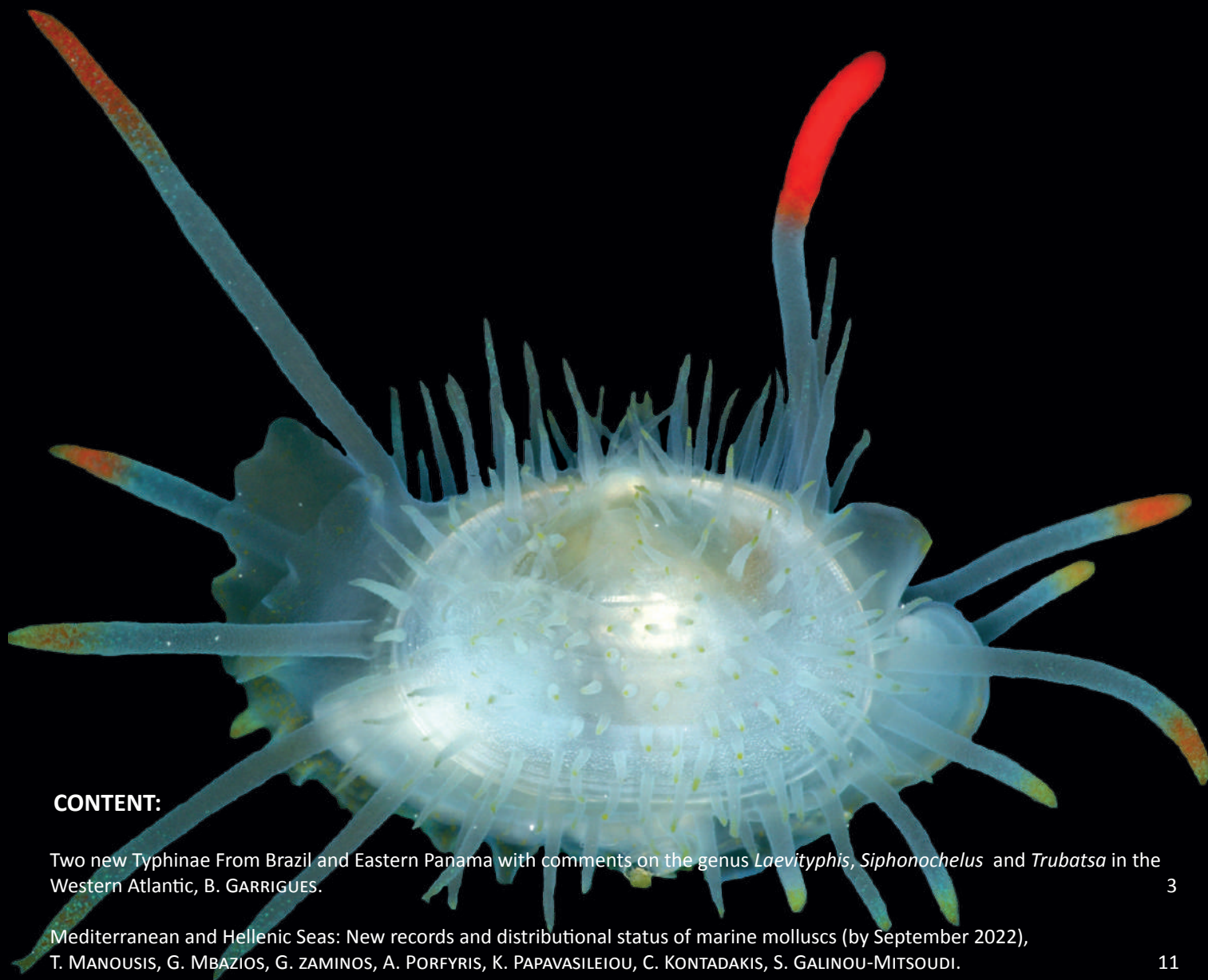




XENOPHORA

TAXONOMY

Supplément à Xenophora, Bulletin de l'Association Française de Conchyliologie



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Galeommatidae

Genus sp.6

MINHN La planète revisitée

Koumac 2018

KR603 LC152 IMGP7981

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TWO NEW TYPHINAE FROM BRAZIL AND EASTERN PANAMA WITH COMMENTS ON THE GENUS *LAEVITYPHIS*, *SIPHONOCHELUS* AND *TRUBATSA* IN WESTERN ATLANTIC

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ABSTRACT

Two new Typhinae are described. The first one, *Laevityphis brasiliensis* originates from the Rio de Janeiro area, Brazil n. sp. It is compared to *L. riosi* (Bertsch & D'Attilio, 1980) from Brazil and *L. radwini* Emerson & D'Attilio, 1979 from Yucatan, Mexico. These last two species are transferred from the *Siphonochelus* to the *Laevityphis* genus. The second species *Trubatsa merlei* n. sp. originates from Eastern Panama. The main characteristics of the Western Atlantic *Laevityphis*, *Siphonochelus* and *Trubatsa* are discussed.

ABBREVIATIONS

Terminology proposed by Merle (2001, 2005).

P	Primary cord
IP	infrasutural primary cord
P1	Shoulder cord
P2-P6	Primary cord of the convex part of the teleoconch whorl
ADP	Adapertural primary cord on the siphonal canal
MP	Median primary cord on the siphonal canal
ABP	Abapertural primary cord on the siphonal canal

MHNBx: Muséum d'Histoire Naturelle de Bordeaux

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

SDNHM: San Diego Natural History Museum, California, USA.

USNM: National Museum of Natural History, Smithsonian Institution, Washington, USA.

BG: Bernard Garrigues collection (Lalande 82400).

MC: Marcus Coltro collection (Femorale, Brazil).

COMMENTS ON THE TYPHINAE GENERA

The genus *Laevityphis* was established by Cossmann (1903) and refers to a type species from the early Eocene of France, *Typhis coronarius* Deshayes, 1865 (= *Typhis muticus* Sowerby, 1834†). Several species of the *Laevityphis* genus are difficult to discriminate from the *Siphonochelus* species (Keen, 1944). But one of the main characters allowing the distinction between genera in Typhinae is in the position of the anal tube in relation to varices. In *Laevityphis*, the tubes are distinct of the varices whereas in *Siphonochelus* they are incorporated into varices (Vella, 1961, Gertman, 1969). In *Laevityphis*, the tube may be closer to the previous varix or halfway two varices, without being connected to them. Another diagnostic character is the presence of a shoulder spine (P2) in most *Laevityphis*,

this spine being lacking in *Siphonochelus*. On the other hand, the laminar extension (partition) between the shoulder and the previous whorl, does not occur in all species. In Western Atlantic, *Laevityphis* is mainly represented by middle Eocene to early Miocene species. In the current state of knowledge, only one extant species was reported: *Laevityphis bullisi* (Gertman, 1969). However, in this area two extant species previously attributed to *Siphonochelus* (Houart *et al.*, 2021) display the diagnostic characters of *Laevityphis*: *Laevityphis riosi* (Bertsch & D'Attilio, 1980) from Brazil and *L. radwini* (Emerson & d'Attilio, 1979) from Yucatan (Mexico). Their generic attribution is then changed.

Jousseume (1880) describes the « *Cyphonochelus* » genus as follows « *coquille ovale courte, dont le canal tubiforme postérieur est soudé aux varices au lieu de leur être intermédiaire comme dans les autres genres ; ouverture petite, ovale, à bords continus et détachés ; canal court, assez large à la base* ». Typical *Siphonochelus* have smooth, spineless varices, four growth steps per whorl. Each anal tube is connected to the succeeding varices instead of being simply intermediate between two varices and forms a strong rounded axial fold, part of an intervarical arcuate axial fold, terminating at the shoulder by a protuberance. Members of *Siphonochelus* are widely distributed from the Oligocene to the Pliocene in Europe and from the Miocene to present day in the Australasian area (Gertman, 1969; Vella, 1961). However a single Miocene species was identified from the Western Atlantic: *Siphonochelus cercadicus* (Mauray, 1917) (see here pl. 2, fig. 6). In this area only two extant species are known: *Laevityphis riosi* (Bertsch & D'Attilio, 1980) from Brazil and *Laevityphis radwini* Emerson & D'Attilio, 1979 from Yucatan (Mexico) (Houart *et al.*, 2021). They were attributed to the *Siphonochelus* genus but this attribution is here reconsidered.

Although Merle (1990: 171) separated *Trubatsa* Dall, 1889 from *Siphonochelus* thanks to the morphological difference of the anal tube, it has long been placed in synonymy of *Siphonochelus*. However recent molecular study formally separated them (Houart *et al.*, 2021). In *Trubatsa*, the anal tube is totally integrated to the varix and extends to the entire intervarical area without forming a fold. This tube is connected to the previous whorl by a buttress. Some specimens display on the terminal varix, a lamellar expansion (partition) between anal tube and previous whorl. In *Siphonochelus* this buttress is lacking, tubes have a narrower base and are slightly differentiated from the varices.

SYSTEMATICS

Family MURICIDAE Rafinesque, 1815

Sous family Typhinae Cossmann, 1903

Genus *Laevityphis* Cossmann, 1903

Type species: *Typhis coronarius* Deshayes, 1865 = *Typhis muticus* Sowerby, 1834†, by original designation, Early Eocene, France and England.

***Laevityphis brasiliensis* n. sp.**

Pl. 1, Figs 1–3

TYPE MATERIAL. Holotype: Macae, north Rio de Janeiro State, dredged at 150–160 m in sand (MHNbX 2023.2.1), H: 11.5 mm, ex BG (pl. 1, figs 1a–i).

TYPE LOCALITY. Macae, North Rio de Janeiro State, at 150–160 m in sand.

RANGE. Macae, North Rio de Janeiro State and Santos, São Paulo State, Brazil.

OTHER MATERIAL. Five specimens from Santos, São Paulo State, Brazil (MC) (pl. 1, figs 2–3).

ETHYMOLOGY. *brasiliensis*: from Brazil, the country of the type locality.

HOLOTYPE DESCRIPTION. Biconic teleoconch of $4\frac{1}{2}$ whorls of 11.5 mm in height and 5.7 mm in diameter. Protoconch of $2\frac{1}{4}$ disjoint whorls (pl. 1, figs 1d–e). Spire high. Apical angle of 43° excluding tubes. Suture impressed. Spiral sculpture consisting of P1, P2 and P3. On the first whorl appearance of varices without anal tube. On the second whorl presence of anal tube in P1. On the last whorl, anal tube in P1, broad triangular spines in P2 and P3 connected by a small lamellar expansion (pl. 1, fig. 1h–i). Axial sculpture of four varices from the first to the last teleoconch whorls and intervarical fold corresponding to anal tubes (pl. 1, fig. 1g). Base of anal tube not connected to succeeding varix and forming an intervarical axial fold near the precedent varix (pl. 1, fig. 1g, i). Tube deviating from the axis of the shell in the abaxial direction and forming an angle of approximately 60° with this axis. Oval opening of tubes. Concave intervarical spaces. Subcircular aperture connected with the last anal tube, only functional. Edge of the aperture erected and smooth forming an entire peristome. Large thickening of the external lip extended obliquely to the end of the siphonal canal. Broad siphonal canal sealed on its total length, with broken end. Wide pseudombilicus. Smooth microsculpture only marked by thin striations corresponding to growth lines. Shell background color entirely creamily white. Operculum unknown.

INTRASPECIFIC VARIATIONS AND OTHER CHARACTERS. Adult size varying from 11 to 14.5 mm in height. Background color varying from cream to light brown. When intact the siphonal canal is of 31–33% of the total length (pl. 1, figs 2, 3). Two spines and lamellar expansion are also present in one of the specimen from Santos as well as in the holotype (pl. 1, fig. 2). The second specimen illustrated (pl. 1, fig. 3) bears a highly developed shoulder spine.

INTERSPECIFIC COMPARAISONS AND DISCUSSION. A close species, *Laevityphis riosi* (Bertsch & D'Attilio, 1980), occurring in the same area, was attributed to the genus *Siphonochelus* (Houart, 1994; Houart *et al.*, 2021). Moreover, Bertsch & D'Attilio (1980) described *Typhina riosi* as a “very simplified *Typhina*”. The problem is linked to the intermediate type sculpture of this species which presents a spine at the shoulder of varices, and lacks of the spiral sculpture and the spinose ornamentation specific to *Typhina* (D'Attilio A., 1975; D'Attilio A. & Hertz C. M., 1988) (pl. 3, fig. 1–2). This character lacks in any of the numerous *Siphonochelus* from European Oligocene to Pliocene species (Lesport & Garrigues, 2022) and from the Indo-Pacific species. Compared to *L. riosi*, *L. brasiliensis* differs in having a disjoint protoconch of $2\frac{1}{4}$ whorls instead of a bulbous protoconch of $1\frac{3}{4}$ whorls (pl. 1, figs 1d–e and pl. 3, fig. 2e). In addition *L. brasiliensis* has a more elongated and robust shell with a higher spire, a wider and straighter siphonal canal and a larger size for the same number of teleoconch whorls. The shell background color of *L. brasiliensis* is creamily white whereas *L. riosi* is semi-translucent. In some specimens of *L. riosi*, such as the holotype, a lamellar expansion develops on the outer edge of the varix. However, this character appears to be inconstant within this species.

Another species from the Caribbean area is *Laevityphis radwini* (Emerson & D'Attilio, 1979). This species was dredged near Cabo Catoche at the extremity of Yucatan, Mexico, at 160 m deep (pl. 3, fig. 3).

Laevityphis brasiliensis n. sp. differs from *L. radwini* by a higher spire, a wider last whorl, a more angular shell and a quite different protoconch: disjoint protoconch of $2\frac{1}{4}$ whorls instead of a bulbous protoconch of $1\frac{1}{4}$ whorls (pl. 3, fig. 3d). *Laevityphis bullisi* (Gertman, 1969) (pl. 2, figs 7–8) species occurring from Colombia and Eastern Panama between 70 and 120 m deep, shares with *L. brasiliensis* a tube separated from varices and a P2 shoulder spine. Nevertheless the shape of the shell is very different and its protoconch separates well the two species as well as the size of shoulder spine which is hypertrophied and hollow in *L. bullisi*. *Laevityphis brasiliensis* has a disjoint protoconch of $2\frac{1}{4}$ whorls instead of a bulbous protoconch of $1\frac{1}{2}$ whorls in *L. bullisi* (pl. 2, fig. 8a).

Moreover, *L. brasiliensis* does not bear a laminar extension (partition) between the shoulder and the previous whorl, while it is present in adult stage of *L. bullisi* (pl. 2, fig. 7, not 8).

Two fossils species assigned to the *Laevityphis* genus allow comparisons with *L. brasiliensis*: *L. gracilis* (Conrad, 1833) from the middle Eocene of Alabama (pl. 2, figs 3–4) and *L. sawkinsi* (Mansfield, 1925) from the middle Miocene of Venezuela (pl. 2, fig. 5).

Laevityphis gracilis share a similar shape with *L. muticus*, type species of the genus. *Laevityphis brasiliensis* differs from *L. gracilis* by a wider shape, a rounder aperture and a different protoconch ($2\frac{1}{4}$ disjoint whorls instead of $1\frac{1}{2}$ tabulate whorls). Their spiral sculpture is also different: two noticeable primary cords in *L. brasiliensis* instead of three in *L. gracilis* (Gertman, 1969).

Compared to *Laevityphis brasiliensis*, *L. sawkinsi* displays, near the suture, a large partition overlapping the preceding whorl (Jung, 1965). These laminar extension is missing in *L. brasiliensis*. The convex part of the whorl is more rounded in *L. sawkinsi* and lacks the P3 primary cord.

The type of spiral sculpture of *Laevityphis brasiliensis* is closed to that of some *Trubatsa*. Thus primary cords in P2 and P3 are

clearly visible in some specimens of *T. merlei* n. sp., which is described below. However *L. brasiliensis* is drastically different from *Trubatsa* by the tube position distinct of the varices and not totally integrated to them (pl.3, figs 4–6; pl. 4, figs 1–4).

Genus *Trubatsa* Dall, 1889

Type species: *Siphonochelus longicornis* Dall, 1888, by original designation, Cuba.

Trubatsa merlei n. sp.

Pl. 4, Figs 1–4

TYPE MATERIAL. Holotype: San Blas, Atlantic coast of Panama, dredged in crushed coral at 60–70 m deep, (MNHN-IM-2000-38673), H: 5.6 mm, ex BG (pl. 4, figs 1a–h), one paratype, same locality, (MNHN-IM-2000-38674), juvenile, H: 4.4 mm, one paratype (BG), same locality, H: 5.9 mm.

TYPE LOCALITY. San Blas, Atlantic coast of Panama, dredged in crushed coral at 60–70 m deep.

RANGE. Atlantic Coast of Panama at 60–120 m deep.

OTHER MATERIAL. Specimen from Atlantic Coast of Panama (MC) (pl. 4, fig. 3).

ETHYMOLOGY. *merlei*: dedicaced in honour to Didier Merle (CR2P, MNHN).

HOLOTYPE DESCRIPTION. Biconic teleoconch of 4 1/2 whorls of 5.6 mm in height and 2.8 mm in diameter including anal tubes. Bulbous protoconch of 11/2 whorls (pl. 4, fig. 1e). Spire high. Apical angle of 40° excluding anal tubes. Suture impressed. Spiral sculpture consisting of P1, P2 and P3. On the first whorl, from the sinusigeral scar, appearance of anal tube (P1) and nodulose spinelet in P2. Same pattern until the last whorl. On the last whorl, anal tube in P1, two short and nodulose spinelets in P2 and P3 (pl. 1, fig. 1f, h). Axial sculpture of four varices from the first to the last teleoconch whorl. On the spire, anal tube totally integrated to the varix. Base of the tube connected to the previous whorl by a buttress (pl. 4, fig. 1f). Tube deviating from the axis of the shell in the abaxial direction and forming an angle of approximately 80° with this axis. Circular opening of tubes. Concave intervarical spaces. Oval aperture connected with the last anal tube, only functional. Edge of the aperture erected and smooth forming an entire peristome. Sharp edge of the external lip, smooth within. Broad siphonal canal sealed on its total lenght. Wide pseudumbilicus. Smooth microsculpture only marked by very thin striations corresponding to growth lines. Shell background color creamly, slightly pink, glossy with light brown spiral band near suture, in P2 and on siphonal canal. Operculum absent.

INTRASPECIFIC VARIATIONS AND OTHER CHARACTERS. Some specimens don't show the angular shape of the holotype but more rounded varices with less apparent cord spines (pl. 3, figs 2, 4). A wider varical edge and a partition are observed in probably more mature specimens as illustrated pl. 4, fig. 3.

INTERSPECIFIC COMPARAISONS AND DISCUSSION. *Trubatsa merlei* n. sp. can be compared to other known *Trubatsa* species from Western Atlantic: *T. longicornis* (Dall, 1888), *T. patera* Garrigues, 2021 and *T. tityrus* (Bayer, 1971).

Trubatsa tityrus (Bayer, 1971) from Northern Coast of Venezuela, between 60 and 180 m deep (pl. 3, fig. 4), is the closest species of *T. merlei*. *Trubatsa merlei* differs in having a narrower shell with a higher spire and a narrower outer lip without wide partition. Moreover spiral sculpture is not apparent in *T. tityrus*. The aperture is also different: ovate and smooth in *T. merlei* whereas it is subcircular with three parietal denticles in *T. tityrus* (fide Bayer, 1971). In addition *T. merlei* is smaller: 5.6 to 7 mm in comparison of 8.3 to 13.6 mm in *T. tityrus*. Finally the rusty brown color with white varices of *T. tityrus* is also different.

Trubatsa longicornis (Dall, 1888), type species of *Trubatsa*, described from Cuba, is also occurring in the Bahamas, the Gulf of Mexico, Jamaica and Colombia between 200 and 720 m deep. *Trubatsa merlei* differs from *T. longicornis* by a less slender shell and more angulate varices. Bayer (1971) indicates the presence of a thin expansion of the rounded varices in all collected specimens. According to Bayer, the lectotype of USNM 94781 (pl. 3, fig.5) clearly shows the broken edge of a varical expansion. In *T. merlei*, this varical expansion is always absent. Compared to *Trubatsa patera* (pl. 3, fig. 6), *T. merlei* has a more angulate shell, a different spiral sculpture with an apparent P3 and a wider aperture with a less thick varical edge. In some *T. patera* and in some *T. longicornis* a small spine is occasionally observed on P2 but never on P3. Moreover, *T. merlei* has a particular glossy surface.

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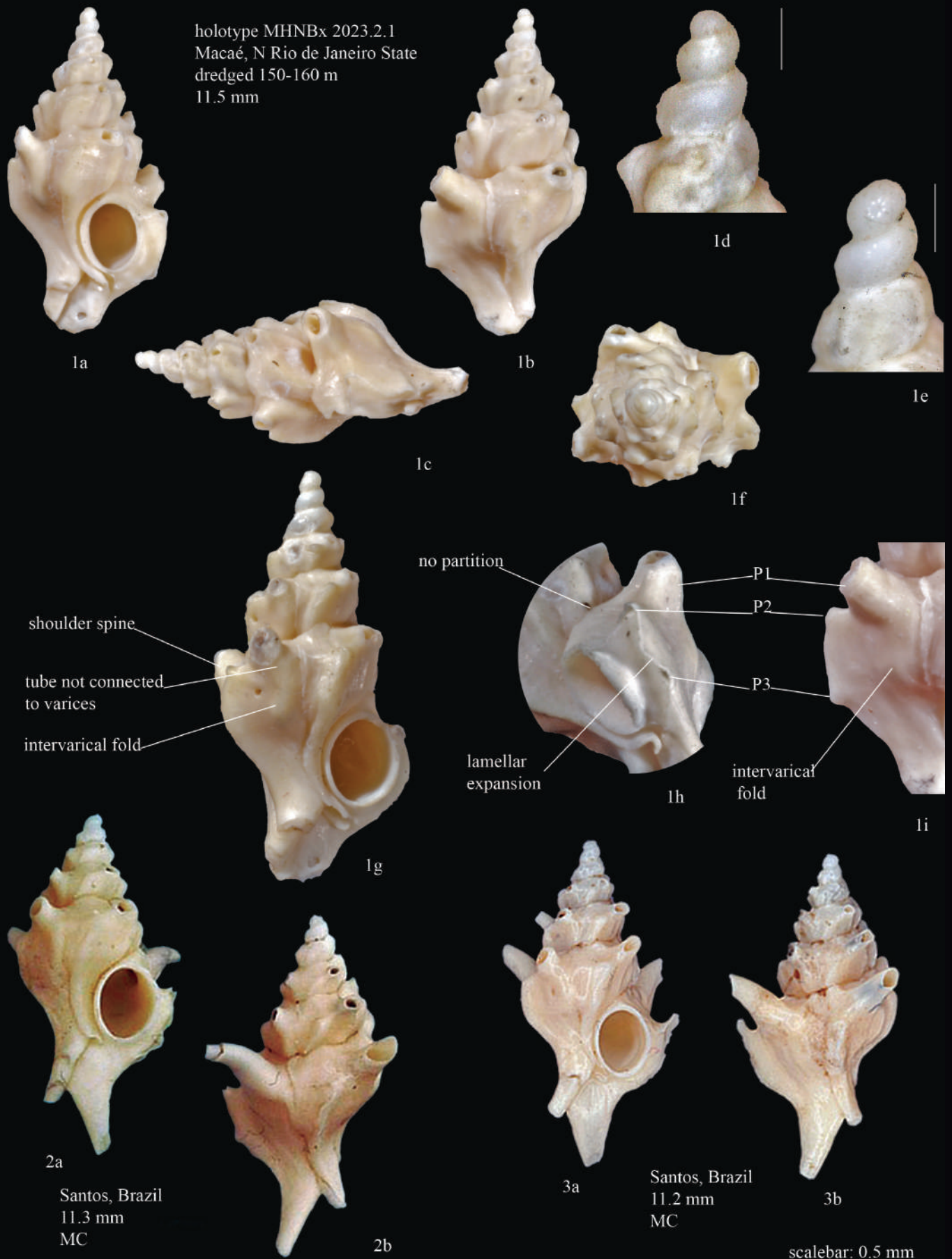
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Pl. 1 *Laevityphis brasiliensis*- Figs 1_4



Pl. 2

Fig. 1-2
Laevityphis muticus
Ypresian
St Gobain



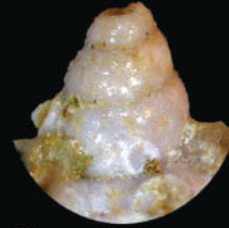
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10 mm

1



7.7 mm BG

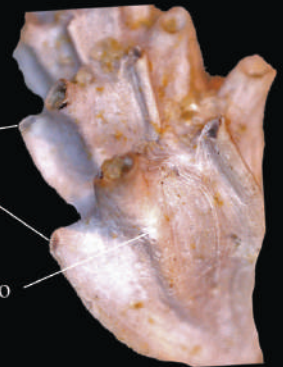
2a



2b

hollow
shoulder
spines

tube non
connected to
varices



2c

Figs 3-4 - *Laevityphis gracilis*
Alabama, Middle Eocene
(from Palmer, 1937, pl. 36,
figs 1,5 modified)



15 mm

3



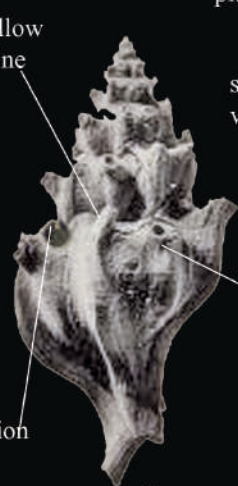
17 mm

4

Fig. 5 - *Laevityphis sawkinsi*
Trinidad, Middle Miocene
23 mm (from Jung, 1965
pl.70, figs 7-8 modified)



5a



5b

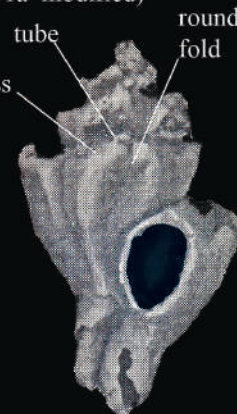
hollow
spine

partition

spineless
varix

tube

Fig. 6
Siphonochelus cercadicus
Dominican Republic, Middle Miocene
6.6 mm (from Gertman, 1969,
pl. 6, fig. 1a modified)



6

tube

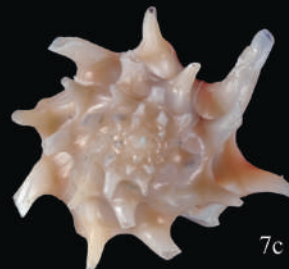
rounded
fold

Figs 7-8 - *Laevityphis bullisi*

Fig. 7 - holotype
USNM 696660
Panama
77 m
26.7 mm



7a



7c



7b

partition



8a

Fig. 8 - Colombia
120 m
juvenile
29 mm,
BG



8b

scale bar: 0.5 mm

Pl. 3

Figs 1-2 - *Laevityphis riosi*

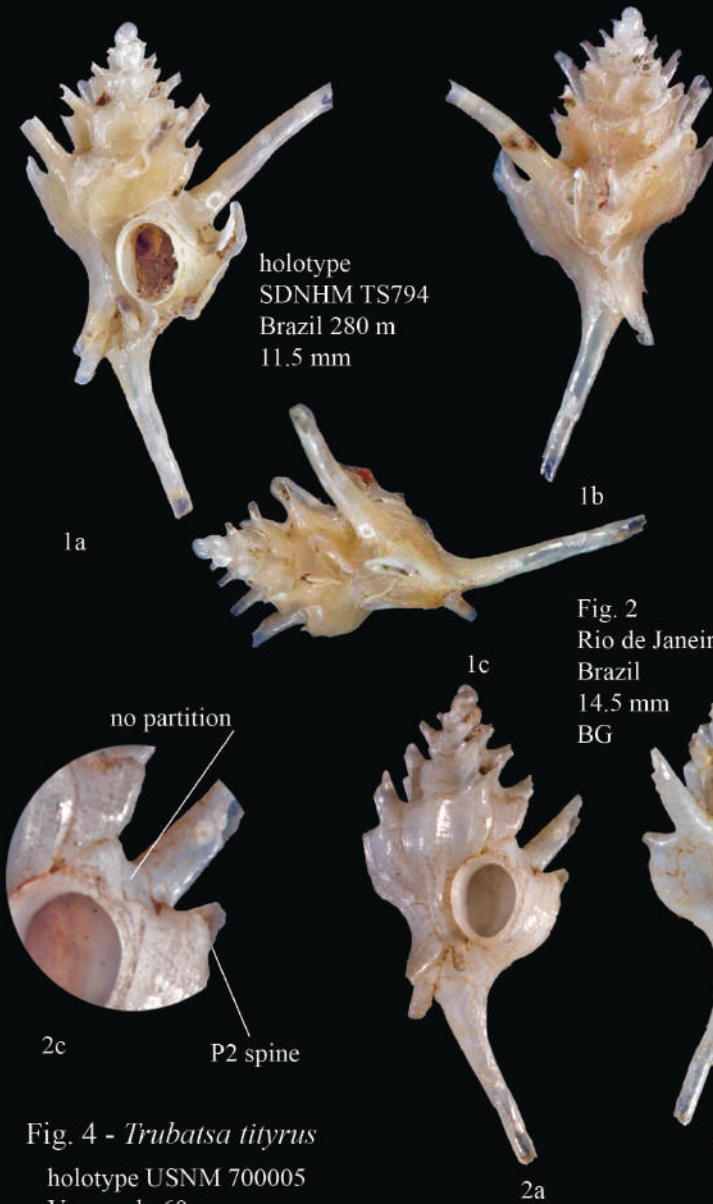


Fig. 3 - *Laevityphis radwini*

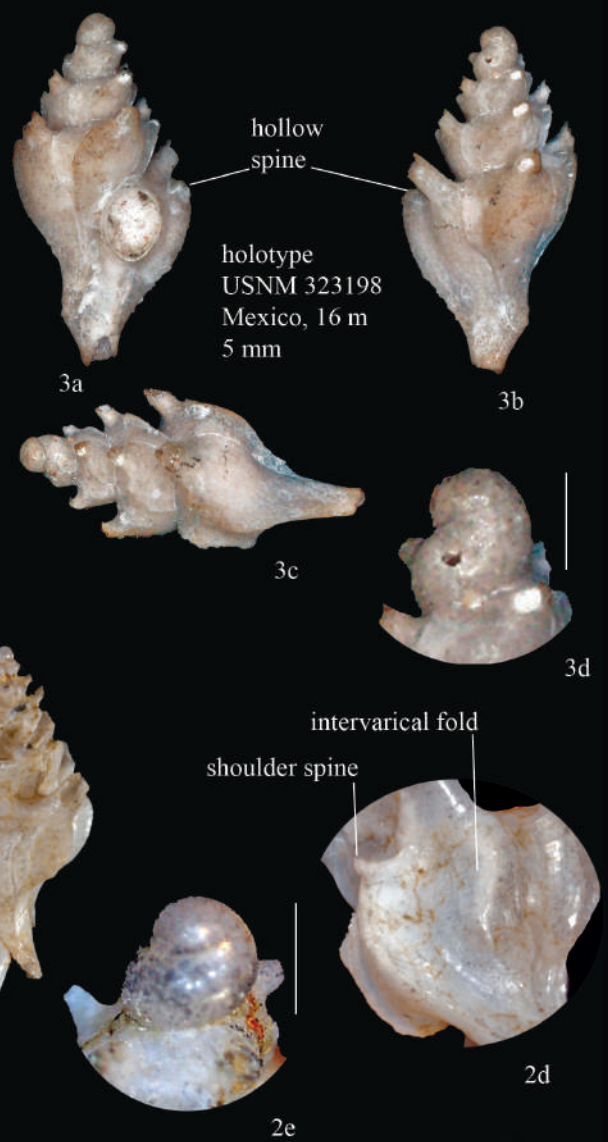


Fig. 4 - *Trubatsa tityrus*

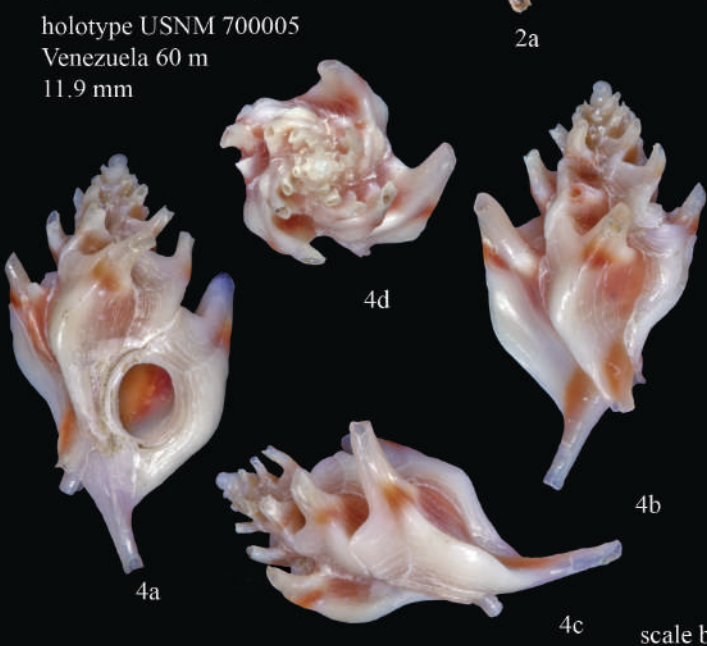


Fig. 5

Trubatsa longicornis

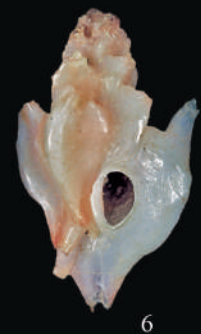
lectotype
USNM 94780
Yucatan
20 mm



Fig. 6

Trubatsa patera

holotype
MNHN IM-2013-61233
Guadeloupe 200 m
8.6 mm



scale bar: 0.5 mm

Pl. 4

Figs 1-4 - *Trubatsa merlei* n. sp.

Atlantic coast of Panama
60-120 m

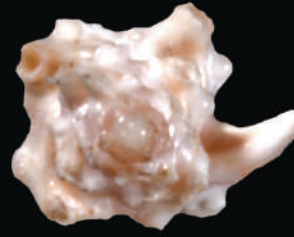


1a

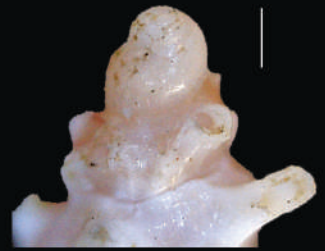


1b

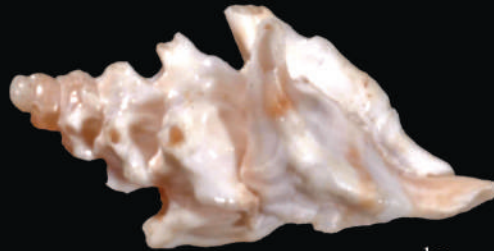
holotype MNHN IM-2000-38673
5.6 mm



1d



1e



1c



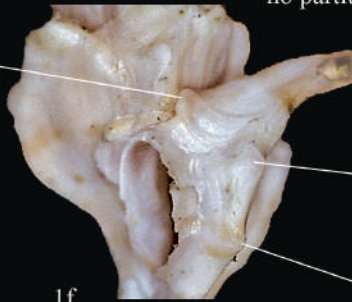
2a

paratype
MNHN IM-2000-38674
juvenile
4.4 mm



2b

buttress
connecting
preceding
varix



1f

no partition

P1

P2

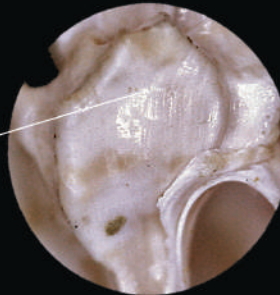
P3



1h

no intervarical
fold

tube totally
integrate to varix
encompassing the
entire intervarical
area



1g



3a

7 mm

partition



3b

scale bar: 0.5 mm



4a

paratype BG
5.9 mm



4b

Mediterranean and Hellenic Seas: New records and distributional status of marine molluscs (by September 2022)

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Keywords

Greece, Lessepsian migrant, Mediterranean Sea, Mollusca, New Records

Abstract

The work is part of an ongoing study on the marine malacofauna of the Hellenic Seas by September 2022. It incorporates 12 species out of which 1 is a new record for the Mediterranean Sea, 1 is a new record for the East Mediterranean, 3 are new records for the Hellenic malacofauna, 1 is a known Lessepsian migrant, 1 exhibits a broader distribution, and 9 are second image documented records for the Hellenic territory. Main taxonomic characteristics and ecological data, such as habitat, distribution and origin, are presented and discussed.

Introduction

The Hellenic marine molluscan biodiversity has been influenced by environmental and anthropogenic changes described and discussed by a number of investigators (e.g. Galil, 2000; Galil & Zenetos, 2002; Zenetos *et al.*, 2005; Abdulla & Linden, 2008; Galil *et al.*, 2008; Zenetos *et al.*, 2009; Skiris *et al.*, 2011; Tsiaras *et al.*, 2012). In addition, new collections and/or researches comprise a source of biodiversity enrichment. Recent faunistic works revealed more than 300 new species for the area (Streftaris & Zenetos, 2007; Manousis *et al.*, 2010, 2012; Tzomos *et al.*, 2012; Crocetta *et al.*, 2013; Manousis & Galinou-Mitsoudi, 2014; Manousis *et al.*, 2017; Micali *et al.*, 2017; Romani *et al.*, 2017; Manousis *et al.*, 2018a, b; 2019; 2020a-c; Mbazios *et al.*, 2020; Kontadakis *et al.*, 2021; Manousis *et al.*, 2021a, b; Zaminos *et al.*, 2021; Kontadakis & Manousis, 2022; Manousis *et al.*, 2022; Mbazios *et al.*, 2022). Diligent search efforts based on perceptive human resources management continue to give us new records.

al., 2020; Kontadakis *et al.*, 2021; Manousis *et al.*, 2021a, b; Zaminos *et al.*, 2021; Kontadakis & Manousis, 2022; Manousis *et al.*, 2022; Mbazios *et al.*, 2022). Diligent search efforts based on perceptive human resources management continue to give us new records.

Methods

Sampling, handling and species recognition were conducted according to Manousis & Galinou-Mitsoudi (2014) and Mbazios *et al.* (2020) from October 2021 to September 2022 in certain locations throughout the Hellenic Seas. All 1st and 2nd documented records for the Mediterranean and the Hellenic Seas are listed in Table 1 with collection data. Adequate description of certain specimens is designated whenever supplemental information facilitates identification. All findings - together with additional images of similar species for comparison - are presented in Figures 1-5. The specimens are deposited in the premises of T. Manousis, G. Mbazios, K. Papavasileiou, A. Porfyris and G. Zaminos. Scientists are welcome to have access to the biological material for inspection by appointment.

Results

Abbreviations:

CEMS - Central and East Mediterranean Sea,

CNB - *Cymodocea nodosa* Bed,

ED - Extended Distribution,

EMS - East Mediterranean Sea,
 EMS1 - First record for the East Mediterranean Sea,
 G1 - First record for Greece,
 G2 - Second record for Greece,
 KLM - Known Lessepsian Migrant,
 Ma - Maerl,
 Ma-An - Mauritania to Angola,
 MB - Mixed Bottom,
 MS - Mediterranean Sea,
 MS1 - First Record for the Mediterranean Sea,
 MuB - Muddy Bottom,
 Ra - Rare,
 Ukn - Unknown,
 Un - Uncommon,
 WCMS - West and Central Mediterranean Sea.

The records

Idas modiolaeformis (Sturany, 1896) (Fig. 1a). A for long known species (Sturany, 1896) was initially image documented for Greece by Giannuzzi-Savelli *et al.* (2001).

Rhomboidella prideauxi (Leach, 1815) (Fig. 1b). First record for Greece of a rare for the Mediterranean Sea species (Gofas *et al.*, 2011) reported for the Adriatic Sea by Legac & Hrs-Brenko (2003) and the Eastern Mediterranean by Öztürk *et al.* (2006).

Kurtiella triangularis (R. B. Watson, 1897) (Fig. 1c). The species was re-described in detail by Gofas & Salas (2008) and image documented for Greece by Manousis *et al.*, (2021b).

Parvicardium carrozzai van Aartsen & Goud, 2001 (Fig. 2a, b). It has been reported for the Tuscan Sea, Italy (200-300 m), for Malta (29 m) and image documented for the Aegean Sea, Elounda, Crete, Greece (90-130 m, small gear fishing nets) (van Aartsen & Goud, 2001). Observed prodissococonch I maximum diameter of our specimens some 150 µm and that of prodissococonch II some 200 µm.

Lepetella barrajoni Dantart & Luque, 1994 (Fig. 2c). Shell rather large for the genus, thin and fragile, cap shaped elevated conical. Base laterally compressed elliptical and concave. Anterior slope convex, posterior almost straight. Colour opaque white, sculpture of weak and irregular growth lines. Apex sub central, slightly posterior and deflected backwards. Protoconch without spire. Shell margin sharp and fragile. The species is known from the European Atlantic coasts and the Central Mediterranean Sea as *L. cf. barrajoni* (Cossignani & Ardevini, 2011). *L. barrajoni* differs from its cogenerate *L. espinosae* Dantart & Luque, 1994 (Fig. 2d) in its larger size and more laterally compressed shell. Our specimen was collected dead but still bearing relics of the animal soft parts.

Monophorus alboranensis Rolán & Peñas, 2001 (Fig. 2e). It has been previously reported and image documented for Greece once (Manousis *et al.*, 2018a, as *M. amicitiae* Romani, 2015).

Alvania datchaensis Amati & Oliverio, 1987 (Fig. 3a). This is the second record for Greece (Manousis, 2021).

Alvania marmarisensis Bitlis & Öztürk, 2017 (Fig. 3b). Originally described by Bitlis & Öztürk (2017). Our specimen is the second

record of this rissoid that has been image documented for Greece first by Mbazios *et al.* (2020).

Crisilla chiarellii (Cecalupo & Quadri, 1995) (Fig. 3c). The specimen of this work is the second image documented record of this species that was first reported for the Hellenic Seas by Zaminos *et al.* (2021).

Raphitoma hispidella Giannuzzi-Savelli & Pusateri, 2019 (Fig. 3d). The species was first reported for Greece as *R. cordieri* (sensu Cossignani & Ardevini, 2011) and image documented by Manousis *et al.* (2018b).

Odostomia dijkhuizeni van Aartsen, Gittenberger & Goud, 1998 (Fig. 4a). Shell small, slender, oval-conical, shiny, of dull white colour and semitransparent. Protoconch bright, of type C tending to B, with a diameter of some 235 µm. The transition from the protoconch to the teleoconch exhibits dense folds which are initially more conspicuous and attenuate gradually along an additional or so whorl. The teleoconch is 2.15 mm high and 0.80 mm wide (h/w = 2.7), with slightly convex and staggered whorls. Body whorl of some 65% of the shell's length, elongated oval and rounded on its periphery. Narrow but deep suture, with narrow subsutural shelf. Surface mate with no apparent sculpture but the somewhat flexuous growth lines, which are prosocline below turning orthocline above, and a faint spiral groove below the suture. Aperture rather large, of some 43%, elongate-oval and acute at its upper part, with sinuous and sharp outer lip. Columella opisthocline, somewhat arched, with a conspicuous but narrow columellar tooth situated above its midpoint. Umbilicus absent. *O. dijkhuizeni* is an infralittoral and circalittoral species known from Mauritania to Angola, including the Principe Island (Peñas & Rolán, 1999; Peñas *et al.*, 2014). According to the latter authors, it is a variable species with some shells more ventricose and others slender, and some with a continuous peristome and a narrow umbilical fissure, while others without umbilical fissure and the peristome very narrow and not continuous. *O. dijkhuizeni* should be compared with similar in their outlook species preferably from close to each other collection areas. Thus, it is distinguished from: *Brachystomia angusta* (Jeffreys, 1867) (Fig. 4b) in that the latter has a more robust shell, the protoconch is of type B, with a sharper apex, the whorls grow faster, the suture is shallow, it lacks a subsutural shelf and the growth lines are orthocline (Manousis, 2021); *B. eulimoides* (Hanley, 1844) (Fig. 4c) bears a type B protoconch of 260 µm (vs. type C and 235 µm of our specimen), a cyrtocoid shell and straight outer lip of the aperture (Manousis, 2021); *B. scalaris* (MacGillivray, 1843) (Fig. 5a) has a more obtuse type C protoconch, the shell is broader and more robust, with more convex whorls (h/w = 2.0 vs. 2.7 of our *O. dijkhuizeni* specimen), the growth lines are straight and orthocline - not sinuous and prosocline - and the columellar tooth is more conspicuous (Manousis, 2021); *O. paardekooperi* van Aartsen, Gittenberger & Goud, 1998 (van Aartsen *et al.*, 1998, page 30, Fig. 28) has a smaller type B protoconch with a sharper apex, the profile of the shell is well conical, the whorls are flat, the body whorl is much lower and angular on its periphery, the suture is shallower, the aperture is proportionally smaller and rhomboid, and the growth lines are prosocline and straight; *O. rissoiformis* Milaschewitsch, 1909 (Fig. 5b), though of similar size protoconch, bears a proportionally smaller body whorl which is more rounded on

its periphery and an umbilicus. All previous species compared with *O. dijkhuizeni* lack the characteristic folded transition between the protoconch and the teleoconch.

Odostomia widmeri Tisselli & Manousis, 2022 (Fig. 5c-e). The specimens of this work comprise the second record for Greece, while the species has been recently officially described and deposited (Manousis *et al.*, 2022). Furthermore, it was also collected from the Gulf of Souda, Crete. The latter specimen bears a protoconch of 184 µm maximum diameter.

Discussion

This work includes collection results of the period from October 2021 to September 2022 and is part of the ongoing study of the marine malacofauna of the entire Hellenic territory. It incorporates 12 species out of which 1 is a new record for the Mediterranean Sea, 1 is a new record for the East Mediterranean, 3 are new records for the Hellenic malacofauna, 1 is a known Lessepsian migrant with broader distribution, and 9 are second image documented records for the Hellenic territory.

Bioinvasions have been recognized as a serious threat in the Mediterranean (Galil *et al.*, 2015) with main vector of introduction the progressive entrance via the Suez Canal (Lessepsian migration or Erythrean invasion). Thus, the area most affected by this migration is the Levantine Sea (Por, 1990; Galil & Zenetos, 2002). Since Pancucci-Papadopoulou *et al.* (2005) have shown an increasing tendency in the introduction of alien molluscan species in the Hellenic Seas, 19 more Lessepsian migrants have been reported (e.g. Manousis *et al.*, 2010; 2020a-c; 2021a, b; Manousis & Galinou-Mitsoudi, 2014; Zenetos *et al.*, 2020; Kontadakis *et al.*, 2021). This number is added to the, by then, already known 28 Lessepsian migrants. The previously recorded specimens of *Rhomboidella prideauxi* from E Adriatic (Legac & Hrs-Brenko, 2003) and the SE Aegean (Öztürk *et al.*, 2006) were found in depths of > 50 m and in rather high salinity (>38‰). As our shells were collected in shallow depths (6 m) we consider inappropriate to extend the depth distribution of the species. Concerning the salinity, it is also high in Preveza as in the other two mentioned areas (Soukissian *et al.*, 2017).

Our findings of *Parvicardium carrozzai* in the N Aegean - 20 years after its original description from NE Crete - are a second report and indicative of a continuous presence of the species in the Hellenic waters.

Lepetella barrajoni is a rather recently described species found now in the E Mediterranean (N Aegean Sea) faraway from its type locality (Dantart & Luque, 1994) and the Central Mediterranean Sea (Cossignani & Ardovalini, 2011). This species expansion/distribution in the whole Mediterranean Sea needs confirmation by more records.

Raphitoma hispidella Giannuzzi-Savelli & Pusateri, 2019 is a Mediterranean species that has been previously described under the name: *Cordieria cordieri* var. *hispidella*, Monterosato, 1890: 187, non *Raphitoma hispidella* Bellardi, 1877; *Cordieria hispidella*, Appolloni *et al.*, 2018: figs. 22 O-P; *Raphitoma cordieri* sensu Manousis *et al.* 2018b: fig. 7a. As there had been confusion on the Mediterranean members of the genus, the species was re-described (Giannuzzi-Savelli *et al.*, 2019) and given a *nomen novum*. The addition of the two specimens

in this work comprises a second documented report of the species from two different locations of the Hellenic Seas and under the new name, and aims at the Greek bibliography to follow the new nomenclature. *Odostomia dijkhuizeni* seems to be one of those allochthonous species that make advantage of the numerous transport factors and the ambient conditions of the Mediterranean basin. The fact that this species was until now only known from the W Africa indicates an introduction via Gibraltar or ship transportation - as it was found on the shipping line towards the port of Thessaloniki.

Interestingly enough, *Odostomia widmeri* specimen collected from the Gulf of Souda (Sea of Crete, this work) bears a protoconch of 184 µm maximum diameter. This size is much bigger than the 154 µm (mean) of the specimens collected from Thermaikos Gulf (North Aegean Sea, Manousis *et al.*, 2022) which in turn is by some 50 µm bigger than that (100 µm) of the specimen from Soreq desalination plant, Israel reported by Albano *et al.* (2021). The observed gradient in the size of the larval shell may represent the effect of environmental factors, such as the temperature, on gametogenesis or even on larval development in this species. The case is in need of further study, perhaps by finding some more specimens and looking for the presence of two distinct protoconch sizes within the same population or the persistence of that gradient relatively to the geographical latitude.

As mentioned above, the majority of the recorded alien species has expanded and/or established. The Hellenic marine ambient conditions nowadays seem to be suitable for those species as the Hellenic seas are being converted from temperate to sub tropic or tropic. During the summer of 2021 the sea temperature of N Aegean was measured to be over 30°C, even at depths of up to 20 m; identical to that of the tropic seas (<https://oceanexplorer.noaa.gov/facts/temp-vary.html>). If the climatic change continues, the biodiversity is expected to change even further with numerous organisms expected to be introduced and established all over the Mediterranean Sea (Mbazio *et al.*, 2022). On the course of our investigation, we keep realizing that the biodiversity of the Mediterranean Sea comprises a dynamic parameter of the marine environment. The two paths of alien species introduction, namely Gibraltar and the Suez Canal in particular, as well as the species transportation by ships alter the composition of the autochthonous populations while sampling in all types of marine environments adds new information (e.g. new records, further species distributions, new species for science).

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Table 1: List of recorded species with collection data.

Class	Family	Species	Figure	Shells	Live	Depth m	Bottom	Area	Global coordinates	Rarity	Origin	Record
Bivalvia	Mytilidae	<i>Idas modiolaeformis</i> (Sturany, 1896)	1a	1		40-80	Ma	Agios Onoufrios, Chania Gulf	35°28'N - 24°11'E	Ra	MS	G2
		<i>Rhomboidella prideauxi</i> (Leach, 1815)	1b	5		6	MB	Pantokratoras, Preveza	38°56'N - 20°44'E	Ra	MS	G1
Gastropoda	Lasacidae	<i>Kurtiella triangularis</i> (R. B. Watson, 1897)	1c	2		70	MB	Toroni, Toroneos Gulf	39°58'N - 23°53'E	Ra	MS	G2
	Cardiidae	<i>Parvicardium carrozzai</i> van Aartsen & Goud, 2001	2a, b	1	1	70	MB	Toroni, Toroneos Gulf	39°58'N - 23°53'E	Un	CEMS	G2
	Lepetellidae	<i>Lepetella barrajoni</i> Dantart & Luque, 1994	2c	1		300	MuB	North Aegean Sea	40°29'N - 24°44'E	Un	WCMS	EMS1, G1
	Triphoridae	<i>Lepetella espinosae</i> Dantart & Luque, 1994, for comparison	2d									
		<i>Monophorus alboranensis</i> Rolán & Peñas, 2001	2e	1		60-80		Paros Island	37°05'N - 25°06'E	Un		G2
	Rissoidae	<i>Alvania datchaensis</i> Amati & Oliverio, 1987	3a	1		6	MB	Chamolia, Attica	37°55'N - 24°01'E	Un	EMS	G2
		<i>Alvania marmarisensis</i> Bitlis & Öztürk, 2017	3b	1		40-80	Ma	Agios Onoufrios, Chania Gulf	35°28'N - 24°11'E	Un	EMS	G2
		<i>Crisilla chiarellii</i> (Ceculupo & Quadri, 1995)	3c	1		70	MB	Toroni, Toroneos Gulf	39°58'N - 23°53'E	Ra		G2
	Raphitomidae	<i>Raphitoma hispidella</i> Giannuzzi-Savelli & Pusateri, 2019	3d	1		50	MB	Ierissos, Chalkidiki	40°25'N - 23°55'E	Un	MS	G2
	Pyramidellidae	<i>Odostomia dijkhuizeni</i> van Aartsen, Gittenberger & Goud, 1998		1		40		Nea Peramos	40°49'N - 24°22'E			
				1		4	MB	Chamolia, Attica	37°55'N - 24°01'E			
			4a	1		50	MB	Central Thermaikos Gulf	39°56'N - 23°04'E	Ukn	Ma-An	MS1, G1
		<i>Brachystomia angusta</i> (Jeffreys, 1867), for comparison	4b			30	MB	Paralia, Epanomi, Thermaikos	40°23'N - 22°52'E			
		<i>Brachystomia eulimoides</i> (Hanley, 1844), for comparison	4c			30-40	MB	Nea Michaniona, Thermaikos	40°25'N - 22°47'E			
		<i>Brachystomia scalaris</i> (MacGillivray, 1843), for comparison	5a			40	MB	Paralia, Epanomi, Thermaikos	40°21'N - 22°48'E			
		<i>Odostomia rissoiformis</i> Milaschewitsch, 1909, for comparison	5b									
		<i>Odostomia widmeri</i> Tisselli & Manousis. 2022	5c-e	3	2	0,2	CNB	Cape, Epanomi, Thermaikos	40°23'N - 22°53'E	KLM, Un	EMS	G2, ED
				1		40-80	Ma	Gulf of Souda	35°29'N - 24°12'E			

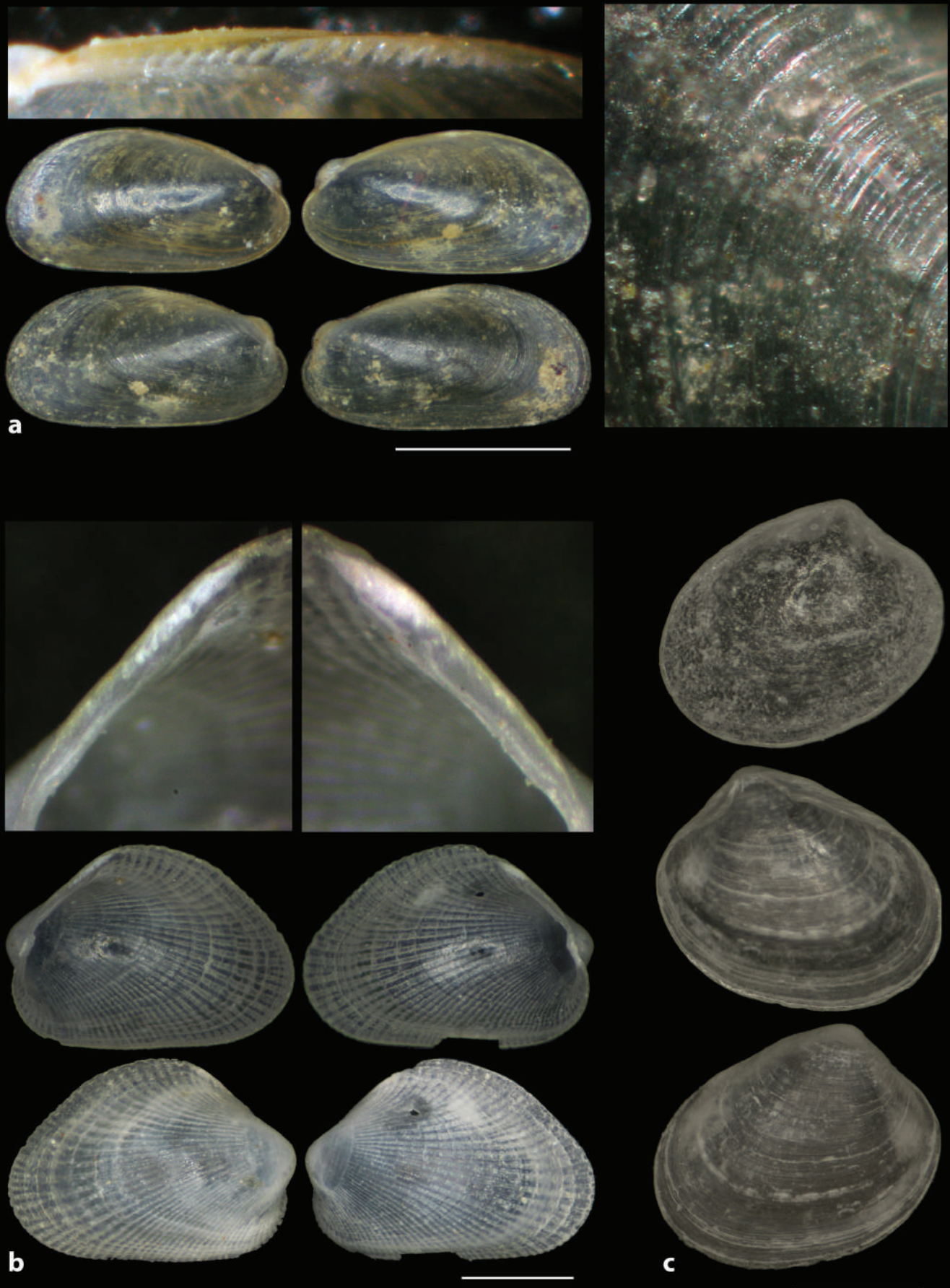


Figure 1: a. *Idas modiolaeformis* (Sturany, 1896); b. *Rhomboidella prideauxi* (Leach, 1815); c. *Kurtiella triangularis* (R. B. Watson, 1897). Barr = 1 mm.



Figure 2: a, b. *Parvicardium carrozzai* van Aartsen & Goud, 2001; c. *Lepetella barrajoni* Dantart & Luque, 1994; d. *Lepetella espinosae* Dantart & Luque, 1994; e. *Monophorus alboranensis* Rolán & Peñas, 2001. Barr = 1 mm, unless otherwise indicated.

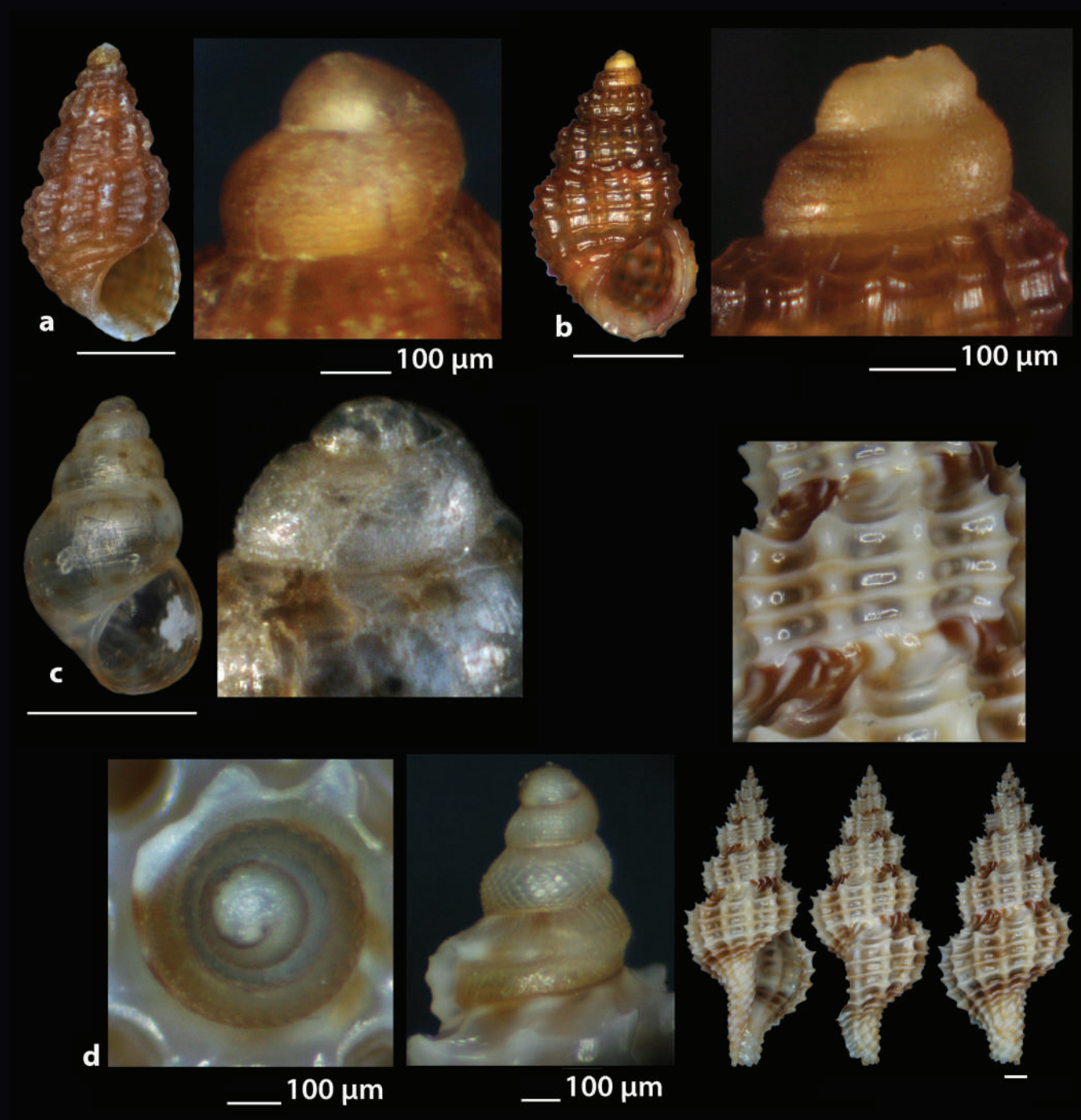


Figure 3: a. *Alvania datchaensis* Amati & Oliverio, 1987; b. *Alvania marmarisensis* Bitlis & Öztürk, 2017; c. *Crisilla chiarellii* (Cecalupo & Quadri, 1995); d. *Raphitoma hispidella* Giannuzzi-Savelli & Pusateri, 2019. Barr = 1mm, unless otherwise indicated.

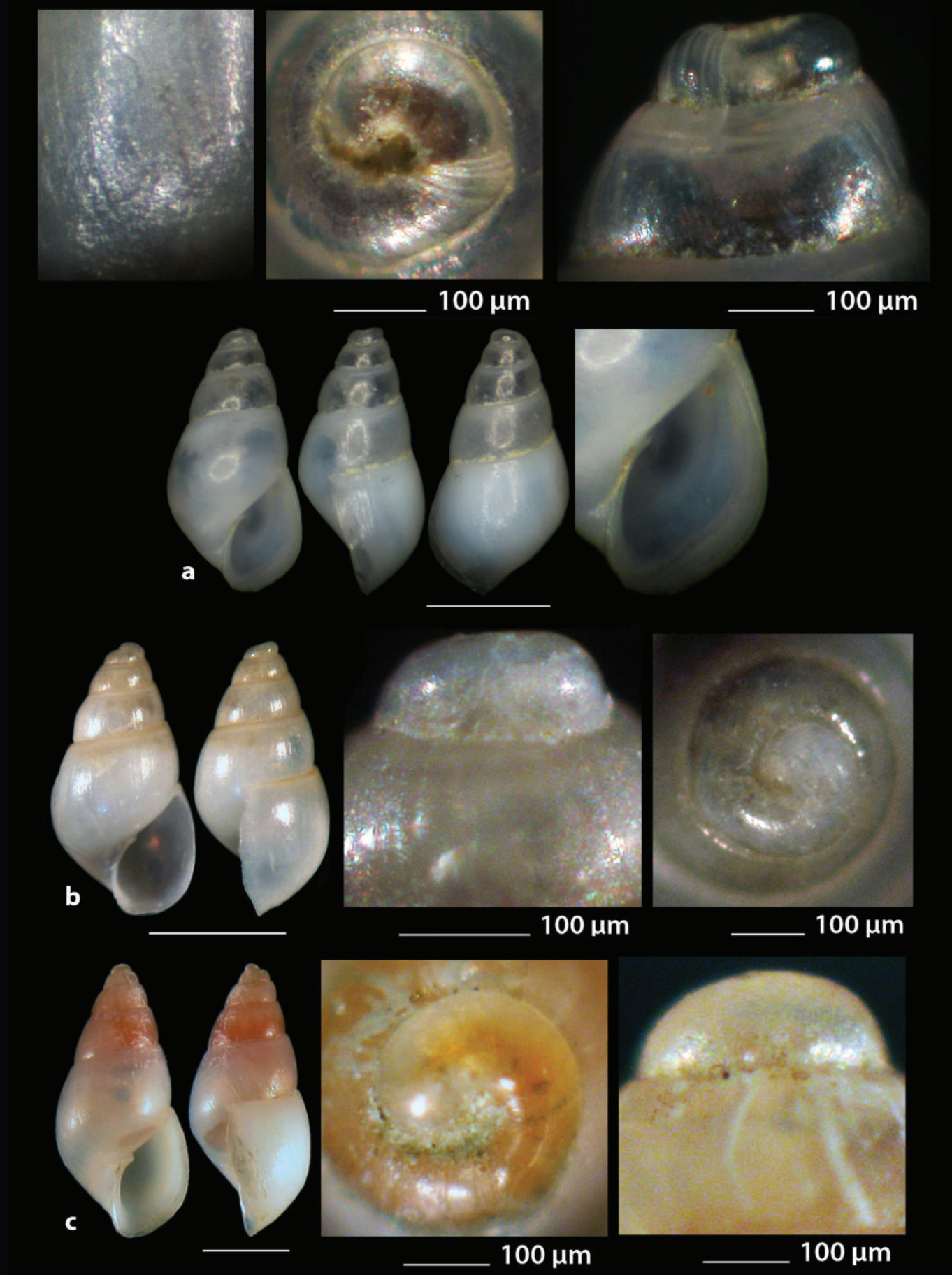


Figure 4: a. *Odostomia dijkhuizeni* van Aartsen, Gittenberger & Goud, 1998; b. *Brachystomia angusta* (Jeffreys, 1867); c. *Brachystomia eulimoides* (Hanley, 1844). Barr = 1 mm, unless otherwise indicated.

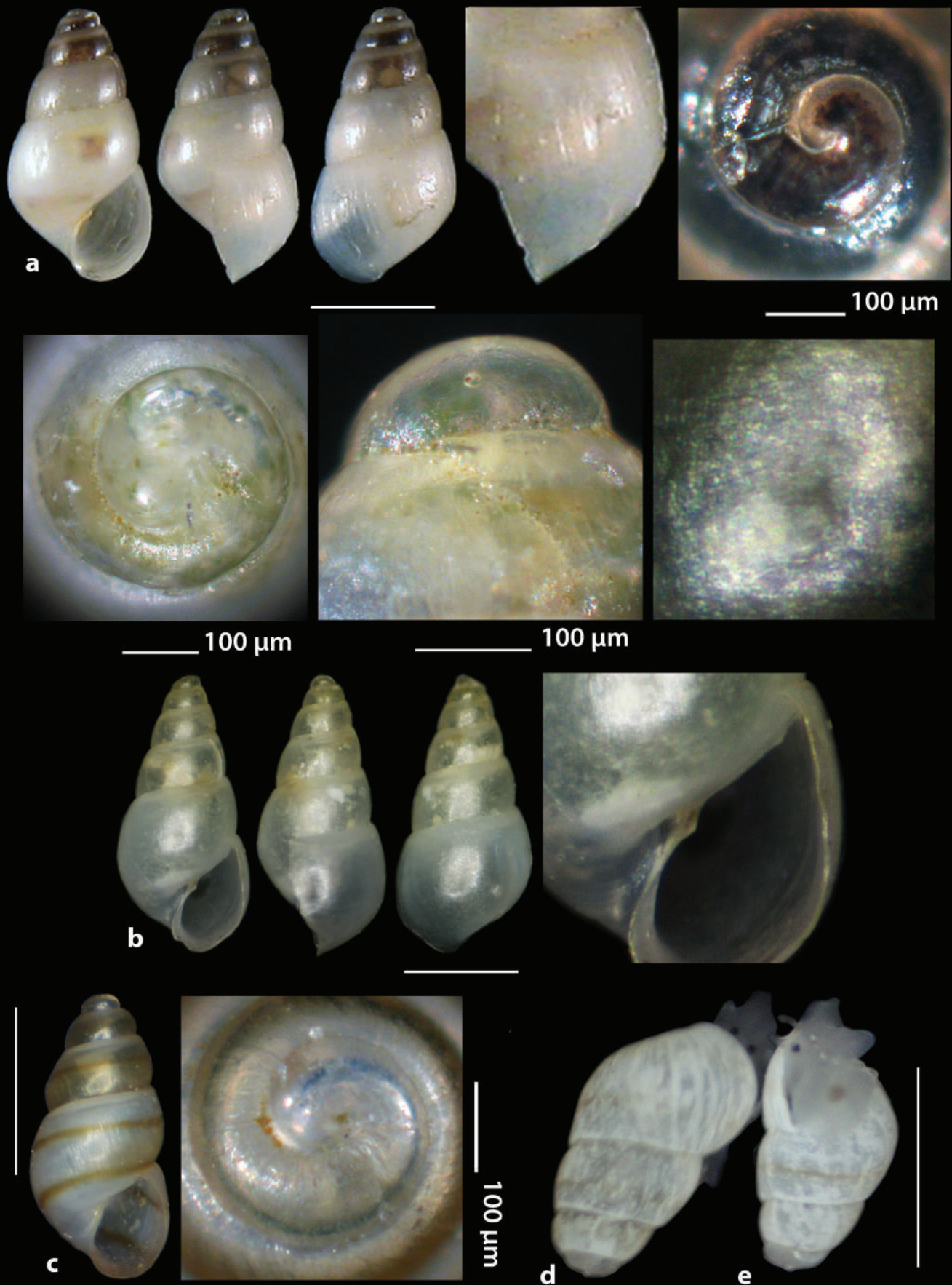


Figure 5: a. *Brachystomia scalaris* (MacGillivray, 1843); b. *Odostomia rissoiformis* Milaschewitsch, 1909; c. *Odostomia widmeri* Tisselli & Manousis. 2022 shell, d, e. *Odostomia widmeri* Tisselli & Manousis. 2022 live specimens. Barr = 1 mm, unless otherwise indicated.

Cerithiopsidae from Indian Ocean Part. 2 – La Réunion

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Résumé

Dans cette deuxième partie concernant le matériel malacologique de la Superfamille Triphoroidea Gray, 1847 de l'Océan Indien est analysé un lot de mollusques dragués à la main jusqu'à 10 m à La Réunion, à Saint Gilles les Bains ; 22 espèces de la famille des Cerithiopsidae H. Adams & A. Adams, 1853 ont été identifiées dont 4 nouvelles pour la science : *Horologica morgabina* sp. nov., *Specula flavida* sp. nov., *Synthopsis latericia* sp. nov., *Tubercliopsis anomala* sp. nov..

Abstracts

In this second part concerning malacological material of the Superfamily Triphoroidea Gray, 1847 from Indian Ocean is analyzed a lot of molluscs hand-dredged up to 10 m in La Réunion, place Saint Gilles les Bains; 22 species of the family Cerithiopsidae H. Adams & A. Adams, 1853 have been identified, 4 of which are new to science: *Horologica morgabina*, *Specula flavida*, *Synthopsis latericia*, *Tubercliopsis anomala*.

Key words

Triphoroidea, Cerithiopsidae, La Réunion, new species.

Introduction

In the material reported by La Réunion Is., from Saint Gilles les Bains, hand-dredged by Mario Nonini (1987) (Ravenna, Italy), up to 10 m, 22 species have been identified: genus *Clathropsis* 1, *Horologica* 3, *Joculator* 8, *Prolixodens* 1, *Specula* 2, *Synthopsis* 6, *Tubercliopsis* 1, allowing us to expand the list of species reported in the paper of Jay & Drivas (2002) of 16 species of which 4 are new to science: *Horologica morgabina*, *Specula flavida*, *Synthopsis latericia*, *Tubercliopsis anomala*.

The re-examination of the species reported by La Réunion allowed us to verify the synonymy of 3 species reported in Cecalupo & Perugia (2012) from Philippines: *Synthopsis noninii* Cecalupo & Perugia, 2012 = *Cerithiopsis hadfieldi* Jay & Drivas 2002 which is allocated in the genus *Synthopsis* Laseron, 1856; *Tubercliopsis minor* Cecalupo & Perugia, 2012 = *Cerithiopsis lamyi* Jay & Drivas, 2002 which is allocated in the genus *Clathropsis* Laseron, 1956; *Horologica jayi* Cecalupo & Perugia, 2012 = *Horologica martini* Jay & Drivas, 2002; *Tubercliopsis maxi* Cecalupo & Perugia, 2012 is allocated in the genus *Synthopsis*.

Acronyms and abbreviations

MNHN Muséum National d'Histoire Naturelle, Paris, France

ESEM Environmental Scanning Electron Microscope

spm(s) specimen (s)

W/H width/height

SYSTEMATICS

Clade **Hipsogastropoda** Ponder & Lindberg, 1997

Informal Group **Ptenoglossa** Gray, 1853

Superfamily **Triphoroidea** Gray, 1847

Family **Cerithiopsidae** H. Adams & A. Adams, 1853

Clathropsis lamyi (Jay & Drivas, 2002)

(Pl. 1, figs. D-G)

Cerithiopsis lamyi Jay & Drivas, 2002: 6, pl. 2, fig. A, pl. I, fig. 7.
Tubercliopsis minor Cecalupo & Perugia, 2012: 72, pl. 15, fig. D, pl. 83, figs. CD, Mactan Is., Punta Engaño, Philippines, holotype MNHN-IM-2000-23987.

Type material:

holotype (MNHN-IM-2000-1556), dim. 1.50 x 0.50 mm, protoconch 0.40 x 0.32 mm.

Type locality:

La Réunion, Trois-Bassins, off Souris-Chaude, 30 m.

Distribution:

La Réunion, Philippines.

Material examined:

figs. **D-F**, spms 2, [Perugia coll.], dim. 3.90 x 0.92 mm, protoconch 0.49 x 0.32 mm; fig. **G**, [Cecalupo coll.], dim. 3.32 x 0.94 mm. Animal not observed.

Remarks:

consider the characteristics we think it should be allocated in *Clathropsis* genus.

Horologica clara Cecalupo & Perugia, 2012

(Pl. 1, figs. K-M)

Type material:

holotype (MNHN-2000-23833), dim. 2.22 x 0.75 mm, protoconch 0.61 x 0.28 mm.

Type locality:

Philippines, Panglao Is., Bingag/Tabalong, up to 80 m.

Distribution:

Philippines, first report from La Réunion.

Material examined:

spm 1 (MNHN-IM-2021-8725), dim. 2.09 x 0.73 mm, protoconch 0.54 x 0.28 mm. Animal not observed.

Horologica martini Jay & Drivas, 2002
(not figured)*Horologica martini* Jay & Drivas, 2002: 26, pl. 6, fig. F, pl. II, fig. 44, La Réunion.*Horologica jayi* Cecalupo & Perugia, 2012: 35, pl. 1 fig. A-C, pl. 42 figs. A-D, holotype (MNHN-IM-2000-35790), Philippines; Cecalupo & Perugia, 2013: 85, pl. 19, figs. D-F, pl. 96 figs. A-D, Vanuatu; Cecalupo & Perugia, 2014: 18, French Polynesia; Cecalupo & Perugia, 2014: 100, fig. 1, T, figs. 8, I-J, South Madagascar; Cecalupo & Perugia, 2016: 101, fig. 1, E, pag. 104, fig. 3 A, Red Sea; Cecalupo & Perugia, 2017: 38, pl. 16 fig. 1a-g, New Caledonia; Cecalupo & Perugia, 2018: 32, pl. 12, figs. 2 a-g, Papua New Guinea; Cecalupo & Perugia, 2019¹: 21, Japan, Okinawa; Cecalupo & Perugia, 2019²: 20, fig. 3P, Bangka Pulau, Indonesia; Cecalupo & Perugia, 2021: 13, Comoro.**Type material:**

holotype (MNHN-2000-1359) dim. 2.22 x 0.80 mm, protoconch 0.44 x 0.32 mm.

Type locality:

La Réunion, Saint Gilles les Bains, off Boucan Canot beach.

Distribution:

from Indian Ocean to West Pacific Ocean.

Material examined:

spms 5, [Perugia coll.].

Remarks:

very common species widely diffused in the Indo-Pacific area, from the Red Sea to Japan and French Polynesia, it shows a considerable dimensional variability and deformed specimens are often found (see Cecalupo & Perugia, 2018: 33, pl. 12, figs. 3 a-e).

Animal not observed.

Horologica morgabina sp. nov.
(Pl. 1, figs. N-P)**Type material:**

holotype (MNHN-IM-2000-38305), dim. 2.91 x 1.12 mm, protoconch partially missing ? x 0.24 mm.

Type locality:

La Réunion, Saint Gilles les Bains, up to 10 m.

Distribution:

known only from type locality.

Material examined:

only the holotype.

Description of holotype:shell small, oval inflated with constricted base, sutures moderately impressed. Protoconch conical not quite perfect, only 2 last smooth, convex whorls remaining, whitish, semitransparent. Teleoconch of 7 whorls with reticulate sculpture of spiral cords crossed by weaker axial ribs, about 18 on last whorl, beads at each intersection. In the first 3 whorls there are only 2 spiral cords of equal thickness, in the 4th whorl an intermediate spiral appears initially very thin but which gradually increases its thickness; in the last round, the 1st cord is thicker, the next 2, thinner of equal thickness. A 4th beaded cord at the base of last whorl emerging from insertion of outer lip; limit between base and columella highlighted by a obsolete cord. Columella short crossed by many threads;

evident columellar callus bordering a circular aperture, anal sulcus and siphonal canal well defined. Color pale reddish brown, first spiral cord darker, columella yellowish. Animal not observed.

Comparison:the particular sculpture of the teleoconch in *Horologica morgabina* sp. nov. is found in *Horologica fraudulenta* Cecalupo & Perugia, 2013 which differs mainly for the less oval shape, the less convex whorls of the protoconch and, upon careful examination, it is noted that the first whorls of the teleoconch have 3 spiral cords, very thin the intermediate, a detail that creates some perplexity about its generic assignment.**Etymology:***morgabina* from “Dina Morgabin” the ancient Arabic name of La Réunion.***Joculator acuminatus*** Cecalupo & Perugia, 2012
(Pl. 1, figs. R-T)**Type material:**

holotype (MNHN-IM-2000-23890), dim. 2.43 x 0.87 mm, protoconch 0.50 x 0.28 mm.

Type locality:

Philippines, Panglao Is., Sungcolan Bay, up to 3 m.

Distribution:

Indopacific area, first report from La Réunion.

Material examined:

spm 1 (MNHN-IM-2021-8726), dim. 2.29 x 0.89 mm, protoconch 0.47 x 0.32 mm. Animal not observed.

Joculator coffeus Cecalupo & Perugia, 2013
(Pl. 2, figs. A-C)**Type material:**

holotype (MNHN-IM-2000-25942), dim. 1.41 x 0.75 mm, protoconch 0.27 x 0.20 mm.

Type locality:

Vanuatu, SE Matewulu, 20 m.

Distribution:

New Caledonia, Papua New Guinea, South Madagascar, Vanuatu, first report from La Réunion.

Material examined:

fig. A-B, spms 2, [Cecalupo coll.], dim. 1.42 x 0.71mm, fig. C, (MNHN-IM-2021-8727), dim. 1.35 x 0.65 mm. Animal not observed.

Joculator ferrii Cecalupo & Perugia, 2013
(Pl. 2, figs. D-F)**Type material:**

holotype (MNHN-IM-2000-25947), dim. 2.18 x 0.78 mm, protoconch 0.50 x 0.22 mm.

Type locality:

Vanuatu, Tutuba Is., 8-9 m.

Distribution:

Vanuatu, first report from La Réunion.

Material examined:

spm 1 (MNHN-IM-2021-8728), dim. 2.39 x 0.88 mm, protoconch 0.50 x 0.24 mm. Animal not observed.

Joculator keszlerae Cecalupo & Perugia, 2021
(Pl. 2 figs. G-H)**Type material:**

holotype (MNHN-IM-2000-36014), dim. 2.20 x 0.75 mm, protoconch 0.40 x 0.22 mm.

Type locality:

Comoro, South Mayotte, 295-336 m.

Distribution:

Comoro, first report from La Réunion.

Material examined:

spm 1 (MNHN-IM-2021-8729), dim. 1.58 x 0.58 mm, protoconch 0.42 x 0.21 mm. Animal not observed.

Joculator lividus Cecalupo & Perugia, 2012
(not figured)**Type material:**

holotype (MNHN-IM-2000-23895), dim. 2.02 x 0.65 mm, protoconch 0.55 x 0.32 mm.

Type locality:

Philippines, Panglao Is., Bingag/Tabalong, up to 80 m.

Distribution:

W Pacific from Japan to French Polynesia, first report from La Réunion.

Material examined:

spm 1 (MNHN-IM-2021-8730), dim. 2.23 x 0.87 mm, protoconch 0.54 x 0.31 mm. Animal not observed.

Joculator myia Jay & Drivas, 2002
(Pl. 2, figs. I-K)**Type material:**

holotype (MNHN-IM-2000-1532), dim. 2.20 x 0.46 mm, protoconch 0.46 x 0.34 mm.

Type locality:

La Réunion, Saint Gilles les Bains, off Boucan-Canot, 30 m.

Distribution:

only known from La Réunion.

Material examined:

spm 1 [Perugia coll.], dim. 2.06 x 0.81 mm, protoconch 0.47 x 0.30 mm. Animal not observed.

Joculator phtyr Jay & Drivas, 2002
(Pl. 2, figs. L-N)**Type material:**

holotype (MNHN-IM-2000-458), dim. 2.00 x 0.90 mm, protoconch 0.44 x 0.26 mm.

Type locality:

La Réunion, off Saint Gilles les Bains, 35 m.

Distribution:

only known from La Réunion.

Material examined:

spm 1 [Perugia coll.], dim. 1.80 x 0.82 mm, protoconch 0.47 x 0.25 mm. Animal not observed.

Joculator variabilis Cecalupo & Perugia, 2012
(Pl. 2, figs. O-Q)**Type material:**

holotype (MNHN-IM-2000-23931), dim. 2.77 x 1.02 mm,

protoconch 0.49 x 0.25 mm.

Type locality:

Philippines, Panglao Is., Bingag/Tabalong, up to 80 m.

Distribution:

New Caledonia, Philippines, Papua New Guinea, Vanuatu, first report from La Réunion.

Material examined:

spm 1 (MNHN-IM-2021-8731), dim. 1.94 x 0.70 mm, protoconch 0.46 x 0.24 mm. Animal not observed.

Prolixodens gorii Cecalupo & Perugia, 2022
(Pl. 2, figs. R-U)**Type material:**

holotype (MNHN-IM-2000-38244), dim. 3.56 x 1.26 mm, protoconch 0.38 x 0.30 mm.

Type locality:

Deep Platou, Mirbat (Dhofar, Oman), 20 m.

Distribution:

Oman, first report from La Réunion.

Material examined:

spms 2, figs. R-T [Perugia coll.], dim. 3.40 x 1.30 mm, protoconch 0.39 x 0.27 mm, fig. U, (MNHN-IM-2021-8732), dim. 3.06 x 1.20 mm, protoconch 0.30 x 0.23 mm. Animal not observed.

Specula dimatteoi Cecalupo & Perugia, 2017
(Pl. 3, fig. A)**Type material:**

holotype (MNHN-IM-2000-30663), dim. 2.49 x 0.98 mm, protoconch 0.31 x 0.29 mm.

Type locality:

New Caledonia, Koumac area, Pointe de Pandop, 2-4 m.

Distribution:

New Caledonia, first report from La Réunion.

Material examined:

spm 1 (MNHN-IM-2021-8733), dim. 2.01 x 0.85 mm, protoconch 0.30 x 0.27 mm. Animal not observed.

***Specula flavida* sp. nov.**
(Pl. 3, figs. B-D)**Type material:**

holotype (MNHN-IM-2000-38306), dim. 1.77 x 0.74 mm, protoconch 0.29 x 0.20 mm.

Type locality:

La Réunion, Saint-Gilles-les-Bains, up to 10 m.

Distribution:

only known from type locality.

Material examined:

only the holotype.

Description of holotype:

shell very small, conical, sutures moderately impressed, last whorls constricted. Protoconch small, conical of 2.5 smooth convex whorls, colour white, opaque. Teleoconch of 6 whorl with reticulate sculpture of 2 spiral cords crossed by weaker axial ribs, about 14 on last whorl; beads at each intersection. A 4th beaded cord at the base of last whorl emerging from insertion of outer lip; limit between columella and base highlighted by a cord. Columella short crossed by crisp thin threads, anal sulcus and siphonal canal well evident, columellar callus bordering an oval aperture. Colour yellow.

Animal not observed.

Comparison:

Specula flavida sp. nov. is compared with the few species having a teleoconch with sculpture of 2 axial spirals: *Specula agamennonei* Cecalupo & Perugia, 2019² from North Sulawesi has protoconch, size and red-brown color similar but differs having an oval outline not conical; *Specula santalensis* Cecalupo & Perugia, 2017 from New Caledonia and Papua New Guinea, has a very different color.

Etymology:

flavidus, a, um from Latin for the color of the teleoconch.

Specula nutzeli (Jay & Drivas, 2002)

(Pl. 1, figs. A-C)

Cerithiopsis nutzeli Jay & Drivas, 2002: 8, pl.2, fig. B, pl. I, fig. 8.

Type material:

holotype (MNHN-IM-2000-460), dim. 3.40 x 1.00 mm, protoconch 0.46 x 0.29 mm.

Type locality:

La Réunion, Saint Gilles les Bains, bet Hermitage and Saint-Paul Bay, 15-30 m.

Distribution:

only known from La Réunion.

Material examined:

spm 1 [Cecalupo coll.], dim. 2.31 x 0.59 mm, protoconch 0.40 x 0.20 mm. Animal not observed.

Remarks:

for its features, size and protoconch of 2.5 whorls, we think it should be allocated in *Specula* genus, Finlay, 1926.

Synthopsis elegans Cecalupo & Perugia, 2012

(Pl. 3, figs. E-F)

Type material:

holotype (MNHN-IM-2000-24013), dim. 4.45 x 1.30 mm, protoconch 0.48 x 0.27 mm.

Type locality:

Philippines, Bohol Is., up to 10 m.

Distribution:

Philippines, first report from La Réunion.

Material examined:

spm 1 (MNHN-IM-2021-8734), dim 3.00 x 1.08 mm, protoconch 0.41 x 0.28 mm. Animal not observed.

Synthopsis hadfieldi (Jay & Drivas, 2002)

(Pl. 3, figs. G-I)

Cerithiopsis hadfieldi Jay & Drivas, 2002: 5, pl. 1, fig. D, pl. I, fig. 4, La Réunion.

Synthopsis noninii holotype Cecalupo & Perugia, 2012: 81, pl. 21, figs. A-B, pl. 95 figs. A-D, (MNHN-IM-2000-24035), Philippines; Cecalupo & Perugia, 2013: 94, pl. 34 figs. G-I, pl. 120 figs. A-E, Vanuatu; Cecalupo & Perugia, 2014¹: 21, French Polynesia, Society Is.; Cecalupo & Perugia, 2016: 97, pl. 50 figs, 3a-c, New Caledonia.

Tubercliopsis turgida Cecalupo & Perugia, 2012: 70, pl. 15 fig. A, pl. 82 figs. A-B, Philippines; Cecalupo & Perugia, 2012, synonymus of *Synthopsis noninii* in Cecalupo & Perugia, 2013: 38.

Type material:

holotype (MNHN-IM-2000-468), dim. 5.60 x 1.40 mm, protoconch 0.82 x 0.32 mm (different measures can be obtained from the photo about 5.00 x 1.33-0.58 x 0.31 mm).

Type locality:

La Réunion, off Saint Gilles les Bains, 45 m.

Distribution:

from Indian Ocean to West Pacific Ocean.

Material examined:

spms 2 [Cecalupo coll.], figs. G-I, dim. 2.77 x 1.00 mm, protoconch 0.50 x 0.30 mm. Animal not observed.

Remarks:

consider the characteristics we think it should be allocated in *Synthopsis* genus Laseron, 1956.

Synthopsis latericia sp. nov.

(Pl. 3, figs. M-O)

Type material:

holotype (MNHN-IM-2000-38307), 3.06 x 1.18 mm, protoconch 0.40 x 0.26 mm.

Type locality:

La Réunion, Saint-Gilles-les-Bains, up to 10 m.

Distribution:

only known from type locality.

Material examined:

only the holotype.

Description of holotype:

shell medium in size, oval, sutures moderately impressed. Protoconch short, cylindrical of 3.5 convex smooth whorls, see under ESEM first 1.5 whorls granulous, sutures marked by minute grains; colour white, opaque. Teleoconch of 6 whorls with reticulate sculpture of 3 equal spiral cords crossed by weaker axial ribs, 16 on last whorl; beads at each intersection. A fourth cord at the base of last whorl emerging from insertion of outer lip; limit between columella and base highlighted by a groove. Columella short crossed by growth lines; siphonal canal and anal sulcus well defined, subcircular aperture. Colour red brown. Animal not observed.

Comparison:

Synthopsis latericia sp. nov. is compared with *Joculator fischeri* Jay & Drivas, 2002 from La Réunion species similar in color and outline but shorter with protoconch of 3.5 smooth convex whorls but without sutures marked by grains; also *Prolixodens lutea* (Cecalupo & Perugia, 2012), with wide geographic distribution is similar in color and outline but with a very different protoconch. *Synthopsis albostrata* Cecalupo & Perugia, 2013 from Vanuatu has a similar shape but differs having a conical protoconch, smaller dimensions and color with a white spiral.

Etymology:

latericia, from the latin *latericius*, a, um, for its red brown color typical of the bricks.

Synthopsis maxi (Cecalupo & Perugia, 2012)
(Pl. 1, figs. H-J)

Tubercliopsis maxi Cecalupo & Perugia, 2012: 71, pl. 15, figs. E-G, pl. 84 figs. A-D.

Type material:

holotype (MNHN-IM-2000-23924), dim. 2.95 x 0.87 mm, protoconch 0.60 x 0.30 mm.

Type locality:

Philippines, Panglao Is., Bingag, 18 m.

Distribution:

Philippines, first report from La Réunion.

Material examined:

spms 4 (MNHN-IM-2021-8735); dim. 2.59 x 0.88 mm, protoconch 0.50 x 0.27 mm. Animal not observed.

Remarks:

the genus *Tubercliopsis* Laseron, 1956, is characterized by more narrowly conical shell with flat-profile and hardly indented sutures therefore, re-examining this species, we think it is more appropriate to include it in the *Synthopsis* genus Laseron, 1956.

Synthopsis turgida Cecalupo & Perugia, 2012
(Pl. 3, figs. J-L)**Type material:**

holotype (MNHN-2000-24405), dim. 2.15 x 0.94 mm, protoconch 0.47 x 0.30 mm.

Type locality:

Philippines, Panglao Is., Looc, 24 m.

Distribution:

Japan (Okinawa), New Caledonia, Philippines, first report from La Réunion.

Material examined:

spm 1 (MNHN-IM-2021-8736), dim. 2.00 x 0.92 mm, protoconch 0.48 x 0.33 mm. Animal not observed.

***Tubercliopsis anomala* sp. nov.**
(Pl. 3, figs. P-S)**Type material:**

holotype (MNHN-IM-2000-38308), dim. 3.73 x 0.97 mm, protoconch 0.48 x 0.31 mm.

Paratype 1: dim. 3.90 x 0.98 mm, (same location).

Type locality:

La Réunion, Saint-Gilles-les-Bains, up to 10 m.

Distribution:

only known from type locality.

Material examined:

only the holotype.

Description of holotype:

shell of medium size, narrowly conical, regularly increasing, flat sides, channeled sutures. Protoconch cylindrical, 2.5/3 granulous convex whorls, color white. Teleoconch of about 8 whorls with reticulate sculpture of 3 equal spiral cords, relatively thin, (1st one, immediately after suture less prominent), crossed by weaker axial ribs, about 25 on last whorl; small beads at each intersection; interspaces between cords wider, 2.5x that the cords. A fourth cord at the base of last whorl emerging from insertion of outer lip; limit between columella and base highlighted by a cord. Columella short and smooth,

columellar callus bordering a circular aperture; siphonal canal well distinct. Color pale orange. Animal not observed.

Comparison:

Tubercliopsis anomala sp. nov. is compared with the similar *Cerithiopsis jousseumei* Jay & Drivas, 2002 from La Réunion; mainly differences are the thinner protoconch, beads stronger and not evident sutures.

Remarks:

the genus *Tubercliopsis* is characterized by a narrowly conical shell with flat-profile and hardly indented sutures not channeled as in this species; however we think to include it in the *Tubercliopsis* genus.

Etymology:

anomala, from latin *anomalus*, a, um with reference to its market sutures; in english anomalous.

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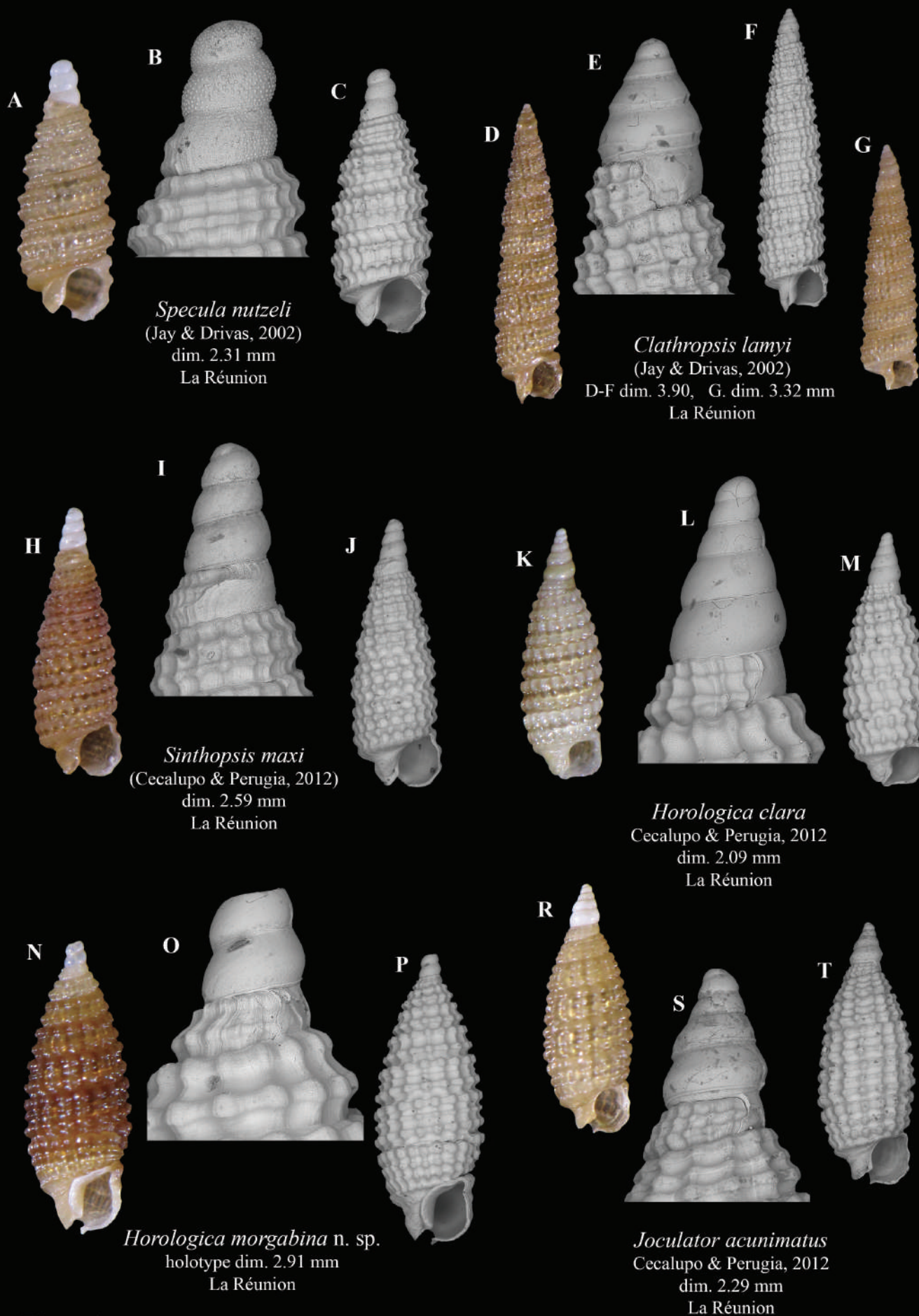
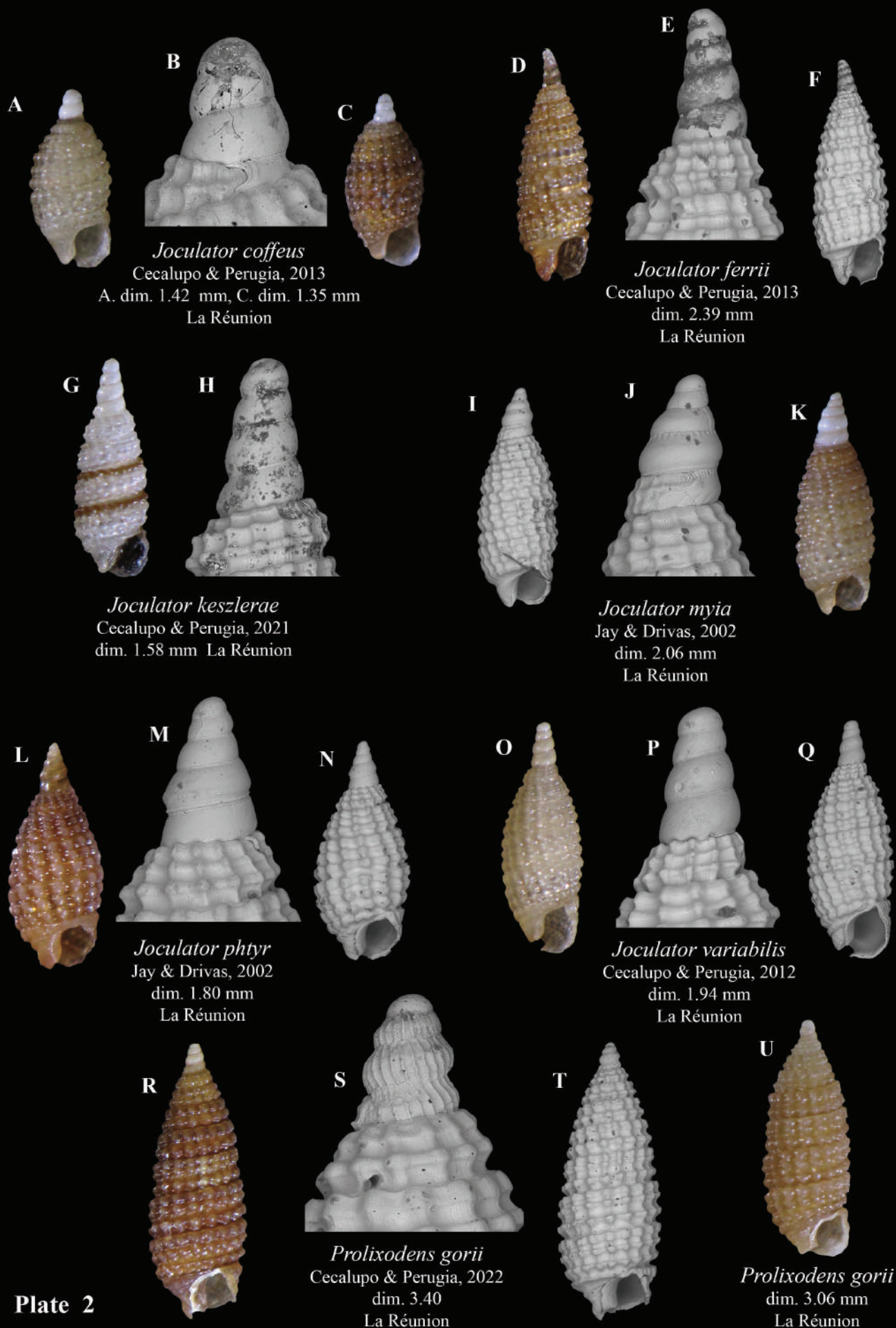
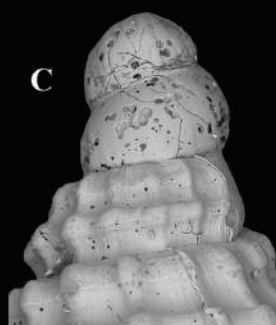


Plate 1





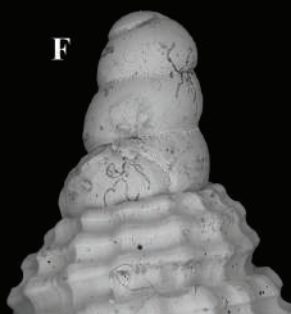
Specula dimatteoi
Cecalupo & Perugia, 2017
dim. 2.01 mm La Réunion



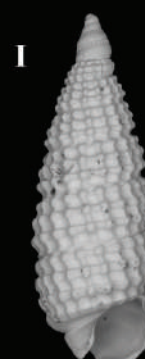
Specula flavida n. sp.
holotype dim. 1.77 mm
La Réunion



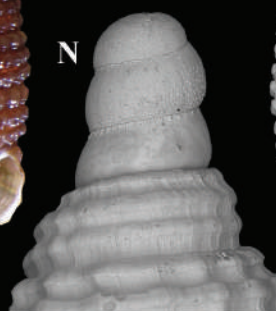
Synthopsis elegans
Cecalupo & Perugia, 2012
dim. 3.00 mm La Réunion



Synthopsis hadfieldi
(Jay & Drivas, 2002)
dim. 2.77 mm La Réunion



Synthopsis latericia n. sp.
holotype dim. 3.06 mm
La Réunion



Synthopsis turgida
Cecalupo & Perugia, 2012
dim. 2.00 mm La Réunion



Tuberclopsis anomala n. sp.
holotype dim. 3.73 mm
La Réunion



T. anomala n. sp.
paratype 1, 3.90 mm
La Réunion

The family Cerithiopsidae (Mollusca: Gastropoda: *Triphoroidea*) in the Hellenic Seas and three new records for the East Mediterranean Sea

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Keywords

Cerithiopsidae, Greece, Mediterranean Sea, Mollusca, Morphology, New Records

Abstract

The Cerithiopsidae family in the Hellenic Seas is reviewed after more than a decade of intense investigation and collection. Thirty one species were identified and their status was compared with existing checklists and other collections. This effort revealed two new *Cerithiopsis* records for the Eastern Mediterranean basin and one for the whole Mediterranean Sea except the Island of Alboran. The main identification characteristics and baseline ecological information are given and discussed when necessary.

Introduction

The Mediterranean Sea is rich in biodiversity with more than 17,000 species (Zenetos *et al.*, 2012), more than 2100 molluscs and more than 1670 gastropods (www.societaitalianadimalacologia.it, accessed October 2022). Among them are members of the caenogastropod family of Cerithiopsidae H. Adams & A. Adams, 1853, which harbors feeders of the microbial flora of sponges (Gofas *et al.*, 2011), is broadly distributed worldwide and includes more than 800 extant species assigned to about 40 genera (Bouchet, 2011). Some of those genera are cosmopolitan and specious (e.g. *Cerithiopsis* Forbes and Hanley, 1850, *Dizoniopsis* Sacco, 1895, *Horologica* Laseron, 1956, *Joculator* Hedley, 1909, *Mendax* Finlay, 1926, *Prolixodens* B. A. Marshall, 1978 and *Synthopsis* Laseron, 1956) while others are represented by few or one

species from confined geographic areas (e.g. *Alipta* Finlay, 1926, *Koilofera* Jay and Drivas, 2002, *Oparopsis* Cecalupo & Perugia, 2015, *Tasmalira* Dell, 1956). Although North and Eastern Atlantic and Mediterranean members of the family have been rather extensively studied (e.g. Peñas *et al.*, 2006; Bouchet *et al.*, 2010; Cecalupo & Robba, 2010; Prkić & Mariottini, 2010, Romani *et al.*, 2018), the family is considered as understudied, both with regard to the total number of harbored species as well as to the intrafamilial and intrageneric phylogenetic relationships. At the same time, anatomical and genetic studies are still very limited, thus resulting in the generic attribution and the species validity to rely mainly upon protoconch and teleoconch features (Romani *et al.*, 2017). More specifically, a number of researchers have applied anatomical and radula characteristics studies (e.g. Sars, 1878; Thiele, 1912; Fretter, 1951; Marshall, 1978; Bouchet & Warén, 1993; Nützel, 1998), while Modica *et al.* (2013) molecular ones in order to resolve cerithiopsid taxonomy in a certain geographic area. The situation is complicated due to the reluctance of the scientific community to adopt morphology-based supraspecific taxonomy proposed by some researchers, as it is the case of the valid and specious (some 200 species) nominotypical genus *Cerithiopsis* Forbes and Hanley, 1850 (Marshall & Gofas, 2016) represented in the Mediterranean Sea by some 20 species (Templado & Villanueva in Coll *et al.*, 2010). Relatively recently, Modica *et al.* (2013) have suggested that the type species (by original designation) *Murex tubercularis* Montagu, 1803 itself actually consists of a complex of cryptic species. All these cryptic species are characterized by shells with a conical and smooth multispiral protoconch of around four whorls, or with a faint sculpture at the suture, and a slender pupoid to sub cylindrical teleoconch, with reticulate sculpture consisting of

axial ribs and spiral cords with pearly intersections (Cecalupo & Robba 2010; Prkić & Mariottini 2010; Modica *et al.* 2013). Despite that, other species ascribed to the same genus possess very different diagnostic shell features, including some from the same biogeographic area of *Cerithiopsis tubercularis* (e.g. *C. diadema* di Monterosato, 1874 and *C. nofronii* Amati, 1987), or from different areas (e.g. *C. greppii* Buzzurro & Cecalupo, 2005 and *C. ladae* Prkić & Buzzurro, 2007), or even specimens of the same species but with differently decorated protoconches (Romani & Bartolini, 2014, Manousis, 2021a) all of which suggest inaccurate supraspecific taxonomy and point out to reassessment. Moreover, there is rather strong evidence that due to the lack of a robust phylogenetic framework and the minute size of the taxa - which are hardly collected live or with an intact protoconch - there are difficulties in ascribing individual species level taxa to the correct genera thus the term *Cerithiopsis* seems to be used as a general “receiver” rather than as a proper phylogenetic lineage (Marshall, 1978; Okutani, 2000; Jay & Drivas, 2002; Landau *et al.*, 2006; Rolán *et al.*, 2007; Cecalupo & Robba, 2010; Romani *et al.*, 2018).

Up to these days, the Hellenic cerithiopsid biodiversity has been described and discussed fragmentary (e.g. Manousis & Galinou-Mitsoudi, 2014; Crocetta *et al.*, 2017 Manousis *et al.*, 2018; Mbazios *et al.*, 2020; Manousis *et al.*, 2021; Zaminos *et al.*, 2021; Mbazios *et al.*, 2022). After the finding in Greece of two fresh and perfect specimens of *Cerithiopsis taruelli* Peñas & Rolán, 2006 - which for the last 16 years was only known from the island of Alboran (Peñas *et al.*, 2006) - considering all the above taxonomical adversities and in order to aid in the understanding and better assessment of species-specific variability, to correct placement within supraspecific taxonomic lineages and to enrich the local fauna with new findings we review and discuss here the members of this family in the Hellenic waters.

Methods

Literature was reviewed for papers reporting previously unpublished and image documented records of Cerithiopsidae from the Hellenic territorial waters (e.g. Manousis, 2021b). Sampling, handling and species recognition were conducted according to Manousis & Galinou-Mitsoudi (2014) and Mbazios *et al.* (2020) from October 2008 to October 2022 in certain locations throughout the Hellenic Seas. Findings were compared with material figured in the literature as well as in our collections. Updated taxonomy and nomenclature follows WoRMS (accessed October 2022). Shells were examined through an Olympus SZ40 stereomicroscope and photographed with a Canon PowerShot A640 camera, while measurements were carried out by means of an Olympus objective micrometer. Protoconch whorls were counted according to Verduin (1977) while teleoconch spiral cords were numbered from the adapical one according to Marshall (1983), with 1st cord the subsutural one, and subsequent cords referred as cord 2, cord 3, etc. All previously reported and documented records are listed below accompanied by the relevant literature, while adequate description for identification and collection data are given for the new records. All findings are presented in Figures 1-8. Material is preserved in the private collections of the coauthors C. Kontadakis, T. Manousis, G. Mbazios, G. Polyzoulis and G. Zaminos and is available for inspection by appointment.

Results

Abbreviations:

EMS1 – First record for the East Mediterranean Sea;
G1 – First record for Greece;
G2 – Second record for Greece;
MS2 - Second Record for the Mediterranean Sea;
WCMS = West and Central Mediterranean Sea.

Systematics

Class GASTROPODA Cuvier, 1795
 Subclass CAENO-GASTROPODA Cox, 1960
 Superfamily TRIPHOROIDEA Gray, 1847
 Family CERITHIOPSIDAE H. Adams & A. Adams, 1853

Type species *Murex tubercularis* Montagu, 1803
 by original designation

The records

Genus *Cerithiopsis* Forbes & Hanley, 1850

Cerithiopsis annae Cecalupo & Buzzurro, 2005 (Fig. 1a).
 Manousis *et al.*, 2018

Cerithiopsis atalaya R. B. Watson, 1885 (Fig. 1b). Manousis & Galinou-Mitsoudi, 2014

Cerithiopsis barleei Jeffreys, 1867 (Fig. 1c). Manousis, 2021a

Cerithiopsis carlottae Cecalupo & Perugia, 2018 (Fig. 1d).
 Zaminos *et al.*, 2021

Cerithiopsis diadema Monterosato, 1874 (Fig. 1e). Manousis & Galinou-Mitsoudi, 2014

Cerithiopsis fayalensis R. B. Watson, 1880 (Fig. 1f). Manousis & Galinou-Mitsoudi, 2014

Cerithiopsis iudithae Reitano & Buzzurro, 2006 (Fig. 1g).
 Mbazios *et al.*, 2020

Cerithiopsis jeffreysi R. B. Watson, 1885 (Fig. 1h). Manousis *et al.*, 2018

Cerithiopsis ladae Prkić & Buzzurro, 2007 (Fig. 2a-c). Manousis *et al.*, 2018

Cerithiopsis sp. (Fig. 2d). The contour of the minute shell is strongly reminiscent of that of *C. ladae* and *C. greppii* but its paucispiral protoconch which is partially covered by the first teleoconch whorl. Embryonic shell (protoconch I) (Fig. 2d, I) measures some 180 µm in its maximum diameter. Larval shell development with additional 0.1 whorls (Fig. 2d, II). 3 beaded spiral cords initiate immediately with the onset of the teleoconch (Fig. 2d, 1, 2, 3) which bears 4 whorls and 2 spiral wavy cords on its restricted base.

Cerithiopsis micalii (Cecalupo & Villari, 1997) (Fig. 3a, b).
 Manousis & Galinou-Mitsoudi, 2014

Cerithiopsis minima (Brusina, 1865) (Fig. 3c-g). Manousis *et al.*, 2018

Cerithiopsis nofronii Amati, 1987 (Fig. 4a). 1 fresh shell was collected from MB, 90 m, Elasa, Crete, 35°12'N - 26°19'E. The minute shell is characterized by a bright, superficially smooth protoconch with a point-like microsculpture and two whorls with a prominent carina in their middle (Amati, 1987; Giannuzzi-Savelli *et al.*, 1999, (https://www.naturamediterraneo.com/forum/topic.asp?TOPIC_ID=34554)). The finding of this rare (Repetto *et al.*, 2005) for the WCMS (Repetto *et al.*, 2005,

Giannuzzi-Savelli *et al.*, 1999) is an EMS1 and G1.

Cerithiopsis oculisfictis Prkic & Mariottini, 2010 (Fig. 4b, c). Manousis *et al.*, 2018

Cerithiopsis petanii Prkic & Mariottini, 2010 (Fig. 4d). Manousis *et al.*, 2018

Cerithiopsis pulchresculpta Cachia, Mifsud & Sammut, 2004 (Fig. 4e, f). 1 fresh shell (Fig. 4e) was collected from mixed bottom material from 80 m depth, brought to the surface by small gear fishing nets, from West Saronic Gulf (37°52'N – 23°13'E). This is a G2 after its initial finding also from the Central Saronic Gulf (Manousis *et al.*, 2021, Fig. 4f).

Cerithiopsis pulvis (Issel, 1869) (Fig. 5a). Manousis *et al.*, 2018; Mbazios *et al.*, 2020; Crocetta *et al.*, 2021.

Cerithiopsis scalaris Locard, 1891 (Fig. 5b-d). Manousis *et al.*, 2018

Cerithiopsis tarruellasi Peñas & Rolán, 2006 (Fig. 5e). A fresh shell was collected from mixed bottom material at 80 m depth, brought to the surface by small gear fishing nets, from West Saronic Gulf (37°52'N – 23°13'E). The small shell is solid, conical-pupoid, of light chestnut-brown background colour and with darker the protoconch, spiral cords and base. Protoconch sub cylindrical, with some 4 convex whorls, the first densely and in loose lines granulose, and the remaining also granulose with numerous prosocline axial riblets, attenuating by the subsutural area and some 8-9 thin spiral lines narrower than the riblets. Axial riblets and spiral lines endow the protoconch with a cancellated appearance. Its maximum diameter is about 300 µm and its height about 440 µm. The teleoconch consists of some 7 slightly convex whorls and a deep suture. Its spiral sculpture is formed by three cords, the first of which is obsolete until the fourth whorl while the axial sculpture is formed by some 17 axial ribs on the body whorl, that form round pearls in their crosses with the spiral cords. Interspaces show thin and dense incremental scars. On the periphery of the body whorl a fourth spiral cord appears which is smooth at first but getting granular by its final section. Base concave and smooth, siphonal canal short and wide. A second also fresh shell was collected from Maerl bed material at 40-100 m depth, brought to the surface by small gear fishing nets, from Paleochora, Crete (35°11'N – 23°38'E). Only known for the last 16 years from the Alboran Sea (Peñas *et al.*, 2006) is now G1 and MS2.

Cerithiopsis tenthrenois (Melvill, 1896). Crocetta *et al.*, 2017

Cerithiopsis tubercularis (Montagu, 1803) (Fig. 6a, b). Manousis *et al.*, 2018

Genus ***Costulopsis*** Cecalupo & Robba, 2019

Costulopsis buzzurroi (Cecalupo & Robba, 2010) (Fig. 6c). Manousis *et al.*, 2018

Costulopsis denticulata (Cecalupo & Robba, 2010) (Fig. 6d, e). Manousis *et al.*, 2018

Costulopsis nana Jeffreys, 1867 (Fig. 7a). Manousis *et al.*, 2018

Genus ***Dizoniopsis*** Sacco, 1895

Dizoniopsis concatenata (Conti, 1864) (Fig. 7b-d). Manousis & Galinou-Mitsoudi, 2014

Dizoniopsis coppolae (Aradas, 1870) (Fig. 7e-h). Manousis, 2021a. The leucistic shell was collected from trawled MB bottom material, at 90 m, Elasa, Crete, 35°12'N – 26°19'E.

Genus ***Horologica*** Laseron, 1956

Horologica sp. (Fig. 8a). Manousis *et al.*, 2018

Genus ***Krachia*** Bałuk, 1975

Krachia cylindrata (Jeffreys, 1885) (Fig. 8b). Mbazios *et al.*, 2020

Krachia tiara (Monterosato, 1874) (Fig. 8c). Manousis *et al.*, 2018

Genus ***Krachiopsis*** Smriglio & Mariottini, 1999

Krachiopsis giannuzzii Smriglio & Mariottini, 1999 (Fig. 8d, e). Mbazios *et al.*, 2020

Genus ***Seila*** A. Adams, 1861

Seila trilineata (Philippi, 1836) (Fig. 8f, g). Manousis, 2021a

Discussion

The present faunistic work includes collection results of the period from 2008 to September 2022 and is part of the ongoing study on the marine malacofauna of the entire Hellenic territory. It incorporates 31 species out of which two are new *Cerithiopsis* records for the Eastern Mediterranean basin and one for the whole Mediterranean Sea except the Island of Alboran. Due to its faunistic character, the work does not aim at addressing the spectrum of issues on the taxonomy of the cerithiopsids, we feel, though, that we have to address certain issues related to the locality, protoconch and teleoconch as they spring up in the course of our studies.

i. The issue of local biodiversity

Until a decade ago, the listed biodiversity of the cerithiopsids in the Hellenic waters numbered 2 genera, namely those of *Cerithiopsis* and *Dizoniopsis*, with 4 species, those of *C. barleii*, *C. minima*, *C. tubercularis* and *D. coppolae* (Koukouras, 2010). In this work the corresponding genera are 7 and the species 31. We consider this outcome as expected taking into account the undisrupted for millennia common spatiotemporal biogeographical entity of the Mediterranean Sea in combination with the particular collection effort expended. This approach is also valid for rare species like *C. nofronii* (Fig. 4a) or *Krachiopsis giannuzzii* (Fig. 8d, e), and also for species that were considered rather endemic like *C. tarruellasi* (Fig. 5e). Especially for the latter species which is collected from two different and distant from each other areas - and taking into account its planktotrophic larval development - we are of the opinion that it is actually more widely spread and it was only a matter of time before the species was collected from other areas. Provided that the effort will go on, we anticipate the finding in the Hellenic waters, at least, all the rest of the already reported genera from other individual Mediterranean regions by researchers abroad. For that latter ambition, the species concept used for taxonomic work and the informative characters delimiting species taxa comprise decisive tools.

ii. Decoration of protoconch

Cerithiopsid species with beaded spiral cords on the teleoconch and a smooth to punctuate protoconch are rather easily

assigned to genera as those of *Cerithiopsis* Forbes & Hanley, 1850 with a planktotrophic protoconch of 3-6 smooth whorls, numerous teleoconch whorls and not constricted base; *Joculator* Hedley, 1909 with small to very small bulbous or ovate teleoconch, constricted base, 3 beaded spiral cords from the earliest whorls of the teleoconch, and an elevated smooth or punctuate protoconch; *Horologica* Laseron, 1956 with ovate teleoconch, constricted base, a smooth protoconch, but only 2 beaded spiral cords on the teleoconch whorls (Jay & Drivas, 2002). Yet, *Cerithiopsis atalaya* (Fig. 1b), *C. barleei* (Fig. 1c), *C. diadema* (Fig. 1e), *C. fayalensis* (Fig. 1f), *C. iudithae* (Fig. 1g), *C. micalii* (Fig. 3a, b), *C. pulchresculpta* (Fig. 4e, f), *C. scalaris* (Fig. 5b-d) and *C. taruellasi* (Fig. 5e) with highly and miscellaneous decorated protoconches are assigned to the same genus as *C. jeffreysi* (Fig. 1h) or *C. tubercularis* (Fig. 6a, b) which have a smooth protoconch. This, at first sight, incompatibility could be easily accepted if we prioritize morphological characters and put the shell shape and number of beaded cords first and the protoconch decoration second. This latter acceptance would also ease our concern for cases when the same teleoconch morphology and presumably same assignment to a taxon is accompanied by two different sculptural forms of the protoconch as is the case of *C. ladae* which is either ribbed (Fig. a, b) or smooth (Fig. 2c) (Romani & Bartolini, 2014, this work Fig. 2a-c). At the same time, very similar in their teleoconch morphology species such as *C. greppii* Buzzurro & Cicalupo, 2005 and *C. ladae* “appear similar, but they differ noticeably in the protoconch shape” (Prkić & Buzzurro, 2007). This latter acceptance together with cases like *Krachia cylindrata* (Fig. 8b) and *K. tiara* (Fig. 8c) with minor differences in their teleoconch sculpture and number of whorls (Giannuzzi-Savelli et al., 1999; Gofas et al., 2011; this work Fig. 8b and 8c, respectively) leave a feeling of taxonomical inconsistency.

iii. Variability of protoconch characters

In continuation with the above, it is commonly accepted among taxonomists that planktotrophic protoconches tend to have a relatively smaller protoconch I (embryonic shell) and a multispiral conical or cylindrical protoconch II (larval shell), while lecithotrophic ones larger and bulbous protoconch I and an of limited growth protoconch II. The cases of *C. greppii* and *C. ladae* are reminiscent of a pair of sibling species differing mainly in the type and size of their protoconches, a phenomenon present also in some Mediterranean members of the genus *Raphitoma*. This phenomenon was recently approached statically on published data and the outcome implied poecilogony (Manousis et al., 2017). In the case of *Raphitoma* the notion of poecilogony was soon approached by the employment of DNA markers analysis and, though still inconclusively, the results pointed out that poecilogony must be the case (Russini et al., 2020). Correspondingly, *C. greppii* bears a protoconch I of some 175 µm maximum diameter while that of *C. ladae* of some 145 µm (Prkić & Buzzurro, 2007), a figure very close to the expected 140 µm (according to Manousis et al., 2017). To make the case more interesting for investigation, the latter authors depict a *C. tenthrenois* (Melvill, 1896) multispiral apex with protoconch I of some 100 µm which is also close to the expected 110 µm, if “sequential poecilogony” (according to Manousis et al., 2017) takes place and the three different species are potentially one and the same. The situation would be poorly described without the

addition of *Cerithiopsis* sp. (Fig. 2d) with the partially covered paucispiral protoconch of size very close to that of *C. greppii* (in Prkić & Buzzurro, 2007). Similarly, *Seila trilineata* exhibits a protoconch size and number of whorls variability (Fig. 8f, g). As far as the protoconch colour is concerned, this generally predisposes to the color of the teleoconch, but there are exceptions as in the case of *Dizoniopsis concatenata* in which the protoconch can be of a variety of shades of chestnut-brown to snow-white in dark chestnut-brown live individuals (Fig. 7d), or also of *C. ladae* (Fig. 2a-c)

iv. Protoconch-teleoconch transition

The sequence of appearance of each of the teleoconch spiral cords in cerithiopsids is a commonly accepted discriminating character and is currently also employed on new Mediterranean findings for assignment in a genus level taxon (e.g. Albano et al., 2021). In instances, that number is not readily observable because the last protoconch whorl is partially covered by the first teleoconch whorl as in the case of the recently described *Joculator problematicus* Albano & Steger, 2021 (Albano et al., 2021). The authors have also used that very character as a discriminating one between *J. problematicus* and *C. ladae* (Albano et al., 2021). As seen on the transition area between protoconch and teleoconch of our two *C. ladae* shells in Fig. 2a, 1, 2, 3, and 2b, 1, 2, 3 there are 3 evident initial teleoconch spiral cords, while in the third shell in Fig. 2c the lower third cord is not evident as the first teleoconch whorl partially covers the last whorl of the protoconch. The concern intensifies by the shell of *Cerithiopsis* sp. (Fig. 2d) the protoconch of which is partially embedded in the first teleoconch whorl. To our opinion, the case could represent interspecific diversity in *C. ladae* and once again recalls the issue of the morphospecies that is it is often difficult to decide exactly where a species begins and ends. Apparently, dealing with fresh benthic material and live specimens would facilitate a possible clarification by means of molecular marker analysis.

v. Variability of teleoconch characters

Species of some abundance offer the opportunity to observe possible variability of teleoconch characters at maturity as in the case of *Cerithiopsis ladae* (Fig. 2a-c), *C. micalii* (Fig. 3a, b), *C. minima* (Fig. 3c-g), *C. oculisfictis* (Fig. 4b, c), *C. pulchresculpta* (Fig. 4e, f), *C. scalaris* (Fig. 5b-d), *C. tubercularis* (Fig. 6a, b), *Dizoniopsis concatenata* (Fig. 7b, c) or *D. coppolae* (Fig. 7d-g) which come in divergent contours, number of whorls and size at maturity. Something similar holds for the variable size and shape of the knobs on the spiral cords as seen in all the above cases. It is commonly accepted from old and new collections that the cerithiopsid shells turn paler with the time and certain transparent parts, such as protoconches, tend to become opaque or white and certain colorations colourless (e.g. Prkić & Buzzurro, 2007). Before that, live specimens and fresh shells of the same species appear in a variety of shades of brown as in the cases of *C. ladae* (Fig. 2a-c), *C. minima* (Fig. 3c-g), *C. oculisfictis* (Fig. 4b, c), *C. pulchresculpta* (Fig. 4e, f), *C. scalaris* (Fig. 5b-d), *C. tubercularis* (Fig. 6a, b), *Costulopsis denticulata* (Fig. d, e), *Dizoniopsis concatenata* (Fig. 7b, c) or *D. coppolae* (Fig. 7d-g). All cases point out to that, strictly speaking, the colour by itself cannot be trusted as a discriminating character among members of the family. This is especially noticeable in the case of a white shell of *Dizoniopsis coppolae* (Fig. 7g) that is

identical to the rest of *D. coppolae* (Fig. 7d-f) shells, apart from its colour. Considering the high resemblance in the morphology of both protoconch and teleoconch someone cannot help but considering leucism in the family of Cerithiopsidae. In this case, molecular analysis could further clarify the issue provided that adequate live specimens are available. As some of the above mentioned species are rather uncommon, extensive mutual cooperation of different research groups would be of paramount importance.

In conclusion, along the Cerithiopsidae taxonomy we encountered the following intractable issues: Specimens of the same number of whorls, size and decoration of protoconch with different teleoconch identified as different species; Specimens of different characters of protoconch with similar teleoconch identified as different species.

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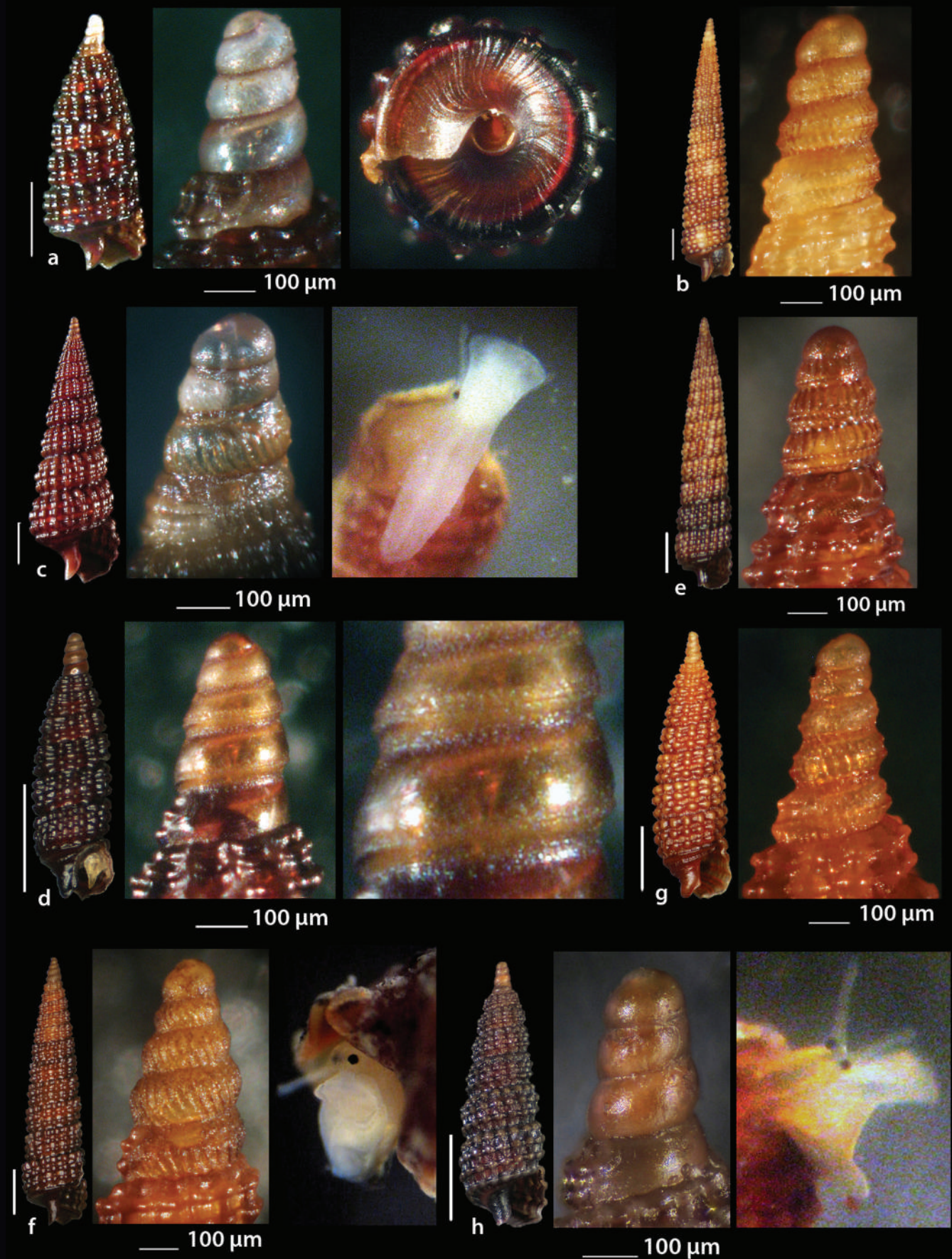


Figure 1: a. *Cerithiopsis annae* Cecalupo & Buzzurro, 2005; b. *Cerithiopsis atalaya* R. B. Watson, 1885; c. *Cerithiopsis barleei* Jeffreys, 1867; d. *Cerithiopsis carlottae* Cecalupo & Perugia, 2018; e. *Cerithiopsis diadema* Monterosato, 1874; f. *Cerithiopsis fayalensis* R. B. Watson 1880; g. *Cerithiopsis iudithae* Reitano & Buzzurro, 2006; h. *Cerithiopsis jeffreysi* R. B. Watson, 1885. Barr = 1 mm, unless otherwise indicated.

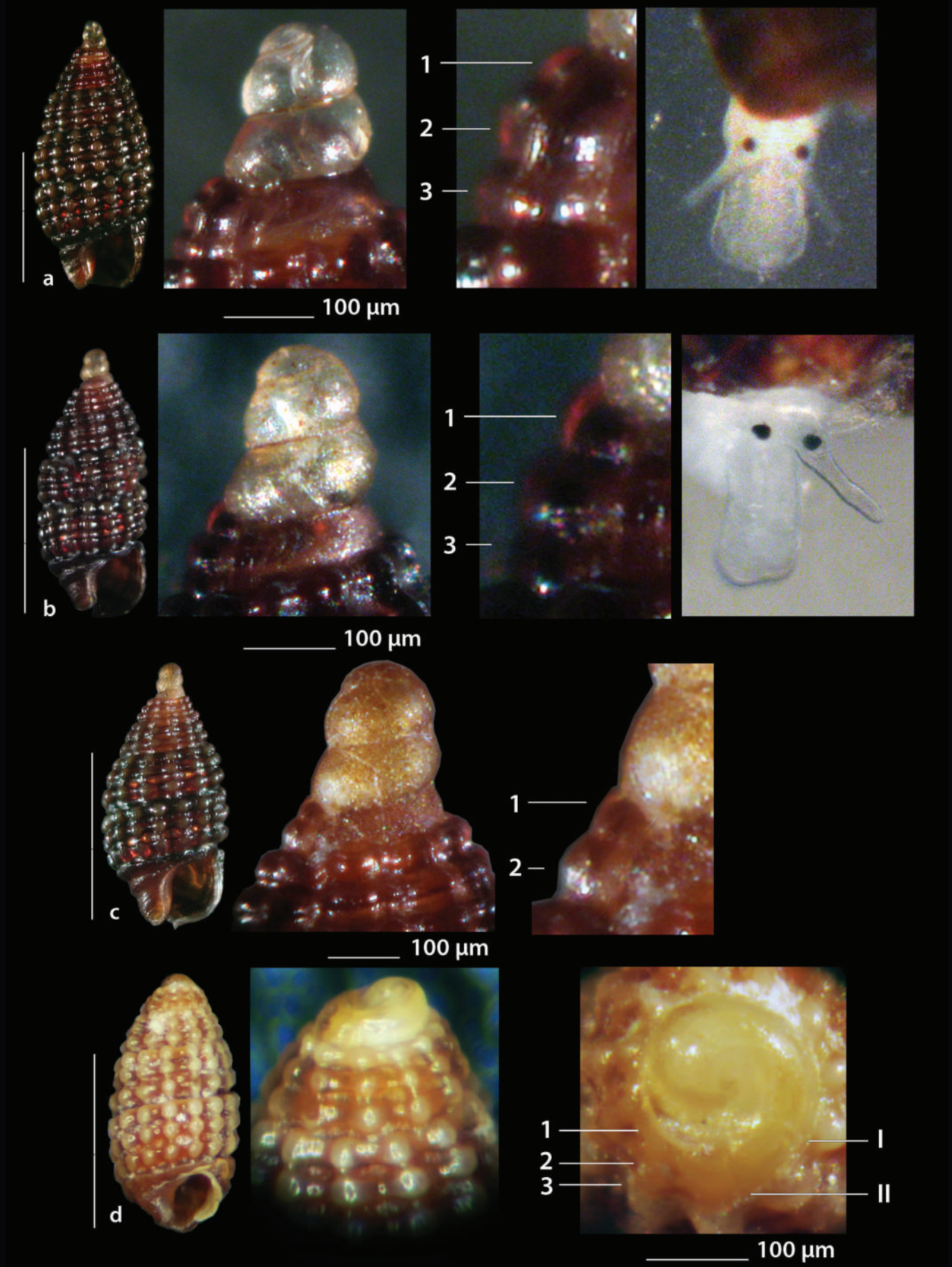


Figure 2: a, b, c. *Cerithiopsis ladae* Prkic & Buzzurro, 2007; d. *Cerithiopsis* sp..
Barr = 1 mm, unless otherwise indicated.

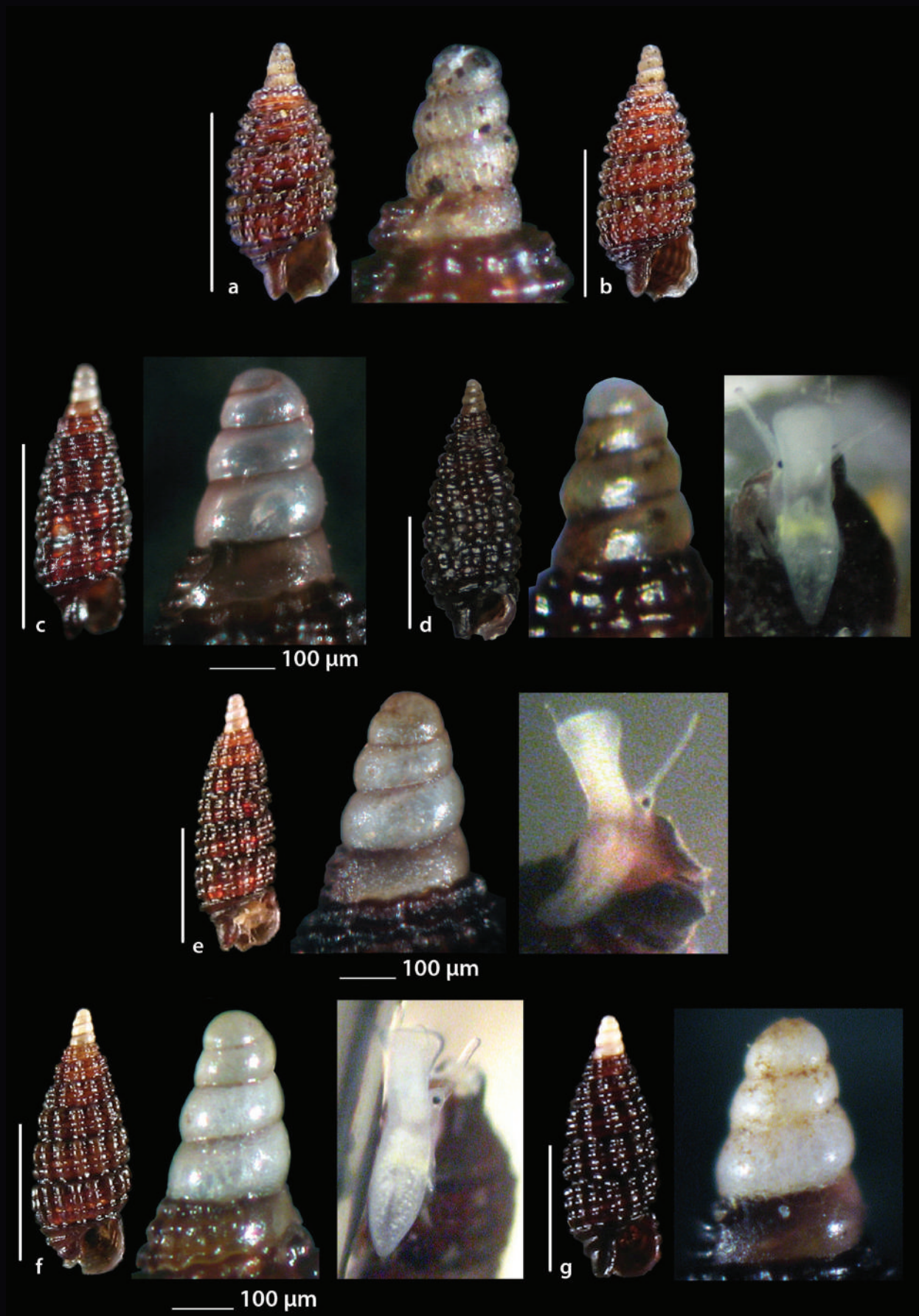


Figure 3: a, b. *Cerithiopsis micalii* (Cecalupo & Villari, 1997); c-g. *Cerithiopsis minima* (Brusina, 1865). Barr = 1 mm, unless otherwise indicated.

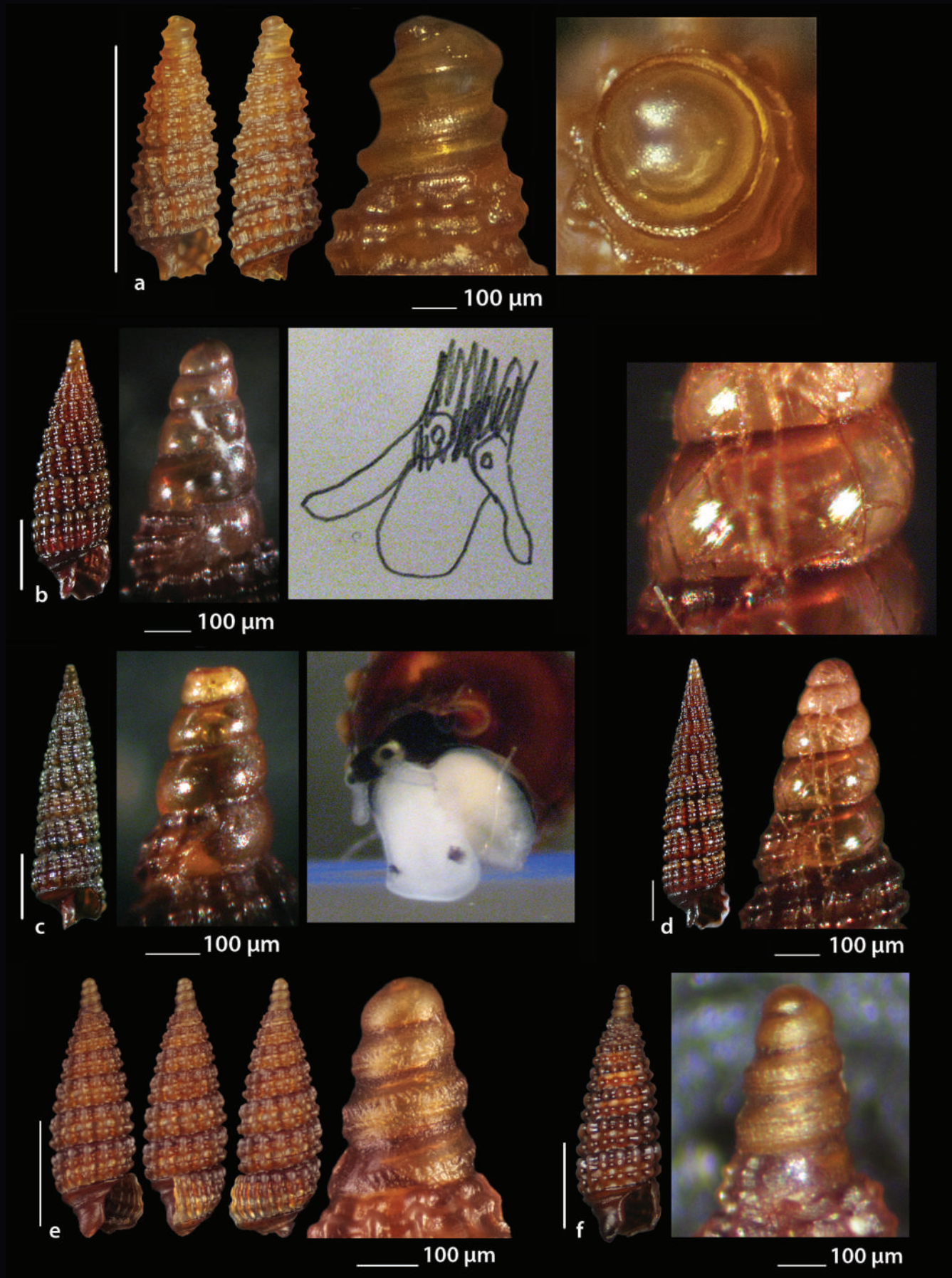


Figure 4: a. *Cerithiopsis nofronii* Amati, 1987; b, c. *Cerithiopsis oculisfictis* Prkic & Mariottini, 2010 and “emergency” drawing of animal; d. *Cerithiopsis petanii* Prkic & Mariottini, 2010; e, f. *Cerithiopsis pulchresculpta* Cachia, Mifsud & Sammut, 2004. Barr = 1 mm, unless otherwise indicated.

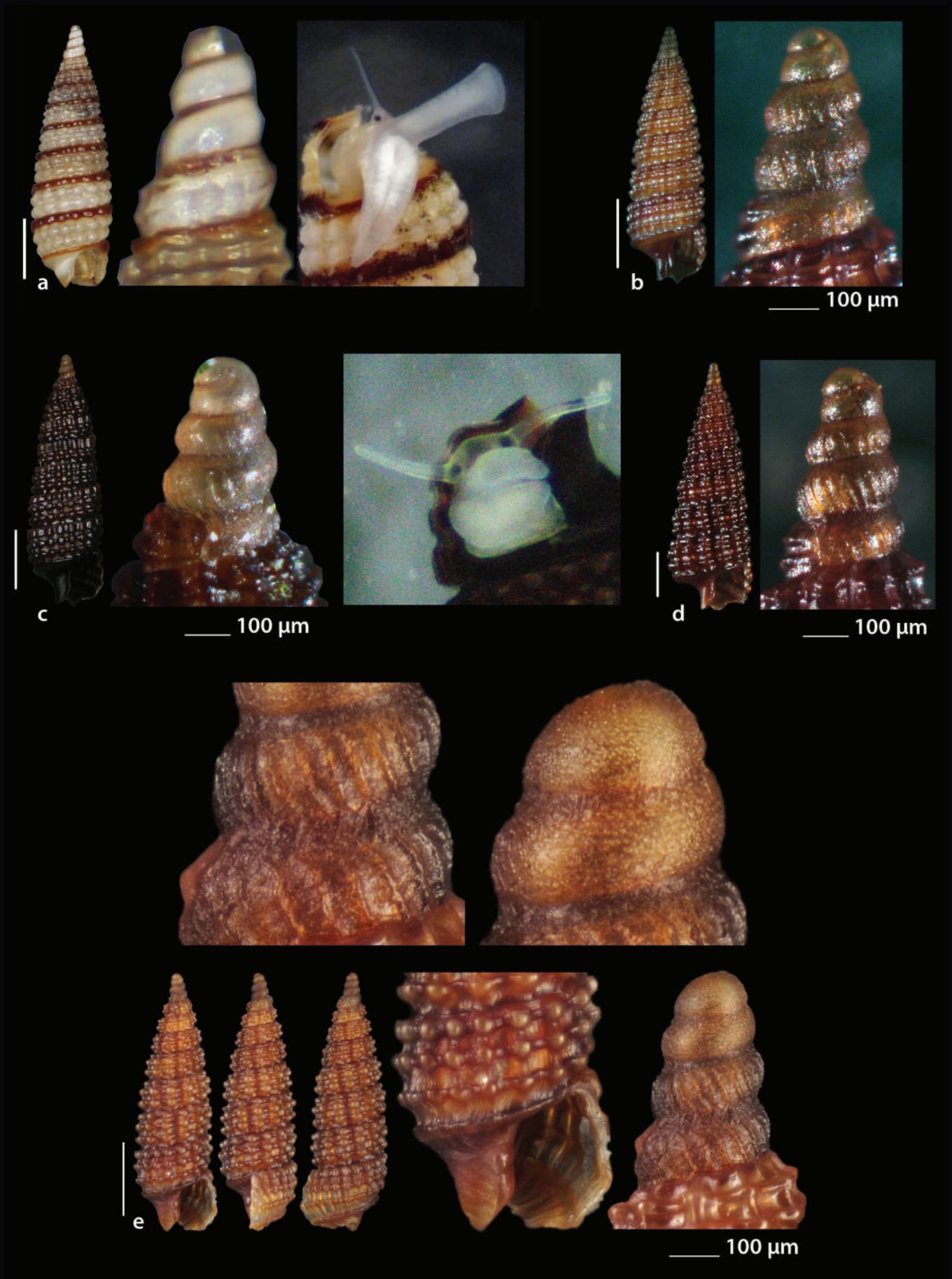


Figure 5: a. *Cerithiopsis pulvis* (Issel, 1869); b-d. *Cerithiopsis scalaris* Locard, 1891; e. *Cerithiopsis tarruellasi* Peñas & Rolán, 2006. Barr = 1 mm, unless otherwise indicated.

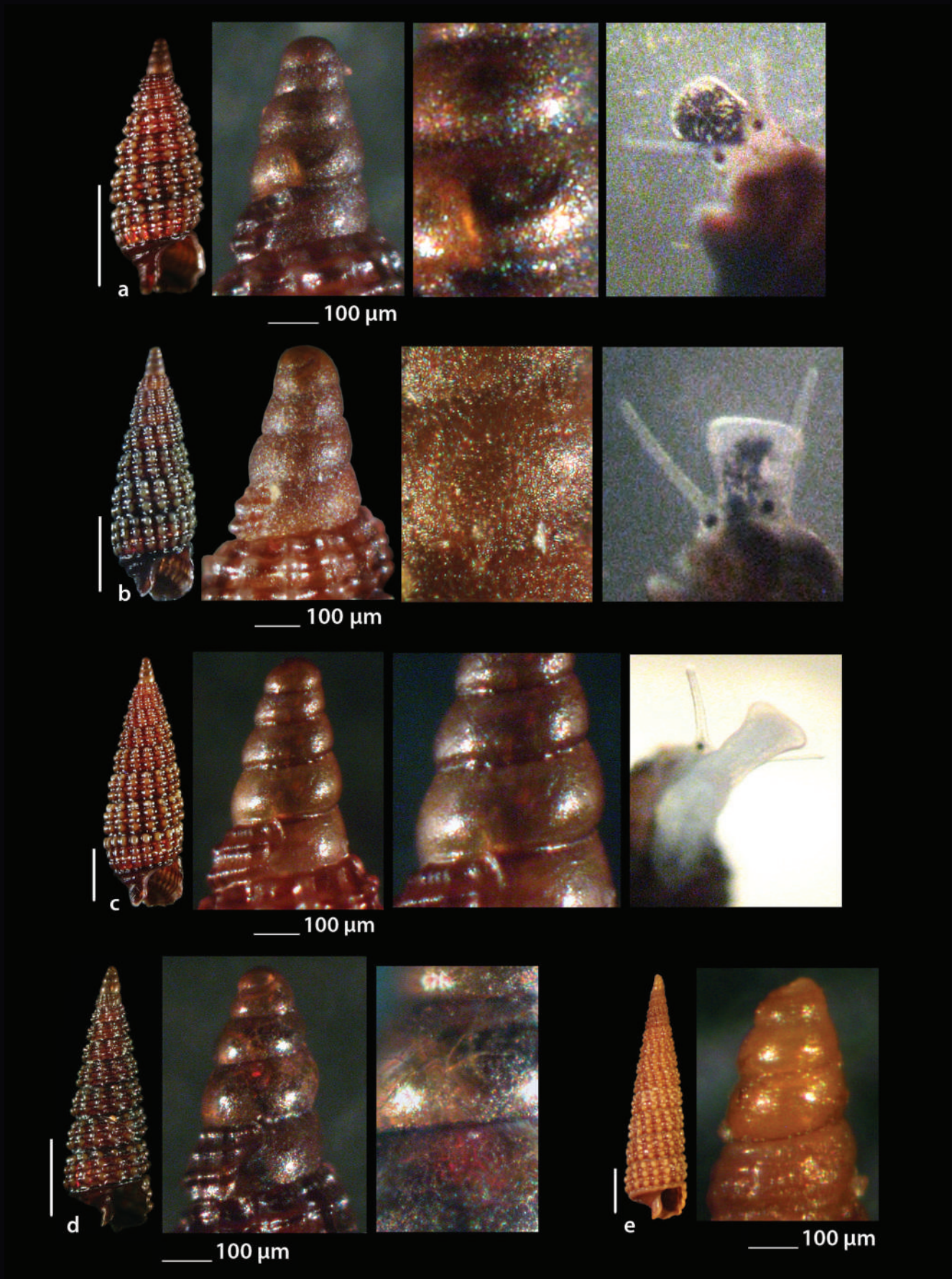


Figure 6: a, b. *Cerithiopsis tubercularis* (Montagu, 1803); c. *Costulopsis buzzurroi* (Cecalupo & Robba, 2010); d, e. *Costulopsis denticulata* (Cecalupo & Robba, 2010). Barr = 1 mm, unless otherwise indicated.

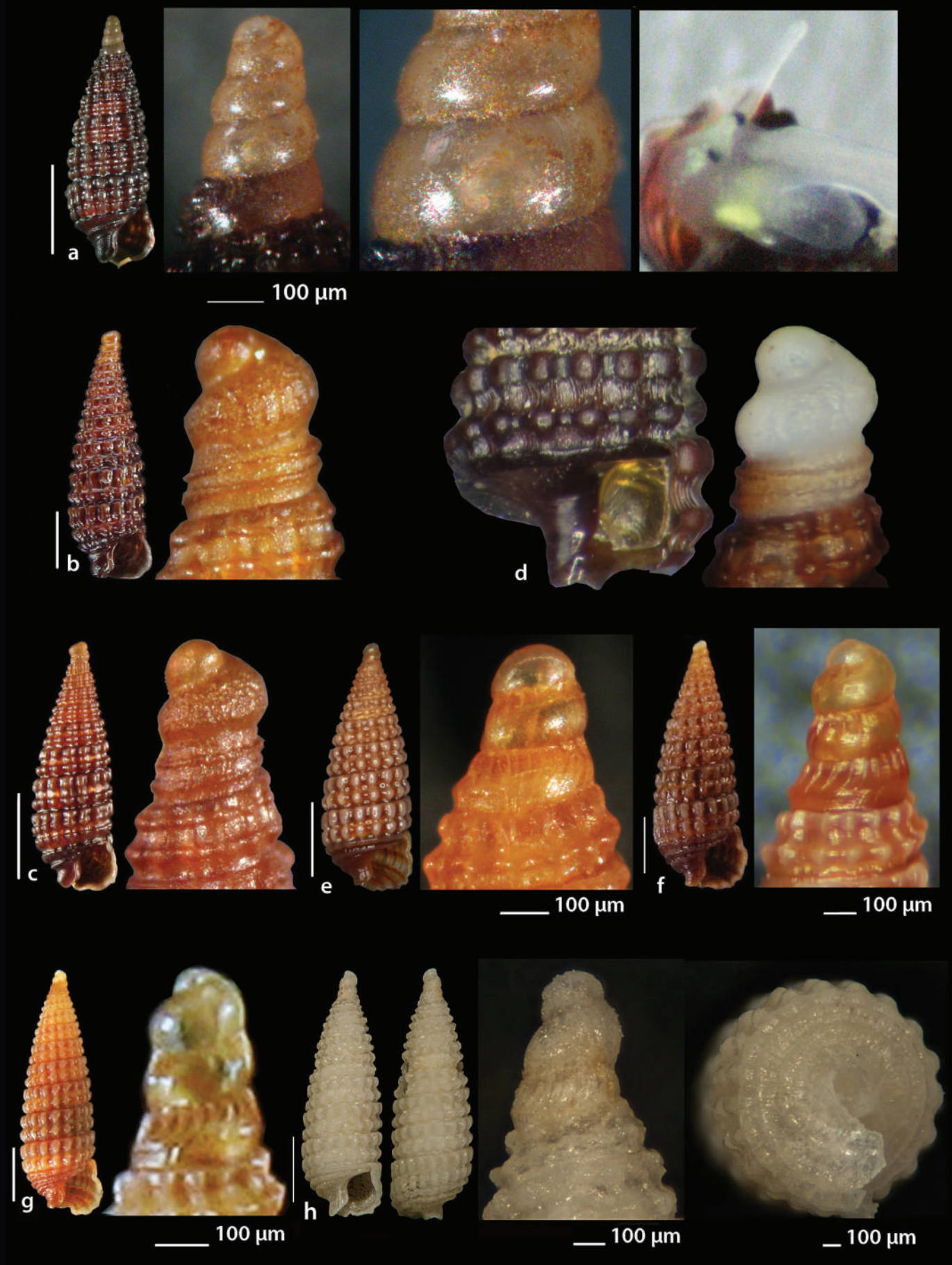


Figure 7: a. *Costulopsis nana* Jeffreys, 1867; b-d. *Dizoniopsis concatenata* (Conti, 1864); e-g; *Dizoniopsis coppolae* (Aradas, 1870); h. *D. coppolae* (Aradas, 1870) leucistic form. Barr = 1 mm, unless otherwise indicated.

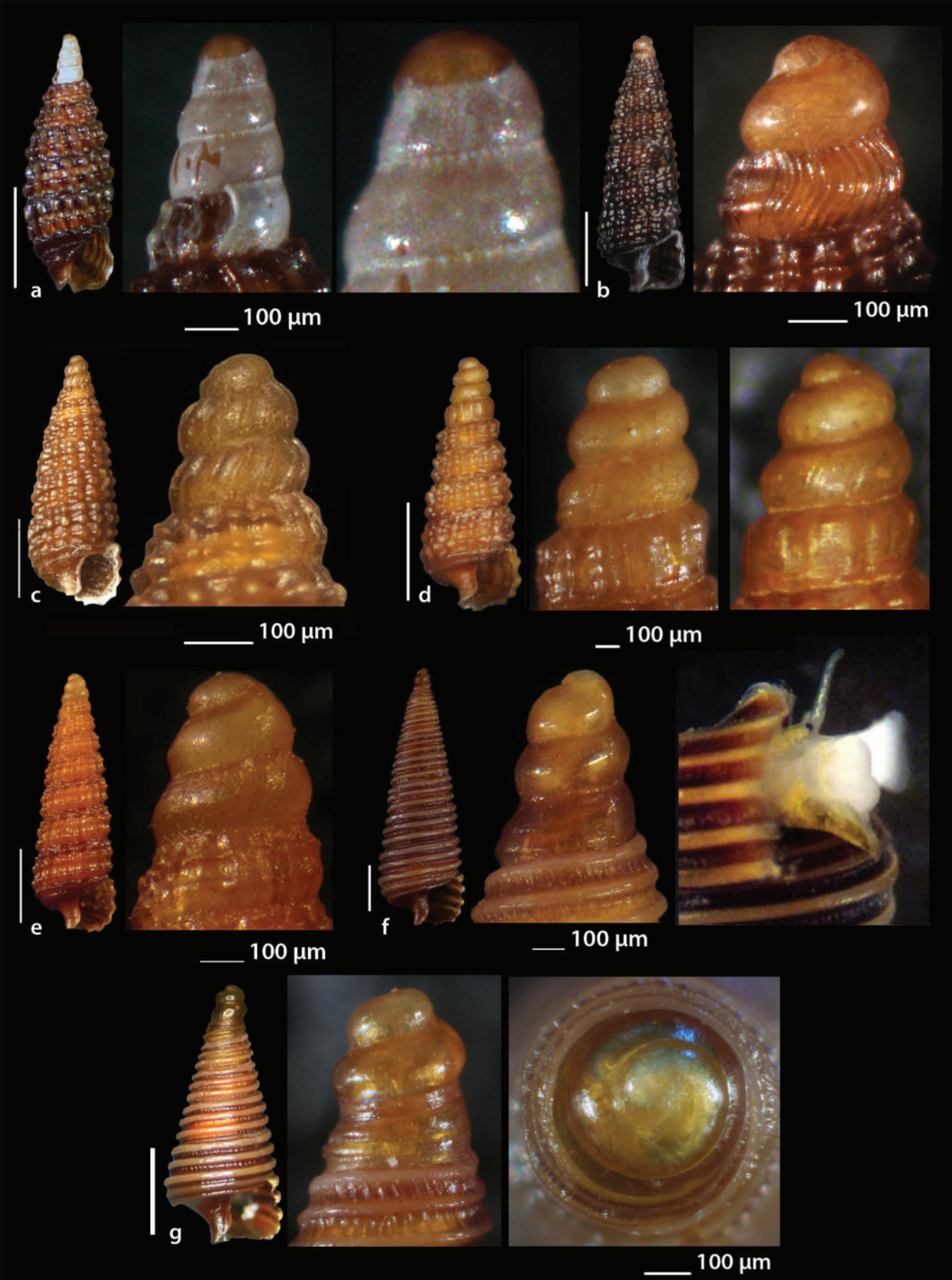


Figure 8: a. *Horologica* sp.; b. *Krachia cylindrata* (Jeffreys, 1885); c. *Krachia tiara* (Monterosato, 1874); d, e. *Krachiopsis giannuzzii* Smriglio & Mariottini, 1999; f, g. *Seila trilineata* (Philippi, 1836). Barr = 1 mm, unless otherwise indicated.

Study of predation by *Euspira catena* (Gastropoda, Naticidae) on the sand beach of Pen Bron, La Turballe, Loire Atlantique.

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Introduction

The purpose of this work is to study the predation by *Euspira catena* on Pen Bron Beach (La Turballe, Loire Atlantique, France).

We show that the species *E. catena* is responsible for observed predation. We list the principal consumed preys. We show that typical characteristics of Naticidae predation are present. We finally highlight that borehole site selectivity may be linked with shell thickness of the prey.

Summary

This study concerns *Euspira catena* predation. It shows that this predator consumes various preys but has preferences for some of them. Therefore *E. catena* is able to choose its preys. Exploitation of results on the overall data and on the three most common bivalves on the beach (*Cerastoderma edule*, *Donax* sp et *Spisula* sp) shows that characteristics of predation may depend on predator size and prey size. This work has been supplemented by study of prey shell thickness, this allowed to show relationship between this parameter and some selectivity characters (prey choice and bored area choice). Predatory behaviour of *E. catena* reveals typical characteristics of the Naticidae family, ensuring maximization of energy efficiency of predation.

Résumé

Cette étude porte sur la prédation d'*Euspira catena*. Elle montre que ce prédateur consomme des espèces variées mais a des préférences pour certaines d'entre elles. Donc *E. catena* est capable de sélectionner ses proies. L'exploitation des résultats sur l'ensemble des récoltes et sur les trois bivalves les plus fréquents sur la plage (*Cerastoderma edule*, *Donax* sp. et *Spisula* sp.) a permis de montrer que les caractéristiques de la prédation peuvent dépendre de la taille du prédateur et de celle de la proie. Ce travail a été complété par l'étude de l'épaisseur des coquilles, cela a permis de montrer des liens entre ce paramètre et certains caractères sélectifs de cette prédation (choix de la proie et choix de la zone percée). Le comportement prédateur de l'espèce montre des caractéristiques typiques de celles observées habituellement pour la famille des Naticidae, assurant une maximisation du rendement énergétique de la prédation.

Method

Collection

During the study, we observed no predation on the surface of sediment or near the shoreline. We have, therefore, used empty shells collected on the beach. Samples have been taken according to the following protocol : Shells have been collected in July 2020 and August 2021, extended over several days, at different times and different tidal heights. All shells over about 5 mm have been collected (except for broken or badly worn shells) on a limited area (Figure 1), from the top of the beach to the shoreline.



Figure 1a : Pen Bron beach left side

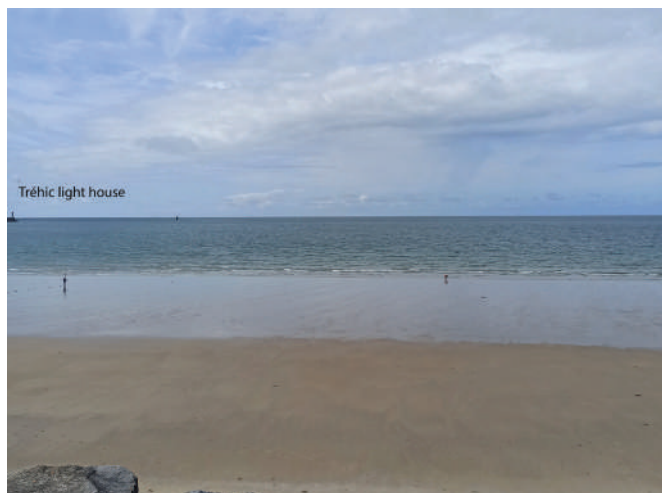


Figure 1b : Pen Bron beach right side

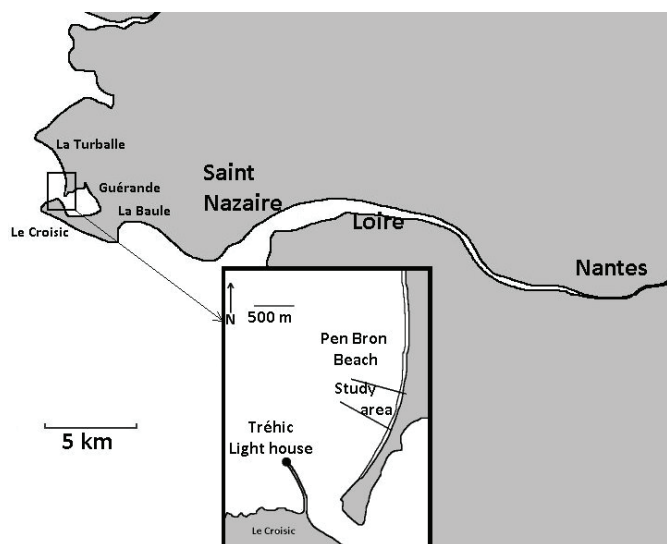


Figure 1c : Map of the study area

The several collections have provided nearly 3400 empty shells. 3359 belong to 13 genus (11 bivalvia and 2 gastropoda) for which the number of specimens exceeds 30.

Genus / species	Valves / Shells	Genus / species	Valves / Shells
<i>Cerastoderma edule</i> (Linnaeus, 1758)	874	<i>Macra sutorum</i> Linnaeus, 1758	43
<i>Donax</i> sp. (<i>Donax vittatus</i> + <i>Donax trunculus</i>)	740	<i>Crepidula fornicata</i> (Linnaeus, 1758)	38
<i>Spisula</i> sp. Mainly <i>Spisula solida</i> (Linnaeus, 1758)	617	<i>Euspira catena</i> (da Costa, 1778)	37
<i>Mytilus edulis</i> Linnaeus, 1758	413	<i>Acanthocardia</i> sp.	37
<i>Macomangulus tenuis</i> (da Costa, 1778)	364	<i>Venerupis</i> sp.	34
<i>Pharus legumen</i> (Linnaeus, 1758)	75	<i>Donacilla cornea</i> (Poli, 1791)	33
<i>Ensis</i> sp.	54	Other various species	about 41

Table 1 : Main species found on the beach

Measurements

For 3 preys : *Spisula* sp., *Cerastoderma edule* and *Donax* sp. a grid pattern has been created. It allows the location of boreholes and thickness measurements.

<i>Spisula</i> sp. Mainly <i>Spisula solida</i> Linnaeus, 1758	<i>Cerastoderma edule</i> (Linnaeus, 1758)	<i>Donax</i> sp. <i>Donax vittatus</i> (Da Costa, 1778) <i>Donax trunculus</i> Linnaeus, 1758
By convention, results are displayed on a diagram of left valve. Red dots are measuring points of thickness. Some measures have not been possible considering geometry of the area. Each area is identified : U : umbo (included in B1 for <i>Spisula</i> and <i>Donax</i>). A : anterior area. C or D : posterior area. E : edge.		

Table 2 : Reference grid for the 3 dominant preys

Shells have been measured then arranged by batches of increasing sizes (5 mm pitch). Each perforation has been located. Maximum thickness of successful drilling have been measured for each prey. Outer border diameter (OBD) and inner border diameter (IBD) have been measured with binocular magnifier. For incomplete boreholes, thickness has been measured around the hole.

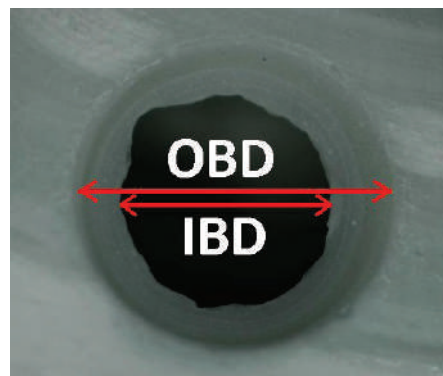


Figure 2 : Inner and outer borders of borehole

For *Spisula* sp., *Donax* sp. and *Cerastoderma edule*, samples have been selected (five non bored specimens for each size class).

Thickness has been measured in each location (cf. table 2). Average thickness was then calculated.

Representativity of the data

Chattopadhyay *et al.* (2013) proposed a way to check if a sample of valves has been transported (therefore modified). In that case, as the umbo-drilled shells have a lower speed threshold, they will be more represented in the sample than non-perforated ones, there will therefore be a distribution with a larger size interval for the umbo perforated than for the non-perforated.

Predation produces the opposite signal since predators have a preference for certain sizes of prey. In this case there will therefore have a distribution with a larger size interval for the non-perforated than for the umbo perforated.

By comparing size distribution of bored and non-perforated (for all preys) we find that distribution of bored shells never has a larger size interval than for the non-perforated ones. It could therefore be assumed that there was no current transportation. Sampling have been done at different times and different tidal heights, for two consecutive years, to minimize a current transportation bias. Finally, the absence of transportation is supported by the presence of numerous non-disarticulated bivalve shells.

Thus it is concluded that shells assemblages are representative of the impact of the predator.

Predator identification

The only Naticidae shells found on the beach belong to the species *E. catena*. A few living specimen were observed (Figure 4).

Boreholes have the characteristic parabolic shape of Naticidae perforations (Figure 2). Grey *et al.* (2005) showed that for the species *Euspira heros*, OBD/IBD ratio is statistically different from those of *Neverita duplicata* and *Neverita lewisii* (however this ratio was not significantly different for *N. duplicata* and *N. lewisii*). Dietl & Kelley (2006) showed that OBD/IBD ratio of *E. heros* was significantly higher than OBD/IBD ratio of *N. duplicata*. Regression lines were different, even though the authors showed that it was not a significant difference.

In our study (Figure 3) the good correlation between the two measurements for the 3 preys is compatible with a single predator.

Size intervals observed for IBD and OBD are explained by different sizes of *E. catena* (Figure 4a).

We can thus conclude that *E. catena* is really the only Naticid predator on Pen Bron beach.

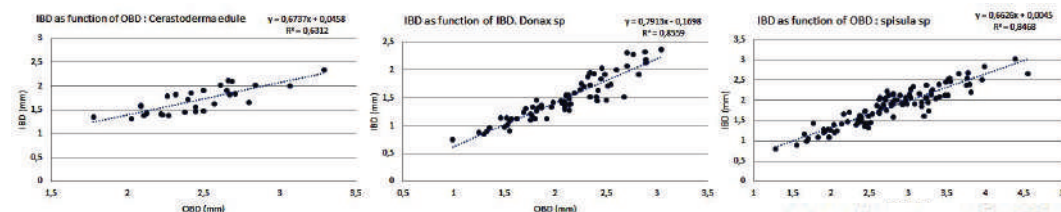


Figure 3 : measurements of IBD and OBD for *C. edule*, *Donax sp.* and *Spisula sp.*

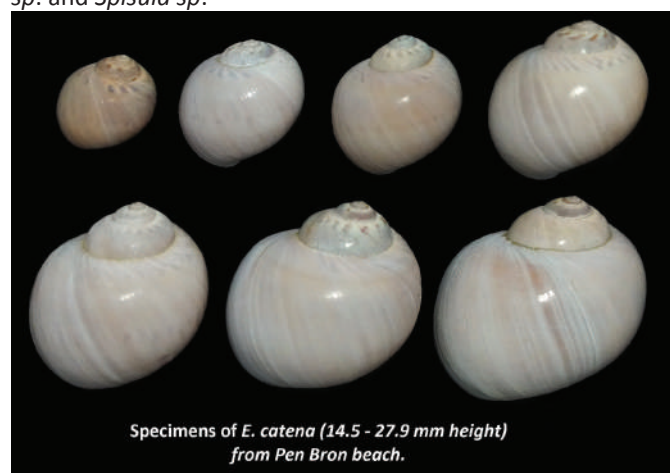


Figure 4a : *E. catena* from Pen Bron beach



Figure 4b : Living *E. catena* from Pen Bron beach

Results

List of the preys of *E. catena*

Table 3 : drilled species and predation intensity

Genus / species	Valves	Bored valves	DF (%)	R (%)	Genus / species	Valves	Bored valves	DF (%)	R (%)
<i>Cerastoderma edule</i>	874	30	3.4	6.9	<i>Pharus legumen</i>	75	4	5.3	0.9
<i>Donax sp</i>	740	195	26.4	44.7	<i>Macra sultorum</i>	43	3	7	0.7
<i>Spisula sp</i>	617	114	18.5	26.1	<i>Acanthocardia sp</i>	37	7	18.9	1.6
<i>Mytilus edulis</i> *	413	3	0.7	0.7	<i>Venerupis sp</i>	34	1	2.9	0.2
<i>Macomangulus tenuis</i>	364	77	21.2	17.7	<i>Donacilla cornea</i>	33	2	6.1	0.5

DF : drilling frequency : ratio bored valves for the species / total valves collected for the species

R : Ratio bored valves for the considered species / total bored

valves for all species

* It should be noted that many valves of *Mytilus* were bored, but almost all perforations were made by Muricidae predator (with typical cylindric shape of borehole). Only 3 specimens have been drilled by *E. catena*. It can also be noted the absence of any confamilial predation.

Distribution of collected valves

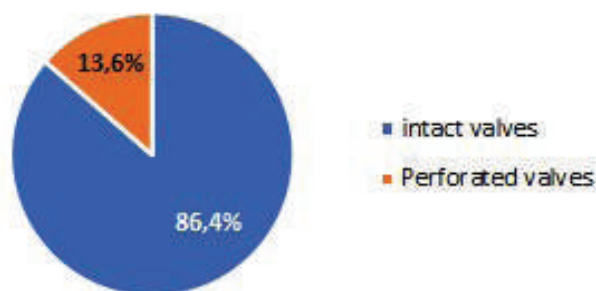


Figure 5 : Status of collected Shells for the 10 preys of *E. catena*

Counting of valves for the 4 main preys

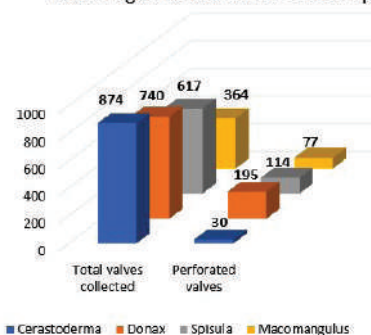


Figure 6 : Intensity of predation by *E. catena* for its 4 main preys

There is a rather substantial proportion (13.6%) of bored shells for the ten preys studied (Figure 5). *Cerastoderma edule*, *Donax sp.*, *Spisula sp.* and *Macomangulus tenuis* are the more hunted preys (Figure 6). These preys have shallow infaunal lifestyle (in the top few centimeters of the sediment), thus they are identically available to the predator. The most frequent prey on the beach (*C. edule*) is the less consumed of the four ($R = 6.9\%$ table 3). *Donax sp.* (second most frequent prey) is the most consumed ($R = 44.7\%$). Therefore prey selection not only depends on its abundance.



Figure 7 : Preys of *E. catena* on Pen Bron beach.

1 a *Acanthocardia* sp. specimens. (L 17 mm, 14.5 mm). **b** borehole. **2 a** *Cerastoderma edule* specimen (L 21.5 mm). **b** borehole. **3 a** *Macra sultorum* specimen (L 33 mm). **b** borehole. **4 a** *Venerupis* sp. specimen (L 16.5 mm). **b** borehole.

5 a *Donacilla cornea* specimens (L 21.5 mm, 26 mm). **b** borehole. **6 a** *Donax* sp. specimens (L 26 mm, 23.5 mm). **b** borehole. **7 a** *Mytilus edulis* specimen (L 21.5 mm). **b** borehole. **8 a** *Macomangulus tenuis* specimen (L 19 mm). **b** borehole. **9 a** *Pharus legumen* specimen (L 80.5 mm). **b** borehole. **10 a** *Spisula* sp. specimen (L 27 mm). **b** borehole.

Study of characteristics of predation by *Euspira catena* upon main preys

- Right or left valve selectivity

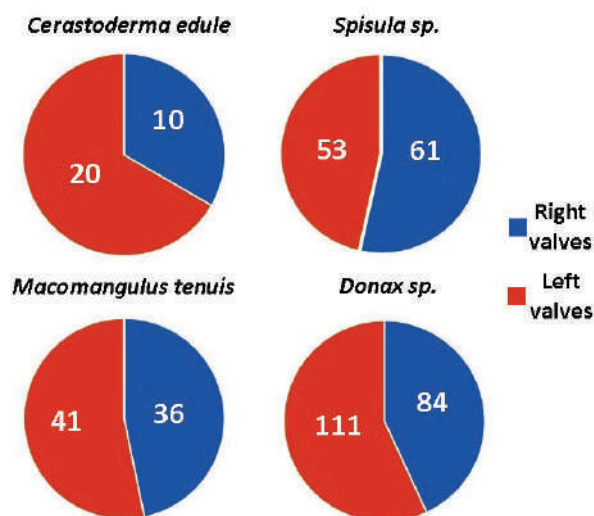


Figure 8 : distribution of bored valves (right or left) for the 4 main preys.

Chi-square test performed for each prey shows that there is no significant difference between these distributions and a random distribution (50% left valve, 50% right valve, with a significant level of 5%). Therefore *E. catena* does not favor right or left valve.

Furthermore, thickness measurements taken symmetrically on the 2 valves of the same specimens (*C. edule*, *Donax sp.* and *Spisula sp.*) have not shown significant differences.

For these reasons, we choose by convention, to represent our results on left valves figures.

- Prey size preference

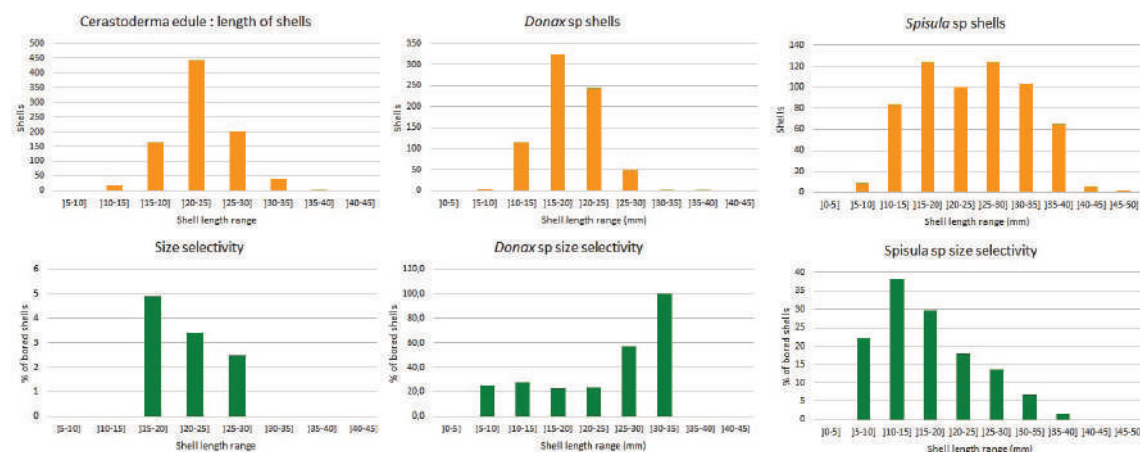


Figure 9 : Size distribution of collected shells (orange top graphs) and percentage of bored shells depending on shell size (green lower graphs) for *C. edule*, *Donax sp.* and *Spisula sp.*

For *Cerastoderma edule* (Figure 9) the most common shells are those of [20-25] mm. However their drilling frequency (DF) is only two-thirds of the DF for [15-20] mm shells, which are the most consumed. No shell is bored beyond 30 mm. This can be explained by a size that makes them inaccessible to *E. catena*

predation or by a too small sample, which does not allow to find bored shells beyond 30 mm. It can be concluded that there is a size preference for small *C. edule* [15-20 mm].

For *Donax sp* (figure 9) the most common shells are those of [15-25] mm, but only slightly more than 20% are bored versus 60 to 100% for greater sizes. There is thus a preference for large size *Donax* (>25 mm).

For *Spisula sp* (Figure 9) a large majority of shells have size ranging between 10 and 35 mm. Maximum drilling frequency is over 35% for shells between 10 and 15 mm length. The greater this length increase beyond 15 mm, the more DF decrease (1% for shells between 35 and 40 mm, 0% beyond). *E. catena* has thus a preference for rather small *Spisula*. Beyond 35 mm, cases of predation are exceptional.

Therefore, for each studied prey population, *Euspira catena* have a prey size preference. This preference is variable according to the prey species.

- link between prey size (*Donax sp.*) and the predator size :

IBD is the diameter of the proboscis of *E. catena* used to penetrate the prey shell to consume tissues. The higher the size of *E. catena* is, the higher is the diameter of the proboscis. We can thus search for a link between prey size and predator size by comparing the relation between IBD and the size of the prey.

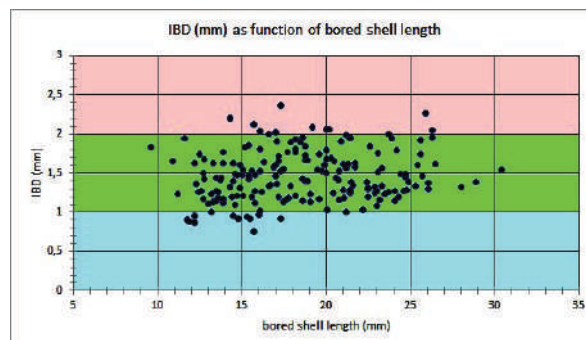


Figure 10 : measurements of IBD and bored prey length (*Donax sp*)

There is no strict relationship between predator and prey size. However when considering small *E. catena* (IBD<1mm Figure 10 blue area) we find that only *Donax* shells smaller than 18 mm are bored. For medium-sized *E. catena* (1 ≤ IBD < 2 mm Figure 10 green area) prey size range is the largest (between 9 and 31 mm). Largest *E. catena* (IBD ≥ 2 mm Figure 10 pink area) have only drilled shells larger than 13 mm.

For the same prey (*Donax sp.*) small *E. catena* tend to attack small preys. Larger *E. catena* (IBD beyond 1 mm) are able to consume both large and small preys. Thus Naticids size influences on prey size choice.

- borehole site stereotyping and link with shell thickness

Length range (mm)	[15-20]	[20-25]	[25-30]
Location of boreholes			
Thickness of shell (mm)			

Table 4 : Borehole site and shell thickness for different sizes of *Cerastoderma edule*

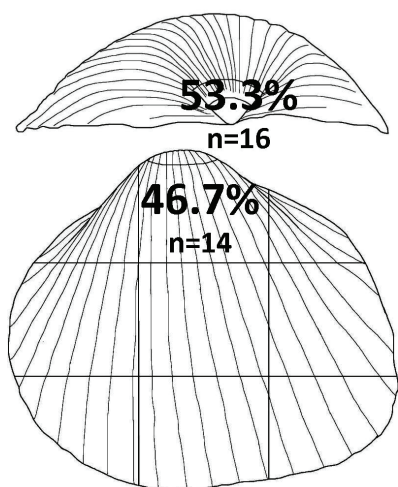


Figure 11 : Location of complete boreholes regardless of *C. edule* length

borehole site choice. There is no borehole for *C. edule* larger than 30 mm while thickness is considerably thinnest than 0.35 for the U area (Figure 12). Therefore this lack of perforation does not seem linked to an excessive thickness. It could possibly be explained by the ability to flee for larger *C. edule*, by inability for *E. catena* to manipulate large *C. edule*, or by a factor related to the ribs on the shell of this prey.

Length range (mm)	[5-10]	[10-15]	[15-20]
Location of boreholes			
Thickness of shell (mm)	Shells too small for measurements		
Length range (mm)	[20-25]	[25-30]	[30-35]
Location of boreholes			
Thickness of shell (mm)			Sample size too small to calculate mean values

Table 5 : Borehole site and shell thickness for different sizes of *Donax* sp.

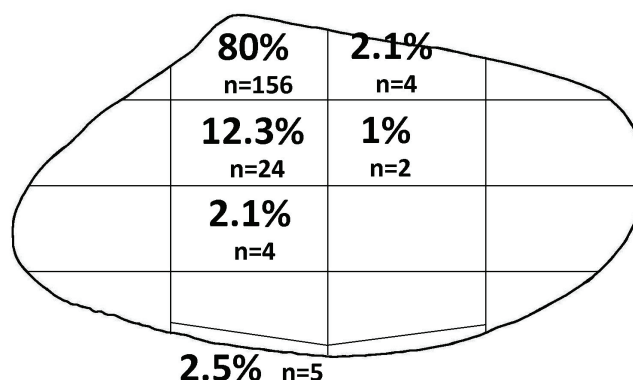


Figure 13 : Location of complete boreholes regardless of *Donax* sp. length

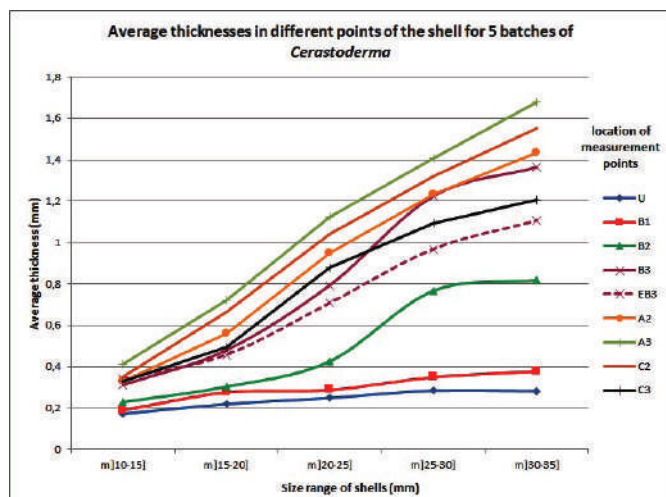


Figure 12 : Shell thickness of *C. edule*

Regardless of *C. edule* length, 100% of boreholes are located in umbonal area U or B1 (Figure 11). We can see (Table 4, Figure 12) that these areas are always the thinnest for a same size interval. Borehole site choice and low thickness are thus correlated.

We can see that [25-35] shells are perforated in B1, this area is 0.35 mm thick. However for thinner area B2 (0.30 mm for shells smaller than 25 mm) there is no perforation (Table 4), therefore shell thickness is not the only explanation for the

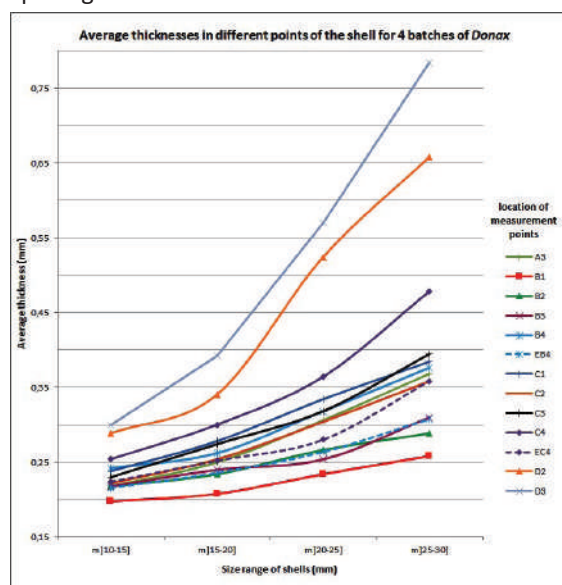


Figure 14 : Shell thickness of *Donax* sp.

B1 (umbonal area) is always the most bored area (74.7 to 100% Table 5 Figure 14). Other locations, in decreasing order of frequency are B2, EB4, B3-C1, C2. We find that B1 is also the thinnest area regardless of *Donax* size. Here, too, borehole site choice and low thickness are thus correlated. For *Donax* larger than 20 mm, B3 and C2 areas are no more bored and edge drilling occurs (EB4). *Donax* is the only prey displaying these unusual perforations. Thus for *Donax* larger than 20 mm, *E. catena* preferentially drills the thinnest areas, including shell edge EB4 (Table 5).

The thickest area drilled is 0.38 mm (in C1 for [25-30] mm specimen). A and D area are never bored, however they can be thinner than 0.38 (Table 5). *E. catena* is potentially able to drill many areas if we only take shell thickness into account, however it always drills in one of the thinnest location. Therefore correlation between drilling site choice and low thickness is not explained by inability to complete shell drilling.

Length range (mm)	[5-10]	[10-15]	[15-20]
Location of boreholes	100% (n=2)	81% (n=26) 3% (n=1) 13% (n=4) 3% (n=1)	100% (n=27)
Thickness of shell (mm)	0.29 0.36 0.33 0.26 0.36 0.36 0.31	0.32 0.38 0.37 0.30 0.44 0.42 0.34	0.45 0.76 0.63 0.42 0.65 0.69 0.43
Length range (mm)	[20-25]	[25-30]	[30-35]
Location of boreholes	89% (n=16) 5.5% (n=1) 5.5% (n=1)	100% (n=17)	100% (n=7)
Thickness of shell (mm)	0.65 1.05 0.91 0.76 0.97 0.90 0.69	1.09 1.45 1.35 1.22 1.44 1.42 1.17	1.51 2.24 1.88 1.61 2.12 2.11 1.60
Length range (mm)	[35-40]		
Location of boreholes	100% (n=3)		
Thickness of shell (mm)	1.96 2.74 2.48 2.17 2.73 2.70 2.12		

Table 6 : Borehole site and shell thickness for different sizes of *Spisula* sp

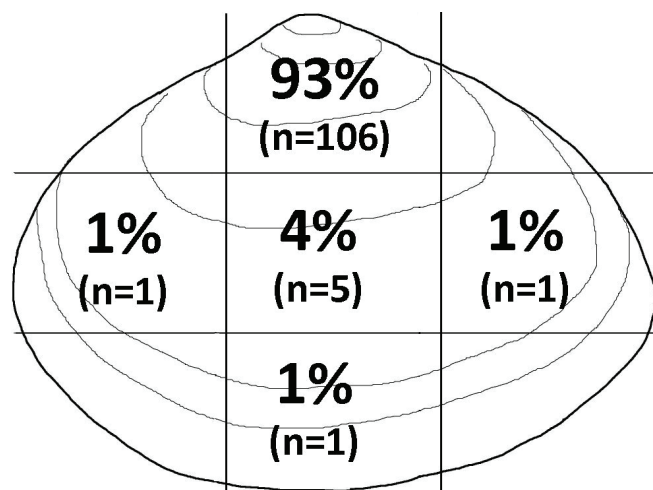


Figure 15 : Location of complete boreholes regardless of *Spisula* sp. length

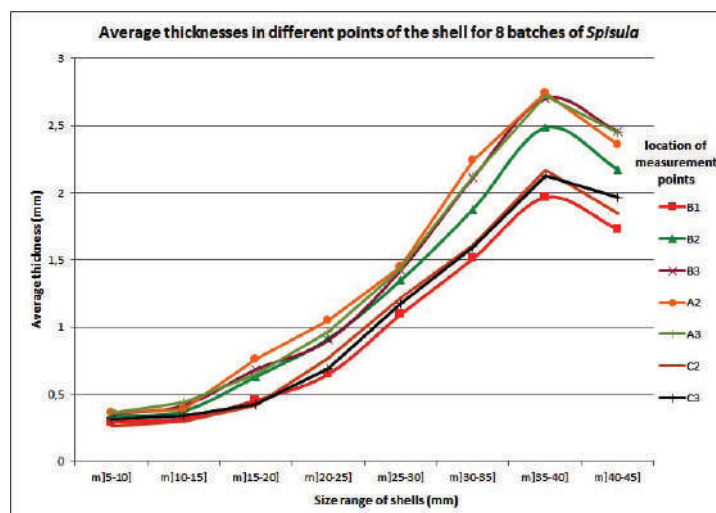


Figure 16 : Shell thickness of *Spisula solida*

B1 (umbonal area) is always the most bored area (85 to 100% Table 6 Figure 15). We find that B1 is also the thinnest area regardless of *Donax* size, except for smaller sizes [5-15] mm for which C2 is only 5 to 10% thinner. Once again, borehole site choice and low thickness are thus correlated.

We can note that *Spisula* has the thickest shell among the 3 studied preys. Thickness rapidly increases with the size of the shell. As noted above, *E. catena* shows a preference for small *Spisula* (Figure 9), which therefore correspond to those which are easiest to drill. *E. catena* perforation capacity for *Spisula* shell is high, up to 1.96 mm (Table 6)

- Multiple perforations

One *Cerastoderma* (Figure 17), 0.1 % of collected valves, 3.6 % of drilled valves of *C. edule*.

Two *Donax* (Figures 18 and 19), 0.27 % of collected valves, 1 % of drilled valves of *Donax* sp.

Double perforations are thus very uncommon.

We can note that in all three cases, valve have an aborted perforation and a complete one. There is no evidence that the second successful attempt was done by the same predator. For one valve of *Donax* (Figure 18) it is obvious that incomplete borehole was made by a small *E. catena*, given the small diameter of the hole. This valve was drilled secondarily by a larger *E. catena*, which leaves a complete and larger drillhole. We can also note that in all three cases, second predator was not able to reuse a hole that was already begun. These observations are consistent with usual behaviour of Naticidae (Kabat, 1990).



Figure 17 *Cerastoderma edule* valve with double borehole.

Figure 18 *Donax* sp. with double borehole.Figure 19 *Donax* sp. with double borehole.

- Aborted perforations

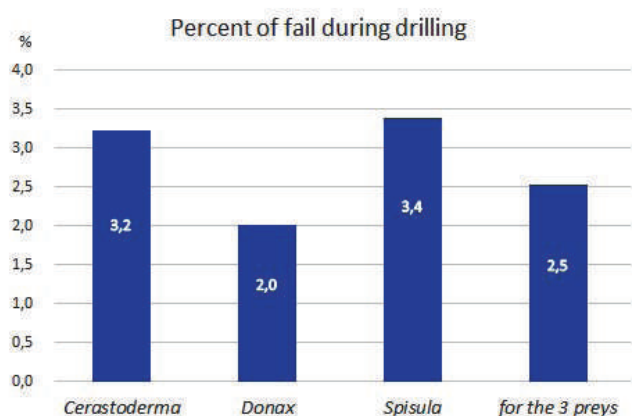


Figure 20 : percentages of aborted perforations

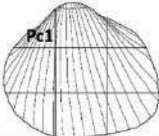
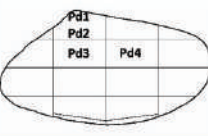
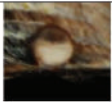
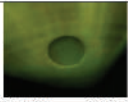
Species	<i>Cerastoderma edule</i>	<i>Donax</i> sp	<i>Spisula</i> sp
Incomplete bored shells	1	4	4
Ratio incomplete boreholes / total attempts for the species	3.2 %	2 %	3.4 %
Location of aborted Boreholes			
Shells length with incomplete bore holes (mm)	28.6	Pd1 : 16.6 Pd2 : 22.5 Pd3 : 22.3 Pd4 : 23.1	Ps1 : 25.1 Ps2 : 31.1 Ps3 : 32.5 Ps4 : 33.0
Outer Border diameter of incomplete perforation (mm)	 Pc1 2.28 mm	 Pd1 1.04 Pd2 1.14 Pd3 0.89 Pd4 1.27	 Ps1 1.81 Ps2 2.24 Ps3 3.38 Ps4 2.62
IBD (mm) calculated based on relationship OBD/IBD (Figure 3) as if hole was complete	1.58	Pd1 0.65 Pd2 0.73 Pd3 0.53 Pd4 0.84	Ps1 1.20 Ps2 1.19 Ps3 2.24 Ps4 1.74
Thickness on the edge of borehole (mm)	1.38-1.87	Pd1 0.33-0.38 Pd2 0.30-0.31 Pd3 0.22-0.23 Pd4 0.25-0.27	Ps1 0.81-1.04 Ps2 1.46-1.56 Ps3 1.23-1.49 Ps4 0.99-1.43

Table 7 : characteristics of aborted drillholes

There are very few incomplete perforations (Figure 20), 9 out of 2231 collected valves for the 3 preys (0.4 %). These drilling failures represent 2 % of all predation attempts.

- For *C. edule* there is only one incomplete borehole in A1. In this study there is no successful perforation in this area. Thickness measured on the edge of this hole is far thicker (1.38 to 1.87 mm) than maximum thickness drilled by *E. catena* for this prey (0.35 mm Table 4). Therefore this failure seems to be caused by an inappropriate choice of drilling site.

- For *Donax* sp., incomplete boreholes are located in B1, B2 and C2, areas normally pierceable (Table 5). For these holes, calculated IBD (Table 7) shows that *E. catena* which attacked were small (IBD < 1mm). In contrast *Donax* valves have rather large size (15 – 25 mm). This confirms (see Figure 10) that small *E. catena* have difficulties to drill large size *Donax*.

- For *Spisula* there are four aborted boreholes for large size valves (>25 mm). 3 are located in B1, area always pierceable (Table 6). Therefore, for these 3 cases, failure is not caused by a too great thickness. One attempt is in A2. For such a size of *Donax*, we observe no successful perforation in this area. This failure seems to be caused by an inappropriate choice of drilling site.

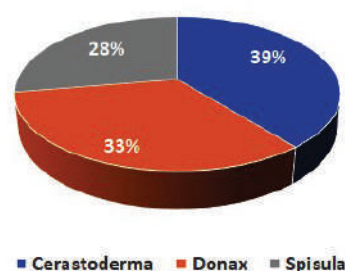
Conclusions

- **Main preys** of *E. catena* on Pen Bron sand beach are bivalves, predominantly *Donax*, *Spisula*, *Macomangulus tenuis* and *Cerastoderma edule*, these four preys representing more than 95 % of bored valves.

- Prey species selectivity

Considering the 3 most common preys, the most abundant (*Cerastoderma edule*) is definitely not the mainly consumed. The most commonly hunted is *Donax* sp. (Figure 21). This species has the thinnest shell (for equal size shell). Such a preference may be explained by a short drilling time, thus a maximization of energetic yield for this prey.

Proportion of collected shells for the 3 species



Proportion of bored shells for the 3 species

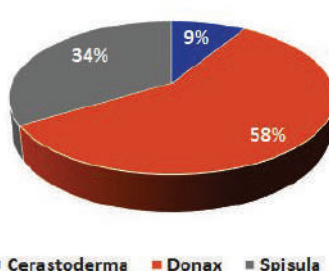


Figure 21 : prey selectivity for the 3 most common preys

- Prey size selectivity

For each prey, *E. catena* shows such a selectivity. Rather small *Cerastoderma* and *Spisula* (more rapidly drilled) are preferred, but *E. catena* prefers large size *Donax*. For this species with thinner shell (easily drillable), consumption of larger specimens maximize energetic yield.

For a single prey species (*Donax* sp.), the smallest *E. catena* hunt small preys, the largest predators are able to attack a much greater range of prey sizes.

- Borehole site selectivity

There is no preference for right or left valve.

Umbonal area is always the preferentially drilled area. This area is also always the thinnest, thus probably the more rapidly drilled. However *E. catena* is potentially able to bore in other locations (if only thickness of shell is considered). It can therefore be assumed that umbonal drilling, while minimizing boring time, maximizes energetic yield of predation.

- Effectiveness of predation

It can be noted that *E. catena* is highly effective (up to 26% of *Donax* bored on the beach), with very few failure when boring has started (2 %). Furthermore, some of these failures are caused by a bad choice of drilled area.

E. catena has a high capacity to drill bivalve shell (up to 1.96 mm for *Spisula* sp. in this study).

The preferred choice of prey species, size and drilled area are correlated to an energetic yield maximization (by reducing drilling time, by increasing food amount). These observations are consistent with those already done for other species of Naticidae (Kabat, 1990).

It appears likely that selective advantage given by this complex stereotypical behaviour has been maintained over time by natural selection.

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Mediterranean and Hellenic Seas: New records and distributional status of marine molluscs (by December 2022)

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Abstract

The work is part of an ongoing study on the marine malacofauna of the Hellenic Seas by December 2022. It incorporates 12 species out of which 4 are new records for the Mediterranean Sea, 2 are new records and 2 are second records for the East Mediterranean, 7 are new records and 4 are second records for the Hellenic malacofauna, 1 is a known Lessepsian migrant with broader distribution, 1 is with corrected identity, 1 is found in a new locality and 1 is a possible new Lessepsian migrant. Main taxonomic characteristics and ecological data, such as habitat, distribution and origin, are presented and discussed.

Introduction

The Mediterranean basin is a semi-enclosed geographical entity that has been shown to be significant for marine biodiversity, endemism and migration (Cachia *et al.*, 1996; 2001a, b; Galil, 2000; Coll *et al.*, 2010; Danovaro *et al.*, 2010; Lejeune *et al.*, 2010; Zenetos *et al.*, 2012; Tzomos *et al.*, 2012). With less than 1% of the Earth's oceanic surface the Mediterranean Sea harbours more than 4% of all recorded marine inhabitants and a percentage of endemism assessed at 45% (Bianchi & Morri, 2000; Coll *et al.*, 2010; Costello *et al.*, 2017). At the same time that the area is considered as a hotspot for biodiversity, it is also affected by environment alterations and invasions of

allochthonous species with an increasing tendency in the last decades (Giunchi *et al.*, 2001; Galil, 2009; Zenetos *et al.*, 2005a, 2012; Crocetta *et al.*, 2013; Öztürk *et al.*, 2015). Favorable geographical formations such as estuaries, lagoons and marinas, changing climatic conditions and intense human activity (e.g. freight transport, ferries, cruise ships and yachting) constitute factors which drive the spread of non-indigenous species (Galil, 2000; Ameer & Olof, 2008; Bianchi *et al.*, 2012; Manousis *et al.*, 2022). The Hellenic marine molluscan biodiversity has been influenced by environmental and anthropogenic changes described and discussed by a number of investigators (e.g. Galil, 2000; Galil & Zenetos, 2002; Zenetos *et al.*, 2005b; Abdulla & Linden, 2008; Galil *et al.*, 2008; Zenetos *et al.*, 2009; Skliris *et al.*, 2011; Tsiaras *et al.*, 2012). Molluscs represent a high proportion of the global biodiversity with some 100,000 identified species among which some 2500 inhabiting the Mediterranean Sea (Sabelli & Taviani, 2014). Out of those, 1423 species, or some 57%, inhabit the Hellenic Seas (Manousis, 2021a). The latter figure ever increases with new findings, thus bringing out the local malacofauna as a substantial part of the Mediterranean molluscan diversity (Mbazios *et al.*, 2020, 2022; Kontadakis *et al.*, 2021; Kontadakis & Manousis, 2022; Manousis *et al.*, 2022, 2023a-c). Mediterranean molluscs incorporate the higher number of invaders with 156 alien species (Zenetos *et al.*, 2011, 2012; Sabelli & Taviani, 2014; Zenetos & Galanidi, 2020). Molluscs exhibit specialized ecological characteristics and feeding modes that directly influence their distribution (Gofas *et al.*, 2011) and this could represent one of the main limiting factors to the establishment of allochthonous species as they

need to find appropriate environment and food resources in a new habitat. Taking into account the above issues, the objective of this study is to investigate the presence of additional autochthonous and allochthonous molluscan species in more localities of the Hellenic Seas.

Methods

Sampling, handling and species recognition were conducted according to Manousis & Galinou-Mitsoudi (2014) and Mbazios *et al.* (2020) from October 2022 to December 2022 in certain locations throughout the Hellenic Seas. All 1st and 2nd documented records from the Mediterranean and the Hellenic Seas are included in the text with collection data. Adequate description on certain specimens is designated whenever supplemental information facilitates identification. All findings - together with additional images of similar species for comparison - are presented in Figures 1-3. The specimens are deposited in the premises of T. Manousis, G. Mbazios, A. Porfyrakis, S. Stasinou and G. Zaminos. Scientists are welcome to have access to the biological material for inspection by appointment.

Results

Abbreviations:

EMS1, EMS2 - First or second record for the East Mediterranean Sea;

FFN - Fish Farming Nets;

G1, G2 - First or second record for Greece;

KLM - Known Lessepsian Migrant;

Ma - Maerl;

MB - Mixed Bottom;

MS1 - First Record for the Mediterranean Sea;

NL - New Location;

NLM - New Lessepsian migrant;

Ra - Rare;

WCMS - West and Central Mediterranean Sea.

The records

Bivalvia

Austronucula perminima (Monterosato, 1875) (Fig. 1a). One more shell of this rare Mediterranean species initially collected from Porto Coufo, Chalkidiki, North Greece (Manousis *et al.*, 2021a) is now collected from Maerl bed material brought to the surface by small gear fishing nets from 40-100 m depth at Paleochora, Crete Island, 35°80'N - 23°39'E, NL, G2.

Crenella pellucida (Jeffreys, 1859) (Fig. 1b). A rare mytilid only known from the West and Central Mediterranean (WCMS) (Repetto *et al.*, 2005) and recently from Israel, E Mediterranean Sea (Albano *et al.*, 2020). 3 shells are now second reported for the East Mediterranean Basin (EMS2). They are collected from Maerl bed material brought to the surface by small gear fishing nets, 40-100 m, Paleochora, Crete Island, 35°80'N - 23°39'E, G1.

Pinna rudis Linnaeus, 1758 (Fig. 1c-e). An uncommon amphiatlantic species (Gofas *et al.*, 2011) also present in the Mediterranean Sea (Repetto *et al.*, 2005) and rather recently also referred from the Hellenic Seas (Salomidi *et al.*, 2016; Gerovasileiou, 2018) without image documentation. One live juvenile specimen was collected in February 2022 (Fig.

1c, 7.5 cm) and kept in sea water under natural conditions (shellfish farming equipment). The specimen was subsequently photographed on 18 August (Fig. 1d, 10.5 cm) and on 26 November 2022 (Fig. 1e, 13.5 cm). FFN, 5 m, Sagiada, Thesprotia, 39°39'N - 20°06'E, EMS2, G2.

Gastropoda

Crisilla ramosorum J. D. Oliver, Templado & Kersting, 2012 (Fig. 1f). Shell small, 1.45 mm high and 0.90 mm wide (h/w = 1.6), of 3 teleoconch whorls. Protoconch of 1.5 whorls, some 300 µm wide and some 190 µm high, ornamented with 5 fine, equally and wide spaced discontinuous spiral cords. Teleoconch superficially smooth, with a very weak subsutural ridge and also very weak spiral cords on all the whorls, which become more obvious in the middle of the body whorl. Shell transparent, yellowish, with 4 spiral series of reddish spots on the last whorl. *C. ramosorum* exhibits similarities to: *C. aartseni* (Verduin, 1984) from the Strait of Gibraltar (Verduin, 1984), which, though of similar outlook, bears more spiral cords on its protoconch; *C. chiarelli* (Cecalupo & Quadri, 1995) from Cyprus (Cecalupo & Quadri, 1995) and Greece (Zaminos *et al.*, 2021), especially in the presence of weak spiral cords on the teleoconch and the color pattern, but *C. chiarelli* is larger, more slender and bears more spiral cords on its protoconch (Oliver *et al.*, 2012). 1 shell, 40-100 m, Maerl bed, Paleochora, Crete, 35°80'N - 23°39'E, EMS1, G1.

Cochlis vittata (Gmelin, 1791) (Fig. 1g, h), First record for the eastern Mediterranean Basin and for the Hellenic Seas of this west Mediterranean and south Atlantic Un species (Repetto *et al.*, 2005; Gofas *et al.*, 2011). 2 fresh shells beached, Kartalia, Akra Sithonia, Chalkidiki, 39°56'N - 23°55'E, EMS1, G1.

Eunaticina papilla (Gmelin, 1791) (Fig. 1i). Two shells of 17 and 25 mm length. This is the second report for Greece of a known Lessepsian migrant first reported for the area by Ragkousis *et al.* (2020). It has been initially reported for the Mediterranean Sea from Iskenderun (Turkey) with a live specimen (Öztürk & Bitlis Bakir, 2013) and subsequently as a shell from Shiqmona (Israel) but described as *E. linneana* (Récluz, 1843) (Schechter & Mienis, 2020) which is considered as a junior synonym of *E. papilla* (Beu *et al.*, 2004). It has been also recently reported from the Israeli Mediterranean coast as a juvenile specimen (Albano *et al.*, 2021). 2 shells, 10 m, MB, Saronic Gulf, 37°57'N - 23°11'E, Un, KLM, G2.

Nucella lapillus (Linnaeus, 1758) (Fig. 1j). One fresh shell of pre-adult individual, *Mytilus galloprovincialis* Lamarck, 1819 culture, Eleusis Gulf, 38°01' 21"N - 23°26' 59"E, Un, EMS2, G2, NL, previously reported and image documented as 2 live specimens from Thermaikos Gulf (Manousis *et al.*, 2018; Manousis, 2021b).

Megastomia crovatoi Nofroni, Renda, Vannozi, 2022. A very recently described species (Nofroni *et al.*, 2022) already presented in Manousis (2021b: p. 329, unnumbered figs.) but erroneously identified as *Odostomia lorioli* (Hornung & Mermod, 1924) - a very similar Lessepsian species in the eastern Mediterranean basin (Nofroni *et al.*, 2022). *M. crovatoi* is included here in order to acknowledge identification and verification of its presence in the Hellenic Seas.

Odostomia* aff. *extenuata Peñas & Rolán, 1999 (Fig. 2a). Shell small, 3.5 mm X 1.2 mm (h/w = 2.9), robust, sub-cylindrical, elongated, white and brilliant. Protoconch submerged of type B tending to C, with a diameter of 190 µm. Teleoconch with elevated spire, 6 staggered and planoconvex whorls, the last of which is elongated-oval (h = 50% total height) and a deep suture. No apparent sculpture, except the straight and slightly opisthocline incremental lines and shallow plaits all over the teleoconch but more conspicuous towards the apex. Aperture narrow, oval and small (= 30% H). Columella slightly opisthocline, straight on its upper half and well arched in the lower. Weak and interior columellar fold situated somewhat above the middle of the columella. Umbilicus absent. 1 shell, 60-80 m, MB, Siggitikos Gulf, 40°06'N - 24°08'E, Ra, Congo, MS1, G1.

Odostomia aff. *extenuata* shares most shell characters with *O. extenuata* Peñas & Rolán, 1999 but the diameter of its protoconch (317 µm, in the latter), the slightly shorter body whorl (h = 57% H, in the latter) and the incremental lines (which are sinuous in the upper part in the latter). *O. extenuata* is an infralittoral species only known from Congo (Peñas & Rolán, 1999).

Odostomia aff. *extenuata* can be compared with:

i. *O. boutani* Dautzenberg & H. Fischer, 1907 (Dautzenberg & Fischer, 1907, plate VI, fig. 8), uncertain, *taxon inquirendum* (<https://www.marinespecies.org/aphia.php?p=taxdetails&id=853884>). Original description: *Testa tenuis, nitida, pellucida, subrimata. Spira elata turrita. Anfr. apicales 2 heterostropfi, normales 5 leves complanati, gradate, sutura valde impressa juncti. Anfr. ultimus ad peripheriam subangulatus. Apertura ovata, superne angulata. Columella arcuata, superne plicam spiralem et validam praebebat. Labrum simplex arcuatum. Color albus hyalinus. Alt. 3.2 mm; diam. Max. 1.3 mm. Apertura 1.2 mm alta, 0.6 mm lata*. English Translation: The shell is thin, shiny, transparent and smooth. Towering spire. Whorls, apical 2 heterostrophic, normal 5 slightly flattened, gradated, joined by a strongly impressed suture. The last whorl sub angular at the periphery. Aperture ovate, angled above. The arched columella bears a strong spiral fold at the top. A simple arched lip. Color white hyaline. Height 3.2 mm, maximum diameter 1.3 mm, aperture 1.2 mm high and 0.6 mm wide. The latter species differs from *O. aff. extenuata* in that it has a proportionally higher body whorl (58% H), lacks the axial plaits on the teleoconch, bears a strong spiral fold, and has an arched outer lip.

ii. *Odostomia digitulus* Peñas & Rolán, 1999 (Peñas & Rolán, 1999, p. 111, figs. 293-296) has a smaller and relatively wider shell, a wider protoconch of 255 µm (instead of 190 µm in *O. aff. extenuata*), more convex and not staggered whorls, a shallower suture and a proportionally larger aperture; *O. dijkhuizeni* van Aartsen, Gittenberger & Goud, 1998 (Peñas & Rolán, 1999, p. 99, figs. 208-215, 346; Manousis *et al.*, 2023b) has a more conical shell, a more inflated shell, a proportionally larger aperture and prosocline growth lines;

iii. *Odostomia gradusuturæ* Peñas & Rolán, 1999 (Peñas & Rolán, 1999, p. 99, figs. 262-265) which has a similar size shell but with a higher spire, a clear subsutural ledge with angular edge, and protoconch of type B and a large protoconch of 290-300 µm;

iv. *Odostomia paardekooperi* van Aartsen, Gittenberger & Goud, 1998 (van Aartsen *et al.*, 1998; Peñas & Rolán, 1999, p. 87, figs. 229-232) has a shell of similar well tapered profile,

but the whorls are flat and not staggered, develop less rapidly, is conical-acute, has an angular periphery, a very weak spiral microsculpture and the incremental lines and border of outer lip well prosocline.

v. *Odostomia pyxidata* Schander, 1994 (Peñas & Rolán, 1999, p. 72, figs. 186, 187) has a truncated-conical profile, flat whorls forming an angle with the suture, the whorls develop slower and are not stepped, and the incremental lines are prosocline;

vi. *Odostomia turriculata* Monterosato, 1869 (Fig. 2b) (see also, Gofas *et al.*, 2011, p. 384; Giannuzzi-Savelli *et al.*, 2014, p. 47, fig. 72; Manousis, 2021b, p. 336), sympatric to *O. aff. extenuata* specimen of *O. turriculata* has a shell of a similar contour, but the whorls develop more slowly and the incremental lines are clearly opisthocline and flexuous;

vii. Sympatric to *Odostomia* aff. *extenuata* specimen of *O. cf. turriculata* (Fig. 2c) with dense spiral decoration (see also, Manousis 2021b, p. 336). At first glance, the specimen of *O. aff. extenuata* is reminiscent of: *Auristomia erjaveciana* (Brusina, 1869) (Giannuzzi-Savelli *et al.*, 2014, page 48, fig. 53) but the latter lacks the spiral decoration and bears convex whorls, orthocline incremental lines (opisthocline and flexuous in our specimen) and, proportionally to its length, larger body whorl; *Auristomia ignorata* Monterosato, 1917 (Monterosato, 1917; Giannuzzi-Savelli *et al.*, 2014, page 55, fig. 108; Appolloni *et al.*, 2018), but our specimen bears opisthocline incremental lines and outer lip of the aperture (prosocline to orthocline in *A. ignorata*), and dense spiral decoration (absent in *A. ignorata*).

Syrnola fasciata Jickeli, 1882 (Fig. 2d). Fresh shell, solid, tapered, vitreous white with 2 faint yellow spiral bands on the body whorl one at its middle and the other at its periphery. Protoconch (Fig. 2d) of type B, with a diameter of 225 µm, peeking over the first teleoconch whorl. Teleoconch of 4 planoconvex whorls, with a shallow suture and a narrow subsutural shelf. Aperture narrow and small, with an inclined prominent columellar tooth, not perpendicular to the columella and three teeth visible in the inner surface of the outer lip. Although known for Greece (Evagelopoulou *et al.*, 2015; Karachle *et al.*, 2016; Manousis, 2021b) we show the specimen here as it is the first bearing teeth (Scaperrotta *et al.*, 2009; Giannuzzi-Savelli *et al.*, 2014; Agamennone *et al.*, 2022) on the inner surface of its outer lip among all other specimens of *S. fasciata* collected from the area where found. 1 shell, 60-80 m, MB, Siggitikos Gulf, 40°06'N - 24°08'E.

Ebala* aff. *communis Bandel, 2005 (Fig. 2e). The minute and translucent white shell is some 1.1 mm long with an almost planispiral heterostrophic protoconch. The teleoconch exhibits a deep suture and flattened whorls with narrow shoulder. Sculptural decoration of sinuous and slightly prosocline growth lines and very fine spiral ones on the smooth surface. Aperture oval, wider anteriorly, and with a simple columella. Our specimen is compared with *Ebala gradata* (Monterosato, 1878) (Fig. 2f) a species with similar looking teleoconch but the shape of the aperture. *E. communis* differs from *E. nitidissima* (Montagu, 1803) by having a more angular outline of the teleoconch whorls (Bandel, 2005). *E. communis* is also quite similar to *Pseudochileutomia carinata* (de Folin, 1870) - also known as *Bacteridium carinatum* (de Folin, 1870) (Peñas *et al.*, 1996) - from which it differs in its less turritiform and graded profile, the weaker subsutural shoulder, and the oval aperture (pear-shaped in *B. carinatum*) (Giannuzzi-Savelli *et al.*, 2014).

Due to the limited morphological information offered by a single shell we present it as in need of affirmation (aff.). 1 shell, 40-100 m, Maerl bed, Paleochora, Crete, 35°80'N - 23°39'E, Ra, possible NLM, MS1, G1.

***Tubulophilinopsis* sp.** (Fig. 3a-j). Shell thin, convex (according to Zamora-Silva & Malaquias, 2017), calcified, semi-transparent, with a small spire and reduced columellar region (Fig. 3a). Axial culpture consisting of a series of irregular and wavy incremental lines more evident on the dorsal region (Fig. 3b). Spiral culpture consisting of dense and fine furrows (Fig. 3c). Body whorl large with a - partially broken - flat and broad external rim (Fig. 3d) on the posterior right-hand side, in which growth lines are faintly visible. Posterior edge simple and curved (Fig. 3e). Posterior dorsal edge with a very thin and transparent fold in the form of a shirt collar leaf (Fig. 3f). Protoconch spiral (Fig. 3g), some 400 µm, protruding from the teleoconch, with two crests (Fig. 3h, i) the lower of which ends in a beak-like projection (Fig. 3j). 1 shell, 40-100 m, Maerl bed, Paleochora, Crete, 35°80'N - 23°39'E, MS1, G1. Our finding strongly resembles: a. the shell of *Melanochlamys diomedea* (Bergh, 1894), a minute aglajid from the northeast Pacific Ocean, as depicted in Cooke *et al.* (2014, Fig. S3A-C). The likeness is about the outline of the shell, its calcification, the small size, the wavy incremental lines on the dorsal region, and the spiral protoconch (Fig. S3A) which bears two crests also, but the latter species bears an elongate posterior process directed backward and separated from the spire by a deep notch; b. The shell of *Tubulophilinopsis* sp. #1 (<http://seaslugsofhawaii.com/species/Tubulophilinopsis-sp1-c.html>) (live animal, <http://seaslugsofhawaii.com/species/Tubulophilinopsis-sp1-a.html>), which also bears a spiral protoconch with a collar-like fold bordering its posterior dorsal edge and a tooth-like projection, but the latter projects like a beak on an otherwise smooth protoconch.

Discussion

This work includes collection results of the period from October 2022 to December 2022 and is part of the ongoing study of the marine malacofauna of the entire Hellenic territory. It incorporates 12 species out of which 4 are new records for the Mediterranean Sea, 2 are new records and 2 are second records for the East Mediterranean, 7 are new records and 4 are second records for the Hellenic malacofauna, 1 is a known Lessepsian migrant with broader distribution, 1 is with corrected identity, 1 is found in a new locality and 1 is a possible new Lessepsian migrant.

Allochthonous species have been recognized as a serious threat in the Mediterranean (Galil *et al.*, 2015) with main vector of introduction the progressive entrance via the Suez Canal (Lessepsian migration or Erythrean invasion). Thus, the area most affected by this migration is the Levantine Sea (Por, 1990; Galil & Zenetos, 2002). Since 2005 (Pancucci-Papadopoulou *et al.* 2005) 19 more Lessepsian migrants have been reported (e.g. Manousis *et al.*, 2010; 2020a-c; 2021a, b; Manousis & Galinou-Mitsoudi, 2014, Zenetos *et al.*, 2020, Kontadakis *et al.*, 2021). This number is added to the, by then, already known 28 Lessepsian migrants (Pancucci-Papadopoulou *et al.* 2005). During the last five decades or so, considerable attention has been drawn to the increasing number of allochthonous molluscs recorded in the Mediterranean Sea, introduced naturally or assisted by man's activities (Gofas & Zenetos, 2003; Zenetos *et al.*, 2004; Mienis, 2005; Zenetos *et al.*, 2005a, b; Delongueville & Scaillet, 2007; Zenetos & Galanidi, 2020;

Zenetos *et al.*, 2022). All these presumed non-native species are categorized as 'casual', 'cryptogenic', 'established', 'excluded', 'invasive', 'questionable', or analogous terms, in accordance with their adaptation to the new environment and their alleged origin (Zenetos *et al.*, 2005b). Apparently, the categorization of a species with any of those terms may be different for different authors or change with time due to more findings (Manousis, 2021b). *Alvania dorbignyi* (Audouin, 1826), for instance, was originally figured by Savigny (1817) and subsequently reported for the first time for the Mediterranean Sea by Nordsieck (1972) who considered the species as originated from the Red Sea. His hypothesis was eventually rejected by Mienis (1985) who considered the species as native to the Mediterranean Sea; after he noticed that Savigny's original tables included both Red Sea and Mediterranean species and that no other species of *Alvania* was known from the Red Sea, while the centre of radiation for the genus seemed to be the Mediterranean Sea. In due time, but not conclusively, the species was endowed by Gofas & Zenetos (2003) with the title of 'cryptogenic' using a term introduced by Carlton (1996) for species with doubtful (autochthonous or allochthonous) status. The still unsettled matter was rather recently and in detail presented by Campani (2009). In conclusion, the investigations on supposedly non-indigenous organisms need to take into account a several ecological parameters such as cryptogenicity, deep prey-predator relationships (food webs and monophagous diet), sympatry, ontogenetical plasticity, ecological niches and availability of vacant ecological niches. Could we consider positively the introduced species as the biodiversity increases? If yes, is it realistic to contemplate preventing the introduction of alien species at least by anthropogenic activities e.g. navigation? Ecological associations among elusive and inconspicuous sea slugs, such as *Tubulophilinopsis* sp., fall into the above mentioned considerations as "It is very difficult to identify aglajids based on the shell only, as it can be variable"..."it is very unlikely that *M. diomedea* is present in the Mediterranean" (Ángel Valdés, personal communication). The latter opinion together with the fact that our shell bears features present in *Tubulophilinopsis* shells prompted us to conclude that our finding belongs to an, as yet, unknown *Tubulophilinopsis* species without excluding the possibility that, in spite the different protoconches, it may belong to *Tubulophilinopsis* sp. #1 (<http://seaslugsofhawaii.com/species/Tubulophilinopsis-sp1-c.html>), as "the shells ... are different..., but they can change ontogenetically, so unless you can find live animals I cannot identify them with certainty" (Ángel Valdés, personal communication). Apparently, the genus *Tubulophilinopsis* is rather recently described on the basis of molecular phylogeny (Zamora-Silva & Malaquias, 2017).

Pinna rudis have been recently shown by means of molecular markers analysis to produce hybrids with *P. nobilis* in nature (Vázquez-Luis *et al.*, 2021). As those recognized hybrids "were also different from each other and in some cases were hard to distinguish from parent species" (Vázquez-Luis *et al.*, 2021), and our specimen bears the morphological characters of *P. rudis* juveniles (Gofas *et al.*, 2011), we identified it as such. Wishing to give a mere idea of the growth rate of a *P. rudis* individual under the Ionian Sea conditions our specimen has developed about 6 cm in length from February till November 2022 (~9 months), that means a growth rate of ~0.22 mm per day or ~0.33 mm per day from August till November. This rate is very low in comparison to that under corresponding environmental

conditions in E Spain (~0.70 mm per day) (Hernandis *et al.*, 2021).

Nucella lapillus was first reported and image documented for Greece with two live specimens from Palioura, Epanomi, north Aegean Sea (Manousis *et al.*, 2018; Manousis, 2021a), and the records were mentioned in a systematic catalogue documented with bibliographic and pictorial references (Manousis, 2021b). The species was earlier cited by Repetto *et al.* (2005) as present in the Strait of Gibraltar and live specimens were also image documented by Cossignani & Ardovini (2011) from Marbella, Alboran Sea. Lately, it was also included in the Accrescimenti series (Scaperrotta *et al.*, 2022) and referred as present in Malaga, Spain, yet the species' presence in the Greek Exclusive Economic Zone was characterized as inaccurate ("species not living in the Mediterranean", <https://www.marinespecies.org/aphia.php?p=distribution&id=1464235>). Apparently, the here reported second location is about 500 kilometers from the first one, but both represent biotopes rich in *Mytilus* Linnaeus, 1758, main diet of *N. lapillus*. The species presence in the Hellenic waters (Manousis *et al.*, 2018) has also been questioned by Zenetos *et al.* (2018) "...the record of *N. lapillus* is based on two live specimens found at 10 m depth. This species only lives at tide level, therefore suggesting that these specimens may have been most likely mechanically discarded in the field". We would oppose to that with the common assumption that live individuals seem to live where found, and that the term "mechanical disposal" is something vague that does not elucidate the origin or the presence of two living specimens in the particular area where found. The case is also reminiscent of the record of two fresh shells of *Cochlis vittata* in this work, which is also considered a west Mediterranean inhabitant.

Finally, citizen science monitoring projects, like ours, are helpful to increase and update collection data, increase ecological knowledge on anthropogenic impacts and, hopefully, induce suitable and effective conservation strategies.

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Figure 1: a. *Austronucula perminima* (Monterosato, 1875); b. *Crenella pellucida* (Jeffreys, 1859); c-e. *Pinna rudis* Linnaeus, 1758 live specimen as on February 2022, 18 August 2022 and 26 November 2022, respectively; f. *Crisilla ramosorum* J. D. Oliver, Temp-lado & Kersting, 2012; g, h. *Cochlis vittata* (Gmelin, 1791); i. *Eunaticina papilla* (Gmelin, 1791); j. *Nucella lapillus* (Linnaeus, 1758)

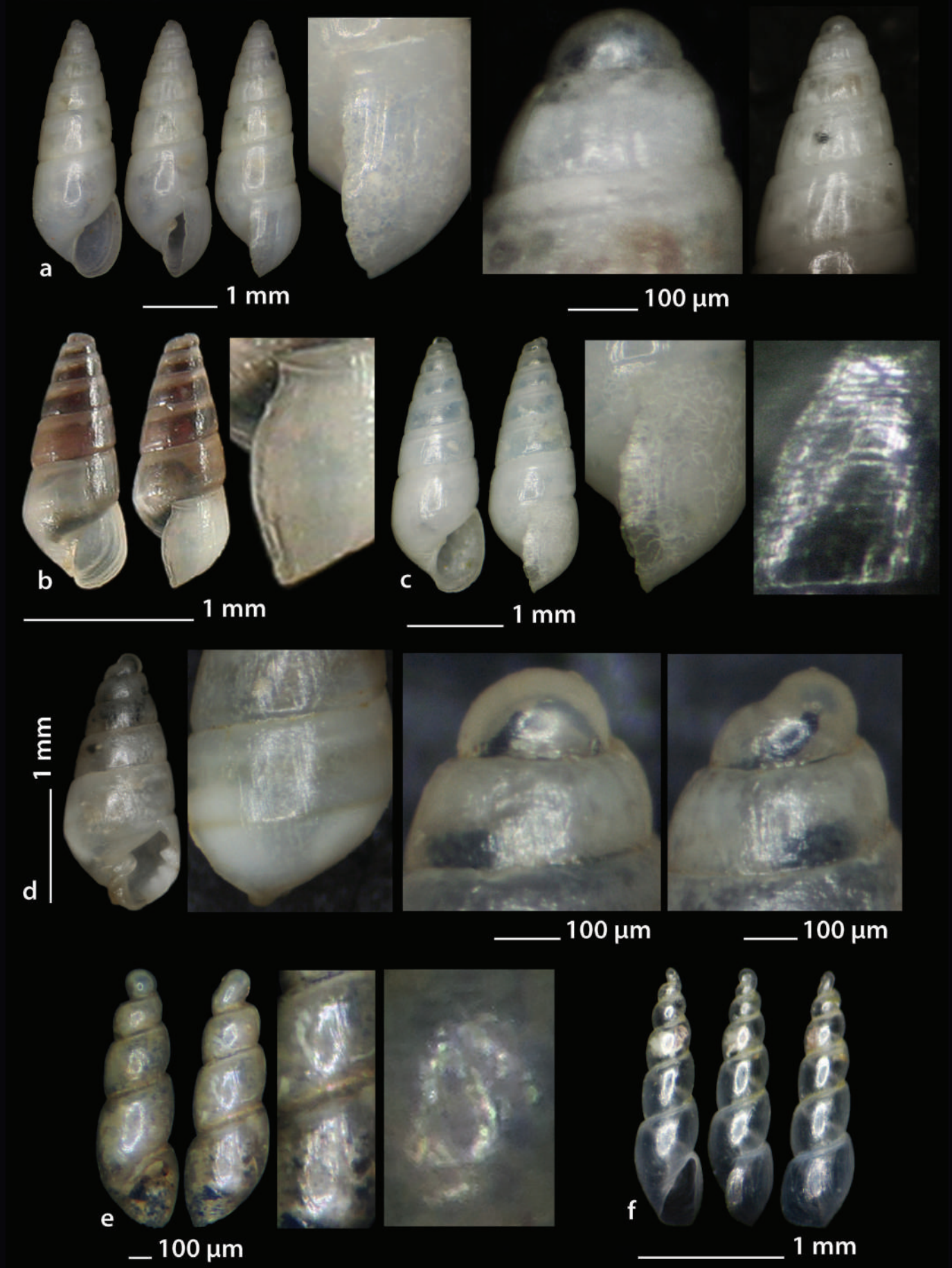


Figure 2: a. *Odostomia* aff. *extenuata* Peñas & Rolán, 1999; b. *Odostomia* *turriculata* Monterosato, 1869; c. *Odostomia* cf. *turriculata* Monterosato, 1869; d. *Syrnola* *fasciata* Jickeli, 1882; e. *Ebala* aff. *communis* Bandel, 2005; f. *Ebala* *gradata* (Monterosato, 1878).

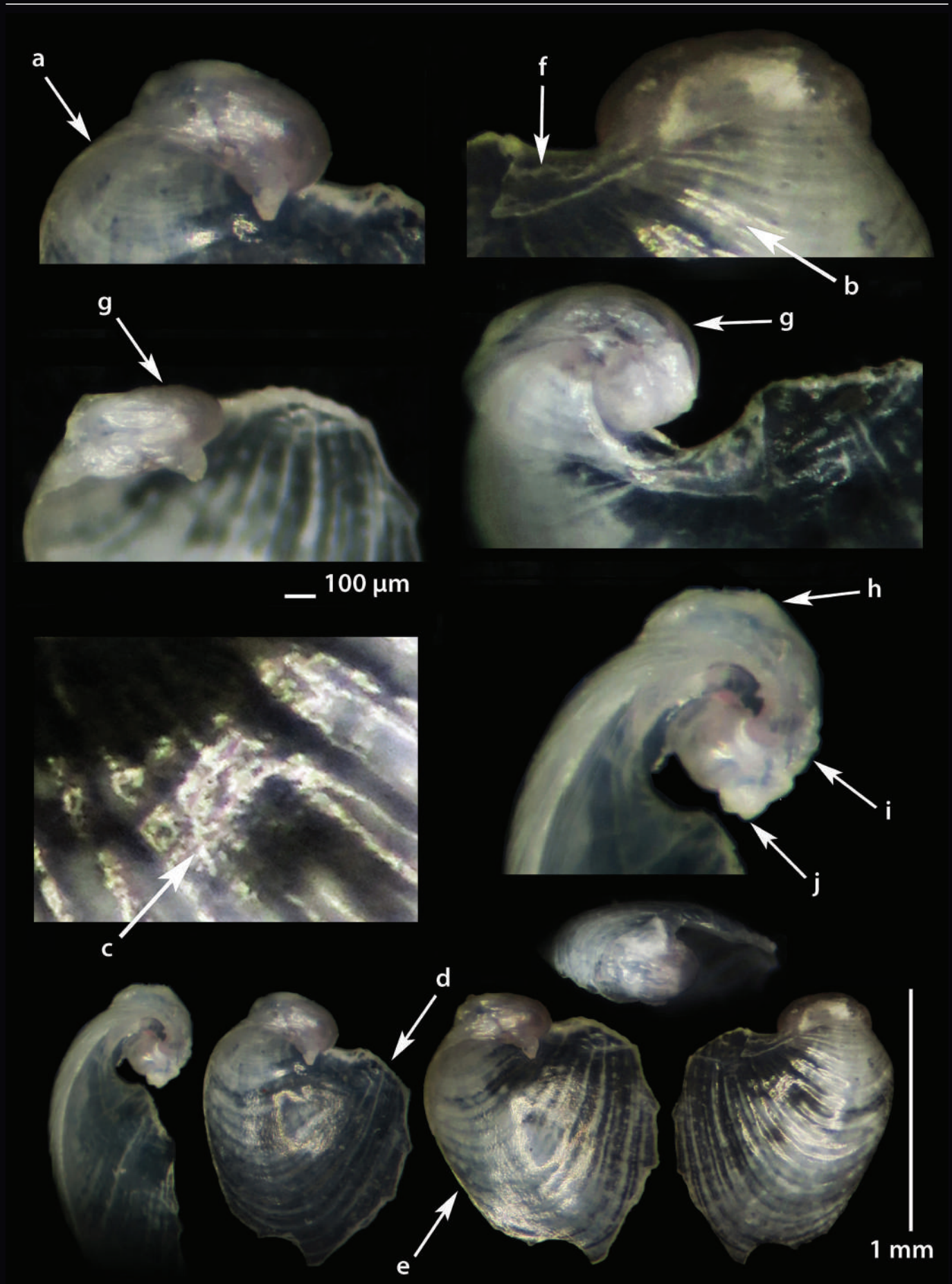


Figure 3: *Tubulophilinopsis* sp.: a. Columellar region; b. Incremental lines; c. Furrows; d. External rim; e. Posterior edge; f. Fold; g. Protoconch; h, i. Two crests; j. Beak-like projection.

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