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"Le monde aurait pu être simple comme le ciel et la mer."

André Malraux

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ABSTRACT

Phasmoconus (P.) rokokorum from Solomon Islands is described and compared with *P. (P.) parius* (Reeve, 1844), *P. (P.) radiatus* (Gmelin, 1791) and *P. (P.) zebra* (Lamarck, 1810) from western tropical Pacific Ocean.

RESUME

Phasmoconus (P.) rokokorum des Iles Salomon est décrit et comparé à *P. (P.) parius* (Reeve, 1844), *P. (P.) radiatus* (Gmelin, 1791) et *P. (P.) zebra* (Lamarck, 1810) de l'ouest de l'Océan Pacifique tropical.

INTRODUCTION

MATERIAL AND METHODS

Taxonomy follows Monnier, Limpalaër, Robin & Roux (2018). We describe shell morphology using the terminology established in Röckel *et al.* (1995) and modified in Monnier, Limpalaër, Robin & Roux (2018).

Adult shells were measured with digital calipers, most of the time the measurements were rounded to 0.01 millimeter. Manuel J. Tenorio performed analysis of the covariance (ANCOVA) for different shell parameters using species hypothesis as factor and shell length (SL as covariate). Additionally, he compared the mean values of SL statistically using t- and U-tests. Statistical tests were carried out using STATGRAPHICS XVII-X64, after all the measurements sets passed the normality tests. Distribution maps were made with Tableau Software using the latitudes and longitudes from the studied specimen data.

REPOSITORIES

MNHN: Muséum National d'Histoire Naturelle, Paris, France.

MHNG: Muséum d'Histoire Naturelle, Geneva, Switzerland.

UCA: Universidad de Cádiz, Cádiz, Spain.

EM: Eric Monnier reference collection, Paris, France.

FP: Fabrice Prugnaud reference collection, Suresnes, France.

LL: Loïc Limpalaër reference collection, Haudivillers, France.

TJ: Thierry Joly reference collection, Saint-Cyr-sur-Mer, France.

CR: Christophe Roux reference collection, Vitry-sur-Seine, France

PL: Philippe Lefebvre reference collection, Bessancourt, France

SL: maximum shell length
MD: maximum diameter
H: height
SH: spire height = SL-AH
HMD: height of maximum diameter
W: shell weight
AH: aperture height
RD: relative diameter (= MD/AH)
V: estimated "model" volume (= SL x MD x H)
RSH: relative spire height (= SH/SL = (SL-AH) / SL)
PMD: relative position of the maximum diameter (= HMD/AH)
RW: relative shell weight 'length' (= W/SL)
RW': relative shell weight 'volume' (= W/V)

RESULTS

SYSTEMATICS

Family CONIDAE Fleming, 1822
Genus *Phasmoconus* Mörch, 1852

Phasmoconus (Phasmoconus) rokokorum sp. nov.
(Plate 1, Figs. 0–15)



Figure 1. Holotype of *Phasmoconus (Phasmoconus) rokokorum* sp. nov. MNHN-IM-2000-35083

Type material: Holotype and 15 paratypes. The holotype is deposited in the Muséum National d'Histoire Naturelle, Paris, France, under the number **MNHN-IM-2000-35083** (ex-Eric Monnier's collection). The paratypes are stored in private collections. (See Table 1 for details)

Material examined: 16 specimens of *(Phasmoconus) rokokorum* sp. nov. have been studied.

Type locality: Solomon Islands.

Distribution and habitat: *P. (P.) rokokorum* sp. nov. has been collected from shallow water (3-25 m) in Solomon Archipelago and Bougainville Island. The new species is probably endemic to these Islands.

Type	Institution	Dimensions – Weight SL x MD x W (mm x mm x g)	Locality
Holotype	MNHN-IM-2000-35083	34.44 x 17.12 x 4.4	Solomon Isl.
Paratype 1	Coll. EM	35.81 x 16.95 x 4.6	Solomon Isl.
Paratype 2	Coll. EM	37.66 x 18.65 x 5.4	Solomon Isl., 3-5 m
Paratype 3	Coll. EM	43.75 x 22.37 x 9.1	Solomon Isl.
Paratype 4	Coll. EM	36.18 x 17.81 x 4.4	Solomon Isl.
Paratype 5	Coll. EM	30.14 x 15.91 x 3.5	Solomon Isl., 10-15 m
Paratype 6	Coll. FP	34.99 x 18.39 x 5.2	Solomon Isl.
Paratype 7	Coll. FP	43.36 x 20.96 x 7.1	Solomon Isl.
Paratype 8	Coll. FP	27.87 x 14.50 x 2.7	Solomon Isl.
Paratype 9	Coll. LL	36.36 x 18.66 x ?	Solomon Isl., 10-15 m
Paratype 10	Coll. CR	26.55 x 12.69 x 1.8	Bougainville, PNG
Paratype 11	Coll. CR	27.52 x 13.32 x 2.4	Makira Isl., Solomon Isl.
Paratype 12	Coll. CR	41.36 x 19.21 x 6.4	Bougainville, PNG
Paratype 13	Coll. TJ	39.60 x 19.70 x 6.4	Santa Isabel Isl., Solomon Isl., 20-25 m
Paratype 14	Coll. TJ	34.06 x 17.15 x 5.0	Santa Isabel Isl., Solomon Isl., 20-25 m
Paratype 15	Coll. TJ	33.30 x 16.30 x 4.4	Santa Isabel Isl., Solomon Isl., 20-25 m

Table 1. Types of *Phasmoconus (Phasmoconus) rokokorum* sp. nov.

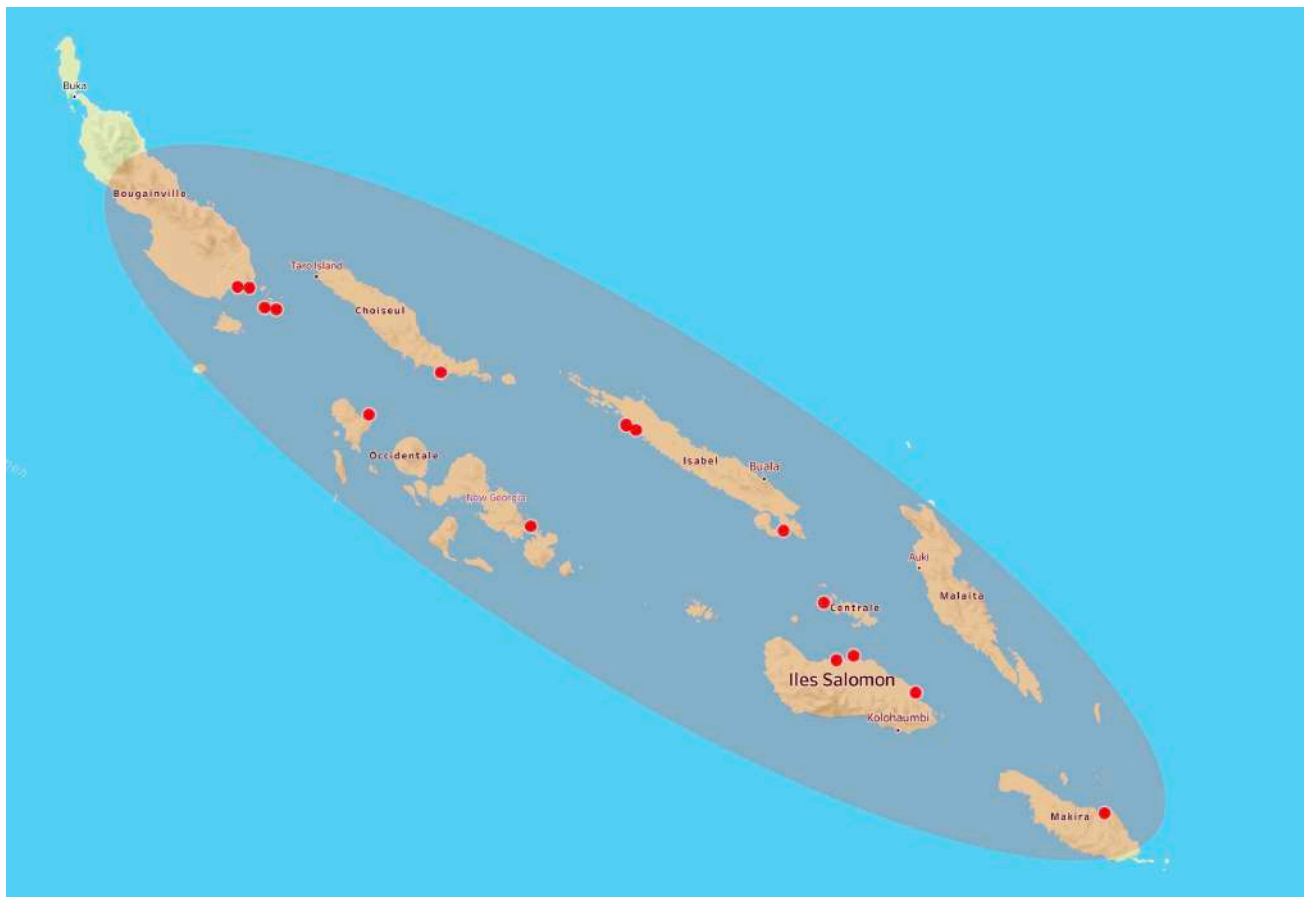


Figure 2. Distribution map of *Phasmoconus (Phasmoconus) rokokorum* sp. nov

Etymology: The new species is formed from the two first letters of the family name of Dr. Röckel Dieter, Korn Werner & Pr. Kohn Alan J..

We honor here the 3 authors of the mythic “Manual of the Living Conidae Volume 1” published in 1995. This book remains an unequaled milestone in the study of Conid biodiversity and it is an always renewed source of inspiration for the authors of the present paper. The species herein described was illustrated in plate 18, fig 4 of the “Manual” as “? *C. parius*”.

Description of the shell of *Phasmoconus (Phasmoconus) rokokorum* sp. nov.

Morphometric parameters:

SL = 26 - 44 mm (mean SL = 35.2 mm); RD = 0.53 - 0.60 (mean RD = 0.56); PMD = 0.77 - 0.87 (mean PMD = 0.82); RSH = 0.07 - 0.13 (mean RSH = 0.11); RW = 0.7 - 2.1 g/cm (mean RW = 1.3 g/cm); RW' = 0.42 - 0.53 g/cm³ (mean RW' = 0.48 g/cm³).

Description:

Shell moderately small to medium sized, ventricosely conical in profile. The shell is moderately heavy to heavy. The protoconch (not observed intact in the examined specimens) is translucent and colorless and is probably paucispiral with less than 2.5 whorls. The shell has about 12 whorls in full adult specimens. Spire is low (mean RSH = 0.11) with a deeply concave outline. The 5 or 6 first teleoconch whorls are piled and detached (Fig. 3 b) and the 3 last ones are juxtaposed. The suture is deep and wide with a linear line. Teleoconch sutural ramps are rather flat with about 5 spiral

grooves and inter-vening ribs and fine radial growth lines and threads.

The shoulder is rounded. The last whorl is smooth with about ten large flat spiral ribs on the abapical part. The profile of the last whorl is convex. The siphonal lip outline is subrounded.

The columellar fold is strong and ivory colored. Columellar lip is straight in the adapical part of the last whorl and almost straight in the abapical one. The aperture lip profile is quite convex and wider at base than near the shoulder. The lip is white colored inside. The outer lip is convex and the profile of the origin of the lip is receding. The ground color of the last whorl is dirty white to cream overlaid with brown axial blotches forming irregular axial lines (rarely regular and almost parallel as in Paratype 11). Some irregular spiral streaks and flecks are also present. The shoulder is always colored by a white band. The color of the first teleoconch whorls is mostly brown in contrast with the translucent white protoconch (Fig. 3) and then becomes progressively white with the brown color limited to a subsutural band and scattered spots.

Living animal and radula:

Even though almost all of the types were collected alive in shallow waters, the morphology of the radula and the DNA of the new species are not yet known. Only the operculum is known: its length represents about 11% of the aperture height. The larval development is probably nonplancetotrophic (in accordance with a probable paucispiral protoconch).

Figure 3. Spires of some paratypes of *Phasmoconus (Phasmoconus) rokokorum* sp. nov



3 a: Paratype 15 33.30 mm, Coll. TJ



3 b: Paratype 2 37.66 mm, Coll. EM



3 c: Paratype 6 34.99 mm, Coll. FP



3 d: Paratype 4 36.18 mm, Coll. EM

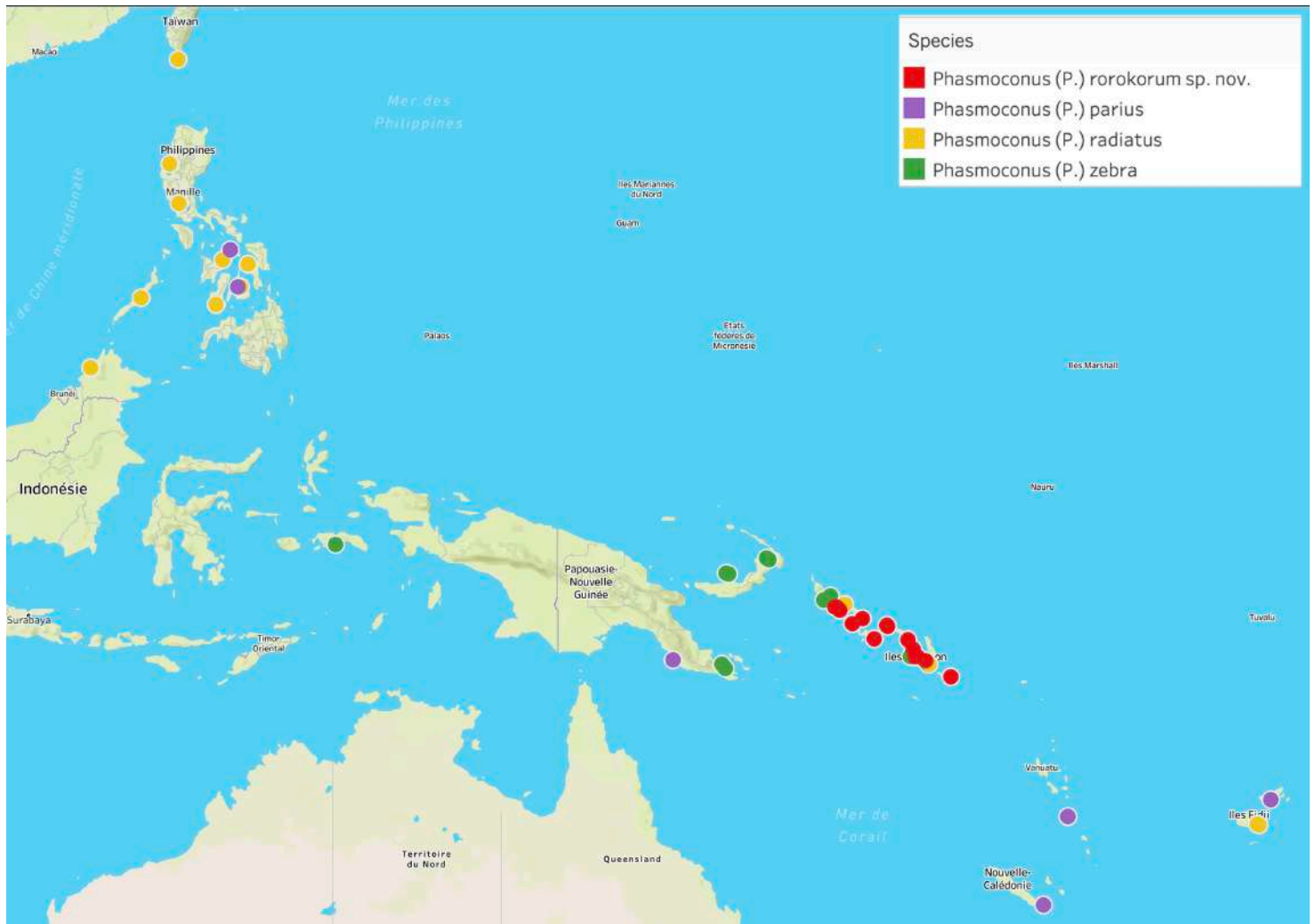


Figure 4. Distribution map of the *Phasmoconus (P.) rokokorum* sp. nov. and 3 relative species.

Figure 4 show the geographical repartition of the *P. (P.) rokokorum* sp. nov., *P. (P.) parius*, *P. (P.) radiatus* and *P. (P.) zebra*, used for this description, in the tropical western Pacific Ocean.

COMPARISONS

Phasmoconus (Phasmoconus) rokokorum sp. nov. can be compared with *P. (P.) parius* (Reeve, 1844), *P. (P.) radiatus* (Gmelin, 1791) and *P. (P.) zebra* (Lamarck, 1810) from western tropical Pacific Ocean.

A. Differentiating features

-1- *P. (P.) parius* (Reeve, 1844)

The original figure of this species is 32 x 18.5 mm, the type locality is not known, the holotype was in the collection of F. J. Stainforth and its present whereabouts are unknown.



Figure 5. *Phasmoconus (P.) parius* figure of the Holotype in Reeve 1844.

Phasmoconus (P.) rokokorum, sp. nov. is reaching a similar size (average size: 35.2 mm with a maximum size SL= 44 mm for the new species instead of an average size of 33.9 mm and a maximum size of 43 mm for *P. (P.) parius*). The new species is more slender (average value of the relative diameter RD = 0.56 versus 0.58 for *P. (P.) parius*), less conoid with an average PMD = 0.82 versus 0.85 for *P. (P.) parius* and with a significantly lower and a slightly more concave spire: average relative spire height RSH= 0.11 versus 0.13 for *P. (P.) parius*.

The new species is separated from *P. (P.) parius* at first sight. The latter is unpatterned with a cream white shell while the new species is strongly coloured with brown axial streaks. The geographical range of the new species seems to be restricted to the Solomon Archipelago and Bougainville Island. This range is nested inside the much wider one of *P. (P.) parius* that lives from New Caledonia, Vanuatu and Fiji to Philippines.

-2- *P. (P.) radiatus* (Gmelin, 1791)

The Lectotype of this *Phasmoconus* designed by Kohn and figured in Martini, 1773, pl. 53, fig. 584, measures 50 x 24 mm. The type locality was designated by Delsaerd (1993) as Luzon Isl., Philippines.



Figure 6. Representation of Lectotype of *Phasmoconus (P.) radiatus* (Gmelin, 1791) in Martini (1773)

Phasmoconus (P.) rokokorum, sp. nov. is significantly smaller, reaching a maximum size of 44 mm versus 110 mm for *P. (P.) radiatus*. The new species is broader than *P. (P.) radiatus* (RD = 0.56 versus 0.53), less conoid (PMD = 0.82 versus 0.85) and with quite a similar height of spire (RSH = 0.11 versus 0.10). *P. (P.) radiatus* is always lighter in weight (RW= 0.34 g/cm³) than the new species (RW'= 0.48 g/cm³). In contrast with the new species, the pattern of *P. (P.) radiatus* is of an almost solid brown color on the last whorl except a white band on the shoulder (as in the new species) and few inconspicuous white spiral bands in some specimens. The pattern of the new species is more complex. The geographical range of *P. (P.) radiatus* starts from Fiji Isl. In the East to S. Taiwan and is roughly similar from that of *P. (P.) parius*. It includes the restricted range of the new species.

-3- *P. (P.) zebra* (Lamarck, 1810)

The Holotype of this species is in MNHN and measures 26.6 x 14.5 mm. The type locality is "Asiatic Ocean".



Figure 7. Lectotype of *Phasmoconus (P.) zebra* MNHN Specimen MNHN-IM-2000-3461 Photo: Reyens C., 2004

Phasmoconus (P.) rokokorum, sp. nov. is slightly larger than *P. (P.) zebra* (average size of 35.2 mm versus 30.4 mm). The shape of *P. (P.) zebra* is rather similar with that of the new species. The new species is very slightly slender than *P. (P.) zebra* (RD = 0.56 versus 0.57), less conoid (PMD = 0.82 versus 0.85) and with a lower spire (RSH = 0.11 versus 0.15). The pattern of this species differs in almost all the specimens with those of the new species by lacking the white band on the shoulder and having a more regular arrangement of axial streaks and spots. In the new species the pattern appears as somewhat blurred in many shells. Nevertheless, the pattern of the new species can be very similar in some specimens (paratypes 10 & 11) to that of *P. (P.) zebra*. The geographical range of *P. (P.) zebra* from Moluccas and PNG to the Salomon Islands is widely sympatric with that of the new species.

Conus nahoniaraensis da Motta, 1986 has a distinct pattern form in which the axial flames are broken in smaller streaks and spots. It is otherwise morphologically identical to *P. (P.) zebra*. The pure white ground colour of the shell differs from the dirty or creamy white seen in the new species. We discuss the status of the different populations of *P. zebra* in the remarks below.



Figure 8. *Phasmoconus (P.) nahoniaraensis* (da Motta, 1986) Holotype MNHG 986.101; 26 x 14 mm; Type Locality: Honiara, Guadalcanal, Solomon Islands. Photo Alan J. Kohn

B. Morphometric study

1. Morphometric statistic study of *Phasmoconus (P.) rokororum* sp. nov. by M.J. Tenorio

The shell length (SL) and the morphometric parameters MD, HMD and SH of *P. (P.) rokororum* sp. nov. (N = 16) were statistically compared to those of *P. (P.) radiatus* (N = 14), *P. (P.) parius* (N = 14) and *P. (P.) zebra* (N = 13).

The shell length of *P. (P.) radiatus* (mean SL of 60 ± 11 mm in the studied samples) is significantly larger than that of *P. (P.) rokororum* sp. nov. (mean SL of 35 ± 3 mm). The differences in shell length are statistically significant, according to pair-wise *t*- ($t = 4.88449$, $p = 0.000038$) and *U*-tests ($U = 12.0$, $p = 0.0000353$). On the other hand, no statistically significant differences in SL were found between *P. (P.) rokororum* sp. nov. and *P. (P.) parius* ($t = -0.820733$, $p = 0.419732$). Comparison with *P. (P.) zebra* yielded significant differences in mean SL ($t = 2.25713$, $p = 0.0323$). However the latter must be taken with much caution, since differences are on the verge of statistical significance, and in fact the *U*-test for differences in median values was non-significant ($U = 59.0$, $p = 0.051$).

We tested for statistically significant differences in MD, HMD and SH among the compared species using analysis of the covariance (ANCOVA) using species hypothesis as factor, the corresponding morphometric parameter as variable, and SL as covariate once all measurements passed the corresponding normality tests. We only found statistically significant differences in the morphometric parameter SH corrected for differences in SL among *P. (P.) rokororum* sp. nov., *P. (P.) parius* and *P. (P.) zebra*. Differences in all other morphometric parameters were statistically non-significant.

Taxon compared	Parameter	F-score	p-value
<i>radiatus</i>	MD	0.25	0.6218
	HMD	0.54	0.4673
	SH	1.22	0.2795
<i>parius</i>	MD	0.93	0.3443
	HMD	0.38	0.5450
	SH*	11.36	0.0023
<i>zebra</i>	MD	2.18	0.1520
	HMD	0.10	0.7580
	SH*	25.07	0.0000

Table 2. Results of the comparison of the morphometric parameters of *P. (P.) rokororum* sp. nov. and those of the indicated by ANCOVA using species hypothesis as factor, the corresponding morphometric parameter as variable, and SL as covariate.

Morphometric parameters with statistically significant differences are marked with * and highlighted in bold characters.

From this analysis we can conclude that *P. (P.) radiatus* definitely has a larger shell length than *P. (P.) rokororum* sp. nov., but the differences in other morphometric parameters are not statistically significant. *P. (P.) parius* and *P. (P.) zebra* can be separated from *P. (P.) rokororum* sp. nov. based upon differences in SH, which is lower in the latter. It can be argued that these differences can be due to systematic erosion of the spire in *P. (P.) rokororum* sp. nov.. However, the ANCOVA on SH using aperture height (AH) instead of shell length as covariate also yielded statistically significant results: $F = 9.76$, $p = 0.0042$ for *P. (P.) parius*; $F = 20.19$, $p = 0.0001$ for *P. (P.) zebra*. Hence, the fact that *P. (P.) rokororum* sp. nov. has a lower spire than *P. (P.) parius* and *P. (P.) zebra* is not an artifact derived from eventual systematic erosion leading to lower SH values. Apart from this, there are basically no differences in shell length among these species.

2. Morphometric parameters for *P. (P.) rokororum* sp. nov. & 3 compared species

Species	Values	SL (mm)	RD	PMD	RSH	RW(g/cm)	RW'(g/cm ³)
<i>P. (P.) rokororum</i> sp. nov.	Our values	26 - 44	0.53 - 0.60	0.77 - 0.87	0.07 - 0.13	0.7 - 2.1	0.42 - 0.53
	Medium value	35.2	0.56	0.82	0.11	1.3	0.48
	RKK*	33 - 41	0.55 - 0.59	0.77 - 0.78	0.09 - 0.12	1.2 - 2.0	-
<i>P. (P.) parius</i>	Our values	28 - 40	0.55 - 0.62	0.80 - 0.92	0.10 - 0.16	1.1 - 2.0	0.4 - 1.0
	Medium value	33.9	0.58	0.85	0.13	1.4	0.55
	RKK	30 - 43	0.53 - 0.63	0.76 - 0.84	0.09 - 0.13	1.0 - 2.0	-
<i>P. (P.) radiatus</i>	Our values	36 - 94	0.49 - 0.58	0.75 - 0.96	0.06 - 0.13	1.1 - 5.8	0.25 - 0.42
	Medium value	60.5	0.53	0.85	0.10	2.4	0.34
	RKK	30 - 109	0.48 - 0.61	0.74 - 0.82	0.05 - 0.11	1.2 - 5.5	-
<i>P. (P.) zebra</i>	Our values	24 - 42	0.54 - 0.60	0.76 - 0.96	0.11 - 0.18	0.50 - 2.1	0.38 - 0.54
	Medium value	30.4	0.57	0.85	0.15	1.01	0.46
	RKK	25 - 33	0.54 - 0.65	0.75 - 0.84	0.10 - 0.17	0.7 - 1.2	-

Table 3. Morphometric and weight parameters including SL, RD, PMD, RSH, RW & RW' for adult specimens of *Phasmoconus (P.) rokororum* sp. nov., *P. (P.) parius*, *P. (P.) radiatus* and *P. (P.) zebra*.

* In the book "RKK" the authors gave values (SL, RD, PMD, RSH & RW) to a population of "? *C. parius*" from Solomon Isl. that fits with our new species

3. Graphical morphometric comparisons

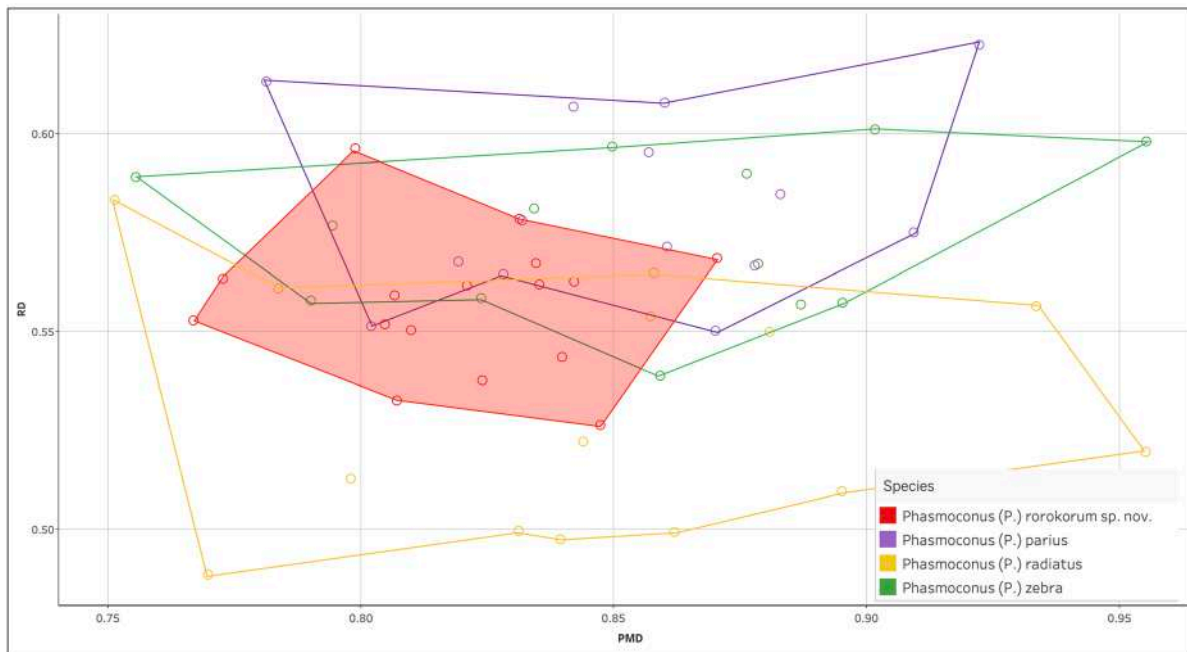


Figure 9. Graph of $RD = f(PMD)$ for 4 species. *Phasmoconus (P.) rokororum* sp. nov. is figured in red color.

Figure 9 shows the plotting area of each 4 species represented on the graph: $RD = f(PMD)$.

It appears that *P. (P.) rokororum* sp. nov. has a central and rather reduced position in this graph, the new species sharing common morphological points with the 3 other *Phasmoconus* species.

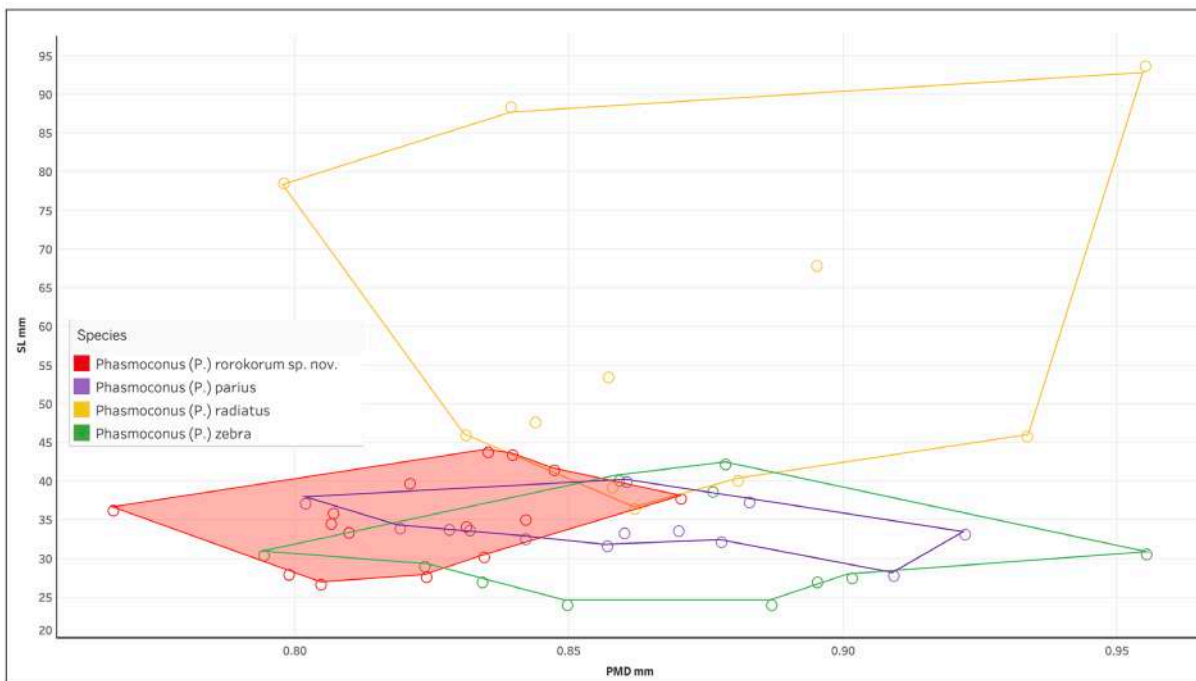


Figure 10. Graph of $SL = f(PMD)$ for 4 species. *Phasmoconus (P.) rokororum* sp. nov. is figured in red color.

Figure 10 shows that the plotting area of the specimens of the 4 related *Phasmoconus* species represented on the graph partially overlap with each other except with the largest species: *P. (P.) radiatus*, the new species having lower values of SL and PMD. The new species broadly overlaps *P. (P.) parius* and *P. (P.) zebra* in SL but its PMD is always lower than 0.87 and is in the average lower than the value of PMD for the two other species.



Figure 11: Comparison of the teleoconch sutural ramps on the spires of *Phasmoconus (P.) rokokorum* sp. nov. and 3 other species of *Phasmoconus*.

Figure 11 allows us to see the details of the spires and of the teleoconch sutural ramps with the spiral grooves of the 4 main species studied. The sutural ramp of *Phasmoconus (P.) rokokorum* sp. nov. presents 6 spiral grooves which is a differentiating factor. *Phasmoconus (P.) parius* has 3 very thin spiral striae barely visible without proper magnification. *Phasmoconus (P.) radiatus* is quite easy to identify with its very well marked broad ribbons with a flat surface containing 5 well-spaced spiral threads. *Phasmoconus (P.) zebra* has a well-rounded and elevated sutural ramp that contains 5 spiral threads.

REMARKS

Previous reports of the new species in literature.

It seems that the first illustration of *Phasmoconus (Phasmoconus) rokokorum* n. sp. was published by the late André Delsaerdt in the first instalment of his revision of the Conidae from the Solomon Islands. He shows a typical specimen of 37 mm x 18.5 mm under the name of *Conus radiatus* (fig. 84 p. 62). In Delsaerdt's latter publications on Solomon Cones, it is not discussed or illustrated anymore.

In page 113 of their Manual, Röckel *et al* suggest that the new species from Solomon Isl. is intermediate in sculpture between *P. (P.) radiatus* and *P. (P.) parius*. They write:

"These shells resemble *C. parius* more closely with respect to morphometry: they differ from both *C. parius* and *C. radiatus* in their last whorl pattern of well-separated brown axial streaks and flames on a white ground. Some specimens show traces of a spiral band within the adapical and abapical thirds. We provisionally assign these specimens to *C. parius* rather to *C. radiatus*."

We agree with Röckel *et al.* opinion that *P. (P.) parius* could be the most closely related species to *P. (P.) rokokorum*, sp. nov. (see the paragraph relative to comparisons) although two of the present authors have presented this new species in Monnier *et al.* (2018) page 721 as *Phasmoconus (P.) aff. radiatus*.

***Conus martinianus* Reeve, 1844** is considered as a synonym of *Phasmoconus (Phasmoconus) radiatus* by most authors. Reeve in its description in *Conchologia Iconica* referred to Martini's figure which is the type figure of *Conus radiatus* Gmelin, 1791. In his "Emendations" (1849) Reeve acknowledged on page 2 that he overlooked the name *radiatus* and that it was the same than his species with the following words: "*C. martinianus*, Reeve, *Conch. Icon. PL. 40 f. 217* described by Gmelin under the name *C. radiatus* to which it is strictly entitled". However *Phasmoconus martinianus* was reintroduced as valid by Tucker and Tenorio in 2013 but without explanation and distinction from *P. radiatus*. We checked the figure of the syntype (in Filmer 2011, online on www.theconecollector.com) that appears to belong to the chestnut colour range of the species and conforms in shape, sculpture, size and structure of the pattern (with the white axial lines) to the current concept of *Phasmoconus radiatus* (Gmelin, 1791).

The taxonomic identity of *Phasmoconus (Phasmoconus) zebra* (Lamarck, 1810).

Another issue is the identity and synonymy of *P. (P.) zebra* and its form *nahoniarraensis* da Motta, 1986. *Conus zebra* remains rather poorly understood. Lamarck described it from a shell without precise locality present in his collection. Kiener gave a fine illustration of the improved (or better said: reconstructed) Lamarck's shell and a comprehensive description. Kohn identified in the MNHN the holotype from Kiener's engraving. But the species remained a kind of mystery for collectors and scholars. As an example, Walls (1979) thought with doubts that it could be a senior synonym of *Ximeniconus ximenes* (Gray, 1839) a species from East Pacific coasts. Shells only started to appear in collections in the beginning of the 1980's. Röckel (card 316, 1982) illustrated two shells from Moluccas

and wrote (translated from German): "Probably Moluccas. It is not yet clear whether similar populations from the Solomon Islands can be assigned to this species". In 1986 Da Motta described *Conus nahoniarraensis* and compared it with *P. (P.) parius*, *P. (P.) pica*, *P. (P.) broderipii* and *P. (P.) collisus* and on the invitation of Dieter Röckel with *Conus zebra*. Da Motta shows two shells that are believed to be *C. zebra* but they are in fact a *Lautoconus ventricosus* (Gmelin, 1791) and one young *Pionoconus magus* (Linnaeus, 1758). He probably missed the match because of that confusion. Gabriella Raybaudi Massilia (1992) wrote a detailed analysis of the confusion in literature and illustrated an impressive bunch of shells from various localities and species. We cannot give a summary of that exhaustive paper. She concluded that *Conus zebra* cannot be identified with any known population of cone snails and should be considered as nomen dubium. André Delsaerdt devoted an important part of his life to the study of shells from the Solomon Islands and specially to the Conidae. In the fifth part of his study (1994) he maintained as distinct species both *Conus nahoniarraensis* and *Conus zebra*. More recently Monnier *et al.* (2018) considered *P. (P.) nahoniarraensis* as a synonym of *P. (P.) zebra* and illustrated shells from various localities showing a continuum of patterns between those typical of the two taxa. We finally remain with several populations that are morphologically identical but with distinct ranges: one appears to live in Moluccas, a second in Southern Papua New Guinea reaching the extreme north of Queensland, a third around New Britain, the form *nahoniarraensis* in Guadalcanal as a fourth one and a final pattern morph in Guadalcanal and Malaita that seems to best match with Lamarck's type. The question of the taxonomic status of these populations remains partly unresolved and the situation may change in the future with more material in hand. Presently, lacking any clear separating features, we keep the Lamarckian name *Phasmoconus (Phasmoconus) zebra* for all of them.

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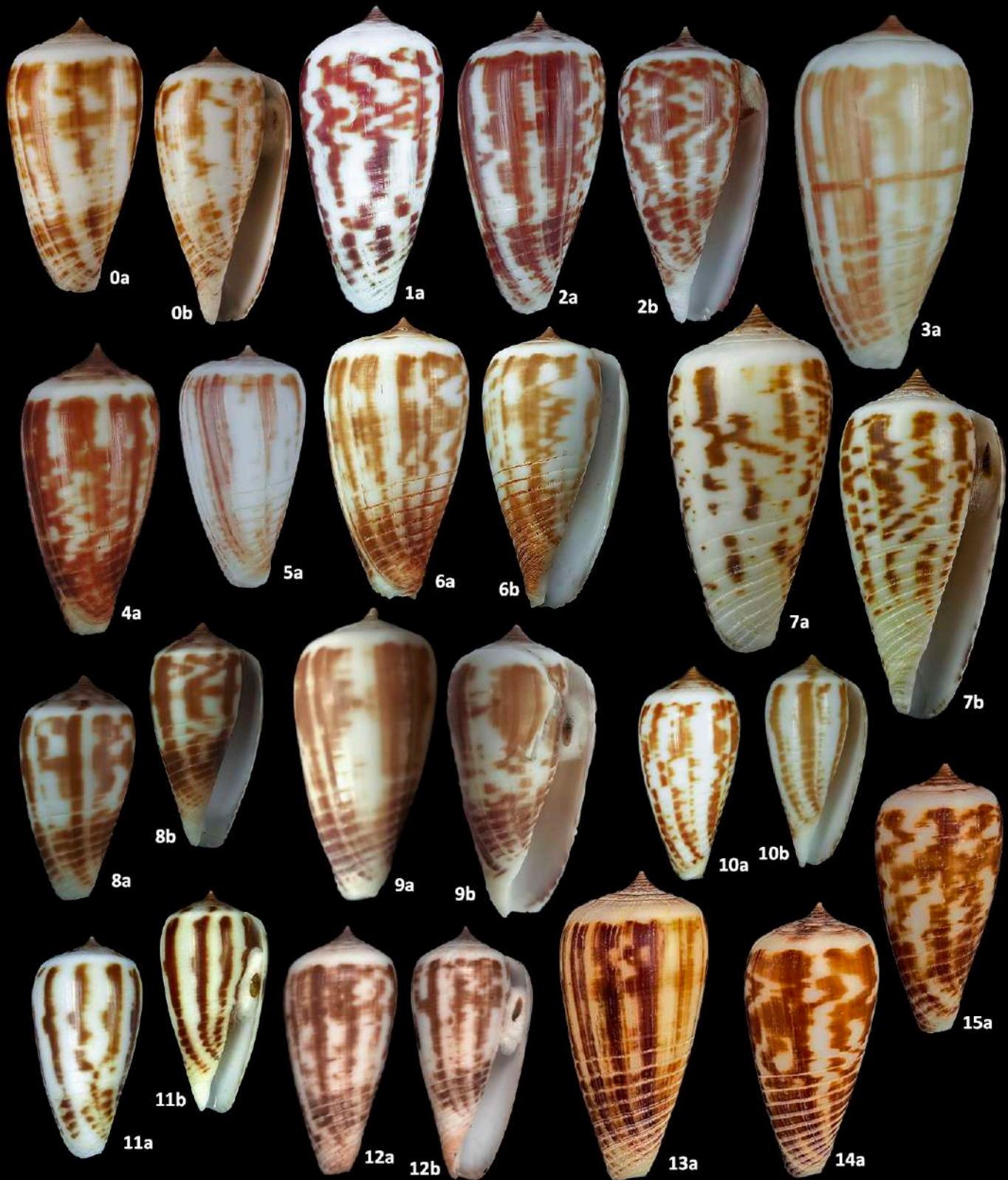
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PLATE 1: *Phasmoconus (Phasmoconus) rokokorum* sp. nov.



0a,b Holotype: 34.44 mm Solomon Islands MNHN-IM-2000-35083

1a Paratype 1: 35.81 mm Solomon Islands Coll. EM

2a,b Paratype 2: 37.66 mm Solomon Islands 3-5 m Coll. EM

3a Paratype 3: 43.75 mm Solomon Islands Coll. EM

4a Paratype 4: 36.18 mm Solomon Islands Coll. EM

5a Paratype 5: 30.14 mm Solomon Islands 10-15 m Coll. EM

6a,b Paratype 6: 34.99 mm Solomon Islands Coll. FP # 4361

7a,b Paratype 7: 43.36 mm Solomon Islands Coll. FP #4362

8a,b Paratype 8: 27.87 mm Solomon Islands Coll. FP #4419

9a,b Paratype 9: 36.36 mm Solomon Islands 10-15 m Coll. LL

10a,b Paratype 10: 26.55 mm Bougainville Island, PNG Coll. CR

11a,b Paratype 11: 27.52 mm Makira Island, Solomon Isl. Coll. CR

12a,b Paratype 12: 41.36 mm Bougainville Island, PNG Coll. CR

13a Paratype 13: 39.60 mm Santa Isabel, Solomon Isl. Coll TJ

14a Paratype 14: 34.06 mm Santa Isabel, Solomon Isl. Coll TJ

15a Paratype 15: 33.30 mm Santa Isabel, Solomon Isl. Coll TJ

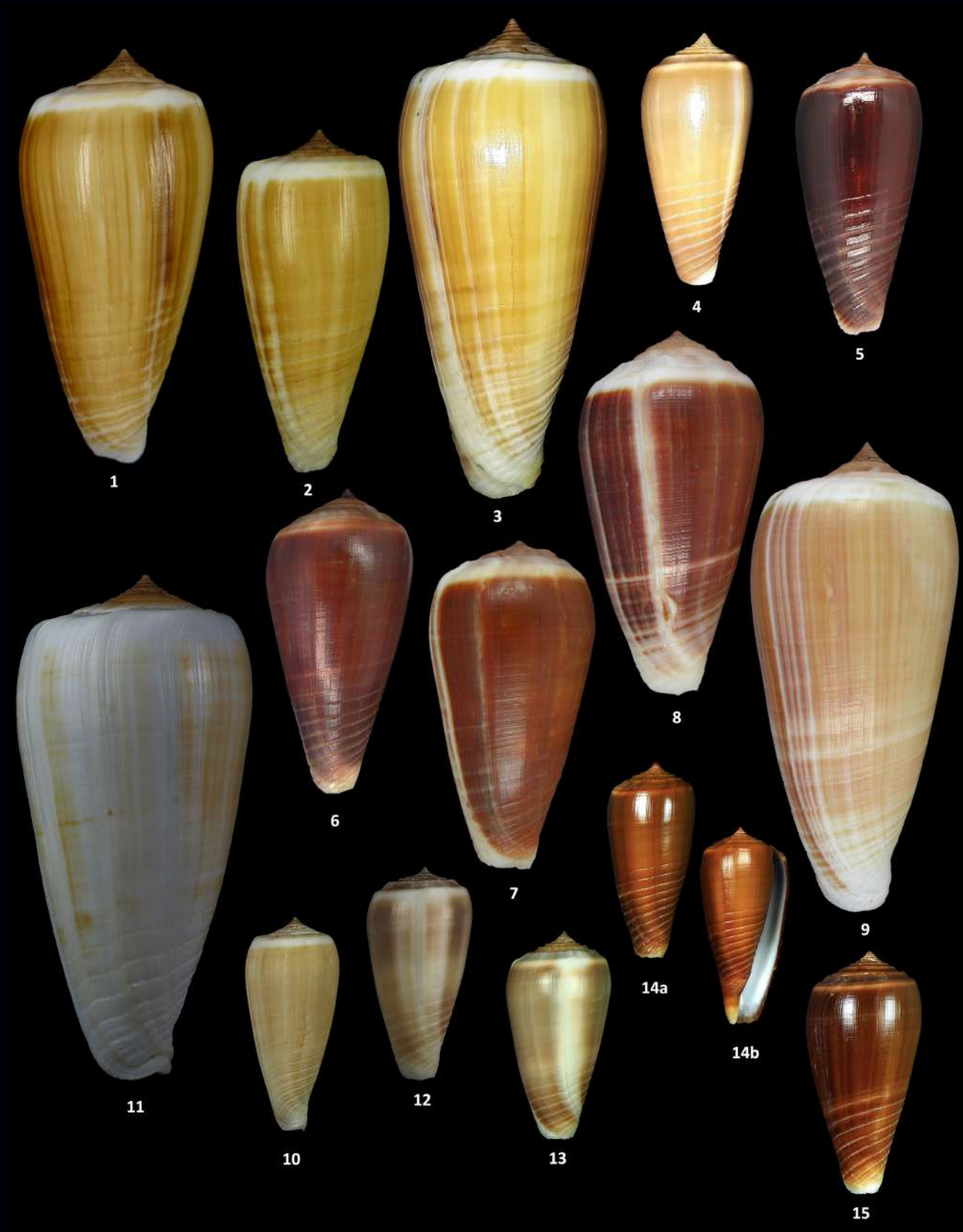
PLATE 2: *Phasmoconus (Phasmoconus) parius* (Reeve, 1844)



- 1 33.24 mm Vate Isl., Vanuatu, 2-6 m Coll. EM
- 2 33.65 mm Vate Isl., Vanuatu, 2-6 m Coll. EM
- 3 37.09 mm Vate Isl., Vanuatu, 2-6 m Coll. EM
- 4 39.85 mm Vate Isl., Vanuatu, 2-6 m Coll. EM
- 5 33.53 mm Vate Isl., Vanuatu, 2-6 m Coll. EM
- 6 37.22 mm New Caledonia Coll. EM
- 7 33.57 mm Papua New Guinea Coll. EM

- 8 32.05 mm Hideaway Isl., Vanuatu 5 m Coll. FP # 4882
- 9 31.57 mm Mactan, Philippines 15m Coll. FP # 2691
- 10 33.07 mm Hideaway Isl. Vanuatu 5 m Coll. FP # 4231
- 11a,b 27.74 mm Vate Isl., with periostracum, Vanuatu Coll. PL
- 12 35.35 mm Vate Isl., Vanuatu, 2-6 m Coll. LL # 5717
- 13 32.50 mm Mastabe Isl., Philippines Coll. CR # 1474
- 14 33.80 mm Vate Isl., Vanuatu, 2-6 m Coll. CR

PLATE 3: *Phasmoconus (Phasmoconus) radiatus* (Gmelin, 1791)



- | | | | |
|---|--------------------------------------|-------|---|
| 1 | 78.46 mm South Taiwan Coll. CR | 8 | 62.05 mm Philippines Coll. EM |
| 2 | 64.50 mm Fiji Islands Coll. CR | 9 | 87.23 mm Philippines Coll. EM |
| 3 | 31.70 mm Vanuatu Coll. EM | 10 | 67.83 mm Negros Island, Philippines 20 m Coll. FP #4668 |
| 4 | 35.40 mm Vate, Vanuatu Coll. EM | 11 | 93.64 mm Marau Sound, Solomon Islands Coll. FP #4363 |
| 5 | 45.90 mm Leyte, Philippines Coll. EM | 12 | 40.02 mm Poroporo Bay, Solomon 10 m snorkel Coll. FP #4659 |
| 6 | 53.37 mm Philippines Coll. EM | 13 | 39.14 mm Borneo, Kota Kinabalu, Malaysia 25m Coll. FP #4232 |
| 7 | 57.77 mm Philippines Coll. EM | 14a,b | 36.37 mm Mosquito Isl., Lami, Fiji, Snorkel 3m in sand Coll. FP #4633 |
| | | 15 | 45.78 mm Olango Island, Philippines 20 m diver Coll. FP #4634 |

PLATE 4: *Phasmoconus (Phasmoconus) zebra* (Lamarck, 1810)



1	26.90 mm Kokomo, PNG 15m Coll. FP #2888	8	30.37 mm Solomon Islands Coll. EM
2	23.91 mm Bougainville, PNG 20m Coll. FP #2889	9	23.91 mm Papua New Guinea Coll. EM
3	27.40 mm Bougainville, PNG 15m Coll. FP #2890	10	26.91 mm Solomon Islands Coll. EM
4a,b	30.52 mm Marau Sound, Solomon Islands Coll. FP #4733	11	28.91 mm Coll. EM
5	38.56 mm New Britain, Bismarck Arch. PNG Coll. EM	12	28.10 mm Solomon Islands Coll. EM
6	40.03 mm New Britain, Bismarck Arch. PNG Coll. EM	13	28.23 mm Papua New Guinea Coll. EM
7	42.13 mm Rabaul, Papua New Guinea Coll. EM	14	30.10 mm Moluca, Indonesia MNHN

* specimens 4, 8, 10 and 12 are often called *P. (P.) zebra* var. *nahoniaraensis*.

Annex 1: Measurements and calculations

measured values
estimated values
calculated values

N°	SL	MD	H Height	AH	HMD	RD	PMD	BSH	W	g/cm	V Volume	RPW + W/V	g/cm3	Repository	Locality
<i>Phasmoconus (P.) rokokorum</i> sp. nov.															
0	34.44	12.12	15.94	30.62	24.70	0.56	0.81	0.11	4.4	1.26	9.49	0.47	0.47	Holotype: MNHN-IM-2006-15083	Solomon Id.
1	36.91	15.84	17.24	32.81	25.69	0.53	0.81	0.11	4.6	1.26	9.61	0.47	0.48	Coll. EM	Solomon Id.
2	37.66	16.95	17.24	32.81	25.69	0.57	0.87	0.13	5.4	1.43	12.11	0.45	0.45	Coll. EM	Solomon Id., 3-5 m.
3	43.75	22.37	20.64	38.92	33.26	0.56	0.84	0.09	9.1	2.06	20.29	0.46	0.46	Coll. EM	Solomon Id.
4	36.18	12.81	16.35	32.22	24.21	0.55	0.77	0.11	4.4	1.22	10.54	0.42	0.42	Coll. EM	Solomon Id.
5	30.14	13.51	14.66	28.05	23.41	0.57	0.83	0.07	3.5	1.16	7.03	0.50	0.50	Coll. EM	Solomon Id., 10-15 m.
6	34.99	18.97	18.62	34.57	28.29	0.54	0.84	0.07	5.2	1.49	10.28	0.42	0.42	Coll. PP	Solomon Id.
7	43.36	20.96	18.62	34.57	28.29	0.54	0.84	0.11	7.1	1.65	16.92	0.42	0.42	Coll. PP	Solomon Id.
8	27.87	14.50	12.51	24.32	19.43	0.60	0.80	0.13	2.7	0.97	5.06	0.53	0.53	Coll. PP	Solomon Id.
9	36.26	18.66	-	34.13	25.60	0.56	0.77	0.09	-	-	-	-	-	Coll. LL	Solomon Id., 10-15 m.
10	26.55	12.69	12.03	23.00	18.51	0.55	0.80	0.13	1.8	0.68	4.05	0.44	0.44	Coll. CR	Bougainville, PNG
11	27.52	13.32	12.72	24.78	20.42	0.54	0.82	0.10	2.4	0.87	4.68	0.51	0.51	Coll. CR	Maiana Id., Solomon Id.
12	41.36	19.21	18.09	36.50	30.93	0.53	0.85	0.12	6.4	1.95	14.37	0.45	0.45	Coll. CR	Bougainville, PNG
13	39.80	19.70	18.20	31.08	28.80	0.56	0.82	0.11	6.4	1.62	14.20	0.45	0.45	Coll. TI	Santa Isabel Id., Solomon Id., 20-25 m
14	34.06	17.15	16.00	29.65	24.65	0.58	0.83	0.13	5.0	1.47	9.35	0.53	0.53	Coll. TI	Santa Isabel Id., Solomon Id., 20-25 m
15	33.30	16.30	15.20	29.65	23.99	0.55	0.81	0.11	4.4	1.32	8.25	0.53	0.53	Coll. TI	Santa Isabel Id., Solomon Id., 20-25 m
Average	35.2					0.53 - 0.60	0.77 - 0.87	0.07 - 0.13		1.3			0.42 - 0.53		
Extremes	26 - 44					0.53 - 0.60	0.77 - 0.87	0.07 - 0.13		0.7 - 2.1					
RKK	33 - 41					0.55 - 0.59	0.77 - 0.78	0.09 - 0.12		1.2 - 2.0					

<i>Phasmoconus (P.) parius</i>															
1	33.24	17.30	16.11	28.46	24.48	0.51	0.86	0.14	4.7	1.41	9.36	0.51	0.51	Coll. EM	Vate Id., Vanuatu, basalt sand, 2-6 m
2	33.65	16.20	15.30	28.70	23.77	0.56	0.83	0.15	4.5	1.34	8.34	0.54	0.54	Coll. EM	Vate Id., Vanuatu, basalt sand, 2-6 m
3	37.09	18.49	17.55	33.54	26.90	0.55	0.80	0.10	5.7	1.54	12.04	0.47	0.47	Coll. EM	Vate Id., Vanuatu, basalt sand, 2-6 m
4	39.85	20.00	19.24	35.00	30.12	0.57	0.86	0.12	7.9	1.90	15.33	0.52	0.52	Coll. EM	Vate Id., Vanuatu, basalt sand, 2-6 m
5	33.53	15.67	15.16	28.48	24.78	0.55	0.87	0.15	4.2	1.28	7.97	0.53	0.53	Coll. EM	Vate Id., Vanuatu, basalt sand, 2-6 m
6	37.22	18.03	18.03	32.38	28.59	0.58	0.86	0.13	7.0	1.85	12.78	0.55	0.55	Coll. EM	New Caledonia
7	33.57	16.51	15.76	28.56	23.76	0.58	0.83	0.15	4.3	1.28	8.73	0.49	0.49	Coll. EM	Vanuatu, 3-4 m, in sand
8	32.05	15.73	13.57	27.76	24.37	0.57	0.88	0.13	3.6	1.13	6.84	0.53	0.53	Coll. PP	Mororan Id., Philippines, 15 m
9	31.57	16.15	14.21	27.13	23.25	0.60	0.86	0.14	3.8	1.21	7.25	0.53	0.53	Coll. PP	Vanuatu, 3-4 m, in sand
10	33.07	17.22	14.83	27.67	25.52	0.62	0.92	0.16	3.8	1.14	8.45	0.45	0.45	Coll. PP	Vanuatu, 3-4 m, in sand
11	27.74	13.38	11.63	23.27	21.16	0.57	0.81	0.16	4.4	1.59	4.32	1.02	1.02	Coll. PL	Vanuatu, 3-4 m, in sand
12	35.35	18.75	17.41	30.55	23.87	0.61	0.78	0.14	-	-	-	-	-	Coll. LL 5717	Vate Id., Vanuatu, basalt sand, 2-6 m
13	32.50	17.41	16.49	28.69	24.16	0.61	0.84	0.12	4.9	1.51	9.93	0.53	0.53	Coll. CR 1474	Mororan Id., Philippines
14	33.80	17.43	16.66	30.71	25.16	0.57	0.82	0.09	5.2	1.54	9.81	0.53	0.53	Coll. CR	Vate Id., Vanuatu, basalt sand, 2-6 m
Average	33.9					0.58	0.85	0.13		1.4			0.55		
Extremes	28 - 40					0.53 - 0.62	0.80 - 0.92	0.10 - 0.16		1.1 - 2.0			0.4 - 1.0		
RKK	30 - 43					0.55 - 0.63	0.76 - 0.84	0.09 - 0.13		1.0 - 2.0					

<i>Phasmoconus (P.) radiatus</i>															
1	78.46	36.06	33.06	70.34	56.13	0.51	0.80	0.10	26.3	3.35	93.54	0.28	0.28	Coll. CR 100812	S. Taiwan
2	64.50	-	-	-	-	-	-	-	-	-	-	-	-	Coll. CR 01348	Fiji Id.
3	88.35	39.10	37.06	78.62	66.00	0.50	0.84	0.11	44.3	5.01	128.02	0.35	0.35	Coll. EM	Marila Bay, Philippines
4	45.50	21.54	20.14	41.27	34.83	0.52	0.84	0.13	7.0	1.47	20.64	0.34	0.34	Coll. EM	Luzon, Philippines, 10-15 m
5	40.90	20.54	19.49	41.12	34.18	0.50	0.83	0.10	6.8	1.48	18.37	0.37	0.37	Coll. EM	Layte, Philippines, 10-15 m
6	53.37	25.96	23.87	46.88	40.19	0.55	0.86	0.12	9.4	1.76	33.07	0.28	0.28	Coll. EM	Layte, Philippines, 10-15 m
7	57.77	29.45	-	52.51	41.15	0.56	0.78	0.09	-	-	-	-	-	Coll. LL 6775	Philippines
8	62.05	32.36	-	55.49	41.69	0.58	0.75	0.11	-	-	-	-	-	Coll. LL 6775	Philippines
9	87.23	38.65	-	79.12	60.91	0.49	0.77	0.09	-	-	-	-	-	Coll. LL 7120	Philippines
10	67.83	31.45	26.87	61.73	55.26	0.51	0.90	0.09	14.6	2.15	57.32	0.25	0.25	Coll. PP	Negros Id., Philippines, 10-30 m, in muddy sand
11	93.64	44.33	38.56	85.32	81.50	0.52	0.96	0.09	54.0	5.77	160.06	0.34	0.34	Coll. PP	Marau Sound, Solomon, 30 m, in muddy sand
12	40.02	20.44	17.81	37.17	32.74	0.55	0.85	0.07	5.6	1.40	14.57	0.38	0.38	Coll. PP	Poroporo Bay, Solomon, 10 m
13	39.34	20.47	17.63	36.25	31.10	0.56	0.86	0.07	5.3	1.36	14.13	0.38	0.38	Coll. PP	Borneo, Kota Kinabalu, Malaysia, 25m
14	36.37	17.12	14.87	34.29	29.56	0.50	0.86	0.06	3.9	1.06	9.26	0.42	0.42	Coll. PP	Mosquito Id., Lamel, Fiji, 3m, in sand
15	45.78	22.63	19.65	40.68	37.98	0.56	0.93	0.11	6.3	1.39	20.36	0.31	0.31	Coll. PP	Clango Id., Philippines, 20 m
Average	60.5					0.53	0.85	0.10		2.4			0.34		
Extremes	36 - 94					0.49 - 0.58	0.75 - 0.86	0.06 - 0.13		1.1 - 5.8			0.25 - 0.42		
RKK	30 - 109					0.48 - 0.61	0.74 - 0.82	0.05 - 0.11		1.2 - 5.5					

<i>Phasmoconus (P.) zebra</i>															
1	12.77	11.09	11.09	22.92	20.32	0.56	0.90	0.15	1.57	0.38	3.81	0.41	0.41	Coll. PP	Kokoro Id., PNG, 15 m
2	12.07	10.40	10.40	20.28	17.19	0.60	0.88	0.15	1.58	0.44	3.06	0.50	0.50	Coll. PP	Bougainville Id., PNG, 20 m
3	13.57	12.02	12.02	22.58	20.36	0.60	0.90	0.18	2.17	0.79	4.47	0.49	0.49	Coll. PP	Bougainville Id., PNG, 15 m
4	30.52	15.01	13.09	25.10	21.98	0.60	0.96	0.18	3.2	1.05	6.00	0.54	0.54	Coll. PP	f. rhombarensis, Marau Sound, Solomon
5	38.56	18.65	18.65	33.63	29.47	0.59	0.88	0.13	6.4	1.66	14.27	0.45	0.45	Coll. EM	New Britain, Bismarck Arch., PNG
6	40.03	18.60	18.30	34.53	29.67	0.54	0.86	0.14	6.3	1.57	13.63	0.46	0.46	Coll. EM	New Britain, Bismarck Arch., PNG, 2 m
7	42.13	20.59	19.65	36.31	31.90	0.57	0.88	0.14	8.8	2.09	17.05	0.52	0.52	Coll. EM	Rabaul, PNG
8	14.70	13.89	13.89	25.49	20.25	0.58	0.79	0.16	2.6	0.86	6.20	0.42	0.42	Coll. EM	f. rhombarensis, Solomon Id., 10 m
9	20.91	11.14	10.50	20.01	17.75	0.56	0.89	0.16	1.2	0.50	2.80	0.43	0.43	Coll. EM	PNG
10	26.91	13.15	12.25	22.63	18.88	0.58	0.83	0.16	2.0	0.62	4.72	0.38	0.38	Coll. EM	f. rhombarensis, Solomon Id.
11	13.34	12.41	12.41	23.89	19.68	0.56	0.82	0.17	1.8	0.74	4.39	0.46	0.46	Coll. EM	f. rhombarensis, Solomon Id.
12	28.10	14.07	-	23.89	18.05	0.59	0.76	0.11	-	-	-	-	-	Coll. LL 5045	f. rhombarensis, Solomon Id.
13	28.23	14.03	-	25.15	19.87	0.56	0.79	0.11	-	-	-	-	-	Coll. LL	PNG ?
14	30.10	-	-	-	-	-	-	-	-	-	-	-	-	MNHN	Moluccas, Indonesia
Average	30.4					0.57	0.85	0.15		1.01			0.46		
Extremes	24 - 42					0.54 - 0.60	0.76 - 0.96	0.11 - 0.18		0.50 - 2.1			0.38 - 0.54		
RKK	25 - 33					0.54 - 0.65	0.75 - 0.84	0.10 - 0.17		0.7 - 1.2					

Records of the Indo-Pacific species *Heliacus implexus* (Mighels, 1845) (Gastropoda, Architectonicidae) established in the Mediterranean Sea

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Keywords

Heliacus implexus, alien, migrant, Mediterranean Sea, Greece

Abstract

The first occurrence and status of the Indo-Pacific architectonicid *Heliacus implexus* (Mighels, 1845) is described for the continental shelf of Central Greece. Comparisons are made with other known species of the Mediterranean Sea and the Indo-Pacific. The species described here exhibits a continuous range from East Africa to Easter Islands inhabiting intertidal waters on colonies of zoanthinarian polyps and is expanding in the Mediterranean Sea.

Abbreviations: CCK -Collection Constantinos Kontadakis, CGB -Collection George Mbazios, CGZ -Collection Giannis Zaminos, CPO -Collection Panayiotis Ovalis, IPR -Infraperipheral Rib, LPR -Lower Peripheral Rib, MB -Mixed Bottom, SD -Shell Diameter, UD -Umbilicus Diameter

Introduction

The family Architectonicidae

Known with the vernacular name of “sundials” the marine gastropod family Architectonicidae Gray, 1850 (or Solariidae Carpenter, 1857) belongs to the “lower heterobranchs” and comprises a still poorly resolved clade within the Gastropoda (Bieler & Petit, 2005). Recent architectonicids exhibit worldwide distribution, mainly in tropical and subtropical waters, at various depths, from the intertidal (e.g., *Heliacus*) to abyssal depths (e.g., *Solatisonax*) with distributional limits defined by the range of suitable coelenterate prey species (Bieler & Petit, 2005). Bieler (1993) recognized nearly 140 species worldwide belonging to 11 genera. They have long-living planktotrophic larvae and often exhibit “local endemism” subsequently grouped in a widely distributed species (Bieler & Petit, 2005). Architectonicids planktic veliger larva is able to drift in near-surface currents and thus to travel long distances (e.g., Robertson, 1964; Scheltema, 1968, 1971, 1979; Scheltema & Williams, 1983). Scheltema (1979) studied plankton samples from the tropical Atlantic and found architectonicid larvae

in approximately 70% of all larval samples. This ability of prolonged metamorphosis enables some species to cross even the East Pacific. As a result, several species appear to extend from the Indo-West and Central Pacific to the American west coast, thus restricting the probability of geographic differentiation leading to speciation, and explaining the wide geographical distribution of most architectonicids such as *Architectonica perspectiva* and *Heliacus implexus* (Robertson, 1976, 1979; Emerson, 1983; Bieler, 1993). Architectonicidae description was given and discussed extensively by Haszprunar (1985) and Bieler (1988, 1992, 1993).

The species *Heliacus implexus*

Synonyms: The species was described under different names (WoRMS). According to Mighels (1845) and Bieler (1993) it is known as the “Hawaiian” *Heliacus implexus* (Mighels, 1845), is known as *H. codoceoe* Rehder, 1980 in the Easter Islands, as *Torinista popula* Iredale, 1936 in Australia, as *H. maorianus* Powell, 1934 in New Zealand, as *H. homalaxis* (Mervill, 1893) in India, and under its two synonyms *H. africanus* Bartsch, 1915 and *H. alfredensis* (Turton, 1932) in South Africa. It shows a high intraspecific range of variation (Bieler, 1993).

Type localities: *Heliacus implexus* has been described from: Hab. Oahu (Hawaiian Islands) as *Solarium implexum* Mighels, 1845; Bombay (India) as *S. homalaxis* Melvill, 1893; Port Alfred (South Africa) as *Heliacus africanus* Bartsch, 1915; Port Alfred (South Africa) as *S. alfredensis* W. H. Turton, 1932; Te Piki, Cape Runaway, Upper Pliocene (New Zealand, Middle Pleistocene 10) as *H. maorianus* Powell, 1934; New South Wales, Sydney Harbour as *Torinista popula* Iredale, 1936; Easter Island as *H. codoceoe* Rehder, 1980 (Bieler, 1993).

Diagnosis: Shell small, disk-shaped to rounded depressed cone-shaped, with narrow to very wide umbilicus; upper-side sculpture of 4 ribs (upper one strongest) with more or less flattened nodules; double-keel formed by 2 ribs, with lower one somewhat weaker; basal sculpture of 6 regular spiral ribs; umbilical side of columellar wall with 1 spiral rib.

Colour yellowish-tan with darker flames, peripheral ribs with tan blotches or flames. Protoconch diameter 0.94-1.40 mm, distinctly heterostrophic, without anal keel (Bieler, 1993).

According to Bieler (1993), in the range of distribution of *Heliacus implexus*, two forms of individuals can be found, one with relatively depressed, wide umbilicus shells, as well as those with more rounded, relatively narrow umbilicus shells. The correlations of large protoconch/wide umbilicus and small protoconch/narrow umbilicus suggest that the teleoconch shape in the species depends upon the protoconch size. It seems that above a certain protoconch size (ca. 1 mm) the postlarval growth continues in a nearly planispiral fashion. The protoconch size correlation is less distinct in other parts of the Indo-Pacific, where smaller umbilicus specimens often have a larger protoconch (Bieler, 1993).

The species is frequently confused with depressed specimens of *Heliacus variegatus* (Gmelin, 1791) and *H. sterkii* (Pilsbry & Vanatta, 1908). The teleoconch of *H. variegatus* has only one midrib (two in *H. implexus*); the shell in *H. sterkii* always has an additional spiral rib between the more widely spaced keel-forming ribs (LPR and IPR) (Bieler, 1993).

Geographical distribution: Continuous range from the African east coast to Easter Islands (Isla de Pascua) (Bieler, 1993).

Habitat: Occasionally encountered intertidally, on colonies of zoanthinarian polyps (mainly *Palythoa nelliæ* Pax, 1935 in South Africa), but major habitat seemingly sublittoral (most records from below 20 m) (Bieler, 1993).

Detailed description of *H. implexus* was given and discussed extensively by Bieler (1993).

While studying the molluscs' biodiversity in the Hellenic seas this unknown to the Mediterranean species was collected. The aim of this work is to add information on the distribution and expansion in the Mediterranean Sea of this species originated in the southern hemisphere.

Material & Methods

Sampling and handling of bottom material and species recognition were conducted according to Manousis & Galinou-Mitsoudi (2014) and Mbazios *et al.* (2020) from May 2019 to October 2020 in various locations of the Hellenic Seas. All *H. implexus* records are listed in Table 1 with collection data and collection areas are shown in Figure 1.

The specimens are deposited in the premises of C. Kontadakis, G. Mbazios, P. Ovalis and G. Zaminos. Scientists are welcome to have access to the biological material for inspection by appointment.

Results

Material examined in this study: Four (4) live individuals and two (2) shells (Fig. 2c, Figs. 3a-d) collected in scattered areas of Saronikos Gulf and NE Ionian Sea (Fig. 1) with their collection details shown in Table 1.

Protoconch: large, heterostrophic, 650 x 945 µm, sinuous varix-forming peritreme, without anal keel, light tan to brown. **Teleoconch:** small, diameter of larger specimen 7.3 mm at 3.15 whorls. **Shape:** round depressed cone with moderately wide umbilicus (UD 20% of SD); early whorls with strongly bulging

base. **Sculpture:** Upper-side: of 4 ribs with flattened nodules, periphery double-keel formed by 2 ribs with the lower one weaker, base with 6 regular ribs increasing in width towards the umbilicus, umbilical side of columellar wall with 1 spiral rib bearing nodules. **Operculum:** higher than wide, characteristic of the genus. **Coloration:** Yellowish-tan with darker flames, peripheral ribs with tan flames.

Discussion

Our specimens identified as *Heliacus implexus* (Mighels, 1845) cannot be mistaken with those of *H. variegatus* (Gmelin, 1791) or *H. sterkii* (Pilsbry & Vanatta, 1908) or even *H. enoshimensis* (Melvill, 1891) because the teleoconch of *H. variegatus* has only one midrib (two in *H. implexus*) while the shells in *H. sterkii* and *H. enoshimensis* always have an additional spiral rib formed between the more widely spaced keel-forming ribs (Rehder, 1980, Bieler, 1993). They are also compared with the ever present in Saronikos Gulf congener *Heliacus fallaciosus* (Tiberi, 1872) of similar size (Fig. 2a, b).

In a publication on the marine alien Mollusca in Italy, Crocetta (2012) characterizes as established an alien species "for which, during the surveyed period, at least a self-maintaining population is currently known to occur in the wild". The statement includes the notions-criteria of a "time lapse" (short or long), "at least one population" and that of "self maintenance" of the population. As the above criteria are subject to several parameters before conclusions are reached, we would take also into account: a. The notion of the density of a population before there are chances of finding and collecting samples e.g. the larger-denser the population the more chances of finding some of its members per fewer efforts; b. The spatio-temporal frequency of sampling; c. The average size of the species e.g. the smaller the species the more chances of being lost during nets drawing; d. The condition of the shells e.g. the better the condition the more recent the animal's death; e. The proportion of the collected live specimens to the shells e.g. the more live specimens per shells, the younger the population; f. The developmental stages of the collected live specimens, e.g. the more developmental stages collected, the more reproducing individuals within a time lapse.

After five decades of search in the Hellenic Seas and two decades in Saronikos Gulf our first finding was that of a shell of *Heliacus implexus* from the Ionian Sea to be followed seven months later by a live specimen from the Aegean Sea, namely Saronikos Gulf. In the next 12 months three more live individuals and a shell were collected from all over Saronikos Gulf in four separate efforts. The specimens collected were from juveniles to nearly mature. Both collected shells were in nearly immaculate condition. Taking into account the parameters above, we are of the opinion that our findings represent a recent expansion of *H. implexus* in the south Hellenic Seas and the establishment of this alien Indopacific architectonicid in Saronikos Gulf.

There are different possibilities for the arrival of *H. implexus* in Greece: a) The possible expansion north of *Palythoa nelliæ* Pax, 1935 - on which *Heliacus implexus* feeds - from the estuaries of the Nile and the north coast of Sinai (WoRMS), b) The prolonged metamorphosis leading to long-living planktotrophic larvae and thus to the ability to drift for long distances autonomously from the Red Sea (Lessepsian migrant),

c. The passive transportation in ships ballast or as hull biofouling of recreational boats/yachts (Floerl & Inglis, 2003; Ulman *et al.*, 2019), d. As epibiont on aquaculture organisms. All the above would render the species an ideal migrant into the ever warming Mediterranean waters. We assume that larvae or even adults of the species had to surpass environmental parameters of the new Mediterranean habitat and also their presence to coincide with the co-migration of their *Polythoa* and/or *Zoanthus* known zoanthinarian hosts – a possibility worth of investigation – or they may have adapted to relative prey species – also in need of study.

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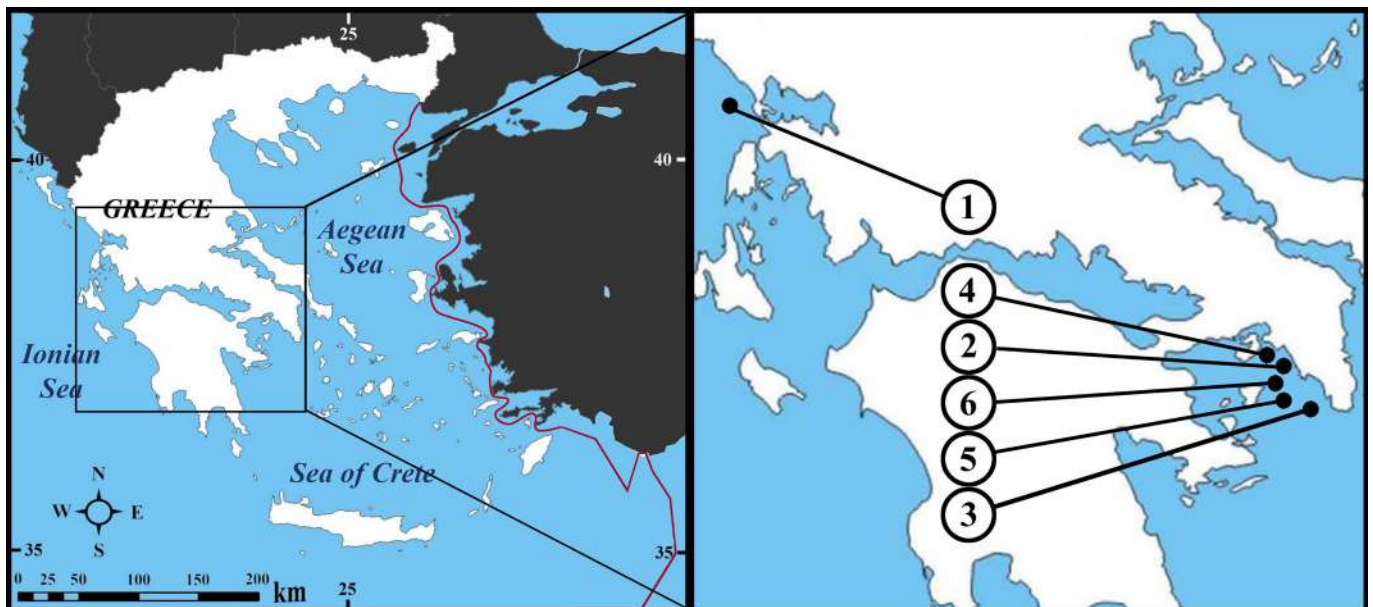


Figure 1. Map of collection areas. Numbers correspond to specimens in the chronological order of collection (see, Table 1)

<i>Heliacus implexus</i> (Mighels, 1845)	Figs.	Maximum	Live	Shell	Bottom	Depth (m)	Area	Global coordinates	Collection	Collector
specimens in chronological order of collection		diameter (mm)			type				date	
1	3a	4.5		*	MB	60-80	Pantokratoras, Preveza	38°94'N - 20°73'E	mai-19	CGB
2	3b	5.9	*		MB	50-70	C Saronikos Gulf, Glyfada	37°51'N - 23°38'E	nov-19	CCK
3	3c, 2c	7.3	*		MB	50-80	S Saronikos Gulf, Palea Fokea	37°42'N - 23°50'E	juin-20	CCK
4	3d	5.4	*		MB	60-70	N Saronikos Gulf, Marina Zeas	37°52'N - 23°35'E	juin-20	CGZ
5	-	3.9		*	MB	50-70	C Saronikos Gulf	37°47'N - 23°43'E	juin-20	CCK
6	-	5.0	*		MB	75-70	C Saronikos Gulf	37°49'N - 23°42'E	oct-20	CPO
<i>Heliacus fallaciosus</i> (Tiberi, 1872), for comparison	2a, b	5.7		*	MB	60-70	Saronikos Gulf			CCK

Table 1. Table of collection data

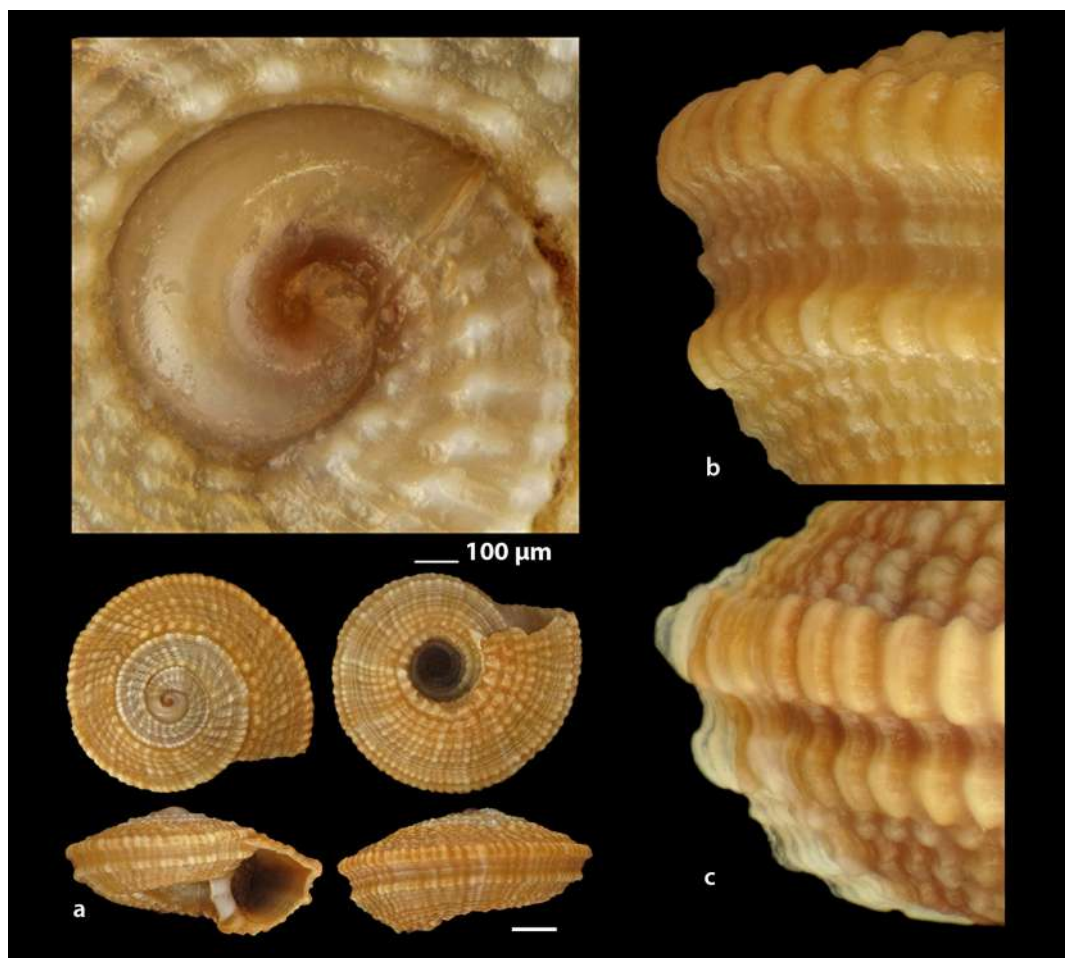


Figure 2. a. *Heliacus fallaciosus* (Tiberi, 1872), b. *H. fallaciosus* detail of periphery, c. *H. implexus* detail of periphery. Barr = 1 mm, unless otherwise indicated



Figure 3. a-d. *Heliacus implexus* (Mighels, 1845): a. Specimen 1, b. Specimen 2 and operculum, c. Specimen 3, d. Specimen 4. Barr = 1 mm, unless otherwise indicated.

***Notocochlis gualteriana* (Récluz, 1844)** Study of morphological variations and critical review of synonymy

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Abstract. The species *Notocochlis gualteriana* (Récluz, 1844) has a very wide distribution throughout the Indo-Pacific region. It has been found from East African coast to Hawaiian and Polynesian areas. Its morphological proximity to a species from the Atlantic area, *Natica marochiensis* (Gmelin, 1791) has caused many confusions for a very long time. It is now proven that the two species are different, but some described since 1844 Indo-Pacific species are synonymised with *N. gualteriana* and many authors since the 1970s do not agree with them. Some specimens are obviously incorrectly identified in conchological books, on websites as well as occasionally in museums. The purpose of this paper is therefore to summarize all of proposed during this period synonyms and to provide a critical review. This work is based on the study of morphological variations in the shell of the species, but also on anatomical data and phylogenetic studies available.

Résumé. L'espèce *Notocochlis gualteriana* (Récluz, 1844) a une très vaste répartition dans tout le domaine Indo-Pacifique, des côtes Est Africaines jusqu'à Hawaï et en Polynésie. Sa proximité morphologique avec une espèce du domaine Atlantique, *Natica marochiensis* (Gmelin, 1791) a longtemps provoqué de nombreuses confusions, aujourd'hui réglées pour ces deux espèces. Il y a cependant aussi beaucoup de synonymes avec des espèces du domaine Indo-Pacifique, et les auteurs successifs, depuis les années 70, ne sont pas tous d'accord sur ces synonymies. Un certain nombre de spécimens visibles sur différents sites internet ainsi que dans des guides d'identification et même des exemplaires de musées sont ainsi mal identifiés ce qui entretient une confusion regrettable. Cet article a donc pour but de récapituler les synonymes proposés depuis cette époque et d'en livrer un examen critique à partir d'une recherche des variations morphologiques de la coquille de cette espèce, mais aussi des données anatomiques et des études phylogéniques disponibles.

List of abbreviations.

CNP : Author's collection.
MA : Auckland Museum.
MNHN : Muséum National d'Histoire Naturelle. Paris.
NHMUK : National History Museum United Kingdom. London.
UCBL-EM : Université Claude Bernard Lyon – Ecole de Mines.

Original description of the species

Natica gualteriana.

Nat. Testa subovata, semigloboso-acuta, tenui, subepidermide fusciscente albida, punctis quadratis spadiceis obsoletisque decurrentibus ornata ; anfractibus ventricosis, ad suturam longe et crebre striatis, fascia alba circumdatis ; spira conico-acuta ; apertura dilatata, basi subproducta et angulosa ; umbilico parvo ; funiculo semiovato, supra oblique plano, umbilicum et canalem valde occultante.

Var. β . Testa minor, fasciis punctorum in medio ventris ultimidubus.

Hab. "Sual, province of Pangasinan, island of Luzon ; found at five to seven fathoms, on sand." H. Cuming.

Long. 12 ½ mill. ; larg. 12 mill. Convex. 9 Mill. Ouverture : long. 10 mill. ; larg. 6 mm. Spire, haut. 5 Mill. Naticae maroccanæ Chemnitzii proxima.

Récluz describes a fairly globular, thin, brownish-white shell with tight streaks along the suture which is surrounded by a white area. Decurrent brown-red square spots adorn the surface.

The spire is sharp conical. A funicle almost close the small umbilicus. β variety is smaller and has two bands of points in the middle of the last whorl. Morphological proximity to *Natica maroccana* from Chemnitz, *Natica marochiensis* (Gmelin, 1791) is also mentioned. The shell comes from Luzon island, Philippines.

In 1850, Récluz described the species again in the «Journal de Conchyliologie» (without reference to its previous description). The Shell is from the island of Bohol, Jacna (currently Jagna, Bohol, Philippines). He obviously described only the β variety, its shell is small (7 mm high by 6 mm width) milky white with sub-sutural streaks. The lowered conical spire is entirely white. Umbilicus is narrow and deep with a spiral callus. No figure is associated, both in 1844 and in 1850. Reeve provided one in 1855 (Species 114 of Conchologia Iconica) see figure 1 which corresponds to the variety β exclusively as demonstrated by the location (Bohol) and brown-red bands interrupted on the last whorl, as well as the reference to the «Journal de Conchyliologie», 1850. Philippi (1852) also represents a very close shell coming from the Philippines, see figure 2.



Figure 1. *Natica gualteriana*
Reeve (1855) Sp 114. Philippines



Figure 2. *Natica gualteriana*
Philippi (1852) Taf 11 Fig 8. Philippines

These two successive descriptions by Récluz actually show colour differences usually found between juveniles and adults of the species. Figure 3 illustrates the changes that occur between the two stages on specimens from Rodrigues Island (Mascarenes). Neither description gave information on the operculum.



Figure 3. *N. gualteriana*. Specimens from Rodrigues Island. (6.4, 9.4, 11.9, 12.1 and 13.8 mm)

Study of the main morphological variations of the species

Note on the use of the morphological characters of the shell

Bouchet & Warén (1993) pointed out that the classification of Naticidae is problematic. The long geological history (since the Triassic period for the authors) as well as the way of life (sediment-dwelling drilling predators) having very probably generated evolutionary convergences for many characters. The difficulties in studying the soft parts of the animal which contracts fully in the shell after death are an additional challenge in establishing a classification.

Bouchet have also showed (1989) that the mode of larval development (planktotrophic or non-planktotrophic) is a specific characteristic of the Prosobranchs and Opisthobranchs gastropods. Following this work, Solsona & Martinell (1999) used the characters of the Protoconch to differentiate species having a similar teleoconch. Protoconch characters (morphology, number of whorls, dimensions) are acquired before the metamorphosis and are therefore directly related to the larval development mode, which can be considered as a specific character. When teleoconches are similar, the use of relationships between the dimensions of adult shells are difficult to use, and should be not significant, the differences observed could be specific or simple intra-specific variations between geographically different populations. However, they stated that the operculum and umbilicus characters have sometimes been used successfully to differentiate genera and species.

Huelsken & al. (2012) established, for species of the genera *Polinices*, *Neverita*, *Euspira*, *Conuber*, *Mammilla* and *Tectonatica*, molecular phylogenies and a phylogeny based on 28 morphological characters conventionally used in the classification of genera and species of Naticidae. The comparative study of the phylogenies shows that, at the genus level, only 5 of the 28 anatomical characters are relevant and seem to correspond to synapomorphies. If only the species of the genus *Polinices* are taken into account, only three characters probably correspond to synapomorphies: the color of the protoconch, it's number of whorls and the color of the operculum. All the other characters (relationships between the dimensions of the teleoconch, umbilicus, general shape, color, configuration of the umbilical or parietal callus) show significant intra-specific variations, with more often important differences between juveniles and adults.

The foregoing leads to use these characters with extreme caution. In this study, there is of course no question of exclud-

ing a priori all the anatomical characters of the teleoconch, but they will be used carefully and combined as much as possible with molecular data (when available) and the characters of the protoconch (when they are known).

The observations and measurements were made on 82 specimens identified a priori as *N. gualteriana* by the author, the collector or the merchant. (2 in 82 have been then excluded because of protoconch features). Geographical origins are as diverse as possible: East Africa (Kenya, Mozambique, Tanzania, South Africa, Mayotte), West Indian Ocean (Madagascar, Seychelles, Reunion, Rodrigues), Red Sea (Egypt), Indo-Pacific (Thailand, Philippines, Australia, New Caledonia), Hawaii. The dimensions of the shells are measured (to the nearest 0.1 mm) with a digital caliper, weighed (empty, without the operculum) at precision balance (accurate to 1/100 g). The protoconchs are photographed with a binocular magnifier (with digital camera). The radula of one specimen from Rodrigues Island have been photographed with microscope with digital camera, after dissection under magnifier and microscope (x40) and inclusion in resin Eukitt®.

Protoconch:

57 shells have the apex which is sufficiently intact to observe the protoconch in its entirety. All show a dark brown suture and a fairly variable diameter, from 670 to 940 µm (mean 830 µm). 50 protoconchs have kept the nucleus. Embryonic shell consists of 2.6 to 3 whorls (mean 2 ¾). Diameter of the first embryonic whorl is 190 +/- 30 µm. Nucleus is reddish brown, then the colour gradually changes to white. The limit with teleoconch is fairly clear. Figure (5) The worn shells show a reddish brown protoconch colour.

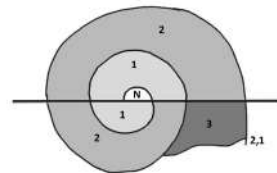


Figure 4. Counting Method for Protoconch features. N : nucleus.

1, 2, 3 : embryonic whorls

Here the protoconch is made of about 2,1 whorl



CNP-2020-074. Egypt

CNP-2019-05. Thailand



CNP-2019-094. Australia

CNP-2007-003 worn

Figure 5. Protoconch of *N. gualteriana*. Scale bar : 500µm

Sizes and sizes ratios:

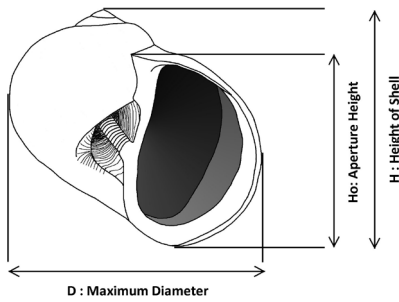


Figure 6. Measurement method

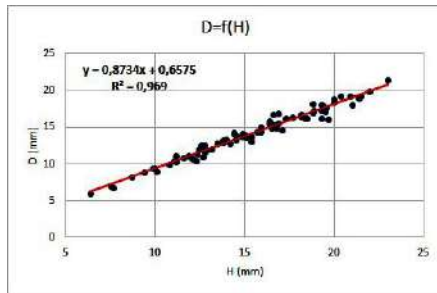


Figure 7. Maximum diameter (D) as a function of height (H)

Total height varies from 6.6 to 23 mm in this study. Cernohorsky (1971) gave an interval of 8 to 25 mm.

Maximum diameter varies from 6 to 21.4 mm. Height of shell and Maximum diameter distributions follow a normal distribution. There is a correlation between these two sizes: $D = 0.875 \times H + 0.635$. ($R^2 = 0.9689$). Figure 8. The ratio H/D varies between 1 and 1.25, regardless of the size (and therefore the age) of the shell. (Figure 9)

The ratio Ho/H ratio varies between 0.59 and 0.88. It decreases with the age of the shell since it varies between 0.73 and 0.88 for specimens under 15 mm in height, and between 0.59 and 0.82 for those over 15 mm in height. (Figure 10)

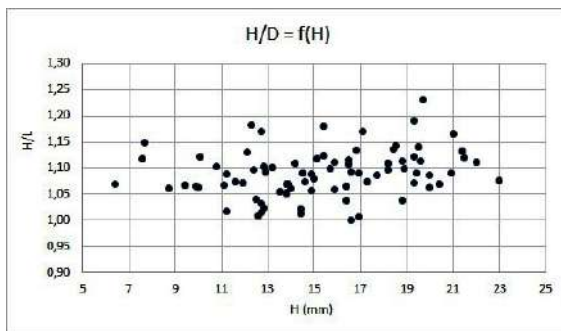


Figure 8. Ratio H/D as a function of height (H)

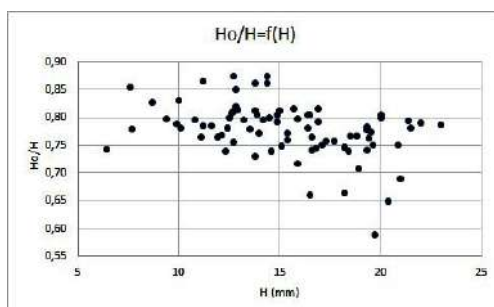


Figure 9. Ratio Ho/H as a function of height (H)

Mass of shells:

The masses measured are between 70 and 3190 mg. This mass increases of course with the size of shell, these two factors being connected by the function $M = 0.144 H^{3.16}$ ($R^2 = 0.9383$).

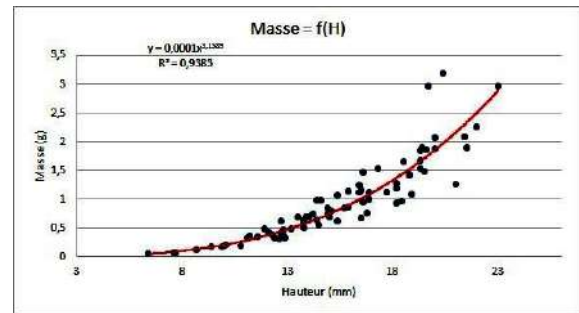


Figure 10. Mass as a function of height (H)

Colours and patterns:

The base is always white and there is most often a white (sometimes inconspicuous) subsutural band. First whorls very often have wavy grey to brown streaks. The background colour varies from light grey (almost white) to reddish brown, some specimen may be olive brown. The shell can have one or more lighter spiral bands (sometimes white). There can also be transverse bands, continuous or interrupted by the spiral bands (Figure 11). These transverse bands can be straight or sometimes wavy. The shells of the youngest specimens almost systematically show two or three spiral rows of brown to reddish wavy lines. These patterns are often noticeable at the top of the spire of the adult shells (Figure 11)

Aperture:

Aperture semi-lunar, the internal colour varies from dark brown (with one or more lighter or white bands for the darkest shells) to white stained with brown for the lighter ones.

Sculpture:

The sculpture is made of fine growth lines. There are always fairly sharp subsutural folds. On the last whorl, their number (generally more than twenty) but also their width and thickness can considerably vary. On the first two whorls of the teleoconch, these folds can be quite wide and deep near the suture and then become less visible. The number of folds varies from 7 to 21 for the first whorl (mean 13), and from 13 to 30 for the second (mean 21). (Figure 12)

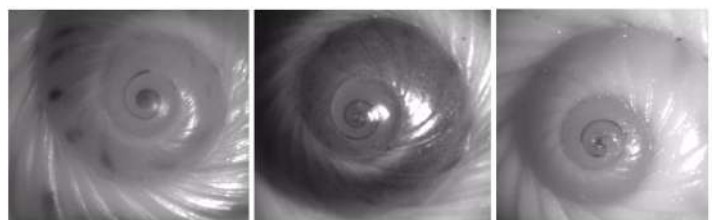


Figure 12. subsutural folds on first two whorls



Figure 11. Shapes, colours and patterns of *N. gualteriana*

Umbilicus :

A large part is closed by a white umbilical callus extended by a funicle which sinks into the anterior part of the umbilicus. It often only remains of the latter a fairly narrow posterior sulcus. Kilburn (1976) notes the possibility of a fully closed umbilicus for some specimens. (Figure 13)

Callus :

Parietal and umbilical callus are white, but the other characteristics vary widely. The parietal callus can be thick or sometimes a little thinner, thus the pattern of the shell is visible through the transparent material. It is generally separated from the umbilical callus by a wide notch, which can be very reduced in some specimen, the two callus can even be merged. (Figures 11 and 13)



Figure 13. Umbilical area of *N. gualteriana*

Operculum :

Cernohorsky (1971) (from specimens from the Fiji Islands) describes a white, calcareous operculum with a single marginal rib. His figures show that this rib can be bordered by a more or less developed furrow. Kilburn (1972 and 1976) confirms the presence of this unique marginal rib for the species, including for South Africa and Mozambique specimen. Features consistently present are the following: White calcified operculum with yellowish inner horny layer, completely filling the aperture. One marginal rib bordered by an internal groove of variable width. The nucleus has a slight brownish grey raised area. (Figure 14)



Figure 14. Operculum of *N. gualteriana*

Radula :

Cernohorsky (1971) gives the following description: «The rachidian of the radula is tricuspid, the basal cusps are mounted on a shield and the lateral has 7 cusps ; the inner marginal is bifid and the outer marginal simple. » Figure 15 This organization is consistent with that observed on specimens from Rodrigues Island. (Figure 16, 17)

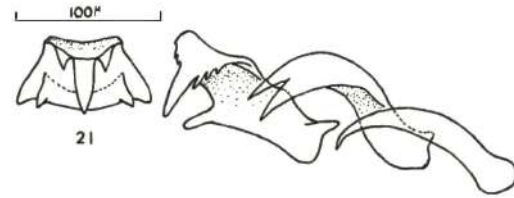


Figure 15. Radula of *N. gualteriana* (Cernohorsky (1971))

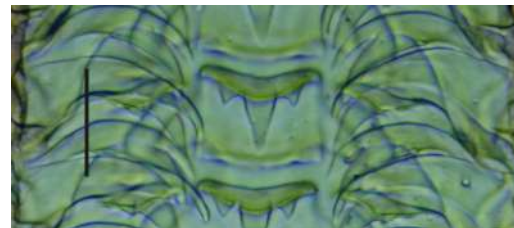


Figure 16. Radula of *N. gualteriana*. Rodrigues

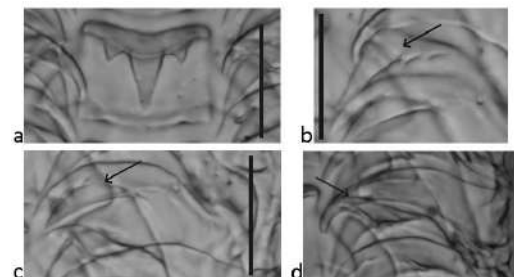
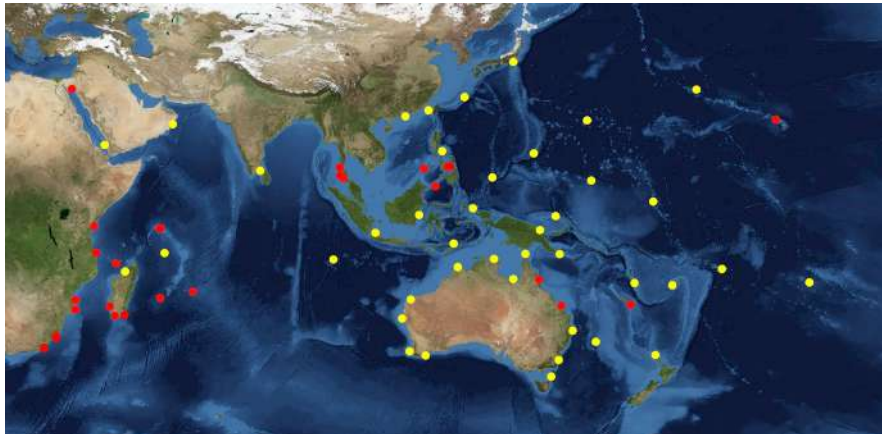


Figure 17. Tooth of *N. gualteriana* : a : Rachidian b : lateral c : inner marginal d : outer marginal (Rodrigue island scale bar: 50 μm)

Geographical distribution :

The species has a very wide distribution in the following areas:
Red Sea (it is also certainly a Lessepsian species) West Indian Ocean, Indo-Pacific, New Zealand, Sino-Japanese and Hawaiian.



Geographical distribution of *N. gualteriana*. Red circles : this study. Yellow circles : Museum specimens. From gbif.org : (Australian Museum (2020). Australian Museum provider for OZCAM. Creuwels J (2020). Naturalis Biodiversity Center (NL) Western Australian Museum (2019). Western Australian Museum provider for OZCAM. Museum and Art Gallery of the Northern Territory (2019). Northern Territory Museum and Art Gallery provider for OZCAM. Museums Victoria (2019). Museums Victoria provider for OZCAM. Academy of Natural Sciences. MAL. Saito H (2020). Mollusca collection of National Museum of Nature and Science. Paulay G, Brown W (2020). UF Invertebrate Zoology. Florida Museum of Natural History.) MAP adapted from NASA Earth Observatory. Blue Marble Collection.

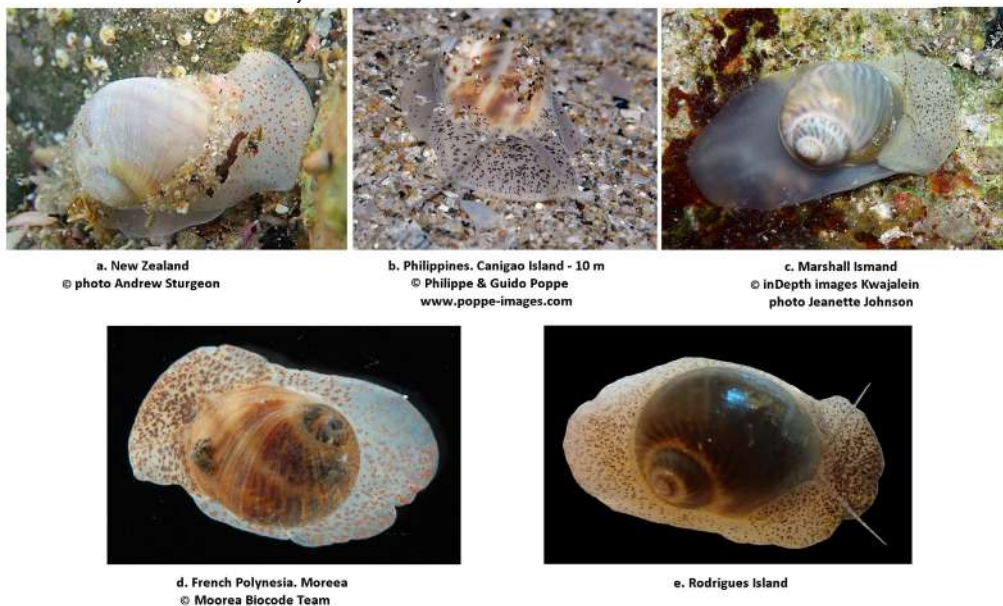


Figure 18. Living specimens of *N. gualteriana*

Living animal

All the images viewed, and the specimens seen alive show an animal whose propodium does not exceed the length of the shell, the metapodium may be a little longer, without however much exceeding the total length of the shell when it moves on the sand. The background colour is white, dotted with brown to reddish brown spots, always more numerous on the propodium than on the metapodium. The two antennas are also stained with dots of the same color. (Figure 18)

The animal lives in shallow water, its hunting method being a little atypical for Naticidae. It hunts prey on the surface of the sand (Savazzi & Reymont 1989) and even in the rocks (Paquien 2019). It is therefore able to be emerged for a long time and explore sand and rocks to capture its prey.

Confusions between *Notocochlis gualteriana* (Récluz, 1844) and *Natica marochiensis* (Gmelin, 1791)

The purpose of this article is not to trace the history of this error, we will refer to the various authors who have clearly explained the successive confusions with «*Neritae maroccanae*» (non binomial, Chemnitz 1781) and *Natica marochiensis* (Gmelin, 1791) of the Atlantic area. Thus, the works of Hedley (1913) Cernohorsky (1971) and Kilburn (1972) based mainly on the characters of the protoconch and the operculum (in addition to the geographical distribution) are sufficient to exclude a possible synonymy between the two species.

Species	Authors quoting synonymy			
	Cernohorsky (1971)	Kilburn (1976)	Majima (1989)	Torigoe & Inaba (2011)
<i>Natica marochiensis</i> Gmelin [not <i>Natica marochiensis</i> Gmelin, 1791]]	Ladd (1934) Kaicher (1956) Keen (1958)	Barnard (1963)	Martin (1905) Ladd (1934) Tesch (1920) Altena (1941) Popenoe & Kleinpell (1978) MacNeil (1960) Shuto (1969) Ladd (1977)	
<i>Natica marochiensis</i> Quoy & Gaymard [not <i>Natica marochiensis</i> Gmelin, 1791]]	mentioned			mentioned
<i>Natica marochiensis</i> var <i>lurida</i> Philippi [not <i>Natica lurida</i> , Philippi, 1836]]		Von Martens (1879)	Cossmann (1910) Uchiyama (1902)	Dautzenberg & Bouge (1933)
<i>Natica lurida</i> Philippi [not <i>Natica lurida</i> , Philippi, 1836]	Habe (?)	Krauss (1848)	Oyama (1969) Azuma (1961) Kuroda, Habe & Oyama (1971)	
<i>Natica lurida</i> , Philippi, 1836	Philippi (1852)		Kuroda & Habe (1952)	Hidalgo (1904) Habe (1961) Azuma (1961) Fukuda (1993)
<i>Natica colliciei</i> Récluz [not <i>Natica colliciei</i> Récluz, 1844]			Yokoyama (1928)	
<i>Natica rufilabris</i> Reeve [not <i>Natica rufilabris</i> Reeve, 1855]			Hirase (1934) Hatai (1941) Kuroda & Habe (1952)	Kuroda (1928) Taki (1960)
<i>Tectonatica adamsiana</i> (Dunker) [not <i>Cryptonatica adamsiana</i> (Dunker, 1859)]			Habe & Kosuge, 1859	
<i>Natica maculosa</i> [not <i>Natica lacunosa</i> Lamarck, 1822]		mentioned		
<i>Natica sagittata</i> Menke [not <i>Natica sagittata</i> Menke, 1843]				Habe & Okutani (1975) Fukuda (1993)
<i>Natica ochrostigmata</i> Rehder [not <i>Natica ochrostigmata</i> Rehder, 1980]				Fukuda (1995)

Table 1. summarizes the confusion resulting from identification errors (with *N. marochiensis* or Indo-Pacific species that are not similar) and the authors who have shown these inconsistencies (with origin of synonymy when known). The «synonymies» thus created should therefore not be regarded as such.

	Cernohorsky (1971)	Kilburn (1976)	Majima (1989)	Higo & al. (1999)	Kabat (2000)	Janssen & al. (2011)	Torigoe & Inaba (2011)	Worms (2020)
<i>Natica tessellata</i> Philippi, 1848	mentioned		Kuroda & Habe (1952)		mentioned		Kuroda & Habe (1952)	Synonym of <i>N. gualteriana</i> Kabat (2000)
<i>Natica antoni</i> Philippi, 1851		Von Martens (1879)			mentioned		Sowerby (1883)	Valid species as <i>Notocochlis antoni</i>
<i>Natica avellana</i> Philippi, 1852							Hidalgo (1904)	Taxon inquirendum
<i>Natica venustula</i> (Philippi, 1851)						mentioned		Valid species as <i>Notocochlis venustula</i>
<i>Natica locellus</i> Reeve, 1855					Tryon (1886)			Synonym of <i>N. gualteriana</i> Kabat (2000)
<i>Natica asellus</i> Reeve, 1855		mentioned			mentioned		Risbecc (1956)	Synonym of <i>N. gualteriana</i> Kabat (2000)
<i>Natica nucula</i> Reeve, 1855							Sowerby (1883)	Synonym of <i>Tectonatica suffusa</i>
<i>Natica robillardii</i> Sowerby, 1894		mentioned						Valid species as <i>Tectonatica robillardii</i>
<i>Natica burnupi</i> Smith, 1903		mentioned			mentioned		Bartsch (1915)	Synonym of <i>N. gualteriana</i> Kilburn (1972)
<i>Natica balteata</i> Sowerby, 1914					mentioned			Synonym of <i>N. gualteriana</i> Kabat (2000)
<i>Natica nemo</i> Bartsch, 1915		mentioned			mentioned		mentioned	Synonym of <i>N. gualteriana</i> Kilburn (1972)
<i>Cochlis migratoria</i> Powell, 1927					mentioned		Powell (1951)	Synonym of <i>N. gualteriana</i> Kabat (2000)
<i>Cochlis vafer</i> Finlay, 1930					mentioned		Iredale & McMichael (1962)	Synonym of <i>N. gualteriana</i> Kabat (2000)

Table 2. species listed as synonyms between the 1970s to that given by the Worms in september 2020 (with origin of synonymy when known)

Study of the possible synonymies of *Notocochlis gualteriana* (Récluz, 1844) with similar Indo-Pacific species

***Natica tessellata* Philippi, 1848**

Natica tessellata Ph. Taf. 7. Fig. 7.

N. testa ovata, inflata, tenui, nitida, alba, zonis tribus, e strigis longitudinalibus fuscis formatis ornata; umbilico satis amplo, callo semicylindrica spirali, mediano instructo; callo labiali distincto, crasso.

Natica tessellata Ph. Zeitschr. F. Malak., 1848. P 158

An *Natica marochiensis* Quoy et Gaim ? Voy. Astrol. II. p. 236; t. 66 fig. 16 ?

Long. 8 ½''' ; diam 7 ½''' . Patria.

The described shell is oval, globose, fine, smooth. Colour is white, adorned with three zones in dark longitudinal furrows. The umbilicus is quite large with a semi-cylindrical median callus. The labial callus is distinct, thick.

Height 18 mm, diameter 15.9 mm. The original description does not give a locality, but Philippi indicates that the shell looks like that of *N. maroccana* from Chemnitz. In 1852, Philippi adds the location of the Tonga islands (Fig 19) and states that the figure of Quoy and Gaimard of *N. marochiensis* (Figure 20) seems to correspond to his species *N. tessellata*.

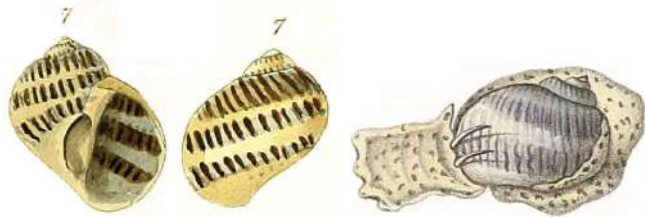


Figure 19. *Natica tessellata* Philippi (1852) Taf 11 Fig 7. Tonga

Figure 20. *Natica plurisériale* *Natica Marochiensis* Quoy & Gaimard (1833) Pl 66 Fig. 16 Tonga



Figure 21. *N. gualteriana* Mozambique 11.2 mm CNP-2019-111

The species is later only reported by E.A Smith (1884) in Mozambique, Dall (1912) in Papua New Guinea (Namatai, New Ireland). No illustration is given. The type specimen, like most of those of Philippi, has probably disappeared (Kabat & Coan 2017). The proportions of the shell, (if we consider the dimensions cited by Philippi and the original drawing) are fully compatible with those of *N. gualteriana*. The description of the umbilicus with a callus and a spiral funicle leaving a fairly open umbilicus, the white base and the white aperture stained with brown

furrows are consistent with the Récluz's descriptions of *N. gualteriana*. The pattern consisting in three series of lines made of dark longitudinal grooves on a light background is also consistent with original descriptions and the drawings of *N. gualteriana* proposed by Reeve (1855) and Philippi (1852).

Lastly, current specimens of *N. gualteriana* with this pattern are commonly observable. (Figure 21)

This synonymy indicated since Cernohorsky (1971) therefore has no reason to be questioned.

***Notocochlis venustula* (Philippi, 1851)**

Natica venustula Ph. Taf. 19. Fig. 20.

N. testa parvula, ovata, tenui, pellucida, laevissima, praeter sulcos obliquos suturales, nitidissima, alba, strigis longitudinalibus fuscis picta; zona solita alba suturam cingente, aliaque caerulea per superiorem anfractibus partem translucida; anfractibus rotundatis, spira tertiam altitudinalis partem aequante, alba, apertura semiorbiculari; umbilico mediocri; callo semicylindrico magno eum fere implente et sinu profundo a callo labiali, satis crasso diviso (...)

Höhe 4, Durchmesser 3 ¼ linien.

Aufenthaltsort: unbekannt.

The shell described (Figure 22) is small, smooth with oblique furrows near the suture. Colour is bright white adorned with rows of brown longitudinal bands, a white or bluish strip along the suture. Upper part of the whorls is white translucent. Spire about 1/3 of the total height. Umbilicus almost filled by a large semi-cylindrical callus which leaves a deep concavity. Labial callus thick.

The illustration shows wavy brown longitudinal bands framed by darker spiral bands.

Height 8.5 mm, width 8 mm. The provenance is unknown. The type specimen has probably disappeared (Kabat & Coan 2017).

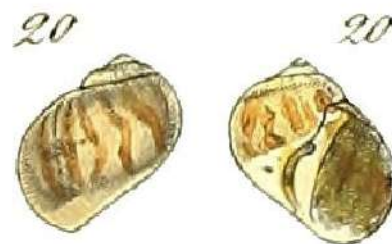


Figure 22. *Natica venustula* Philippi, 1851 Philippi (1851) Taf 19 Fig 2



Figure 23. *N. gualteriana* CNP-2015-007 La



Figure 24. *N. gualteriana* CNP-2020-042 Seychelles

The species is illustrated by Hollmann (2008) in Philippine marine mollusks, vol. 1. WORMS cites this reference (2020) and gives the species as valid. The three shells illustrated by Hollmann measure 5.9, 6.4 and 7.2 mm in height, they clearly show a spire and a white umbilical zone, and the two dark lines on the last whorl between which are axial brown bands. The large semi-circular white callus is also consistent with the Philippi's original description. However, these shells are absolutely comparable to juveniles of *N. gualteriana*. The observation of specimen from Réunion Island, Seychelles Island (Figures 23, 24) shows that young specimens of *N. gualteriana* can have all these characteristics. The same work present a photograph of a living specimen with a white propodium spotted with brown dots and a less densely spotted white mesopodium. These characteristics are identical to that of *N. gualteriana*. Janssen & al. (2011) mentioned the possibility of a synonymy with *N. gualteriana* by noting that specimens of the latter species (from Safaga in Egypt) have brown broken axial bands very similar to what is described by Philippi and presented as syntype by Higo & al. (2001) (not seen).

The specimens first identified as *N. venustula* examined in this study (Figure 25), from the Philippines and the original illustration are compared with young *N. gualteriana* of similar sizes. (Figure 26)



Figure 25. Various *Notocochlis venustula* (Philippi, 1851) from Philippines

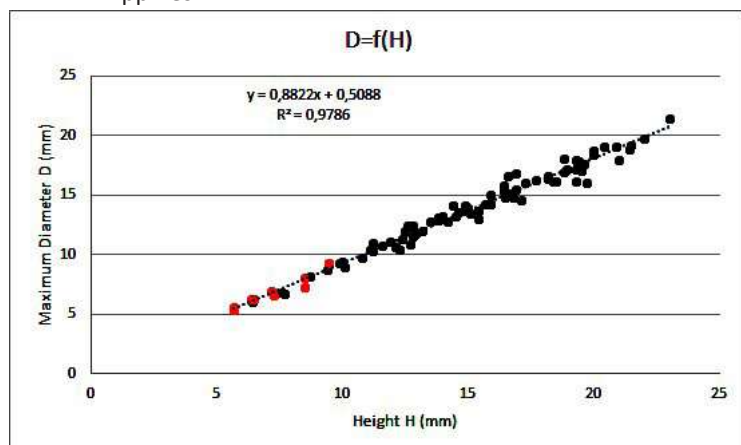


Figure 26: Maximum diameter (D) as a function of height (H) Red circles *N. venustula*. Black circles *N. gualteriana*

It may be noted (Figure 27) that the individuals identified as *N. venustula* (c) are perfectly similar to the spire of adult individuals of *N. gualteriana* (a) from the same geographical region. Colors, pattern and apex are indistinguishable (b and d).

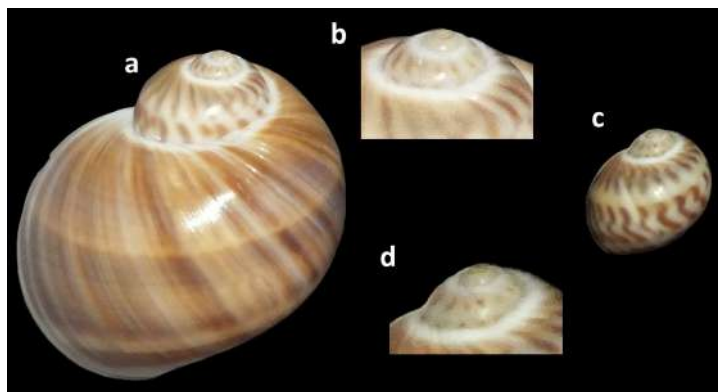


Figure 27.

27a, 27b : *N. gualteriana*. CNP-2020-065. Philippines 16.5 mm
27 c, 27 d: *N. venustula* CNP-2020-036. Philippines. 7.3 mm

features	<i>N. venustula</i>	<i>N. gualteriana</i> of similar sizes
H/D (mean ; min – max)	1.07 (1.03 – 1.18)	1.09 (1.06 – 1.15)
Ho/H (mean ; min – max)	0.77 (0.69 – 0.86)	0.80 (0.74 – 0.86)
Protoconch diameter (µm)	186 (170 – 200)	188 (130 – 230)
First embryonic whorl diameter	844 (770 – 900)	829 (670 – 940)
Number of protoconch's whorls	2.8 (2.75 – 2.9)	2.75 (2.6 – 3)
Nucleus	brown	brown
Subsutural folds (1° / 2° whorl)	14 (8–20) / 23 (16 / 27)	14 (9 – 21) / 22 (14 / 30)
Umbilicus	Partially filled by a thick white callus	Partially or completely filled by a thick white callus
Umbilical and Parietal callus	White, thick, separated by a wide notch	White, thick, separated by a wide notch, sometimes merged
Colour and Pattern	White background. White subsutural band. Wavy brown longitudinal bands framed by darker spiral bands	Highly variable

Table 3. Comparison of anatomical characters of the shells of *N. venustula* and *N. gualteriana*

The results of the comparisons which are summarized in the table 3 show that it is impossible to differentiate *N. venustula* from young *N. gualteriana*. All of these elements leave no doubt that the species *Natica venustula* Philippi, 1851 is a junior synonym of *Notocochlis gualteriana* (Récluz, 1844).

Natica antoni Philippi, 1851

Natica antoni Ph.

N. testa oblongo-ovata, solida, laevi, ad suturam oblique radiatim sulcata, fusco-olivacea, interdum maculis fuscis transversim seriatis picta, circa umbilicum alba ; anfractibus rotundatis ; spira tertiam totius altitudinalis partem occupante ; callo magno semicirculari, umbilicum angustum omnino opplente, et cum callo labiali crasso confluyente ; apertura semicirculari ; margine columellari vix concavo : faucibus atropurpureis, basi albis. Alt. 7''' , diam. 6'''.

Patria : Mare Chinense , ad insulas Liewkiew (Largilliert) ; coll. Antoni et Philippi.

N marroccanae quidem similis, sed forma longe angustiore, umbilico angustiore, callo crasso eum obturante et cum callo labiali longe crassiore connato satis diversa videtur. (Juli 1851)

The shell described (Figure 28) is oval-oblong, solid, smooth, with oblique radiating furrows near the suture. Colour is olive-brown, sometimes with a series of oblique brown spots, the umbilical zone is white. Whorls are rounded and the spire occupies $\frac{1}{3}$ of the height. A large semicircular callus completely fills the narrow umbilicus, merging with a thick labial callus. Aperture is semicircular, purple black, the columellar margin is barely concave. The base is white. Height 14.8 mm, diameter 12.7 mm. Description and figure do not show any

white subsutural area.

Typical locality: Ryukyu Islands (Okinawa).

Philippi mentions the resemblance to *N. marrocanae* but notes a narrower and more elongated shape, with a smaller umbilicus. Calluses are more developed and connected to each other.



Figure 28. *Natica antoni* Philippi, 1851. Philippi (1852) Taf 19 Fig 18. Okinawa

This shell shows some specific characteristics of *N. gualteriana*, the oblique grooves near the suture, the proportions of the shell, as well as the white color at the base. The umbilicus closed by the umbilical callus fused with the parietal callus can also fit with this species. However, the very uniform colour (although there may be 3 spiral bands of oblique dots), including aperture which is totally purple black are atypical.

Subsequent authors mention the presence of the species in the following locations:

Mozambique (Quelimane) Smith in Von Martens (1877), Sri Lanka (Trinquemalay) Herdman in Standen & Leicester (1906), Pakistan (Gwadar, prof 9 m), Melvill & Standen (1901), Mauritius and Seychelles (Aldabra Island) Thiele (1899).

Kabat (2000), on the basis of morphological characters, gives *N. antoni* as a synonym for *N. gualteriana*. The species is illustrated by Hollman (2008) in Philippine marine mollusks, vol. 1. Philippines (Mactan island). The shell illustrated by Hollman, however, does not conform to the original description. It shows characters typical of *N. gualteriana*, the umbilical and parietal callus are not completely fused as indicated in the description and the original figure of Philippi, similarly the umbilicus is not completely filled by the callus.

Kilburn (1972) makes it a synonym of *Natica burnupi* species which he indicates as being a synonym of *N. gualteriana*. The very different shape and color of the shell of *N. burnupi* (species treated here) leads to reject this proposition.

Huelsken (2008) established a phylogeny synthesizing data from several genes separating a species identified as *N. antoni* and *N. gualteriana*.

If the species identified as *N. antoni* shows subsutural folds, a closed umbilicus and merged umbilical and parietal callus, the photographs of the sequenced specimens show important differences with the description and illustration of Philippi. The shells (3 specimens) have a white background, sometimes a little bluish. The apex and the umbilical area are white. The last whorl has two bluish-gray to gray-brown bands that surround a lighter band. At least one of the specimens also shows discreet brown dots at the top of the large lighter area. These characters do not fit with *N. antoni*, they are much more in agreement with those of *Natica asellus*. (see the paragraph concerning this species).

There are examples of *N. gualteriana* with characteristics that can be related to *N. antoni*. Shells from places as varied as Rodrigues Island, Mozambique or China (Figure 29) can indeed present a uniform olive-gray to olive-brown colour, with an inconspicuous white subsutural band, a totally dark brown aperture. Some also show a more or less complete fusion of the callus and the umbilicus can be completely filled. These shells resembling *N. antoni* moreover have protoconchs perfectly conforming to those of *N. gualteriana*.



Figure 29. Various specimens of *N. gualteriana*

These elements led to the conclusion that the species *Natica antoni* Philippi, 1851 is a junior synonym of *Notocochlis gualteriana* (Récluz, 1844).

Note

Kang *et al.* (2018) have also done a molecular phylogeny based on the COI gene sequence in which a species which could be *N. antoni* (from Taiwan) is clearly separated from *N. gualteriana*. However, the authors indicate that they are not sure of the identification of the shell, which they carefully call «*Notocochlis* sp. aff. *Antoni*.» The photograph (Figure 30) of the specimen shows greyish-brown shell with a lighter spiral band, subsutural folds and growth streaks. Aperture is white, there is also a white subsutural area, and the umbilicus is not closed by the umbilical callus, nor is the latter fused with the parietal callus. The shell looks like that of *N. gualteriana*, as does its white operculum with a single groove. The living animal which is also described by the authors has a translucent white mantel with dark brown spots on the dorsal side, antenna are black tipped. Whatever the correct identification of the specimen, the genetic differences with the other specimens of *N. gualteriana* is irrefutable. The antennas (tipped) also do not conform to those of *N. gualteriana*.



Figure 30. *Natica* sp. aff. *Antoni* (Philippi, 1851). Kang *et al.* (2018) Fig. 7

Photo courtesy of Dun-Run Kang. (National Sun Yat-sen University)

The authors conclude “We are currently unable to confirm the

taxonomic relationship between our specimens and *N. antoni*.». This species is not *N. antoni* (features of umbilicus and callus are different, aperture is white) but it is clearly not *N. gualteriana* (ADN, antenna features...) and it is therefore probably necessary to describe this species from Taiwan.

***Natica avellana* Philippi, 1852**

***Natica avellana* Ph.**

Taf. 11. Fig 14.

N. testa ovata, satis solida, nitida, laevi, ad suturam radiatim sulcata, fusca, concolore, regione umbilicali alba ; anfractibus convexis ; spira quartam altitudinis partem superante ; umbilico mediocri vix circumscripto ; callo spirali semicylindrico, satis magno, medium ejus occupante, et sinu profundo a parte adnata labii, satis callosa diviso ; apertura semilunari patula ; faucibus pallide fuscis, labio lacteo.

Höhe : 7 ½ linien, Durchmesser eben so viel. Aufenthaltstort : unbekannt.

Von *N. maroccana* Chem. Durch gedrängtere Form, kürzere Spira, so wie durch die Färbung hinlänglich unterschieden.

The shell described (Figure 31) is oval, fairly solid, shiny and smooth. There are radiated furrows near the suture. The color is uniformly brown, the umbilical region is white ; whorls are convex ; spire represents a quarter of the height. Umbilicus sparsely developed and barely delimited. The fairly large semi-cylindrical callus occupies the middle of the umbilicus. Callus is divided by a deep depression near the lip. Large semi-lunar aperture. Colour is pale brown, with white lip.

The taxonomic history of this species is quite confused. Dunker (1860) considered it as a synonym of the Japanese species *Natica adamsiana* Dunker, 1860 (today *Cryptonatica adamsiana*) which is a species with a very characteristic globular form, without sub-sutural folds. It does no way corresponds to the species here described. Weinkauff (1868) likens it to a variety of *Natica maroccana* from Algeria. Tryon (1886) indicated that the species would be a chestnut-brown form (without stripes) of *Natica dillwynii* Payraudeau, 1826, a Mediterranean species. This suggestion is surprising, as all the shells of *N. dillwynii* (actually brown) without stripes at least carry at the base a white band with brown chevrons, which is not the case of the species described by Philippi. Kobelt (1887) makes it a synonym of *Natica prietoi* Hidalgo, 1873, a species with a different pattern and which also has a very different umbilical callus. None of these four synonymies will ever be taken up by any author. Liénard (1877) indicates the presence of the species in the Indian Ocean (Mauritius), Hidalgo (1904) is the first who evokes a synonymy with *N. gualteriana*. Hedley (1913) do the same and this idea is finally reiterated by Torigoe & Inaba (2011).



Figure 31. *Natica avellana* Philippi, 1852
Philippi (1852) Taf 11 Fig 14



Figure 32. *N. gualteriana* from Mayotte Island

The sizes and proportions of the illustrated shell ($H/D = 1$ to 1.06 and $Ho/H = 0.75$) are compatible with *N. gualteriana*.

The original illustration as well as the original description perfectly fit with *N. gualteriana* like those presented in the figure 32

It is therefore appropriate to consider *Natica avellana* Philippi, 1852 as a junior synonym of *N. gualteriana*.

***Natica asellus* Reeve, 1855**

Species 136. (Mus. Cuming.)

***Natica Asellus*.** Nat. Testa obtecta umbilicata, oblique globosa, subtus depressa, spira brevissima, anfractibus convexis, laevigatis, nitentibus, prope suturam obscure plicato-striatis, apertura semilunari-ovata, columella callositate lata umbilicum tegente ; alba, fasciis duabus latiusculus caerulea-nigricantibus cingulata, punctorum serie minuta in interstitio. THE LITTLE ASS *NATICA*. Shell with a covered umbilicus, obliquely globose, depressed beneath, spire very short, whorls convex, smooth, shining, faintly plicately striated next the suture, aperture semilunar-ovate, columella with two rather broad blue-black bands, with a minute series of dots in the interstices.

Hab. Australia.

The shell described (Figure 33) is globose, smooth and shiny with an umbilicus closed by a large columellar callus. Spire very short. The whorls are convex, slightly plicated striated near the suture. Aperture is semilunar-oval. Colour is white with two fairly thick blue-dark brown bands, and a series of small dots between the two bands. Type locality: Australia. Original illustration shows small brown dots. Aperture is white with two brown bands showing the arrangement of the spiral bands. The species is then mentioned to be present in the Gulf of Suez (Egypt, Ras Mahommed) M'Andrew (1870), Java (Badjumat) Weber (1902), but these authors note the absence of points between the bands, which makes identification uncertain. Odhner (1918) identifies the species (6 mm specimen) in Madagascar, but with brown streaks that cross the bands instead of dots. Here again the identification is not really sure. Confusion with *N. venustula* is quite possible. In the absence of an illustration for these observations, care should be taken over the geographic distribution.

Kilburn (1976) is the first to mention the «near certainty» of synonymy with *N. gualteriana*, based on similarities of the shell patterns between the juveniles.

Synonymy is also given by Kabat (2000). However, the design showing two bands framing small dots is not observed in the juveniles of the species, always showing more or less wavy elongated spots.

If we compare specimens of *N. gualteriana* to the available specimens (original drawing, specimens photographed by Huelsken and one shell from Philippines, Figure 34) we note a small size (maximum 11.2 mm), the H/D ratios are in a shorter range in *N. asellus* (Figure 35 ; but this can be linked to the weaker sample), the p value test of 0.102 is not in favor of a significant difference, on the other hand the Ho/H ratio is generally lower (Figure 36), the p value test of 0.00042 suggesting that this difference is significant. In both cases the hypothesis tested is that there is only one species.



Figure 33. *Natica asellus* Reeve, 1855 Sp 136. Aus-

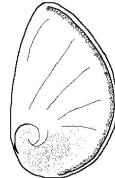


Figure 35. Operculum of *N. asellus*



Figure 34. CNP-2017-112 *Natica asellus* Reeve, 1855 Philippines . Canigao Island.

The operculum of *N. asellus*, like that of *N. gualteriana* is white, calcified with a horny inner layer. It also has a marginal rib, the nucleus have a slight granular relief, however, it does not have a gray brown colour. (Figure 35)

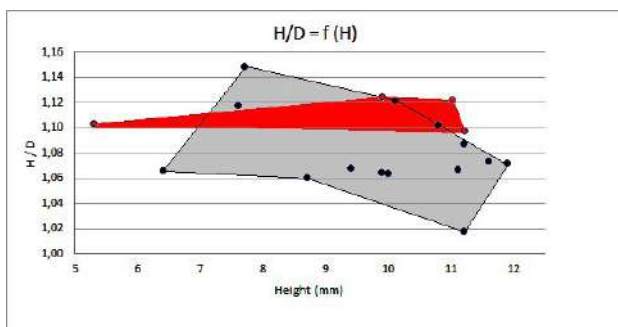


Figure 36. Ratio H/D as a function of height (H)

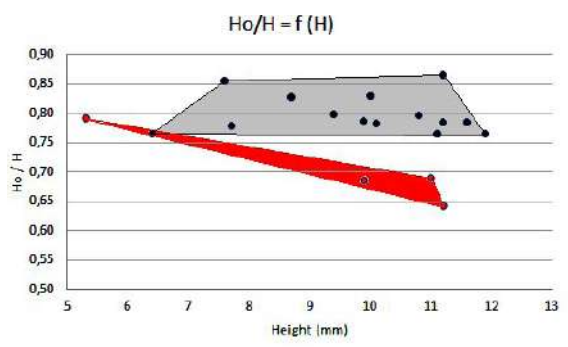


Figure 37. Ratio Ho/H as a function of height (H)
Grey areas: *N. gualteriana*. Red areas: *N. asellus*

Protoconches are very similar even if the diameter of the first embryonic whorl (one specimen studied) is high. (see table 4)

features	<i>N. asellus</i>	<i>N. gualteriana</i> of similar sizes
H/D (mean ; min – max)	1.12 (1.10 – 1.13)	1.08 (1.02 – 1.15)
Ho/H (mean ; min – max)	0.72 (0.64 – 0.79)	0.80 (0.76 – 0.87)
Protoconch diameter (µm)	870 (1 specimen)	829 (670 – 940)
First embryonic whorl diameter	230 (1 specimen)	188 (130 – 230)
Number of protoconch's whorls	2.8 (1 specimen)	2.75 (2.6 – 3)
Nucleus	white	brown
Subsutural folds (1° / 2° whorl)	12 / 14 (1 specimen)	14 (9 – 21) / 22 (14 / 30)
Umbilicus	Filled by callus	variable
Umbilical and Parietal callus	White, merged	variable
Colour and Pattern	White bluish background. two brown bluish band , with more or less conspicuous brown spots between.	Highly variable but never with spots between spiral bands
Operculum	White with one marginal rib Nucleus white	White with one marginal rib Nucleus white to gray-brown

Table 4. Comparison of anatomical characters of *N. asellus* and *N. gualteriana* shells of comparable sizes

Huelsken (2008) established a phylogeny synthesizing data from several genes separating a species wrongly identified as *N. antoni* and *N. gualteriana*. the photographs of the sequenced specimens show all the specific characters given and represented by Philippi: a white bluish background, folds of the sutures, two more or less dark gray-bluish bands surrounding a lighter band. Two specimens also show inconspicuous brown dots at the top of the large, lighter area. Umbilicus is closed by a white umbilical callus merged with the parietal callus of the same color. The molecular phylogeny (Figure 38) clearly separates these three specimens and *N. gualteriana*. This result confirms that it is indeed a different species. We also note that the specimens sequenced by Huelsken come from Australia, type locality of the species.

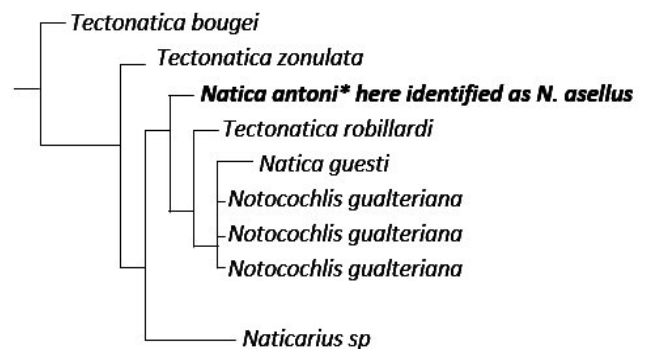


Figure 38. Phylogenetic tree based on a multi-gene analysis. After Huelsken (2008)

Some elements of the shell morphology (coloration, umbilicus always closed, lower Ho/H ratio, aperture, perhaps the size of the first embryonic whorl with light nucleus, white nucleus of operculum), the small size as well as the available genetic data show that there are indeed two different species, the name of *Natica asellus* Reeve, 1855 is therefore valid even if *Notocochlis asellus* (Reeve, 1855) is certainly preferable according to the operculum and the common features with species *N. gualteriana* and *N. venustula*.

***Natica locellus* Reeve, 1855**

Species 134. (Mus. Cuming.)

***Natica Locellus*.** Nat. testa minute umbilicata, sub-globosa, spira exserta, apice acuta, anfractibus rotundatis, laevis, apertura lunari-ovata, columella tenue callosa ; livido-carnea, fulvo-aurantia obscure tincta et vittata.

THE LITTLE PURSE *NATICA*. Shell minutely umbilicated sub-globose, spire exserted, sharp at the apex, whorls rounded, smooth, aperture lunar-ovate, columella thinly callous ; livid flesh-tinged, fulvous-brown, obscurely filleted and stained.

Hab. - ?

The shell described (Figure 39) is subglobulous, with a very reduced umbilicus, a prominent spire, pointed at the apex. The whorls are rounded, smooth. Aperture is lunar-oval. Columellar callus is thin. The colour is flesh-livid, decorated with discreet brown-fawn lines. The original illustration shows a smooth shell with a high spire and a band of wavy brown bands in the middle of the whorl. The umbilicus is deep, a funicle fills its anterior part. The operculum is calcareous, white.



Figure 39.
Natica locellus
Reeve (1855) SP



Figure 40. *Natica locellus* Reeve
(1855) Lectotype. NHMUK
1995210
© Courtesy of the Trustees of the
of the Natural History Museum,
London.

The lectotype (figure 40) measures 11.1 mm in height, it confirms the high spiral and the white calcareous operculum. The latter has an arched internal edge, never observed in *N. gualteriana*. The aperture also shows a concave columella. The umbilicus is clearly visible, a small white umbilical callus is in the very anterior area, it extends into the umbilicus in a white funicle. The colour of the shell is light gray-beige, with traces of brown periostracum.

The species is practically no longer cited by the following authors, Tryon (1876) thinks it may be a form of *Natica marochiensis* (Gmelin, 1791) and Kabat (2000) also uses this synonymy. The H/D (1.11) and Ho/H (0.68) ratios are compatible with those of *N. gualteriana*. However, the very particular shape of the umbilicus and its callus, the characteristic concavity of the columella, the absence of any folds and white subsutural band clearly show a different species.

It is therefore preferable to consider *Natica locellus* Reeve, 1855 either as a valid species (of unknown geographic origin) or as species inquirenda, because it is difficult to match with known species.

***Natica nucula* Reeve, 1855**

Species 140. (Mus. Cuming.)

***Natica Nucula*.** Nat. testa obtecte umbilicata, subquadrato-globosa, solida, spira minuta, anfractibus superne obtuse rotundatis, deinde subplanatis, apertura semilunari-ovata, columella callositate lata rotundata umbilicum tegente, sordide tutescente-alba, apice livida.

THE LITTLE NUT *NATICA*. Shell with a covered umbilicus, somewhat squarely globose, solid, spire very small, whorls obtusely rounded at the upper part, then rather flattened, aperture semilunar-ovate, columella with a broad button-like callosity covering the umbilicus ; dull yellowish-white, livid at the apex.

Hab. New Ireland

The shell described (Figure 41) is globose with a very short spire, the large umbilical callus fills the umbilicus. The colour is dull yellowish white, livid at the apex. Reeve's figure unfortunately does not show the aperture or the umbilical zone.

Type locality: Papua New Guinea (Bismarck Archipelago).

Only Tryon (1886) later mentioned the species. He gave two illustrations (Figure 42). One shows aperture and umbilicus of a dark shell with a clear apex and aperture.



Figure 41. *Natica nucula* Reeve, 1855 Sp
140 Papua New Guinea



Figure 42. *Natica nucula* Reeve, 1855 Tryon
(1886) Pl 12 Fig 9. Pl 9 Fig 80



Figure 43. *Natica nucula* Reeve, 1855 Lectotype.
NHMUK 1991030 © Courtesy of the NHM. London

Kabat (2000) gives the synonymy with *Tectonatica suffusa* (Reeve, 1855), which is consistent with the description and the lectotype of *N. nucula* (Figure 43). This specimen shows a very globose form with reduced spire, as well as the typical purplish coloration, especially at the apex.

The synonymy proposed by Torigoe & Inaba (2011) with *N. gualteriana*, who cite Sowerby's reference (1883) should therefore not be retained.

Tectonatica robillardi* (Sowerby III, 1893)**Natica Robillardi*, n. sp. Pl. IV. Fig. 12**

Shell with umbilicus almost closed, solid, sub-oval, pale yellow, or even white, with two dark bands ; spire reduced, slightly prominent ; whorls 5 , increasing rapidly, convex, rounded, with oblique furrows at the upper part, suture very scared, last whorl globose ; columella almost straight, upper part reflected, umbilical callus thick ; aperture semicircular. Operculum quite thick, polished, white, with a remarkable brown spot, narrow marginal carina. Lenght. 19. Maj. Diam. 17 mm. Hab - Mauritius.

The shell described (Figure 44) is globular with subsutural grooves. The thick umbilical callus almost completely fills the umbilicus. The most remarkable point given by Sowerby is the dark brown spot on the operculum. Type locality: Mauritius Island. The species is reported throughout the tropical Indo-Pacific area: North West Australia (Wells, 1986), Cocos Keeling Islands (Wells, 1994), Ouvea Island (Loyalty Island, Coles, 1977), Laccadives Sea (Minicoy Island, Maalhos Island, Smith 1903), Mayotte (Comoros Islands, Deuss, Richard & Verneau, 2013), Vanuatu (Port d'Efate, figure 45), Society Islands (Huahine Island).

Kilburn (1976) indicate synonymy with *N. gualteriana*, however this will not be used by the subsequent authors, and the WORMS (2020) considers the species valid as *Tectonatica robillardi* Sowerby III, 1893.



Figure 44. *Natica robillardi* Sowerby III, 1893
Sowerby III (1893) Pl IV Fig 12 Mauritius



Figure 45. *Natica robillardi* Sowerby III, 1893
CNP-2018-022 Vanuatu. Efat Island. 14 mm

The size and proportions of the shell, as well as the presence of the subsutural folds, are consistent with the species *N. gualteriana*. However, the Protoconch is clearly different. The number of whorls is lower and the diameter of the first whorl is larger. The umbilicus is always completely closed with merged callus. The shell does not show color variations, it is always whitish to yellowish with two inconspicuous darker yellowish spiral bands. Nucleus of the operculum is always brown to honey-brown (figure 45)

Huelsken (2008) from a multigenic analysis, gives a phylogenetic tree (figure 37) which clearly shows a separation between

T. robillardi and *N. gualteriana*. (The specimens located in this phylogeny are photographed, they show all the distinct characters of each species)

All of these arguments clearly show that *Tectonatica robillardi* (Sowerby III, 1893) is indeed a valid species.

However, many identification errors are observed, including in museums. Typical specimens of *N. gualteriana* having a dark gray nucleus operculum are wrongly identified as *T. robillardi*, and some *T. robillardi* are labeled *N. gualteriana*. An observation of the other specific characters would suffice to rectify these errors.

features	<i>T. robillardi</i>	<i>N. gualteriana</i>
H/D (mean ; min – max)	1.13 (1.09 – 1.19)	1.08 (1.02 – 1.15)
Ho/H (mean ; min – max)	0.82 (0.78 – 0.89)	0.80 (0.76 – 0.87)
Protoconch diameter (µm)	843 (n=2)	829 (670 – 940)
First embryonic whorl diameter	268 (n=2)	188 (130 – 230)
Number of protoconch's whorls	2.4 (n=2)	2.75 (2.6 – 3)
Nucleus	brown	brown
Subsutural folds (1° / 2° whorl)	20 (20-21) / 21 (18-24)	14 (9 – 21) / 22 (14 / 30)
Umbilicus	closed	variable
Umbilical and Parietal callus	merged	variable
Colour and Pattern	Always whitish with 2 inconspicuous darker spiral bands	Highly variable
Operculum	Calcereous. White with one marginal rib. Nucleus grey-brown with a honey-brown patch	Calcereous. White with one marginal rib. Nucleus white to grey-brown

Table 5. Comparison of anatomical characters of *T. robillardi* and *N. gualteriana* shells of comparable size

Natica burnupi***Natica (polinices) Burnupi*, n. sp. Pl. XV, Fig 11.**

Testa parva, ovata, obtece perforata, crassiuscula, fuscocinerea vel rufescens ; anfractus 5, convexi, superiores parvi, ultimus magnus, antice oblique descendens, oblique striatus ; apertura parva, semi-circularis, intus fuscescens ; columella obliqua, recta, callo crasso albo reflexo instructa. Long. 11, diam. 7 mm. ; apertura 6 mm. longa, 3 lata.

Hab. –Durban Bay (Burnup).

Larger specimens are 17 mm. in lenght.

The shell described is small, thick and striated. The color is brown to red. The umbilicus is completely filled by a thick white callus. The aperture is small and semi-circular, with a red interior. Protoconch is not described, nor is the operculum. The typical locality is in South Africa, Durban Bay.

The original illustration (Figure 46) shows a thick conical oval shell, suggestive of some *Polinices* specimen.



Figure 46. *Natica (Polinices) burnupi* Smith, 1903.
Smith (1903) Pl XV Fig 11. South Africa

Bartsch (1915) confirms the presence of the species in Durban Bay.

The species is then reported in Madagascar Ampasipohé, Tulear and Ankilibe by Dautzenberg (1923).

Kilburn (1972) was the first to give synonymy with *N. Gualteriana*. His work is based on the observation of specimens and

three syntypes present in the Natal Museum. For Kilburn the species *N. gualteriana* and its form “*burnupi*” live side by side in the area and show all possible intermediate forms. There is however no photo of these intermediates, the article unfortunately only shows a photo of the typical form next to the *burnupi* form. For Kilburn, this particular form is only found in South Africa (Durban Bay and Port Edward, Kwazulu-Natal) but he later points out the observation of Dautzenberg (1976).

Kilburn's observations, as well as the examination of photographs of the 4 NHMUK type specimens (Figure 47), are rather confusing. For sizes varying between 11 (for the described specimen) and 13.9 mm at most, the very elongated shape does not fit with individuals of *N. gualteriana*. The colour is reddish brown, the thick shell shows marked striation of growth lines. The subsutural region shows a lighter band and inconspicuous folds.

Kilburn notes that in South Africa adult *N. gualteriana* have this type of solid color, greyish brown to olive brown, without the patterns often seen elsewhere in the Indo-Pacific. He also notes an often dark apex, characteristic which is attributed to probably particular environmental conditions. The operculum has a single groove on its external face, and its nucleus does not always have a dark color. These observations are consistent with the usual variations of the *N. gualteriana*.

Based on the observation of three syntypes present in the Natal Museum (N° 864; T499) and of collected specimens, he makes the assumption that the suture line of these individuals has gradually lowered whorl by whorl, giving an elongated shape «*Polinices* type» with umbilicus completely closed by a thick callus. Many species sometimes show the existence of aberrant shells, mostly isolated in populations. The Durban area presents or has presented a large number of specimens showing a range of deformations which are consistent with the Kilburn hypothesis. Figure 48 shows what would be the growth of an individual whose suture line would be shifted downward compared to a normal growing specimen. The similarity to a specimen from the Durban region (Figure 48 g) is very convincing. The schematized specimens all coming from this same region (sizes between 17 and 22 mm) indeed give good intermediate forms which can be completely interpreted by an abnormal growth of the whorls, the suture line presenting varying lowering levels.

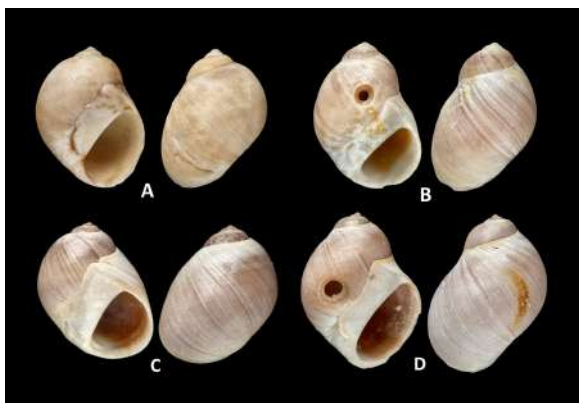


Figure 47. syntypes from NHMUK 1903.9.9.22-3
A-D A (9 mm) B (9.6 mm) C (12.55 mm) D (13.85 mm)
© Courtesy of the Trustees of the Natural History Museum,

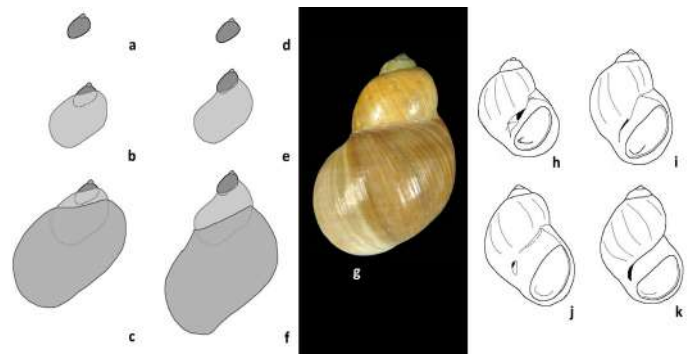


Figure 48.

48 a, b, c. Classic growth of *N. gualteriana*

48 d, e, f. Growth with lowering of sutural line giving a «*burnupi*» shape

48 g. Specimen from Durban. *Notocochlis gualteriana* f *burnupi* (27.4 mm) © G. & Ph. Poppe

48 h, i, j, k. Figures of shells of *N. gualteriana* from South Africa

The height varies between 11 and 27.7 mm. The other features of the shell, colour, folds, operculum remain very homogeneous in all the specimens. The umbilicus is still largely closed by the merged callus, leaving most of the time only a reduced sulcus. The variations in the H/D and Ho/H ratios in *N. gualteriana* are extreme here, a modification of the development genes involved in the growth of the shell could explain such specimens. None of the Durban region shells in my possession show such deformations.

The reddish brown color, the folds and white subsutural area, the characteristic calcareous operculum are consistent with a local form of the *N. gualteriana*. The existence of all intermediate forms also clearly calls for such a conclusion.

Its presence in Madagascar is based on a single observation. There is no illustration of the specimens observed by Dautzenberg in 1923. We can however compare this observation with the presence of shells described in 2010 in Madagascar: *Polinices parvulus* Bozzetti, 2010.

***Polinices parvulus* Bozzetti, 2010**

Specie dalla conchiglia di piccole dimensioni per il genere (13.80-14.70 mm), solida, ovoide-elongata, spira alta. Protoconca bassa, globosa, costituita da 1 giro liscio, 3. ? -4 giri di teleoconca convessi, sutura incisa, scultura della teleoconca costituita da fitte costole assiali prosocline, sviluppate sulla rampa subsuturale, al disotto si affievoliscono, senza scomparire e raggiungendo la base. Rampa subsuturale piatta o lievemente concava, soprattutto sull'ultimo giro, apertura ampia, semi-circolare, labbro esterno sottile, uniformemente convesso, columella diritta, opistocline. Callo parietale molto sviluppato, particolarmente rilevato nell'area posteriore, inferiormente si espande occludendo quasi completamente l'ombelico del quale residua una debole incisione falciforme. Colore di fondo marroncino con sfumature lilla, 2 bande spirali più chiare, una alla periferia, ed una, meno sviluppata, subsuturale. Interno della fauce e callosità basale biancastri. Parti molli ed operculo sconosciuti.

Località-Tipo Gli esemplari studiati provengono da Vinanibe, Tolagnaro, Madagascar Meridionale, spiaggiati e privi delle parti molli

The shell described (from Madagascar) is small, elongated ovoid with a high spire. There are subsutural folds fading away, suture is quite deep. The white parietal and umbilical callus are fused, almost completely occluding the umbilicus, only a sickle-shaped sulcus remains. The shell is brown, with a white base and white subsutural band. Observation of the Holotype (figure 49) shows a shell that closely looks like *N. burnupi* described by Smith in 1903. Protoconch is broken and worn, it has a similar aspect to that of a *N. gualteriana* in the same state of wear.

The species also occurs in Mauritius and on Rodrigues Island (figure 49)



Figure 49. Specimens of *P. parvulus*

features	<i>N. burnupi</i>	<i>P. parvulus</i>	<i>N. gualteriana</i>
H/D (mean ; min – max)	1.30 (1.14 – 1.57) n=14	1.31 (1.20-1.40) n=7	1.09 (1.01 – 1.23) n=82
Ho/H (mean ; min – max)	0.63 (0.51 – 0.73) n=14	0.73 (0.63-0.82) n=5	0.78 (0.59 – 0.87) n=82
Protoconch diameter (µm)	?	≈ 850 (n=2)	829 (670 – 940)
First embryonic whorl diameter	?	Always worn	188 (130 – 230)
Number of protoconch's whorls	?	Always worn	2.75 (2.6 – 3)
Nucleus	?	Always worn	brown
Umbilicus	closed by the umbilical callus	closed by the umbilical callus	variable
Umbilical and Parietal callus	White, merged	White, merged	variable
Shell colour and pattern	Reddish brown. White umbilical area, inconspicuous clear subsutural band	Reddish brown. White umbilical area, white subsutural band	Many possible variations
Operculum	Calcareous: White with one marginal rib. Nucleus grey-brown	Not known	Calcareous: White with one marginal rib. Nucleus grey-brown

Table 6. Comparison of the characters of *N. burnupi*, *P. parvulus* and *N. gualteriana*

Comparison of data and photographs shows that *P. parvulus* is a junior synonym of *N. burnupi*. As Kilburn has correctly shown that the latter is only a very particular form of *N. gualteriana* it is therefore clear that *Natica burnupi* E. A. Smith, 1903 and *Polinices parvulus* Bozzetti, 2010 are junior synonyms of *N. gualteriana*.

It can be noted that these forms are very particular and atypical morphotypes (as said previously probably in connection with a modification of the expression of homeotic genes) No specimen have ever been reported outside the Western Indian Ocean.

Natica balteata Sowerby III, 1914

Natica balteata, n. sp.

Testa ovata, solidiuscula, laevis, albo-straminea, balteo lato fusco-griseo colorata, apice fusco ; spira elatiuscula, ad apicem obtuse exserta ; anfractus 5, convexe declives, laeves, oblique obscurissime plicati ; anfractus ultimus ¾ longitudinis testae aequans, ovatus ; umbilicus clausus ; apertura semilunata ; peristoma acutum ; columella leviter, obliqua, sinistrorsum callose effusa. Operculum testaceum, albo-nitidum, depressum. Alt. 12. maj. diam. 10 mm.

Hab. New Caledonia.

The shell described (figure 50) is smooth, oval in shape, with a fairly high spire, with inconspicuous oblique folds near the suture. Umbilicus is completely filled by a thick white callus. Colour is mainly a broad grey-brownish band, covering more than half of the last whorl. The original picture is unfortunately of poor quality but observation of the holotype (NHMUK 1914.4.2.4 figure 51) shows a fairly elongated shell, grey-beige with bluish-grey spiral, and a white subsutural band. The white parietal and umbilical callus are merged, the umbilicus is almost completely closed. The greyish white calcareous operculum has a single marginal rib and a slightly darker nucleus.



Figure 50. *Natica balteata* Sowerby III, 1914 Holotype. NHMUK 1914.4.2.4 © 1914 New Caledonia Courtesy of the Trustees of the Natural History Museum, London.



Figure 52. *N. gualteriana* CNP-2007-003 Mayotte 12.3

Some specimen of *N. gualteriana* (Figure 52) show such a pattern and callus features.

Size ratios, aperture, pattern, callus and operculum of *Natica balteata* are consistent with the proposition of Kabat (2000) *Natica balteata* Sowerby III, 1914 is a junior synonym of *N. gualteriana*.

***Natica nemo* Bartsch, 1915**

Natica nemo, new species.

Plate 13, figs. 6, 9, 12.

Shell subglobose, narrowly umbilicated, moderately elevated, uniformly cream colored. Nuclear whorls two and one-third, moderately well rounded smooth. Postnuclear whorls well rounded, marked by numerous, very decided notchings, which are strongest near the summit, weakening gradually as they pass over the whorls ; on the early whorls they extend to the suture. Suture feebly impressed. Periphery of the last whorl well rounded. Base well rounded, narrowly umbilicated. The periphery and the base are marked by the feeble continuations of the impressed lines. The umbilicus is almost closed by a strong, spiral callus, which occupies the middle of the umbilical wall. The callus on the parietal wall is interrupted at the posterior termination of the spiral umbilical callus where a deep notch is present ; outer lip thin at the edge, colored very light brown within.

The type has three postnuclear whorls, and the whole shell measures : Length, 14.2 mm. ; diameter, 13.8 mm.

It comes from Port Alfred, and is Cat. No. 187083, USNM. (Coll. No. 625).

The shell described (figure 53) is globular with rounded whorls. The subsutural folds and the shape of the parietal and umbilical calluses which can close the umbilicus are consistent with those of *N. gualteriana*. The H/D (1.03) and Ho/H (0.75) ratios are within the limits of usual variations of *N. gualteriana*. The protoconch of 2.33 whorls seems a bit low for *N. gualteriana* (mean 2.75) but there is no picture nor detailed description, so it is:



Figure 53. *Natica nemo* Bartsch, 1915
Bartsch (1915) Pl XIII Fig 6, 9 South Africa



Figure 54. *Natica nemo* Bartsch, 1915
Holotype USNM 187083
© Department of Invertebrate Zoology, NMNH

There is no sufficient reason to question Kilburn (1972) and Kabat (2000) who gave *Natica nemo* Bartsch, 1915 as a junior synonym of *N. gualteriana*.

***Cochlis migratoria* Powell, 1927**

Cochlis migratoria n. sp. (Figs. 3, 4, 5, 6).

Natica gualteriana of Australian authors. Shell small, semiglobose, fairly solid, polished; spire low, about one-third height of aperture; funicle large leaving at junction with parietal wall a narrow crescentic groove which terminates above in very small rounded umbilicus. Whorls five, smooth, polished, except on shoulder, which is sculptured on all adult whorls with close fine furrows, radiating from suture. Suture abutting. Protoconch minute, depressed, of one and a half whorls. Ground-colour greyish-white; protoconch reddish-brown ; early post-nuclear whorls and broad sutural band, white; body-whorl with four narrow spiral bands of chestnut or purplish-brown; upper two sometimes fused into one broad band; funicle and parietal callus pale-rose, stained darker in places, mostly along edge of parietal callus and umbilical margin of funicle. Operculum typical of *Cochlis* with single marginal sulcus, rather thin and flat, exterior glistening white, interior with yellowish polished horny epidermis.

Powell notes that it is the shell (Figure 55) identified *N. gualteriana* as by previous authors in Australia. Operculum (Figure 56) matches with that of *N. gualteriana*.

Type locality. Australia and New Zealand.

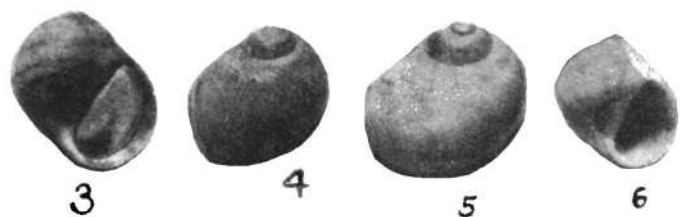


Figure 55. *Cochlis migratoria*, Powell 1927

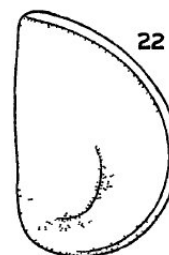


Figure 56. *Cochlis migratoria*, Powell 1927
Powell (1927) Pl 33 Fig 3-6. New Zealand.
Operculum. Powell (1934) Fig 22

The original description of the protoconch could raise a doubt, 1.5 whorl is too low (mean 2.75 in *N. gualteriana*) however, method counting is not specified. Furthermore, in 1934, Powell mentions the value of 3.5 for protoconch of this same species.

Shells from Australia (Figure 57) shows features (colours, pattern, sizes ratio, callus) that are all consistent with those of *N. gualteriana*, as well as the operculum (figure 56).

The five Australian specimens of *N. gualteriana* studied here (or *C. migratoria* if it is a different species present in Australia) all show protoconchs with the features summarized in the table 7.



Figure 57. Various *N. gualteriana* from Australia

Features of protoconch	<i>C. migratoria</i> . (<i>N. gualteriana</i> ?) from Australia	<i>N. gualteriana</i>
Protoconch diameter (µm)	868 (830 – 900)	829 (670 – 940)
First embryonic whorl diameter (µm)	179 (170 – 185)	188 (130 – 230)
Number of protoconch's whorls	2.75 (2.8 – 2.9)	2.75 (2.6 – 3)
Nucleus	brown	brown

Table 7. Comparison of the protoconchs features of *C. migratoria* and *N. gualteriana*

A drawing of the radula, Powell (1934) (Figure 58) Shows a tricuspid rachidian tooth, a serrated lateral, a bifid inner marginal, and the simple outer marginal. This configuration is consistent with that of *N. gualteriana*.

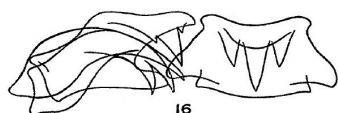


Figure 58. Radula of *C. migratoria*. Powell (1934) Fig. 16

Even the light color and patterns are not specific to the Oceania region since they can be found for East African or Red Sea shells. (Egypt, Kenya. Figure 11)

All the features here examined are therefore consistent with the conclusions of Kilburn (1972), Kabat (1989, 2000), Pastorino & Costa (2012), *Cochlis migratoria* Powell, 1927 is a junior synonym of *N. gualteriana*.

Cochlis vafer n. sp.

Natica gualteriana of Australian authors.

Powell (*Trans. N.Z. Inst.*, vol. 57, p. 560, 1927) has lately described a New Zealand shell from the north Cookian region as *C. migratoria* (see Figs. 34, 36), stating that it is identical with the Peronian *gualteriana* auct., which he shows is not really Récluz's species. I do not think, however, that the specific identity of the New Zealand and Australian shells can be upheld ; apart from the unlikelihood of finding an animal so responsive to environment as a Naticoid unchanged on both sides of the Tasman Sea, comparison of actual specimens shows valid differences. Specimens from Shell Harbour, N.S.W. (whence Powell made his Australian identification) resemble *migratoria* very closely, but are slightly more vertically compressed in whorling, and the base is thus flatter. Especially is the nick between funicle and parietal callus much deeper, so that the umbilical furrow and notch in pillar form a full semicircle, instead of only a quarter to a third of a circle as in *migratoria*. The sutural furrows tend, on the earlier whorls at least, to be coarse and further apart. Colouring and size are the same in the two species.

Here again the author assumes that Australian specimens are representatives of a different species. The comparison of the shell and the holotype (Figures 59, 60) with that of *Cochlis migratoria* shows only a few differences in the shape of the shell, especially at the base and the umbilical callus.

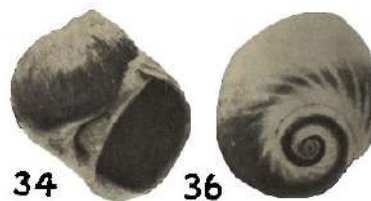


Figure 59. *Cochlis vafer* Finlay, 1930



Figure 60. *Cochlis vafer* Finlay, 1930

Finlay (1930) PI 44 Fig 34, 36

Holotype MA70178 © Auckland Museum CC BY

These differences observed for Australian shells did not convince the following authors. Powell (1934) makes it a synonym of *C. migratoria*. Kilburn (1972) doubts that the two species are valid and the synonymy with *N. gualteriana* is given by Kabat (2000).

The same conclusion which have been done for *C. migratoria* (see above) can therefore be repeated here. *Cochlis vafer* Finlay, 1930 is a junior synonym of *N. gualteriana*.

Conclusion

It can be concluded that the only specific shell characteristics are:

- A subsutural lighter folded area.
- A calcareous white operculum with one rib and a darker greyish nucleus.
- A Protoconch of about 2 ¾ whorls, white with reddish brown nucleus and dark brown suture. Diameter of first embryonic whorl is about 200 µm.

The living animal has a translucent white mantel with brown to reddish spots more numerous on the propodium. The two antennas are stained with dots of the same color.

N. gualteriana is a polymorphic species, it remains impossible to find combinations of features (size, ratios, shape, colour...) typical of a single geographic area (with the exception of the "form" *burnupi* / *parvulus* from West Indian Ocean). We hope that a large-scale genetic analysis for specimens from various geographic origins will be done to determine if genetic isolation of subpopulations has happened over time in the Indo-Pacific area.

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Jaspidiconus laudelinoi sp. nov. & *Jaspidiconus gregorioi* sp. nov. (Gastropoda: Conidae), new species from Bahia State, Northeast Brazil.

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ABSTRACT

Jaspidiconus laudelinoi sp. nov. from Itapuã beach, Salvador city, Bahia State, Brazil is described and compared to *Jaspidiconus itapua* Petuch & Berschauer, 2018 and to juvenile *Stephanoconus regius* (Gmelin, 1791).

Jaspidiconus gregorioi sp. nov. from Itapuã beach, Salvador city, Bahia State, Brazil is described and compared to *Jaspidiconus josei* Petuch & Berschauer, 2016, and to *Jaspidiconus itapua* Petuch & Berschauer, 2018.

RESUME

Jaspidiconus laudelinoi sp. nov. de la plage d'Itapuã, Salvador city, état de Bahia, Brésil est décrit et comparé à *Jaspidiconus itapua* Petuch & Berschauer, 2018 et à *Stephanoconus regius* (Gmelin, 1791) dans sa forme juvénile.

Jaspidiconus gregorioi sp. nov. de la plage d'Itapuã, Salvador city, état de Bahia, Brésil est décrit et comparé à *Jaspidiconus josei* Petuch & Berschauer, 2016 et à *Jaspidiconus itapua* Petuch & Berschauer, 2018.

INTRODUCTION

Following the steps of our mentor, Dr Sérgio Vanin, entomologist at Institute of Biology of University São Paulo USP and passionate shell collector, who passed on 21/10/2020, we created a group of four Malacologist interested in the Conidae family in the surroundings of the Bahia State 2 years ago. We collected and acquired various Conidae and, together, discovered the species described here.



Dr. Sérgio Antônio Vanin (1948-2020)

MATERIAL AND METHOD

Taxonomy follows Monnier, Limpalaër, Robin & Roux (2018). We describe the shell morphology using the terminology established in Röckel *et al.* (1995) and modified in Monnier, Limpalaër, Robin & Roux (2018). Adult specimens were measured using digital calipers, measurement was rounded to the millimeter except for holotypes.

REPOSITORIES

MZSP: Museu de Zoologia da Universidade de São Paulo
OC: Olivier Crabos, reference collection, Salvador, Bahia, Brazil
GO: Geraldo Semer Pomponet Oliveira, reference collection, Salvador, Bahia, Brazil
LA: Laudelino Passos de Almeida, reference collection, Salvador, Bahia, Brazil
GQ: Gregorio Pereira de Queiroz, reference collection, São Paulo, S Paulo State, Brazil

SYSTEMATICS

Family CONIDAE Fleming, 1822

Genus *Jaspidiconus* Petuch, 2003

Jaspidiconus laudelinoi sp. nov.



Figure 1: Holotype of *Jaspidiconus laudelinoi* sp. nov.
MZSP, MZSP152462

Type Material: Holotype and 8 paratypes. The holotype is deposited in the Museu de Zoologia da Universidade de São Paulo, Brazil under the number MZSP152462, the other paratypes are stored in private collections.

Material examined: 8 specimens of *Jaspidiconus laudelinoi* sp. nov. have been studied. The holotype measures 14 mm long and 8 mm wide, and there are 8 paratypes, 2 in the collection of Olivier Crabos (paratype 1 with 15 mm and paratype 2 with 15 mm), 2 in the collection of Laudelino Almeida (paratype 3 with 12 mm and paratype 4 with 14 mm) and 4 in the collection of Geraldo Semer Pomponet Oliveira (paratype 5 with 12,5 mm and paratype 6 with 11,5 mm, paratype 7 with 11 mm, paratype 8 with 11.5 mm).

Distribution and habitat: All studied exemplars are beached, from Itapuã beach, nearby the lighthouse, in Salvador city (Bahia State). We could not find any live specimens yet.

Etymology: This species is dedicated to Laudelino Passos de Almeida, a passionate sheller from Piatã, Salvador, Brazil, a beloved friend.

Description of the shell of *Jaspidiconus laudelinoi* sp. nov.

Jaspidiconus laudelinoi sp. nov. is a small species, from 10 to 15 mm, found in the same shore as *Jaspidiconus itapua* Petuch & Berschauer, 2018.. It is characterized by the same shape as *J. itapua* but can get thinner, it has a constant pattern from ivory to tan, but the more frequent colour is straw, with discrete white patches and nodules on the shoulder.

Comparison:

The differences with *Jaspidiconus itapua* Petuch & Berschauer, 2018 are a smaller size for *Jaspidiconus laudelinoi* sp. nov. a constant straw background colour paler than *Jaspidiconus itapua* Petuch & Berschauer, 2018 (even if *Jaspidiconus itapua* Petuch & Berschauer, 2018 colour is quite variable) and the white patches. We compared it to very young regius shells, these were showing a white background, bigger brown patches, and very protuberant nodules.

SYSTEMATICS

Family CONIDAE Fleming, 1822

Genus *Jaspidiconus* Petuch, 2003

Jaspidiconus gregorioi sp. nov.



Figure 2: Holotype of *Jaspidiconus gregorioi* sp. nov. MZSP, MZSP152460

Type Material: Holotype and 5 paratypes. The holotype is deposited in the Museu de Zoologia da Universidade de São Paulo, Brazil under the number MZSP152460 the other paratypes are stored in private collections.

Material examined: 6 specimens of *Jaspidiconus gregorioi* sp. nov. have been examined. The holotype measures 24 x 14 mm and there are 2 paratypes in the collection of Olivier Crabos measuring respectively 25.6 and 24.4 mm (both were acquired with operculum), 2 in the collection of Geraldo Semer Pomponet Oliveira with 28.0 and 28.5 mm and 1 in the collection of Gregorio Pereira de Queiroz with 22.0 mm.

Distribution and habitat: 2 paratypes were found live in the premises of Itapua beach at depth from 2 to 30 meters, the other 3 were caught dead. The holotype was discovered beached at Itapua Beach by the primary author.

Etymology: The new species is dedicated to Gregorio Pereira de Queiroz, the man from our group who dedicated his passion to shells early in the 70s. He links São Paulo where he lives with Salvador where his heart found his place near Barra Beach and other landscapes from the first historical Capital of Brazil.

Description of the shell of *Jaspidiconus gregorioi* sp. nov.

J. gregorioi is a medium species found exclusively on Itapuã beach. The whole 6 shells are very similar: heavy for their size, quite fat barrel like body with 16 to 18 fainted brown interrupted lines on a pale brown background, white aperture, pale pink protoconch quite flat, shoulders showing about 15 brown spots, rather convex sides.

Comparison: *Jaspidiconus gregorioi* sp. nov. can be compared with *Jaspidiconus josei* Petuch & Berschauer, 2016, that is also found in Itapuã. But *J. josei* often shows a pale blue to lilac background colour, the shell is thinner and lighter with a very pointy protoconch. *Jaspidiconus josei* Petuch & Berschauer, 2016 is around 20 to 21 mm in average size when *Jaspidiconus gregorioi* sp. nov. average is 25 mm.

J. gregorioi sp. nov. can also be compared to *J. itapua* Petuch & Berschauer, 2018: it measures 25 mm against 15 mm for *J. itapua*, the background colour is cream on *J. gregorioi* and pink for *J. itapua*.

Remarks:

There are still many Conidae from Brazil to be described, the richest fauna being the one from Bahia and Espírito Santo at our knowledge.

Nowadays the species we found at Itapuã Beach, Salvador, Bahia are the following ones from more frequent to rarest: *Jaspidiconus itapua*, Petuch & Berschauer, 2018 (endemic) *Stephanoconus regius* (Gmelin, 1791) *Dauciconus (Purpuriconus) archetypus* (Crosse, 1865) *Kohniconus centurio* (Born, 1778) *Jaspidiconus laudelinoi* sp. nov. (endemic) *Jaspidiconus josei* Petuch & Berschauer, 2016 (was said to be endemic, but seems to go Northern, getting scarce in Itapuã) *Dauciconus worki* (Petuch, 1998) *Dauciconus riosi* (Petuch, 1986)

Jaspidiconus gregorioi sp. nov. (endemic)

Dauciconus worki (Petuch, 1998)

Dauciconus riosi (Petuch, 1986)

The more common gastropods species found there are *Gemophos auritula* (Link, 1807), *Leucozonia ocellata* (Gmelin, 1791), *Erosaria acicularis* (Gmelin, 1791) or *Erosaria acicularis marcuscoltroi* Petuch & Myers, 2015, *Columbella mercatoria* (Linné, 1758), *Stramonita rustica* (Lamarck, 1822), *Vasula deltoidea* (Lamarck 1822), dwarf and normal *Cypraea testiculus* (Linné, 1758), *Fissurella rosea* (Gmelin, 1791), *Tonna pennata* (Mörch, 1853), *Polinices uberinus* (D'Orbigny, 1842) and *Eulithidium affine* (C. B. Adams, 1850).

The limiting factor concerning taxonomy is that many different species were found only in one exemplar, and that we have a lack of shells found alive to allow DNA tests that would be desirable to describe new species with full confidence.

Acknowledgements

The authors are grateful to:

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Luiz Simone from MZUSP who is hosting the 2 holotypes. **Bernardo Linhares** from Salvador who started shell collecting in Bahia state and inspired a lot of people like the Coltro brothers for instance.

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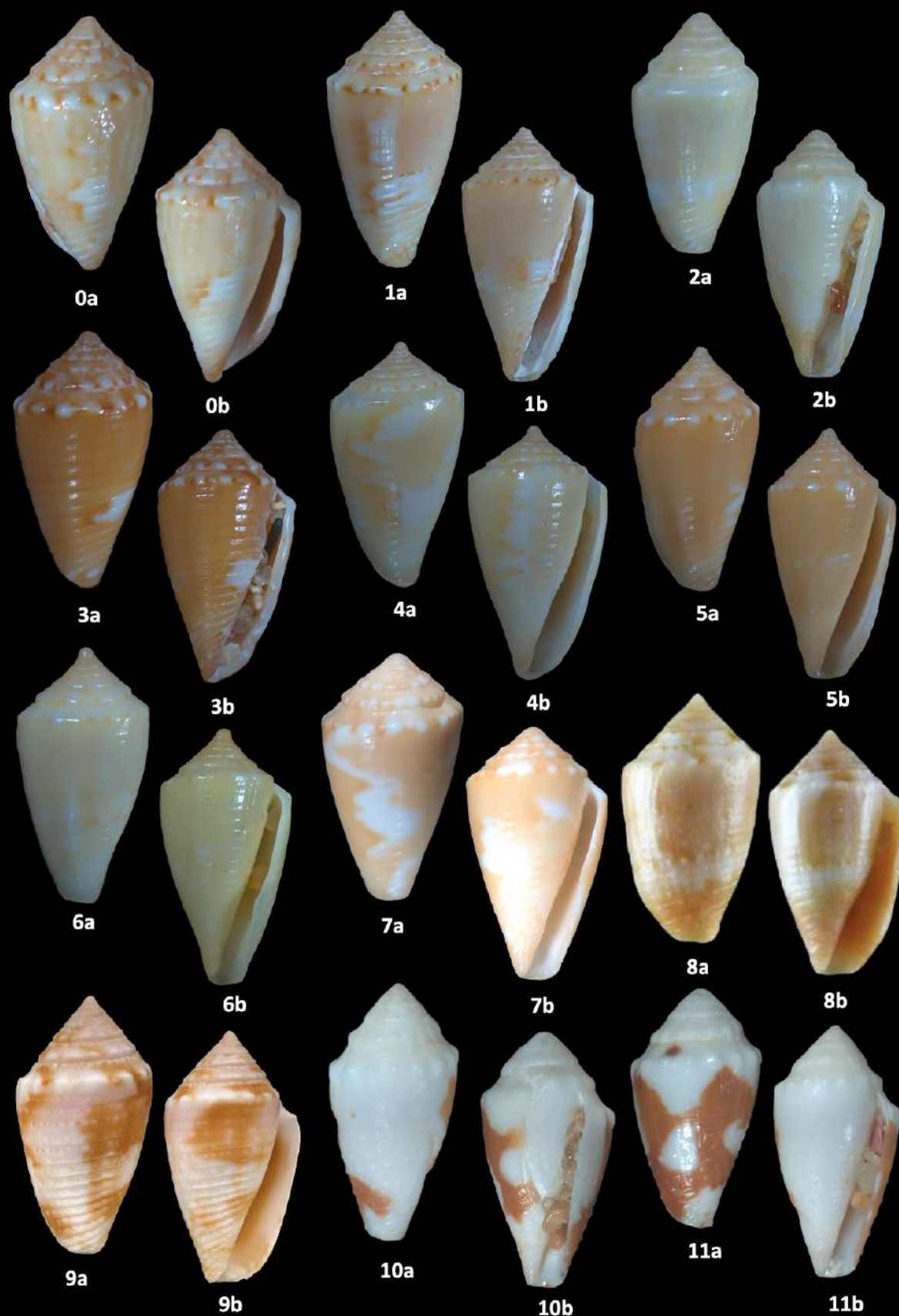
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Lighthouse of Itapuã, Praia de Itapuã, Salvador, Bahia showing the biotope of *Jaspidiconus laudelinoi* sp. nov. & *Jaspidiconus gregorioi* sp. nov.

PLATE 1 *J. laudelinoi* sp. nov. and comparative species.



0a-0b *J. laudelinoi* sp. nov. holotype, 14 x 8 mm MZSP MZSP152462

1a-1b *J. laudelinoi* sp. nov. paratype 1, 15 mm Coll. OC

2a-2b *J. laudelinoi* sp. nov. paratype 2, 15 mm Coll. OC

3a-3b *J. laudelinoi* sp. nov. paratype 3, 12 mm Coll. LA

4a-4b *J. laudelinoi* sp. nov. paratype 4, 14 mm Coll. LA

5a-5b *J. laudelinoi* sp. nov. paratype 5, 12,5 mm Coll. GO

6a-6b *J. laudelinoi* sp. nov. paratype 6, 11,5 mm Coll. GO

7a-7b *J. laudelinoi* sp. nov. paratype 7, 11 mm Coll. GO

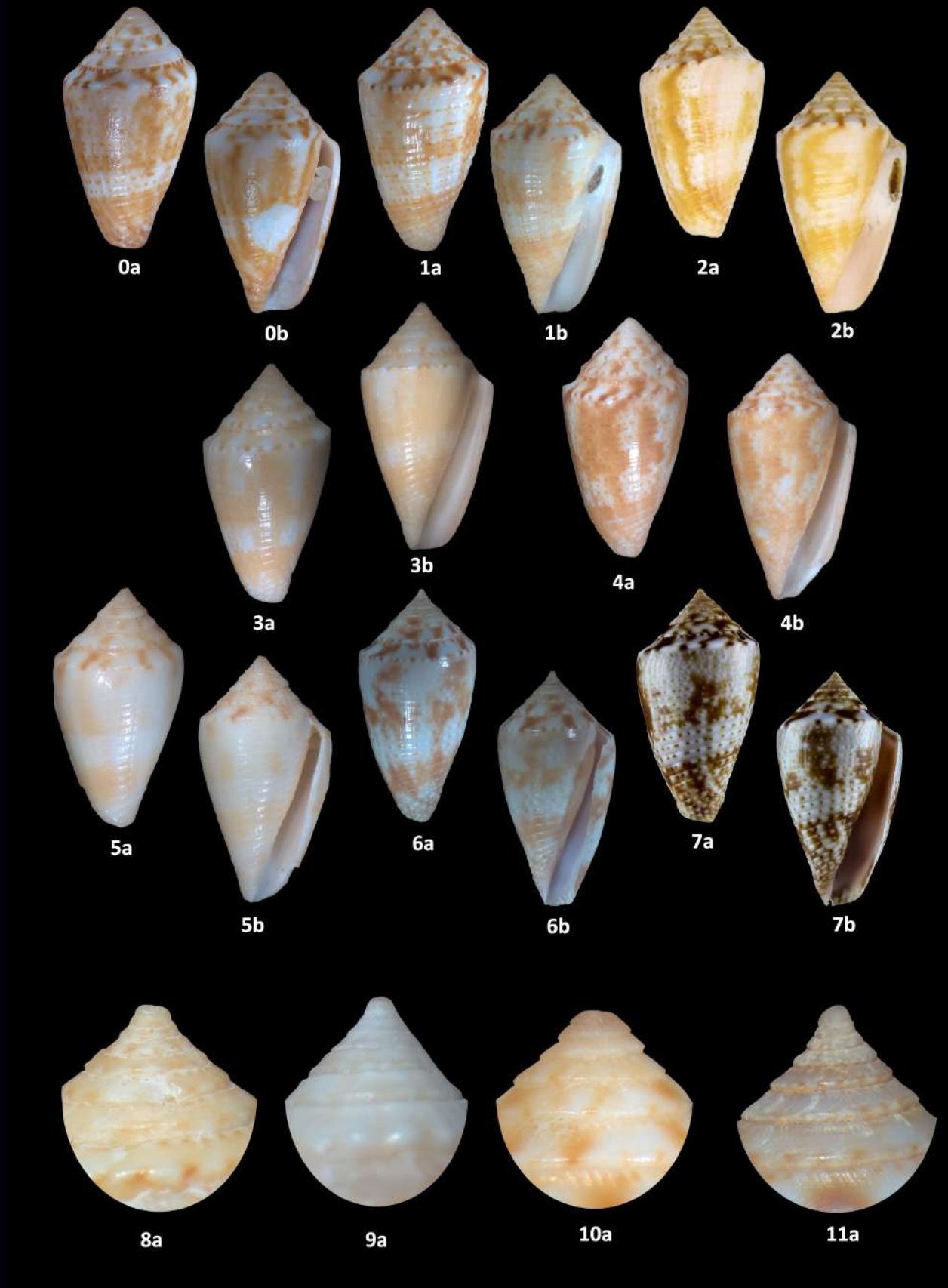
8a-8b *J. itapua* holotype Itapuã, Brazil MZSP 135602, 14.4 mm

9a-9b *J. itapua*, Itapuã, Brazil 13 mm Coll. AP

10a-10b *Stephanoconus regius* juvenile Itapuã 13 mm Coll. OC

11a-11b *Stephanoconus regius* juvenile Itapuã 13 mm Coll. OC

PLATE 2 *J. gregorioi* sp. nov. and comparative species and protoconch of the studied species.



0a-0b *J. gregorioi* sp. nov. holotype, 24 x 12 mm MZSP MZSP152460

1a-1b *J. gregorioi* sp. nov. paratype 1 25.6 mm Coll. OC

2a-2b *J. gregorioi* sp. nov. paratype 2 24.4 mm Coll. OC

3a-3b *J. gregorioi* sp. nov. paratype 3 28 mm, Coll. GO

4a-4b *J. gregorioi* sp. nov. paratype 4 28,6 mm, Coll. GO

5a-5b *J. gregorioi* sp. nov. paratype 5 22.0 mm, Coll. GQ

6a-6b *J. josei* Itapuã low tide 21 mm Coll. OC

7a-7b *J. josei* holotype 20.1 x 10.7 mm MZSP 131315

8a *J. laudelinoi* protoconch details

9a *J. itapua* protoconch details

10a *J. gregorioi* protoconch details

11a *J. josei* protoconch details

SOME NEW MICROSHELLS FROM OMAN (Masirah Is.)

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Abstract

Some new species of microshells found analyzing beached sediment from Masirah Is. (Oman) are illustrated in this paper: the following new species are established, *Alvania albachiarae*, *Alvania masirahensis*, *Merelina iohannae*, *Setia incognita*, *Badepigrus piae*, *Eatonina omanensis*, *Stenothyria cecaluporum*, and *Pedipes bodomoli* for a species already described by Bosch *et al.*, 1995 illustrated but not established as new species; *Barleeia cf. unifasciata*, *Pisinnia cf. boucheti* and *Zafra phaula* are also illustrated.

Resumé

Quelques nouvelles espèces de micro-coquillages trouvées par analyse de sédiments de Masirah Is. (Oman) sont illustrées et les nouvelles espèces suivantes sont décrites: *Alvania albachiarae*, *Alvania masirahensis*, *Merelina iohannae*, *Setia incognita*, *Badepigrus piae*, *Eatonina omanensis*, *Stenothyria cecaluporum*, and *Pedipes bodomoli* pour une espèce déjà décrite par Bosch *et al.*, 1995 illustrée mais non décrite comme nouvelle espèce; *Barleeia cf. unifasciata*, *Pisinnia cf. boucheti* and *Zafra phaula* sont aussi illustrées.

Keywords

Mollusca, Gastropoda, Rissooidea, Truncatelloidea, Cingulopsidea, Ellobioidea, Masirah, Oman.

Introduction

Specific works on Persian Gulf material were made by Melvill and Melvill & Standen between 1893-1918 and later by Bosch & Bosch, 1982 and Bosch *et al.*, 1995.

Today the interest in this area seems to have renewed, especially for Oman with recent articles published in the *Xenophora* magazine.

Two of my journeys in Masirah Isl., SE Oman, allow me to report microshells found from the beached sediment examination, some new for Science: 4 Rissoidae, 1 Barleeiidae, 2 Anabathridae, 1 Cingulopsidae, 1 Stenothyridae and 1 Ellobiidae, already reported by Bosch *et al.* (1995) but not established as a valid species.

Material and method

All the materials comes from the beached sediment examination reported from Masirah Isl. (Oman), 20°24.50'N-58°49.20'E, Feb-Nov 2018; the species are described and illustrated with color and SEM photos.

Abbreviation

W/H - width/height ratio.

MNHN - Muséum National d'Histoire Naturelle, Paris, France.

NMR - Natural History Museum Rotterdam.

n. sp. - new species.

SEM - Scanning Electron Microscope.

SPF - Superfamily.

SPF CINGULOPSIDEA Fretter & Patil, 1958

Family **Cingulopsidae** Fretter & Patil, 1958

Genus **Eatonina** Thiele, 1912

Type taxon **Eatonina pusilla** (Thiele, 1912)

Eatonina omanensis n. sp.

(Plate 1, figs. a-c)

Type material

Holotype - (MNHN-IM-2000-36179), 0.82 x 0.58 mm.

Paratype 1- 4 (Perugia coll., Ravenna, Italy).

Etymology

omanensis from type locality.

Type locality Oman, Masirah Is.

Material examined

Oman, Masirah Is., beached sediment, 20°24,50'N-58°49,20'E, spms 8, Nov2018.

Description

Shell minute, ovate-conical, solid, smooth, semitransparent. Proto dom-shaped, transition to teleo indefinable; a total of 3,5 convex whorls, the last about 80% of total height, sutures impressed, aperture circular, outer lip thin, continuous, umbelical narrow partially hidden by outer lip. Background colour orange-brown with a white band under suture, darker umbelical area; the orange aperture shows the upper white band. Operculum and soft parts unknown.

Comparison

In Indian Ocean are reported only three species of the genus *Eatonina* Thiele, 1912:

E. pulicaria (Fischer, 1873) from La Réunion and Mauritius easily recognizable having an opaque white background color with brown spots, regularly spaced and more or less extended on all surface, and less convex whorls;

E. halia (Bartsch, 1915) from South Africa has a "broadly ovate" shape and uniform light brown color; *E. albachiarae* Perugia, 2011 from South Madagascar having opaque white color with protoconch brown and two brown narrow bands on the base, in the last whorl shows six axial rectangular semitransparent patches.

SPF RISSOOIDEA Gray, 1847

Family **Rissoidae** Gray, 1847

Genus **Alvania** Risso, 1826

Typetaxon **Alvania cimex** (L., 1758)

Alvania albachiarae n. sp.

(Plate 1, figs. d-f)

Etymology

albachiarae, after my granddaughter Albachiara Perugia.

Type material

Holotype - (MNHN- IM-2000-36180), 1.88 x 1.13 mm.

Paratype 1 - 2.00 x 1.15 mm (Perugia coll., Ravenna, Italy).

Paratype 2 - 1.97 x 1.14 mm (Perugia coll., Ravenna, Italy).

Paratype 3 - 1.87 x 1.07 mm (Perugia coll., Ravenna, Italy).

Type locality Oman, Masirah Is.

Material examined

Oman, Masirah Is., beached sediment, 20°24,50'N-58°49,20'E, spms 4, Nov2018.

Description

Shell small for the genus, conical, sutures impressed. Protoconch paucispiral of 2 smooth rounded whorls. Teleoconch of 3 slightly convex whorls; sculpture of 4 equidistant spiral cords (other 5 in the base under the insertion of the outer lip) crossed by weaker axial ribs, about 24 on the last whorl; evident beads at each intersections. Aperture subcircular internally smooth, outer lip not thickened, umbilical barely visible. Shell semitransparent, background color white, embryonic whorl red-brown, first and fourth spiral cords yellow with orange spots regularly spaced (about 8 on the last whorl). Operculum and soft parts unknown.

Comparison

Bosh et al. (1995), describes and publishes the SEM photo of *Alvania* cf *mahimensis* Melvill, 1893 present in Masirah Is. The color is similar "White with a spiral red band below sutures and another around base"; differs by having a sculpture of 6 spiral cords vs 4, less impressed sutures and larger size, 2.5 vs 2.0 mm. The species does not correspond to *Pseudomerelina mahimensis* (Melvill, 1893) illustrated in Ponder (1984). Hasegawa, 2006 published *Alvania isolata* (Laseron, 1956), quite similar in shape and color to *A. albachiarae* n. sp. but the images in Ponder (1985), show the different protoconch sculptured with spiral keels.

***Alvania masirahensis* n. sp.**

(Plate 1, figs. g-i)

Type material

Holotype - (MNHN-IM-2000-36181), 2.02 x 104 mm.
Paratype 1 - 1.90 x 0.99 mm (Perugia coll., Ravenna, Italy).
Paratype 2 - 1.75 x 0.92 mm (Perugia coll., Ravenna, Italy).

Etymology

masirahensis, from type locality.

Type locality Oman, Masirah Is.

Material examined

Oman, Masirah Is., beached sediment, 20°24,50'N-58°49,20'E, spms 5, Nov2018.

Description

Shell small for the genus, conical, sutures impressed and wide, color white, opaque. Protoconch paucispiral of 1/1.5 smooth whorls. Teleoconch of 3.5 whorls; sculpture of equidistant spiral cords, 3 in the first 2 whorls, 4 in the following last whorls where a 4th starts immediately after the suture, other 3 in the base under the insertion of the outer lip. The spirals are crossed by axial ribs, about 16 on the last whorl; beads at each intersections; cords and ribs with same of the same thickness. Aperture subcircular with 4/5 teeth inside, outer lip moderately thickened, umbilical barely visible. Operculum and soft parts unknown.

Comparison

For the south Indian Ocean are reported: *Alvania fenestrata* (Krauss, 1848) from South Africa and *Alvania ignota* Cecalupo & Perugia, 2009 from South Madagascar. In the drawings of *A. fenestrata* a completely different pointed and conical proto is highlighted, differs in shape and smaller size, 1.5 x 0.8 mm with a ratio W/H 0.53; *A. ignota* has different protoconch, larger size 2.42 x 1.40 mm with a ratio W/H 0.55-0.58 vs 0.49-0.51 and sutures less deep.

Genus *Setia* H. Adams & A. Adams, 1852

Typetaxon *Rissoa pulcherrima* Jeffreys, 1848

***Setia incognita* n. sp.**

(Plate 2, figs. a-c)

Type material

Holotype - (MNHN-IM-2000-36183), 1.20 x 0.70 mm.
Paratype 1- 1.20 x 0.69 mm (Perugia coll., Ravenna, Italy).

Etymology

incognita, from latin *incognitus*, a, um, in English unknown.

Type locality

Oman, Masirah Is.

Material examined

Oman, Masirah Is., beached sediment, 20°24,50'N-58°49,20'E, spms 2, Nov2018.

Description

Shell minute, ovate-conical, smooth, transparent. Protoconch dom-shaped, in poor condition but, under SEM, the last whorl shows few thin distinct spiral threads; transition to teleoconch indefinable. Shell has a total of 3.5 convex whorls, the last about 70% of total height, sutures impressed, aperture circular, outer lip thin, continuous, umbilicus narrow partially hidden by outer lip and a rather complex coloring. Protoconch brownish, teleoconch with first whorls whitish top half, lower brown; main whorls transparent, vitreous, yellowish background color with 2 bands of white square spots, the first sub-sutural, the second emerging from the insertion of the outer lip. The spots, initially regularly spaced, merge in a continuous band approaching the outer lip; the second band is bounded, above and below, by two thin obsolete brownish lines, evanescent towards the outer lip. Operculum and soft parts unknown.

Comparison

WoRMS lists many species of the genus *Setia* of Mediterranean, Atlantic and some of Indo-Pacific none of the Indian Ocean. In shape it approaches *Setia pulcherrima* (Jeffreys, 1848) and for the colored bands of the last whorl *S. valvatoidea* (Milaschewitch, 1909), both with an Atlantic/Mediterranean distribution.

Etymology

incognita, from latin *incognitus*, a, um, in English unknown.

Family *Lironobidae* Ponder, 1967

Genus *Merelina* Iredale, 1915

Typetaxon *Rissoa cheilostoma* Tenison Woods, 1877

***Merelina iohannae* n. sp.**

(Plate 1, figs. j-l)

Type material

Holotype - (MNHN-IM-2000-36182), 1.98 x 0.87 mm.
Paratype 1- 1.85 x 0.83 mm (Perugia coll., Ravenna, Italy).
Paratype 2 - 1.90 x 0.83 mm (Perugia coll., Ravenna, Italy).

Etymology

iohannae, after my wife Giovanna Maria Viti.

Type locality Oman, Masirah Is.

Material examined

Oman, Masirah Is., beached sediment, 20°24,50'N-58°49,20'E, spms 3, Nov2018.

Description

Shell small, conical, non-umbilicate, sutures wide, deep and slightly channeled, color white. Protoconch paucispiral of 2 whorls, the 2nd shows 4 lines of minute grains. Teleoconch of 4 slightly convex whorls; sculpture of 12 predominant orthocline axial ribs crossed in the middle by 2 spiral cords, equidistant between them and from the sutures, other 2 strong cords on the base of the shell. Under SEM the entire surface, clearly eroded, appears crossed by very fine dense spiral lines. Aperture circular with duplicate peristoma; interspaces with a broad excavation furrowed by many very thin threads. Operculum and soft parts unknown.

Comparison

Merelina iohannae n. sp. shows a remarkable resemblance to *Merelina cancellata* Criscione & Ponder, 2011 which differs mainly by having flatter sutural ramps and only 2 more robust spiral cords at the base.

Family **Barleeiidae** Gray, 1857

Genus **Barleeia** W. Clark, 1853

Typetaxon ***Barleeia unifasciata*** (Montagu, 1803)

Barleeia cf unifasciata (Montagu, 1803)

(Plate 3, figs. a-c, d; e-h)

(Bosch et al., 1995 (pag. 48: *Barleeia* sp. 140)).

Figured specimens

(MNHN-IM-2018-2006) 2.93 x 1.55 mm.

2.37 x 1.30 mm (Perugia coll., Ravenna, Italy).

Material examined.

Oman, Masirah Is., beached sediment, 20°24,50'N-58°49,20'E, spms 27, Nov2018.

Remarks

The genus *Barleeia* has a wide infraspecific variability of shape, size and color. Few other species of the Barleeidae family are known from the Western Indian Ocean: *Barleeia microthyra* Martens, 1880 from La Réunion and Mauritius, *B. smithi* Bartsch, 1915 from S. Africa, *B. tropica* Thiele, 1925 and *B. malgascia* Cecalupo & Perugia, 2009 from South Madagascar, all clearly different.

B. unifasciata (Montagu, 1803) is known from the Mediterranean and from East Atlantic, from British Isles (Graham, 1988) to Canary Isl. (Ardevini & Cossignani, 2004); this species, first report from Northern Indian Ocean, has some small differences, less convex whorls, less impressed sutures and a more strictly conical shape, which may be acceptable in the wide range of variability of the species.

The images in Ardevini & Cossignani, 2004 from Morocco and in NMR (www.nmr-pics.nl) from Trapani (Italy), are very similar in color.

Some specimens (Perugia coll.) of *B. unifasciata* are illustrated: 2 from Italy, Capraia Is., - 45 m, 2.70 x 1.47 mm (Tyrrhenian Sea) and Porto Cesareo, beach, 3.27 x 1.67 mm (Ionian Sea), 1 from Spain, Ribadeo, beach, 2.90 x 1.75 mm (Gulf of Biscay, Atlantic Ocean) and 1 fossil from Stirone river, 3.23 x 1.57 mm (Quaternary, Parma, Italy).

SPF TRUNCATELLOIDEA Gray, 1840

Family **Anabathridae** Keen, 1971

Genus ***Pisinna*** Monterosato, 1878

Typetaxon ***Pisinna glabrata*** (Munhofeld, 1824)

Pisinna cf boucheti Palazzi, 1982

(Plate 2, figs. d-f)

Figured specimen

(MNHN-IM-2018-2007), 1.20 x 0.65 mm.

Type locality Gesira, near Mogadiscio, Benadir, South Somalia, East Africa.

Material examined

Oman, Masirah Is., beached sediment, 20°24,50'N-58°49,20'E, spms 3, Nov2018.

Description

Shell very small, pupiform, solid, smooth, surface glossy. Protoconch of about 2 whorls, dome-shaped, smooth; under SEM it shows a surface minutely pitted. Teleoconch of 2.5 convex whorls, body whorl large, smooth except for growth lines. Aperture obliquely oval, peristome continuous, sutures impressed. No varix, umbilicus absent. Colour purple-red, on the last whorl it shows an abapical pale whitish narrow band; aperture yellow. Soft parts unknown.

Remarks

The species of the genus *Pisinna* reported from Indian Ocean are only *P. boucheti* and *P. ponderi* both Palazzi (1982) from Somalia. This species from Oman differs from the holotype only in the color, purple-red vs chestnut in holotype, size (max 1.41 x 0.70 mm) and shape correspond.

Genus ***Badepigrus*** Iredale, 1955

Typetaxon ***Badepigrus badius*** (Petterd, 1884)

***Badepigrus piae* n. sp.**

(Plate 2, figs. g-i)

Type material

Holotype (MNHN-IM-2000-36184), 1.20 x 0.67 mm.

Etymology

piae, after Pia Viti of Matera, Italy.

Type locality Oman, Masirah Is.

Material examined

Oman, Masirah Is., beached sediment, 20°24,50'N-58°49,20'E, spm 1, Nov2018.

Description

Shell very small, oval, solid, smooth, semitransparent, colorless, vitreous, sutures. Protoconch dom-shaped of about 1.5 whorls, under SEM shows a scattered surface by microscopic weak incised holes. Teleoconch of 2.5 slightly convex smooth whorls, the last about 75% of total height; under SEM they show few very thin growth lines; sutures impressed. A deep wide umbilical fissure separates an aperture oval and flat on the top from the body of the last whorl; outer lip continuous. Soft parts unknown.

Comparison

Five species of the genus *Badepigrus* Iredale, 1955, are known, all from Australia; more similar is *Badepigrus pupoides* (H. Adams, 1865) which differs for the color pale orange brown, is more elongated with the last whorl 66% of height while *B. piae* n. sp. is colorless, oval with the last whorl of 75%.

Family **Stenothyridae** Tryon, 1866

Genus ***Stenothyra*** Benson, 1856

typetaxon ***Stenothyra deltae*** (Benson, 1837)

***Stenothyra cecaluporum* n. sp.**

(Plate 4, figs. a-d)

Type material

Holotype - (MNHN-IM-2000-36185), 1.20 x 0.45 mm.

Paratype 1 - (MNHN-IM-2000-36186), 1.07 x 0.43 mm.

Paratype 2 - 8 (Perugia coll., Ravenna, Italy).

Etymology*cecaluporum*, dedicated to the family of Alberto Cecalupo, the friend with whom I shared travels, researches and the many works on Cerithiopsidae.**Type locality** Oman, Masirah, beached sediment.**Material examined**

Oman, Masirah Is., beached sediment, 20°24,50'N-58°49,20'E, spms 36, Feb/Nov 2018.

Description

Shell minute, cylindrical, smooth, semitransparent. Protoconch of about 1.5 whorls; a total of 4.5 whorls, the last about 75% of total height, sutures moderately impressed, aperture near circular, outer lip thin, continuous, umbilicus narrow partially hidden by outer lip. Background colour orange-brown. Soft parts unknown.

RemarksThe shell is temporarily inserted in the Stenothyridae family. The stenothyrids are not purely marine but rather brackish while this rather common species is found on the south side of Masirah Is., coast totally exposed to the Indian Ocean characterized by black rocks alternating with beaches. The shape of *Stenothyra cecaluporum* n. sp. is similar to the more solid species of the genus *Badepigrus* Iredale, 1955, and has a smaller size than the species of the family (see Okutani, 2000 and Golding, 2014).**SPF BUCCINOIDEA Rafinesque, 1815**Family **Columbellidae** Swainson, 1840Genus ***Zafra*** A. Adams, 1860Typetaxon ***Zafra mitriformis*** A. Adams, 1860***Zafra phaula*** (Melvill & Standen, 1901)

(Plate 4, figs. i-m)

Figured specimens

(MNHN-IM-2018.2008) (fig. K) 3.23 x 1.33 mm; (fig. I) 3.21 x 1.30 mm; (fig. L) 3.33 x 1.33 mm; (fig. J) 3.10 x 1.23 mm; (fig. M) 3.20 x 1.35 mm (Perugia coll. Ravenna, Italy).

Type locality

Karachi.

Material examined

Oman, Masirah Is., beached sediment, 20°24,50'N-58°49,20'E, spms 6, Nov2018.

SPF ELLOBIODEA Pfeiffer, 1854 (1822)Family **Ellobiidae** Pfeiffer, 1854 (1822)Genus ***Pedipes*** A. Ferussac, 1821Typetaxon ***Pedipes pedipes*** (Bruguière, 1789)***Pedipes bodamoli* n. sp.**

(Plate 4, figs. e-h)

Pedipes sp. in Bosch et al., 1995 (pag. 184, *Pedipes* sp. 857)**Type material**

Holotype (MNHN-IM-2018-36187), 9.60 x 5.90 mm.

Paratype 1 - (MNHN-IM-2018-36188), 4.50 x 3.90 mm.

Paratype 2 - 5 (Perugia coll., Ravenna, Italy).

Etymology*bodamoli*, name derived from the names Bosch, Dance, Moolenbeek and Oliver who first reported and described the species.**Type locality** Oman, Masirah Is.**Material examined**

Oman, Masirah Is., beached sediment, 20°24,50'N-58°49,20'E, spms 13, Feb/Nov 2018; beached sediment, 20° 27,42' N-58° 46,40'E, spms 2, Nov2018

Description in Bosch et al., 1995*"13 mm. Solid, dull, ovate, short spired, sutures appressed, very large last whorl with inner lip narrowly separated from adjacent wall, umbilicus very narrow; protoconch not seen. Sharp fold on parietal wall, 2 rounded, columellar folds. Unevenly spaced, spiral threads crossed by fine, obliquely axial lines. Orange-brown fading to white. May be an undescribed species. Habitat: beached, probably from mud flats. Distribution: Gulf of Oman, Masirah, Southern Oman."*

Additional description: protoconch small of about two whorls with inclination of about 120°, transition to teleoconch indefinable, apical nucleus partially immersed in the first whorl of the teleoconch (heterostrophic type). Smooth, simple outer lip without denticles.

RemarksMartins (2007: 4, 5) illustrating the protoconches of the Ellobiidae family in figs 42, 43 shows the protoconch of the genus *Pedipes* of anastrophic type while in *Pedipes bodamoli* n. sp. it is of heterostrophic type corresponding to the genus *Melampus* Montfort, 1810, figs 51, 52.**Acknowledgements**

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Plate 1

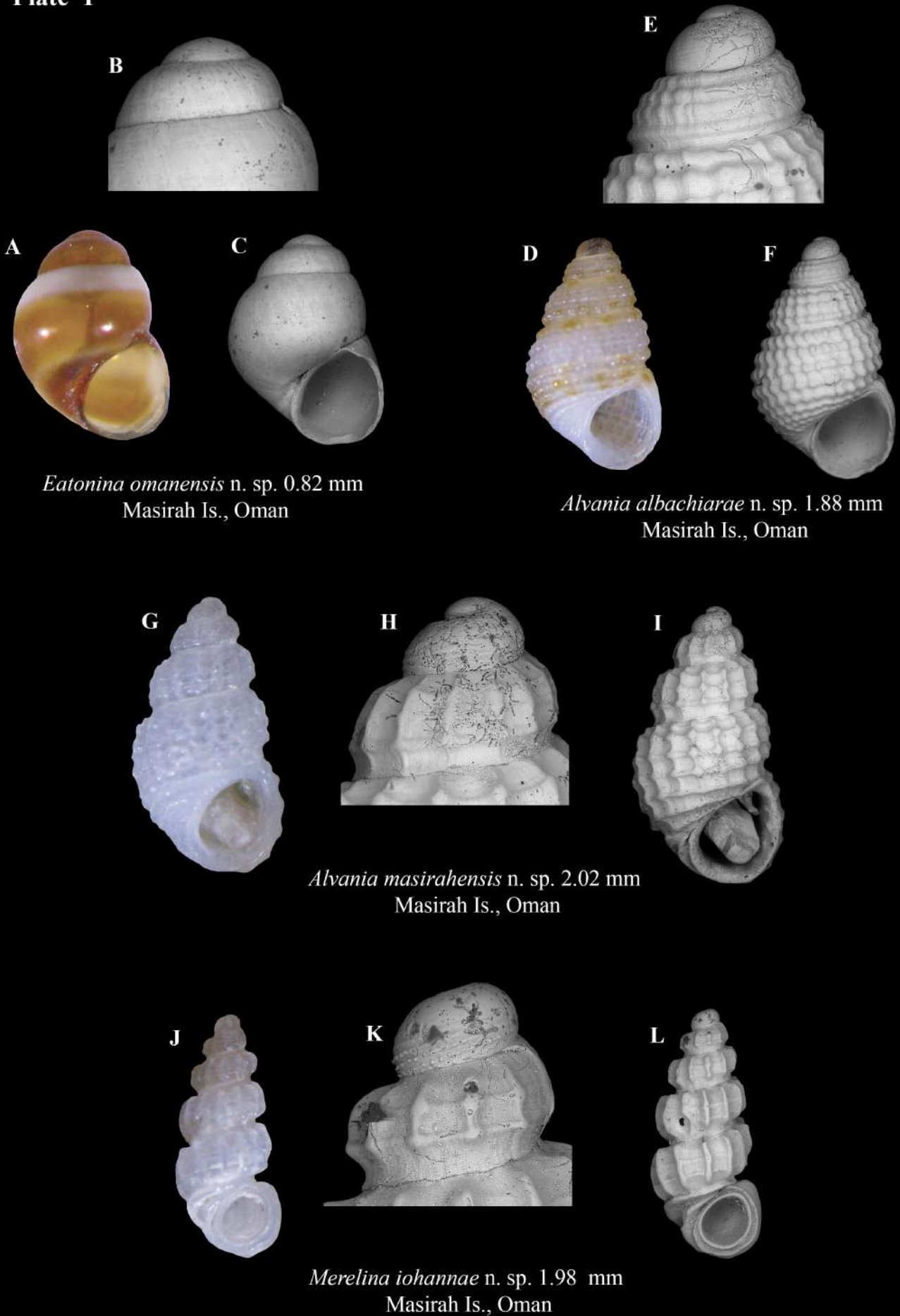


Plate 2

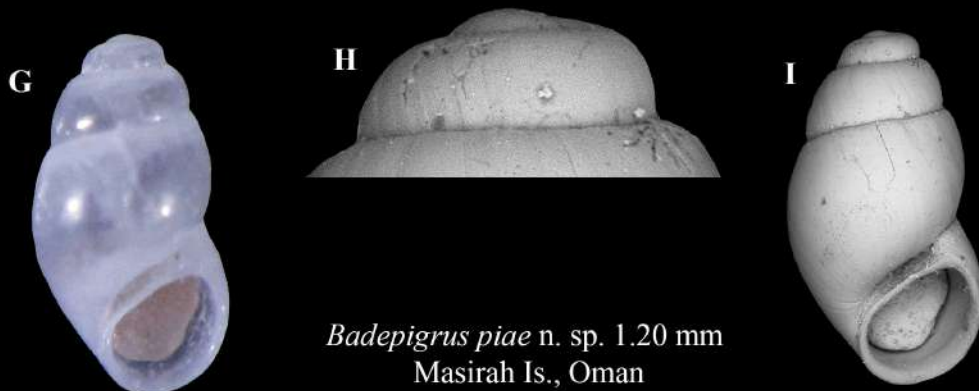
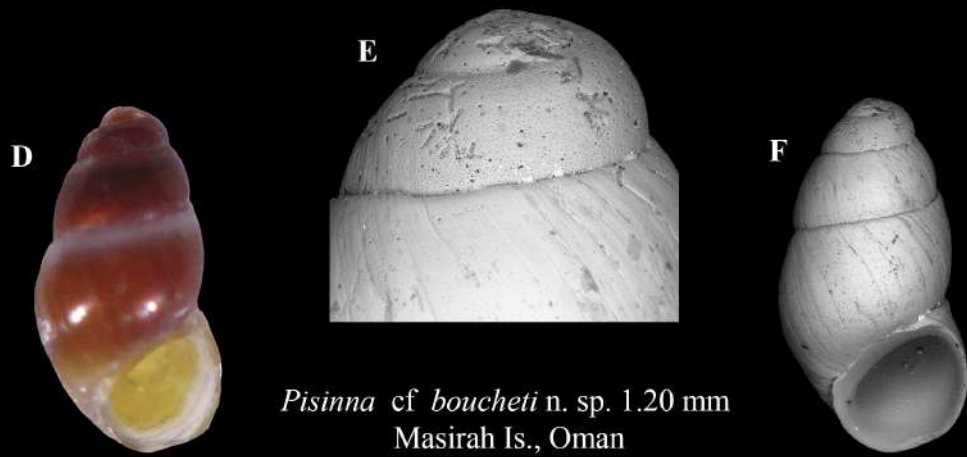
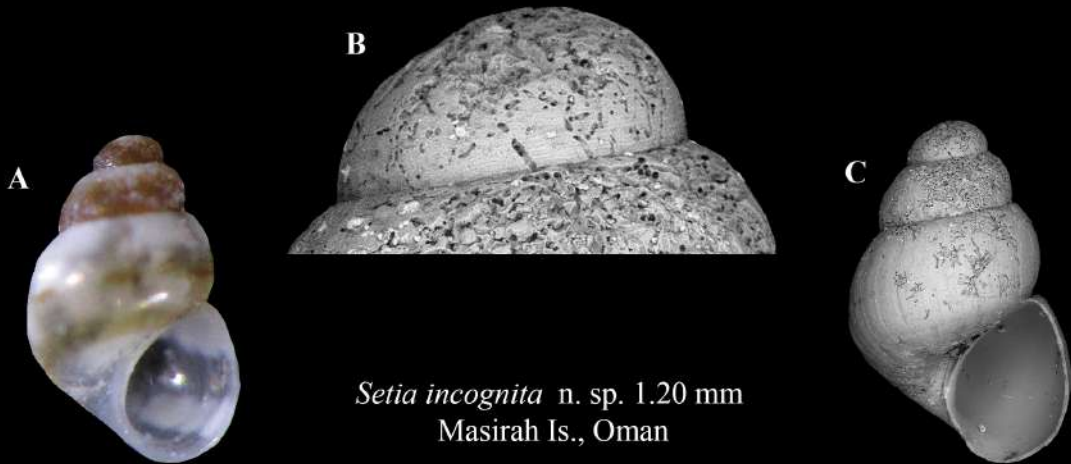
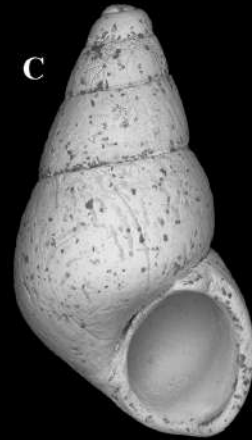


Plate 3



Barleeia cf. *unifasciata* 2.93 mm
Masirah Is., Oman



Barleeia cf. *unifasciata* 2.93 mm
Masirah Is., Oman



Barleeia *unifasciata* 3.27 mm
Pto Cesareo, beach, Italy



Barleeia *unifasciata* 2.90 mm
Ribadeo, beach Spagna



Barleeia *unifasciata* 2.70 mm
Capraia Is. -45, Italy.

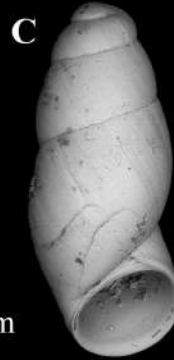
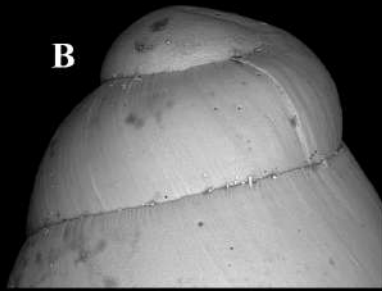


Barleeia *unifasciata* 3.23 mm
Quaternary Parma, Italy

Plate 4



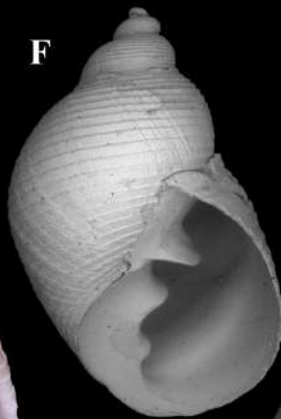
Stenothyra cecaluporum n. p. 1.20 mm
Holotype Masirah Is., Oman



Stenothyra cecaluporum n. p. 1.07 mm
Paratype 1, Masirah Is., Oman



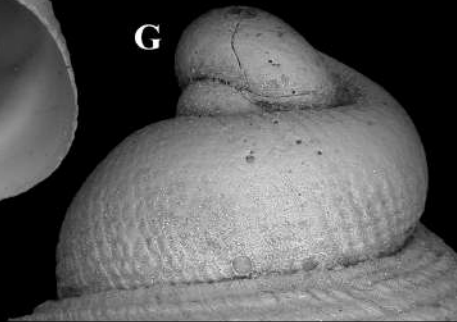
F



Pedipes bodomoli n. p. 9.60 mm
Holotype Masirah Is., Oman



G



Pedipes bodomoli n. p. 9.60 mm
Paratype 1, Masirah Is., Oman



J



Zafra phaula
3.10 mm

L



Zafra phaula
3.33 mm

I



Zafra phaula
3.21 mm

K



Zafra phaula (Melvill, & Standen, 1901)
3.23 mm, Masirah Is., Oman

M



Zafra phaula
3.20 mm