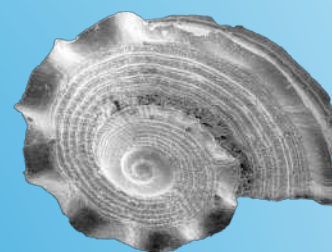




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T A X O N O M Y

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"Parfois je lève la tête et regarde mon frère l'Océan avec amitié: il feint l'infini, mais je sais que lui aussi se heurte partout à ses limites, et voilà pourquoi, sans doute, tout ce tumulte, tout ce fracas"

Romain Gary,
"La promesse de l'aube"(1960)

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Phasmoconus (Phasmoconus) vegaluzi sp. nov. (Gastropoda: Conidae), new species from the Bali Strait and S.E. Java, Indonesia.

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ABSTRACT

Phasmoconus (Phasmoconus) vegaluzi sp. nov. from the Bali Strait and S.E. of Java, Indonesia is described and compared with *P.(P.) broderipii* (Reeve, 1844); *P.(P.) zandbergeni* (Filmer & Moolenbeek, 2010); *P.(P.) collisus* (Reeve, 1849), *P.(P.) lynceus* (Sowerby II, 1858) and with 4 species of the *P.(P.) inscriptus* (Reeve, 1843) complex.

RESUME

Phasmoconus (Phasmoconus) vegaluzi sp. nov. du Déroit de Bali et S.E. Java, Indonésie est décrit et comparé à *P.(P.) broderipii* (Reeve, 1844) ; *P.(P.) zandbergeni* (Filmer & Moolenbeek, 2010) ; *P.(P.) collisus* (Reeve, 1849) et *P.(P.) lynceus* (Sowerby II, 1858) et avec 4 espèces du complexe *P.(P.) inscriptus* (Reeve, 1843).

INTRODUCTION

During these last 2 years several specimens of *Phasmoconus* sp. were dredged by fishermen at about 60-120 m deep in the waters of the S.E. Java and in the Bali Strait. In a preliminary analysis we thought that this was the rediscovery of the enigmatic and very rare *P.(P.) broderipii*. However, the morphology, size and pattern of the shells of this population clearly cannot fit with the species cited.

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 and weighted in a scale to the nearest 0.1 gram. Graphical morphometric comparisons of the five taxa of *Phasmoconus broderipii* / *zandbergeni* / *collisus* / *lynceus* complex of species was also performed by the authors. 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. The distribution map was generated using the general bathymetric map of the American National Geospatial-Intelligence Agency.

Specimens available through pictures only have been measured by their owners for SL while MD, AH and HMD have been estimated using the rule of three through the proportions of the shell in the photograph.

REPOSITORIES

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

MNCN: Museo Nacional de Ciencias Naturales, Madrid, Spain

NBC: Naturalis Biodiversity Center, Leiden, The Netherlands.

NHMUK: Natural History Museum of United Kingdom, London, UK.

EM: Eric Monnier reference collection, Paris, France.

FP: Fabrice Prugnaud reference collection, Suresnes, France.

LL: Loïc Limpalaër reference collection, Haudivillers, France.

PK: Paul Kersten reference collection, Hoornaar, Netherlands.

RVL: Ricardo Vega Luz reference collection, Malaga, Spain.

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

Shell morphometry
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) vegaluzi* sp. nov.

(Plate 1, Figs. 0-8; Plate 2, Figs. 9-17; Plate 3, Figs. 18-25)

Type material: Holotype and 25 paratypes. The holotype is deposited in the Muséum National d'Histoire Naturelle, Paris, France under the number MNHN-IM-2000-35771 (ex-Eric Monnier's collection). The paratype 1 is in MNCN, and the other paratypes are stored in private collections.

(see Table 1 for details)

Material examined: 26 specimens of *Phasmoconus (Phasmoconus) vegaluzi* sp. nov. have been examined and studied.

Type locality: Bali Strait, Indonesia

Figure 1: Holotype of *Phasmoconus (Phasmoconus) vegaluzi* sp. nov. MNHN IM-2000-35771

	Institution	Dimensions - Weight SL x MD x W (mm x mm x g)	Locality
Holotype	MNHN IM-2000-35771	38.29 x 17.90 x 4.0	Bali Strait, S.E. Bali
Paratype 1	MNCN	34.00 x 17.00 x 4.0	Bali Strait, S.E. Bali
Paratype 2	Coll. EM	51.43 x 25.24 x 14.2	Bali Strait, S.E. Bali
Paratype 3	Coll. EM	40.55 x 21.33 x 7.5	Bali Strait, S.E. Bali
Paratype 4	Coll. EM	51.16 x 24.87 x 10.7	Bali Strait, S.E. Bali
Paratype 5	Coll. EM	38.50 x 19.38 x 5.8	Bali Strait, S.E. Bali
Paratype 6	Coll. EM	40.74 x 20.80 x 6.5	Bali Strait, S.E. Bali
Paratype 7	Coll. EM	46.38 x 23.72 x 10.1	Bali Strait, S.E. Bali
Paratype 8	Coll. FP	45.44 x 22.04 x 10.0	Bali Strait, S.E. Bali
Paratype 9	Coll. FP	39.30 x 19.79 x 7.5	Bali Strait, S.E. Bali
Paratype 10	Coll. LL	45.86 x 21.32 x 6.9	Bali Strait, S.E. Bali
Paratype 11	Priv. Coll	43.13 x 21.17 x 7.3	Bali Strait, S.E. Bali
Paratype 12	Priv. Coll	49.51 x 26.30 x 12.6	Bali Strait, S.E. Bali
Paratype 13	Priv. Coll	49.85 x 23.74 x 9.1	Bali Strait, S.E. Bali
Paratype 14	Priv. Coll	50.80 x 23.00 x ?	Bali Strait, S.E. Bali
Paratype 15	Coll. PK	38.50 x 19.61 x 7.2	Aru Isl., Indonesia
Paratype 16	Priv. Coll	43.10 x 21.20 x ?	Bali Strait, S.E. Bali
Paratype 17	Priv. Coll	45.25 x 22.38 x ?	Bali Strait, S.E. Bali
Paratype 18	Priv. Coll	50.90 x 24.62 x ?	Bali Strait, S.E. Bali
Paratype 19	Priv. Coll	47.70 x 22.59 x ?	Bali Strait, S.E. Bali
Paratype 20	Coll. PK	51.6 x 23.25 x 11.1	S. Java
Paratype 21	Priv. Coll	46.95 x 21.93 x ?	Bali Strait, S.E. Bali
Paratype 22	Coll. TJ	49.70 x 23.50 x 9.0	Bali, Indonesia
Paratype 23	Coll. TJ	42.80 x 20.70 x 7.0	Java, Indonesia
Paratype 24	Coll. TJ	41.10 x 19.90 x 6.0	Java, Indonesia
Paratype 25	Coll. RVL-CO2	44.10 x 21.27 x 9.0	Bali Strait, S.E. Bali

Table 1: Types of *Phasmoconus (Phasmoconus) vegaluzi* sp. nov. (estimated values are in red)

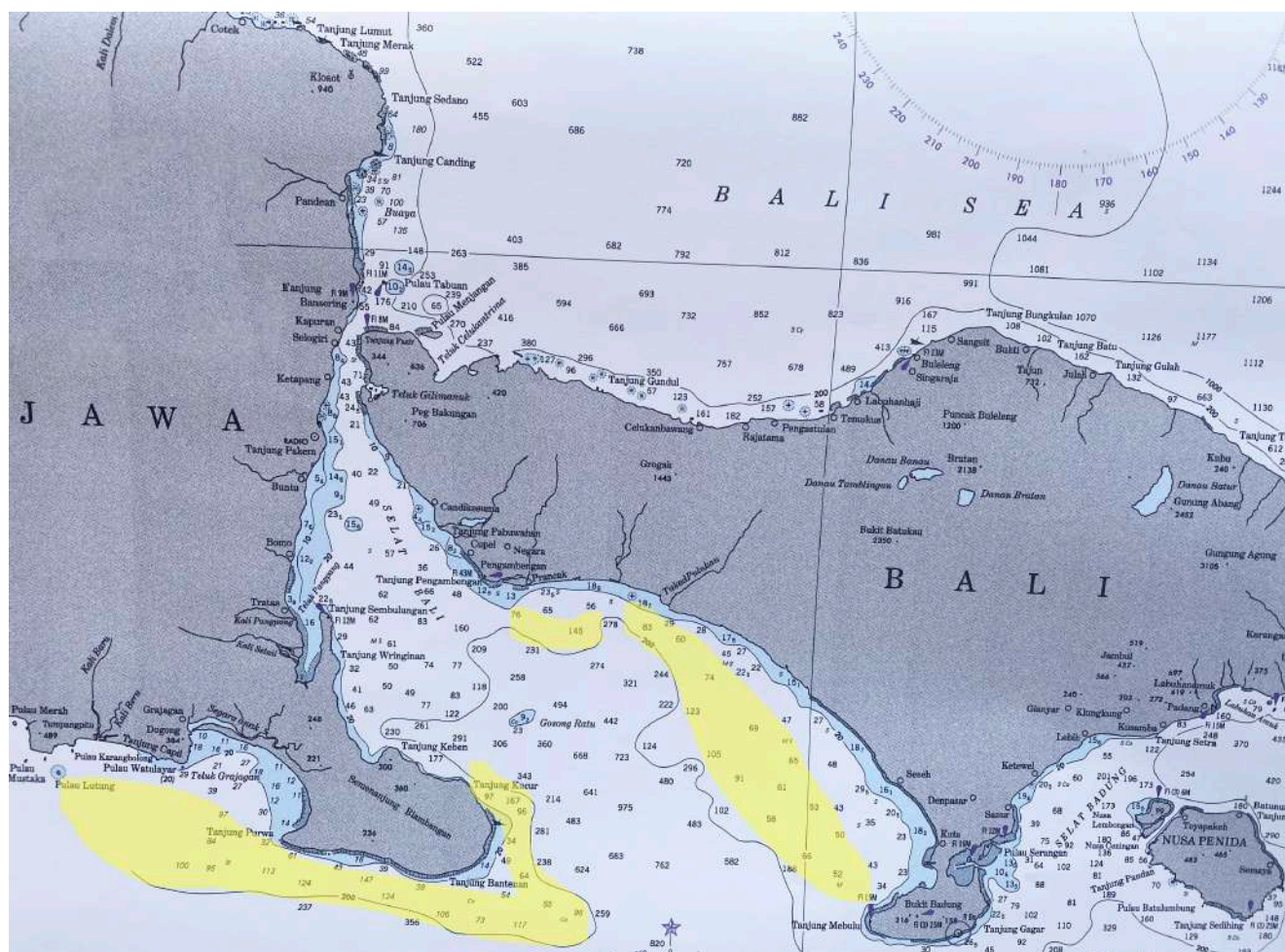


Figure 2: Probable distribution map of *Phasmoconus (Phasmoconus) vegaluzi* sp. nov. in the Bali Strait and S.E. Java

Distribution and habitat: The species has been recently collected in the Bali Strait and S.E. Java at 60–120 m deep in Indonesia. The Bali Strait, located between the S.E. of Java and the S.W. of Bali, has a width of 2.4 to 60 Km with an average depth of 60 m. From Ricardo Vega Luz (pers. comm.) interviews of the local lobster fishermen we understand the zones of capture as those given above. The fishing equipment used by the fishermen are tangle nets. Therefore, only 1 or 2 specimens appear to have been live collected. *Cylinder abbas* (Hwass in Bruguière, 1792), *Phasmoconus (P.) stramineus*, (Lamarck, 1810), *Textilia vicwei* (Old, 1973) or *Cymbiola innexa* (Reeve, 1849) have also surfaced in the same area with the same equipment.

Shells claimed to come from other localities as Aru Islands need confirmation with additional material.

So far, we think that the range of the new species is restricted to the type locality.

Etymology: This species is named after and dedicated to Ricardo Vega Luz, shell collector from Malaga, Spain. Ricardo sourced from his contacts in Indonesia almost all of the specimens here presented.

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

Morphometric parameters: SL = 34–52 mm (mean SL = 44.9 mm); RD = 0.52–0.62 (mean RD = 0.58); PMD = 0.83–0.91 (mean PMD = 0.86); RSH = 0.11–0.19 (mean RSH = 0.15); RW = 1.0–2.8 (mean RW = 1.8); RW' = 0.34–0.51 (mean RW' = 0.41).

Description: Shell medium sized, conical to ventricosely conical in profile. The shell is moderately solid. The protoconch is smooth, translucent white and paucispiral with about 2–2.5 whorls and a diameter of nucleus about 0.5 mm and of first half whorl about 1.0 mm (Verduin's "counting method"). The shell has 12–13 whorls in full adult specimens. The spire is of moderate height, with a rather concave outline. The first 4 or 5 teleoconch whorls are stepped and nodose. The following whorls are juxtaposed and the suture is narrow, well-marked and linear. The teleoconch sutural ramps are almost flat with 5 spiral grooves and 6 intervening ribs with smooth radial growth lines. The shoulder is subangulate. The last whorl is mostly smooth with wide flat spiral ribs on the basal part becoming obsolete apically. The profile of the last whorl is markedly convex (but straighter on the abapical quarter for the subadult specimens).

The columellar fold is strong and white-colored. The siphonal lip outline is straight (to subrounded in subadult specimens). The aperture has a slightly convex profile and is slightly wider at the base than near the shoulder, it is violet to purple colored inside becoming white close to the lip. The outer lip is straight to convex and the profile of the origin of the lip is straight to slightly receding.

The ground color of the last whorl is of an ivory white. Shells are overlaid with orange-brown to chestnut color. The pattern is basically made of axial streaks that coalesce in variably sized spirals rows of dots, axial dashes and blotches. These spiral rows are more distinct on each side of the middle of the last whorl. In the upper part and the middle of the last whorl, the pattern is most often interrupted by the spiral grooves. The pattern and

color of the spire are in accordance with that of the last whorl.

Living animal and radula:

Morphology of the soft parts, radula, periostracum and DNA of the new species are not yet known.

COMPARISONS

Phasmoconus (Phasmoconus) vegaluzi sp. nov. can be compared with four other species of *Phasmoconus* from Indonesia, tropical eastern Indian and western Pacific oceans.

A. Differentiating features



Figure 3: Protoconch and apex of *P. (P.) vegaluzi* sp. nov. (paratype 1, MNCN) (Photo by Serge Gofas)

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

From Moluccas, Indonesia, *Phasmoconus (P.) vegaluzi*, sp. nov. is rather constant in shape and pattern. It is always larger, slender, has a higher spire, and is heavier than *P. (P.) broderipii*. One diagnostic feature is that the sutural ramps are slightly convex with 2 spiral grooves instead of being almost flat with 5 grooves in the new species.

The patterns of both species are strongly similar. The differences are subtle: in *P. (P.) broderipii*, the spiral grooves are mostly

devoid of brown color and form narrow spiral lines. In the new species, the shallow or obsolete grooves in the spiral bands are colored. The color of the aperture is violet inside for both species.



Figure 5a & 5b: *P. (P.) broderipii*, MNHN

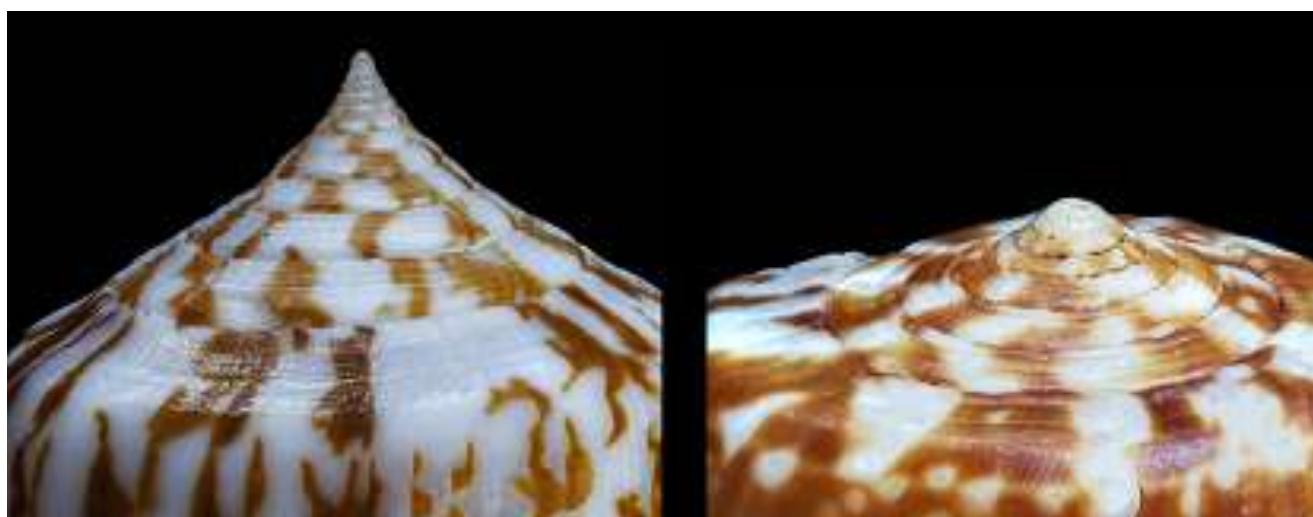


Figure 4a & 4b: comparison of the spires of *P. (P.) vegaluzi* sp. nov (left) (paratype 2) and *P. (P.) broderipii*, MNHN (right)

2- *P.(P.) zandbergeni* (Filmer & Moolenbeek, 2010) is recorded from southern Philippines, Sulawesi, Indonesia, Northern Australia and Solomon Islands. This species was described 10 years ago after a long confusion with *P.(P.) broderipii* (e.g. Röckel & al. 1995). The new species is larger and more slender with a more intricate pattern and a violet interior of aperture instead of a pink one turning white on the outskirt in *P.(P.) zandbergeni* whose shape is more similar to *P.(P.) broderipii*. In *P.(P.) zandbergeni* the pattern is always darker in the spiral grooves of the last whorl.



Figure 6: *P.(P.) zandbergeni* 37.4 x 18.8 mm Sulu Sea, Philippines, coll. FP

3- *P.(P.) collisus* (Reeve, 1849) from Thailand and Gulf of Bengal. The new species has a similar shape with *P.(P.) collisus* but the outer lip of the latter is straighter and its origin is also very straight. The inside of the aperture is whitish instead of violet in the new species. The highly variable pattern of *P.(P.) collisus* is quite different and less intricate than the one of the new species.

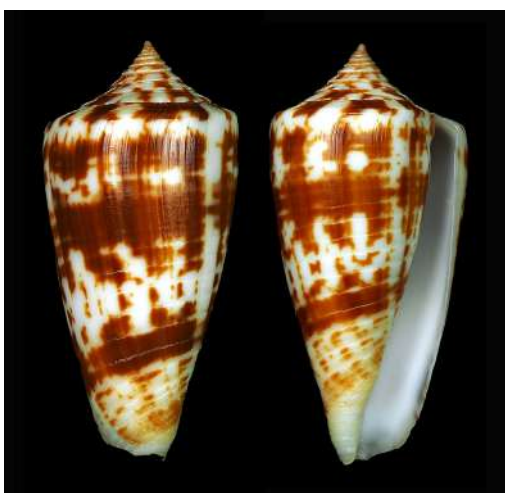


Figure 7: *P.(P.) collisus* 38.9 x 19.0 mm Lembata, Coll. FP

4- *P.(P.) lynceus* (Sowerby II, 1858) from the tropical Indo-Pacific (Taiwan, Philippines, Vietnam, Queensland, Solomon Islands and north Madagascar (Tucker & Bozzetti, 2010 as *Conus cavailloni*)). Dharma (2005) illustrate Indonesian specimens from West Java, West Kalimantan and the Arafura Sea. This species is much larger than the new one and has a different and more variable pattern with square dots that may fuse in two broad spiral bands in the middle and abapical third of

the last whorl. Some shells have solid chestnut to dark brown or devoid of brown pattern. The shallow or obsolete spiral grooves are devoid of pattern except in the solid spiral bands. The axial streaks seen in *P.(P.) vegaluzi* sp. nov. are always absent. The protoconch is multispiral in relation to the wide distribution of this species in the Tropical Indo-Pacific area. *P.(P.) lynceus* has purple violet color inside the aperture like the new species.



Figure 8: *P.(P.) lynceus* 71.9 x 30.9 mm, Luzon Philippines, coll. FP

5- Species from the *P.(P.) inscriptus* (Reeve, 1843) complex.

Phasmoconus (P.) vegaluzi sp. nov. can also be compared with *P.(P.) inscriptus* (Reeve, 1843) from Red Sea to west India ; *P.(P.) maculospirus* (Pilsbry, 1922) from Gulf of Bengal to Thailand; *P.(P.) adenensis* (E.A.Smith, 1891) from Somalia and *P.(P.) aff. adenensis* from Mozambique, Madagascar and Natal. Nevertheless all this species from the *P.(P.) inscriptus* complex are much larger than *P.(P.) vegaluzi* sp. nov. and none of them has consistently a violet aperture like the new species.

B. Morphometric Study

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

The shell length (SL) and the morphometric parameters MD, HMD and SH of *P.(P.) vegaluzi* sp. nov. were statistically compared with those of *P.(P.) broderipii*, *P.(P.) zandbergeni*, *P.(P.) collisus*, and with *P.(P.) lynceus*. *P.(P.) vegaluzi* sp. nov. is significantly larger than *P.(P.) broderipii*, *P.(P.) zandbergeni* and *P.(P.) collisus*, with a mean SL of 44.9 mm in the sample studied. The differences in shell length are statistically significant in all cases, according to pairwise *t*- and *U*-tests (all comparisons yielded *p*-values smaller than 0.05). On the other hand, *P.(P.) lynceus* has a larger mean SL (68.5 mm versus 44.9 mm), and the differences are also statistically significant ($t = 11.544$, $p = 0$; $U = 0$, $p = 0$). We tested for statistically significant differences in MD, HMD and SH among the different 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 did not find any statistically significant differences in morphometric parameters corrected for differences in SL among *P.(P.) vegaluzi* sp. nov., *P.(P.) broderipii*, *P.(P.) zandbergeni* and *P.(P.) collisus*, as shown in Table 3, with the only exception of the slight but significant difference between *P.(P.) vegaluzi* sp. nov. and *P.(P.) zandbergeni*. At variance with this, the differences in MD and HMD (but not in SH) between *P.(P.) vegaluzi* sp. nov. and *P. lynceus* were statistically significant at 95% probability level.



Figure 9: *P.(P.) inscriptus* (Reeve, 1843) 65.80 mm, India, Coll. EM



Figure 10: *P.(P.) maculospirus* (Pilsbry, 1922) 66.43 mm, Madras, Tamil Nadu, S.E. India, Coll. EM



Figure 11: *P.(P.) adenensis* (E.A. Smith, 1891) 56.03 mm, Merka, Somalia, Coll. EM



Figure 12: *P.(P.) aff. adenensis* 60.99 mm, Quelimane, N. Mozambique, Coll. EM



Figure 13: *P.(P.) vegaluzi* sp. nov. 45.44 mm, Paratype 8, Bali Strait, Indonesia, Coll. FP

2. Data for the 5 compared species.

Species		SL (mm)	RD	PMD	RSH	RW (g/cm)	RW' (g/cm ³)
<i>P. (P.) vegaluzi</i> sp. nov.	present study	34 - 52	0.52 - 0.62	0.83 - 0.91	0.11 - 0.19	1.0 - 2.8	0.34 - 0.51
	average value	44.9	0.58	0.86	0.15	1.8	0.41
<i>P. (P.) broderipii</i>	present study	26 - 33	0.58 - 0.64	0.80 - 0.86	0.08 - 0.15	0.8*	0.36*
	average value	30.1	0.60	0.82	0.11	0.8	0.36
	RKK	27 - 33	0.58 - 0.63	0.75 - 0.78	0.05 - 0.12	0.6 - 1.0	-
	Filmer, M.	25 - 34	0.53	-	0.12 - 0.15	0.31 - 1.04	-
<i>P. (P.) zandbergeni</i>	present study	25 - 43	0.57 - 0.61	0.81 - 0.88	0.14 - 0.19	1.0 - 2.2	0.37 - 0.51
	average value	35.4	0.59	0.83	0.15	1.3	0.42
	RKK**	30 - 41	0.53 - 0.65	0.74 - 0.83	0.09 - 0.16	1.0 - 2.0	-
	Filmer, M.	20 - 42	0.48 - 0.51	-	0.16 - 0.24	1.6	-
<i>P. (P.) collisus</i>	present study	35 - 47	0.52 - 0.58	0.85 - 0.90	0.11 - 0.16	1.1 - 2.0	0.36 - 0.48
	average value	40.0	0.56	0.87	0.14	1.4	0.39
	RKK	35 - 60	0.53 - 0.60	0.80 - 0.90	0.09 - 0.18	1.0 - 2.4	-
	Filmer, M.***	35 - 50	-	-	0.12 - 0.21	1.4	-
<i>P. (P.) lynceus</i>	present study	57 - 88	0.51 - 0.55	0.79 - 0.87	0.14 - 0.18	2.1 - 5.6	0.31 - 0.45
	average value	68.5	0.53	0.83	0.16	3.46	0.39
	RKK	50 - 89	0.50 - 0.58	0.75 - 0.86	0.11 - 0.18	1.5 - 7.0	-

Table 2: Morphometric and weight parameters including SL, RD, PMD, RSH, RW & RW' for adult specimens of the compared species

*: one weighted shell only (MNHN)

Taxon compared	Parameter	F-score	p-value
<i>broderipii</i>	MD	0.78	0.3844
	HMD	1.40	0.2454
	SH	0.54	0.4671
<i>zandbergeni</i>	MD	0.09	0.7690
	HMD*	16.21	0.0003
	SH	0.93	0.3404
<i>collisus</i>	MD	2.97	0.0929
	HMD	1.18	0.2852
	SH	1.16	0.2882
<i>lynceus</i>	MD*	17.10	0.0002
	HMD*	13.02	0.0008
	SH	0.04	0.8396

Table 3: Results of the comparison of the morphometric parameters of *P.(P.) vegaluzi* 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 *

From this analysis we can conclude that *P.(P.) lynceus* can be separated from *P.(P.) vegaluzi* sp. nov. based upon differences in shell shape and size with high degree of certainty. However, the other compared taxa did not show statistically significant differences in morphometric parameters, with the sole exception of HMD which is slightly lower in the case of *P.(P.) zandbergeni* (30.6 mm in *P.(P.) vegaluzi* sp. nov. versus 29.3 mm in *P.(P.) zandbergeni*). This means that once corrected for differences in shell

length, all these taxa have shells that do not differ significantly in shape from *P.(P.) vegaluzi* sp. nov., although they do differ in mean SL. Furthermore, a discriminant function analysis using SL, MD, HMD and SH as variables and species hypothesis (*P.(P.) vegaluzi* sp. nov., *P.(P.) broderipii*, *P.(P.) zandbergeni*, *P.(P.) collisus*) only classified correctly 74.1 % of the specimens of *P.(P.) vegaluzi* sp. nov., which is confused mainly with *P.(P.) collisus* (18.5 %) and *P.(P.) zandbergeni* (7.4 %). Therefore, separation among these taxa relies exclusively on differences in mean SL, which do not have overlapping ranges.



Figure 14: protoconch and apex of *Phasmoconus (Phasmoconus) vegaluzi* sp. nov. (paratype 2)

3. Graphical morphometric comparisons of the five species

This figure shows the plotting area of each species represented on the graph:

$PMD = f(RD)$.

P.(P.) vegaluzi sp. nov. has a central position in this graph, this new species sharing common morphological points with *P.(P.) collisus* but being apart from the other relative species and specially with *P.(P.) broderipii*.

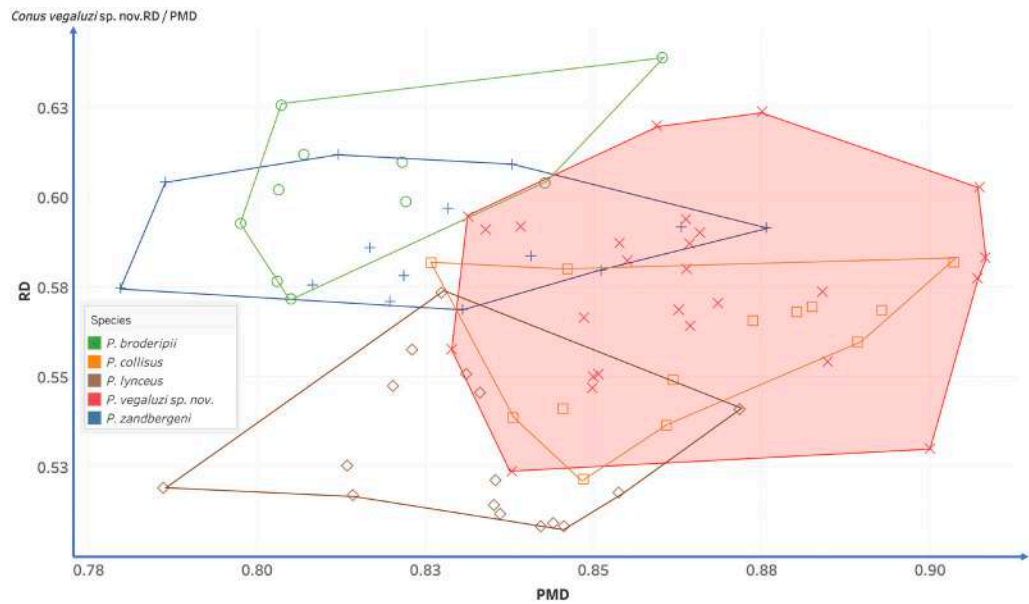
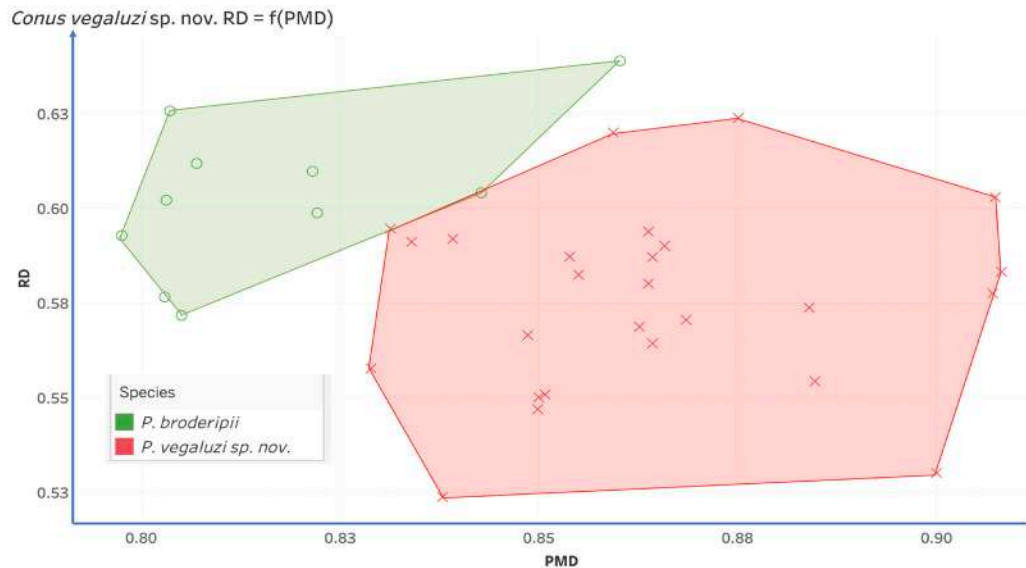


Figure 15: Graph of $PMD = f(RD)$ for the five species. *Phasmoconus (P.) vegaluzi* sp. nov. is figured in red color



Despite the relative dispersion of the dots of both species in figure 16, no more than 1% of the area delimited by the dots corresponding to the new species are shared with *P.(P.) broderipii*.

Figure 16: Graph of $PMD = f(RD)$ for the two species from Indonesia. *Phasmoconus (P.) vegaluzi* sp. nov. and *Phasmoconus (P.) broderipii*

The dots representing the two species *Phasmoconus (P.) vegaluzi* sp. nov. and *Phasmoconus (P.) broderipii* in Figure 17 are separated by the size.

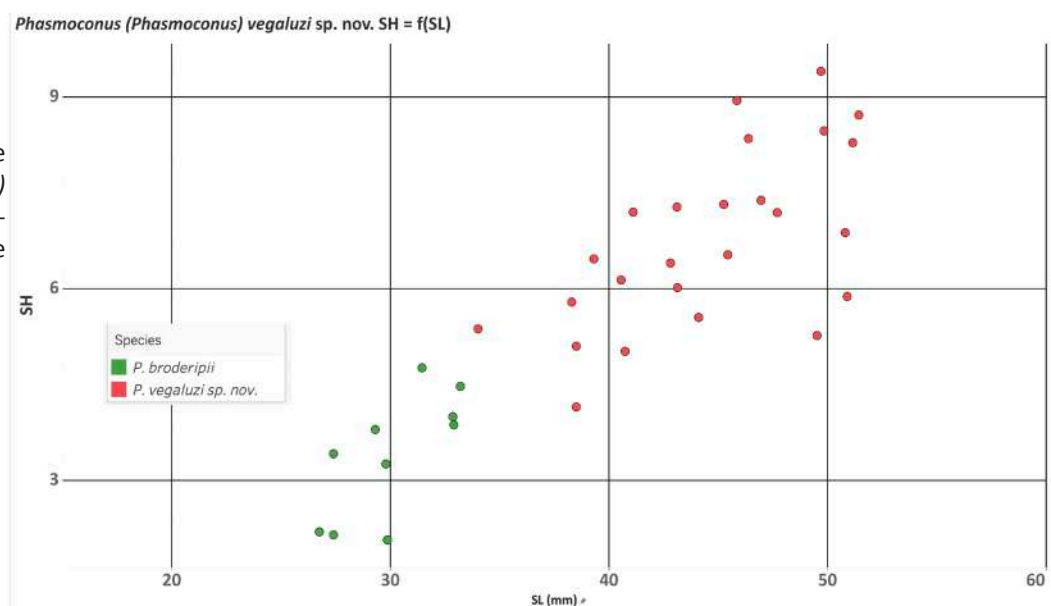


Figure 17: Graph of $SH = f(SL)$ for the two species: *P. (P.) vegaluzi* sp. nov. and *P. (P.) broderipii*

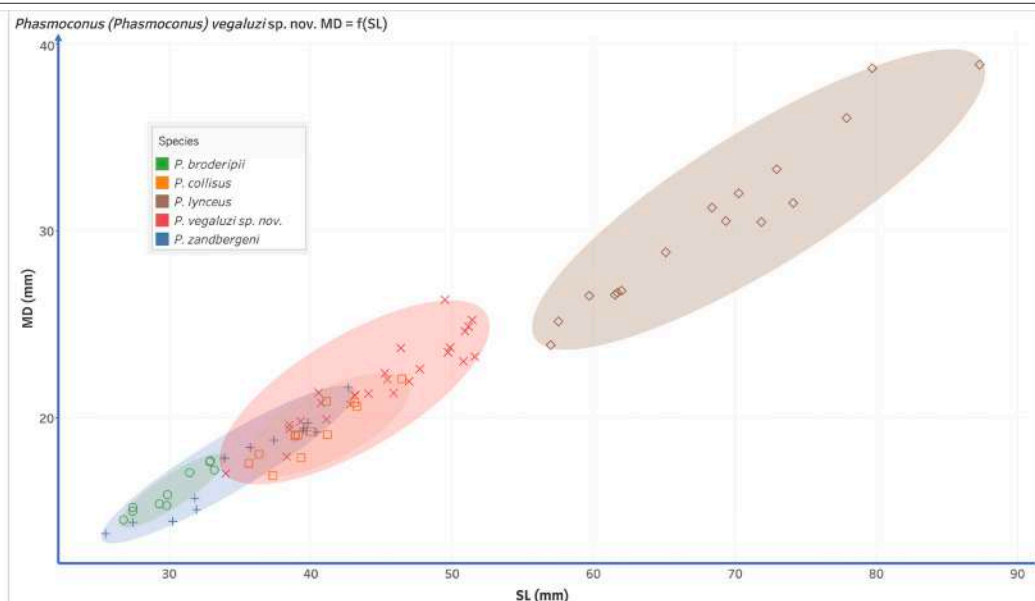


Figure 18: Graph of $SL = f(MD)$ for the 5 species. *Phasmoconus (P.) vegaluzi* sp. nov. is figured in red color

REMARKS

Phasmoconus (P.) vegaluzi sp. nov. was discovered only a few years ago by shell collectors in Java and Bali. At first we believed - and so did other shell collectors - that this was the rediscovery of *P.(P.) broderipii* (Reeve, 1844). As more samples started to surface in the collector market we started to notice subtle differences in the spire and in the body structure and we also managed to fill the gap in shell size between old “*broderipii*” samples and the newly fished specimens. We therefore decided to perform more detailed studies in order to assess this new population and to confirm or refute that this was indeed *P.(P.) broderipii*. A survey of literature did not reveal any previous mention or illustration of the new species.

The new species is placed in the subgenus *Phasmoconus* (*Phasmoconus*) on account of its conchological features that agree with other similar species. A definite assignment awaits study of preserved soft parts, radular teeth and DNA sampling and comparison.

of *Phasmoconus*. A review of this question is beyond the scope of this paper but the reader may usefully refer to Filmer 2011 and Moolenbeek & Filmer 2010. It was notably confused with *P.(P.) zandbergeni* by Röckel, Korn & Kohn, 1995. The concept used in this study is the one of Monnier, Limpalaër, Roux & Robin, 2018 which only differs from that of Filmer, 2011 by the inclusion of Sulu Sea specimens in *P.(P.) zandbergeni* by the former authors. Some of the *P.(P.) broderipii* pictures that can be found on the internet with a locality of the Sulu Sea are best matches to the description of *P.(P.) zandbergeni* and the locality indications therefore cannot be taken into consideration in this paper. For these reasons we restrict the known range of *P.(P.) broderipii* to the Moluccas Archipelago. It remains to this day an elusive species that is still to be rediscovered.

The holotype and 3 possible paratypes are stored in London (NHMUK), 4 other specimens are in Leiden (NBC) and one specimen in Paris (MNHN). They form the sample we studied here in.



Figure 19: *P.(P.) broderipii* (Reeve, 1844) Naturalis Biodiversity Center - ZMA.MOLL.39030 –

Phasmoconus (P.) broderipii has been the object of many citations in literature through time and it has been heavily confused and placed in synonymy with many similar species



Figure 20: *P.(P.) broderipii* (Reeve, 1844) MNHN with a dubious data “Andaman”

The type locality of this species has been subject to many discussions. It was designated as “Moluccas, Indonesia” by Coomans, Moolenbeek & Wils (1982, p. 40 figs. 184, 260-261 & 291, with illustrations of *P.(P.) zandbergeni*). The oldest data label attached to the 3 shells belonging to NBC Naturalis

in Leiden indicates “Molukken” in Dutch (Fig. 19).

This sample originates from the F. Van Heukelom collection donated in 1873 to the Museum with his library. F. Van Heukelom was one of the founders of the “Netherland Indian Bank of Commerce” (The term “Indian” stands for the former Dutch East-Indies that became Indonesia in 1945). His knowledge of the localities and the great care he practiced in collecting implies that there is no reason to question that locality. The Moluccas Archipelago is located some 1,700 km away from the Bali Strait region and is on the top of the Banda pits (-7,400 m). *P.(P.) vegaluzi* sp. nov. protoconch being paucispiral it seems very unlikely that it might be the same species as *P.(P.) broderipii*. None of the examined *P.(P.) broderipii* samples showed any intact apex and the protoconch therefore remains unknown. Fortunately, there is a key distinctive conchological characteristic in the difference in number of spiral grooves on the sutural ramps between them.

ACKNOWLEDGEMENTS

Our most sincere thanks go to:

- Alain Robin for his assistance with the photography of many of the specimens illustrated.
- Ricardo Vega Luz for his pictures of the new species and informations about the locality and the depth of the new species.
- Guido Poppe for high resolution photographs of 8 specimens of *P.(P.) broderipii* published in Filmer's study in Visaya (2011).
- Manuel J. Tenorio for the morphometric statistic study.
- André Poremski & António Monteiro for reviewing this work.
- Philippe Bouchet, Virginie Heros, Philippe Maestrati from the MNHN for the loan of the *P.(P.) broderipii*.
- Serge Gofas for the picture of the protoconch of the paratype 1 of the new species.
- Naturalis Biodiversity Center for the high resolution pictures available at: https://commons.wikimedia.org/wiki/File:Naturalis_Biodiversity_Center_-_ZMA.MOLL.39030_-_Conus_broderipii_Reeve,_1844_-_Conidae_-_Mollusc_shell.jpeg (accessed 08/29/2020).

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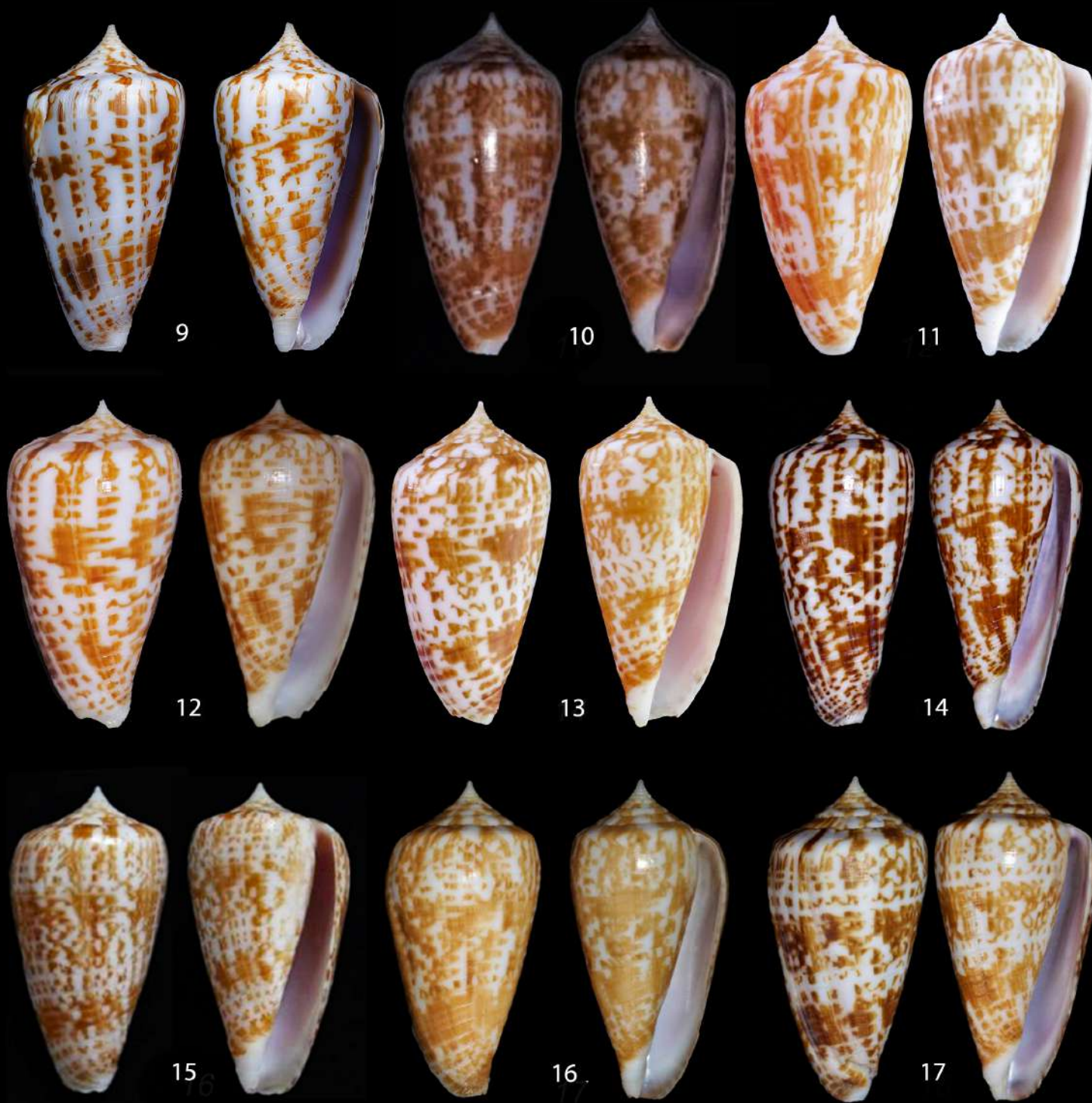
Plate 1 : *Phasmoconus (Phasmoconus) vegaluzi* sp. nov



0 Holotype: 38.29 mm Bali Strait, S.E. Bali, 60 m MNHN
 1 Paratype 1: 34.00 mm Bali Strait, S.E. Bali, 60 m MNCN
 2 Paratype 2: 51.43 mm Bali Strait, S.E. Bali, 120 m Coll. EM
 3 Paratype 3: 40.55 mm Bali Strait, S.E. Bali, 120 m Coll. EM

4 Paratype 4: 51.16 mm Bali Strait, S.E. Bali, 120 m Coll. EM
 5 Paratype 5: 38.50 mm Bali Strait, S.E. Bali, 120 m Coll. EM
 6 Paratype 6: 40.74 mm Bali Strait, S.E. Bali, 80 m Coll. EM
 7 Paratype 7: 46.38 mm S.W. Bali, Indonesia, 40 m Coll. EM
 8 Paratype 8: 45.44 mm Bali Strait, S.E. Bali, 120 m Coll. FP

Plate 2: *Phasmoconus (Phasmoconus) vegaluzi* sp. nov.



9 Paratype 9: 39.30 mm Bali Strait, S.E. Bali, 120 m Coll. FP
 10 Paratype 10: 45.86 mm Bali Strait, S.E. Bali, 120 m Coll. LL
 11 Paratype 11: 43.13 mm Bali Strait, S.E. Bali, 120 m priv. Coll.
 12 Paratype 12: 49.10 mm Bali Strait, S.E. Bali, 120 m priv. Coll.

13 Paratype 13: 49.85 mm Bali Strait, S.E. Bali, 120 m priv. Coll.
 14 Paratype 14: 50.80 mm Bali Strait, S.E. Bali, 120 m priv. Coll.
 15 Paratype 15: 40.40 mm Aru Isl., E. Indonesia Coll. PK
 16 Paratype 16: 43.10 mm Bali Strait, S.E. Bali, 120 m priv. Coll.
 17 Paratype 17: 45.25 mm Bali Strait, S.E. Bali, 120 m priv. Coll.

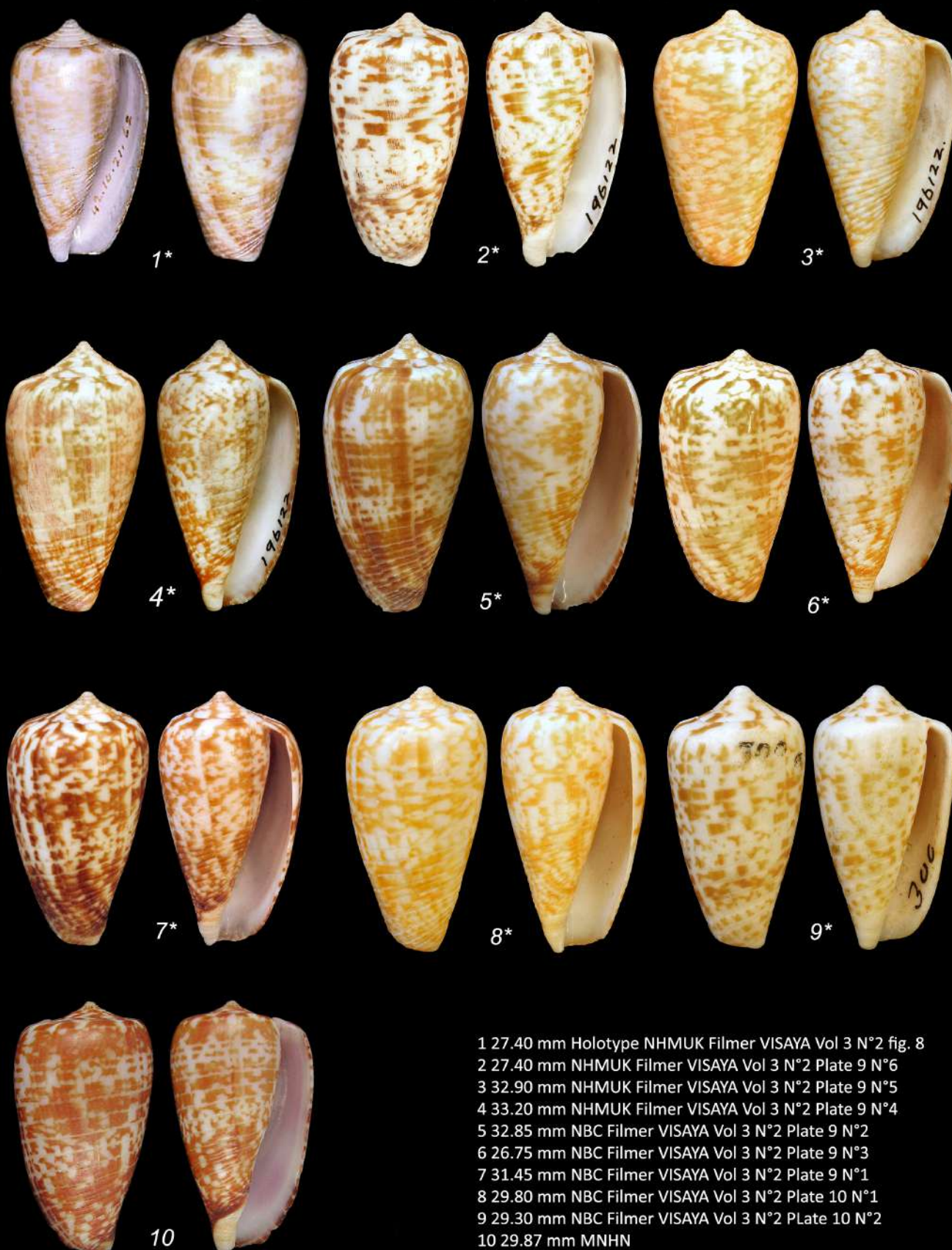
Plate 3: *Phasmoconus (Phasmoconus) vegaluzi* sp. nov.



18 Paratype 18: 50.90 mm Bali Strait, S.E. Bali, 120 m priv. Coll
 19 Paratype 19: 47.70 mm Bali Strait, S.E. Bali, 70 m priv. Coll
 20 Paratype 20: 51.60 mm South Java, Indonesia 70 m Coll. PK
 21 Paratype 21: 46.95 mm Bali Strait, S.E. Bali, 80 m priv. Coll

22 Paratype 22: 49.70 mm Bali Indonesia Coll. TJ
 23 Paratype 23: 42.80 mm Java Indonesia Coll. TJ
 24 Paratype 24: 41.10 mm Java Indonesia Coll. TJ
 25 Paratype 25: 44.10 mm BALI Strait, S.E. Bali, 70 m Coll RVL

Plate 4: *Phasmoconus (Phasmoconus) broderipii* (Reeve, 1844)



- 1 27.40 mm Holotype NHMUK Filmer VISAYA Vol 3 N°2 fig. 8
- 2 27.40 mm NHMUK Filmer VISAYA Vol 3 N°2 Plate 9 N°6
- 3 32.90 mm NHMUK Filmer VISAYA Vol 3 N°2 Plate 9 N°5
- 4 33.20 mm NHMUK Filmer VISAYA Vol 3 N°2 Plate 9 N°4
- 5 32.85 mm NBC Filmer VISAYA Vol 3 N°2 Plate 9 N°2
- 6 26.75 mm NBC Filmer VISAYA Vol 3 N°2 Plate 9 N°3
- 7 31.45 mm NBC Filmer VISAYA Vol 3 N°2 Plate 9 N°1
- 8 29.80 mm NBC Filmer VISAYA Vol 3 N°2 Plate 10 N°1
- 9 29.30 mm NBC Filmer VISAYA Vol 3 N°2 Plate 10 N°2
- 10 29.87 mm MNHN

* with the authorisation of Guido Poppe Conchology.inc

Plate 5: *Phasmoconus (Phasmoconus) zandbergeni* (Filmer & Moolenbeek, 2010)



- 1 39.48 mm Swainson Reefs, Australia Coll. EM
 2 39.68 mm Zamboanga, Philippines Coll. EM
 3 42.67 mm Jolo, Philippines 50-60 m Coll. EM
 4 39.80 mm N.W. Australia 10-15 m Coll. EM
 5 35.73 mm Tara Tara, Sulu, Philippines Coll. EM
 6 39.52 mm Philippines Coll. EM
 7 27.40 mm Aliguay Philippines Coll. FP

- 8 40.41 mm Thevenard Isl. Australia Coll. EM
 9 25.5 mm Aliguay, Philippines Coll. FP
 10 31.90 mm Sulu Sea Philippines Coll. FP
 11 37.40 mm Sulu Sea Philippines Coll. FP
 12 33.90 mm Jolo Isl. , Sulu sea Philippines Coll. FP
 13 31.80 mm Jolo Isl. Philippines Coll. FP

Plate 6: *Phasmoconus (Phasmoconus) collisus* (Reeve, 1849)



1 38.94 mm Mergui Isl. Myanmar Coll. EM
 2 41.16 mm W. Thailand Coll. EM
 3 43.10 mm Andaman Sea, Thailand Coll. EM
 4 35.61 mm Thailand Coll. EM
 5 46.46 mm Phuket, Thailand, 5-7 m Coll. EM
 6 43.23 mm Phuket, Thailand Coll. EM

7 38.90 mm Lembata Indonesia Coll. FP
 8 39.33 mm Malacca Strait, Coll. EM
 9 36.33 mm Kantang, Thailand Coll. EM
 10 37.32 mm Gulf of Bengal, E. India Coll. EM
 11 39.12 mm Thailand Coll. EM
 12 41.10 mm Andaman Sea Coll. FP
 13 40.00 mm Andama, Sea Coll. FP

Plate 7: *Phasmoconus (Phasmoconus) lynceus* (Sowerby II, 1858)



- 1 61.98 mm Luzon, Philippines Coll. EM
 2 56.99 mm Balut, Philippines Coll. EM
 3 61.71 mm Bohol, Philippines Coll. EM
 4 72.96 mm Luzon, Philippines 10-20 m Coll. EM
 5 59.70 mm off Fraser Isl., Queensland, Australia Coll. EM
 6 74.11 mm Luzon, Philippines 5-10 m Coll. EM
 7 87.29 mm Nha Trang, Vietnam Coll. EM

- 8 70.28 mm Philippines Coll. EM
 9 69.35 mm Nha Trang, Vietnam Coll. EM
 10 68.37 mm Luzon, Philippines Coll. EM
 11 65.11 mm Philippines Coll. EM
 12 57.51 mm Philippines Coll. EM
 13 71.9 mm Luzon Philippines Coll. FP
 14 61.51 mm Philippines Coll. EM

Annex 1: Measurements and calculations

Phasmoconus (P.) vegaluzi sp. nov.														
N°	SL mm	MD mm	H Height mm	AH mm	HMD mm	RD	PMD	RSH	W g	RW = W/SL g/cm	V Volume cm3	RW' = W/V g/cm3	Repository	Locality
0	38.29	17.90	16.53	32.50	27.65	0.55	0.85	0.15	4.0	1.04	11.33	0.35	HOLOTYPE MNHN-IM-2000-35771	Bali Strait, S.E. Bali, 60 m
1	34.00	17.00	16.00	28.63	24.73	0.59	0.86	0.16	4.0	1.18	9.25	0.43	MNHN	Bali Strait, S.E. Bali, 80 m
2	51.43	25.24	24.03	42.71	35.62	0.59	0.83	0.17	14.2	2.76	31	0.46	PARATYPE 2, Coll EM	Bali Strait, S.E. Bali, 120 m
3	40.55	21.33	19.65	34.41	29.57	0.62	0.86	0.15	7.5	1.85	17	0.44	PARATYPE 3, Coll EM	Bali Strait, S.E. Bali, 120 m
4	51.16	24.87	23.39	42.88	37.04	0.58	0.86	0.16	10.7	2.09	30	0.36	PARATYPE 4, Coll EM	Bali Strait, S.E. Bali, 120 m
5	38.50	19.38	18.33	34.35	29.69	0.56	0.86	0.11	5.8	1.51	14	0.42	PARATYPE 5, Coll EM	Bali Strait, S.E. Bali, 120 m
6	40.74	20.80	19.29	35.72	30.54	0.58	0.85	0.12	6.5	1.60	16	0.40	PARATYPE 6, Coll EM	Bali Strait, S.E. Bali, 80 m
7	46.38	23.72	22.27	38.03	33.28	0.62	0.88	0.18	10.1	2.18	24.50	0.41	PARATYPE 7, Coll EM	S.W. Bali, Indonesia, 40 m
8	45.44	22.04	20.30	38.91	33.02	0.57	0.85	0.14	10.0	2.20	20	0.49	PARATYPE 8, Coll FP	Bali Strait, S.E. Bali, 120 m
9	39.30	19.79	18.85	32.83	29.79	0.60	0.91	0.16	7.5	1.91	15	0.51	PARATYPE 9, Coll FP	Bali Strait, S.E. Bali, 120 m
10	45.86	21.32	19.88	36.92	33.49	0.58	0.91	0.19	6.9	1.50	19	0.35	PARATYPE 10, Coll LL	Bali Strait, S.E. Bali, 120 m
11	43.13	21.17	19.72	37.11	32.23	0.57	0.87	0.14	7.3	1.69	18	0.41	PARATYPE 11, priv. Coll	Bali Strait, S.E. Bali, 120 m
12	49.51	26.30	24.33	44.24	36.78	0.59	0.83	0.11	12.6	2.54	32	0.40	PARATYPE 12, priv. Coll	Bali Strait, S.E. Bali, 120 m
13	49.85	23.74	22.63	41.38	36.58	0.57	0.88	0.17	9.1	1.83	27	0.34	PARATYPE 13, priv. Coll	Bali Strait, S.E. Bali, 120 m
14	50.80	23.00	-	43.92	36.80	0.52	0.84	0.14	-	-	-	-	PARATYPE 14, priv. Coll	Bali Strait, S.E. Bali, 120 m
15	38.50	19.61	-	33.40	28.52	0.59	0.85	0.13	7.2	1.87	-	-	PARATYPE 15, Coll PK	Aru Isl., E. Indonesia
16	43.10	21.20	-	35.82	30.06	0.59	0.84	0.17	-	-	-	-	PARATYPE 16, priv. Coll	Bali Strait, S.E. Bali, 120 m
17	45.25	22.38	-	37.93	32.84	0.59	0.87	0.16	-	-	-	-	PARATYPE 17, priv. Coll	Bali Strait, S.E. Bali, 120 m
18	50.90	24.62	-	45.02	38.26	0.55	0.85	0.12	-	-	-	-	PARATYPE 18, priv. Coll	Bali Strait, S.E. Bali, 120 m
19	47.70	22.59	-	40.51	33.58	0.56	0.83	0.15	-	-	-	-	PARATYPE 19, priv. Coll	Bali Strait, S.E. Bali, 70 m
20	51.60	23.25	-	43.80	39.57	0.53	0.90	0.15	11.1	2.15	-	-	PARATYPE 20, Coll PK	S. Java, 70 m.
21	46.95	21.93	-	39.57	35.01	0.55	0.88	0.16	-	-	-	-	PARATYPE 21, priv. Coll	Bali Strait, S.E. Bali, 80 m
22	49.70	23.50	22.8	40.3	36.6	0.58	0.91	0.19	9.0	1.81	27	0.34	PARATYPE 22, Coll PK	Bali, Indonesia
23	42.80	20.70	19.50	36.40	31.40	0.57	0.86	0.15	7.0	1.64	17.28	0.41	PARATYPE 23, Coll PK	Java, Indonesia
24	41.10	19.90	18.70	33.90	29.30	0.59	0.86	0.18	6.0	1.46	15.29	0.39	PARATYPE 24, Coll PK	Java, Indonesia
25	44.10	21.27	19.70	38.54	32.72	0.55	0.85	0.13	9.0	2.04	18.48	0.49	PARATYPE 25, Coll PK	Bali Strait, S.E. Bali, 70 m
Average	44.9					0.6	0.9	0.2		1.8		0.4		
Extremes	34 - 52					0.52 - 0.62	0.83 - 0.91	0.11 - 0.19		1.0 - 2.8		0.34 - 0.51		

Phasmoconus (P.) broderipii (Reeve, 1844)														
N°	SL mm	MD mm	H Height mm	AH mm	HMD mm	RD	PMD	RSH	W g	RW = W/SL g/cm	V Volume cm3	RW' = W/V g/cm3	Repository	Locality
0	27.40	15.00	-	23.98	19.27	0.63	0.80	0.12	-	-	-	-	Holotype NHMUK	"Indonesia, Moluccas"
1	27.40	15.20	-	25.25	20.28	0.60	0.80	0.08	-	-	-	-	coll. Cumming, NHMUK paratype	"Indonesia, Moluccas"
2	32.90	17.70	-	29.03	23.85	0.61	0.82	0.12	-	-	-	-	coll. Cumming, NHMUK paratype	"Indonesia, Moluccas"
3	33.20	17.20	-	28.73	23.62	0.60	0.82	0.13	-	-	-	-	coll. Cumming, NHMUK paratype	"Indonesia, Moluccas"
4	32.85	17.65	-	28.85	23.28	0.61	0.81	0.12	-	-	-	-	coll. F. van Herkelom NBC Leiden 0391	"Indonesia, Moluccas"
5	26.75	14.55	-	24.55	19.58	0.59	0.80	0.08	-	-	-	-	coll. F. van Herkelom NBC Leiden 0391	"Indonesia, Moluccas"
6	31.45	17.05	-	26.69	22.96	0.64	0.86	0.15	-	-	-	-	coll. F. van Herkelom NBC Leiden 0391	"Indonesia, Moluccas"
7	29.80	15.30	-	26.54	21.31	0.58	0.80	0.11	-	-	-	-	NBC Leiden 038839	"Indonesia, Moluccas"
8	29.30	15.40	-	25.50	21.49	0.60	0.84	0.13	-	-	-	-	coll. J. de Priester NBC Leiden 03883	"Indonesia, Moluccas"
9	29.87	15.89	14.62	27.80	22.38	0.57	0.81	0.07	2.5	0.84	6.94	0.36	MNHN	Andaman Islands ?
Average	30.1					0.60	0.82	0.11		0.84		0.36		
Extremes	26 - 33					0.58 - 0.64	0.80 - 0.86	0.08 - 0.15		0.80		0.36		
RKK	27 - 33					0.58 - 0.63	0.75 - 0.78	0.05 - 0.12		0.6 - 1.0				

<i>Phasmoconus</i> (<i>P.</i>) <i>zandbergeni</i> (Filmer & Moolenbeek, 2010)													
N°	SL	MD	H Height	AH	HMD	RD	PMO	RSH	W	RW = W/SL	V Volume	RW' = W/V	Locality
1	39.48	19.34	18.11	33.14	27.86	0.58	0.84	0.16	5.3	1.34	13.83	0.38	Swainson reefs, Queensland, Australia
2	39.68	19.32	18.03	33.44	27.74	0.57	0.82	0.15	6.5	1.64	13.82	0.47	Zamboanga, Sulu, Philippines, 5-7 m
3	42.67	21.60	20.04	35.46	29.71	0.61	0.84	0.17	9.4	2.20	18	0.51	Jolo, Philippines, 50-60 m
4	30.23	14.47	13.71	24.46	21.42	0.59	0.88	0.19	3.0	0.99	6	0.50	Philippines
5	39.80	19.72	18.49	34.26	27.69	0.58	0.81	0.14	5.4	1.36	15	0.37	N.W. Australia, 10-15 m
6	35.73	18.40	17.24	30.83	25.54	0.60	0.83	0.14	4.6	1.29	11	0.41	Tera Tara Id., Sulu, Philippines
7	40.41	19.23	18.18	33.18	28.24	0.58	0.85	0.18	5.5	1.36	14	0.39	Threvenard Id., W. Australia
8	39.52	19.44	18.38	32.86	28.36	0.59	0.86	0.17	6.0	1.52	14.12	0.42	Philippines
9	27.40	14.40	14.06	25.06	19.54	0.57	0.78	0.09	1.6	0.58	6	0.29	Alligay, Philippines
10	25.50	13.60	13.48	22.84	17.96	0.60	0.79	0.10	1.4	0.55	4.74	0.30	Alligay, Philippines
11	31.90	15.10	14.84	26.55	22.05	0.57	0.83	0.17	3.1	0.97	7.15	0.43	Sulu, Philippines
12	37.40	18.80	18.28	32.09	26.21	0.59	0.82	0.14	5.4	1.44	12.85	0.42	Sulu, Philippines
13	33.90	17.84	17.46	29.16	23.68	0.61	0.81	0.14	4.3	1.27	11	0.41	Jolo, Sulu, Philippines
14	31.80	15.70	15.18	27.16	22.32	0.58	0.82	0.15	3.9	1.23	8	0.51	Jolo, Sulu, Philippines
Average	35.4					0.59	0.83	0.15		1.27		0.42	
Extremes	25-43					0.57-0.61	0.81-0.88	0.14-0.19		1.0-2.2		0.37-0.51	
FILMER	20-42					0.48-0.51		0.16-0.24					

<i>Phasmoconus</i> (<i>P.</i>) <i>collisus</i> (Reeve, 1849)													
N°	SL	MD	H Height	AH	HMD	RD	PMO	RSH	W	RW = W/SL	V Volume	RW' = W/V	Locality
1	38.94	19.09	18.09	33.52	29.58	0.57	0.88	0.14	5.9	1.52	13.45	0.44	Mergui, Myanmar, 50-100 m
2	41.16	19.08	18.05	35.56	30.61	0.54	0.86	0.14	5.1	1.24	14.18	0.36	W. Thailand
3	43.10	20.83	19.36	38.50	32.55	0.54	0.85	0.11	6.8	1.58	17	0.39	Andaman Sea, Thailand
4	35.61	17.55	16.22	31.03	27.11	0.57	0.87	0.13	4.1	1.15	10	0.40	Thailand
5	46.46	22.08	21.12	39.45	35.08	0.56	0.89	0.15	9.1	1.96	22	0.42	Phuket, Thailand, 5-7 m
6	43.23	20.59	19.41	37.49	32.31	0.55	0.86	0.13	6.4	1.48	17	0.37	Phuket, Thailand
7	39.33	17.86	16.89	33.16	27.79	0.54	0.84	0.16	4.4	1.12	12	0.37	Malacca Strait
8	36.33	18.04	17.01	31.00	28.01	0.58	0.90	0.15	5.3	1.46	11.15	0.48	Kantang, Andaman Sea, Thailand
9	37.32	16.90	16.16	32.41	27.50	0.52	0.85	0.13	4.0	1.07	10	0.39	Gulf of Bengal, E. India
10	39.12	19.06	17.92	33.55	29.53	0.57	0.88	0.14	5.4	1.38	13.36	0.40	Thailand
11	41.10	20.88	20.37	35.89	29.64	0.58	0.83	0.13	5.9	1.44	17.48	0.34	Andaman Sea, Thailand, 80 m
12	40.00	19.25	19.18	33.86	30.23	0.57	0.89	0.15	4.6	1.15	14.77	0.31	Lembata, Indonesia, 70 m
13	38.90	19.00	18.31	32.76	27.72	0.58	0.85	0.16	5.2	1.34	14	0.38	Lembata, Indonesia, 70 m
Average	40.0					0.56	0.87	0.14		1.37		0.39	
Extremes	35-47					0.52-0.58	0.85-0.90	0.11-0.16		1.1-2.0		0.36-0.48	
RKE	35-60					0.53-0.60	0.80-0.90	0.09-0.18		1.0-2.4			

<i>Phasmoconus</i> (<i>P.</i>) <i>lynceus</i> (Sowerby II, 1858)													
N°	SL	MD	H Height	AH	HMD	RD	PMO	RSH	W	RW = W/SL	V Volume	RW' = W/V	Locality
1	61.98	26.79	25.36	52.70	44.38	0.51	0.84	0.15	16.6	2.68	42.11	0.39	Luzon, Philippines, Op.
2	56.99	23.89	22.65	46.67	39.02	0.51	0.84	0.18	13.0	2.28	30.84	0.42	Palut, Philippines
3	61.71	26.67	25.23	52.46	44.36	0.51	0.85	0.15	18.7	3.03	42	0.45	Bohol, Philippines
4	72.96	33.28	31.31	61.00	50.82	0.55	0.83	0.16	31.4	4.30	76	0.41	Luzon, Philippines, 10-20 m
5	59.70	26.52	25.39	51.09	40.16	0.52	0.79	0.14	12.5	2.09	40	0.31	Fraser Id., Queensland, Australia, 50-80 m
6	74.11	31.49	30.16	61.23	51.14	0.51	0.84	0.17	27.5	3.71	70	0.39	Luzon, Philippines, 5-10 m
7	87.29	38.88	36.78	71.88	62.66	0.54	0.87	0.18	48.8	5.59	125	0.39	Nha Trang, Vietnam
8	70.28	32.00	30.44	58.45	47.94	0.55	0.82	0.17	26.2	3.73	68.46	0.38	Philippines
9	69.35	30.53	28.61	58.57	48.93	0.52	0.84	0.16	22.4	3.23	61	0.37	Nha Trang, Vietnam
10	68.37	31.23	29.13	56.71	47.13	0.53	0.83	0.17	23.3	3.41	62.20	0.37	Luzon, Philippines
11	65.11	28.86	27.36	55.82	45.45	0.52	0.81	0.14	20.9	3.21	51.41	0.41	Philippines
12	57.51	25.14	23.88	47.86	38.93	0.53	0.81	0.17	14.7	2.56	34.53	0.43	Philippines
13	61.51	26.58	25.02	52.19	44.05	0.51	0.84	0.15	13.5	2.19	41	0.33	Philippines
14	79.70	38.70	37.65	67.49	55.84	0.57	0.83	0.15	41.7	5.23	116.13	0.36	Nha Trang, Vietnam, 25 m
15	77.90	36.04	35.82	64.65	53.21	0.56	0.82	0.17	36.7	4.70	100.57	0.36	Philippines
16	71.88	30.47	29.78	58.85	50.24	0.52	0.85	0.18	24.6	3.42	65	0.38	Luzon, Philippines
Average	68.5					0.53	0.83	0.16		3.46		0.39	
Extremes	57-88					0.51-0.55	0.79-0.87	0.14-0.18		2.1-5.6		0.31-0.45	
RKE	50-89					0.50-0.58	0.75-0.86	0.11-0.18		1.5-7.0			

New records of Lower Heterobranchia (Mollusca: Gastropoda) for the Mediterranean and the Hellenic Seas

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Abstract

Several environmental changes and the introduction of alien species affect the biodiversity of the Hellenic Seas. With this study we continue the contribution to the knowledge of the Hellenic marine malacofauna, accumulating data from the entire Greek territory, during the period from October 2008 to October 2019. It includes 34 species of not previously reported gastropods or reported only once and belonging to 17 families. Out of those species, 7 are new for the Mediterranean Sea, 11 are new for the Eastern Mediterranean Sea, 27 are new for the Hellenic malacofauna, 5 are new lessepsian migrants and 2 are previously reported lessepsian migrants. Main taxonomic characteristics and ecological information such as habitat, distribution and origin, are given and discussed.

Introduction

The Hellenic Seas have been influenced by still in progress environmental changes described recently by a number of investigators (e.g. Skliris *et al.*, 2011, Tsiaras *et al.*, 2012). These environmental changes were contemplated to affect the marine biodiversity and that biodiversity should be disclosed and evaluated. Recent faunistic works revealed new species for the Hellenic Seas (Streftaris & Zenetos, 2007; Manousis *et al.*, 2012; Tzomos *et al.*, 2012; Manousis and Galinou-Mitsoudi, 2014; Crocetta *et al.*, 2013; Manousis *et al.*, 2017, Romani *et al.*, 2017; Manousis *et al.*, 2018a,b; Manousis *et al.*, 2019; Mbazios *et al.*, 2020; Manousis *et al.*, 2020, accepted). The anthropogenic factors related to this enrichment of biodiversity are extensively discussed (e.g. Galil, 2000; Galil & Zenetos, 2002; Zenetos *et al.*, 2005; Abdulla & Linden, 2008; Galil *et al.*, 2008; Zenetos *et al.*, 2009). As the number of the collected new species for the area exhided 200, their outright publication was impossible. The aim of this study was to continue with the publication of the new material from the Hellenic Seas that would eventually propound an updated list of the Hellenic gastropod fauna.

Methods

Sampling, handling and species recognition were conducted according to Manousis & Galinou-Mitsoudi (2014) and Mbazios *et al.* (2020) from October 2008 to October 2019 in certain locations throughout the Hellenic Seas. The selected references in Table 1 include detailed and helpful information for the presented species identification. The described species in the text are the less known and/or uncommon. The specimens are deposited in the premises of C. Kontadakis, Dr. T. Manousis, G. Mbazios, and C. Zeimbekis. Scientists are welcome to have access to the biological material for inspection by appointment.

Results

The records

All 1st and 2nd documented records from the Hellenic Seas are listed in Table 1 with collection data. A brief description of certain findings is given bellow whenever additional information is supportive to their identification. They are all presented in Figures 1 to 10.

Abbreviations: **A** – Atlantic, **Be** – Beached, **BS** – Black Sea, **CMS** – Central Mediterranean Sea, **Co** – Common, **CB** – Coralligenous Bottom, **Cos** – Cosmopolitan, **EMS** – East Mediterranean Sea, **EMS1** – First record for the East Mediterranean Sea, **EMS2** – Second record for the East Mediterranean Sea, **G1** – First record for Greece, **G2** – Second record for Greece, **IP** – Indo-Pacific, **LM** – Lessepsian Migrant, **Mad** – Madeira, **Mat** – matte, **MB** – Mixed Bottom, **MS** – Mediterranean Sea, **MS1** – First record for the Mediterranean Sea, **Mu** – Muddy Bottom, **NLM** – New Lessepsian Migrant, **NZ** – New Zealand, **Ra** – Rare, **Sh** – Shipwreck, **SP** – South Pacific, **Un** – Uncommon, **Unk** – Unknown, **WCMS** – West and Central Mediterranean Sea, **WMS** – West Mediterranean Sea, **ZB** – *Zostera* bed.

Retusa crebrisculpta (Monterosato, 1884) (Fig. 1b).

Shell small, mean h/w ratio 2.2, cylindrical with straight walls but slightly narrower at the top, upper spire sunken to form an umbilicus, narrow umbilical fissure at its base, weak and straight columellar callus, flexuous outer lip slightly protruding posteriorly, sculpture of dense spiral incisions crossing axial flexuous riblets allover the surface and forming a cancelate

pattern. *R. crebrisculpta* differs from of *R. laevisculpta* (Granata-Gillio, 1877) (Fig. 1d, e) by not exhibiting a restriction at its lower part, by its rounded apex instead of truncate and by its stronger sculpture. *R. desgenettii* (Audouin, 1826) is smaller and stubby, has an oblique columella and lacks the upper umbilicus (Oliverio & Tringali, 2001; Repetto *et al.*, 2005; Gofas *et al.*, 2011; Scaperrotta *et al.*, 2011).

Retusa desgenettii (Audouin, 1826) (Fig. 1c).

Shell small, off-white and translucent, h/w ratio 2, cylindrical, slightly restricted in the middle and slightly expanded anteriorly, aperture width is almost the same at its total height, columella oblique, sculpture consisting of prominent and irregular spiral striae crossed by narrow axial ribs most evident in the vicinity of the apex and reaching as a sinistral vortex the apex umbilicus. Sculpture similar to that of *P. fourieri* (Audouin, 1826) but the two species are distinguished easily due to their different dimensions and the different h/w ratio (*P. fourieri* is slender) and sculpture. Another similar species is *R. minutissima* (Monterosato, 1878) (Fig. 2a) which, though of the same size and profile, lacks the characteristic sculpture of *R. desgenettii* - that uncommon lessepsian migrant known from the Levantine Sea, East Mediterranean Sea (Scaperrotta *et al.*, 2011; Crocetta & Tringali, 2015).

Retusa laevisculpta (Granata-Grillo, 1877) (Fig. 1d, e).

Shell small, off-white and translucent, h/w ratio 2.15, cylindrical, restricted in the middle part, with the apical part truncate and the upper edge of the last whorl well-rounded back. Oblique columella with a weak fold. Sculpture of very fine unequal spiral striations spread over the entire surface. *R. laevisculpta* is similar in its outlook to *R. crebrisculpta* (Monterosato, 1884) but exhibits a restriction at its lower part - not present in *R. crebrisculpta* - a truncate apex instead of a rounded in *R. crebrisculpta*, and a weaker sculpture. Sedimentary bottoms of the continental shelf, Mediterranean Sea (Gofas *et al.*, 2011).

Retusa minutissima (Monterosato, 1878) (Fig. 2a).

Shell small, transparent, h/w ratio 1.92, cylindrical, with a mild restriction in the middle. Outer lip arquated, columella oblique. Sculpture only of fine axial striae. Apex flat, with numerous irregular helical striae. It differs from *R. desgenettii* (Audouin, 1826) by the complete lack of spiral striation and the restriction in the median part of the shell. Common, infralittoral, Mediterranean (Oliverio & Tringali, 2001; Scaperrotta *et al.*, 2011). The species has been referred from the Cretan Sea (Crocetta *et al.*, 2015).

Retusa nitidula (Loven, 1846) (Fig. 2b).

Shell sub-cylindrical, narrower at the top than at the bottom, superficially smooth, if observed at a magnification (X30) exhibits very weak growth marks and equally weak spiral and flexuous striae more frequent towards the base. Apical area rounded with the spire sunken to form a shallow umbilicus, straight columella with weak callus and a tooth, umbilical slit, smoothly arquated outer lip with its apical part extending over the spire and well-rounded back. Color milky-white and slightly iridescent. Similar in its outlook to *R. umbilicata* (Montagu, 1803) which, though, is larger, heavily sculptured and slender (Coppini, 2002; Repetto *et al.*, 2005). It is also similar to *R. crossei* (Bucquoy, Dautzenberg & Dollfus, 1886) (Fig. 2d), the later being easily recognizable due to its ovate outlook

in combination with the cancelate decoration (Gaglioli, 1991; Coppini, 2002; Repetto *et al.*, 2005).

Retusa tornata (Watson, 1886) (Fig. 2e).

Shell constantly small, robust, mean h/w ratio 2.24, cylindrical with straight walls (reminiscent of a slender *Bombix mori* cocoon), upper spire sunken to form a shallow umbilicus, umbilical slit at its base, straight and oblique columella with weak callus, smoothly arquated outer lip, sculpture of dense but shallow spiral incisions crossing axial arquated riblets all over the surface and forming a weak cancelate pattern. White spiral bands of uneven width alternate translucent ones all over the surface. Animal translucent white with two ear-like lobes behind the eyes. *R. tornata* shell at first glance looks quite similar to that of *R. umbilicata* (Montagu, 1803) (h/w ratio 2.1), but *R. tornata* is slender, more cylindrical and with a slightly sinuous peristome in frontal view. Common in Madeira (Segers *et al.*, 2009).

***Retusa* sp.1** (Fig. 3a).

Very similar to *R. truncatula* (Bruguère, 1792) (Fig. 3b) but slimmer and with extended lower part of the external lip.

Haminoea orbignyana (Férussac, 1822) (Fig. 4c). Shell fragile, somehow piriform, significantly narrower in its apical part and with inflated the central area. Columellar callus whitish. Light greenish-brown with light brown periostracum. The only European species of the genus that is easily distinguished by its shell, it is found in estuaries and sandy-muddy tidal flats and seaweeds (Gofas *et al.*, 2011).

Haminoea ortei Talavera, Murillo & Templado, 1987 (Fig. 4d).

Shell hyaline, thin, fragile, semi-transparent and with pail beige periostracum. Surface with prominent growth lines, but no spiral striations, and with prominent callus on a gently arquated columella. *H. ortei* is more elongated and less globular than all other European species of the genus. Muddy or sandy-muddy bottoms, intertidal to - 30 m, East Atlantic and WMS (Repetto *et al.*, 2005; Gofas *et al.*, 2011). Its presence in Greece (Vervaert, 2007) has been recently disputed (Crocetta *et al.*, 2015) while in 2015 it was collected from Maliakos Gulf W Central Aegean by Garabedian *et al.* (2017).

Philine powelli Rudman, 1970 (Fig. 6e).

The white transparent shell is elongate with a restriction just above its middle, sculptured on the outer surface by strong spiral pitted grooves producing a punctuate pattern. The inner surface is brilliant. The outer lip extends apically beyond the spire forming a spinous process. Apex denticulate through the extension of strong spiral ridges. New Zealand (Rudman, 1970).

Scaphander punctostriatus (Mighels & Adams, 1842) (Fig. 7a).

The juvenile shell is oval, involute, semi-transparent, white, with straw-yellow periostracum, height/width ratio 1.4, spire submerged, apex perforated. Aperture wide, upper edge of outer lip slightly towering over apex. Inner lip S-shaped, no parietal callus or columellar fold, columellar umbilicus closed. Embryonic shell smooth, heterostrophic, consisting of 1.5 whorls. First teleoconch whorl smooth, partly covering protoconch, body whorl with fine spaced spiral sculpture, more dense by the upper part of the shell and absent by the apex, consisting of rows of irregularly shaped micro pits which

increase in size and regularity as they reach the shell's base. Juveniles of *S. punctostriatus* of this developmental stage superficially resemble those of *S. lignarius* (Linnaeus, 1758) (Fig. 7b), but *S. lignarius* juveniles are different as: a. they are cylindrical (h/w 1.7) instead of oval (h/w 1.4); b. Have an arquated and projecting external lip instead of plain; c. The shell sculpture just behind the outer lip in the middle of the shell consists of spiral chains of irregularly shaped and connected lings, instead of spiral rows of distinct rounded micro pits; d. The columella is straight instead of S-shaped (Chaban & Nekhaev, 2013; Eilertsen & Malaquias, 2013). Its presence in the East Mediterranean (Janssen, 1989) has been recently disputed (Crocetta *et al.*, 2015).

Elysia nealae Ostergaard, 1955 (Fig. 8b). Mottled in dark and light green, with white freckles and low parapodia that meet dorsally in many folds. Moderately common on rocky bottoms at depths of 1-2 m of Maui, Oahu, Kauai, Japan, Guam and Palmyra Atoll (https://en.seaslug.world/species/elysia_nealae; <http://seaslugsofhawaii.com/species/Elysia-nealae-a.html>). Similar to *Elysia margaritae* Fez, 1962.

Berthellina* cfr. *edwardsii (Vayssi re, 1897) (Fig. 9b). It is presented with uncertainty (cfr.) because it was not collected as live animal.

Spurilla neapolitana (Delle Chiaje, 1841) (Fig. 9c). Overall color greenish-yellow. Cerata in 11 groups and bent towards the axis of the animal, their number increases with the size which is larger closer to the cephalic region, they are gray-olive in color with pinkish-white tips. The rhinophores bear orange-yellow alternating in size lamellae and a narrow and white free edge. The tail is short and the foot wide in tones of orange. Usually under rocks of the shallow waters and near the anemones that eats and has similar colors (Gofas *et al.*, 2011). The species has been recently referred from the Cretan Sea (Crocetta *et al.*, 2015).

Jorunna onubensis Cervera, Garcia-Gomez & Garcia, 1986 (Fig. 10a). Oval shaped, of vivid orange-red color with darker the mantle and the color blotches scattered allover its surface, rhinophores deep orange and lamellate and the gills in 5 also deep orange groups. The foot is lobate. Shallow waters, under stones (Gofas *et al.*, 2011).

Limapontia capitata (O. F. M ller, 1774) (Fig. 10b). On *Chondrosia reniformis* Nardo, 1847 sponge. Comparison with other similar species impossible. (http://species-identification.org/species.php?species_group=mollusca&id=761; <http://www.seaslugforum.net/find/22752>)

Runcina adriatica T. Thompson, 1980 (Fig. 10c, d). In *Posidonia oceanica* (Linnaeus) Delile, 1813 rhizome. Background color dark brown on the dorsum and the foot covered with black and cream-yellow spots. There is a translucent white band with scattered chalk-white spots extending peripherically from the head to the posterior area of the notum. Triangular tail again with the central color pattern and a white band on each side. A herbivorous species of shallow rocky bottoms (Gofas *et al.*, 2011).

Discussion

Out of the 34 presented species, 27 are new for the Hellenic malacofauna that is now raised from 701 species (Mbazios *et al.*, 2020, accepted) to 729. It is noteworthy that 7 species are reported for the first time for the Mediterranean Sea and 11 are new records for the Eastern Mediterranean Sea, while 5 species are new lessepsian migrants.

We did not collect the live animal of *Berthellina* cfr. *edwardsii* to proceed with the direct observation and comparison with that of *Berthella aurantiaca* (Risso, 1818). *Berthellina edwardsii* (Vayssi re, 1896) shell covers a very small portion of the visceral mass of the animal in contrast to that of *B. aurantiaca* – a similar animal when live, while the two shells are also quite similar (Gofas *et al.*, 2011). For that reason we present the shell with uncertainty, therefore, as cfr.

As the Greek territory had not been thoroughly searched, the finding of a considerable number of Lower Heterobranchia species even in shallow waters did not come as a surprise and encourages us to go on with the job.

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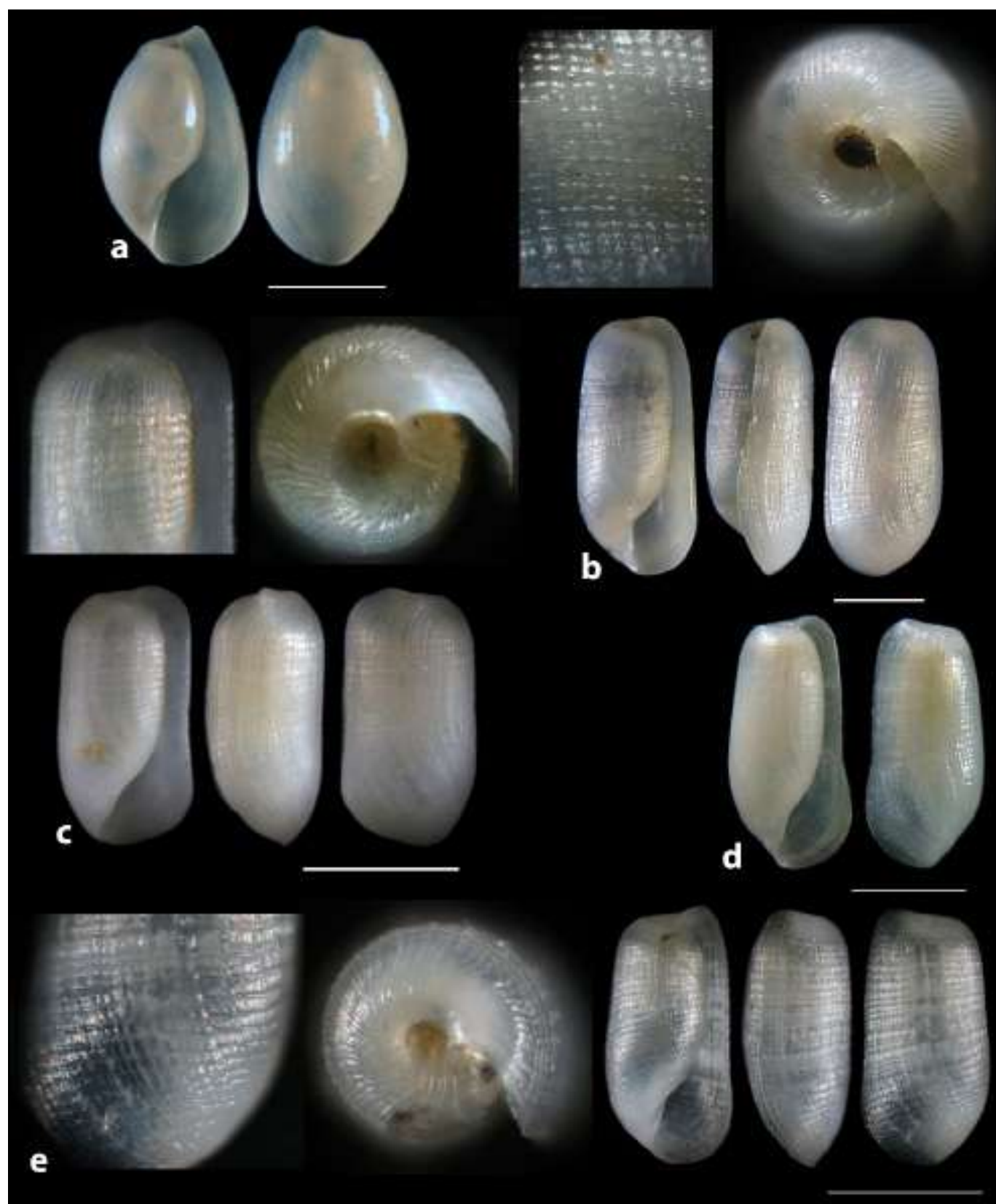


Figure 1: a. *Pyrunculus ovatus* (Jeffreys, 1871), b. *Retusa crebrisculpta* (Monterosato, 1884), c. *Retusa desgenettii* (Auduin, 1826), d and e. *Retusa laevisculpta* (Granata-Grillo, 1877). Barr = 1 mm.

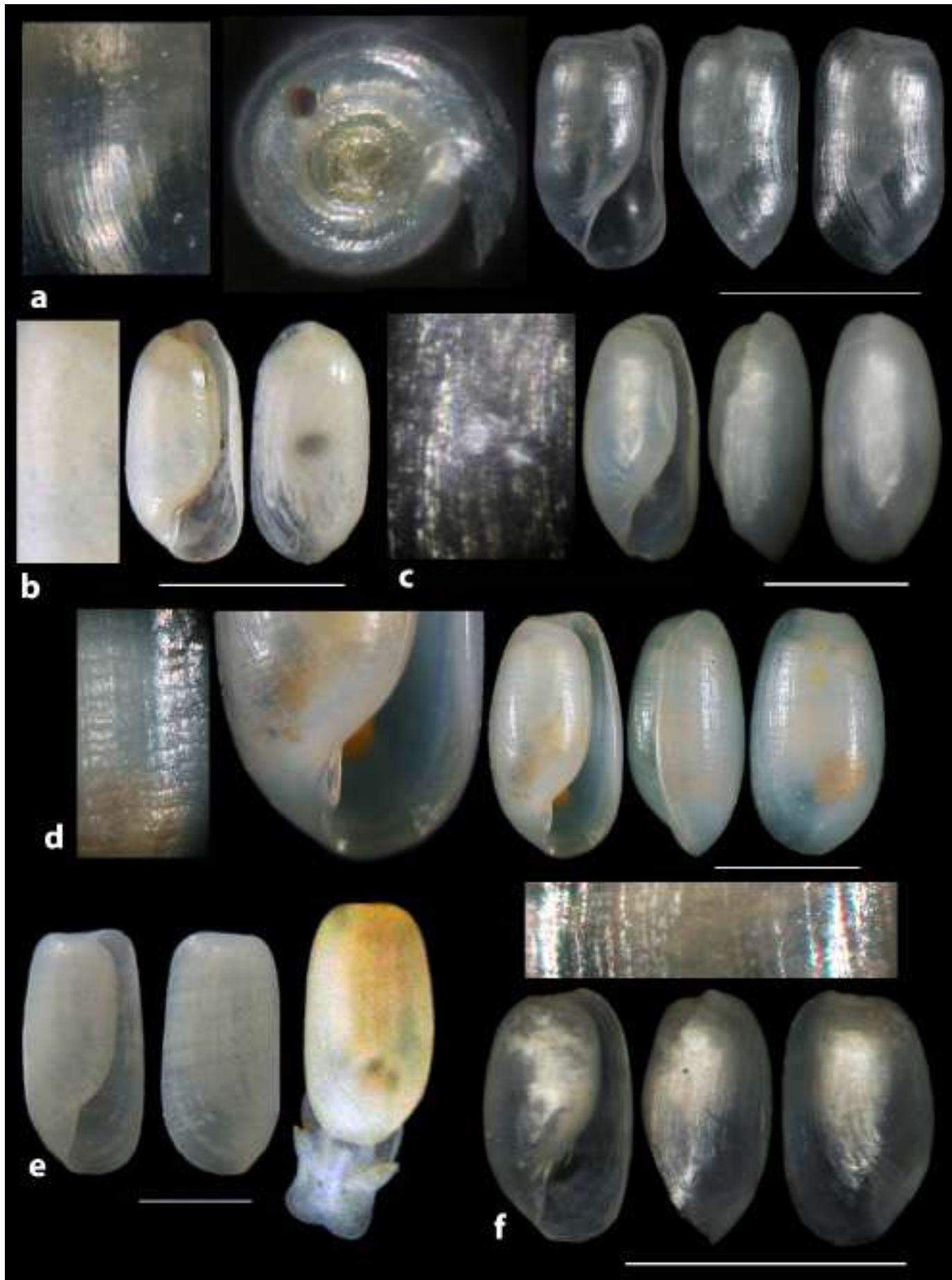


Figure 2: a. *Retusa minutissima* (Monterosato, 1878), b. *Retusa nitidula* (Loven, 1846), c. *Retusa parvula* (Jeffreys, 1883), d. *Retusa crosseii* (Bucquoy, Dautzenberg & Dollfus, 1886), e. *Retusa tornata* (Watson, 1886), f. *Retusa variabilis* (Milaschewitsch, 1912). Barr = 1 mm.





Figure 3: a. *Retusa* sp. 1, b. *Retusa truncatula* (Bruguière, 1792), c. *Retusa* sp. 2. Barr = 1 mm.

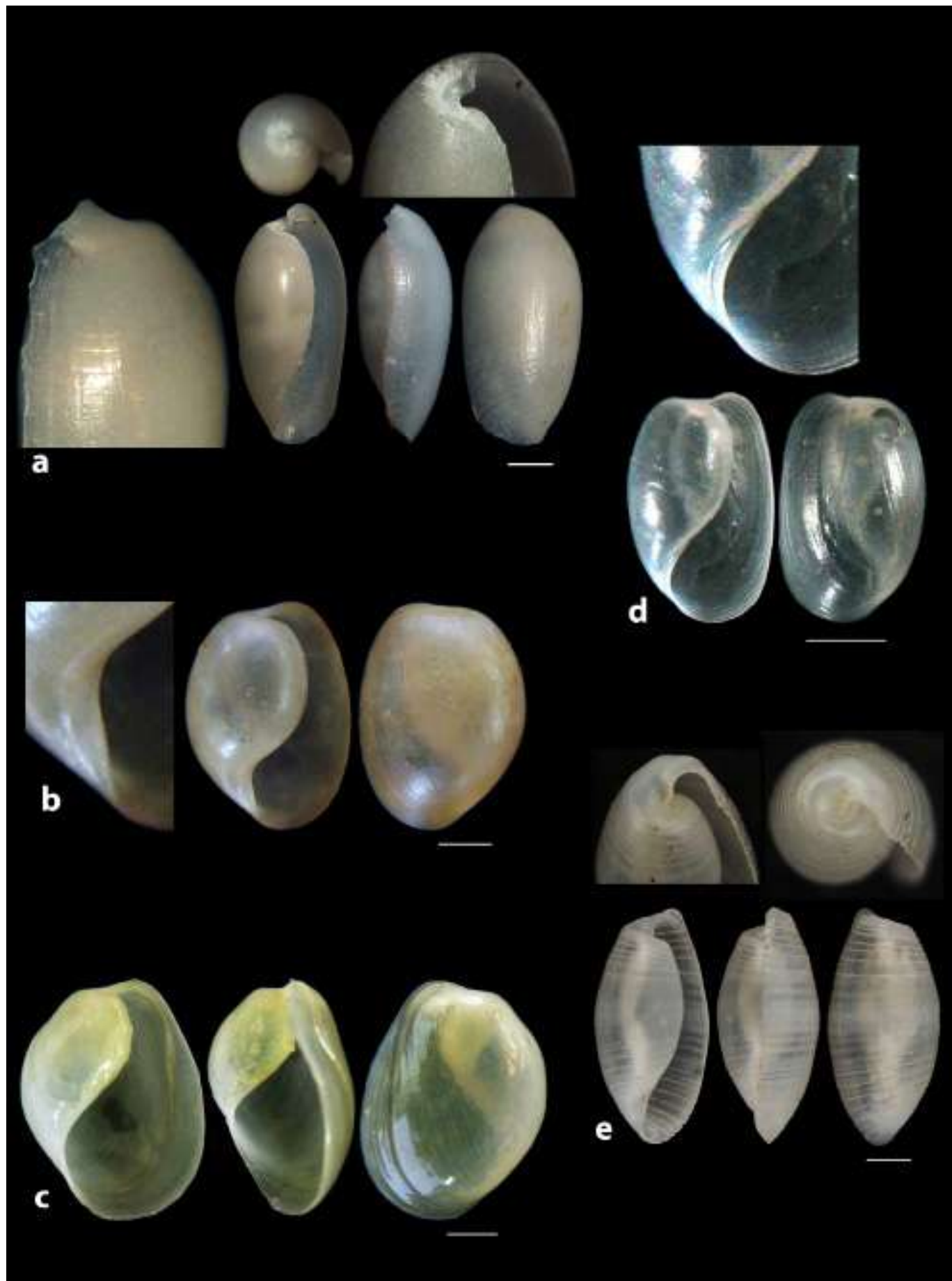


Figure 4: a. *Aliculastrum cylindricum* (Helbling, 1779), b. *Haloa japonica* (Pilsbry, 1895), c. *Haminoea orbignyana* (Férussac, 1822), d. *Haminoea ortei* Talavera, Murillo & Templado, 1987, e. *Weinkauffia macandrewii* (E. A. Smith, 1872). Barr = 1 mm.



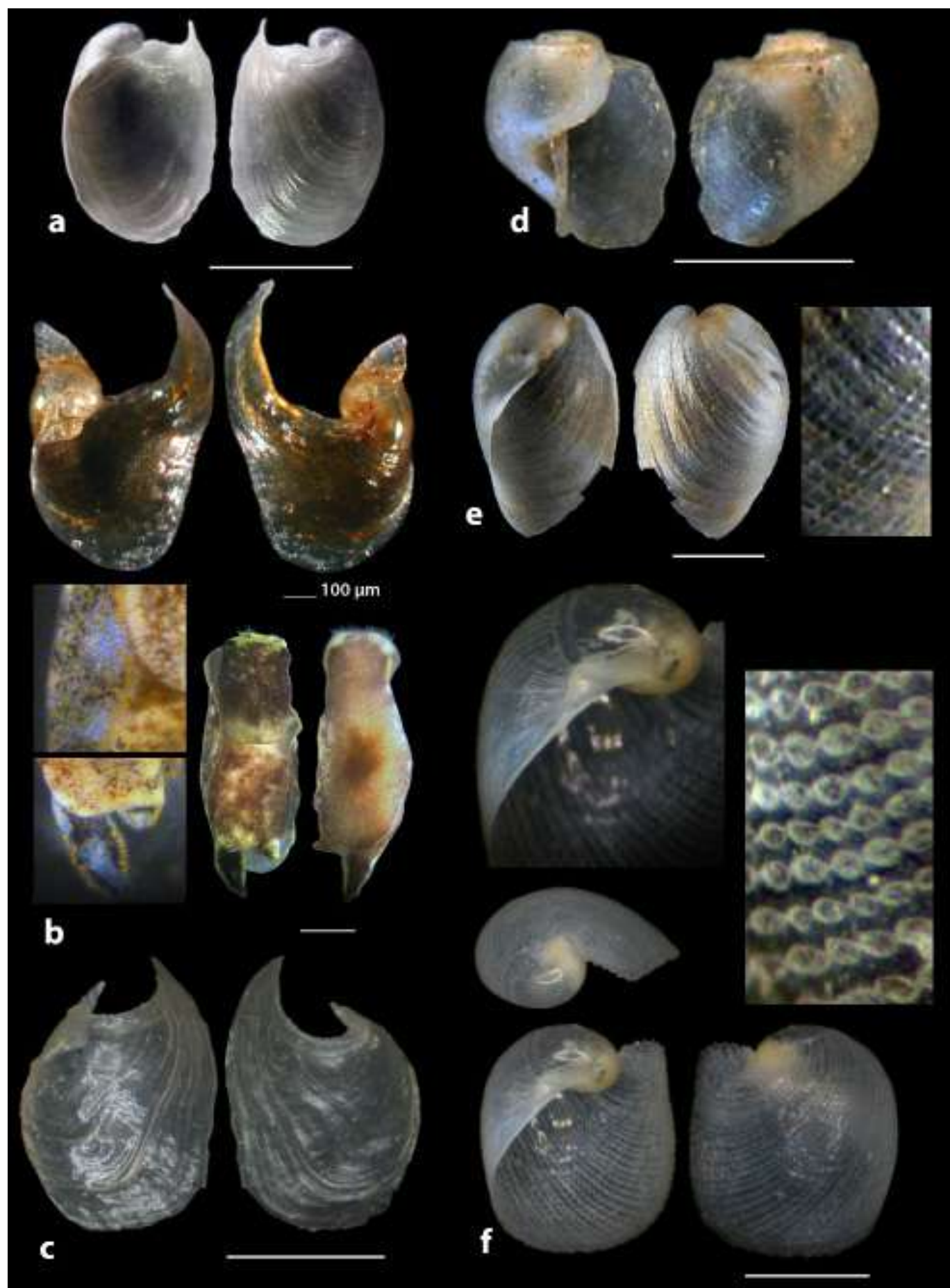


Figure 5: a. *Biuve fulvipunctata* (Baba, 1938), b. *Camachoaglaja africana* (Pruvot-Fol, 1953), c. *Melanochlamys wildpretii* Ortea, Bacallado & Moro, 2003, d. *Colpodaspis pusilla* M. Sars, 1870, e. *Laona pruinosa* (W. Clark, 1827), f. *Laona quadrata* (S. Wood, 1839). Barr = 1 mm, unless otherwise indicated.

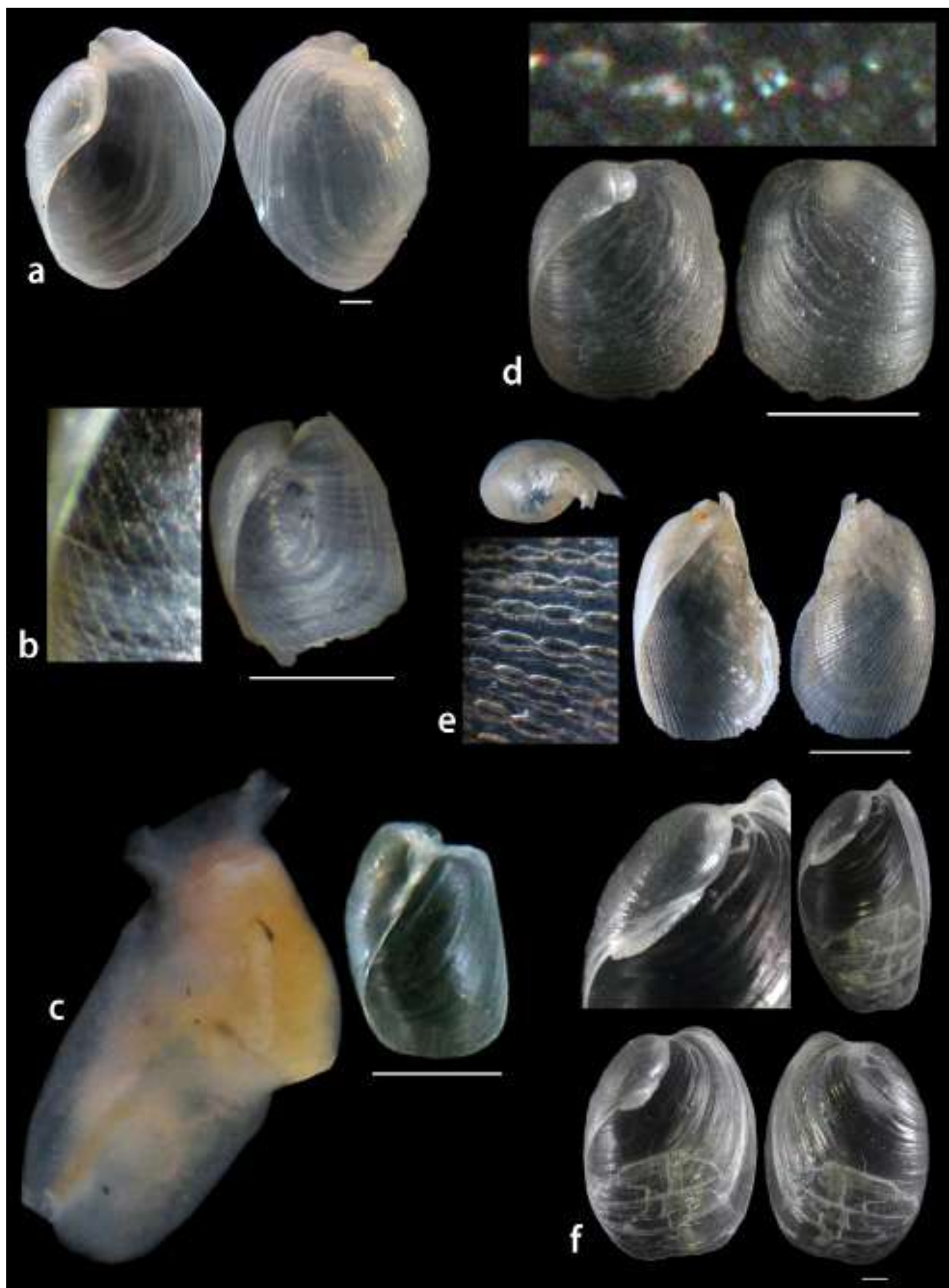


Figure 6: a. *Philine angasi* (Crosse, 1865), b. *Philine angulata* Jeffreys, 1867, c. *Philine denticulata* (J. Adams, 1800) live and shell, d. *Philine monterosati* Monterosato, 1874, e. *Philine powelli* Rudman, 1970, f. *Philine* sp. 1, an aberrant shell of *P. quadripartita* Ascanius, 1772 (?). Barr = 1 mm.

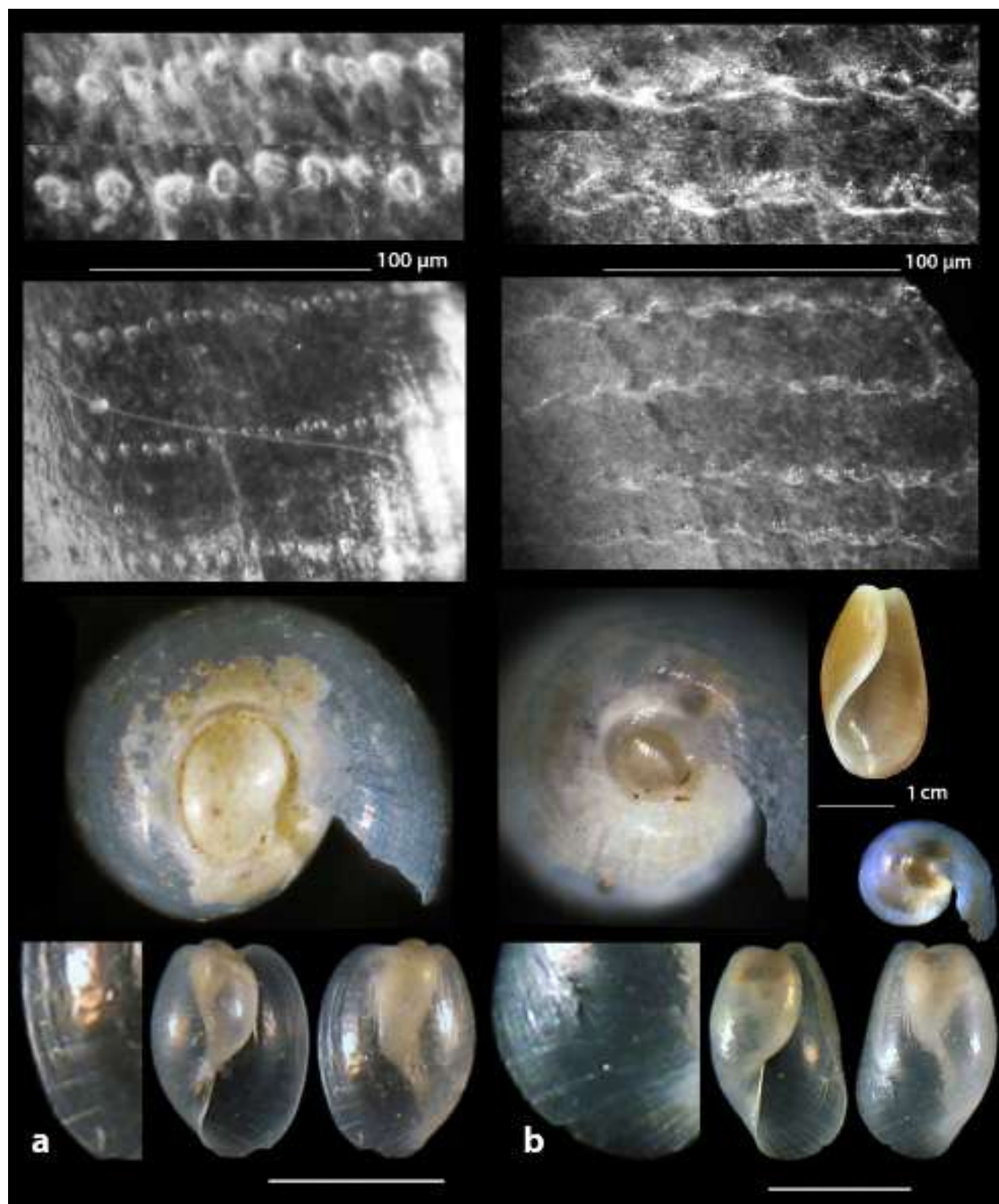


Figure 7: a. *Scaphander punctostriatus* (Mighels & Adams, 1842), b. *Scaphander lignarius* (Linnaeus, 1758). Barr = 1 mm, unless otherwise indicated.

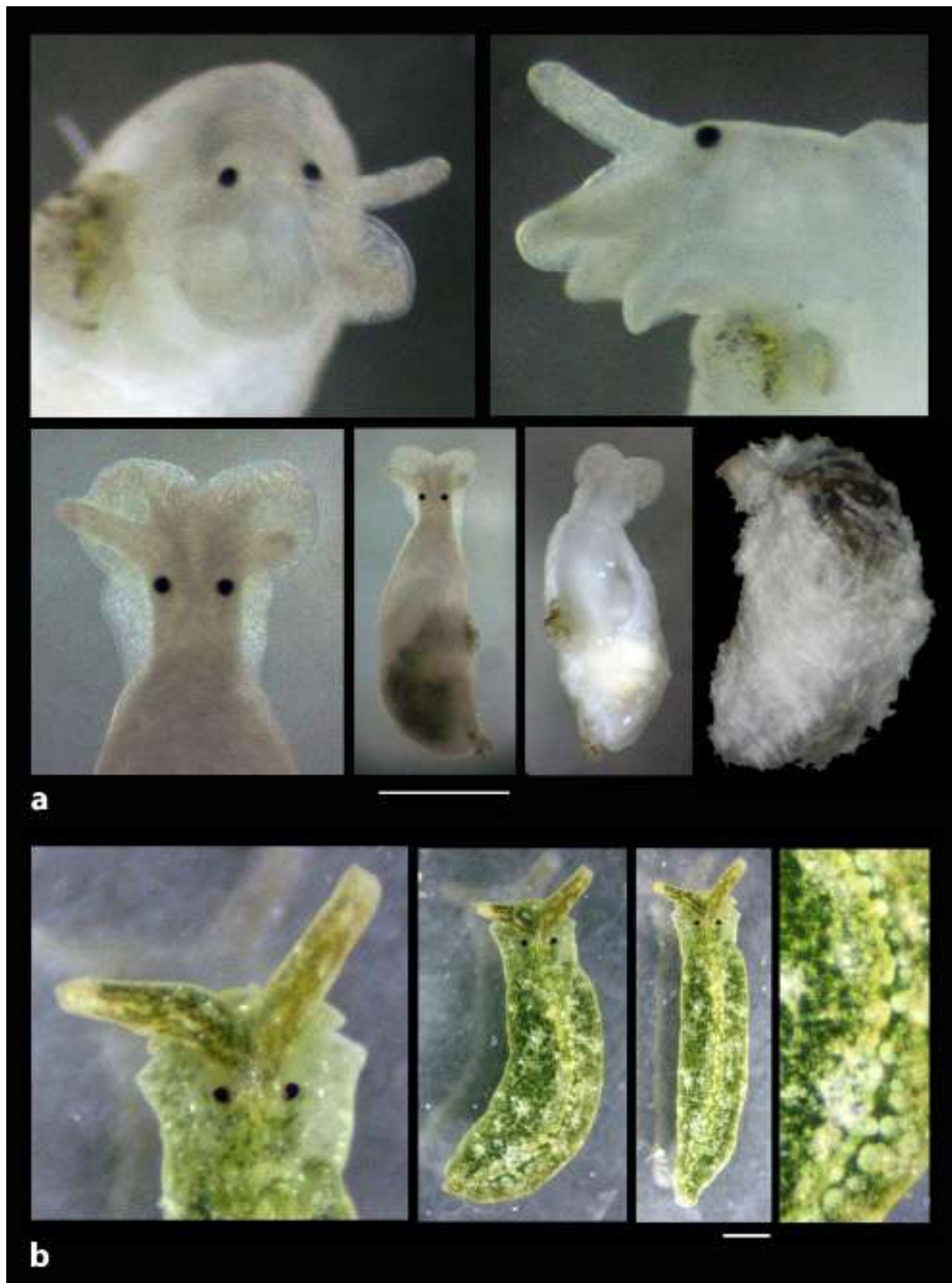


Figure 8: a. *Hedylopsis spiculifera* (Kowalevsky, 1901), b. *Elysia nealae* Ostergaard, 1955. Barr = 1 mm.



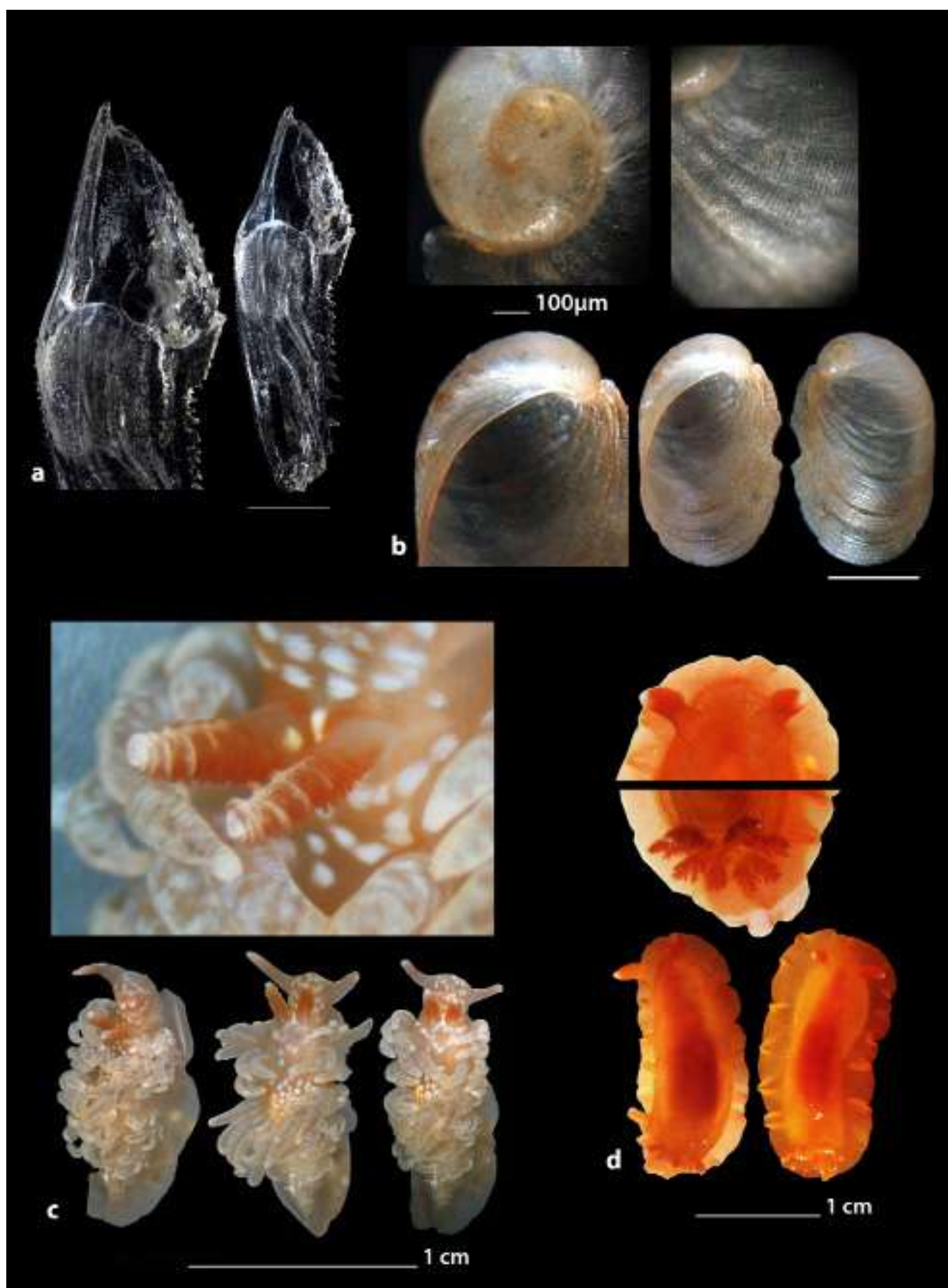


Figure 9: a. *Cymbulia peronii* Blainville, 1818, b. *Berthellina* cfr. *edwardsii* (Vayssière, 1897), c. *Spurilla neapolitana* (Delle Chiaje, 1841), d. *Dendrodoris herytra* Valdés & Ortea in Valdés, Ortea, Ávila & Ballesteros, 1996. Barr = 1 mm, unless otherwise indicated.

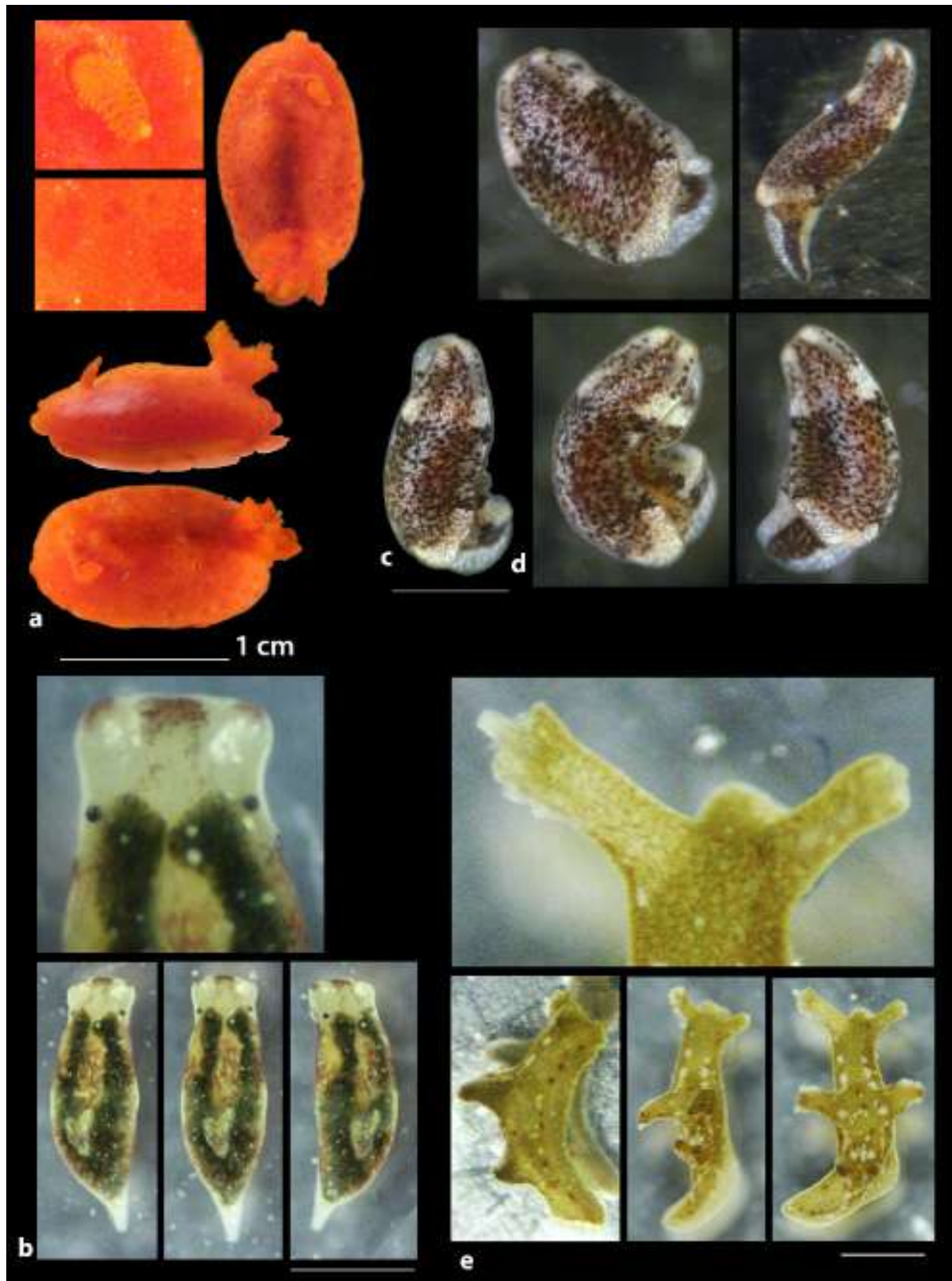


Figure 10: a. *Jorunna onubensis* Cervera, Garcia-Gomez & Garcia, 1986, b. *Limapontia capitata* (O. F. Müller, 1774), c and d. *Runcina adriatica* T. Thompson, 1980, e. *Notobryon bijecurum* Baba, 1937. Barr = 1 mm, unless otherwise indicated.



Table 1: List of recorded species with collection data and corresponding references.

Family	Species	Figure	Shells	Live	Depth m	Bottom	Area	Global coordinates	Rarity	Origin	Record	Literature
Retusidae	<i>Pyrrunculus ovatus</i> (Jeffreys, 1871)	1a	1		300	CB	Lemnos Island	40°02'N - 25°08'E	Un	WMS	G1, EMS1	Cachia <i>et al.</i> , 2001 Sparerrotta <i>et al.</i> , 2011
	<i>Retusa crebrisculpta</i> (Monterosato, 1884), in text	1b	4		20 40 0,2	MB MB ZB	Nea Michaniona Paralia, Epanomi Paralia, Epanomi	40°27'N - 22°50'E 40°23'N - 22°51'E 40°24'N - 22°53'E	Un	CMS	G1, EMS1	Oliverio & Tringali, 2001 Repetto <i>et al.</i> , 2005 Cossignani & Ardovini, 2011 Sparerrotta <i>et al.</i> , 2011
	<i>Retusa desgenettii</i> (Auduin, 1826), in text	1c	1		20	Mu	Chalastra, Thessaloniki Bay	40°31'N - 22°46'E	Un	LM, EMS	G1	Sparerrotta <i>et al.</i> , 2011 Crocetta & Tringali, 2015
	<i>Retusa laevisculpta</i> (Granata-Grillo, 1877), in text	1d, e	8	10	20 0,2	MB ZB	Nea Michaniona Paralia, Epanomi	40°27'N - 22°50'E 40°24'N - 22°53'E	Un	MS	G1	Gofas <i>et al.</i> , 2011
	<i>Retusa minutissima</i> (Monterosato, 1878), in text	2a	6	7	20 0,2 0,2	MB ZB ZB	Nea Michaniona Paralia, Epanomi Cape, Epanomi	40°27'N - 22°50'E 40°24'N - 22°53'E 40°23'N - 22°53'E	Co	MS	G2	Oliverio & Tringali, 2001 Sparerrotta <i>et al.</i> , 2011 Crocetta <i>et al.</i> , 2015
	<i>Retusa nitidula</i> (Loven, 1846), in text	2b	1		30	MB	Paralia, Epanomi	40°23'N - 22°52'E	Un	MS	G1	Gagliani, 1991 Coppini, 2002 Repetto <i>et al.</i> , 2005
	<i>Retusa parvula</i> (Jeffreys, 1883)	2c	1		350	CB	Lemnos Island	40°02'N - 25°11'E	Un	MS	G2	Repetto <i>et al.</i> , 2005 Crocetta <i>et al.</i> , 2015
	<i>Retusa crosseii</i> (Bucquoy, Dautzenberg & Dollfus, 1886), for comparison	2d										
	<i>Retusa tornata</i> (Watson, 1886), in text	2e	6	4	3 0,2	MB ZB	Palioura, Epanomi Cape, Epanomi	40°25'N - 22°52'E 40°23'N - 22°53'E	Co	Mad	G1, MS1	Segers <i>et al.</i> , 2009 http://www.marinespecies.org/aphia.php?p=image&tid=141137&pic=118145
	<i>Retusa variabilis</i> (Milaschewitsch, 1912)	2f	2 1		1 0,2	Sh MB ZB	Cape, Epanomi Epidauros Gulf Cape, Epanomi	40°22'N - 22°53'E 37°38'N - 23°15'E 40°23'N - 22°53'E	Un	BS	G1, MS1	Kantor & Sysoev, 2006
	<i>Retusa</i> sp.1, aberrant form of <i>R. truncatula</i> (Bruguière, 1792) (?)	3a	1									
	<i>Retusa truncatula</i> (Bruguière, 1792), for comparison	3b										
	<i>Retusa</i> sp.2, aberrant form of <i>R. laevisculpta</i> (Granata-Grillo, 1877) (?)	3c	1	10		MB	Palioura, Epanomi	40°25'N - 22°52'E				
	<i>Aliculastrum cylindricum</i> (Helbling, 1779)	4a	1		10	MB	Agathopes, Syros Island	37°22'N - 24°53'E	Co	IP	G1, MS1, NLM	Too <i>et al.</i> , 2014
Haminoeidae	<i>Haloea japonica</i> (Pilsbry, 1895)	4b	1		70	MB	Central Thermaikos Gulf	40°09'N - 23°01'E	Un	LM	G1	Crocetta <i>et al.</i> , 2013 Oskars <i>et al.</i> , 2019

<i>Haminoea orbignyana</i> (Férussac, 1822), in text	4c	5	7	0,2 70	ZB MB	Cape, Epanomi Central Thermaikos Gulf	40°23'N – 22°53'E 40°09'N - 23°01'E	Co	MS	G1	Gofas <i>et al.</i> , 2011
<i>Haminoea ortea</i> Talavera, Murillo & Templado, 1987, in text	4d	2		0,2 70	ZB MB	Cape, Epanomi Central Thermaikos Gulf	40°23'N – 22°53'E 40°09'N - 23°01'E	Un	MS	G2	Vervaeke, 2007 Crocetta <i>et al.</i> , 2015 Garabetian <i>et al.</i> , 2017 Valdés, 2017
<i>Weinkauffia macandrewii</i> (E. A. Smith, 1872)	4e	4		0,2	ZB	Cape, Epanomi	40°23'N – 22°53'E	Un	MS	G2	Gofas <i>et al.</i> , 2011 Sparerrotta <i>et al.</i> , 2011 http://www.marinespecies.org/aphia.php?p=image&tid=1342949&pic=62113
<i>Biue fulvipunctata</i> (Baba, 1938)	5a	2		0,2	ZB	Cape, Epanomi	40°23'N – 22°53'E	Ra	WCMS	G1, EMS2	Repetto <i>et al.</i> , 2005 Ohnheiser & Malaquias, 2013, from synonym Malaquias <i>et al.</i> , 2016, from synonym Zamora-Silva & Malaquias, 2017, from synonym
<i>Camachoaglaia africana</i> (Pruvot-Fol, 1953)	5b		7	1	Sh	Cape, Epanomi	40°22'N – 22°53'E	Un	WCMS	G1, EMS1	Gofas <i>et al.</i> , 2011
<i>Melanochlamys wildpretii</i> Ortea, Bacallado & Moro, 2003	5c	1		0,2	ZB	Cape, Epanomi	40°23'N – 22°53'E	Ra	MS	G2	Manousis <i>et al.</i> , 2012
<i>Colpodaspis pusilla</i> M. Sars, 1870	5d	1		70	MB	Central Thermaikos Gulf	40°09'N - 23°01'E	Un	WMS	G1, EMS1	Repetto <i>et al.</i> , 2005 Cossignani & Ardovini, 2011
<i>Laona pruinosa</i> (W. Clark, 1827)	5e	4		300 350	CB CB	Lemnos Island Lemnos Island	40°06'N – 25°16'E 40°02'N – 25°11'E	Un	WCMS	G1, EMS1	Gofas <i>et al.</i> , 2011
<i>Laona quadrata</i> (S. Wood, 1839)	5f	3		300	CB	Lemnos Island	40°06'N – 25°16'E	Un	MS	G2	Crocetta <i>et al.</i> , 2015
<i>Philine angasi</i> (Crosse, 1865)	6a	1		0,2	ZB	Paralia, Epanomi	40°24'N - 22°53'E	Un	SP	G1, MS1, NLM	Price <i>et al.</i> , 2011
<i>Philine angulata</i> Jeffreys, 1867	6b	2		100	MB	North Aegean Sea	39°49'N – 23°28'E	Ra	WCMS	G1, EMS1	Repetto <i>et al.</i> , 2005 Gofas <i>et al.</i> , 2011
<i>Philine denticulata</i> (J. Adams, 1800), included for the live animal	6c										
<i>Philine monterosati</i> Monterosato, 1874	6d	1		30	Mu	Thessaloniki Bay	40°31'N 22°48'E	Ra	MS	G2	Repetto <i>et al.</i> , 2005 Koukouras, 2010 Gofas <i>et al.</i> , 2011
<i>Philine powelli</i> Rudman, 1970, in text	6e	1		40	MB	Paralia, Epanomi	40°23'N – 22°51'E	Un	NZ	G1, MS1, NLM	Rudman, 1970
<i>Philine</i> sp. 1, an aberrant shell of <i>P. quadrata</i> Ascanius, 1772 (?)	6f	1		20	MB	Palioura, Epanomi	40°25'N - 22°51'E				
<i>Scaphander punctostriatus</i> (Mighels & Adams, 1842), in text	7a	1		350	CB	Lemnos Island	40°02'N – 25°11'E	Un	A, WMS	G1, EMS1	Janssen, 1989 Repetto <i>et al.</i> , 2005

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Description of two new species of cone snails from the Lesser Antilles

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Abstract

Specimens in the *Conus (Dauciconus) daucus* (Hwass in Bruguière, 1792) complex differ by subtle differences in the colour pattern, including a yellowish to orange vs pink apex. The two forms co-occur subtidally in 5–30 m, and cluster in two distinct molecular clades. The species with yellowish to orange apex is described as *Conus (Dauciconus) quasidaucus* spec. nov. A sequenced neotype is designated for *Conus daucus*. Another cone collected in 90–95 m off Guadeloupe and resembling *C. eversoni*, with which had earlier been misidentified, is described as *Conus (Dauciconus) karubenthos* spec. nov.

Résumé

Les spécialistes et amateurs de cônes ont depuis longtemps reconnu l'existence, chez *Conus daucus*, de deux formes se distinguant par des différences subtiles du patron de coloration et, surtout, par la présence d'un apex rosé chez certains spécimens, et d'un apex jaunâtre à orange chez d'autres. Ces deux formes co-existent de 5 à 30 m de profondeur, sans distinction particulière d'habitat. Le séquençage de huit spécimens provenant des expéditions du MNHN en Martinique et en Guadeloupe montre que ces deux formes correspondent à deux groupes moléculaires bien distincts, et donc à deux espèces différentes. L'espèce à apex rosé conserve le nom *Conus daucus* Hwass in Bruguière, 1792, pour lequel un néotype séquencé est désigné ici, le lectotype original étant perdu. La deuxième espèce avec un apex jaunâtre à orange est décrite comme nouvelle sous le nom *Conus (Dauciconus) quasidaucus* spec. nov. Trois spécimens collectés durant la mission KARUBENTHOS 2, dont deux vivants ayant été séquencés, avaient un moment été identifiés comme *Conus eversoni* Petuch, 1987, puis comme "*Dauciconus* sp."; cette espèce est ici décrite sous le nom *Conus (Dauciconus) karubenthos* spec. nov.

Introduction

Among the cones identifiable as *Conus (Dauciconus) daucus* collected during recent MNHN expeditions in the Lesser Antilles, Clovel & Touthou (2020: 140–145) had noted that the molecular tree distinguished two groups, one with a pink apex, the other with a yellowish to orange apex. This species pair is the subject of the present paper. Beside, the identification of specimens from off Guadeloupe identified by Rabiller & Richard (2019) as *Conus eversoni* Petuch, 1987, was challenged by Clovel & Touthou (2020: 274–275), who simply referred to them as "*Dauciconus* sp.". Re-examination of these led us to conclude that they represent a new species, described

below as *C. karubenthos* spec. nov.

Deciding whether *Dauciconus* should be considered at the genus (as in Tucker & Tenorio 2013) or subgenus (as in Puillandre & al. 2015) rank would require a complete re-assessment of cone snails classification. Pending this revision, we follow Puillandre & al. (2015), and the new species are placed in the genus *Conus*, subgenus *Dauciconus*.

Repositories

MNHN: Muséum National d'Histoire Naturelle, Paris, France.
DT: David Touthou reference collection, Collobrières, France.
PC: Pierre Clovel reference collection, Martinique, France.

Molecular analysis: DNA was extracted and a fragment of the *cox1* gene sequenced following standard procedures (e.g. Puillandre & al. 2017). Newly-obtained sequences were combined with previously published sequences from Caribbean cone snails. A Bayesian phylogenetic tree was obtained using MrBayes 3.2.6 (Huelsenbeck, Ronquist & Hall, 2001), with two runs consisting of eight Markov chains and 10 000 000 generations, with four chains, three swaps at each generation, a sampling frequency of one tree each 1 000 generations and a chain temperature set at 0.02. A consensus tree was reconstructed after checking for convergence and after removal of the first 25% trees as burnin. Each of the two new species *C. quasidaucus* spec. nov. and *C. karubenthos* spec. nov. constitute well-supported clades (Posterior Probabilities = 1), well differentiated from their sister-species. In the case of *C. quasidaucus* spec. nov. the morphologically similar species, *C. daucus*, is actually not even its sister species, reinforcing the conclusion that they are not conspecific.

***Conus (Dauciconus) quasidaucus* spec. nov.**

Type data: Martinique: Rocher de la Caravelle, 14°48.4' N, 60°52.8' W, 13–25 m, 20 Sept. 2016 [MADIBENTHOS stn AR198], holotype (40.4 mm, MNHN-IM-2013-72653) and paratype 3 (37.5 mm, MNHN-IM-2013-72652). - Guadeloupe: Grand Cul de Sac Marin, 16°21.8' N, 61°36.4' W, 24 m, 5 May 2012 [KARUBENTHOS 2012 stn GR07], paratype 1 (49.0 mm, MNHN-IM-2013-19586). - Martinique: Anse Couleuvre, 14°50.4' N, 61°13.4' W, 10 m, 1 Oct. 2016 [MADIBENTHOS stn AR464], paratype 2 (47.7 mm, MNHN-IM-2013-71819).

Description: Shell medium sized, conical. The apex is yellowish to orange. The spire is low. The sutural ramp is flat, with slightly stepped whorls and shows a blurry alternation of slightly darker

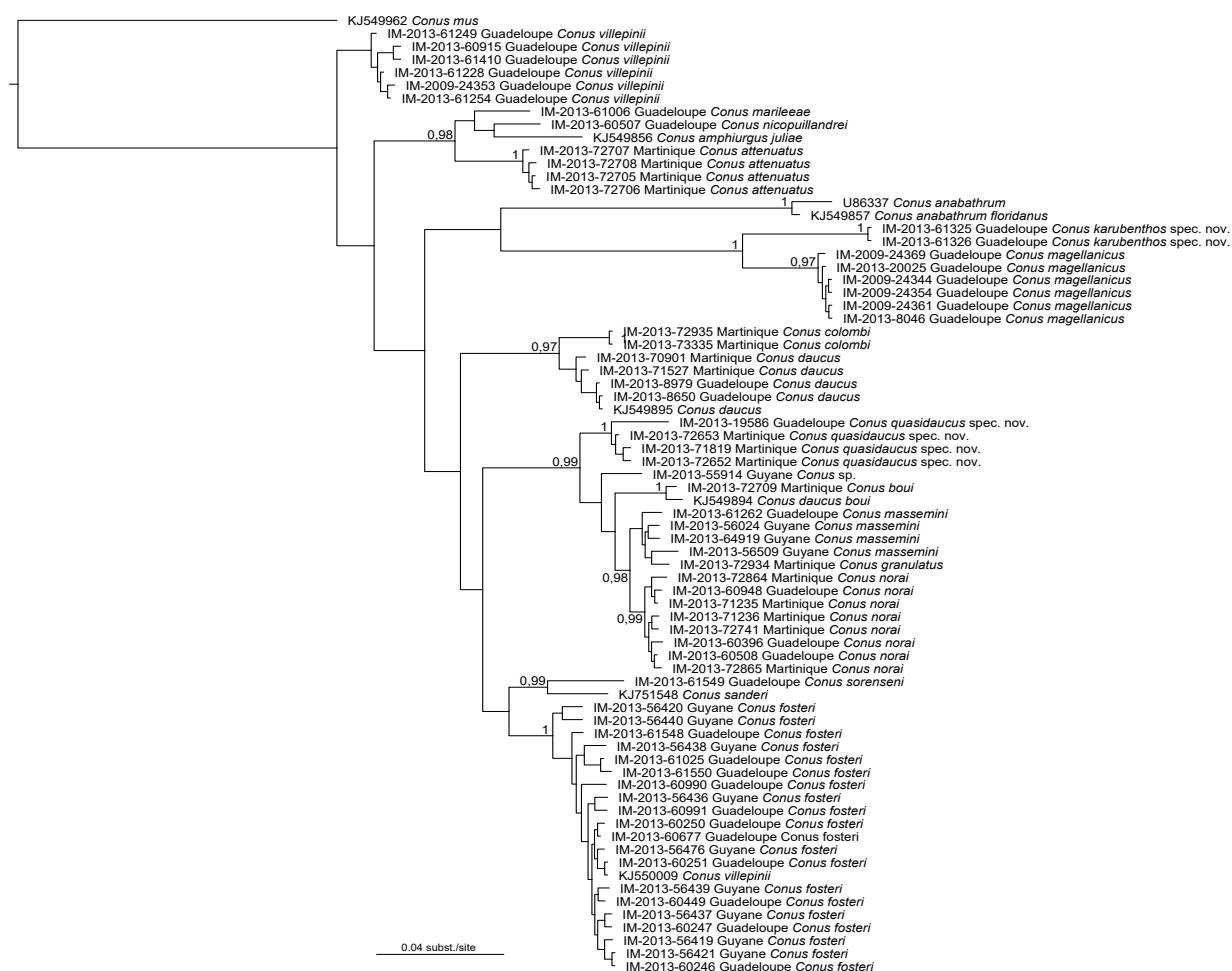


Figure 1 : Bayesian phylogenetic tree obtained with the *cox1* gene. Sample names include the MNHN voucher number or the GenBank accession number, followed by the locality and the species name. Posterior probabilities are indicated for each node when > 0.95. The specimen corresponding to the GENBANK KJ550009 sequence has most probably been misidentified and is probably a specimen of *Conus fosteri* Clench & Aguayo, 1942.

orange blotches on orange background. The suture is linear and incised. Shoulder is angulate and smooth. Last whorl is smooth. Aperture is straight, with a whitish to light pinkish interior. Lip is thin, fragile, even in mature specimens. The ground color of the last whorl is orange. The pattern shows a whitish spiral band at mid-whorl (2 to 5 mm broad), bordered by two brownish spiral bands (and also has a broader, light spiral band at shoulder in paratype 1). Darker axial flammules at mid-whorl are partially covering the light band; several irregular spiral lines made of brown spots can be present on either side of the median white band. Periostracum is brown, thick and slightly hairy.

Living animal: The animal is completely orange.

Etymology: The name *quasidaucus* refers to the strong resemblance with *Conus (Dauciconus) daucus*. Used as a noun in apposition.

Distribution and habitat: *Conus quasidaucus* co-occurs subtidally with *C. daucus* in 5–30 m (KARUBENTHOS and MADIBENTHOS data), among rocks or algal fields with sandy areas. A specimen was dredged alive on April 15, 1976, off Dania Beach, Broward County, Florida, in 380 feet (115 m) (Bill Fenzan, pers. comm., 2020) and *C. daucus* is reported from 1–90 m (Monnier & al., 2018). Like *C. daucus*, *C. quasidaucus* seems to have a wide distribution range throughout the Caribbean area and is reported (B. Fenzan, pers. comm., 2020) from many localities

(Honduras, Netherlands Antilles, St. Kitts, Florida, British Virgin Is., Cuba, Puerto Rico, Dominican Republic, Turks & Caicos Is., Bahamas and Barbados).

Discussion: *Conus (Dauciconus) daucus* Hwass in Bruguière, 1792 is renowned for the variability of its shell pattern, as reflected in its long list of synonyms (Tucker & Tenorio, 2013; Kohn, 2014; Monnier & Limpalaër, 2016). A molecular analysis of the MNHN expeditions specimens actually shows two genetically distinct groups (Fig. 1; see also Clovel & Touitou, 2020) and an examination of these shells reveals that the two groups differ in the colour of their apex: pink in *C. (D.) daucus* and yellowish to orange in the newly described *C. quasidaucus* spec. nov. Specialists and amateurs alike have long noted this difference in colour and, among amateurs, the hypothesis is that the pinkish color would fade over time. However, the apex of shells collected over 50 years remains pinkish, and the four specimens from MNHN expeditions with a yellowish to orange apex were collected very recently. A review of the synonyms of *C. (D.) daucus* did not reveal any description that fits the specimens with a yellowish to orange apex (Clovel & Touitou, 2020), that are described as a new species, *C. quasidaucus* spec. nov. *Conus daucus* seems to be more variable in colour than *C. quasidaucus* spec. nov. However, for the moment, only specimens of *C. quasidaucus* spec. nov. of orange colour have been sequenced and specimens from other localities might reveal more colour variation. In addition, the brownish spiral

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bands bordering the light mid-whorl one seem to be more clearly marked in *C. quasidaucus* spec. nov. (this character is strongly expressed on specimens on specimens illustrated Pl. 2 Figs 3, 4 and 5). The discovery that *Conus* (*D.*) *daucus* is a complex of two cryptic species requires to stabilize its nomenclature. Clench (1942) designated as lectotype the shell illustrated by Chemnitz (1788: pl. 144A, fig. L), which was referred to by Hwass in Bruguière (1792: 651). This specimen is lost (Kohn, 1968). We therefore designate the sequenced specimen MNHN-IM-2013-71527, 26.3 mm [Martinique: Grande Anse du Diamant, 14°28.0' N, 61°00.1' W, 12 m, 26 Sept. 2016, MADIBENTHOS stn AB360] as neotype of *C. (D.) daucus*. This specimen matches well the accepted taxonomic extension of this species, with an orange body-whorl and a pink apex, alternating light blotches on the orange background of the spire, and some white blotches on the last whorl, as described by Hwass.

***Conus (Dauciconus) karubenthos* spec. nov.**

Type data: Guadeloupe: W of Marie-Galante, 15° 49.4' N, 61° 28.7' W, 90–95 m, 27 June 2015 [KARUBENTHOS 2 stn DW4631], 3 spms (holotype, 16.0 mm, MNHN-IM-2013-61325, paratype 1, 17.9 mm, MNHN-IM-2013-61326, paratype 2, 18.8 mm, MNHN-IM-2018-5416).

Description: Shell small-sized (all studied shells measure less than 20 mm), slightly bulging, elongated conical. The apex is yellowish. The protoconch is paucispiral. The spire is moderately low. The sutural ramp shows alternating white and brown blotches on an orange background. The suture is linear and incised. Shoulder is subangulate, smooth to slightly crenulated (whitish to yellowish crenulations). The ground color of the last whorl is orange. The pattern shows a spiral median band overlaid by brown and white blotches; the last whorl can be covered by numerous spiral lines composed of small brown dots. The periostracum is thin, translucent and slightly hairy.

Distribution and habitat: *C. karubenthos* spec. nov. is known from a single station from West of Marie-Galante (Guadeloupe) where it was dredged in 90–95 m on a bottom of coarse sand, gravel and silt.

Etymology: karubenthos is the acronym of the expedition that collected the material, itself derived from Karukéra, the Amerindian name of Guadeloupe, and benthos; used as a noun in apposition.

Comparison with similar species: *C. karubenthos* spec. nov. resembles *C. eversoni* Petuch, 1987, with which it had been identified by Rabiller & Richard (2019: 274–275), and the two share a similar adult size under 25 mm, shell colour, spiral lines made of dark dots, and smooth to slightly crenulated shoulder, but *C. eversoni*, described from Honduras in 6–20 m, has a narrower shell and higher and more stepped spire. Protoconch is “pale tan” (Petuch, 1987) and the median clear spiral band is usually lacking or very subdued and there is no visible white and brown blotches in *C. eversoni*. So far, no specimen of *C. eversoni* from Honduras have been sequenced.

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Plate 1: *Conus (Dauciconus) quasidaucus* spec. nov.



1. *C. quasidaucus* spec. nov. 49.0 mm PARATYPE 1 MNHN-IM-2013-19586
2. *C. quasidaucus* spec. nov. 37.5 mm PARATYPE 3 MNHN-IM-2013-72652
3. *C. quasidaucus* spec. nov. 47.7 mm PARATYPE 2 MNHN-IM-2013-71815
4. *C. quasidaucus* spec. nov. 40.4 mm HOLOTYPE MNHN-IM-2013-72653

5. PARATYPE 1 with periostracum
6. PARATYPE 2 with periostracum
7. HOLOTYPE with periostracum
8. PARATYPE 3 with periostracum

Plate 2 : *Conus (Dauciconus) daucus* Hwass in Bruguière, 1792 & *C. (Dauciconus) quasidaucus* spec. nov.



1. *C. daucus* 26.7 mm Martinique, NEOTYPE MNHN-IM-2013-71527
2. *C. daucus* NEOTYPE with periostracum
3. *C. quasidaucus* spec. nov. 50.1 mm Martinique, Coll. DT
4. *C. quasidaucus* spec. nov. 45.4 mm Martinique, Coll. DT
5. *C. quasidaucus* spec. nov. 30.4 mm Martinique, Coll. DT
6. & 6a. *C. quasidaucus* spec. nov. 39.0 mm Martinique, Live

Plate 3 : *Conus (Dauciconus) daucus* Hwass in Bruguière, 1792



1. & 1a. *C. daucus* 42.6 mm Guadeloupe MNHN-IM-2013-8650
 2. & 2a. *C. daucus* 42.3 mm Martinique, Coll. PC
 3. & 3a. *C. daucus* 31.5 mm Martinique, Coll. PC
 4. & 4a. *C. daucus* 35.6 mm Martinique, Coll. PC
 5. & 5a. *C. daucus* 39.5 mm Martinique, Coll. PC
 6. & 6a. *C. daucus* 34.3 mm Martinique, with periostracum, Coll. PC
 7. & 7a. *C. daucus* 34.3 mm Martinique, Coll. PC
 8. & 8a. *C. daucus* 14.3 mm Guadeloupe, MNHN-IM-2013-8979

Plate 4: *Conus (Dauciconus) karubenthos* spec. nov.



1. *C. karubenthos* spec. nov. 16.0 mm Marie-Galante, Guadeloupe, MNHN-IM-2013-61325 HOLOTYPE
- 1a. SEM micrograph of the protonconch and early postnuclear teleoconch whorls of *C. karubenthos* spec. nov. MNHN-IM-2013-61325
2. *C. karubenthos* spec. nov. 17.9 mm Marie-Galante, Guadeloupe, MNHN-IM-2013-61326 PARATYPE 1
- 2a. SEM micrograph of the protonconch and early postnuclear teleoconch whorls of *C. karubenthos* spec. nov. MNHN-IM-2013-61326
3. *C. karubenthos* spec. nov. 18.8 mm Marie-Galante, Guadeloupe, MNHN-IM-2018-5416 PARATYPE 2
- 3a. *C. karubenthos* spec. nov. PARATYPE 2 with periostracum

***Carinatus*, a new genus for the family Vitrinellidae (Gastropoda, Truncatelloidea) from the Pacific Ocean, with the description of 8 new species**

***Carinatus*, un nuevo género de la familia Vitrinellidae (Gastropoda, Truncatelloidea) del Océano Pacífico, con la descripción de 8 especies nuevas**

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KEY WORDS: Gastropoda, Truncatelloidea, Vitrinellidae, new genus and new species.

ABSTRACT

A new genus and 8 new species belonging to the family Vitrinellidae (Caenogastropoda: Truncatelloidea) are described. The species studied are from the southeastern tropical Pacific and were collected in the Marquesas Is., Vanuatu, Solomon Is., Fiji, Philippines and Papua New Guinea.

The new genus *Carinatus* is based on unique morphological features that are present in the 8 new species described; their systematic position is discussed and the new genus is compared with other genera presenting similar morphological characters. Each species is illustrated by scanning electron microscope photographs; their specific variability is discussed, and information about their habitat, geographical distribution and bathymetric range is provided.

RESUMEN

Se describen un nuevo género y 8 especies nuevas pertenecientes a la familia Vitrinellidae (Caenogastropoda: Truncatelloidea). Las especies estudiadas proceden del sudeste del Pacífico tropical recolectadas en las Islas Marquesas, Vanuatu, Islas Salomón, Fidji, Filipinas y Papúa Nueva Guinea.

El nuevo género *Carinatus* se ha basado en caracteres morfológicos únicos presentes en las 8 nuevas especies descritas; se discute su posición sistemática y se compara con otros géneros con caracteres morfológicos similares. Cada una de las especies se ilustra mediante fotografías al microscopio electrónico de barrido, discutiendo su variabilidad específica y aportando datos sobre el hábitat, distribución geográfica y rango batimétrico.

RESUME

Un nouveau genre et 8 nouvelles espèces appartenant à la famille des Vitrinellidae (Caenogastropoda: Truncatelloidea) sont décrits. Les espèces étudiées, provenant du sud-ouest de l'Océan Pacifique tropical, ont été récoltées aux îles Marquises, au Vanuatu, aux îles Salomon, aux Fidji, Philippines et Papouasie Nouvelle-Guinée.

Le nouveau genre *Carinatus* est décrit sur des caractères morphologiques uniques présents dans les 8 nouvelles espèces ; sa position systématique est discutée et comparée aux autres genres qui ont des caractères morphologiques identiques. Chacune des espèces est illustrée de photographies prises au microscope électronique à balayage, montrant sa variabilité spécifique, donnant des informations sur sa distribution géographique, son habitat et sa bathymétrie.

INTRODUCTION

After the examination of the “vitrinelliform” gastropods from the tropical Pacific collected mostly during the Tropical Deep-Sea Benthos and our Planet Reviewed expeditions conducted respectively by IRD and MNHN, and MNHN and Pro-Natura International, our attention has been drawn to some groups displaying unique sets of characters, leading us to describe them as new genera: *Monodosus* (Rubio & Rolán, 2016), *Circuitus* (Rubio & Rolán, 2017a), *Tuberes* (Rubio & Rolán, 2017b) and *Collatus* (Rubio & Rolán, 2018).

A further small group of species, which, in view of their general appearance, could belong to the genus *Circulus* Philippi, 1836, but was finally retained as distinct, is the object of the present work. They have a depressed-turbinate shell, totally covered by spiral cords, keeled, widely umbilicate and with the protoconch with thick flexuous oblique riblets.

Ponder (1994: 258) defined the genus *Circulus* as: “*vitrinellids having a spirally ridged shell with a simple non varicose aperture*”.

MATERIALS AND METHODS

The material studied in this paper originates essentially from several expeditions conducted by MNHN and Pronatura International (PNI) in partnership with the University of Papua New Guinea (UPNG) as part of the *Our Planet Reviewed* programme (PAPUA NIUGINI 2012); by MNHN and Institut de Recherche pour le Développement (IRD) as part of the *Tropical Deep-Sea Benthos* programme (**MUSORSTOM** 9, 10; **SALOMON** 1; see Bouchet *et al.* 2008).

Material from the central Philippines: Panglao, Dauis, Cortes, Tagbilaran and Baclayon, and the Bohol and Sulu Seas, is also included.

The above mentioned expeditions are detailed as follows:

MUSORSTOM 9 (1997) on board R/V *Alis*. Marquesas Archipelago (doi.org/10.17600/97100020)

MUSORSTOM 10 (1998) on board R/V *Alis* explored the Fijian Archipelago (doi.org/10.17600/98100080)

SALOMON 1 (2001) on board R/V *Alis* surveyed the central part of the Solomon Islands, from Guadalcanal to Malaita and Makira. (doi.org/10.17600/1100090)

Philippines Panglao, Dauis, Cortes, Tagbilaran and Baclayon.

SANTO 2006 (Global Biodiversity Survey) explored the waters of Spiritu Santo Island in Vanuatu.

PAPUA NIUGINI 2012 expedition to the Madang lagoon and

the adjacent part of the Bismarck Sea, Papua New Guinea. (doi.org/10.17600/18000841).

Illustrations for all the studied species were prepared using a Scanning Electron Microscope (SEM) Quanta 200 and Evo IS15. Measurements of the teleoconch, the maximum height (H) and maximum diameter (D) are based on the scale bar of the SEM micrographs.

The protoconch was measured by the Verduin (1976) method, in which a nucleus is considered at the beginning of the spire.

Abbreviations:

MNHN Muséum national d'Histoire naturelle, Paris
D maximum diameter of the shell, measured perpendicular to the axis of coiling
H total height of the shell
Stn station
s clearly empty shells

SYSTEMATIC PART

Superfamily TRUNCATELLOIDEA Gray, 1840
Family VITRINELLIDAE Bush, 1897

Carinatus n. gen.

Type species: *Carinatus regius* n. sp.

Etymology: The genus name *Carinatus* is a Latin conversion from the word *carina*, *ae* which means “which have carinae or keels,” alluding to the prominent keels always present in the species of this genus. We are treating the new word as masculine.

Description: Shell depressed-turbiniform, with a low to very low spire; protoconch multispiral, slightly elevated with respect to the first teleoconch whorl, ornamented with thick flexuous oblique riblets; teleoconch keeled, with 1-3 keels distributed between the suture and the base and totally covered by spiral cords. Spaces between cords totally covered by micro granules. Growth lines strongly prosocline. Aperture rounded; margin of the outer lip modified by the keels. Umbilicus widely opened, usually totally covered by fine spiral cords inside.

Remarks: The shells included in this genus, although having different morphology, all share the main characters, which are: the protoconch with about 2 whorls, ornamented with thick flexuous oblique riblets; the teleoconch keeled, totally covered by spiral cords with micro granules on interspaces. These characters are highly diagnostic.

Circulus Jeffreys, 1865 is the genus whose species may have shapes similar to those of species in the new genus *Carinatus*. However, the genus *Circulus* is very different, its differential morphological characters being: protoconch without axial folds, teleoconch with uniformly thick spiral cords, both adapical and abapically, and a wide and deep umbilicus.

Monodosus Rubio & Rolán, 2016 and *Collatus* Rubio & Rolán, 2019 are the only genera whose species have a similar protoconch, but the rest of the morphological characters are totally different (shell discoidal, much flattened and strongly keeled, with adapical nodes on the teleoconch whorls).

Carinatus regius n. sp. (Figures 1A-G)

Type material: Holotype (Figs. 1A-b, 2A-c), MNHN-IM-2000-35732. This species is also the type species for the genus *Carinatus*.

Material examined: 1 s: Papua New Guinea, PAPUA NIUGINI: 1 s, Yomba Island, Stn. PD73, 05°15'S-145°47'E, 20-25 m.

Type locality: Papua New Guinea, Yomba Island, 05°15'S-145°47'E, 20-25 m [PAPUA NIUGINI: Stn. PD73].

Etymology: The specific name derives from the Latin *regius*, *a, um* which means “royal”, alluding to the form of the upper carina that seems to be a crown or a royal diadem.

Description: Shell small (<2 mm), rounded, depressed, fragile, protoconch with a little more than 2 whorls that are smooth, except for the small oblique and depressed lines visible from the inner suture, not very noticeable in the first whorl, because of erosion. Nucleus about 50 µm in diameter, the protoconch having a diameter of 460 µm. The teleoconch has 1 ¼ whorls with three carinae, the upper one very prominent, undulating with points in the upper border; the second one is in the middle of the external border and it is very small; the third one is a little more prominent and is placed in the base where the surface of the shell goes towards the umbilicus which is wide and very deep. The surface of the shell is covered with spiral irregular elevations, 7 at the beginning, flatter and more regular at the end, separated by wider interspaces. Aperture rounded, with its border modified by the ends of the three spiral carinae. Dimensions of the holotype are 1.95 mm in diameter and 0.97 in height.

Habitat: Infralittoral species collected at 20-25 m deep.

Distribution: Only known from Papua New Guinea.

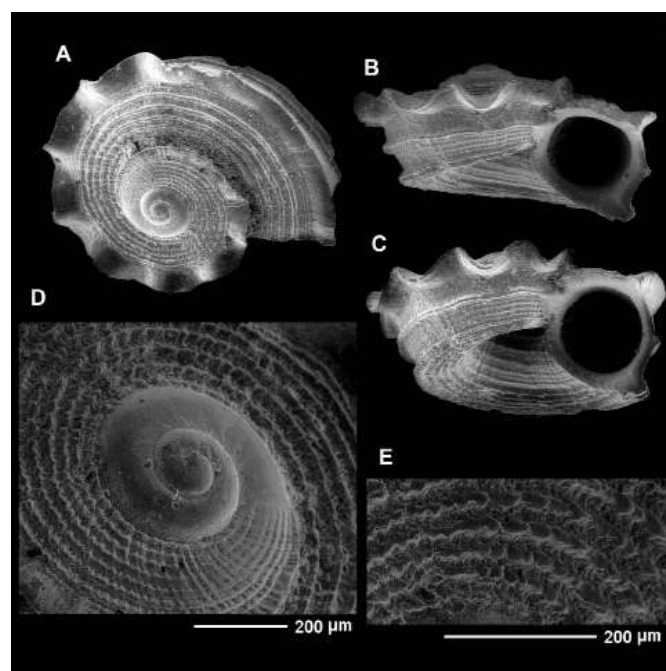


Figure 1. A-E. *Carinatus regius* n. sp. A-C: holotype, 1.95 mm in diameter, Yomba Island, Papua New Guinea, Stn PD73, 20-25 m (MNHN); D: protoconch; E: microsculpture.

Remarks: *Carinatus regius* n. sp. is characterized by those characters mentioned in the genus, but in this species, the upper carina is very prominent, and the border is undulating, a feature that is not present in the other species of this genus.

***Carinatus simplex* n. sp.** (Figures 2A-G)

Type material: Holotype (Figs. 2A-G), MNHN-IM-2000-35733.

Material examined: 2 s: Philippines, 4: 1 s, Panglao Island, Bolod, 09°32'N-123°48'E, 152 m, coarse sand (holotype); 1 s, Panglao Island, off San Isidro, 09°34'N-123°50'E, 97-120 m, fine sand with seagrass, MNHN-IM-2012-25494.

Type locality: Philippines, Panglao Island, Bolod, 9°32'N-123°48'E, 152 m, coarse sand.

Etymology: The specific name derives from the Latin word *simplex*, meaning "simple" and alluding to the fact that the typical characters of the genus are not very conspicuous.

Description: Shell small (<2.5 mm), rounded, depressed, fragile protoconch, with a little more than 2 whorls that are smooth, except for the small oblique and depressed lines visible from the inner suture, beginning after the first whorl and ending before the last quarter whorl. There are 15 lines with irregular interspaces and only present on 1/3 of the surface of the protoconch. The protoconch has a nucleus with 57 µm diameter, the protoconch being 570 µm in diameter. The teleoconch has 1.7 whorls and shows a prominent carina in the middle of the external border; below, there is another carina just where the

external border is going to penetrate in the umbilicus, which is very wide and deep; the surface between the two carinae has an upper part smooth and the lower part with two spiral cords; the remaining shell has numerous spiral cords and in the interspaces between them numerous tubercles irregularly disposed. Aperture rounded with its border modified by the end of the two spiral carinae which produce two pointed prominences. The rest of the apertural border is smooth.

Dimensions: the holotype is 2.15 mm in diameter and 0.91 in height. Other shell is 3.9 mm in diameter and 1.4 mm in height.

Habitat: Circalittoral to bathyal species dredged at 152 m in coarse sand bottom and at 97-120 m in fine sand with seagrass bottom.

Distribution: Only known from Panglao Island, Philippines.

Remarks: *Carinatus simplex* n. sp. is characterized by the two peripheral carinae, the upper one more prominent; both end in the aperture forming a tip; the protoconch has the characteristic riblets; all the surface of the shell present numerous spiral cords with tubercles as microsculpture in the interspaces. See *Carinatus bicarinatus* n. sp.

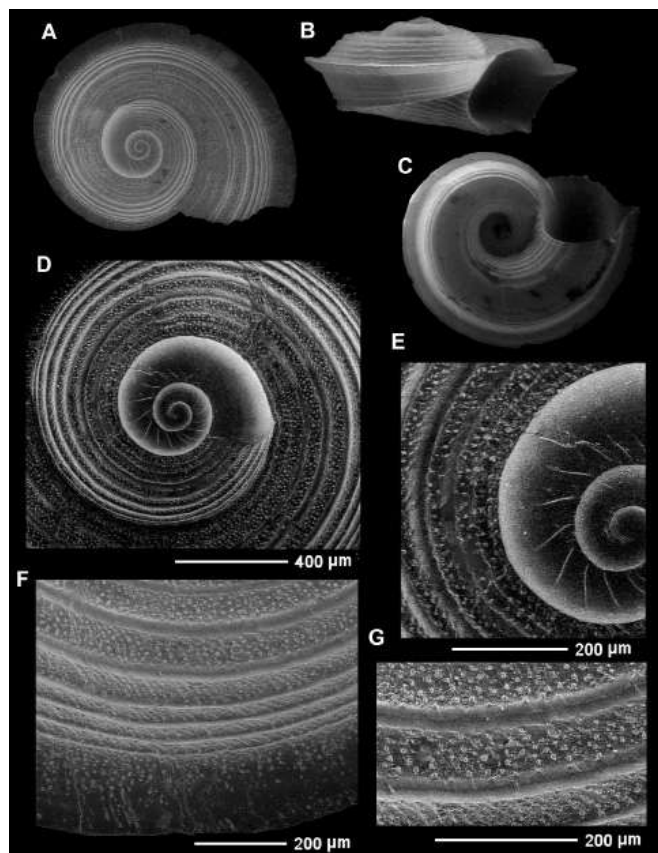


Figure 2. A-G. *Carinatus simplex* n.sp. A-C: holotype, 2.15 mm in diameter, Panglao Island, Bolod, 09°32'N-123°48'E, 152 m (MNHN); D-E: protoconch and detail; F-G: microsculpture and detail.

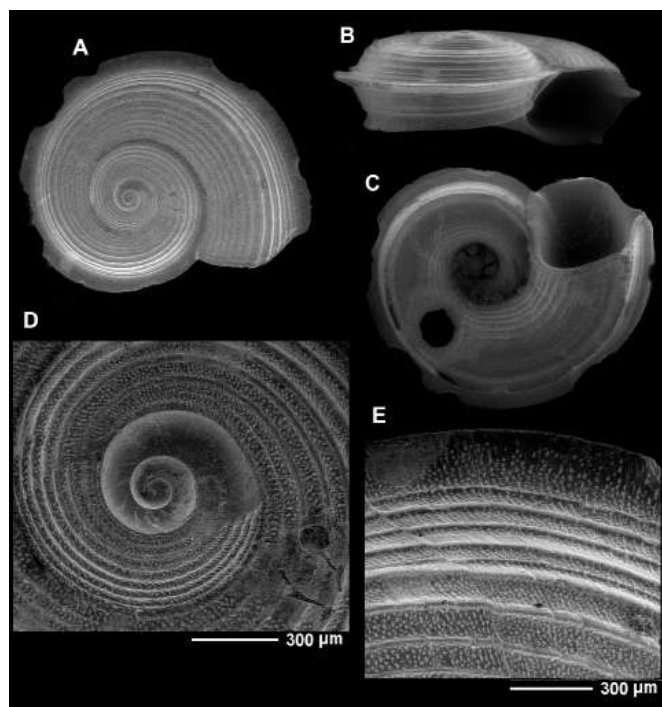


Figure 3. A-E. *Carinatus simplex* n. sp. A-C: shell, 3.9 mm in diameter, Panglao Island, off San Isidro, 09°34'N-123°50'E, 97-120 m (MNHN); D: protoconch; E: microsculpture.

***Carinatus bicarinatus* n. sp.** (Figures 4A-F)

Type material: Holotype (Figs. 4A-F), MNHN-IM-2000-35734.

Material examined: 1 s: Solomon Islands, SALOMON 1: 1 s, Stn. DW1767, 08°19'S-160°40'E, 90-200 m.

Type locality: Solomon Islands, 08°19'S-160°40'E, 90-200 m [SALOMON 1: Stn DW1767].

Etymology: The specific name derives from the two prominent peripheral carinae.

Description: Shell small (< 4 mm), rounded, depressed, fragile; protoconch with a little more than 2 whorls which are smooth

except by the small oblique and depressed lines which are visible from the inner suture, beginning after the first whorl and finishing near the end. There are 19 lines with irregular interspaces only absent from the first whorl and a narrow region at the end of the protoconch. The protoconch has a nucleus with 60 μm in diameter, the protoconch being 560 μm in diameter. The teleoconch has 1 $\frac{3}{4}$ whorls showing two prominent carinae on the external border: the upper one finishes in the upper part of the aperture, and the lower one in the middle; the external border is going to penetrate in the umbilicus, which is very wide and deep, just below the second carina; the surface between the two carinae has four spiral flat cords with tubercles in the interspaces; the rest of the shell has numerous spiral cords and in the interspaces between them numerous tubercles irregularly disposed. Aperture is supposed to be rounded, but is broken in the holotype.

Dimensions: the holotype measures 3.6 mm in diameter and 1.1 mm in height.

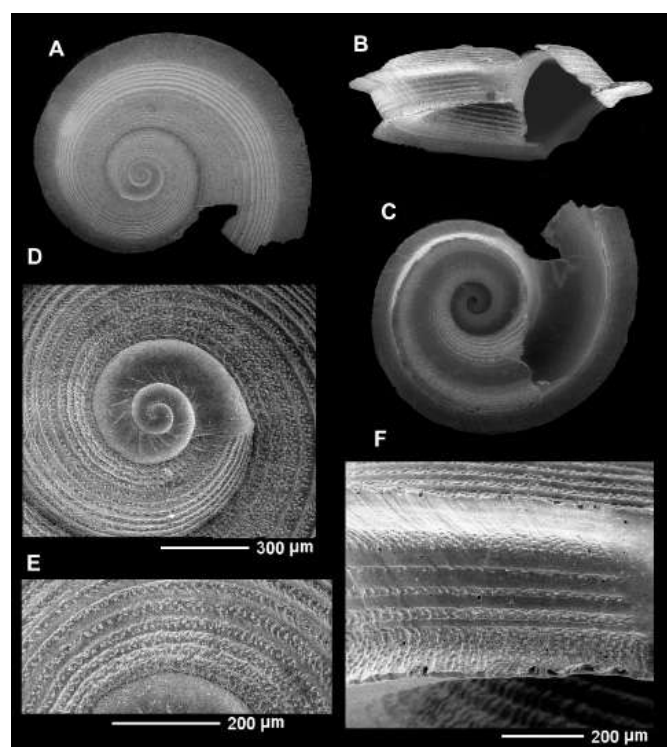


Figure 4. A-F. *Carinatus bicarinatus* n. sp. A-C: holotype, 3.6 mm in diameter and 1.1 mm in height (MNHN); D: protoconch; E-F: microsculpture and detail.

Habitat: Circalittoral to bathyal species dredged at 90-200 m depth.

Distribution: Only known from Solomon Islands.

Remarks: *Carinatus bicarinatus* n. sp. is characterized by the two prominent carinae which are placed in the periphery. *Carinatus simplex* n. sp. has also two keels but the lower one is very small, the shell is also smaller, and the space between the two carinae has only a couple of spiral cords, whereas *C. bicarinatus* has four.

***Carinatus ministriatus* n. sp. (Figures 5A-F)**

Type material: Holotype (Figs. 5A-F), MNHN-IM-2000-35735 and 6 paratypes, MNHN-IM-2000-35736.

Material examined: 9 s: Marquesas Islands, MUSORSTOM 9: 7

s, Nuka Hiva Island, Stn. DW1184, 08°49'S-140°04'W, 23-30 m (type material); 1 s, Nuka Hiva Island, Stn. DW1161, 08°56'S-140°06'W, 30-37 m; 1 s, Fatu Hiva Island, Stn. DR1247, 10°34'S-138°42'W, 1150-1250 m.

Type locality: Marquesas Islands, Nuka Hiva Island, 08°49.3'S-140°03.6'W, 23-30 m [MUSORSTOM 9: Stn DW1184].

Etymology: The specific name derives from the small size of the oblique lines present on the protoconch, which are of smaller size than those present in other species of the genus.

Description: Shell small (<5 mm), rounded, depressed, fragile; protoconch with 2 and $\frac{1}{4}$ whorls that are smooth except for the small oblique and depressed lines visible from the inner suture, beginning after the end of the first protoconch whorl and finishing just at the end of the protoconch. There are about 34 lines with irregular interspaces between them and not present at the beginning of the protoconch. The latter has a nucleus which measures 57 μm in diameter, the protoconch being 570 μm in diameter. The teleoconch has a little more than 2 whorls, showing a slightly prominent carina in the middle of the external border; the entire surface of the shell has numerous spiral cords and in their interspaces there are numerous tubercles, irregularly disposed. Aperture rounded with its border modified by the end of the spiral carinae where can be seen a pointed prominence. The rest of the apertural border is smooth, but the end of the spiral cords can be observed.

Dimensions: The holotype measures 4.1 mm in diameter and 1.9 mm in height.

Habitat: Infralittoral to bathyal species dredged at 23-37 m and 1150-1250 m depth.

Distribution: Only known from Marquesas Islands.

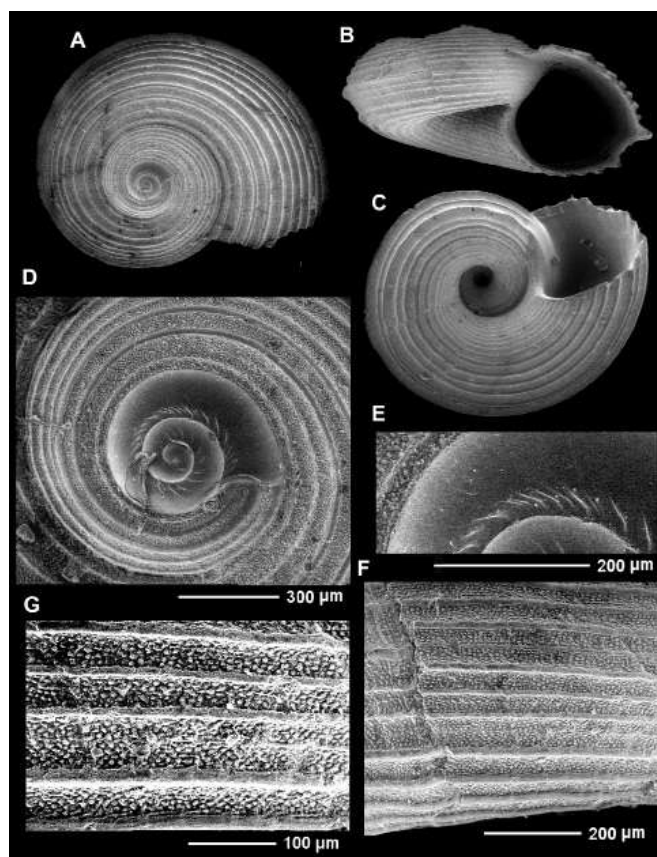


Figure 5. A-F. *Carinatus ministriatus* n. sp. A-C: holotype, 4.1 mm in diameter, Nuka Hiva Island, Stn. DW1184, 08°49'S-140°04'W, 23-30 m (MNHN); D-E: protoconch and detail; F-G: microsculpture and detail.

Remarks: *Carinatus ministriatus* n. sp. is characterized by only one little prominent carina with all the surface covered by spiral cords. The oblique lines of the protoconch are smaller than in any other species of the genus.

***Carinatus fijiensis* n. sp.** (Figures 6A-F)

Type material: Holotype (Figs. 6A-F), MNHN-IM-2000-35737 and 6 paratypes MNHN-IM-2000-35738.

Material examined: 7 s: Fiji, MUSORSTOM 10: 7 s, Bligh Water, Stn. DW1329, 17°19'S-177°47'E, 102-106 m.

Type locality: Fiji, Bligh Water, 17°19'S-177°47'E, 102-106 m [MUSORSTOM 10: Stn DW1329].

Etymology: The specific name derives from the island where the species was collected.

Description: Shell small (<2.5 mm), rounded, depressed, solid; protoconch with 2 and $\frac{1}{4}$ whorls that are smooth, except for the small oblique and depressed lines visible from the inner suture, beginning after the end of the first protoconch whorl and finishing just at $\frac{1}{4}$ of whorl before the end of the protoconch; but in this last quarter they are replaced with other badly defined lines, which appear in the suture and have not well defined endings. There are about 34 lines with irregular interspaces between them, absent from the beginning of the protoconch (in the first whorl). This protoconch has a nucleus which measures about 45 μ m in diameter, the protoconch being 560 μ m in diameter. The teleoconch has about 1 $\frac{1}{2}$ whorls, showing a scarcely prominent carina in the middle of the external border; all the surface of the shell has numerous spiral cords, and, in their interspaces, there are numerous tubercles irregularly disposed. Aperture rounded, with its border modified by the end of the spiral carinae where can be seen a pointed prominence. The rest of the apertural border is smooth but the end of the

spiral cords can be observed.

Dimensions: The holotype measures 2.3 mm in diameter and 1.0 mm in height.

Habitat: Bathyal species dredged at 102-106 m depth.

Distribution: Only known from Fiji.

Remarks: *Carinatus fijiensis* n. sp. is characterized by numerous spiral cords, finer in the abapical area, and by a prominent carina in the middle of the external border.

***Carinatus obesus* n. sp.** (Figures 7A-E)

Type material: Holotype (Figs. 7A-E), MNHN-IM-2000-35739.

Material examined: 1 s: Philippines, 1 s, Bohol Island, Cortes, 09°42'N - 123°50'E, 80-100 m, muddy bottom with sponges.

Type locality: Philippines, Bohol Island, Cortes, 09°42'N - 123°50'E, 80-100 m, muddy bottom with sponges.

Etymology: The specific name derives from the wide spire and aperture, which give the sensation that it is wider than other species of the genus, so being obese.

Description: Shell small (< 2.0 mm), rounded, somewhat depressed, fragile; protoconch with 2 whorls and $\frac{1}{4}$, which is smooth in the first whorl, and also in the last $\frac{1}{4}$, for the rest presenting the small oblique and depressed lines that are visible from the inner suture, in numbers of 12-13. The protoconch has a nucleus with 55 μ m in diameter, the protoconch being 540 μ m in diameter. The teleoconch has 1 $\frac{1}{4}$ whorls showing a not very prominent carina in the middle of the external border; below this carina there is a space formed by a spiral band without sculpture, while in the rest of the shells there are numerous spiral cords with microsculpture in the interspaces formed by numerous tubercles irregularly disposed. Aperture rounded, with its border modified by the end of the spiral carinae where is formed a prominent elevation. The rest of the apertural border is smooth but being observed some points where the spiral cords finish.

Dimensions: The holotype measures 1.55 mm in diameter and 1.0 mm in height.

Habitat: Circalittoral species dredged at 80-100 m in muddy bottom with sponges.

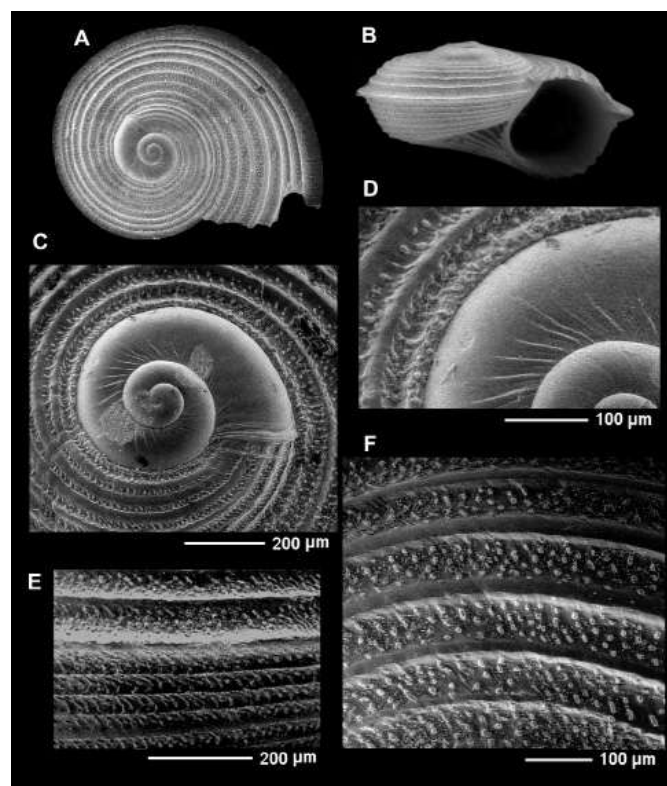


Figure 6. A-F. *Carinatus fijiensis* n. sp. A-B: holotype, 2.3 mm, Bligh Water, Stn. DW1329, 17°19'S-177°47'E, 102-106 m (MNHN); C-D: protoconch and detail; E-F: microsculpture and detail.

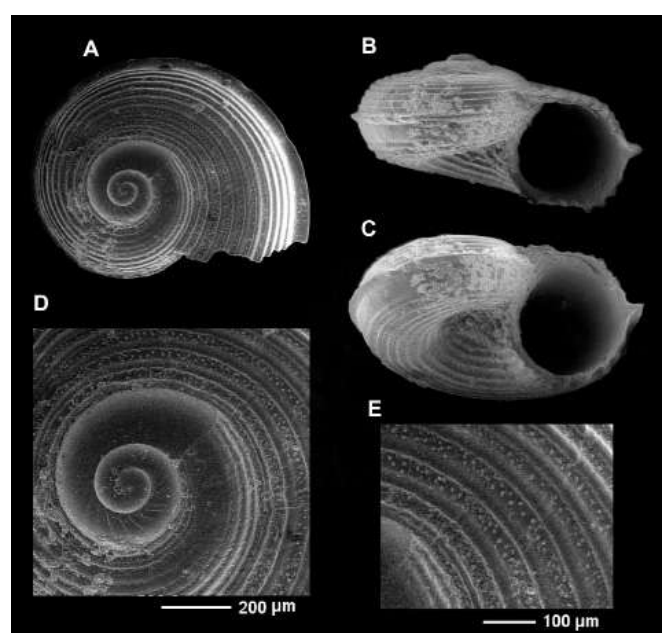


Figure 7. A-E. *Carinatus obesus* n. sp. A-C: holotype, 1.55 mm in diameter, Bohol Island, Cortes, 09°42'N - 123°50'E, 80-100 m (MNHN); D: protoconch; E: detail of the microsculpture.

Distribution: Only known from Cortes, Bohol Island, Philippines.
Remarks: *Carinatus obesus* n. sp. is characterized by a slightly elevate carina, a smooth space below it, and numerous cordlets in all the shell with tubercles in the interspaces. *Carinatus fijiensis* n. sp. may have a similar aspect, but the oblique lines in the protoconch are more numerous.

***Carinatus gracilis* n. sp. (Figures 8A-G)**

Type material: Holotype (Figs. 8A-G), MNHN-IM-2000-35740.

Material examined: 1 s: Philippines: 1 s, Panglao Island, lagoon off Poblacion, 9°34'N-123°44'E, 2 m, fine sand and seagrass.

Type locality: Philippines, Panglao Island, lagoon off Poblacion, 9°34'N-123°44'E, 2 m, fine sand and seagrass.

Etymology: The specific name derives from the Latin word *gracilis*, e, which means "gracile, slender".

Description: Shell small (<2.5 mm), rounded, hardly depressed, solid; protoconch with 2 whorls, the first one smooth; then the small oblique and depressed lines appear, visible from the inner suture, beginning after the end of the first protoconch whorl and ending just near the end of the protoconch, being about 20. This protoconch has a nucleus which measures about 45 µm in diameter, the protoconch being 410 µm in diameter. The teleoconch has almost 1 ½ whorls, showing a prominent carina in the middle of the external border; the entire surface of the shell has spiral cords and in their interspaces there are numerous irregular prominences, very dense and close. Aperture rounded with its border modified by the end of the spiral carinae where can be seen a pointed prominence. The rest of the apertural border is smooth. Adapically and abapically there are two angulations which do not form carinae.

Dimensions: the holotype measures 1.84 mm in diameter and 0.75 in height.

Habitat: Infralittoral species collected 2 m in fine sand and seagrass bottom.

Distribution: Only known from Panglao Island, Philippines.

Remarks: *Carinatus gracilis* n. sp. is characterized by its very depressed shell which is solid and has one external carina and two angulations, one adapical and other abapical. The surface between the cords is very much sculptured. No other species in this genus is so depressed.

***Carinatus variabilis* n. sp. (Figures 9A-F, 10A-F,)**

Type material: Holotype (Figs. 9A-F), MNHN-IM-2000-35741.

Material examined: 3 s: Vanuatu, SANTO 2006: 1 s, N Urelapa Island, Stn. AT44, 15°37'S-167°03'E, 86-118 m (holotype); 1 s, Vanuatu, Stn. DW1105, 15°03'S-167°07'E, 154-179 m (MNHN-IM-2012-25495); 1 s, Stn. DW1065, 16°16'S-167°21'E, 360-419 m (MNHN-IM-2012-25496).

Type locality: Vanuatu, N Urelapa Island, 15°37'S-167°03'E, 86-118 m [SANTO 2006: AT44].

Etymology: The specific name alludes to the differences in the material collected, which are mentioned in the description.

Description: Shell small (<2.5 mm), orbicular, depressed-turbiniiform, fragile. Protoconch of 2 ¼ whorls, and a size of 550 µm in diameter with a nucleus of 66 µm; it has 2 phases: the first one of near one whorl is totally smooth and the second has about 32 oblique folds that are extended from the suture towards the periphery, but with a short space and are distributed throughout the second phase. Teleoconch formed by 1 ¾ convex whorls, strongly keeled peripherally and with the surface totally covered by spiral cords.

In the last whorl, 6 spiral cords are observed between the two sutures and at the end there are 10 other cords between the suture and the peripheral keel. Below the keel, there is a completely smooth area and below it 6 spiral cords that cover even the inside of the umbilicus. The cords are generally narrower than the intermediate spaces, which appear entirely covered by microgranules.

The umbilicus is open and its interior is covered by spiral cords. The aperture is rounded and slightly prosocline; columella arched and slightly reflected to the umbilicus; inside of the outer lip is scalloped and its outer margin is modified by the spiral cords and the peripheral keel.

The three shells examined show some small differences: the first teleoconch whorl has a variable part smooth, and the same occurs in the external border below the keel and in the inner abapical part of the shell, but these differences seems to be intraspecific variable characters.

Dimensions: The holotype measures 2.42 mm in diameter and 1.23 mm in height.

Habitat: Circalittoral species dredged between 86-118 m and 360-419 m depth.

Distribution: Only known from Vanuatu.

Remarks: *Carinatus variabilis* n. sp. is characterized by obvious differences among the collected shells, a prominent keel and areas in the first teleoconch whorl, below the keel and in the base in which the spiral cords may be less evident or disappear.

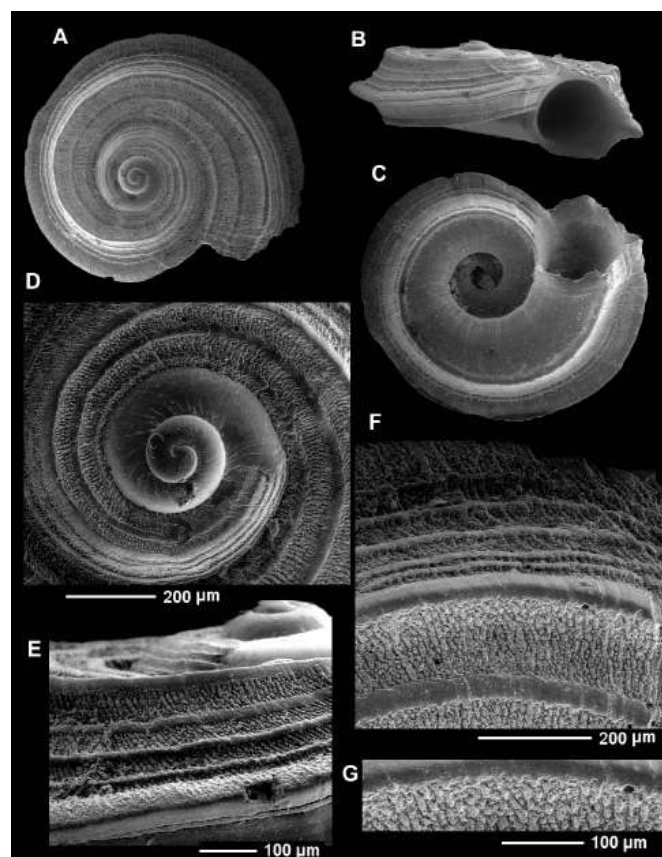


Figure 8. A-G. *Carinatus gracilis* n. sp. A-C: holotype, 1.84 mm in diameter, Panglao Island, lagoon off Poblacion, 9°34'N-123°44'E, 2 m (MNHN); D: protoconch; E-G: microsculpture and detail.

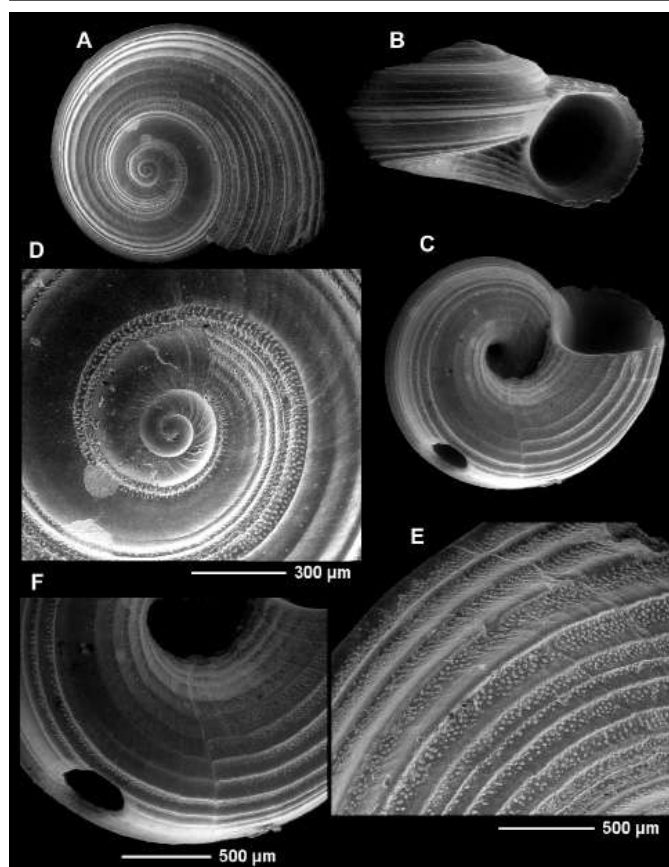


Figure 9. A-F: *Carinatus variabilis* n. sp. A-C: holotype, 2.42 mm in diameter, Urelapa Island, Stn. AT44, 15°37'S-167°03'E, 86-118 m (MNHN); D-E: protoconch and detail; F: microsculpture detail.

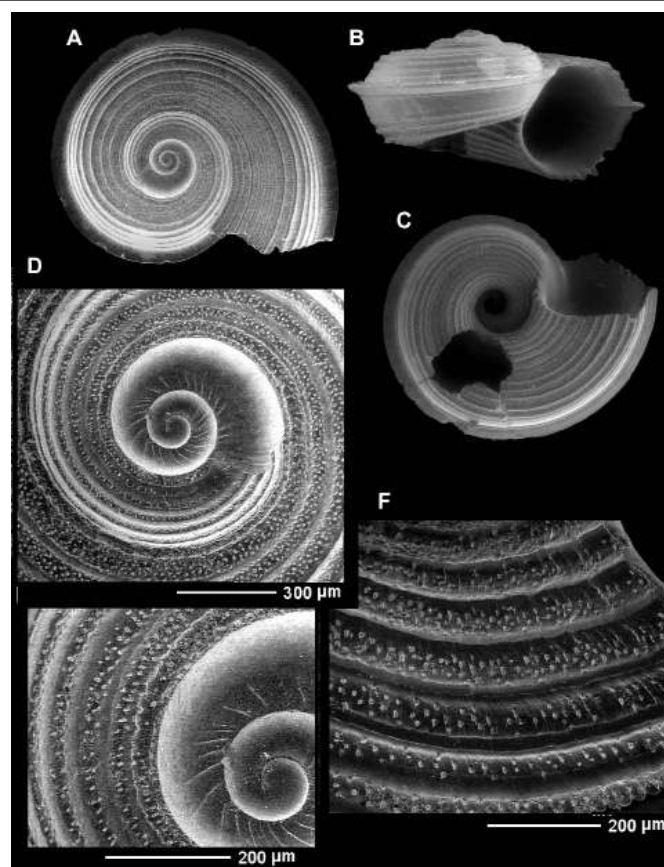


Figure 11. A-F: *Carinatus variabilis* n. sp. A-C: shell, 2.03 mm in diameter 1 s, Stn. DW1065, 16°16'S-167°21'E, 360-419 m (MNHN); D: protoconch; E-F: microsculpture and detail

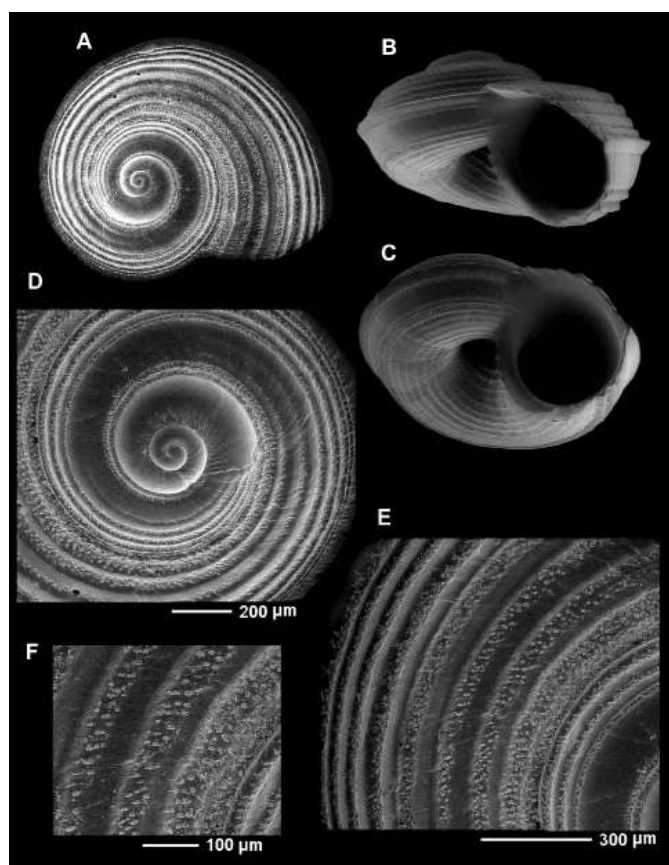


Figure 10. A-F: *Carinatus variabilis* n. sp. A-C: shell, 2.7 mm in diameter, Vanuatu, Stn. DW1105, 15°03'S-167°07'E, 154-179 m; D: protoconch; E: microsculpture and detail; F: umbilicus.

CONCLUSIONS

The new genus is created after the observation of some characters that are present in the species here mentioned but absent from numerous others studied in the circuliiform group of species in the studied area. The new genus is added to others (such as *Circuitus*, *Tuberes*, *Collatus*), which were created along some years of study, sorting, comparing and making micrographs of the material collected by MNHN and IRD in the study area. Amongst more than 300 species actually under study, it is very probable that new groups of species will eventually be separated and described as further new genera. But the study is difficult, and a long time and lots of micrographs are necessary to reach any conclusions.

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