.39]; Paratype 28: 31.7 × 17.4 × 13.4 (13:16) [4.31] coll. Phuket Seashell Museum; Paratype 29: 26.1 × 15.3 × 11.6 (12:13) [2.97] coll. CLSF 16422; Plus 40 additional paratypes in collection MSF No. 8355(40). All from Phuket Is., W Thailand. Twenty-one additional paratypes in coll. CLSF no. 8442 (2), 8421 (10), and 16357(9). All other paratypes in the collection of the author.

Description

The shell is medium sized, slightly depressed and elongate-oval. The extremities are projecting and slightly margined. The marginal callus is somewhat developed and borders the dorsum with a shallow groove labrally. The aperture is wide, slightly curved, and widening anteriorly. The labral teeth are coarse, extending across the lip, reaching the margin towards the extremities. On the columellar side, there are fine teeth along the aperture, of which only some extend across

the base as a broad ridge. In the anterior half, the extensions of the teeth are notable mainly as slightly paler stripes. The dorsal profile is distinctly flattened in the midsection. Its ground color is cream, with two paler transverse bands. Dense and very fine brown freckling covers the dorsum. There is no dorsal blotch, but rarely, an accumulation of darker pattern. The margins are separated from the dorsum by a paler encircling band. The callosities are orange-tan, brown in fresh shells. The teeth are notably paler, their interstices darker orange to brown. The marginal spots are rather sparse and mainly distributed along the dorsal part of the margins. Strongly calloused shells are rare and always rather elongated. Most shells are depressed and narrow cylindrical. None of the shells studied has a distinct dorsal blotch.

The animal has a semi-transparent grey mantle with a rough surface. There are numerous short, stalked papillae with numerous dendritic branches at their tips. Their surface is beaded. The mantle is ornamented with fine black reticulations. These form more compact areas along the mantle edges. The foot is transparent grey with similar fine black markings which become coarser along its margin. The tentacles are yellow-orange. The siphon is transparent grey with fine papillae along its edges (Text-Fig. 1). As in *elongata*, the animal of *chrismeyeri* may autotomize a posterior portion of its foot when disturbed.



Text-Fig 1: *Erronea caurica chrismeyeri* n. ssp., living animal.

Distribution and habitat

Western coast of Thailand. In vital reef, and in muddy areas with dead coral rubble. Always in shallow water.

Etymology

Named in honor of my friend Dr. CHRISTOPHER P. MEYER, geneticist and like-minded cowry enthusiast from Washington DC, USA.

Discussion

The taxa associated with *caurica* show considerable local variability throughout their ranges (Map 1). Strongly calloused individuals occur in most populations (except *elongata* and *chrismeyeri*) and may be difficult to identify, as subtle conchological differences may be obscured. Identification of a subspecies should be done on larger series of shells from ascertained localities. Table 1 compares the most important shell features of the subspecies; types of the taxa are shown in Text-Fig. 2.

Pacific:

caurica caurica (LINNAEUS 1758)

Assumed type locality: Ambon, Indonesia (IREDALE 1939). Text-Fig. 2c: Lectotype.

Synonyms: *longior* IREDALE 1935 (Queensland), *thema* IREDALE 1939 (New Caledonia), *obscurata* SCHILDER & SCHILDER 1938 (New Caledonia), *caledonica* COEN 1949 (New Caledonia).

The typical *caurica* has a wide range in the western Pacific. It usually has a clearly discernible denticulate columellar sulcus. The shape varies from narrow cylindrical to rhomboidal calloused. The columellar teeth are coarse and usually short in northwestern shells, in Melanesia and Micronesia the teeth are more strongly developed.

caurica samoensis LORENZ 2002

Type locality: West Samoa. Text-Fig. 2g: Holotype.

This most eastern population is usually broad, depressed and calloused, with coarser and more distant columellar teeth. The coarser dorsal netting is a rather constant feature separating *samoensis* from its Pacific relatives.

Indian Ocean:

caurica blaesa IREDALE 1939

Type locality: NW Australia. Text-Fig. 2f: Holotype.

The West Australian *blaesa* differs from the Pacific *caurica* mainly by the more inflated shell with a weakly developed labral callus. The short and coarse columellar teeth separate it from the

other subspecies. Molecular data does not support its status as a separate subspecies, but places it with *caurica caurica*. However, the differences in dentition and shape are quite constant within its defined geographic range along the Western Australian coast.

caurica dracaena (BORN 1778)

Assumed type locality: India (STEADMAN & COTTON, 1946). Text-Fig. 2b: Holotype.

Possibly synonymous: ?*derosa* GMELIN 1791 replacing the invalid *corrosa* GRONOVIUS 1781 (locality unknown) Text-Fig. 2a: Type figure from GRONOVIUS 1781.

The holotype of *dracaena* in the Natural History Museum of Vienna is a slender, cylindrical shell with a distinct dorsal blotch, moderately short, regular columellar teeth, strong labral teeth, and a slightly produced columellar sulcus. Such shells are typical for the southern coast of India and Sri Lanka.

Very calloused, oval-depressed specimens of *dracaena* are occasionally found in Sri Lanka, India, and the Maldives. The name *corrosa* is in popular use for such shells. However, it was introduced in a non-binominal manner. The name *derosa* was proposed by GMELIN to replace it. In their Prodrome (1938), the SCHILDERs use *corrosa* and cite GRONOVIUS as author, but in their Systematic Catalogue (1971) they quote themselves (SCH. & SCH. 1938) as authors of the name. Associating these names with *dracaena* is arbitrary, as they are based on the same poor illustration in GRONOVIUS, which depicts a shell that is calloused on dorsal but more slender on basal view, with small, sparse marginal spots, rather long, equally formed columellar teeth, a smooth, distorted columella and a narrow, distorted labrum (Text-Fig. 2a). It allows no confinement of *derosa*/*corrosa* to any population of *caurica*, and no type specimen is preserved. In a taxonomical sense, *corrosa* is invalid, and *derosa* is a nomen dubium.

caurica quinquefasciata (RÖDING 1798)

Assumed type locality: Red Sea (STEADMAN & COTTON 1946). Text-Fig. 2d: Type figure from MARTINI & CHEMNITZ 1796.

Synonyms: *immaculata*, *pseudoarabicula* COEN 1949 (Somalia), *multidentata* COEN 1949 (Red Sea), *nabeqensis* HEIMAN & MIENIS 2000.

The name *quinquefasciata* is based on an ancient illustration from MARTINI, which is inappropriate to characterize a particular population of *caurica*. No type locality was given, but the assignment to the population from the Red Sea and Arabia was proposed by the SCHILDERs (1938). In contrast to the poor illustration of *corrosa*/*derosa*, that of *quinquefasciata* may indeed represent a shell from that area, as it has brown callosities, a dorsal blotch, and a rather broad posterior extremity.

According to the molecular data, the populations of *caurica* from the Red Sea and Oman form a unit, but conchologically, there are differences between shells from these areas. Generally, shells from Oman and Persian Gulf are more depressed, the callosities are brown rather than grey, the spire is completely concealed by callus and the columellar teeth are longer than in specimens from the Red Sea. Shells from the northern Red Sea have been described as separate subspecies, *nabeqensis* HEIMAN & MIENIS 2000. It is claimed to be more calloused than southern shells, but based on a large series of specimens collected in the vicinity of Hurghada, Egypt, northern shells show the same range of variations in shape and the degree of callosities. No molecular differences have so far been found to ascertain the status of *nabeqensis*, which is still under study.

caurica elongata (PERRY 1811)

Assumed type locality: SE Africa (STEADMAN & COTTON, 1946). Text-Fig. 2e: Type figure from PERRY, 1811.

The name *elongata* was introduced for a specimen of unknown origin. SCHILDER & SCHILDER (1938) generalized it for the East African subspecies of *caurica*. Unlike other subspecies of *caurica*, there are basically no variations with calloused margins in *elongata*. The marginal spots are large and dense, and they may be connected to a dark longitudinal band. The most important characteristics setting *elongata* apart from the conchologically similar *quinquefasciata* are the less distinct, long and fine columellar teeth, the narrower labrum, the lack of a distinct groove separating the labrum from the dorsum, the more conspicuous dorsal banding, and the purplish grey instead of pale tan basal callosities.

The East African *elongata* can be quite similar to *quinquefasciata* in general appearance, but differs in being more inflated, with an exposed spire, by having a wider aperture anteriorly, more

distinct dorsal banding, larger marginal spots which are confluent labrally towards the extremities, and a grey instead of brown base (not apparent in fresh shells). The columellar teeth of *elongata* do not extend onto the middle of the base, and they are still finer.

caurica mayottensis VACHON & VERNEAU 2017

Type locality: Mayotte Is. Text-Fig. 2h: Holotype.

At Mayotte Is., a distinctive population of *caurica* has recently been described as *mayottensis*. As the article in which the name was first introduced (VACHON & VERNEAU 2008) was not intended as a formal description (VERNEAU pers. comm. 2016), another description was published in 2017. The shells of this population can be depressed, with strongly developed marginal callus. The labral margin forms a deep, distinct groove along the dorsum. The marginal spots are small and usually situated in that groove and along the area where the callus meets the dorsum. A conchological peculiarity is that in one fourth of the shells studied, some of the labral teeth are split into two narrower ones. In cleaned, dried shells, the dorsal banding is completely absent, and it is less distinct in fresh shells than in other subspecies of *caurica*. In their article about the cowries of Mayotte, the authors also mention "typical *elongata*" from Mayotte. However, the shells they depict seem to represent a rather slender, less calloused variation of *mayottensis*, discernible by the formation of the marginal spotting. Molecular data for specimens from Mayotte itself is not available so far, but the population from the Seychelles represents a distinct lineage. Some of the shells from that area are less calloused. Shells similar to those from Mayotte, as well as slender forms resembling *elongata* are also found in Mauritius. The assignment of the populations from the Mascarenes and Seychelles to the name *mayottensis* is, therefore, tentative.

caurica chrismeyeri n. ssp.

Type locality: Phuket Is., W Thailand. Text-Fig. 2k: Holotype.

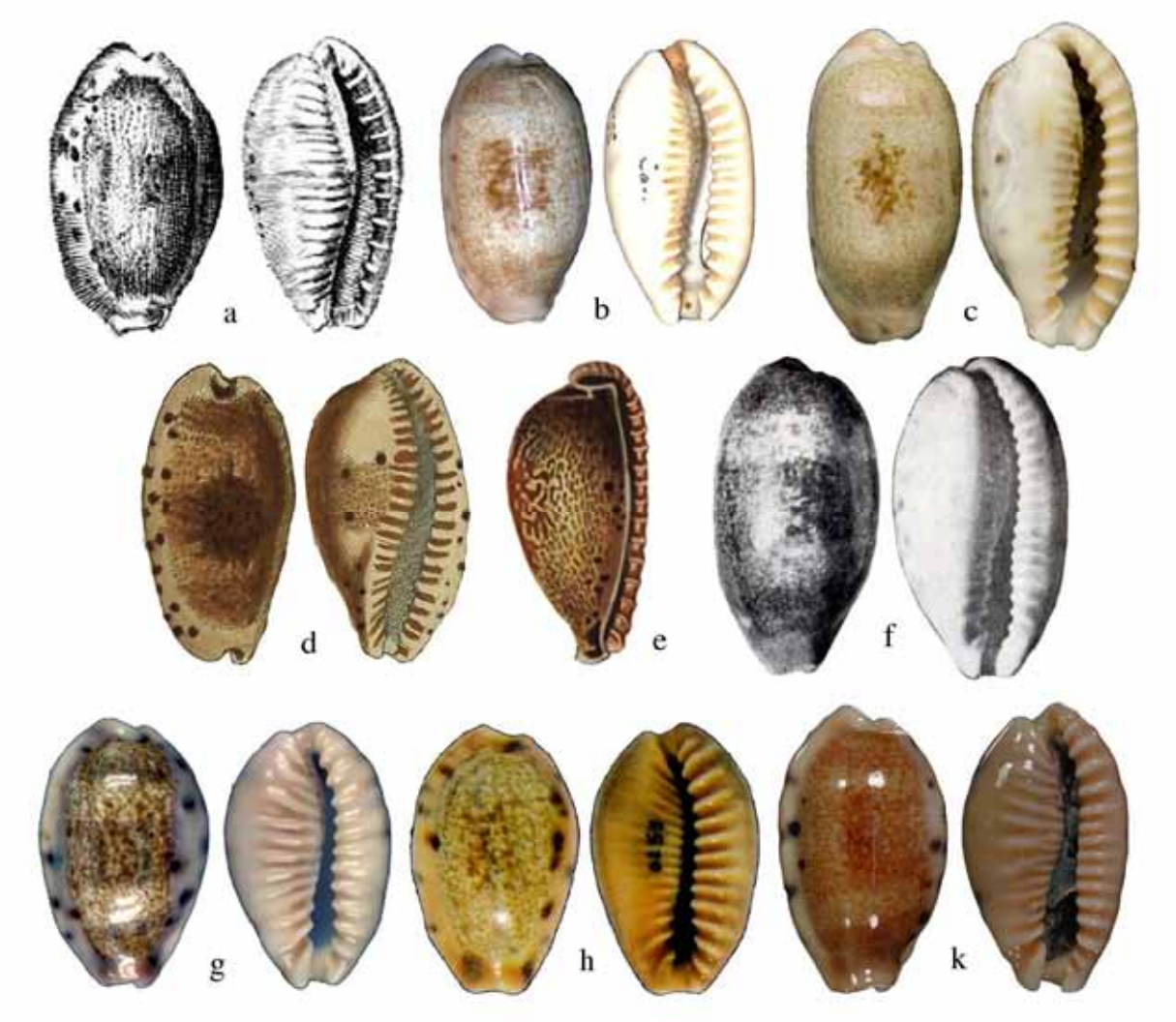
The constant conchological features of *chrismeyeri* make this new subspecies readily recognizable. The lack of a defined dorsal blotch and the finer dorsal pattern are the most obvious differences from *dracaena*. Among larger series of *chrismeyeri*, strongly calloused individuals, as they occur in *dracaena*, are basically missing. A peculiarity about the columellar dentition is that only some of the teeth present along the aperture are thickened and extend onto the middle of the base, with smaller and shorter interstitial ones, or with two smaller teeth joining to form one prominent extending ridge. This feature, though less obvious, is also found in calloused *dracaena*, especially in the population from the Maldives, which is poorly known and requires further study.

Table 1: Comparison of the subspecies of *Erronea caurica*.

	c. caurica	***c. blaesa***	***c. samoensis***	***c. dracaena***	***c. chrismeyeri***	***c. quinquef.***	***c. elongata***	***c. mayotten.***
distri-bution	West to central Pacific	Western Australia	Western Polynesia	India, Sri Lanka	W Thailand	Red Sea, Oman, Somalia	East Africa, Madagascar	Mayotte Is., Seychelles?, Mascarenes?
shape	oval to cylindrical	elongate oval, inflated	oval, depressed to cylindrical	cylindrical, slightly depressed		elongate oval, depressed	elongate oval, inflated	oval, broad, depressed
aperture	narrow, straight	rather narrow, curved	wide, rather straight	narrow, straight	wide, slightly curved	wide, curved	wide, wider anteriorly, curved	rather narrow
dorsal profile	flattened	rounded	slightly flattened	flattened	flattened	rounded		
left callus	less produced, low	thin, evenly rounded, high	mostly strong, bent up, high	less thick, rounded, high	less produced, rounded, high	less developed, rather high	absent	strongly produced
labral callus	weak, no groove, low	weak, no grove, high	strong, shallow groove, high	mostly weak, no groove, low	weak, shallow groove, high	strong, shallow groove, high	mostly absent, no groove, low	produced, low, deep groove
labral teeth	swollen, extending across lip	less swollen, shorter	swollen, less numerous, extending onto lip	less swollen, extending across lip	swollen, less dense, extending across lip	swollen, dense, extending across lip	less swollen, extending across lip	swollen, extending scross lip

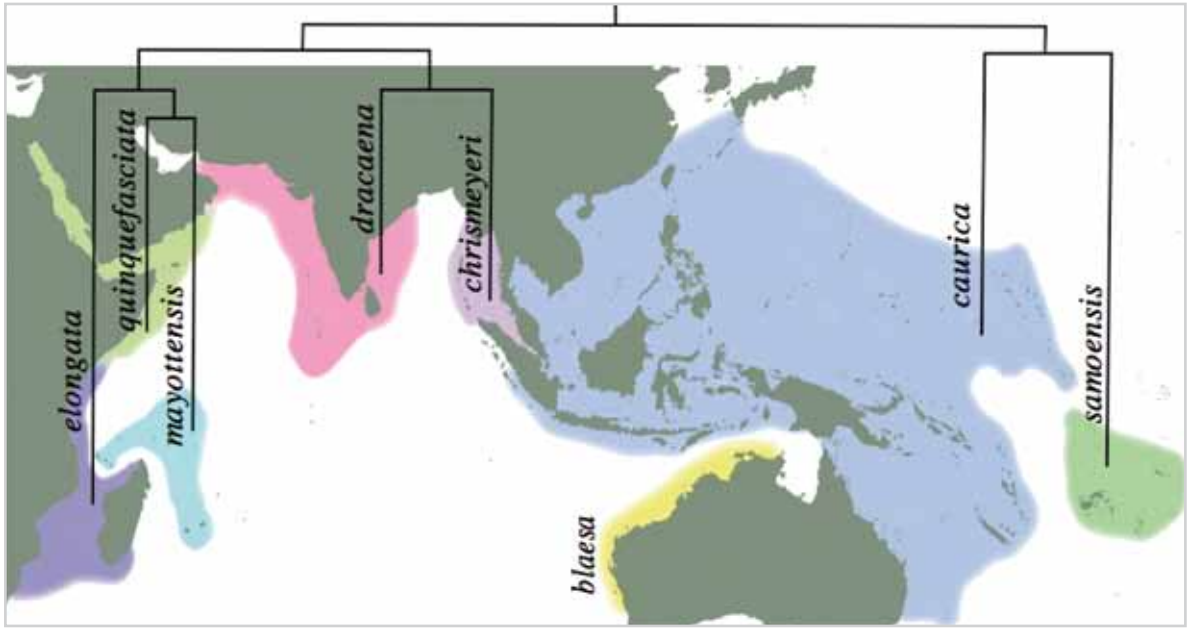
Table 1 (cont.): Comparison of the subspecies of *Erronea caurica*.

	c. caurica	***c. blaesa***	***c. samoensis***	***c. dracaena***	***c. chrismeyeri***	***c. quinquef.***	***c. elongata***	***c. mayotten.***
colum. teeth	coarse, extending onto base	coarse, short	swollen, coarse, ext. across base, branching	fine, ext. onto base, often branching	swollen, extending across base, branching	fine, short, hardly extending, not forming branches		fine, unbranched, extending onto base
marginal spotting	small, distinct, sparse, evenly distributed	large, distinct, denser, larger dorsally	larger, often indistinct, dense, condensing dorsally	large, distinct, sparse, reaching base	small, less distinct, sparse, restricted to dorsal area	large, indistinct, sparse, restricted to dorsal area	rather small, dense, often confluent	small, mostly sparse, mainly in groove
dorsal blotch	diffuse or absent	diffuse, mostly absent	mostly absent	more compact, conspicuous	indistinct, diffuse, mostly absent	diffuse, large	rather small, often compact	small, diffuse
dorsal freckling	fine, dense, distinct	coarser, sparser	coarse, dense, diffuse	coarse, dense, distinct	paler, rather fine, distinct	coarse, diffuse	mostly sparse, fine, distinct	fine, sparse
darker dorsal bands	rather distinct, compact	distinct, interrupted		distinct, compact	indistinct but discernible	distinct, mostly compact	distinct, compact	absent in dried shells
color of callus	cream to brown	pale grey to cream	greyish orange	saturate brown	orange brown, paler band along dorsum	pale orange to brown	grey to cream	tan to brown



Text-Fig 2: *Erronea caurica* ssp., types and original figures; cfr. Text for details.

The available molecular data reveals that *caurica* is more diverse genetically in the western Indian Ocean than in the Pacific (Text-Fig. 3). While there are multiple samples from India, Thailand, the Oman, the Seychelles, and East Africa, a lot more localities are yet to be investigated. No molecular data is so far available from the various populations found e.g. in the Mascarene Islands, southern Madagascar, Mayotte, the Comoros, and the Maldives. Each of these places is known to yield a population of *caurica* that cannot be safely assigned to the existing taxa. It may turn out that we are looking at a species complex with a greater genetic diversity than shell features would allow us to recognize, a parallel to the genera *Bistolida* and *Cribrarula*. Comprehensive molecular sampling in the above mentioned places could lead to further insights in the evolutionary processes that led to the diversity of cryptic cowry species encountered in the western Indian Ocean.



Text-Fig. 3: Distribution map and simplified phylogram of the subspecies of *Erronea caurica*, based on mtDNA analysis, after MEYER (2004), and pers. comm. 2013, modified.

Plate 1 (on opposite p.)

Fig. 1: *Erronea caurica caurica*, Tioman, Malaysia.
Fig. 2: *Erronea caurica caurica*, 25.7 mm, Balabac Is., S Palawan, Philippines.
Fig. 3: *Erronea caurica caurica*, 43.3 mm, Ceram Is., Irian Jaya, Indonesia.
Fig. 4: *Erronea caurica caurica*, 46 mm, Kwajalein Atoll, Marshall Is.
Fig. 5: *Erronea caurica samoensis*, Apia, West Samoa.
Fig. 6: *Erronea caurica samoensis*, 33 mm, Savaii, West Samoa.
Fig. 7: *Erronea caurica quinquefasciata*, 39.3 mm, Muscat, Oman.
Fig. 8: *Erronea caurica quinquefasciata*, 29.2 mm, Ras Tanuraa, Persian Gulf.
Fig. 9: *Erronea caurica quinquefasciata*, 28.2 mm, Safaga, Egypt.
Fig. 10: *Erronea caurica elongata*, Dar-es-Salaam, Tanzania.
Fig. 11: *Erronea caurica elongata*, 33.3 mm, Ukunda, Kenya.
Fig. 12: *Erronea caurica elongata*, 43.5 mm, Bazaruto Is., Mozambique.

Plate 1

Explanation on opposite p.

Plate 2 (on opposite p.)

Fig. 1: *Erronea caurica chrismeyeri* n. ssp., 37.2 mm, Phuket Is., Thailand. Holotype, coll. USNM 1422342.
Fig. 2: *Erronea caurica chrismeyeri* n. ssp., 37.4 mm, Phuket Is., Thailand. Paratype 1.
Fig. 3: *Erronea caurica chrismeyeri* n. ssp., 35.4 mm, Phuket Is., Thailand. Paratype 2.
Fig. 4: *Erronea caurica chrismeyeri* n. ssp., 25.8 mm, Phuket Is., Thailand. Paratype 3.
Fig. 5: *Erronea caurica chrismeyeri* n. ssp., 24.5 mm, Phuket Is., Thailand. Paratype 4.
Fig. 6: *Erronea caurica chrismeyeri* n. ssp., 26,0 mm, Phuket Is., Thailand. Exceptionally calloused shell.
Fig. 7: *Erronea caurica dracaena*, 26 mm, Beruwela, SW Sri Lanka.
Fig. 8: *Erronea caurica dracaena*, 36 mm, Chennai, India.
Fig. 9: *Erronea caurica* cf. *dracaena*, 28 mm, Male Atoll, Maldives.
Fig. 10: *Erronea caurica dracaena*, Pidgeon Is., Sri Lanka.
Fig. 11: *Erronea caurica dracaena*, 23 mm, Kerala, India.
Fig. 12: *Erronea caurica blaesa*, 39.6 mm, Thevenard Is., NW Australia.
Fig. 13: *Erronea caurica* cf. *mayottensis*, 31.8 mm, Mahe, Seychelles, coll. USNM.
Fig. 14: *Erronea caurica mayottensis*, 32.3 mm, Mayotte Is.
Fig. 15: *Erronea caurica mayottensis*, 33 mm, Mayotte Is.

Plate 2

Explanation on opposite p.

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Mauritia maculifera andreae n. ssp. from the Philippines (Gastropoda: Cypraeidae)

By ULF ERDMANN & FELIX LORENZ

With 1 Text-Figure, 1 Table and 11 Figs on Plates 1-2

Keywords

Mauritia mauritiana andreae, new subspecies, Philippines.

Abstract

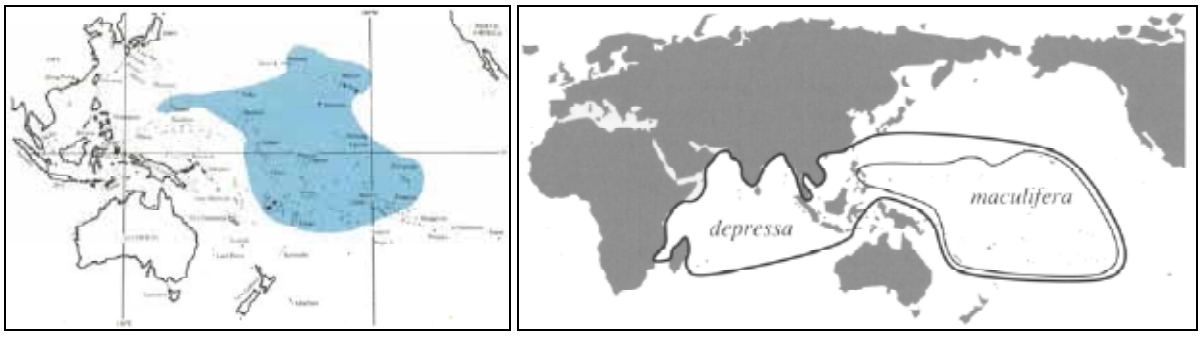
The distribution of the cowry *Mauritia maculifera* SCHILDER 1932 is discussed. *Mauritia maculifera andreae* n. ssp. from the Philippines differs from the other three subspecies by the reduction or absence of a compact basal blotch, by often having fine paler transverse lines and spots in the darker dorsal pattern, and by numerous, subtle morphological differences.

Zusammenfassung

Das Verbreitungsgebiet der Kauri *Mauritia maculifera* SCHILDER 1932 wird diskutiert. *Mauritia maculifera andreae* n. ssp. von den Philippinen unterscheidet sich von den übrigen drei Unterarten durch die Reduktion oder das Fehlen eines kompakten Basalflecks, durch helle, feine Längslinien und Punkte im dunkleren Dorsalmuster, sowie durch weitere subtile Gehäusemerkmale.

Introduction

Mauritia maculifera SCHILDER 1932 is a variable species with a wide distribution in the Pacific Ocean. In the "Prodrome" SCHILDER & SCHILDER (1938) gave the distribution of *Mauritia maculifera* as East Polynesia to Rarotonga, French Frigate Shoals (Hawaii), Marinas, Yap and Gilbert Islands. In 1965, SCHILDER reported the finding of *Mauritia maculifera* on Frigate Island in the Seychelles, based on a record given by WALTER OLIVER CERNOHORSKY. The rather poor image of the shell seems to show *Mauritia maculifera*, but intensive search in the following half century did not produce another record of *maculifera* from the Indian Ocean. BURGESS (1970) restricted the distribution to the central Pacific and Tahiti, and in the second edition (1985) reported a range from Hawaii to Tahiti, westward to Kiribati (Gilbert Islands), Wake Island, Guam, and Kwajalein (see Text-Fig. 1).



Text-Fig. 1: Distribution of *Mauritia maculifera* according to BURGESS (1985) and LORENZ & HUBERT (2000).

LORENZ & HUBERT (1993, 2000) added the Philippines and New Caledonia. OKUTANI (2000) extended the range northwards to the Izu Islands in Southern Japan, and THACH (2005) to the coast of South Vietnam. HEIMAN (2005) adds the Ryu-Kyu Islands as a locality from where the species has been reported. The first mention of the Philippine population described herein, accompanied by an illustration, was found in SPRINGSTEEN & LEOBRERA (1986).

MEYER (2003, 2004) demonstrated that the populations of *maculifera* from Tahiti and the Marquesas differed considerably by their mitochondrial DNA and shared this information with LORENZ (pers. comm. 2002), who named these populations, noticing also conchological differences between these and the nominate

Hawaiian *maculifera*. He established *Maurita maculifera martybealsi* from the Marquesas and *Mauritia maculifera scindata* from the Society and Tuamotu islands. In this description, LORENZ already pointed out that the systematic position of the populations of *maculifera* from the Philippines required further study: these shells differ mainly by a distinctly curved aperture and a reduced basal blotch. In 2005, HEIMAN introduced the synonym *Mauritia maculifera hawaiiensis*, challenging the origin of the holotype (see discussion below). A comprehensive revision of the complex is in preparation. The following shall merely fill a taxonomic gap by providing a name for the Philippine population, which we name in honor of ANDREA ERDMANN, author's wife, for lifelong support.

Mauritia maculifera andreae n. ssp.

(Pl. 1 Fig. 4, Pl. 2)

Material

More than 120 specimens from Samar Island, Philippines, measurements listed length × width × height (mm), (counted labral : columellar teeth) weight.

Holotype: 51.6 × 33.5 × 27.7 (22 : 25) [26.02], coll. SMF 349101.

Paratype 1: 50.7 × 33.0 × 25.0 (25 : 27) [24.30]; coll. MSF 8314; Paratype 2: 54.1 × 36.5 × 29.2 (23 : 24) [33.38]; Paratype 3: 54.7 × 35.0 × 25.8 (25 : 22) [27.73]; Paratype 4: 61.6 × 45.7 × 36.3 (27 : 23) [49.07], coll. MARTY BEALS; Paratype 5: 55.8 × 34.9 × 28.7 (24 : 26) [25.21]; Paratype 6: 51.1 × 35.3 × 26.2 (22 : 24) [20.88]; Paratype 7: 55.7 × 38.5 × 29.2 (26 : 23) [40.88], coll. MARTY BEALS; Paratype 8: 55.9 × 33.5 × 27.3 (23 : 22) [26.68]; Paratype 9: 37.6 × 26.2 × 18.6 (22 : 20) [13.26], coll. ULF ERDMANN; Paratype 10: 38.6 × 25.9 × 18.9 (23 : 25) [12.15], coll. ULF ERDMANN; Paratype 11: 41.4 × 29.6 × 21.9 (23 : 21) [17.76], coll. ULF ERDMANN; Paratype 12: 1.7 × 27.8 × 20.4 (22 : 21) [16.27], coll. ULF ERDMANN; Paratype 13: 37.7 × 27.5 × 20.4 (20 : 19) [13.78], coll. MARTY BEALS; Paratype 14: 45.7 × 35.2 × 23.9 (23 : 23) [23.96], coll. MARTY BEALS; Paratype 15: 49.6 × 33.7 × 26.8 (22 : 15) [28.83], coll. MARTY BEALS; Paratype 16: 50.8 × 34.0 × 26.0 (25 : 22) [25.75], coll. SMF 349102; Paratype 17: 56.3 × 37.9 × 27.7 (25 : 26) [32.00], coll. MSF 8315; Paratype 18: 68.2 × 45.1 × 45.0 (25 : 23) [63.89]; Paratypes 19-35 in coll. MSF No. 8316-8333; Paratypes 36-46 in coll. CLSF No. 5579, 10466, 10453; 8 further unnumbered paratypes in coll. MARTY BEALS, and an additional 57 specimens in coll. ULF ERDMANN.

Shell formula: 46 (67-50-75) 19 : 19 [21.4]

Description

The holotype shell is elongate oval and solid. The base is slightly convex, the dorsum slightly humped, with the highest part in the posterior third. The margins are slightly calloused, but not expanded and barely separated from the dorsum midways, while a groove is present towards either side of the extremities. The posterior extremity is broad and evenly tapering. The anterior extremity is typical for the genus, with flattened, pointed tips. The spire is pointed and partly embedded in the callus of the extremity. The aperture is rather narrow, slightly widened in front, and somewhat bending to the left posteriorly. The teeth are prominent and restricted to the aperture, while their chestnut brown staining proceeds onto both sides. The staining on the labral side is more or less of equal length. The staining on the columellar side is somewhat shorter anteriorly, getting longer in the middle part and is shortening again posteriorly. The fossula is produced, with coarse ribbing originating from prolongations of the columellar teeth. It is slightly projecting and totals about a third of the aperture's full length, extending as a distinct columellar peristome, which is ribbed, but not connected with the columellar teeth above. Between the edge of the aperture and the peristome, there is an area without callus, displaying the zigzag banding of the subadult shell.

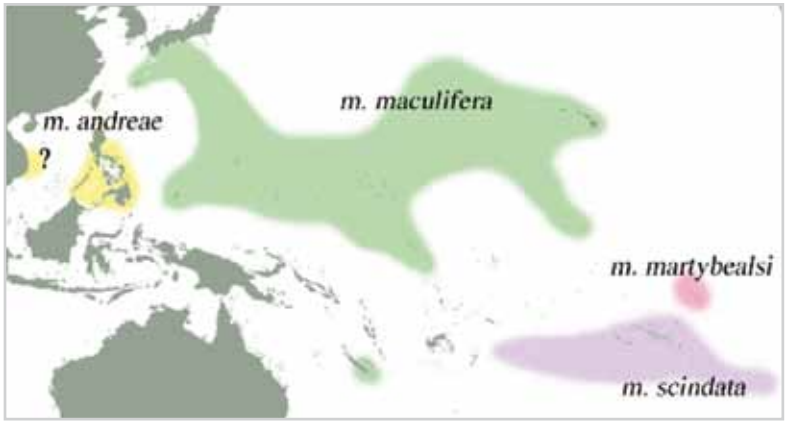
The ground color of the base is cream, but there are darker blurred blotches of brown and blue labrally and towards the margins of the columellar side, where the dense spotting of the margins extends onto the base. Along the midsection of the columellar side of the base, there is a faint darker zone bordering the dark stained lines extending from the teeth. The marginal spotting is rather dense, with darker areas between the spots. The extremities are blotched darker. The dorsal ground color is bluish grey, with three narrow transverse bands. The darker pattern consists of brown reticulated netting forming large, often distant lacunae. The areas where the brown pattern is not interrupted and narrowed by lacunae show fine paler lines of predominantly longitudinal orientation, or small paler spots, which are fragments of the longitudinal lines. A narrow dorsal line runs nearly centrally across the dorsum. The interior of the shell is purple, the fossula and the peristome are cream-white.

In some of the paratypes, the spire is more distinctly projecting and only covered with little enamel. The length of the shells varies considerably from 33 to 69 mm, and the shape varies from oval-depressed to elongate-cylindrical. The color of the margins varies from cream to bluish grey. Also, the density of the marginal spotting varies, but the spotting is usually distinct and rarely confluent. In some shells the darker zone above the columellar teeth may be more distinct and rarely, it forms a distinct darker blotch (in about 10 % of the shells studied). The dorsal line tends to be shifted to the labral side of the shell. The dorsal reticulation varies only slightly in the shape of the lacunae and the width of the darker netting between them, whose fine longitudinal lines or spots may be absent or blurred. Shells with a well-developed and dark basal blotch are rare (less than 5 % of the specimens studied), but shells with an indication of a blotch in form of a darker area above the columellar teeth in the midsection are common (60 % of the shells studied). Some paratypes do not show even an indication of a basal blotch.

Habitat and distribution

Mauritia maculifera andreae n. ssp. is known from those areas in the Philippines which are exposed to open oceanic conditions: The eastern coasts of Samar and Siargao in the east of the Archipelago, and southern Palawan and Balabac Island in the west, are confirmed localities. Records from Mactan and other places in the Visayas are definitely incorrect. The identity of the populations from Vietnam is not confirmed, but suspected to be *andreae*. Figure 2 gives a preliminary update to the distribution of *M. maculifera* and its subspecies.

The populations of *M. maculifera andreae* are confined to areas with rough, open-ocean conditions. At Siargao, shells of andreae were found from just below the low tide level, to 40 m, in rocky crevices and caves also inhabited by typical open-ocean species such as *Arestorides argus* (LINNAEUS 1758), and *Callistocypraea aurantium* (GMELIN 1791) on the side of the large-shelled cowries, *Annepona mariae* (SCHILDER 1927), and *Ipsa childreni* (GRAY 1825) as typical small-shelled species with this habitat preference.



Text-Fig. 2: Distribution of *Mauritia maculifera* and its subspecies.

Discussion

The shells of the four subspecies of *maculifera* are separable by subtle features, which may be obscured by individual variability. Table 1 gives a comparison based on a larger number of shells. Some differentiating features may not be obvious in individual specimens. In addition to the features discussed in the table, a statistical analysis of the shell parameters processed by the shell formula reveals significant differences of the Philippine *andreae* from other populations. A more comprehensive treatise to elaborate on these morphometric aspects is in preparation by the first author.

Molecular data for the new subspecies is not available so far. Although the general shell morphology suggests a close relationship to *depressa* (GRAY 1824), *maculifera* is a sister to the *Arabica* complex comprising *arabica* (LINNAEUS 1758), *asiatica* SCHILDER & SCHILDER 1939, and *immanis* SCHILDER & SCHILDER 1939. Genetically, *depressa* is a sister of *mauritiana* (LINNAEUS 1758) and only remotely related to *maculifera* within the genus (MEYER 2004). The

similarity of *depressa* and *maculifera* in shape and coloration can be interpreted as a product of convergent adaptation to a similar habitat, with *depressa* being more confined to shallow, turbid waters of fringing reefs that are influenced by tidal action. This habitat is shared by *maculifera*, but that species ranges much deeper, to 40 m in the Philippines.

The three established subspecies of *maculifera* show a genetic pattern that places *martybealsi* basal to *maculifera* and *scindata*, which are close, yet distinct, sisters. Genetically, the nominate *maculifera* populations encompass the area between Guam, Kwajalein, and Hawaii, which abrogates the attempt to subdivide between northwestern Pacific shells and the Hawaiian population as proposed by HEIMAN (2005). The Polynesian *scindata* seems to be restricted to Tahiti and the Tuamotus. The status of the populations from the Cook Islands and New Caledonia requires further study, as tissue has not yet been available for molecular analysis. It is suspected to be derived from *scindata*, judging from a comparison of their shells. The genetically and morphologically distinct *martybealsi* is endemic to the Marquesas Archipelago.

The darker dorsal pattern component of *andreae* tends to be frequently interrupted by fine, mostly longitudinally oriented paler lines which resemble the pattern of *arabica* (in 25 % of the shells studied). A similar feature is also found in *martybealsi* (approximately 15 % of the shells studied), but only very rarely in the nominate *maculifera* and *scindata* (in less than 5 % of the specimens studied). This may or may not indicate relationship between *arabica* and *andreae*, in which case this westernmost subspecies might be the most archaic, and the eastern populations derived. Molecular analysis of *andreae* will shed light on this issue, which at present is mere speculation.

The reduction of the darker basal blotch in *andreae* distinguishes the majority of specimens from the nominate *maculifera* and the eastern subspecies. The Japanese population seems to belong to the nominate *maculifera* as well, based on the single shell depicted from dorsal view in OKUTANI (2000) and considering his mention of a basal blotch. On the other hand, the Vietnamese population reported by THACH (2005) may be assigned to *andreae*, as the illustrated specimen seems to be small and rather slender, the basal blotch discrete, and on a pale background. Due to the geographic component, the Vietnamese population is tentatively assigned to *andreae*. Both OKUTANI's and THACH's records require confirmation as no material from these areas was available to us. Three specimens from Samar in the Philippines, illustrated by POPPE (2008), agree with the conchological concept of *andreae*, but a fourth shell on pl. 104, fig. 5a shows a basal blotch that is far more distinct and darker than in any Philippine specimen that we could study. Also the shell shape and the distribution of color on the base are typical for the nominate *maculifera* from Hawaii.

GUIDO POPPE (pers. comm. 2016) informed us that this shell was purchased from an unreliable source, and that it possibly originated from Hawaii. Also, the shell depicted in LORENZ & HUBERT (2000) p. 540, fig. 1 is *andreae*, as well as the shell on pl. 14, fig. 23, whose locality data should read Samar, and not Cebu, from where it was purchased.

Acknowledgements

We wish to thank MARTY BEALS for loan of shells and helpful advice. Dr. MICHAEL A. MONT for proofreading. GUIDO POPPE for helpful advice. The second author sends special thanks to JEAN-PIERRE and RUTH BARBIER. Last but not least, we thank our ladies, ANDREA ERDMANN and JANA KRATZSCH.

Table 1: Comparison of the four subspecies of *Mauritia maculifera*. Explanations in the text.

	andreae	***maculifera***	***martybealsi***	***scindata***
Distribution	Philippines, Vietnam	Japan, Vietnam, Guam, Marshall Is., Kiribati, to Hawaii	Marquesas	Tahiti, Tuamotu, (? Cook Is. to New Caledonia)
General shape	oval to cylindrical	oval	rhomboidal	oval
Dorsal profile	slightly humped	evenly convex	humped	convex, depressed
Posterior extremity	blunt to evenly pointed	blunt	pointed	blunt
Margins	narrow, less calloused, low	slightly expanded, calloused, slightly bent up	broadly calloused, bent up	slightly expanded, calloused, low
Marginal ground color	pale cream to grey	rich purple	cream	pale grey to cream
Marginal spots	less dense, rather distinct	dense, confluent towards the dorsum	larger, dense, mostly confluent	somewhat smaller, less dense
Basal blotch	indistinct to absent	large, dark and distinct	large, dark and distinct	smaller, mostly distinct
Basal color	cream to pale grey, with bluish dashes	darker purplish, paler area along the aperture	paler cream to grey, orange along the aperture	rather pale, cream to bluish grey
Lacunae	large, often rather distant	small, dense	mostly small, distant	small and dense
Darker dorsal pattern	brown, wide, often with longitudinal paler lines or spots between the lacunae	dark brown to black, narrow, without finer lines or spots	dark brown to black, narrow, sometimes with finer lines or spots	brown to reddish brown, narrow, without finer lines or spots

Plate 1 (on p. 44)

Fig. 1: ***Mauritia maculifera maculifera*** (53.9 mm) Oahu, Hawaii.
Fig. 2: ***Mauritia maculifera martybealsi*** (54.6 mm) Nuku Hiva, Marquesas.
Fig. 3: ***Mauritia maculifera scindata*** (54.4 mm) Taiarapu, Tahiti.
Fig. 4: ***Mauritia maculifera andreae*** n. ssp. (54.7 mm) Samar, Philippines. Holotype, coll. SMF.

Plate 2 (on p. 45)

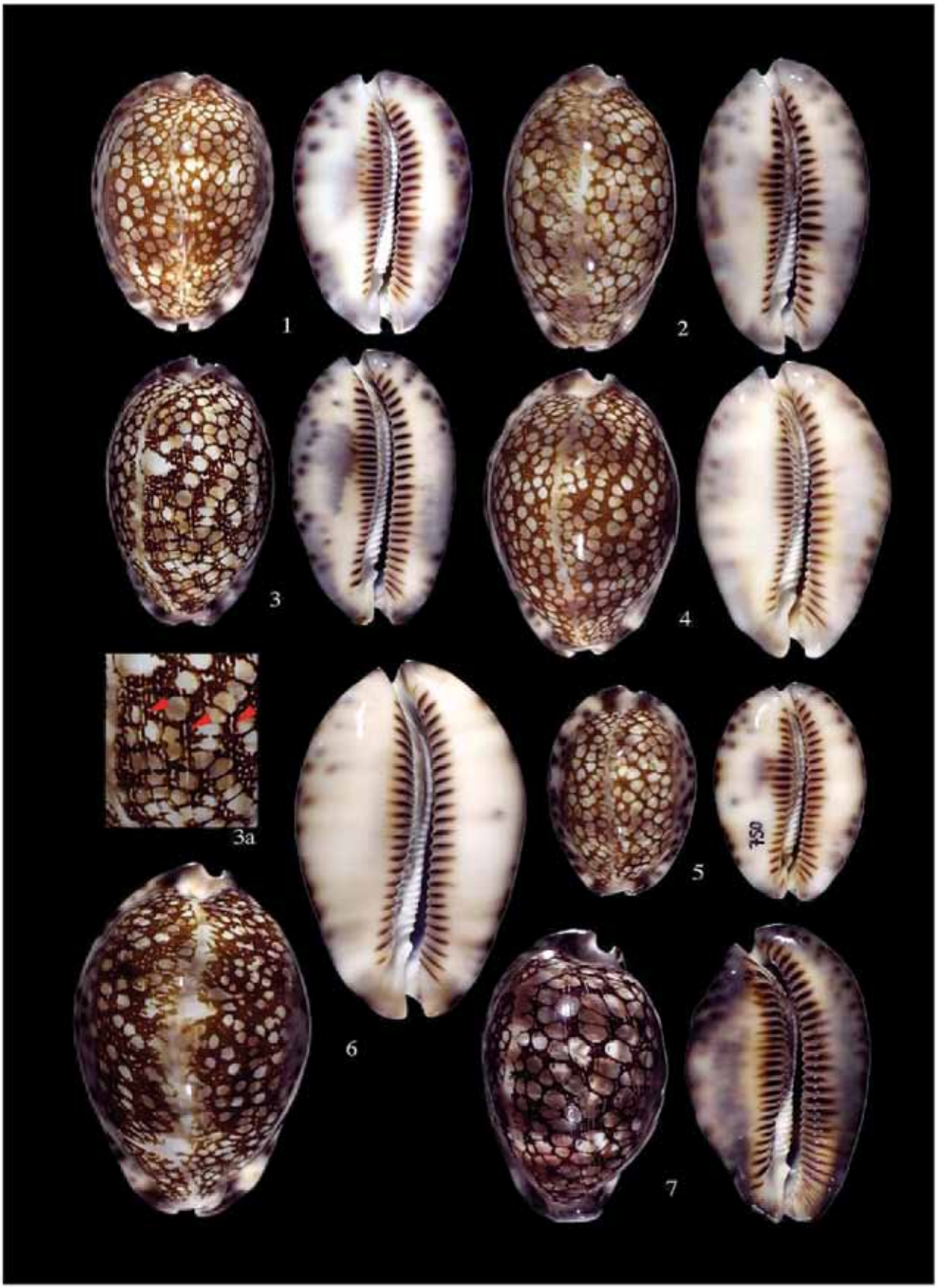
Mauritia mauritiana andreae n. ssp.

Fig. 1: (51.1 mm) Samar. Paratype 6.
Fig. 2: (55.9 mm) Samar. Paratype 8.
Fig. 3: (55.7 mm) Samar. Paratype 5.
Note the fine paler longitudinal lines and dots in the darker pattern (Fig. 3a).
Fig. 4: (54.2 mm) Samar. Paratype 2.
Fig. 5: (37.6 mm) Samar. Paratype 9.
Fig. 6: (68.2 mm) Samar. Paratype 18.
Fig. 7: (57.7 mm) General Luna, Siargao Is., at 40 m.

Plate 1

Explanation on p. 43

Plate 2



Explanation on p. 43

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A new subspecies of *Bistolida stolida* (LINNAEUS 1758) from Queensland (Gastropoda: Cypraeidae)

By FELIX LORENZ

With 3 Text-Figures, 1 Table and 33 Figs on Plates 1-4

Keywords

Bistolida stolida lorrainae, new subspecies, Australia, Queensland.

Abstract

Bistolida stolida lorrainae n. ssp. from Queensland differs from the conchologically most similar sympatric *B. brevidentata fluctuans* by the number of columellar versus labral teeth, and other subtle shell features. Its less thickened teeth, lack of posterior callus, reduced blotching and spotting, separates *B. s. lorrainae* from other subspecies of *B. stolida*. The Australian taxa of the *stolida* species complex are briefly discussed.

Zusammenfassung

Bistolida stolida lorrainae n. ssp. aus Queensland unterscheidet sich von der conchologisch ähnlichen, sympatrischen *B. brevidentata fluctuans* durch das Zahlenverhältnis der Columellar- zu den Labralzähnen, sowie subtiler Gehäusemerkmale. Ihre weniger verdickten Zähne, das Fehlen von Kallus am Posteriorende, und die reduzierte Musterung unterscheiden *B. s. lorrainae* von anderen *B. stolida*-Unterarten. Die Australischen Taxa des *stolida*-Artkomplexes werden kurz diskutiert.

Introduction

The *Bistolida stolida* (LINNAEUS 1758) species-complex shows a great diversity throughout its distribution in the Indo-Pacific (RAYBAUDI 1978, 1992, LORENZ 1998, 2002, MEYER 2003, BOZZETTI 2008). The confusing conchological similarity of its members has led to numerous misidentifications and controversial systematic treatments in the literature (e.g. BURGESS 1985 listed all its taxa under *stolida*). A particularly difficult case is the status of the Australian *Bistolida stolida* populations, the sibling *B. brevidentata* (G. B. SOWERBY II 1870), and its three subspecies. While the taxonomic treatment of the latter is rather comprehensive, the Australian populations of *stolida* have not been considered in a taxonomically valid manner. The following describes the subspecies of *stolida* from Queensland, Australia.

Bistolida stolida lorrainae n. ssp.

(Text-Figs 2a + b, Pl. 1, Pl. 2 Figs 1-4)

Material

More than two hundred specimens of *B. brevidentata* and its subspecies were available, deposited in the collections of the CLSF, MSF, LR and FL. Twenty specimens of *stolida* from confirmed Western Australian localities in the author's collection could be studied, and 27 specimens of the new subspecies in the collections of the CLSF, LORRAINE RUTHERFORD, and the collection of the author, of which 22 specimens were chosen as types. Measurements listed length × width × height (mm), (counted labral : columellar teeth), weight in gram.

Holotype: 25.5 × 14.8 × 12.0 (16:16) [1.94] Coll. WAM S99130.

Paratype 1: 21.9 × 12.5 × 9.9 (17:18) [1.58] Coll. MSF; Paratype 2: 24.2 × 13.3 × 10.9 (17:17) [1.71]; Paratype 3: 25.5 × 14.4 × 11.7 (17:18) [1.97] Coll. LORRAINE RUTHERFORD; Paratype 4: 22.4 × 12.8 × 10.3 (18:17) [1.35] Coll. MSF; Paratype 5: 21.1 × 12.2 × 9.5 (15:15) [1.37]; Paratype 6: 30.8 × 17.9 × 14.9 (20:20) [2.21] Coll. LORRAINE RUTHERFORD; Paratype 7: 29.2 × 16 × 12.9 (18:17) [2.65] Coll. LORRAINE RUTHERFORD; Paratype 8: 26.0 × 14.7 × 11.6 (18:19) [2.17] Coll. LORRAINE RUTHERFORD; Paratype 9: 29.6 × 16.3 × 13.7 (20:20) [2.85] Coll. Lorraine RUTHERFORD; Paratype 10: 26.5 × 14.9 × 11.9 (17:18) [2.2] Coll. LORRAINE RUTHERFORD; Paratype 11: 30.0 × 16.9 × 14.0 (18:18) [3.10] Coll. Lorraine RUTHERFORD; Paratype 12: 23.4 × 12.3 × 9.9 (18:18) [1.36] Coll. LORRAINE RUTHERFORD; Paratype 13: 22.0 × 12.6 × 10.4 (17:17) [1.47]; Paratype 14: 25.6 × 14.3 × 11.7 (19:19) [1.84] Coll. MSF; Paratype 15: 25.6 × 15.0 × 11.9 (17:17) [2.10]; Paratype 16: 22.1 × 12.9 × 10.2 (16:17) [1.36]; Paratype 17: 26.1 × 15.4 × 12.5 (19:19) [1.78] Coll. MSF; Paratype 18: 27.8 × 16.2 × 12.9 (19:19) [2.54]; Paratype 19: 23.7 × 13.8 × 10.6 (16:17) [1.69] Coll. MSF; Paratype 20: 22.2 × 12.7 × 9.9 (16:17) [1.42];

Paratype 21: 22.1 × 12.9 × 10.3 (16:17) [1.68] DNA voucher #2870.

The holotype and paratypes 1 to 20 are from the intertidal of Conserdine Reef, North Keppel Is., Keppel Bay, Queensland. Paratype 21 was mislabeled "Cape York", but is most likely also from the Keppel Bay area. Its animal was preserved and DNA has been analyzed by Dr. CHRISTOPHER P. MEYER (2015).

Formula: 25 (57 - 46 - 80) 17 : 18 [15.8] (created after BRIDGES & LORENZ 2013)

Description

The shell is rather small, elongate-cylindrical. The dorsal profile is only slightly flattened. The base and the margins are hardly calloused. The labral margin is narrow, rather angular and separated from the dorsum by a shallow groove. The posterior extremity is without prominent callus accumulation, its tips are slightly pointed. The anterior extremity is rather short, broad, its tips pointed, and its margins slightly flanged. The spire is deeply umbilicate, the protoconch prominent and exposed. The aperture is rather equally wide throughout, and rather straight. The labral teeth are narrow, slightly angular, deeply incised, and extending across the moderately broad lip. There are two small crenulations inside the posterior canal which do not extend onto the lip. The columellar teeth are restricted to the aperture anteriorly, slightly extending towards the base in the midsection, with the last tooth at the posterior tip reduced to a crenulation. The first anterior columellar tooth is somewhat swollen, and separated from the terminal ridge by a narrow, incised gap. The fossula is concave, weakly projecting, with distinct first three fossular denticles. The peristome shows faint but discernible denticles all along the columella. The terminal ridge is produced and split towards its inner end.

The dorsal ground colour is grayish blue, without discernible banding. The margins are cream, somewhat darker towards the tips. The base is paler, but not clear white. The dorsum displays two compact, square-shaped, dark brown blotches, separated by a narrow longitudinal gap mid-dorsally. The margins have two smaller orange blotches above the marginal edge. The posterior labral blotch is connected to the dorsal blotch. The blotches on the left side are faintly connected with it. The anterior labral blotch is isolated. The dorsum is sparsely covered with barely visible, small brown spots. The margins show indistinct orange-brown spots fusing to a brown line that borders the dorsum longitudinally along the left side, connecting the two marginal blotches. The terminal blotches are pale brown, rather large, and indistinct.

The paratypes show a certain variability in shape, the w/l ranges from 53 to 58. Some specimens are narrow cylindrical (e.g. paratype 12, Pl. 1: 7). In many shells, the dorsal profile is more distinctly flattened than in the holotype specimen. The length of the columellar teeth varies. In some shells, the teeth are restricted to the aperture throughout. In all specimens examined, the counted numbers of columellar versus labral teeth are about equal, sometimes there are slightly more columellar teeth than labral teeth. The number of posterior labral crenulations (which are not counted as teeth) varies from 2 in smaller shells, up to 4 in larger ones. These crenulations differ from the first countable labral tooth by not reaching onto the lip itself. In most shells, the connections of the marginal blotches to the dorsal blotch are indistinct, or partly absent. Specimens in which all four blotches are connected to the dorsal blotch are less common. The size and shape of the dorsal blotches vary considerably. Usually, there are one or two compact square blotches as in the holotype, but in specimens from the south of the new subspecies' distribution (the area of Mooloolaba near Sunshine Coast), there is one large blotch or two overlapping ones, which can be irregularly perforated, with more prominent connections to the marginal blotches. Southern shells also tend to be more inflated than shells from the type locality.

The animal of *stolida lorrainae* is very similar to that of other members of the genus. It has a semi-transparent greyish mantle with numerous small and multi-branched papillae of class 4 (after LORENZ & HUBERT 1993). The siphon has one row of short siphonal papillae. Mantle, siphon, and foot show minute sparse black spots, but no other coloration. The tentacles are orange (Text-Figs 2 a, b).

Habitat and distribution

All specimens of *B. stolida lorrainae* n. ssp. have been collected intertidally to a depth of 2 m, under rocks and coral slabs, mostly in slightly muddy areas. The confirmed range reaches from the islands of Keppel Bay, where it occurs sympatrically with *B. brevidentata fluctuans* IREDALE 1935, to the Mooloolaba area in

Queensland. Records from other Queensland localities are quite sparse, and most of them require confirmation (Text-Fig. 3).

Etymology

This new subspecies is named in honor of Mrs. LORRAINE RUTHERFORD, renowned expert on seashells of the Queensland coast. LORRAINE has supported this description by generously making her extensive collection of these rare cowries available to me. She is also known for having the ovulid *Dentiovula rutherfordiana* (CATE 1973) named in her honor.

Discussion

The new subspecies described herein has been illustrated and correctly assigned to the species *stolida* by WILSON (1993: pl. 32 fig. 8c). LORENZ & HUBERT (1993: pl. 79 fig. 11) illustrated a specimen of *stolida crossei* (MARIE 1869) labeled "Keppel Bay", but the shell is obviously not from there. It was obtained by me at the Keppel Bay Shell Show in 1982, and my assumption that it originated from this area turned out to be erroneous. My error, and a complete mixup of locality data of shells in collections, and of shells supplied by Australian shell dealers, made me overlook the characteristics of *stolida lorrainae* until recently. In World Shells No. 3 (1992 p. 62-63 fig. 154h) RAYBAUDI introduced the name *stolida* var. *keppelensis* in a taxonomically invalid manner (ICZN §13.1, §45.5). The illustration (see Text-Fig. 1) apparently shows a specimen of *brevidentata fluctuans* (IREDALE 1935).

Text-Fig. 1: *Bistolida stolida* var. *keppelensis* RAYBAUDI 1992, from World Shells No. 3: 63 fig. 154h.

Along the Australian coast, three subspecies of *brevidentata* are found, which differ from each other rather consistently (see Table 1).

In Western Australia, a population of typical *stolida stolida* occurs alongside the nominate *brevidentata*. The separation of these taxa does not present any problem as the constantly less numerous, shorter teeth, the small, isolated marginal blotches and the compact dorsal blotch without smaller spotting sets *b. brevidentata* apart from any subspecies of *stolida* at first glance. In addition to these two distinct taxa, a possible third member of the *stolida* species complex is found, e.g. at the Montebello Islands. These shells are more depressed, with fine, short teeth and a general appearance that resembles the East African *s. clavicola* LORENZ 1998. The status of this population is uncertain, as only a few specimens could be studied (pl. 4 fig. 9).

There is no reliable information about the occurrence of *stolida* in the Northern Territory or the northern Queensland coast, so that *brevidentata deceptor* (IREDALE 1935) seems to occur without a sibling *stolida*. Its shell is inflated, and the teeth less numerous and mostly short. In *b. deceptor*, the dorsal blotch is often connected to the marginal blotches, and there are numerous smaller brown spots, which make the dorsal aspect of some specimens of *b. deceptor* resemble a "blown up" *stolida*.

Along the coast of central and southern Queensland, *brevidentata fluctuans* is found scattered along the mainland and certain offshore islands. It is characterized by an inflated shell with a compact blotch that is rarely absent. The teeth are somewhat more numerous than in the western *b. brevidentata*. Throughout its distribution, *b. fluctuans* displays rather distinctive local variations. In the north of its distribution (e.g. at Sarina Beach), the shells are inflated, with short extremities, and dark terminal blotches. Shells from Collins Island are usually more slender, and somewhat paler. The most extensive and well-known population is that of Dingo Beach. The shells are pale bluish, mostly small, inflated, with reduced terminal and marginal blotches. The holotype figure in IREDALE (1935) shows an unblotched specimen, likely of this population. The most southern population of *b. fluctuans* is from Tryon Island in the Bunker Group. The shells are plain white, more heavily calloused, the teeth extend far onto the base in the posterior third. Interestingly, the dorsal profile is flattened

Text-Fig. 2: Living animals. a: *B. stolida lorrainae* n. ssp., Keppel Bay. B: *B. stolida* cf. *lorrainae*, Big Sandy Reef, Swains Reef. Note this specimen has a third tentacle. See Pl. 2 fig. 4 for the shell of this specimen c: *B. brevidentata*.

in many specimens, which is normally understood as a feature characterizing *stolida* (see HEIMAN, 2012, 2013). The status of the Tryon Island shells deserves further attention. In all of these local populations, the lower number of columellar versus labral teeth is a consistent feature that seems to characterize *b. fluctuans*, and helps to separate it from *stolida lorrainae*. Text-Fig. 3 shows the populations just discussed, in the context of their geographic origin.

In some areas, *b. fluctuans* occurs sympatrically with *s. lorrainae*, e.g. in Keppel Bay. As mentioned above, the main structural difference between *b. fluctuans* and *s. lorrainae* is that in *b. fluctuans*, the number of columellar teeth is consistently lower than the number of labral teeth. The shape of *b. fluctuans* is more inflated (w/l = 60 opposed to 57 in *s. lorrainae* from the same area), the dorsal profile is usually rounded, the teeth somewhat shorter and more swollen, and the marginal blotches are reduced.

All shells of *stolida* from the Central to the southern Queensland coast studied so far belong to the new subspecies described herein, with some uncertainty about a single shell. It has long, produced teeth and narrow, rostrated extremities. It was collected recently, at Big Sandy Reef in the Swains Reef area, where no *b. fluctuans* or typical *s. lorrainae* seem to occur. This unique shell is shown on pl. 2 fig. 4, and its assignment to *s. lorrainae* is tentative.

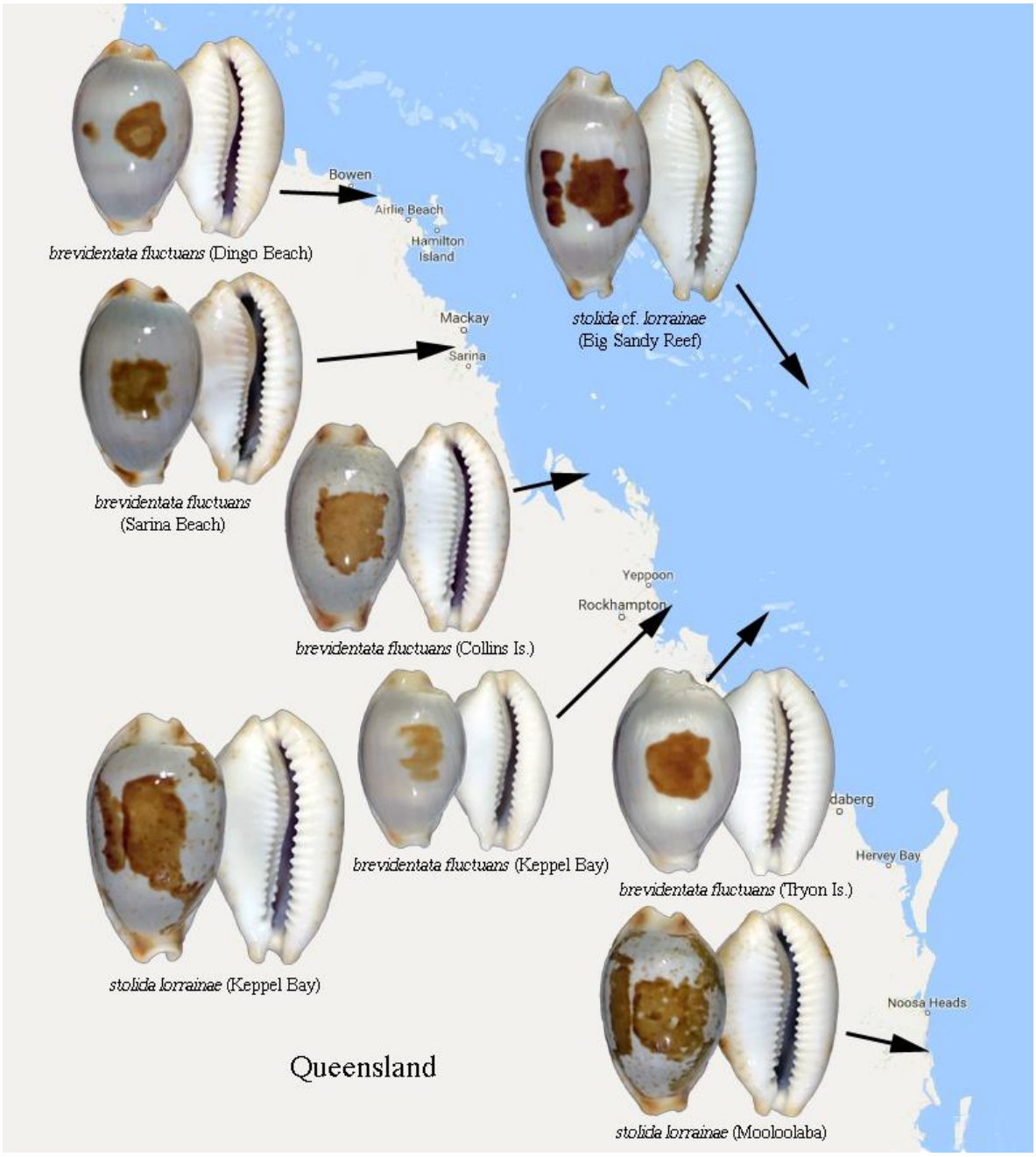
Superficially, the shell of *s. lorrainae* is closer to *b. fluctuans* than to *stolida*, on account of its rather short, hardly swollen teeth, the reduction of the connections between the dorsal blotch and the marginal blotches, the less calloused posterior extremity, and the lack of marginal callus. The lack of callus at the posterior extremity, the reduced marginal callus, the less swollen teeth, and the reduction of marginal and basal spotting distinguish *s. lorrainae* from all western Pacific variations of *stolida stolida* and the Melanesian *stolida crossei*. As molecular data for the Australian members of the *stolida* species complex is almost nonexistent, it cannot be used for a distinction of taxa. A sample taken from a specimen of *s. lorrainae* (paratype 21) shows relationship to the Pacific *stolida stolida*, and distinction from the only sample of *b. fluctuans* so far available. Apparently, the conchological similarity of these taxa is a product of convergent adaptation to local conditions in the habitat they share. Hopefully, this study will inspire the preservation of animal tissue of the various populations of *s. stolida*, *s. lorrainae* n. ssp., and the three *brevidentata* subspecies. Their evolution seems to represent an interesting parallel to the genus *Cribrarula*, whose members display great diversification with minimal conchological modifications. As in *Bistolida*, there are also look-alike, yet distinct, species of *Cribrarula* sharing their often restricted ranges along the western and eastern coasts of Australia.

Acknowledgements

Many thanks to LORRAINE RUTHERFORD and the members of the Keppel Bay Shell Club, who kindly donated some of the type material used for this study. To GORDON VERHOEF and Seacomber Publications. To CHRISTOPHER P. MEYER, DAVID PRESTON, THIERRY VULLIET and JO VAN HEESVELDE. To Dr. MICHAEL A. MONT for proofreading and to JANA KRATZSCH.

Table 1: Comparison of *stolida lorrainae* n. ssp. with the three subspecies of *brevidentata*.

Bistolida	***stolida lorrainae***	***b. brevidentata***	***b. fluctuans***	***b. deceptor***
Range	Central to Southern Queensland	West Australia to Northern Territory	Central Queensland	Northern Queensland
Formula - shape teeth (normalized) mass ratio (%)	25 (57 - 46 - 80) 17 : 18 [15.8]	22 (110 - 48 - 72) 14 : 13 [15.4]	23 (60 - 48 - 80) 17 : 15 [17.4]	26 (63 - 50 - 79) 16 : 15 [17.1]
shape	oval to cylindrical	elongate oval	oval, rostrate	oval, inflated
dorsal profile	slightly flattened	mostly rounded		
extremities	short, pointed	rather blunt	slightly rostrate	rostrate
teeth	mostly extending onto base	less produced, less extending	may extend onto base posteriorly	short, rarely extending
terminal spots	indistinct, pale	distinctly blotched brown	less distinctly blotched reddish	
marginal blotches	prominent	small, distinct	indistinct or absent	distinct
dorsal blotch	split, connected to marginal blotches	isolated, often absent	isolated	often connected to marginal blotches
fine dorsal spotting	mostly present	absent		mostly present
fine marginal spots	dense, distinct	scarce or absent	mostly absent	mostly present
marginal callosities	cream	white	white	cream



Text-Fig. 3: Geographical distribution of the subspecies of the *Bistolida stolida* complex in eastern Australia.

Plate 1 (on opposite p.)

Bistolida stolida lorrainae n. ssp.

Fig. 1: (25.5 mm) Holotype, coll. WAM.
Fig. 2: (26.0 mm) Paratype 8, coll. Lorraine RUTHERFORD.
Fig. 3: (22.1 mm) Paratype 16.
Fig. 4: (22.0 mm) Paratype 13.
Fig. 5: (22.1 mm) Paratype 21.
Fig. 6: (26.5 mm) Paratype 10, coll. Lorraine RUTHERFORD.
Fig. 7: (23.4 mm) Paratype 12, coll. Lorraine RUTHERFORD.
All from Conserdine Reef, North Keppel Is., Queensland.
Fig. 8: (22.7 mm) Mooloolaba, Queensland.

Plate 1

Explanation on opposite p.

Plate 2 (on opposite p.)

Bistolida stolida lorrainae n. ssp.

Figs 1-2: (23-25 mm) Mooloolaba, Queensland.
Fig. 3: (24 mm) Middle Is., Keppel Bay, Queensland, coll. LORRAINE RUTHERFORD.
Fig. 4: cf. *lorrainae* (27 mm) Big Sandy Reef, Swains Reef, Queensland, coll. LORRAINE RUTHERFORD.

Bistolida brevidentata fluctuans IREDALE 1935

Fig. 5: (20 mm) Middle Is., Keppel Bay, Queensland, coll. LORRAINE RUTHERFORD.
Figs 6-8: (23-26 mm) Dingo Beach, Queensland.

Plate 3 (on p. 56)

Bistolida brevidentata fluctuans IREDALE 1935

Figs 1-2: (26-27 mm) Shoalwater Bay, Collins Is., Queensland, coll. LORRAINE RUTHERFORD.
Figs 3-4: (23-26 mm) Sarina Beach, Queensland, coll. LORRAINE RUTHERFORD.
Figs 5-8: (24-26 mm) Tryon Is., Bunker Group, Queensland, coll. LORRAINE RUTHERFORD (6-8).

Plate 4 (on p. 57)

Bistolida brevidentata deceptor IREDALE 1935

Fig. 1: (29 mm) Badu Is., Torres Strait, Queensland, coll. MSF.
Fig. 2: (23 mm) Thursday Is., Torres Strait, Queensland.

Bistolida brevidentata brevidentata (G. B. SOWERBY II 1870)

Figs 3-4: (24 mm) Port Hedland area, W Australia.
Fig. 5: (32 mm) Bathurst Is., Northern Territory.
Fig. 6: (23 mm) Broome area, W Australia.
Fig. 7: (28 mm) Exmouth, W Australia.

Bistolida stolida stolida (LINNAEUS 1758)

Fig. 8: (23 mm) Montgomery Reef, 500 km N of Broome, W Australia.
Fig. 9: variation (27 mm) Montebello Is., W Australia.

Plate 2

Explanation on opposite p.

Plate 3

Explanation on p. 54

Plate 4

Explanation on p. 54

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A new subspecies of *Cypraea tigris* LINNAEUS 1758 (Gastropoda: Cypraeidae)

By CHRISTOPHER P. MEYER & SARAH M. TWEEDT

With 2 Text-Figures, 2 Tables and 18 Figs on Plates 1-3

Keywords

Cypraea tigris, new subspecies, Marquesas Islands.

Abstract

Cypraea tigris lorenzi n. ssp. from the Marquesas Islands differs from the other Indo-Pacific populations of that species by being wider, with more angular margins, and a greater relative mass. The molecular data sets the population apart as a separate monophyletic lineage.

Zusammenfassung

Cypraea tigris lorenzi n. ssp. von den Marquesasinseln unterscheidet sich von den übrigen indo-pazifischen Populationen der Art durch ein breiteres, stärker gerandetes Gehäuse mit höherer relativer Masse. Molekulare Untersuchungen belegen den Status als separate, monophyletische Linie.

Introduction

The tiger cowry, *Cypraea tigris*, is perhaps one of the best known and most widely collected shells worldwide. Its amazing diversity of color morphs and patterns has led to a plethora of proposed names and variants, of which only *C. tigris schilderiana* CATE 1961 is currently recognized and widely used to describe the large shells found in the Hawaiian Islands. ALISON KAY (1963) performed more detailed analyses comparing *C. t. tigris* with *C. t. schilderiana* from localities throughout the Pacific and confirmed that *C. t. schilderiana* was signify-cantly larger than shells from other localities with the exception of Johnston Atoll which appears to harbor a similar population of conchologically related individuals. Unfortunately, she did not compare populations of shells from the Marquesan Islands of French Polynesia. Molecular sequence data cannot differentiate *C. t. schilderiana* from *C. t. tigris* based on the criteria established in MEYER (2004), but the geographic isolation and consistently larger shells support an unique recognizable subspecies. DNA sequence data from Marquesan tiger cowries, however, do show a unique molecular signature (N = 5), and this lineage was used by HICKERSON & MEYER (2008) to test various competing evolutionary models of marine vicariance and isolation. Further analyses of additional *C. tigris* shells in various collections confirm unique conchological differences and demonstrate that the Marquesan lineage deserves recognition. The Marquesan tiger cowrie population is herein described as

Cypraea tigris lorenzi n. ssp.

(Pl. 1 Figs 1a-f, Pl. 2 Figs 1-6)

Etymology

In honor of FELIX LORENZ, worldwide expert in cowries, who has contributed immeasurably to our understanding of this group of marine gastropods.

Material

Holotype: USNM 1422331, Taiohae, Nuku Hiva, 81.5 × 62.2 × 47.5 (22:20) [123.8], NCBI record locator DQ207139.1.

Paratype 1: USNM 700219, Taiohae, Nuku Hiva, 99.4 × 71.6 × 55.6 (23:21) [145.3]; Paratype 2: USNM 700219, Taiohae, Nuku Hiva, 96 × 69 × 50.8 (23:20) [151.4]; Paratype 3: USNM 700219, 91.3 × 67.4 × 52.3 (20:20) [148.2]; Paratype 4: USNM 700219, 96.4 × 70.7 × 56.9 (21:21) [169.1]; Paratype 5: USNM 798772, Hanavava, Fatu Hiva, 89.6 × 65.1 × 49.1 (22:20) [143.3]; Paratype 6: USNM 798772, 85.3 × 60.8 × 49.6 (22:21) [108]; Paratype 7: Motu Mano, Nuku Hiva, 86.7 × 66.0 × 49.2 (21:19) [148.5]; Paratype 8: Taiohae, Nuku Hiva 84.4 × 63.5 × 47.9 (21:21) [128.7]; paratypes 7, 8 and further paratypes in collection of MARTY BEALS. See Pl. 1, Table 1.

Description

Shells large, heavy, generally pyriformly ovate, humped dorsally, posteriorly slightly umbilicate; margins thickened more than other conspecifics, sides with slight angular curve from dorsum to base, generally more pronounced on the labial side; extremities somewhat produced; base and

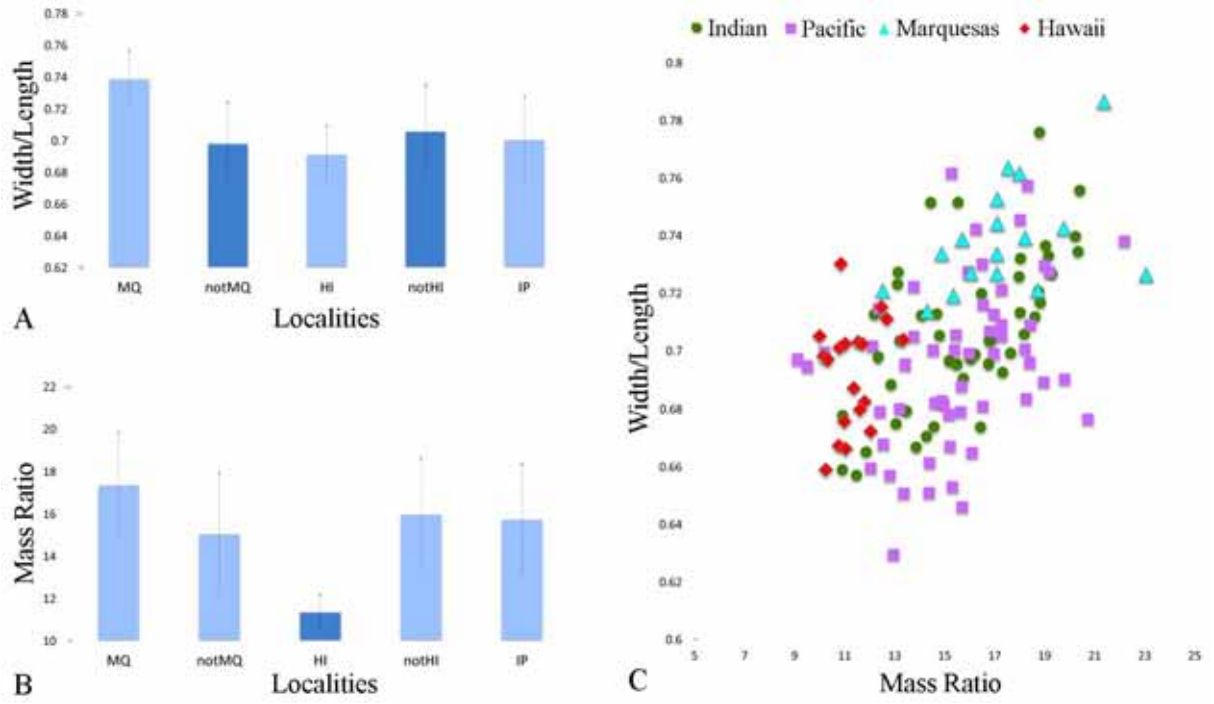
lip sloping inward to denticles; aperture wide, straight, curving left posteriorly; labral teeth not extending onto base and columellar teeth extending slightly onto base in middle. Labial teeth strong, wide, short; interstices deeply channeled, rounded; columellar teeth longer, finer, thickening pointedly on columellar ridge and extending unbroken across fossula; fossula broad, increasingly concave anteriorly; terminal ridge hardly oblique; primary shell surface white or off white, sometimes with bluish-grey tone, thickly covered with brownish-black spots which are superimposed upon larger underlying spots often with purplish brown tone formed earlier in adult shell deposition; base white, often with transparent layer in the center of the columellar side revealing juvenile shell patterning; teeth white; orange-brown mantle sulcus traverses the length of the right side of the dorsum.

Distribution

Endemic to Marquesas, French Polynesia.

Occurrence, habitat

According to MARTY BEALS (pers. comm.), *C. t. lorenzi* can be found in the Marquesas along hard cliff faces and rock falls from 2 to 30 meters. During the day, they tend to be hidden in crevices among boulders, whereas at night they can be found crawling about. *C. t. lorenzi* individuals are less abundant in the Marquesas than other *C. tigris* populations throughout its Indo-Pacific range. Of the large cowries in the Marquesas, *C. t. lorenzi* are less common than *Mauritia maculifera martybealsi* LORENZ 2002 and *Mauritia mauritiana* (LINNEAUS 1758).



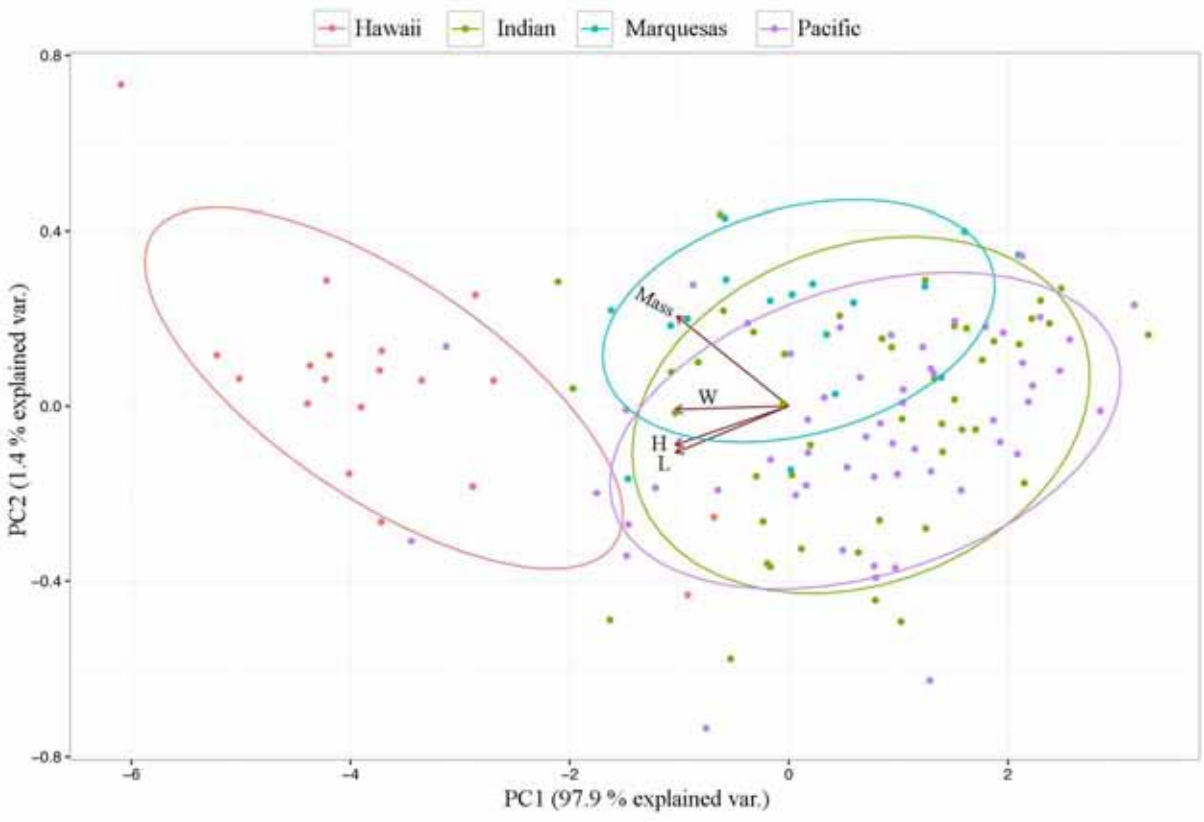
Text-Fig. 1: Histograms of (A) shell width/length and (B) Mass ratio for Marquesan (MQ) vs non-Marquesan shells; Hawaiian (HI) vs. non-Hawaiian shells, and all Indo-Pacific (IP) Shells. Error bars represent the standard deviation. (C) Plot of shell width/length values vs. mass ratio for all shells analyzed, colored by region.

Discussion

A recent exhibit at the Smithsonian National Museum of Natural History entitled "Objects of Wonder" spurred this study. The lead author selected over 100 shells from throughout the *Cypraea tigris* range to exhibit the breadth and diversity of form found among *Cypraea tigris* in NMNH collections. Measurements were taken of all the shells in the exhibit, supplemented by additional shells from both Hawaii and the Marquesas, especially those kindly submitted by MARTY BEALS, in order to increase the statistical sampling power of the study (Table 1, Pl. 2). *C. tigris schilderiana* shells from Hawaii are indeed larger than those from throughout the range, and one shell from Johnston Atoll (USNM 1186907) falls within *C. t. schilderiana*'s distribution (see Table 1, Text-Fig. 1C). This individual is consistent with described simi-

larities between Hawaiian and Johnston Island shells (KAY 1963), and the faunal affinity between the Hawaiian archipelago and Johnston Atoll has been postulated by KOBAYASHI (2006) and in other analyses (e.g. TIMMERS et al. 2011). When normalized for size, *C. t. schilderiana* demonstrates significant ($p < 0.05$) slightly narrower and higher shell morphologies (see Table 2), confirming this subspecies' concholo-gical distinction. Johnston Atoll likely harbors a subpopulation of this *C. tigris* subspecies.

On the other hand, shells from the Marquesas, herein described as *C. tigris lorenzi*, are wider, and show a significant statistical difference in the ratio of shell width : length; *C. t. lorenzi* averages 0.738 (± 0.019) versus an average of 0.698 (± 0.027) for non-Marquesan shells (Text-Fig. 1). A two-tailed t-test of W/L values indicates that the populations are not drawn from the same underlying distribution ($p << 0.0001$) (Table 2). Conchologically, the Marquesan *C. t. lorenzi* shells have more angulate margins versus most other *C. t. tigris* shells and are heavier for their size. Both shell mass : length and mass ratios (BRIDGES & LORENZ 2013) are significantly greater in *C. t. lorenzi* shells versus other *C. t. tigris* shells, including those from Hawaii ($p = 0.004$ and $p = 0.023$, respectively) (Table 2).



Text-Fig. 2: Biplot summarizing the first two principal components derived from PCA of shell morphometric data (L, length; W, width; H, height; and mass). Specimens are colored by geographic region (Hawaii, Indian Ocean, Marquesas, other Pacific localities) and ellipses represent 75% confidence intervals (CIs).

Table 1: List of all specimens examined in this study.

Specimen #	region	Locality	L (mm)	W (mm)	H (mm)	LT	CT	Mass (g)	M/L	W/L	H/L	M/W	Mratio
USNM 1422331 (holotype)*	M	Marquesas	81.5	62.2	47.5	22	20	123.8	1.519	0.763	0.583	1.990	17.547
USNM 700219*	M	Marquesas	96	69	50.8	23	20	151.4	1.577	0.719	0.529	2.194	15.357
USNM 700219*	M	Marquesas	91.29	67.4	52.33	20	20	148.2	1.624	0.738	0.573	2.199	15.711
USNM 700219*	M	Marquesas	99.42	71.63	55.57	23	20	145.3	1.461	0.720	0.559	2.028	12.528
USNM 700219*	M	Marquesas	96.39	70.69	56.88	21	21	169.1	1.754	0.733	0.590	2.391	14.887
USNM 798772*	M	Marquesas	89.59	65.08	49.07	22	20	143.3	1.600	0.726	0.548	2.202	17.097
USNM 798772*	M	Marquesas	85.27	60.83	49.65	22	21	108.0	1.266	0.713	0.582	1.775	14.310
MBeals_MQ01	M	Motu Mano, Nuku Hiva, Marquesas	86.7	66	49.2	21	19	148.5	1.713	0.761	0.567	2.250	18.002
MBeals_MQ02	M	Taiohae, Nuku Hiva, Marquesas	84.4	63.5	47.9	21	21	128.7	1.525	0.752	0.568	2.027	17.110
MBeals_MQ03	M	Colette Bay, Nuku Hiva, Marquesas	82.7	61.1	44.6	20	23	120.3	1.455	0.739	0.539	1.969	18.219
MBeals_MQ04	M	Motu Mano, Nuku Hiva, Marquesas	81.6	59.3	45.6	21	21	103.8	1.272	0.727	0.559	1.750	16.055
MBeals_MQ05	M	Taiohae, Nuku Hiva, Marquesas	79.8	57.5	43.7	21	23	110.0	1.378	0.721	0.548	1.913	18.723
MBeals_MQ06	M	Hakehetau, Ua Pou, Marquesas	73.7	54.7	39.6	21	20	92.5	1.255	0.742	0.537	1.691	19.775
MBeals_MQ07	M	Motu Mano, Nuku Hiva, Marquesas	73.1	53.6	40.3	23	21	79.1	1.082	0.733	0.551	1.476	17.097
MBeals_MQ08	M	Taiohae, Nuku Hiva, Marquesas	69	50.1	39.1	14	18	91.3	1.323	0.726	0.567	1.822	23.054
MBeals_MQ09	M	Taiohae, Nuku Hiva, Marquesas	81.6	60.7	44.7	20	21	111.0	1.360	0.744	0.548	1.829	17.111
MBeals_MQ10	M	Taiohae, Nuku Hiva, Marquesas	63.6	50	35.9	20	21	71.5	1.124	0.786	0.564	1.430	21.376
USNM 1186893*	H	Hawaii, Hawaii Kona Coast	109.14	78.01	61.18	23	24	190.3	1.744	0.715	0.561	2.439	12.469
USNM 1186893*	H	Hawaii, Hawaii Kona Coast	112.94	77.58	63.91	20	20	186.5	1.651	0.687	0.566	2.404	11.367
USNM 876708*	H	Hawaii, Maui	116.47	85	69.97	23	21	220.2	1.891	0.730	0.601	2.591	10.849
USNM 876709	H	Hawaii	124.1	86.95	68.3	22	25	233.0	1.878	0.701	0.550	2.680	10.790
USNM 876710	H	Hawaii, Oahu	121.7	84.79	69.83	23	22	217.9	1.790	0.697	0.574	2.570	10.321
USNM 876711	H	Hawaii	126.4	84.3	71.3	25	25	239.6	1.896	0.667	0.564	2.842	10.764
USNM 876712*	H	Hawaii, Oahu	117.97	79.26	64.32	22	22	212.2	1.799	0.672	0.545	2.677	12.042
USNM 876714*	H	Hawaii	119.76	83.56	68.54	24	23	204.2	1.705	0.698	0.572	2.444	10.161
USNM 876714*	H	Hawaii, north shore	121.8	85.5	68.49	22	25	244.6	2.008	0.702	0.562	2.861	11.704
MBeals_HI01	H	Kaneohe Bay, Oahu, Hawaii	142	95.9	72.6	30	32	318.4	2.242	0.675	0.511	3.320	10.992
MBeals_HI02	H	Kaneohe Bay, Oahu, Hawaii	135.9	89.5	70.7	30	34	258.2	1.900	0.659	0.520	2.885	10.248
MBeals_HI03	H	Kahuku, Oahu, Hawaii	130.7	92.1	74.6	29	30	263.1	2.013	0.705	0.571	2.857	10.000
MBeals_HI04	H	Punaluu, Oahu, Hawaii	127.5	84.9	69.2	26	23	242.3	1.900	0.666	0.543	2.854	11.040
MBeals_HI05	H	Honokowai, Maui, Hawaii	123.5	86.7	67.8	28	24	234.5	1.899	0.702	0.549	2.705	11.025
MBeals_HI06	H	Kaneohe Bay, Oahu, Hawaii	120.2	82	65.9	26	27	224.5	1.868	0.682	0.548	2.738	11.796
MBeals_HI07	H	Kaneohe Bay, Oahu, Hawaii	117	82.2	68.3	27	24	222.1	1.898	0.703	0.584	2.702	11.540
MBeals_HI08	H	Kaneohe Bay, Oahu, Hawaii	110.6	77.8	61.1	26	20	205.5	1.858	0.703	0.552	2.641	13.340
MBeals_HI09	H	Waianae, Oahu, Hawaii	98.9	67.2	53.2	25	25	120.3	1.216	0.679	0.538	1.790	11.612
MBeals_HI10	H	Waianae, Oahu, Hawaii	94	66.8	51.5	24	23	120.2	1.279	0.711	0.548	1.799	12.686
Cate_Holotype	H	Koko Head, Oahu	126.1	87.7	73.1			N/A		0.695	0.580		
Cate_Paratype 1	H	Waikiki, Oahu	131.5	91.3	74			N/A		0.694	0.563		
Cate_Paratype 2	H	Koko Head, Oahu	129.7	86.6	69.5			N/A		0.668	0.536		
Cate_Paratype 3	H	Koko Head, Oahu	124	84.8	68.2			N/A		0.684	0.550		
Cate_Paratype 4	H	Nanakuli, Oahu	124	88.1	71			N/A		0.710	0.573		
Cate_Paratype 5	H	Koko Head, Oahu	120	85.5	67.8			N/A		0.713	0.565		
Cate_Paratype 6	H	Makua, Oahu	115.5	79.1	69			N/A		0.685	0.597		
Cate_Paratype 7	H	Makua, Oahu	113.9	80.7	63.9			N/A		0.709	0.561		
Cate_Paratype 8	H	Keei, Oahu	109.8	71.7	58.3			N/A		0.653	0.531		
Cate_Paratype 9	H	Waialua Bay, Oahu	108.1	74	59.5			N/A		0.685	0.550		
Cate_Paratype 10	H	Maunalua Bay, Oahu	106.8	71	59.8			N/A		0.665	0.560		
USNM 1186891	I	Tamil	79.75	57.64	44.49	23	22	78.6	0.986	0.723	0.558	1.364	13.119
USNM 1186895	I	Sri Lanka	88.1	60.63	48.23	23	22	97.1	1.102	0.688	0.547	1.601	12.859
USNM 1186897	I	Tamil Nadu, India	57.16	39.58	31.1	21	18	35.7	0.625	0.692	0.544	0.902	17.317
USNM 597132	I	Zanzibar	90.83	65.35	49.1	23	24	140.7	1.549	0.719	0.541	2.153	16.476
USNM 597132	I	Zanzibar	102.07	72.72	58.47	24	24	186.8	1.830	0.712	0.573	2.569	14.690
USNM 597132	I	Zanzibar	89.5	63.67	49.49	20	23	153.8	1.718	0.711	0.553	2.416	18.613
USNM 597132	I	Zanzibar	82.12	61.68	48.01	21	24	102.9	1.253	0.751	0.585	1.668	14.442
USNM 597132	I	Zanzibar	87.5	60.83	46.94	22	25	122.7	1.402	0.695	0.536	2.017	16.761
USNM 597132	I	Zanzibar	75.1	52.48	40.65	21	20	82.8	1.103	0.699	0.541	1.578	17.639
USNM 604221	I	Kenya	96.27	67.86	52.16	23	22	147.8	1.535	0.705	0.542	2.177	14.799
USNM 604244	I	Dar es Salaam (Tanzania)	73.97	52.01	39.51	22	21	75.0	1.014	0.703	0.534	1.442	16.836
USNM 604317	I	Sinda Is (Tanazania)	66.53	47.92	37.09	21	21	65.0	0.977	0.720	0.557	1.356	18.752
USNM 604317*	I	Sinda Is (Tanazania)	86.43	61.53	48.51	21	24	106.4	1.231	0.712	0.561	1.729	14.076
USNM 604317	I	Sinda Is (Tanazania)	72.86	53.87	40.36	19	22	93.9	1.289	0.739	0.554	1.743	20.231
USNM 604317	I	Sinda Is (Tanazania)	70.6	51.72	40.31	21	21	82.6	1.170	0.733	0.571	1.597	19.153
USNM 604317	I	Sinda Is (Tanazania)	71.39	50.36	37.74	21	23	72.3	1.013	0.705	0.529	1.436	18.186
USNM 604317	I	Sinda Is (Tanazania)	61.63	46.55	34.4	20	23	59.0	0.957	0.755	0.558	1.267	20.404
USNM 604317	I	Sinda Is (Tanazania)	64.3	46.7	34.87	19	22	59.2	0.921	0.726	0.542	1.268	19.296
USNM 604317	I	Sinda Is (Tanazania)	63.03	48.88	36.54	19	20	62.0	0.984	0.776	0.580	1.268	18.797
USNM 604317	I	Sinda Is (Tanazania)	64.04	47.01	35.62	20	19	63.9	0.998	0.734	0.556	1.359	20.338
USNM 604397	I	Zanzibar	85.23	56.66	43.86	22	26	73.6	0.864	0.665	0.515	1.299	11.860
USNM 611700	I	Rodrgues	104.99	69.97	58.62	23	23	174.9	1.666	0.666	0.558	2.500	13.862
USNM 618270	I	Seychelles	88.83	63.27	50.46	23	24	101.3	1.140	0.712	0.568	1.601	12.191
USNM 618270*	I	Seychelles	90.58	63.18	49.78	25	26	103.0	1.137	0.698	0.550	1.630	12.340
USNM 633126	I	Maldives	94.08	65.39	51.38	23	24	143.4	1.525	0.695	0.546	2.194	15.488
USNM 633126	I	Maldives	92.09	61.72	49.64	24	25	118.0	1.281	0.670	0.539	1.912	14.274
USNM 633273	I	Seychelles	76.15	53.02	40.1	23	24	72.1	0.946	0.696	0.527	1.359	15.188
USNM 633273	I	Seychelles	78.4	54.75	42.17	20	22	86.0	1.097	0.698	0.538	1.571	16.215
USNM 633433	I	Madagasar	77.35	52.09	39.52	24	25	76.7	0.992	0.673	0.511	1.473	16.442
USNM 634648	I	Seychelles	104.7	70.93	57.88	23	25	137.6	1.314	0.677	0.553	1.939	10.922
USNM 673831	I	Mogadishu (Somalia)	77.73	55.41	42.2	21	21	96.0	1.235	0.713	0.543	1.732	18.019
USNM 694008	I	Karachi	76.56	56.02	43.59	21	23	98.8	1.290	0.732	0.569	1.763	18.033
USNM 702231	I	Aldabra	82.31	54.05	44.41	26	26	66.4	0.807	0.657	0.540	1.229	11.472
USNM 703877	I	Tanzania	69	51.83	42.2	19	22	68.7	0.996	0.751	0.612	1.325	15.536

Table 1 (contd.): List of all specimens examined in this study.

USNM 703907	I	Tanzania	69.88	51.44	39.35	21	20	78.9	1.129	0.736	0.563	1.534	19.038
USNM 703907	I	Tanzania	66.5	48.34	38.86	19	17	48.1	0.723	0.727	0.584	0.995	13.142
USNM 781986	I	Admirante Is, Seychelles	88.26	60.93	47.51	24	26	117.9	1.336	0.690	0.538	1.935	15.749
USNM 781986	I	Admirante Is, Seychelles	81.88	59.39	43.25	21	21	110.8	1.353	0.725	0.528	1.866	17.980
USNM 781986	I	Admirante Is, Seychelles	77.81	52.83	42.88	22	23	69.6	0.894	0.679	0.551	1.317	13.476
USNM 781986	I	Admirante Is, Seychelles	69.3	49.64	37.63	21	21	71.4	1.030	0.716	0.543	1.438	18.825
USNM 792232	I	Mauritius	98.68	64.99	50.39	21	22	103.3	1.047	0.659	0.511	1.589	10.909
USNM 887176	I	Astove Is (Seychelles)	71.87	50.1	39.8	20	22	67.4	0.937	0.697	0.554	1.344	16.040
USNM 887176	I	Astove Is (Seychelles)	97.69	65.8	52.9	22	24	145.2	1.486	0.674	0.542	2.207	14.574
USNM 887176	I	Astove Is (Seychelles)	88.62	62.31	51.29	22	26	109.6	1.237	0.703	0.579	1.759	13.208
USNM 887176	I	Astove Is (Seychelles)	84.04	56.69	45.92	20	23	83.7	0.996	0.675	0.546	1.476	13.058
USNM 887176	I	Astove Is (Seychelles)	88.79	62.44	48.67	20	24	132.7	1.495	0.703	0.548	2.125	16.785
USNM 1186898	P	Kwajelein (Marshalls)	117.87	82.41	66.88	25	26	194.1	1.647	0.699	0.567	2.355	10.198
USNM 1186907	P	Johnston	111.71	79.79	63.95	21	22	206.5	1.849	0.714	0.572	2.588	12.365
USNM 1186909	P	Bali (Indonesia)	85.42	56.09	43.66	23	20	78.5	0.919	0.657	0.511	1.400	12.808
USNM 1186909	P	Bali (Indonesia)	82.79	55.26	43.05	22	23	72.4	0.875	0.667	0.520	1.311	12.550
USNM 1186909*	P	Bali (Indonesia)	84.16	58.9	44.22	19	23	93.4	1.110	0.700	0.525	1.586	14.543
USNM 240916	P	Mactan (Phillipines)	82.38	55.92	45.6	25	20	76.4	0.928	0.679	0.554	1.366	12.414
USNM 346156	P	Japan	76.5	54.75	42.99	21	23	87.3	1.141	0.716	0.562	1.594	16.544
USNM 348441	P	Palmyra (Line Islands)	85.4	60.22	46.81	22	21	109.0	1.276	0.705	0.548	1.810	15.455
USNM 422536	P	New Caledonia	100.41	70.41	56.58	22	23	142.1	1.415	0.701	0.563	2.018	12.121
USNM 485847	P	Yap	65.58	48.38	35.36	21	20	73.0	1.112	0.738	0.539	1.508	22.193
USNM 513068	P	Guam	77.47	51.21	38.79	23	23	64.9	0.838	0.661	0.501	1.268	14.396
USNM 513068	P	Guam	65.71	46.57	37.52	20	20	58.1	0.884	0.709	0.571	1.248	17.277
USNM 544085	P	Ponape	70.69	47.13	37.47	22	19	55.7	0.787	0.667	0.530	1.181	15.215
USNM 586139	P	Bikini	85.69	56.85	45.55	21	23	N/A		0.663	0.532		
USNM 586139	P	Bikini	92.1	62.91	50.05	22	24	N/A		0.683	0.543		
USNM 589006	P	Okinawa	87.56	56.95	45.57	21	23	89.0	1.017	0.650	0.520	1.563	13.369
USNM 589166	P	Cocos Keeling	67.6	47.03	36.92	22	22	63.3	0.936	0.696	0.546	1.346	18.406
USNM 589166	P	Cocos Keeling	80.45	58.71	43.15	24	22	98.6	1.225	0.730	0.536	1.679	16.505
USNM 600439	P	Solomon Islands	78.13	54.44	44.06	22	19	50.1	0.641	0.697	0.564	0.920	9.124
USNM 600439	P	Solomon Islands	62.26	42.2	34.09	21	23	39.8	0.640	0.678	0.548	0.944	15.173
USNM 611502	P	Majuro (Marshalls)	77.4	52.75	41.39	21	21	74.1	0.957	0.682	0.535	1.405	14.963
USNM 613141	P	Tuamotu (vahi tahi)	98.28	66.81	55.89	21	20	142.0	1.444	0.680	0.569	2.125	13.202
USNM 613141	P	Tuamotu (vahi tahi)	102.2	66.49	56.01	21	20	160.4	1.569	0.651	0.548	2.412	14.381
USNM 615219*	P	Ailuk, Marshall Is.	89.63	61.11	49.32	23	23	115.7	1.291	0.682	0.550	1.893	14.618
USNM 616996	P	Palau	55.4	41.94	31.93	20	19	39.8	0.719	0.757	0.576	0.949	18.319
USNM 617158	P	Queensland	93.69	65.11	51.71	21	19	124.1	1.324	0.695	0.552	1.905	13.422
USNM 618273	P	Manus	71.41	48.61	38.54	22	21	64.8	0.907	0.681	0.540	1.333	16.526
USNM 618355	P	Gree Is Cairns	72.59	54.09	42.08	21	22	87.2	1.202	0.745	0.580	1.612	18.017
USNM 621043	P	Palau	64.87	44.7	33.5	19	20	54.0	0.832	0.689	0.516	1.208	18.966
USNM 630036	P	Bora Bora	90.11	58.81	45.46	23	22	108.1	1.200	0.653	0.504	1.838	15.315
USNM 630036	P	Bora Bora	76.54	54.52	42.78	19	18	88.8	1.160	0.712	0.559	1.629	16.979
USNM 631648	P	Gigmoto (Phillipines)	67.68	49.36	37.35	21	23	69.5	1.026	0.729	0.552	1.407	19.002
USNM 632109	P	Mandi Darrah (N. Borneo)	81.85	59.51	46.83	22	22	106.6	1.302	0.727	0.572	1.791	15.948
USNM 654309	P	Tonga	104.41	68.82	56.01	25	27	142.1	1.361	0.659	0.536	2.064	12.047
USNM 654749	P	Pulau Siburu	89.2	63.01	48.65	25	22	134.7	1.510	0.706	0.545	2.137	16.810
USNM 655744	P	Eniwetok	81.35	55.53	44.69	19	21	88.0	1.082	0.683	0.549	1.585	14.877
USNM 658396	P	Northern Borneo	77.21	54.04	42.39	21	25	79.8	1.034	0.700	0.549	1.477	15.399
USNM 666945	P	Aitutaki (Cook Islands)	65.12	45.89	34.48	19	23	52.2	0.801	0.705	0.529	1.137	17.277
USNM 668433	P	Tahiti	80.66	52.08	44.25	23	23	85.5	1.061	0.646	0.549	1.642	15.706
USNM 668433	P	Tahiti	71.44	48.49	38.17	19	19	60.6	0.848	0.679	0.534	1.250	15.642
USNM 675753	P	Samoa	74.05	51.1	38.47	20	19	84.5	1.140	0.690	0.520	1.653	19.800
USNM 684978	P	Aitutaki (Cook Islands)	91.52	67.9	50.52	21	23	149.6	1.634	0.742	0.552	2.203	16.259
USNM 691893	P	Barrow Is (W Australia)	109.16	68.68	55.89	24	22	159.0	1.456	0.629	0.512	2.315	12.950
USNM 692407	P	Vanuatu	86.83	61.18	48.34	22	22	103.6	1.193	0.705	0.557	1.693	13.769
USNM 692427	P	Vanuatu	85.33	61.6	47.44	22	20	100.6	1.179	0.722	0.556	1.633	13.769
USNM 695005	P	Fiji	83.05	55.19	44.19	22	23	95.5	1.150	0.665	0.532	1.731	16.094
USNM 708640	P	Tarawa (Gilberts)	67.11	45.38	35.14	20	23	65.0	0.969	0.676	0.524	1.432	20.730
USNM 708640	P	Tarawa (Gilberts)	79.72	54.82	43.12	20	21	86.6	1.086	0.688	0.541	1.579	15.675
USNM 723518	P	Raroia	85.56	59.78	47.93	20	21	121.9	1.425	0.699	0.560	2.039	16.971
USNM 747983	P	Moluccas (Indonesia)	74.91	54	39.85	20	23	81.6	1.090	0.721	0.532	1.512	17.283
USNM 748097	P	Davao (Phillipines)	78	55.27	41.95	19	21	97.7	1.252	0.709	0.538	1.767	18.430
USNM 762719	P	Moluccas (Indonesia)	69.37	50.43	37.83	21	18	74.4	1.073	0.727	0.545	1.476	19.192
USNM 768697	P	Tokelau (north of Am. Samoa)	80.12	55.98	43.33	22	23	91.0	1.135	0.699	0.541	1.625	15.974
USNM 768697	P	Tokelau (north of Am. Samoa)	75.75	51.76	41.04	19	21	86.1	1.137	0.683	0.542	1.664	18.264
USNM 778351	P	Palawan (Phillipines)	65.58	49.93	36.35	20	20	53.3	0.813	0.761	0.554	1.067	15.281
USNM 781463	P	Chuuk	98.04	68.07	53.36	24	19	99.3	1.012	0.694	0.544	1.458	9.513
USNM 782733	P	Rangiroa	81.76	57.25	44.89	22	23	112.2	1.372	0.700	0.549	1.959	18.217

* indicates imaged in Plates

A principal component analysis (PCA) of *C. tigris* morphological variables likewise distinguishes *C. t. schilderiana* and *C. t. lorenzi* conchologically from other Indo-Pacific shells (Text-Fig. 2). The first principal component appears primarily driven by size, clearly demarcates *C. t. schilderiana* specimens from others, and accounts for almost 98% of variance in the *C. tigris* morphometric data. The second principal component demonstrates the effect of shell mass, which exhibits the highest loading on PC2 and partitions the Marquesan *C. t. lorenzi* along the mass vector. This indicates that *C. t. lorenzi* quantifiably differs from non-Marquesan *C. tigris*, in part, by shell mass (Text-Fig. 2).

As discussed in HICKERSON & MEYER (2008), *C. t. lorenzi* specimens are a monophyletic lineage based on DNA barcodes of the cytochrome oxidase subunit I gene with an average pairwise difference between Marquesan members and those of the sister *C. t. tigris* lineage of 0.019 (K2P distance). This sequence

difference falls within the range of other Marquesan endemic cowrie lineages such as *Naria helvola bellatrix* LORENZ 2009 (0.008), *Purpuradusta fimbriata marquesana* LORENZ 2002 (0.020), *Mauritia maculifera martybealsi* (0.031), *Lyncina carneola propinqua* (GARRETT 1879) (0.020) and *Cribrarula astaryi* SCHILDER 1971 (0.028) [all K2P distances] (HICKERSON & MEYER, 2008: Suppl., table 1). Based on a hierarchical approximate Bayesian computation model (HABC), *C. t. lorenzi*, along with other Marquesan endemic cowries, strongly supports simultaneous colonization of the Marquesas and subsequent isolation, consistent with its recent geological history.

Table 2: Statistical Results (T tests) of morphometric analyses.

	avg W/L	STDEV W/L	avg H/L	STDEV H/L	avg Mratio	STDEV Mr
MQ	0.738	0.019	0.560	0.017	17.292	2.559
notMQ	0.698	0.027	0.549	0.020	14.987	2.952
HI	0.690	0.019	0.558	0.020	11.302	0.901
notHI	0.705	0.030	0.549	0.019	15.912	2.709
IP	0.700	0.028	0.547	0.019	15.680	2.676

T-test	p value*
t test MQ W/L	3.6669E-08
t test MQ H/L	0.03068793
t test HI W/L	0.00143132
t test HI H/L	0.03312475
t test MQ Mratio	0.00247661
t test HI Mratio	7.6329E-24
t test MQ Mratio non HI	0.02590261

* All p values significant at p<0.05

Acknowledgements

We especially want to thank MARTY BEALS for his contributions of samples, knowledge and feedback to this study.

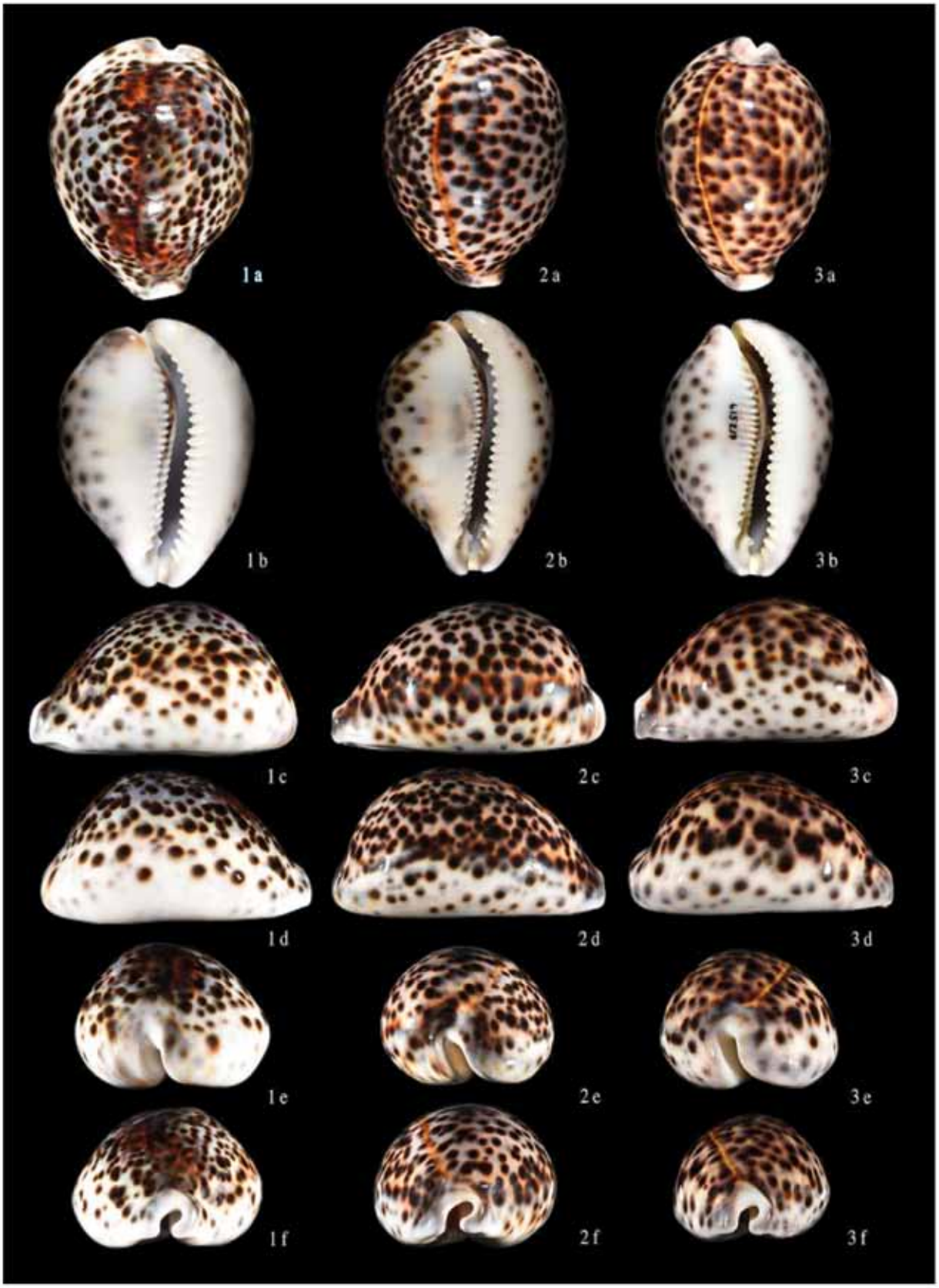
Plate 1 (on opposite p.)

Comparison of ***Cypraea tigris*** subspecies.

Fig. 1 a-f: *Cypraea tigris lorenzi* n. ssp., 81.5 mm, Nuku Hiva, Marquesas, holotype USNM 1422331.
Fig. 2 a-f: *Cypraea tigris schilderiana* CATE 1961, 119.8 mm, Hawaii, USNM 876714.
Fig. 3 a-f: *Cypraea tigris tigris* LINNAEUS 1758, 89.6 mm, Ailuk, Marshall Islands, USNM 615219.

Shells sizes adjusted to the same length.

Plate 1



Explanation on opposite p.

Plate 2 (on opposite p.)

Cypraea tigris shells from throughout the range.

C. *tigris lorenzi* n. ssp.

Fig. 1: 81.5 mm, Marquesas, USNM 1422331, holotype.
Fig. 2: 96.4 mm, Marquesas,USNM 700219.
Fig. 3: 99.4 mm, Marquesas, USNM 700219.
Fig. 4: 89.6 mm, Marquesas, USNM 798772.
Fig. 5: 85.2 mm, Marquesas, USNM 798772.
Fig. 6: 75.9 mm, Marquesas, MSF 8359.

C. tigris schilderiana CATE 1961

Fig. 7: 119.8 mm, Oahu, Hawaii, USNM 876714.
Fig. 8: 109.1 mm, Kona, Hawaii, USNM 1186893.
Fig. 9: 112.9 mm, Kona, Hawaii,USNM 1186893.
Fig. 10: 121.8 mm, Oahu, Hawaii,USNM 876714.

Plate 3 (on p. 68)

Cypraea tigris shells from throughout the range.

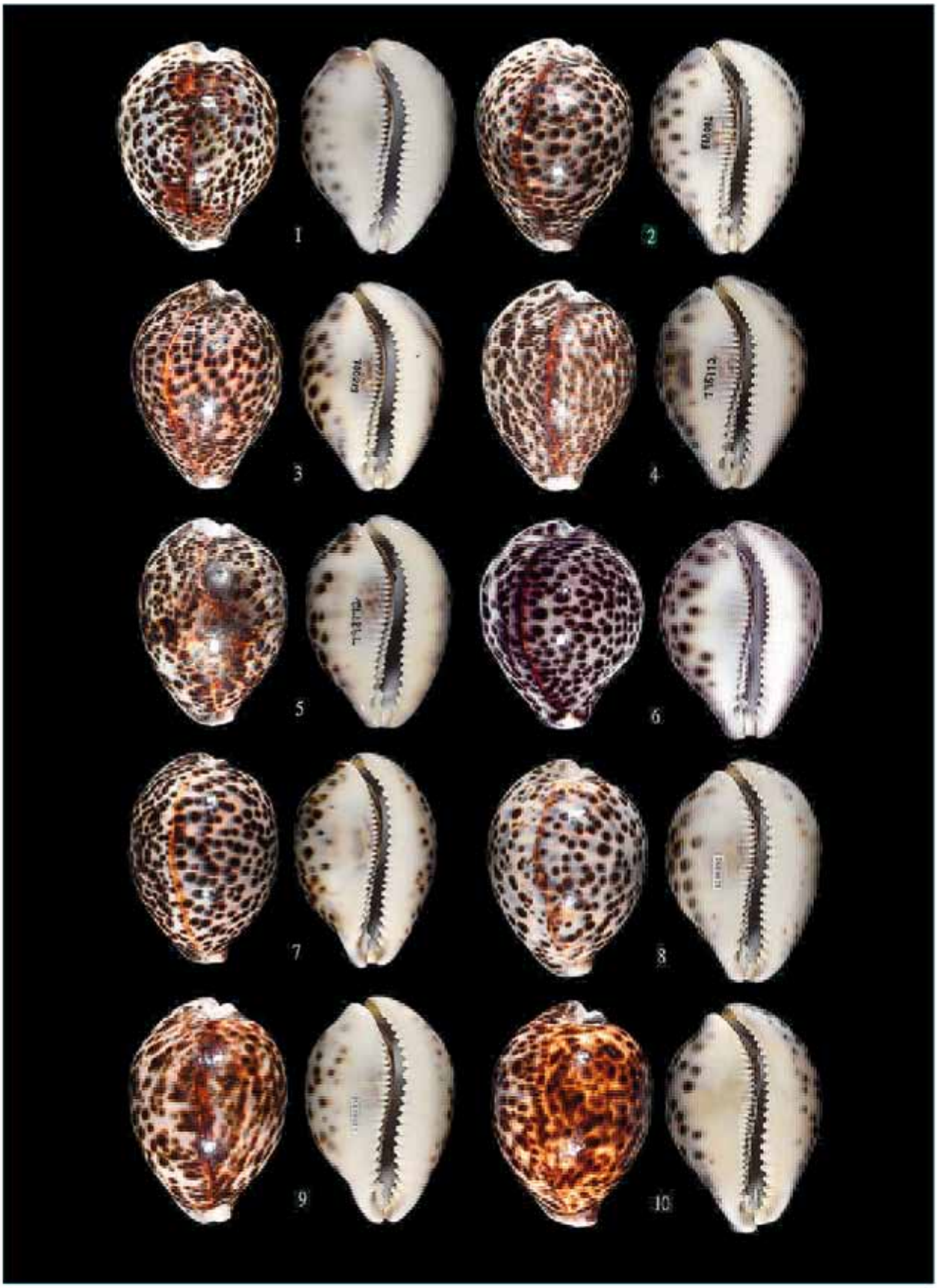
C. tigris schilderiana CATE 1961

Fig. 11: 118 mm, Oahu, Hawaii, USNM 876712.
Fig. 12: 116.5 mm, Maui, Hawaii, USNM 876708.

C. tigris tigris LINNAEUS 1758

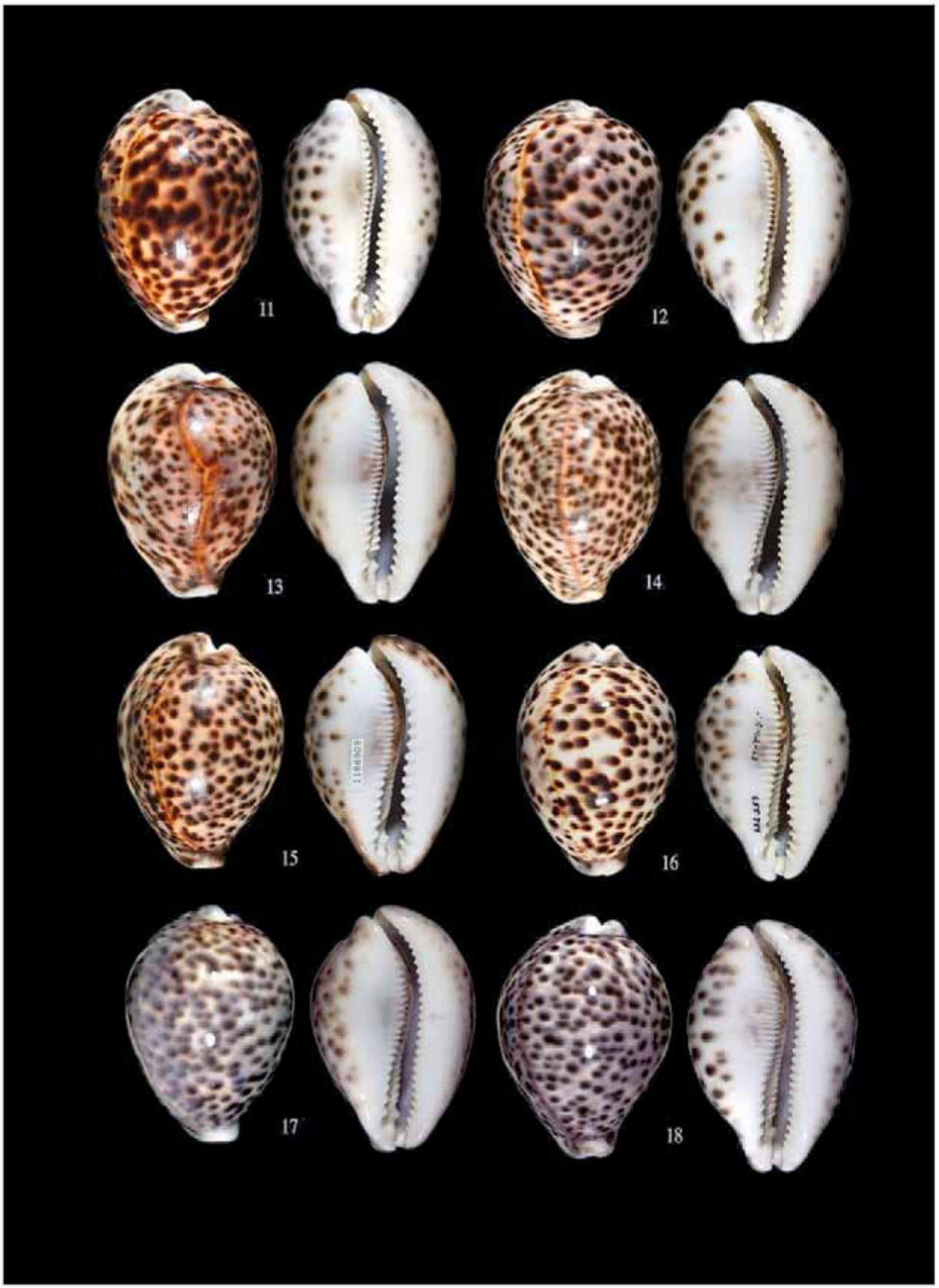
Fig. 13: 86.4 mm, Sinda, Tanzania, USNM 604317.
Fig. 14: 90.6 mm, Seychelles, USNM 618270.
Fig. 15: 84.2 mm, Bali, Indonesia, USNM 1186909.
Fig. 16: 89.6 mm, Eniwetok, Marshall Islands, USNM 655744.
Fig. 17: 92.2 mm, Agalega, Indian Ocean.
Fig. 18: 103.3 mm, Ramsgate, KwaZulu, Natal, South Africa.

Plate 2



Explanation on opposite p.

Plate 3



Explanation on p. 66

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The Philippine population of *Austrasiatica langfordi* (KURODA 1938) (Gastropoda: Cypraeidae)

By FELIX LORENZ & MARCO CHIAPPONI

With 1 Map, 2 Tables and 15 Figs on Plates 1-2

Keywords

Austrasiatica langfordi, Philippines, new subspecies.

Abstract

Austrasiatica langfordi poppeorum n. ssp. from the Philippines differs from the nominate subspecies by the oval instead of pyriform shape, the finer dorsal pattern, by a paler, evenly distributed coloration of the basal callus, as well as by an angular instead of rounded left margin. The morphology and geographical distribution of *A. langfordi* and other deep water species is discussed.

Zusammenfassung

Austrasiatica langfordi poppeorum n. ssp. von den Philippinen unterscheidet sich von der Nominatform durch ein ovales statt birnenförmiges Gehäuse, feineres Muster, blasseren, gleichmäßiger gefärbten basalen Kallus und einen kantigeren linken Seitenrand. Die Morphologie und Verbreitung der vier Unterarten von *A. langfordi* und anderer Tiefwasserarten wird diskutiert.

Introduction

The Philippine population of *Austrasiatica langfordi* (KURODA 1938) was discovered in the 1980s with the invention of tangle-nets for the collection of seashells. For many years, it remained a great rarity and sought-after collector's item. Unlike its eastern Australian and New Caledonian subspecies, the Philippine population has never been officially named. Although RAYBAUDI (1986) informally introduced a forma name "*philippina*", which he had also used for *Austrasiatica hirasei* (ROBERTS 1913), the first detailed description and differentiation of the Philippine population was published by POPPE (2008). The following provides a name for this fourth subspecies of *A. langfordi*.

Austrasiatica langfordi poppeorum n. ssp.

(Pl. 1 Figs 1-6)

Material

Twenty well-preserved specimens of the new subspecies, all from the type locality, twenty specimens of the nominate *A. langfordi langfordi* from China and Japan, ten specimens of *A. l. moretonensis* (SCHILDER 1965), and seventeen specimens of *A. l. cavatoensis* LORENZ 2002 in the collections of the CLSF and the first author have been studied.

Holotype: 51.0 × 32.1 × 24.7 (23:25) [16.02] Coll. MNHN Reg. No. MNHN-IM-2000-31686.

Paratype 1: 53.8 × 35.2 × 27.1 (23:25) [19.82]; Paratype 2: 56.7 × 36.1 × 28.5 (26:25) [23.49]; Paratype 3: 63.6 × 39.6 × 31.7 (23:28) [29.57]; Paratype 4: 59.4 × 38.2 × 30.2 (28:26) [28.52]; Paratype 5: 54.8 × 35.8 × 27.2 (25:27) [22.98] Coll. MSF; Paratype 6: 51.4 × 32.9 × 25.1 (24:21) [15.40] Coll. SMF 347501; Paratype 7: 44.9 × 27.7 × 22.4 (26:26) [10.12]; Paratype 8: 60.3 × 36.1 × 29.5 (23:26) [26.12] Coll. CLSF 10239; Paratype 9: 49.1 × 30.7 × 24.7 (23:24) [14.50] Coll. CLSF 10240; Paratype 10: 60.1 × 37.8 × 30.0 (24:21) [26.45] Coll. CLSF 10238a; Paratype 11: 63.0 × 39.0 × 31.4 (26:24) [24.87] Coll. CLSF 10238b; Paratype 12: 57.6 × 34.3 × 27.3 (23:28) [23.58] Coll. CLSF 10238c; Paratype 13: 62.2 × 38.3 × 31.3 (28:27) [28.68] Coll. CLSF 10241a; Paratype 14: 59.5 × 37.8 × 30.3 (24:24) [26.87] Coll. CLSF 10241b; Paratype 15: 55.7 × 34.9 × 27.5 (23:28) [20.82] Coll. CLSF 10241b; Paratype 16: 52.8 × 32.4 × 26.5 (26:25) [13.35] Coll. CLSF 13856; Paratype 17: 53.5 × 34.5 × 26.1 (25:25) [19.7]; Paratype 18: 48.5 × 32.5 × 24.5 (22:23) [16.7]; Paratype 19: 48.8 × 31.4 × 24.3 (27:25) [12.2]

All taken by tangle nets at approximately 180 m, Balut Is., S Mindanao, Philippines

Formula: 56 (63 - 50 - 79) 19 : 19 [13.1]

Description

The shell is medium-sized and moderately depressed, the outline is oval, with slightly rostrated extremities. The marginal callosities are well developed, bent up and angular at the widest point, from where they continue half way onto the dorsum. The margins form slight, angular flanges at the extremities labrally. The spire is flat and hidden under the callus of the posterior extremity. The aperture is narrow, slightly curved behind, somewhat widening anteriorly. The fossula is rather short, slightly projecting, showing five weak denticles. The labral teeth are fine, restricted to the aperture, slightly extending anteriorly. The columellar teeth are short throughout, hardly extending into the shell and separated from the denticles of the fossula. The ground color is pale greenish grey, with three weak uninterrupted transverse bands. The callosities of the extremities and the margins are pale orange dorsally, becoming gradually paler basally. The base and the area of the aperture are uniform pale yellow-orange. The dorsal pattern is pale orange-brown, fine and irregularily reticulated. Mid dorsally the pattern forms an irregular, perforated blotch.

The paratypes all agree with the holotype in shape, the angular margins and the coloration. In some shells, there is a discrete darker basal blotch. The saturation of the orange colour of the callosities varies with the age of the specimen. In old shells, the base is uniform pale yellow, the margins and extremities pale orange. The dorsal pattern varies in density, but is always quite pale and inconspicuous.

Distribution and habitat

Most specimens of *Austrasiatica langfordi poppeorum* n. ssp. have been taken by tangle nets at 120 to 200 m off Balut Is., S Mindanao, Philippines (type locality). It has also been reported from Cebu Is. and Aliguay Is., NW Mindanao.

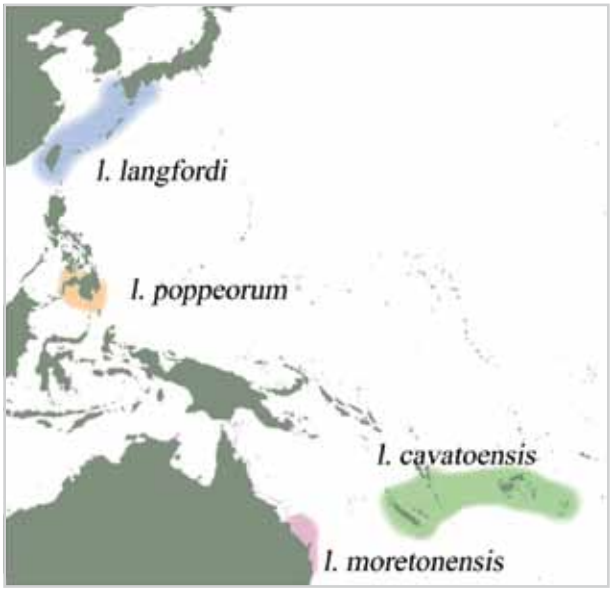
Etymology

This new subspecies is named in honour of the father-son synergy GUIDO and PHILIPPE POPPE of Mactan, Philippines. Both contribute immensely to the advancement of malacology. They generously share their knowledge and resources with the community of professional malacologists and shell-enthusiasts alike. It is only fair that one of the most spectacular members of the Philippine cowry fauna is named after them.

Discussion

Austrasiatica langfordi is widely distributed in the western Pacific to western Polynesia (Map 1), found at depths ranging from 120 to 450 m. It is split into four subspecies, which differ mainly in their coloration. The whitish to pink band dividing the colour of the margins from the dorsum separates *A. l. moretonensis* (SCHILDER 1964) and *A. l. cavatoensis* LORENZ 2002 from *A. l. langfordi* and *A. l. poppeorum* n. ssp., both of which lack that band. The Japanese *A. l. langfordi* tends to have a considerable colour contrast between the margins and the base. Many specimens have a plain white base, but with orange margins and a darker orange frame towards the dorsum. This is also present in shells from China, which are generally darker on the base. The Philippine *A. l. poppeorum* does not have a marked colour difference between the three sections – the dorsal, marginal and basal colour, but the orange coloration gradually becomes paler towards the aperture. In the nominate *A. l. langfordi*, the aperture and the tips are usually paler than the base and the margins.

The dorsal netting in *A. l. poppeorum* is finer, more delicate, and less blotched than in the nominate *A. l. langfordi*, in which the pattern is considerably darker and coarser, but also more sparse. The ground colour of *A. l. poppeorum* often has a greenish grey stain which is absent in the nominate subspecies. The shape of the two subspecies also differs: while *A. l. langfordi* is elegantly pyriform, with thickly calloused extremities, the shell of *A. l. poppeorum* is oval, with its widest area towards the midsection. The margins are more angular, especially on the left side, where it is evenly rounded in *A. l. langfordi*. When laid out for comparison, specimens of *A. l. poppeorum* are paler with less contrasting colours, with the differences in the marginal coloration and the characteristics of the dorsal pattern being the most striking (Map 1, Table 1).
The differentiation of the Philippine population of *A. l. langfordi* from the nominate Japanese and Chinese populations, as well as those from Australia and Melanesia, is consistent with that of other members of Cypraeidae living in a similar deep water habitat. This indicates a separate evolutionary history between the Philippine Cypraeid deep water fauna from these of other provinces.



Map 1: Distribution of the four subspecies of *Austrasiatica langfordi*.

Table 1: Features characterizing the four subspecies of *Austrasiatica langfordi*.

	langfordi	***poppeorum***	***moretonensis***	***cavatoensis***
Distribution	China, Japan	Philippines	Queensland, New South Wales	New Caledonia, Fiji, Tonga
Formulae (Dimensions)	57 (62 - 50 - 80)	56 (63 - 50 - 79)	59 (60 - 49 - 81) (narrowest)	45 (63 - 51 - 80)
Normalized toothcount	19 : 18 (less numerous)	19 : 19 (less numerous)	21 : 21 (more numerous)	21 : 22 (more numerous)
Mass ratio	[13.3] (heaviest)	[13.1]	[9.2] (lightest)	[11.8]
Shape	pyriform	oval, depressed	pyriform, slender	pyriform, depressed
Left margin	rounded, thick	angular, thick	rounded, thin	angular, thick
Extremities	calloused, pronounced	less calloused and pronounced	less calloused, shorter	calloused,shorter, narrow posteriorly
Flanges at extremities	thick	less pronounced	reduced	angular. narrower
Anterior columellar teeth	coarser, longer	finer, shorter	fine, short	fine, short
Spire	flat, calloused. discernible	calloused, flat. concealed	less calloused, projecting	calloused, slightly projecting
Marginal callus dorsally	saturate orange brown	pale orange	white	whitish, often faintly spotted
Margins at widest point	paler than towards dorsum	as dorsal margin	darker than dorsally	darker than dorsally
Colour of base	paler along sides, whitish along aperture	gradually paler towards aperture	darker orange	darker, uniform orange
Colour of posterior tips	paler than margins	as margins	darker than margins	darker or same as margins
Dorsal pattern	dark, coarse. sparse	paler, finer. dense	dark, coarse. dense	dark, finer. dense
Blotches	dark, distributed	paler, discrete	larger, compact	indistinct
Ground colour	cream	greenish grey	white	cream

Table 2 enumerates a few examples, and it is likely that others will follow, for example, the poorly known, large shelled Philippine population of *Nesiocypraea m. midwayensis* AZUMA & KUROHARA 1967, which seems to differ from the nominate Japanese form and also the Polynesian *N. m. kontiki* LORENZ 2012. In addition, once sufficient data becomes available to back up their status, the distinctness of the populations of *Austrasiatica hirasei* (ROBERTS 1913) might eventually be ascertained.

Table 2: Geographic sub-specific differentiation of some Indo-Pacific Cypraeidae.

Japan. China	Philippines	Australia. Melanesia. Polynesia
Erronea hungerfordi hungerfordi (G. B. SOWERBY III 1888)	*Erronea hungerfordi bealsi* MOCK 1996	*Erronea hungerfordi coucomi* SCHILDER 1964, Queensland
Perisserosa guttata azumai (SCHILDER 1960)	*Perisserosa guttata guttata* (GMELIN 1791)	*Perisserosa guttata*, undescribed ssp., Queensland, New South Wales
Nesiocypraea teramachii teramachii (KURODA 1938)	*Nesiocypraea teramachii polyphemus* LORENZ 2002	*Nesiocypraea teramachii neocaledonica* LORENZ 2002, New Caledonia
Nesiocypraea midwayensis midwayensis AZUMA & KUROHARA 1967	*Nesiocypraea midwayensis*, undescribed ssp.	*Nesiocypraea midwayensis kontiki* LORENZ 2012, Tuamotu
Austrasiatica hirasei (ROBERTS 1913)	*Austrasiatica hirasei* var. *philippina* (RAYBAUDI 1981, invalid name)	*Austrasiatica hirasei* var. *queenslandica* (SCHILDER 1966)

Acknowledgements

We wish to express our gratitude to Dr. MICHAEL A. MONT, ANTONELLA CRIPPA and JANA KRATZSCH, for helpful suggestions.

Plate 1 (on opposite p.)

Austrasiatica langfordi poppeorum n. ssp.

Fig. 1: Holotype (51.0 mm), Balut Is., at 180 m.
Fig. 2: Paratype 1 (53.8 mm), Balut Is., at 180 m.
Fig. 3: Paratype 3 (63.6 mm), Balut Is., at 180 m.
Fig. 4: Paratype 4 (59.4 mm), Balut Is., at 180 m.
Fig. 5: Paratype 5 (54.8 mm), Balut Is., at 180 m.
Fig. 6: Paratype 1, Note angular margin (arrow).

Austrasiatica langfordi langfordi (KURODA 1938)

Fig. 7: (59.8 mm) Eastern China, at 220 m.
Fig. 8: (49.0 mm) Kii, Japan, at 200 m.

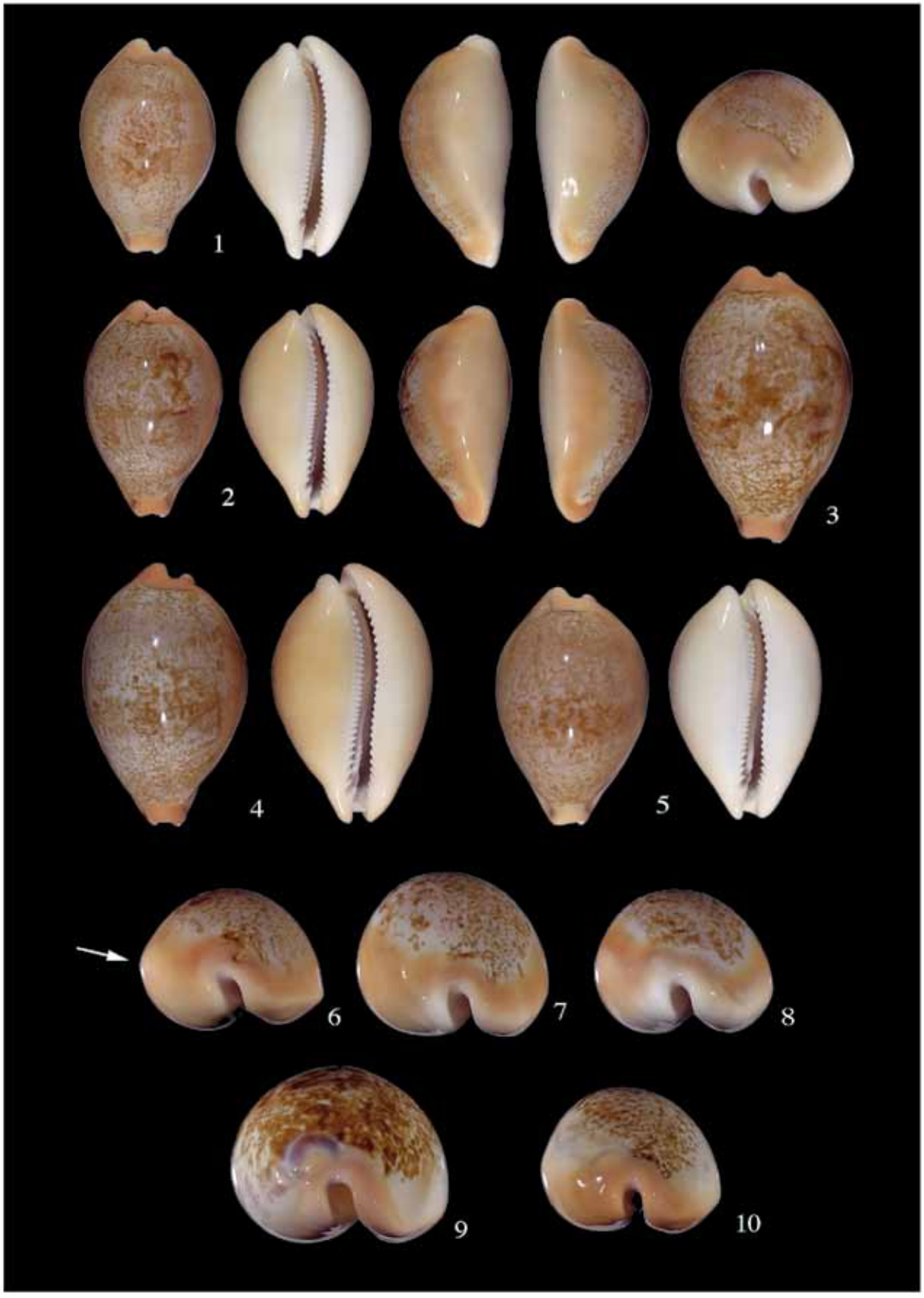
Austrasiatica langfordi moretonensis (SCHILDER 1965)

Fig. 9: (59.8 mm) Cape Moreton, Queensland, at 150 m.

Austrasiatica langfordi cavatoensis LORENZ 2002

Fig. 10: (50.1 mm) Banc Jumeau, S New Caledonia, at 350 m.

Plate 1



Explanation on opposite p.

Plate 2 (on opposite p.)

Austrasiatica langfordi langfordi (KURODA 1938)

Fig. 1: (59.8 mm) Eastern China, at 220 m.
Fig. 2: (61.9 mm) Eastern China, at 220 m.
Fig. 3: (49.0 mm) Kii, Japan, at 200 m.

Austrasiatica langfordi moretonensis (SCHILDER 1965)

Fig. 4: (59.8 mm) Cape Moreton. Queensland, at 150 m.

Austrasiatica langfordi cavatoensis LORENZ 2002

Fig. 5: (50.1 mm) Banc Jumeau. S New Caledonia, at 350 m.

Plate 2

Explanation on opposite p.

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A new bathymetric subspecies of *Austrocypraea reevei* (Gastropoda: Cypraeidae)

By MARCO CHIAPPONI

With 1 Map, 1 Table and 17 Figs on Plates 1-2

Keywords

Austrocypraea reevei lorenzoi, new subspecies, SW-Australia.

Abstract

Austrocypraea reevei lorenzoi n. ssp. is described from deep water off SW Australia. It differs from the nominate *reevei* and the eastern deep-water *bishopi* by a smaller, narrower shell with a lower dorsal profile and an extremely developed fossula.

Zusammenfassung

Austrocypraea reevei lorenzoi n. ssp. aus dem Tiefwasser vor SW Australian unterscheidet sich von der Nominatform und der östlichen *bishopi* durch ein kleineres, schmaleres Gehäuse mit flacherem dorsalen Profil und einer extrem entwickelten Fossula.

Introduction

The sole surviving species of an Australian endemic genus, *Austrocypraea reevei* (G. B SOWERBY I 1832), shows some interesting geographic and bathymetric variability. Recently, PETUCH & BERSCHAUER (2017) described *reevei bishopi* from 145 m depth off Eucla in the Great Australian Bight. They extend the range of their taxon westward, to Albany and Esperance. However, this area yields a morphologically different population of deep-water *reevei*, which has been known for a long time. It is here described as

Austrocypraea reevei lorenzoi n. ssp.

(Pl. 2 Figs. 3-9)

Etymology

In honour of my grandson LORENZO CHIAPPONI.

Material

Holotype: 25.70 × 15.41 × 13.46 (28:25) [1.53], Albany, coll. WAM S79960.

Paratype 1: 27.98 × 16.62 × 14.36 (29:23) [1.82] Esperance area, coll. CLSF 16254b; Paratype 2: 23.4 × 14.2 × 12.4 (26:22) [1.48] Albany, coll. F. LORENZ; Paratype 3: 24.3 × 14.4 × 12.1 (30:23) [1.13] Albany, coll. F. LORENZ; Paratype 4: 28.2 × 16.4 × 13.8 (36:27) [1.55] Albany, coll. F. LORENZ; Paratype 5: 27.16 × 16.08 × 14.48 (32:23) [1.97] Albany, coll. CLSF 2528; Paratype 6: 31.46 × 19.98 × 17.95 (30:26) [3.52] Albany, coll. CLSF 16334e; Paratype 7: 26.67 × 16.56 × 14.57 (26:27) [1.99] Esperance area, coll. CLSF 9846a; Paratype 8: 27.22 × 15.89 × 15.11 (29:25) [2.02] Esperance area, coll. CLSF 9846b; Paratype 9: 25.67 × 15.08 × 12.91 (28:25) [1.36] Esperance area, coll. CLSF 9846c; Paratype 10: 23.89 × 13.78 × 11.56 (26:24) [1.13] Esperance, coll. CLSF 9847a; Paratype 11: 26.89 × 17.23 × 14.18 (27:23) [1.44] Esperance, coll. CLSF 9847b; Paratype 12: 25.01 × 14.19 × 12.48 (27:24) [1.23] Esperance, coll. CLSF 9847c; Paratype 13: 30.05 × 18.05 × 15.39 (33:26) [1.61] Albany, coll. CLSF 9848a; Paratype 14: 23.47 × 14.82 × 12.41 (25:23) [1.15] Albany, coll. CLSF 9848b; Paratype 15: 25.24 × 14.41 × 12.21 (29:26) [1.36] Esperance area, coll. CLSF 3989; Paratype 16: 26.10 × 16.66 × 14.47 (28:22) [1.74] Esperance area, coll. CLSF 16254a; Paratype 17: 28.35 × 17.44 × 15.42 (29:28) [2.22] Albany, coll. CLSF 16585a; Paratype 18: 26.86 × 15.95 × 14.31 (30:21) [1.67] Albany, coll. CLSF 16585b; Paratype 19: 25.83 × 15.13 × 12.86 (28:22) [1.46] Albany, coll. CLSF 16334d; Paratype 20: 26.05 × 15.01 × 13.08 (28:24) [1.49] Albany, coll. CLSF 16334b; Paratype 21: 29.38 × 18.24 × 16.71 (29:25) [3.17] Albany, coll. CLSF 16334c.

Description

The shell is rather small and lightweight, narrowly oval, nearly cylindrical. The dorsal profile is flattened. The posterior extremity is slightly rostrate. The spire is large and projecting, only partly covered by callus. The protoconch has a diameter of 2.2 mm and shows 3 whorls, indicating direct development. The anterior extremity is short, broad and rather blunt. The dorsal surface is faintly malleate and irregular. The aperture is wide, widening anteriorly, and evenly curved throughout its length. The labrum is declivous in front, with slight callus towards

the extremities only. The base is hardly calloused. The teeth are restricted to the aperture on both sides. The columellar teeth form extensions towards the columella, which become gradually thicker in the anterior half of the shell. The fossula is greatly produced, convex, and evenly projecting in the anterior third of the aperture. It consists of 10 denticles, of which the 6 anteriormost ones are distinctly swollen along the fossular edge. The gap between the terminal ridge and the first fossular denticle is narrow.

The ground colour is pale yellow-grey, and the weak callosities are slightly paler cream. The extremities are faintly stained with reddish pink, and the spire is conspicuously red.

The paratypes show some variation in colour, ranging from pale yellow to saturate grey. The spire is always conspicuous and projecting. The posterior extremity is often shorter than in the holotype. In all specimens, the fossula is greatly produced, as in the holotype.

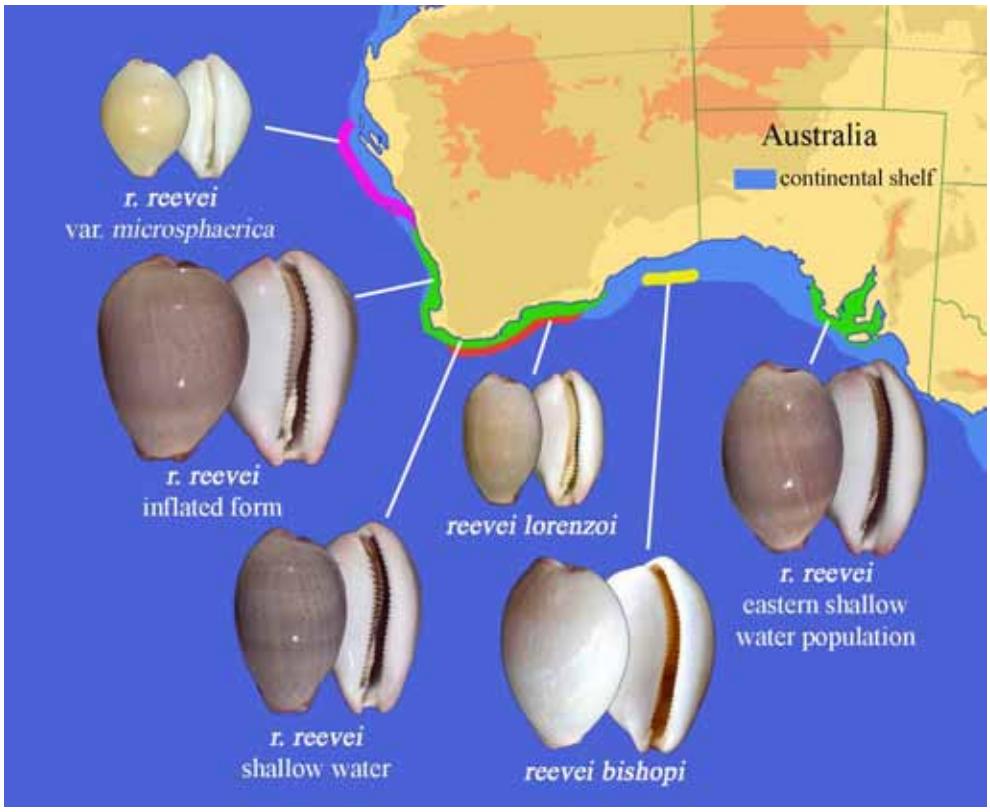
The animal characteristics are unrecorded.

Distribution

The type locality is 35-40 km south of Albany, SW Australia, taken ex pisce at 80-100 m. Typical specimens have been found between Albany and Esperance, SW Australia, nearly always taken from fish stomachs.

Occurrence, habitat

Common. Usually recovered from the stomach contents of the Southern Blue Morwong fish, *Nemadactylus valenciennesi* (WHITLEY 1937), along with numerous juvenile bulla shells (Pl. 2 Fig. 9). Other Cypraeidae found alongside it include *Notocypraea comptonii* (GRAY 1847), *N. piperita occidentalis* IREDALE 1935 and *N. pulicaria* (REEVE 1846). All these are spongivores and direct developers. A single specimen has been taken by a remotely operated vehicle off Windy Harbour, between Augusta and Albany, at 135 m. This is the most western record of the new subspecies.



Map 1: The distribution of *Austrocypraea reevei*, its subspecies and variations.

Discussion

Austrocypraea reevei has a wide distribution along the southern and western Australian coast, covering the area between Shark Bay in the northwest and Thorny Passage in the southeast. It is found from just below the low tide level to a

depth of 300 m. The first comprehensive treatise on the species was published by RAYBAUDI (1980). He named two variations: a small, globular var. *microsphaerica* from the north-western part of the species' distribution, and a large, inflated var. *macrosphaerica* from the Esperance area. In his revision of 1986, the name *macrosphaerica* is no longer listed. It is still sometimes used for the inflated local variation found in the area between Rottnest Island and Geraldton on the western coast of SW Australia. These names do not comply with the International Code of Zoological Nomenclature (ICZN) because they were explicitly introduced at the level of a form or variation (Article 15.2).

Recently, *A. reevei bishopi* PETUCH & BERSCHAUER was proposed as a deep-water subspecies from the Great Australian Bight (type locality: Eucla, at 145 m). That name was based on four specimens which are characterized as being thinner and more delicate than typical *reevei*, by being more inflated and globular, by having a higher and more domed dorsum, and by a much lighter shell colour of pale yellow-white as opposed to the dark greyish brown colour of the nominate subspecies. The extremities are paler-coloured and the fossula is said to be much larger and more developed, but this is not obvious in the illustration of the holotype (length given as 40 mm, width 26 mm). There is a specimen from 100-110 m off Point Culver at the western end of the Great Australian Bight that closely corresponds with this description (measuring 33.92 × 22.63 × 19.24 (33:27) [2.98] CLSF 9845). Table 1 compares the new subspecies described herein with the nominate *reevei*, *bishopi* and the variation *microsphaerica*. Interestingly, there is a wide gap in the known distribution of *reevei* along the Great Australian Bight. Only a few specimens are known from deeper offshore waters from its central part, which is also the type locality of *bishopi*. The eastern shallow water population of the nominate *reevei* is conchologically inseparable from the western one. Generally, deep water populations (from below the 80 m level) of *reevei* can have a yellow to pale cream colour, which is not found in shallow water populations. Map 1 shows the diversity of the species along its distribution.

Table 1: Comparison of the geographical and bathymetrical populations of *Austrocypraea reevei.*

	reevei	***bishopi***	***lorenzoi***	***microsphaerica***
Range	Geraldton to Spencer Gulf	Great Australian Bight	Albany to Esperance	Geraldton to Shark Bay area
Depth	2-40 m	145 m	80-140 m	80-180 m
Length	30-45 mm	32-40 mm	24-34 mm	25-32 mm
Formula	38 (64 - 56 - 87) 27 : 23 [9.1]	36 (67 - 58 - 86) 25 : 21 [6.9]*	28 (60 - 52 - 87) 28 : 24 [9.9]	29 (69 - 63 - 91) 27 : 23 [10.7]
Shape	pyriform	pyriform, inflated	elongate, narrow	globular
Dorsal dome	rounded	humped	low	humped
Texture	solid, calloused	lightweight	solid	solid, calloused
Fossula	rather flat	more developed, rather flat	strongly developed, projecting	less developed, shorter
Spire	flat	flat	projecting	flat
Colour	bluish grey	pale grey to whitish yellow	pale yellow to saturate grey	pale yellow to pale brown

*: formula based on the measurements of the holotype and the specimen in coll. CLSF 9845.

The differences in shape are expressed by the formulae: *bishopi* is wider and higher than the nominate *reevei*, whereas *lorenzoi* is considerably narrower and more depressed. The smaller-shelled *lorenzoi* is also more solid than typical *reevei*, as shown by the mR, while *bishopi* is considerably lighter in weight. The northwestern variation *microsphaerica* is by far the conchologically most extreme, with a much wider and higher shell and highest relative mass of all; it probably deserves recognition as separate subspecies as well. Interestingly, there are no shallow water populations of *reevei* in the northwestern part of the species' distribution. However, while the data for *lorenzoi* and *reevei* is based on more than twenty specimens per set, only two shells of *bishopi* and eight specimens of

microsphaerica were available to create the formulae.

The scarcity of shells of *bishopi* leaves some doubt as to its status, since the holotype shell closely resembles occasional specimens of typical *reevei* from shallow water. RAYBAUDI (1980) mentions a "light and very pale" specimen collected at 125 m off Kangaroo Island. Perhaps this shell also belonged to *bishopi*. Hopefully further specimens will become available to ascertain the morphological differences described by the authors of that taxon. The status of *microsphaerica* is a pending matter, hopefully to be resolved once molecular data can be obtained.

On the other hand, the extremely developed fossula, along with the smaller, narrower shell with a lower dorsal profile separate the deep-water population of *lorenzoi* from the others in a convincingly consistent manner, which supports the distinction as a bathymetric subspecies.

Acknowledgements

For support in assembling this study I wish to thank ANTONELLA CRIPPA for assisting in the photography, and FELIX LORENZ for valuable suggestions.

Plate 1 (on opposite p.)

Austrocypraea reevei reevei (G. B. SOWERBY I 1832)

Fig. 1: (34.8 mm) Thorny Passage, Port Lincoln, S Australia, at 8-10 m.
Fig. 2: (38.1 mm) Thistle Island, Port Lincoln, S Australia, at 16-18 m.
Fig. 3: (33.0 mm) Bremer Bay, SW Australia, at 2 m.
Fig. 4: (39.2 mm) Observatory Island, Esperance, SW Australia, at 25 m.
Fig. 5: (39.3 mm) Rottnest Island, SW Australia, at 20 m.
Fig. 6: var. *microsphaerica* (26.9 mm) False Entrance, Shark Bay area, W Australia, at 110 m.
Fig. 7: var. *microsphaerica* (25.5 mm) W Bernier Island, W Australia, at 180 m.
Fig. 8: var. *microsphaerica* (28.5 mm) W Bernier Island, W Australia, at 135 m.

Plate 2 (on p. 82)

Austrocypraea reevei bishop PETUCH & BERSCHAUER 2017

Fig. 1: (40 mm) Off Eucla, W Australia, at 145 m. Holotype, coll. South Australian Museum D4324, after PETUCH & BERSCHAUER (2017).
Fig. 2: cf. *bishopi* (33.8 mm) Off Point Culver, SW Australia, at 100-110 m.

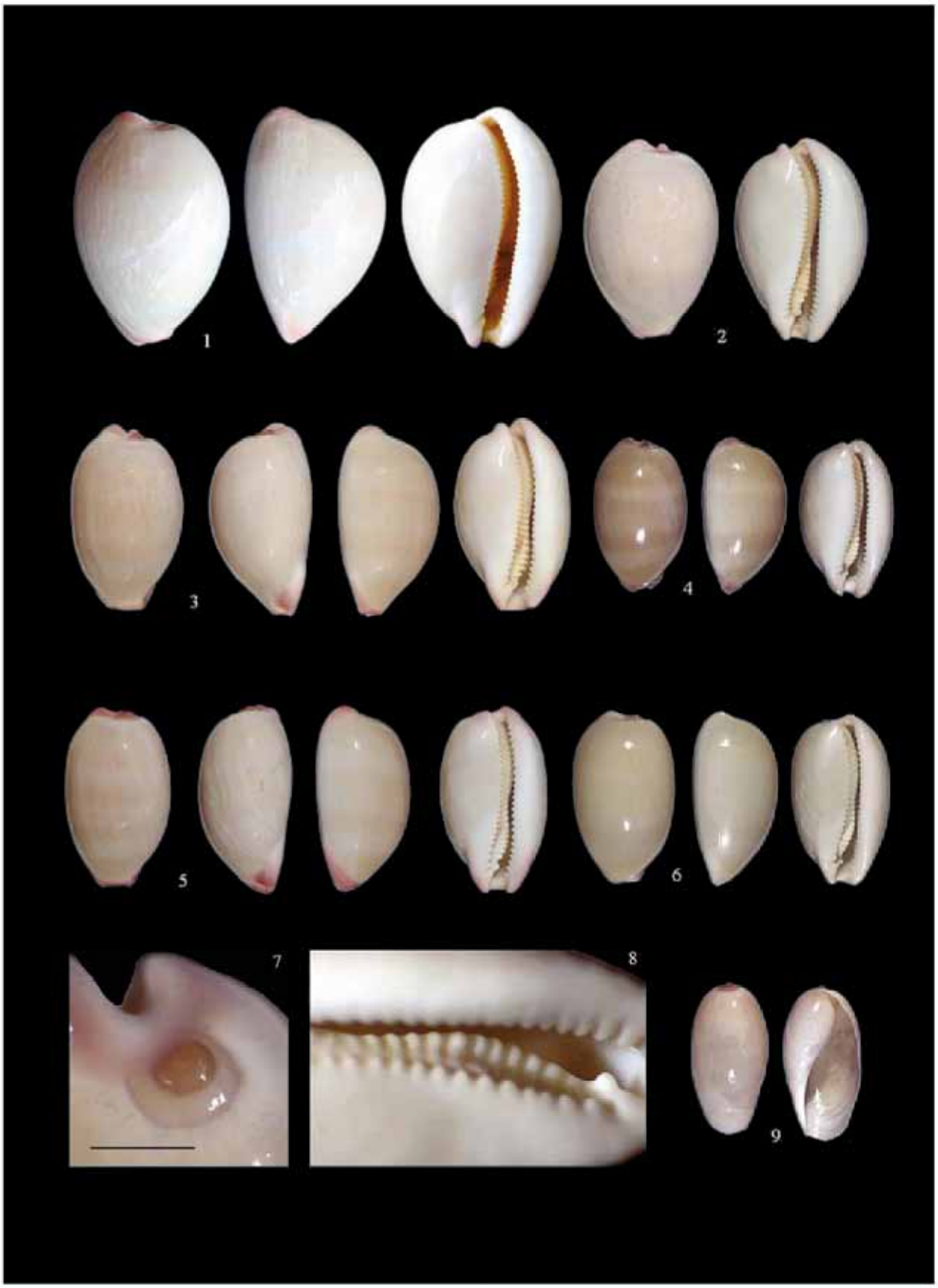
Austrocypraea reevei lorenzoi n. ssp.

Fig. 3: (25.7 mm) 35-40 km S of Albany, SW Australia, at 80-100 m. Holotype coll. Western Australian Museum (WAM).
Fig. 4: (23.4 mm) Albany, SW Australia, at 80-100 m. Paratype 2.
Fig. 5: (23.9 mm) Esperance area, SW Australia, at 80-100 m.
Fig. 6: (24.3 mm) Albany, SW Australia, at 80-100 m. Paratype 3.
Fig. 7: Paratype 2, detail of the spire with protoconch. Scale = 5 mm.
Fig. 8: Paratype 3, detail of fossula.
Fig. 9: (19 mm) Albany, SW Australia, at 80-100 m. Bulla shell.

Plate 1

Explanation on opposite p.

Plate 2



Explanation on p. 80

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A new subspecies of *Purpuradusta minoridens* (Gastropoda: Cypraeidae)

By FELIX LORENZ

With 1 Map and 11 Figs on Plate 1

Keywords

Purpuradusta, new subspecies, Indian Ocean.

Abstract

Purpuradusta minoridens julianjosephi n. ssp. from the Indian Ocean and Bali, Indonesia, differs from the nominate Pacific sister mainly by a pyriform instead of cylindrical shell, a more projecting fossula and the purple stain of the anterior terminal ridge being restricted to that structure. Its primary banding often forms a peculiar reticulated pattern unique in the genus.

Zusammenfassung

Purpuradusta minoridens julianjosephi n. ssp. aus dem Indischen Ozean und Bali, Indonesien unterscheidet sich von der Pazifischen Nominatform vor allem durch ein birnenförmiges statt zylindrisches Gehäuse, eine stärker hervorstehende Fossula und die Begrenzung der purpurnen Färbung auf die Terminalrippe. Die primäre Bänderung zeigt oft eine Netzstruktur, die einzigartig für die Gattung ist.

Introduction

The occurrence of *Purpuradusta minoridens* (MELVILL 1901) in the Indian Ocean has been known for a long time (BURGESS 1985, LORENZ & HUBERT 1993). Subsequent research has shown that many records of the species along the coast of East Africa and the Red Sea were based on confusion with *Purpuradusta microdon chrysalis* (KIENER 1843), which occurs throughout the Indian Ocean and the Red Sea. In the south of Sri Lanka, around Phuket Is. and near the Similan Islands in W Thailand, a conchologically distinct population constitutes an Indian Ocean sister of *Purpuradusta minoridens minoridens*, which is widespread throughout the Pacific. Although conchologically distinct, it has never been described. A specimen is illustrated in LORENZ & HUBERT (2000: 540 figs 11-12) as *Purpuradusta* sp. Its origin is western Thailand, the data given as "Philippines" was due to confusion of labels. Specimens of the new subspecies have also been found in Bali, Indonesia, which is known to display a mix of both, Pacific and Indian Ocean cowries (MEYER 2004). Recently, a fair number of specimens could be obtained from the west of Thailand, which confirms the differences to Pacific *minoridens*. The new subspecies is described as

Purpuradusta minoridens julianjosephi n. ssp.

(Pl. 1 Figs. 1-5, 9 + 11)

Etymology

In honour of my friend and proofreader JULIAN M. G. JOSEPH, British conchologist.

Material

Holotype: 11.6 × 5.9 × 5.1 [19:20] Bon Is., Phuket, W Thailand, coll. MNHN IM 32675

Paratype 1: 10.7 × 6.2 × 5.1 [20:18] CLSF6984a; Paratype 2: 11.1 × 6.3 × 5.1 [20:20]; Paratype 3: 14.3 × 7.8 × 6.5 [19:23]; Paratype 4: 11.1 × 6.1 × 4.8 [18:18]; Paratype 5: 11.9 × 7.0 × 5.3 [18:22]; Paratype 6: 12.9 × 7.1 × 5.7 [22:21]; Paratype 7: 11.4 × 6.2 × 5.1 [19:17]; Paratype 8: 11.2 × 6.0 × 5.0 [19:22]; Paratype 9: 10.2 × 5.8 × 4.7 [17:18]; Paratype 10: 10.4 × 5.7 × 4.5 [19:23]; Paratype 11: 10.1 × 5.2 × 4.3 [20:20]; all from Bon Is., Phuket, Thailand, in the author's collection.

Description

The shell is very small, pyriform and inflated. The extremities are rostrate and constricted. Their pointed tips are visible anteriorly on dorsal view. The aperture is slightly curved. The labrum is constricted anteriorly where the aperture widens. The labral teeth are well-produced and slightly extending onto the labrum. The columellar teeth are very fine posteriroly, barely discernible in the midsection and gradually becoming coarser anteriorly. The fossula is distinctly projecting and densely ribbed. The spire is flat. The brown pointed protoconch is partly exposed.

The dorsum is pale brown, with several regular and darker transverse bands, which may be reticulated. There are large and conspicuous dorsal spots of brown colour. The labrum is sparsely but distinctly spotted with dark brown. On the columellar side there are fine brown dots blending in with the dorsal spotting. The pale purple stain of the anterior canal on the base is restricted to the terminal ridge.

The ground colour is pale yellow to grey, and the weak callosities are slightly paler cream. The extremities are faintly stained with reddish pink, and the spire is conspicuously red.

The paratypes show some variation in colour, ranging from pale yellow to saturate grey. The spire is always conspicuous and projecting. The posterior extremity is often shorter than in the holotype. In all specimens, the fossula is greatly produced, as in the holotype.

The animal has a bright red mantle with tiny, sparse white papillae. The foot and tentacles are yellow.

Distribution

The type locality and that of the paratypes is the southern end of Bon Island (7°45.15‘N, 98° 19.77‘E), S of Rawai, Phuket, W Thailand. Empty shells have been collected by the author in the Similan Islands off Phuket, Weligama in the south of Sri Lanka, and at Pemuteran in the northwest of Bali, Indonesia. Balinese specimens are also known from Lovina and Tulamben.

Occurrence, habitat

Rare. Intertidally to 25 m, in dead coral reef, in association with sponges. Most specimens are found fresh dead in coral rubble or on beaches.

Map 1: The distribution of *Purpuradusta m. minoridens* and *m. julianjosephi* n. ssp.

Discussion

The new subspecies from the Indian Ocean to Bali differs consistently from shells from the Pacific, and despite the lack of sufficient molecular data, the shell morphology justifies its status as a geographical subspecies. The main differences from Pacific *minoridens* is that in *julianjosephi* the fossula is longer and more projecting, with more numerous denticles (Pl. 1 Figs 10, 11). The shell is more rostrate and pyriform instead of cylindrical. The staining of the canal is remarkable and constant: in *minoridens*, it extends into the gap between the terminal ridge and the first tooth, whereas in *julianjosephi* the staining is less conspicuous and restricted to the terminal ridge (Pl. 1 figs 8, 9). In some specimens of *julianjosephi*, the transverse primary banding forms a reticulated or tessellated pattern which is unique in the genus. The margins of *minoridens* are usually unspotted, whereas in *julianjosephi* there are usually several clearly visible darker spots along the labral margin.

Plate 1 (on p. 86)

Purpuradusta minoridens julianjosephi n. ssp.

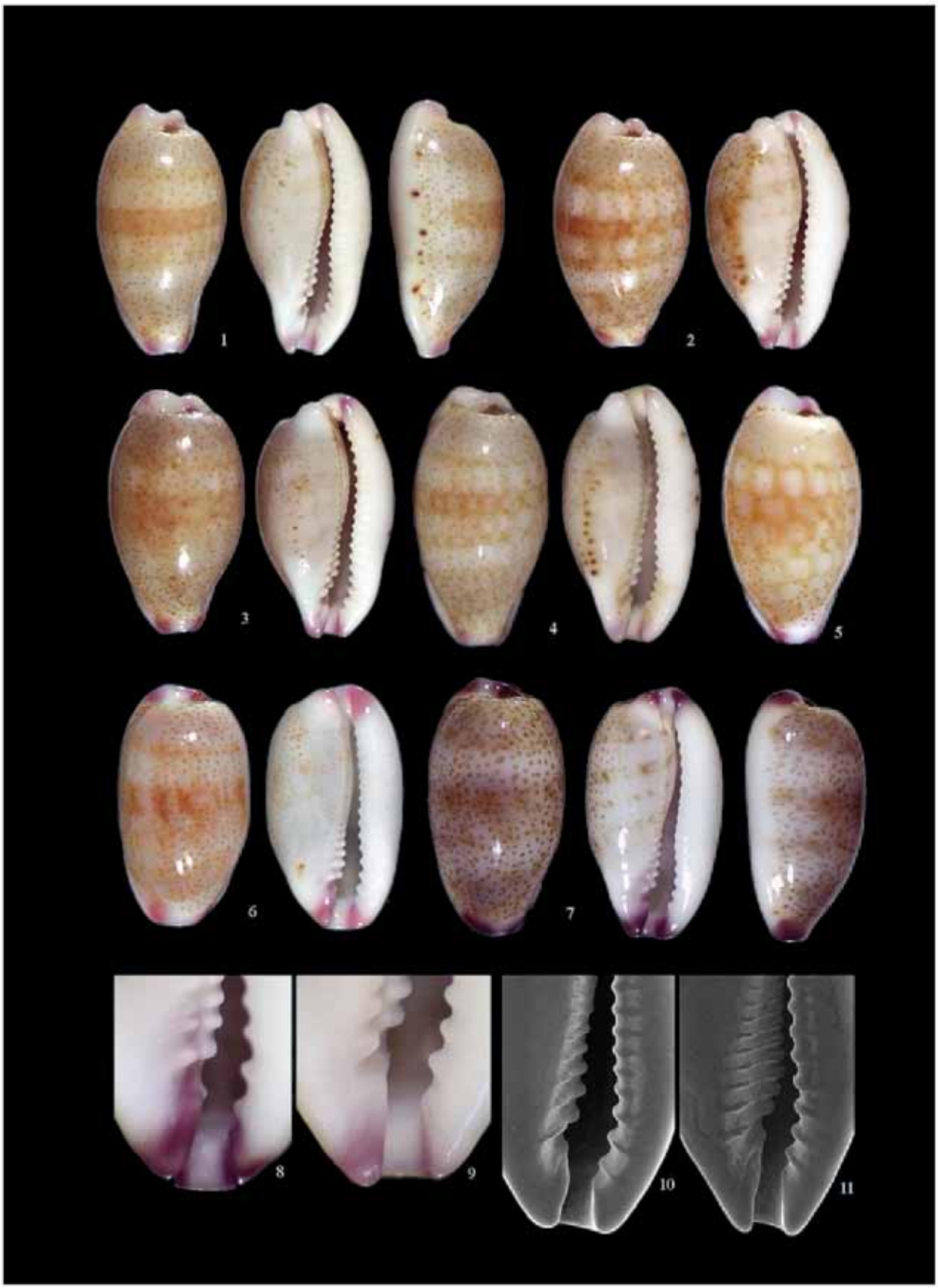
Fig. 1: (11.6 mm) Holotype, coll. MNHN IM 32675.
Fig. 2: (10.7 mm) Paratype 1, coll. CLSF6984a.
Fig. 3: (11.1 mm) Paratype 2.
Fig. 4: (11.1 mm) Paratype 4.
Fig. 5: (10.8 mm) specimen showing tessellated primary banding. Coll. CLSF.
Fig. 9: Detail of the anterior extremity. The purple stain is restricted to the terminal ridge.
Fig. 11: Detail of the fossula area.
All from Bon Island, Phuket, W Thailand.

Purpuradusta minoridens minoridens (MELVILL 1901)

Fig. 6: (12.2 mm) Lamont Reef, Queensland, Australia.
Fig. 7: (9.1 mm) Fingal Head, northern New South Wales, Australia.
Fig. 8: Detail of the anterior extremity. Note that the purple stain continues towards the anterior columellar teeth.
Fig. 10: Detail of the fossula area.

SEM photos by PETER STAHLSCHMIDT.

Plate 1



Explanation on p. 85

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The most bizarre Cowry that ever lived: *Gisortia megaloptera* n. sp. (Gastropoda: Cypraeidae)

By FELIX LORENZ, D-Buseck-Beuern

With 1 Table and 21 Figs on Plates 1-8

Keywords

Gastropoda, Cypraeidae, *Gisortia*, new species, Ypresian, Eocene, Paleogene, France.

Abstract

Gisortia megaloptera n. sp. is described from the Ypresian, early Eocene of Gan, France. It differs from the younger *G. coombii* (J. DE C. SOWERBY in DIXON 1850) from the Lutetian Eocene by the structure of the posterior extremity, the stronger development of lateral flanges and protuberances, by the presence of a prominent dorsal wing, and numerous other conchological aspects. The extreme features of the holotype are backed up by several less bizarre specimens of the same provenance, which are tentatively assigned to the new species.

Zusammenfassung

Gisortia megaloptera n. sp. wird aus dem Ypresium, frühes Eozön von Gan, Frankreich, beschrieben. Sie unterscheidet sich von der jüngeren *G. coombii* (J. DE C. SOWERBY in DIXON 1850) aus dem Lutetien, mittleres Eozän, durch die Struktur der Hinterextremität, die stärkere Ausbildung seitlicher Fortsätze, das Vorhandensein eines stark entwickelten dorsalen Flügels, sowie mehrere andere conchologische Aspekte. Die extrem ausgeprägten Merkmale des Holotypus werden durch weitere, weniger bizarre Exemplare gleicher Herkunft bestätigt, die unter Vorbehalt der neuen Art zugeordnet werden.

Introduction

The species of the family of Cypraeidae have a considerable range of adult specimen sizes: Among the living species, *Purpuradusta oryzaeformis* LORENZ & STERBA 1999, the smallest known member, barely ever exceeds 10 mm. At the other end of the scale, *Macrocypraea cervus* (LINNAEUS 1771) can reach 190 mm. The Miocene of Victoria, Australia, bears members of the genus *Gigantocypraea* that reached 230 mm in length. After all, this group includes the mysterious species of the long-extinct genus *Gisortia*, that must have been quite widespread in the late Cretaceous to the Eocene. Among the few well-preserved specimens known, there are some exceeding 260 mm.

Most living and fossil species of Cypraeidae have a smooth, finely ribbed, or granulose surface, and only a few groups constitute exceptions. Certain variations of *Muracypraea mus* (LINNAEUS 1758) are the only living example of cowries with dorsal tubercles. Some of the Miocene *Barycypraea* from Java, Indonesia, had prominent ridges and tubercles, surpassed only by the Eocene *Vicetia*, which were also considerably larger, reaching 150 mm. The Miocene *Umbilia gastroplax* (MCCOY 1867) had a thin marginal flange encircling the entire shell, giving it the outline of a saucer. *Umbilia siphonata* (CHAPMAN 1922) from the same area in Victoria, Australia, had extended extremities forming upward-pointing canals. However, the chart of cowries with the most spectacular protuberances is also led by the members of *Gisortia*. Some of them had prominent tubercles, wide marginal flanges, or spoon-shaped processes at the margins and the dorsum.

The shell which inspired this report was collected several decades ago and was deposited in a private collection. It has never been illustrated or described to the best of my knowledge. When the specimen was offered, its state of restoration was rather pitiful. It had been coated with a thick layer of semi-transparent brown varnish. The cracks had been filled and covered up with a slightly flexible material, possibly window putty. White plaster had been used to attach or cover up fragments of the dorsum. Plaster and brown putty were also used to fill the aperture, perhaps to stabilize the base, the labrum, and the gaps between the actual shell and the characteristic grey clay of the fossil site that it had been recovered from. But even in this state, the specimen appeared to me the most stunning malacological item ever seen.

The first step in recovering the specimen was to remove the clay and plaster from the aperture. It turned out that the entire labrum, the canals, and the fossular area were intact. A piece of the labrum that had broken off had been clumsily glued back at an angle, and could be put in its proper place once the plaster and clay had been removed. Embedded in the clay taken from the aperture and the interior of the shell, additional fragments of the dorsum were recovered. The tip of the left wing was missing and was remodeled based on the tip of the opposite, complete wing, and by judging from the way the flange tapered. The majority of the dorsal wing was also missing. The reconstruction of it had to be based on the width of the preserved area where it was attached to the dorsum, and the shape of the transverse dorsal flange connecting it with the left wing.

The genus *Gisortia* appeared in the late Cretaceous, but only internal casts and poorly preserved traces allow assumptions about what these shells actually looked like. However, in the Ypresian, early Eocene, amazing fossils suddenly appear. The genus became extinct towards the end of the Lutetian, less than 20 million years after its appearance. Internal moulds ("stone casts") that have been assigned to the genus on account of their size and shape are known from France, Spain, Belgium, Italy, Hungary, England, North America, Egypt, India, and Pakistan. However, only in a few sites are smaller or larger fragments of the shells, or more rarely, complete specimens, preserved.

The type specimens of those taxa of *Gisortia* that are based on reasonably complete fossils have been discussed by DOLIN & DOLIN (1983), PACAUD & LOUBRY (2005), and most comprehensively, by PACAUD (2008a). All authors agree to reject those names based on internal stone casts, as they cannot be included in a morphological analysis.

The studies conducted by PACAUD & LOUBRY (2005) and PACAUD (2008a) concluded that only two species of *Gisortia* existed during the Eocene of Europe: *G. tuberculosa* from the Ypresian of France and the early Lutetian of England, and *G. coombi* from the Lutetian of France, England, and, in the form of internal moulds, from some other European sites. PACAUD documented the variability observed in the few well-preserved specimens known, and illustrated all of the following (see Pl. 8):

Ovula tuberculosa DUCLOS 1825, Ypresian, early Eocene of Laon, France. Based on a complete, well-preserved specimen.

Cypraea coombii J. DE C. SOWERBY in DIXON 1850, Lutetian, middle Eocene of Sussex, England. A suggestion to declare this oldest available name for the larger-shelled Lutetian species a *nomen oblitum* was rejected by PACAUD (2004). Accordingly, the following names are considered synonyms of *coombii*:

Ovula gisortiana PASSY 1859, Lutetian, middle Eocene of Boisgeloup, France. The holotype is a fragment of a base. This name was formerly in universal use for the species.

Gisortia chevallieri COSSMANN 1886, Lutetian, middle Eocene of Boisgeloup, and Chaumont-en-Vexin, France. The "holotype" is a reconstruction made from two large fragments of different origin. On closer scrutiny it is apparent that many of its structures have undergone some remodeling.

Gisortia gigantea pterophora SCHILDER 1927, Lutetian, middle Eocene of Boisgeloup, France. Based on a nearly complete specimen that was lost for more than a century, and recently re-discovered by PACAUD (2008b), in the collection of the Royal Academy of Natural Sciences, Bruxelles.

On comparing all the available illustrations and specimens, a distinction should be made between the specimens of the Lutetian, middle Eocene, and those from older deposits of Gan, Pyrenées-Atlantiques, France, assigned to the Ypresian (Cuisian), early Eocene. This latter species has never been recognized, and is, therefore, described in the following report. It constitutes perhaps the most bizarre of all cowries, in which the formation of wings, spines, and flanges attains the greatest peculiarity ever recorded. While the holotype is unique in this regard, several less extreme shells are known, whose assignment to the new species is tentative.

Gisortia megaloptera n. sp.

Holotype

Length 236 mm. From La Tuilerie, Gan, France, 43°13' N – 0°23' W, Ypresian (Cuisien), early Eocene.

Deposited in the public collection of the Molluscan Science Foundation, Inc., Owings

Mills, Maryland, USA Reg.-No. fs8899. A data file suitable for printing copies of the shell is available online: http://www.molluscan-science.org/3d/megaloptera.zip.

Further material studied:
Five specimens possibly belonging to the new species from the same locality and period as the holotype were studied: A cast of a specimen in collection GOURGUES, and photographs of four further specimens (after PACAUD, 2008a, 2012, DOLIN & DOLIN 1983, and Piet HESSEL).

Etymology

μέγας (megas) large, πτερόν (pterón) wing (ancient Greek).

Description

The holotype shell is very large and solid (see Pl. 1 for the abbreviations of structures, and Pl. 2 Fig. 3 for how the measurements were taken). The completeness of the specimen exceeds 90 %. Its surface is glossy, indicating it was in a fresh state of preservation when it was embedded. The outline of the dorsum is inflated, pyriform, slightly rhomboidal, and the posterior third is humped. The spire is flat and completely concealed by thick callus. The anterior extremity is solid (a), forming a canal which is slightly curved to the left on dorsal view. Its sides are supported by thick, evenly tapering anterior flanges (b, c).

The greatest longitudinal expansion is 264 mm, measured from the tip of the labral spine to the anterior tip. The actual length of the shell, from its posterior protrusion to the anterior tip is 236 mm. The maximum lateral expansion is approximately 200 mm, but an exact measurement is not possible as the tip of the left wing has been remodeled. The length of the actual shell without protuberances (from the tips of the anterior to the posterior canal) is 205 mm. The height of the dorsal dome (not considering the dorsal wing) is 98 mm, its width 128 mm.

The aperture is narrow, strongly curved to the left posteriorly, hardly wider in the anterior third. The columellar side of the aperture is gently sloping in the posterior half, but steep anteriorly, forming a smooth, slightly projecting fossula 35 mm in length (d). A distinct groove separates the fossula from the curved, narrowly margined terminal ridge, which measures 57 mm in length (e). The columellar margin of the aperture in this area is angular and slopes into the aperture at a right angle (f).

The labrum is thick, broad, and declivous in front. There are 34 labral teeth (l), which are more deeply cut in the anterior third, gradually becoming weaker and more widely spaced towards the posterior. The teeth form shallow extensions across the labral border along the aperture. The left posterior tip (j) is rounded and strongly calloused, and the left part of the posterior extremity does not exceed this structure in length. In the posterior third of the labrum there is a wing-like spine (g) with a length of 90 mm, and a width of 70 mm before it joins a spatulate protrusion of width 33 mm, and a length of 40 mm (h), by which it extends past the comparatively short (28 mm) and narrow (23 mm) posterior extremity (k). The inner margin of this protrusion is bent upwards, forming two thickened denticles (i).

Along the opposite, left side, there is a wing (m) comparable to the labral one (g), measuring approximately 80 mm in length and 60 mm in width at its base (approximately 25 mm of the tip were replaced, marked with grey color in Pl. 1). This wing is joined to the posterior extremity on the left by a flange of 20 mm width (n). The left and right wings are concave dorsally and are joined to the dorsum by a transverse ridge on the left side (p) and a thickened flange on the right (q). Both supporting structures are at a right angle to the base of the wings. The labral wing is up to 22 mm thick, the left wing 16 mm at its insertion area.

The transverse dorsal ridge extends to a spoon-like dorsal wing (r), whose original dimensions are unknown, but at least 50 mm in height and 60 mm width at its base, a figure derived from the existing fragments and the area it was riding from. Adjacent to the dorsal wing, there is a supporting flange (t) and a shallow mid-dorsal tubercle further towards the anterior (u). On the labral (left on dorsal view) side of the dorsal wing, there is a somewhat more prominent tubercle (s), but no transverse flange as on the left side. The base is flattened, the flanges are gently curved upward. In those places where the base rests on the surface, there are areas of 10 mm diameter where the enamel seems to have eroded and been replaced by the animal on a regular basis (v).

Under ultraviolet light, traces of color pattern can be seen, indicating that the shell had darker

stained teeth, narrow transverse stripes on the base and along the callosities left and right of the anterior extremity, and rather large, sparse spots along the margins and on the underside of the wings.

There are several specimens of *Gisortia* from the same locality and period, which show affinities to the holotype of *G. megaloptera* n. sp.:

The closest morphological resemblance is found in a shell owned by DIDIER GOURGUES, of which a copy is in the MNHN R64942, illustrated by PACAUD in 2008a (p. 45 fig. 10 (drawing)) and 2012. Another cast of it is shown here on Pl. 6 Fig. 1. It seems to be a rather complete specimen measuring 193 mm. The dorsum is more inflated and acutely angled in the posterior fourth. The left lateral wing consists of a transverse ridge of 20 mm length. It extends onto the dorsum along is highest part and joins a dorsal flange of height 25 mm and width 40 mm.

As only a cast of the original specimen is available for study it is hard to say if the dorsal wing is original or reconstructed. There is a prominent labral wing which seems to have broken off and been repaired while the animal was alive. The posterior end of the labrum does not seem to be original. The specimen also differs from the holotype of *G. megaloptera* by the position of the dorsal tubercles, which are more pronounced, with the median one situated further towards the anterior and the right one half way between the dorsal and the labral wing. As in the holotype, the labrum is quite distinctly denticulate throughout.

A spectacular sample is a moderately complete, carefully reconstructed specimen measuring 220 mm in the collection of the Fossil Shell Museum, Utrecht, Reg. No. 17375. It is equally inflated as the previous specimen, but has more prominent lateral wings connected to the prominent, pointed dorsal wing by narrow transverse flanges. There is a spatulate posterior protrusion similar to the one in the holotype. Also in this specimen, the labrum is distinctly denticulate. The dorsal tubercles are not visible.

An additional specimen is illustrated by DOLIN & DOLIN (1983). Its dorsal and lateral wings are similar to those of the preceeding 220 mm specimen in the Fossil Shell Museum, and there is also a spatulate posterior protrusion. A weak right tubercle is also present.

The specimen illustrated by PACAUD (2008a) has an enormous dorsal wing and, as in the holotype, there is a prominent left posterior flange connecting the ear-shaped left wing with the posterior extremity (Pl. 7 Fig. 2 herein). The author was unable to study this specimen to determine how much of these structures was original, but judging from the photo, most of them were. A fifth specimen is shown by PACAUD (2014: fig. 2E; Pl. 7 Fig. 1 herein). It has long and broad marginal wings which are oriented backward, and a posterior protrusion. The labrum is also distinctly denticulate, as in all other specimens.

Discussion

All taxa of the genus *Gisortia* based on recognizable type material originate from Lutetian deposits of the Middle Eocene subepoch, from various places in France and one site in England. They share a moderately similar shell morphology in which only the shell's length and minor details in the formation of the protuberances vary. The holotype of *G. megaloptera*, and all specimens tentatively assigned to this new species, originate from the Ypresian of Gan in France. These fossils are at least 5 million years older, and their shells differ in a number of structural features, compared in Table 1.

During this period, the smaller *G. tuberculata* was also rather widespread, and well-preserved specimens are quite readily available. They show discrete dorsal tubercles and a shallow posterior flange, but there are no protuberances as in the larger-shelled *G. coombii* and the new species described herein. As *G. tuberculata* rarely exceeds 120 mm in length, confusion with the other taxa is unlikely (see Pl. 7).

To objectively compare the shells of highly variable species, it is necessary to analyze each conchological feature, to determine which structures are homologous, inherently initiated in the juvenile, and later expressed to different degrees in the adult. In the case of the genus *Gisortia*, the structures of the lateral and dorsal tubercles, spines, or wings are compared, as well as the formation of the posterior extremity and its accessory structures, the formation of the labrum and its structures, and the shape of the posterior tip of the left (columellar) side.

In none of the additional Ypresian specimens, are produced marginal protuberances comparable to

those in the holotype. These shells might represent a second undescribed species of the genus. The holotype is unique in the way the wings and the posterior flanges exceed the posterior end of the actual shell and form antler-like structures that expand the posterior part of the specimen by a shield taking up more than one-fourth of the shell. The differences listed in table 1, however, are independent of the degree to which they are expressed in the individual specimens, and apply to all known specimens.

Table 1: Comparison of *G. coombii* and *G. megaloptera*. See Pl. 1 for the abbreviations of the shell features.

	Gisortia coombii	***Gisortia megaloptera***
Epoch	Lutetian, middle Eocene (41.3-47.8 myr)	Ypresian (Cuisien), early Eocene (53-49 myr)
Aperture	much wider anteriorly	rather narrow throughout
left posterior tip (j)	narrow, pointed	broad, rounded
posterior protrusion (h)	narrow, restricted to the canal	spatulate, bordering the canal, extending to the labral wing (g)
labral wing (g)	isolate, narrow, short	connected to the posterior extremity, broad, very long
right dorsal tubercle (s)	absent	prominent
dorsal wing (r)	absent or indicated as small tubercle	prominent, tall and broad
left transverse ridge (p)	absent	well-developed
left wing (m)	isolate, short, narrow, flat	prominent, very long, broadly spoon-shaped
anterior columellar side	narrow	broader, solid
labral teeth	restricted to the area opposite the fossula, short, or absent	well-developed along the anterior half of the aperture, weaker behind, extending

On examining the holotype of *G. megaloptera*, the question arises as to what kind of habitat these animals lived in. The enormous lateral and posterior expansion on one hand, and the tapering anterior, suggest that the animal dug itself into mud or sand to attach itself on a hard substrate below, which would explain the erosion where its base touched the ground. These areas show traces of repair nacre, indicating that the animal continuously deposited repair callus to cover them. The dorsal wing might have acted as a support to prevent the shell from resting on its back when turned over. These features, along with the solidness of the shell, could be an adaptation to a shallow water habitat with strong surf, an analogy to species of the family Cassidae, e.g. *Cassis cornuta* (LINNAEUS 1758), in which a flat basal shield supports holdfast in a sandy habitat, and dorsal tubercles prevent the shell from resting on its back. A painting by JOM PATAMAKANTHIN depicts a hypothetical animal of *megaloptera* in a sandy habitat with seaweed, in which the shells roam around in search of food, possibly consisting of sponges, echinoderms and other invertebrates (Plate 5). Other individuals can be seen half buried in the sand supported by the lateral flanges. However, all of this is speculation, triggered by the fascination that all of these ancient cowries inspire, and in particular, the holotype of *G. megaloptera*.

Plate 1

Gisortia megaloptera n. sp. Holotype. 1: posterior view; 2: basal view; 3: dorsal view; 4: left view. Reconstructed areas are marked grey. See "Description" for further explanations.

a: anterior extremity
b: right anterior callous flange
c: left anterior callous flange
d: fossula
e: terminal ridge
f: columellar margin of the aperture
g: labral spine or wing
h: posterior protrusion
i: denticles on the margin of the posterior protrusion
j: left posterior tip
k: posterior extremity
l: labral teeth
m: left spine or wing
n: left posterior flange of spine or wing
p: left transverse ridge
q: right flange of spine or wing
r: dorsal spine or wing
s: right dorsal tubercle
t: supporting flange of dorsal spine or wing
u: mid-dorsal tubercle
v: eroded areas

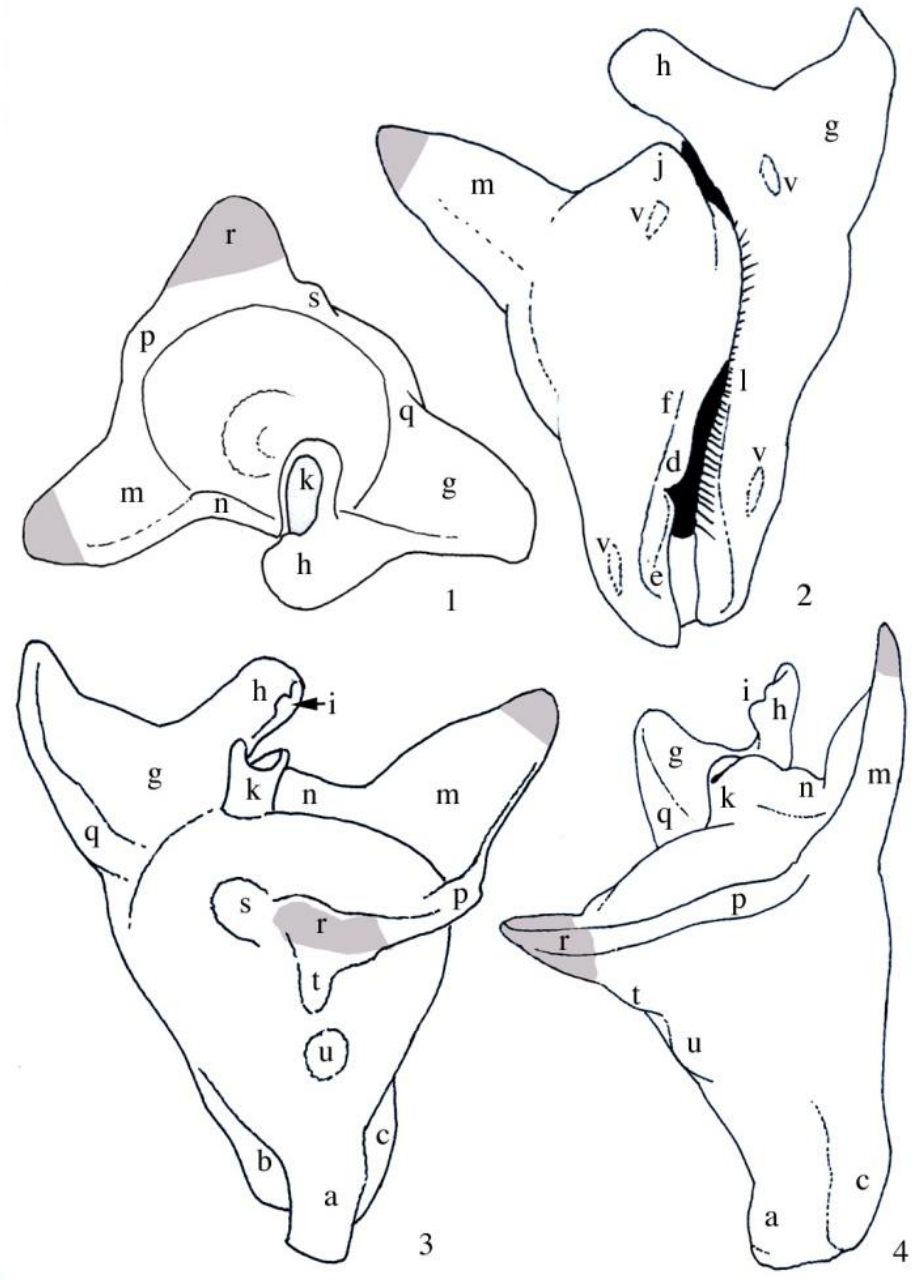


Plate 2

Gisortia megaloptera n. sp. Holotype. Ypresian of Gan, France.

1: dorsal view; 2: posterior view; 3: Dimensions (in mm).

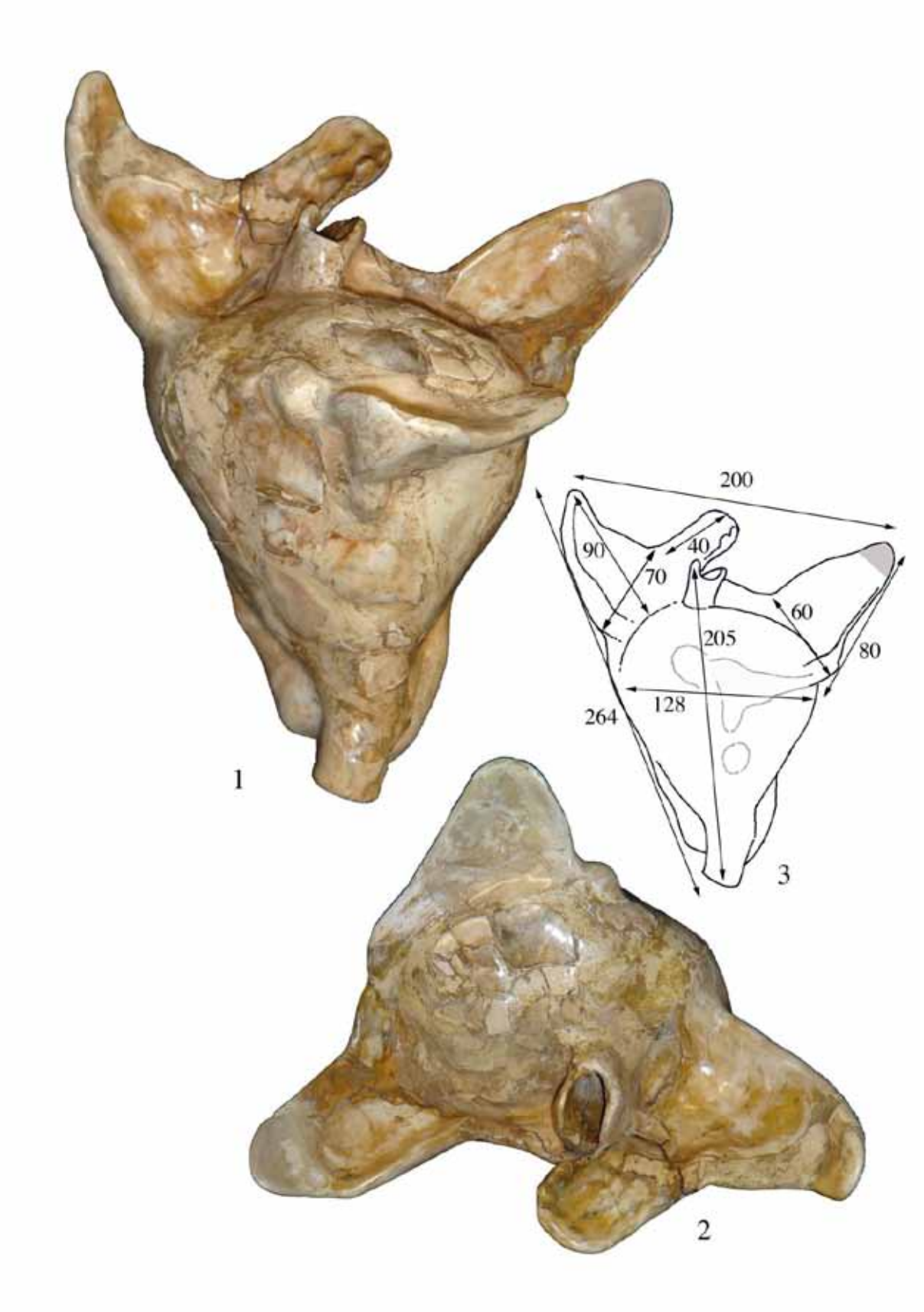


Plate 3

Gisortia megaloptera n. sp. Holotype.

1: basal view; 2: anterior view.

Plate 4

Gisortia megaloptera n. sp. Holotype.

1: left view; 2: labral (right) view.

1

2

Plate 5

"The holotype of ***Gisortia megaloptera***", and reconstruction of its environment as imagined by the Thai artist JOM PATAMAKANTHIN (2017).

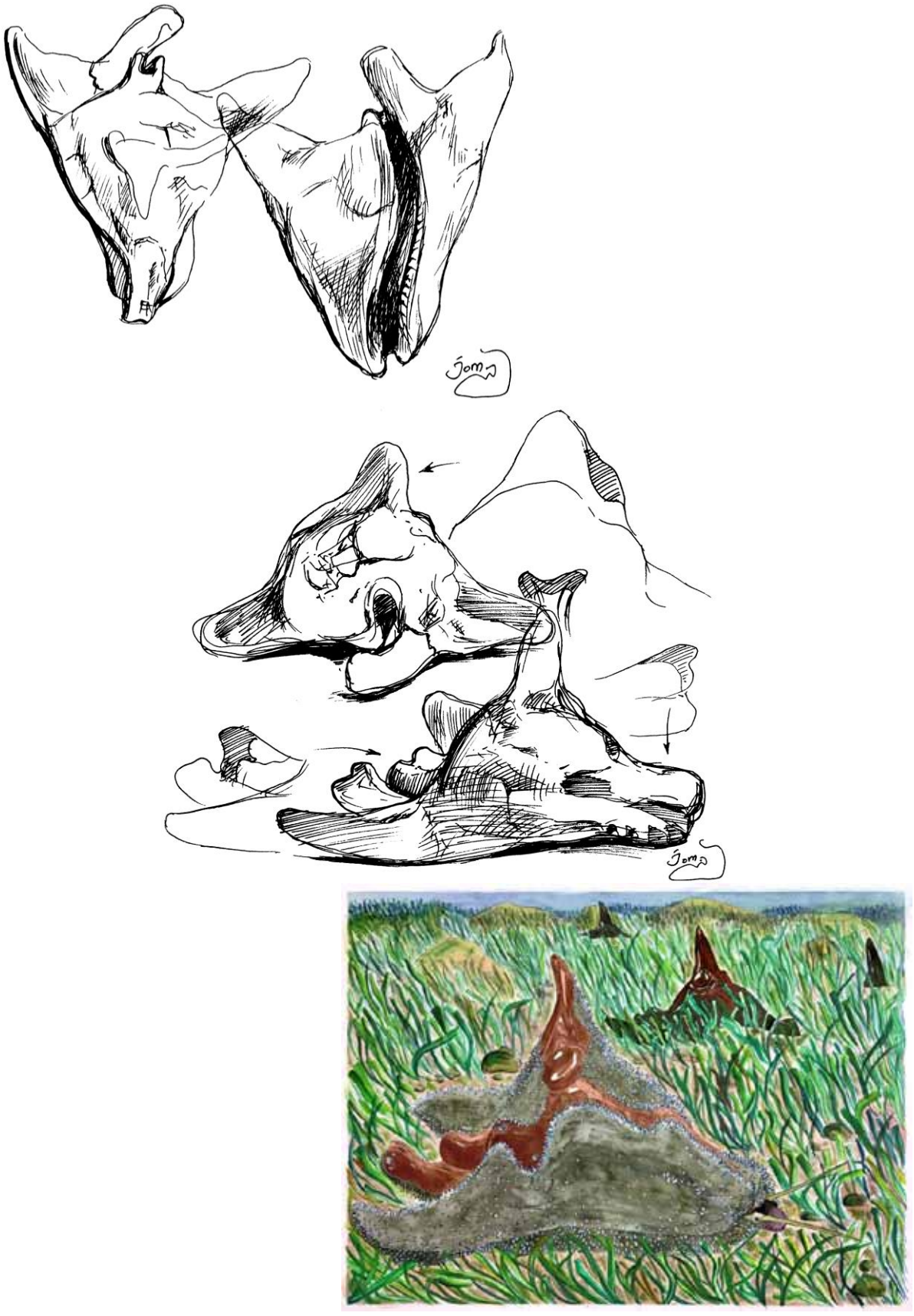


Plate 6

Gisortia cf. ***megaloptera***.

1: 193 mm, Ypresian, early Eocene, Gan, France. Collection GOURGUES, cast.
2: 220 mm, Ypresian, early Eocene, Gan, France. Collection Fossil Shell Museum, Utrecht Reg. No. 17375, photo courtesy PIET HESSEL.

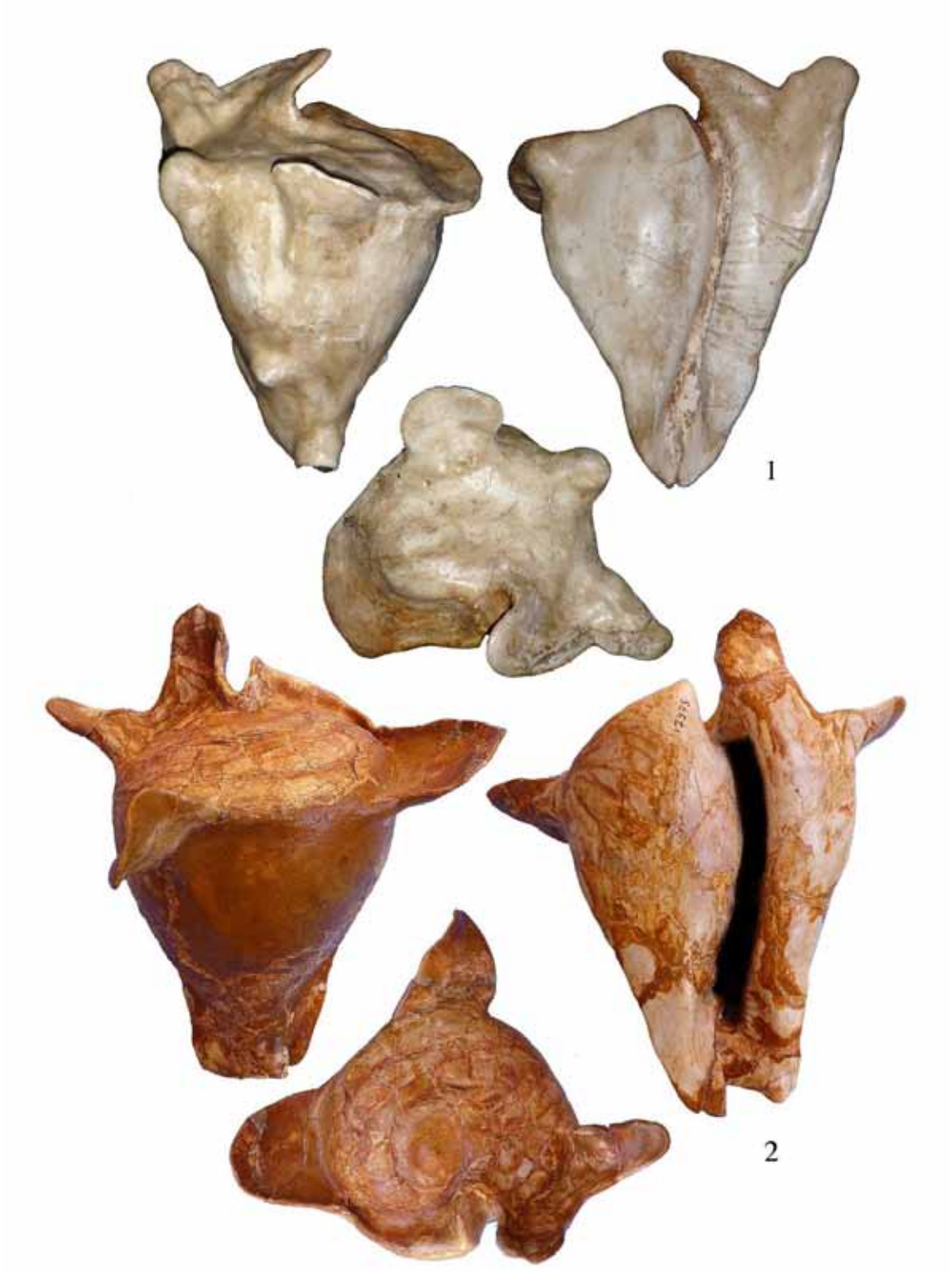


Plate 7

1 ***Gisortia*** cf. ***megaloptera***, 225 mm, Ypresian, early Eocene, Gan, France. Collection GOURGUES. After PACAUD (2012).

2 ***Gisortia*** cf. ***megaloptera***, 175 mm, Ypresian, early Eocene, Gan, France. Collection CHASSAGNE. After PACAUD (2008a).

3, 4 ***Gisortia tuberculata***, 100-110 mm, Ypresian, early Eocene, Soissons, France.

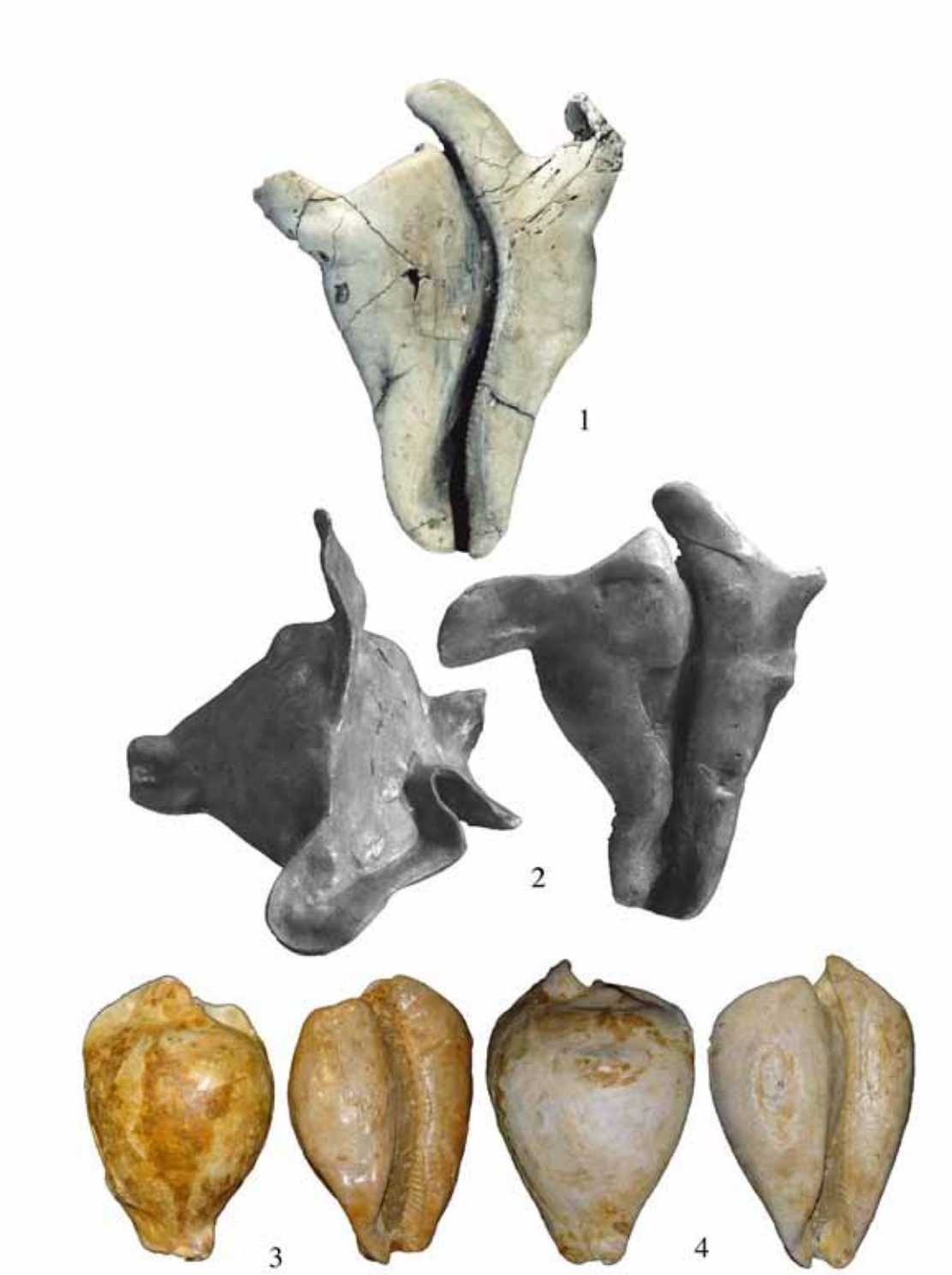


Plate 8

Type specimens and original illustrations.

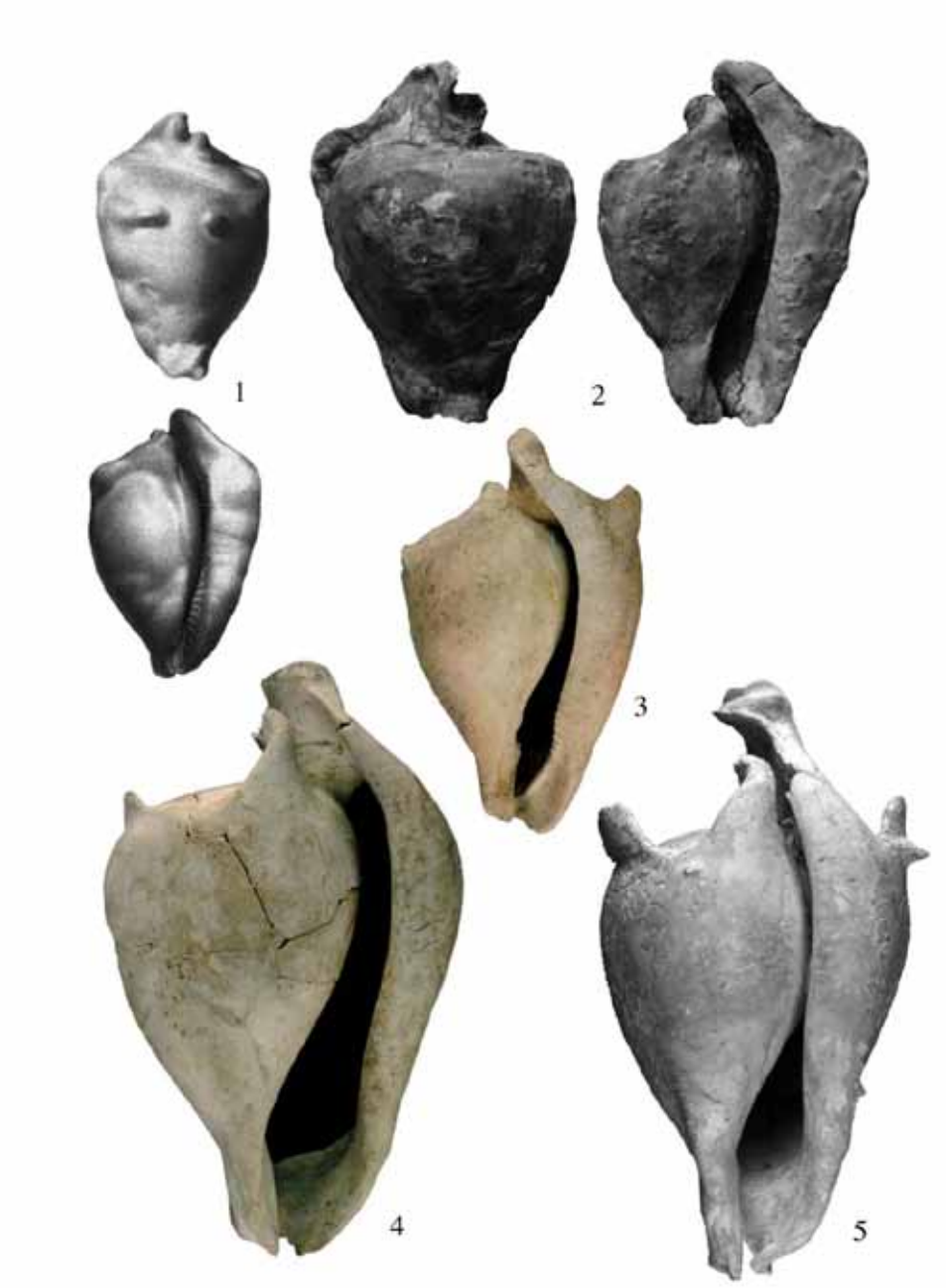
1 ***Gisortia tuberculata***. Syntype. Ypresian, early Eocene, Laon, France. After DUCLOS (1825), and PACAUD (2008a).

2 ***Gisortia coombi***, 166 mm. Lectotype. Lutetian, middle Eocene, Bracklesham Bay, Sussex, England. Collection British Museum of Natural History, London, 71108a. After PACAUD (2008a).

3 ***Gisortia coombi***, 178 mm. Holotype of *chevallieri* (COSSMANN 1885). Reconstructed from two fragments from the Lutetian, middle Eocene, Boisgeloup, and Chaumont-en-Vexin, France. Collection Université Claude Bernard, Lyon, EM 32822. After PACAUD & LOUBRY (2005).

4 ***Gisortia coombi***, 257 mm. Holotype of *gisortiana* (PASSY 1859). Lutetian, middle Eocene, Boisgeloup, France. Collection Université Claude Bernard, Lyon, EM 33142. After PACAUD & LOUBRY (2005).

5 ***Gisortia coombi***, 264 mm. Holotype of *pterophora* (SCHILDER 1927). Lutetian, middle Eocene, Boisgeloup, France. Collection of the Royal Academy of Natural Sciences, Bruxelles, C. I. 6062. After PACAUD (2008b).



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