



XENOPHORA

T A X O N O M Y

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



© B. Abela

New gastropod records for the Mediterranean Sea and the Hellenic Seas
G. MBAZIOS, C. KONTADAKIS, S. GALINO-MITSOUDI & T. MANOUSIS

Darioconus cathyae sp.nov. and *Darioconus michelcharlesi* sp. nov.
two new species from the *D. aulicus* / *D. auratinus* complex
E. MONNIER, L. LIMPALAËR & F. PRUGNAUD



Association Française de Conchyliologie

www.xenophora.org
2 square La Fontaine
75016 Paris

Président

Eric Monnier,

e-mail: ericm2007@hotmail.fr

194 Rue du Chateau des Rentiers - 75013 PARIS

Vice-Président

Fabrice Prugnaud

e-mail: fprugnaud@gmail.com



XENOPHORA TAXONOMY is a supplement to **XENOPHORA**, the quarterly bulletin published by AFC. It is shipped to all AFC members with the regular publication.

VOUS ÊTES TOUS LES DEUX TENEBREUX ET DISCRETS :
HOMME, NUL N'A SONDE LE FOND DE TES ABÎMES,
Ô, MER NUL NE CONNAÎT TES RICHESSES INTIMES
TANT VOUS ÊTES JALOUX DE GARDER VOS SECRETS

Charles Baudelaire, "L'Homme et la Mer"
Les Fleurs du Mal, 1857

Guidelines

AFC and its magazine *Xenophora Taxonomy* accept to publish taxonomic works including descriptions of new species and revisions of supraspecific groups of mollusks. The manuscripts must be in accordance with the rules and recommendations of the ICZN (International Code of Zoological Nomenclature). The manuscripts will be submitted to a board of referees before publication. Decisions to publish or not will follow careful refereeing and this committee may suggest changes to the author.

These descriptions will be sent to the Editor of *Xenophora* (redaction@xenophora.org) in English (with an abstract or introduction in French). The illustrations must be provided in high definition, on CD or other digital media. Colour pictures are preferred. Captions of the figures and plates must be provided with the references to the pictures. Texts shall be provided in *.doc, *.txt or *.rtf format, while the photos must be in jpg format with 300 dpi resolution. The pictures submitted can be used by *AFC-Xenophora* for any of its publication, magazine or its web-site.

Publication is free of charge for the authors. At least one of the Authors must be an AFC member. The Senior author will receive two print copies of the paper, the juniors one copy.

Copyright © Association Française de Conchyliologie
Reproduction in whole or part without written permission is prohibited.

Impression : Sprinters - ☎ 01 86 22 10 10
42 Rue de Panicale - 78320 La Verrière

New gastropod records for the Mediterranean and the Hellenic Seas

George Mbazios¹

Email: gmpazios@gmail.com

Constantinos Kontadakis²

Email: costaskontadakis@yahoo.com

Sofia Galinou-Mitsoudi^{3*} Corresponding author

Email: galimits@otenet.gr

Thanasis Manousis⁴

Email: athanasiosmanousis@gmail.com

¹Orfanidou 27, 11142 Athens, Greece

²Aristotelous 24, 16777 Hellinicon, Athens, Greece

³International Hellenic University (IHU)

Department of Environmental Engineering

P.O BOX 141, 574 00 Thessaloniki, Greece

⁴PO Box 48 K, 57500 Epanomi, Greece

Keywords

Aegean Sea, biodiversity, gastropods, Greece, Lessepsian migrant, live, Mediterranean Sea.

Abstract

The Hellenic Seas are affected by environmental changes under way and the introduction of alien species, which influence their biodiversity. This study continues the contribution to the knowledge of the Hellenic marine malacofauna accumulating data from the entire Greek region during the period from October 2008 to October 2018. It includes 53 species of not previously reported gastropods or reported only once from Greece and belonging to 23 families. From those species, 2 are new for the Mediterranean Sea, 17 are new for the Eastern Mediterranean Sea, 34 are new for the Hellenic malacofauna and 2 are previously reported as Lessepsian migrants. Main taxonomic characteristics and ecological information such as habitat, distribution and origin, are given and discussed.

Résumé

Les mers helléniques sont affectées constamment par l'évolution de l'environnement et l'introduction d'espèces étrangères, ce qui a un impact sur leur biodiversité. Cette étude participe à la connaissance de la faune marine hellénique, rassemblant des informations de toute la région d'octobre 2008 à octobre 2018. Elle cite 53 espèces de gastéropodes, appartenant à 23 familles, non répertoriés en Grèce ou seulement par un seul individu. Deux espèces sont nouvelles pour la Méditerranée, 17 pour l'est de la Méditerranée, 34 pour la faune de Grèce et 2 sont espèces lessepsiennes. Les principaux caractères taxonomiques et écologiques sont donnés, tels l'habitat, l'aire de répartition et le lieu de récolte.

Introduction

Benthos research developments, anthropogenic factors and changing environmental conditions affect substantially the recorded marine biodiversity whilst detailed and persevering surveys increase the number of species, especially of those of small sizes (e.g. Streftaris & Zenetos, 2007; Manousis *et al.*, 2017, 2018a, b). As far as anthropogenic factors are concerned, ballast water is considered a main vector for the introduction of exotic species (e.g. Zenetos *et al.*, 2005; Abdulla & Linden, 2008; Galil *et al.*, 2008). The Hellenic seas are an intensive navigation carrefour of the Mediterranean Sea. Moreover, biodiversity, mainly in the E Mediterranean Sea –close to the Suez Canal that has recently been widened– and the Strait of Gibraltar, has undergone modifications during recent decades, following the introduction of non-indigenous species, attributed to

the expansion of shipping traffic, aquaculture activities and migration (Por, 1990; Galil & Zenetos, 2002; Streftaris *et al.*, 2005). The aim of this work was to further study the marine gastropod diversity of Greece.

Methods

The sampling and handling of the specimens were conducted according to Manousis & Galinou-Mitsoudi (2014) from October 2008 to October 2018 in certain locations throughout the Hellenic Seas. In addition, we have applied: a. Soft brushing on holothurians, sea urchins and sponges either *in situ* or on live material brought temporarily to the surface in several localities and from various habitats, b. Sampling vertical substrates (e.g. poles, embankments) by means of a metal pole scraper connected to a 120 µm mesh nylon net, c. Dissociating matte material, d. Keeping until examined and sorting out benthic material in cool sea water until photography of live specimens took place. Maintaining cool conditions for the biological material in sea water was achieved by means of Dewar flask and gel freeze ice pack under the examination vessel. The protoconch whorls were counted according to Verduin (1976), the protoconch's visible height was measured parallel to its axis, from the tip to the intersection of the larval scar and the teleoconch suture, while for the shell's slenderness (h/w) the outer lip of the aperture was included in the shell's width. The species recognition was based on: a. Systematic guides and atlases (e.g. Galil & Zenetos 2002; Scaperrotta *et al.*, 2015) b. Faunistic and review articles (e.g. Aslan-Cihangir & Ovalis, 2013; Doneddu & Trainito, 2005), c. Studies on the Mollusca fauna in the Hellenic seas (e.g. Manousis & Galinou-Mitsoudi, 2014, Zenetos *et al.*, 2008). Information from specific web sites was also taken into account. More specifically, for the species nomenclature update, besides the Marine Biodiversity and Ecosystem Functioning EU Network of Excellence (MarBEF) (<http://www.marbef.org>.) and the World Register of Marine Species (WoRMS) (<http://www.marinespecies.org>.), the Taxonomic on-line Database on European Marine Mollusca (CLEMAM) (http://www.somali.asso.fr/clemam/biota_xis.php.) was also used. In addition, the Ellenic Network on Aquatic Invasive Species (ELNAIS) (<https://services.ath.hcmr.gr>.) and the Marine Mediterranean Invasive Alien Species database (MAMIAS) (<http://www.mamias.org>.) were used for the alien species status in the Hellenic and Mediterranean Seas. All previous referred web sites were accessed by 31 July 2019. Records were compared with the checklist of Koukouras (2010). The specimens in dry or wet (95% ethanol) storage are deposited in the premises of C. Kontadakis, G. Mbazios and Dr. T. Manousis. Scientists are welcome to have access to the biological material for inspection by appointment.

Results

The records

All 1st and 2nd documented both at species and at genus level records (62 species) from the Hellenic Seas are listed in Table 1 with collection data. A brief description of certain findings is given below whenever additional information is supportive to their identification. They are all presented in Figures 1 to 15.

Abbreviations: **BB** - Biogenic Bottom, **Be** - Beached, **CEMS** - Central and East Mediterranean Sea, **CMS** - Central Mediterranean Sea, **Co** - Common, **CB** - Coralligenous Bottom, **Cos** - Cosmopolitan, **EA** - East Atlantic, **EM** - Endemic to Madeira, **EMS** - East Mediterranean Sea, **EMS1** - First record for the East Mediterranean Sea, **EMS2** - Second record for the East Mediterranean Sea, **G1** - First record for Greece, **G2** - Second record for Greece, **KI** - Karpachos Island, **LM** - Lessepsian Migrant, **Ma** - Maerl, **MB** - Mixed Bottom, **MS** - Mediterranean Sea, **MS1** - First record for the Mediterranean Sea, **Mu** - Muddy, **Ra** - Rare, **Ro** - Rocky, **Un** - Uncommon, **Unk** - Unknown, **WCMS** - West and Central Mediterranean Sea, **WMS** - West Mediterranean Sea, **WCMS** - West and Central Mediterranean Sea, **ZB** - *Zostera* bed.

Turritella sp. (Fig. 2a). One broken abapical part of a shell (2.00 mm high, 0.70 mm wide). Shell bright, hyaline, robust. Protoconch obtuse of 0.75 whorls, 145 µm in diameter, off white. Teleoconch of 6 existing flat whorls, rather thick-walled for its size. Each whorl starts with a flat shoulder perpendicular to the axis and a quadrangular carina delimited adapically by 2 narrow cords of equal width as their interspace. At its lower part and over the shallow suture there is an additional triangular carina. Between this lower carina and the 2nd cord of the upper carina there is a flat interspace exhibiting a dense axial sculpture of sinuous and opisthocline growth lines. Through the broken part of the shell a 3rd carina is visible as an extension of the suture. Columella smooth, aperture ellipsoid. Honey-yellow towards the apex and red-brown towards the base. The specimen strongly resembles in its outlook *Turritella* (*Archimediella*) *plana* Binkhorst, 1861, a Mesozoic fossil turritellid from Madagascar (MNHN/Paleontology(F)/R07692).

Viriola cf. *bayani* Jousseaume, 1884 (Fig. 2b). Animal agile, of a general dark burgundy-red colour consisting of darker blotches interspersed on a cream background. Foot, periocular areas and cephalic tentacles translucent white with white speckles. Two similar in colour but short additional tentacles as an extension of the lower part of each periocular area. Steger *et al.* (2018) referred as important distinguishing characteristic the inclination of the axial ribs between the main cords in *V. cf. bayani* (orthocline) and *V. corrugata* (prosocline). Marshall (1983) and Albano *et al.* (2019) underline the deep reddish brown colour of *V. cf. bayani* in comparison to the beige of *V. corrugata*. It is believed that the introduced *Viriola* species in the Mediterranean is *V. cf. bayani* (Albano *et al.*, 2019).

Epitonium jolyi (Monterosato, 1878) (Fig. 3c). Similar to *Epitonium clathrus* (Monterosato, 1878) but pure white, wider, with foliaceous axial costae in continuation with those of the previous whorl, profound suture and lack of spiral sculpture.

Melanella sp. 1 (Fig. 6a, b). 1 live individual that we call *M. sp.1a* (Fig. 6a) (10.65 mm high, 3.75 mm wide). Shell cyrtconoidal, opaque, pinkish-white (apparently, the color of the fresh animal inside affected the shell's overall color), thick, with a high, rapidly widening cyrtconoidal spire and a conical protoconch of approximately 2-3 whorls. Its teleoconch consists of 9 moderately convex whorls aligned in two slightly bent axes forming

an angle almost in the middle of the spire and giving the false impression that the, apparently perfect, shell recovered from a breakage. This late characteristic in combination with the rapidly widening of the teleoconch and the prominent suture gives the shell a caecum-like outlook. Surface smooth, shiny and bright, with strong incremental growth marks but not aligned. Under high magnification the surface exhibits very fine and dense spiral striae (perhaps not a true sculpture, but only a product of light refraction/absorbance). The body whorl has a rounded base and occupies almost 45% of the total height. The drop-shape aperture bears a very thick oblique columellar edge with no discontinuity between the columellar edge and the parietal one. The outer lip is orthocline and slightly arquated in its lower part. Operculum corneous and uniformly straw-yellow in color. Animal color light beige-pink with the frontal part and the foot white with an orange imperfect ring around the eyes and translucent white tentacles. One additional live specimen that we call *M.sp.1b* (Fig. 6b) (7.85 mm high, 3.00 mm wide) from the surface of a *Holothuria tubulosa* (Gmelin, 1791) host, at exactly the same spot as the first individual but with a time lapse of 9 years. Its cyrtconoidal shell strongly resembles that of the *M.sp.1a* but it differs in the body whorl which is characteristically angular at the periphery, occupies some 45% of the total height and bears a rhomboid aperture. Operculum corneous and uniformly straw-yellow in color. Animal color beige-pink with the frontal part and the foot white with an orange imperfect ring around the eyes and translucent white tentacles. *Melanella* sp. 1a shell resembles a rather elongated *M. boscii* (Payraudeau, 1826) from which it differs in that *Melanella* sp. 1a: a. has more convex whorls; b. has a more rapidly widening teleoconch; c. develops in two distinctive axes; d. has an outer lip with a different shape. Concerning the animal characters both *M. sp. 1* and *M. boscii* share an orange line below the eyes. It be mentioned that the later character is also present in various other Eulimids such as *M. polita* (Linnaeus, 1758).

M. sp. 1b shell is reminiscent of that of *M. conoidea* Kurtz & Stimpson, 1851 but it is cyrtconoid instead of conical and the operculum is of uniform color in contrast to that of *M. conoidea* which bears shades of golden-brown (<http://calphotos.berkeley.edu/>, free online). Unlike *M. alba* in which the tentacles are orange-yellow from their base to their tip (Gofas *et al.*, 2011), there is only a yellow-orange strip at their base in *M. sp. 1a* & *b*. *M. sp. 1a* & *b* are characteristically different from *M. lubrica* (Monterosato, 1890) in its cyrtconoidal shell (Gofas *et al.*, 2011; Scuderi & Criscione, 2011). *Melanella* sp. 1a & *b* individuals were collected from a highly searched *Zostera* bed rich in holothurians of the genus *Holothuria*, and perhaps represent female and male of a new species. The two specimens have been also compared with *Melanella* species depicted in Chirli (2009).

Melanella sp. 2 (Fig. 7a). 1 shell (5.70 mm high, 2.15 mm wide). The gray-white, smooth and opaque shell has a conical planktotrophic protoconch of 3 whorls, 400 µm high, 240 µm wide, and a teleoconch of 10 almost flat and aligned in two axes whorls, without spiral striation. Growth marks do not align. The body whorl occupies 43% of the shell's length, has an angular base and a prismatic aperture which is 26% of the total length. Inner lip with no parietal callus, reflects over the columella, is straight and forms a 140° angle with the shell's base, The outer lip forms an 115° angle, is orthocline and highly arquated by its lower part as a vertically inverted capital S. *M. sp. 2* resembles the shell of *Parvioris ibizenca* (Nordsieck, 1968) (Fig. 7b) male from which it differs in that *M. sp. 2* shell: a. it is almost double the size of a mature *P. ibizenca* male (Gofas

et al., 2011); b. does not exhibit a bent apex; c. has more flat whorls; d. has a spire developing in two axes; e. has orthocline outer lip in contrast to the prosocline one of *P. ibizenca* (Gofas *et al.*, 2011) (for comparison, see Fig. 7b); f. has a highly arquated outer lip; *M. sp. 2* shell strongly resembles that of *M. conoidea* Kurtz & Stimpson, 1851 an uncommon eulimid of the distant from Greece Gulf of Mexico, but the later has a cyrtocoid spire, fine incised suture and a less sinuous outer lip (<https://www.tapataalk.com/groups/conchologistforum/melanella-conoidea-kurtz-stimpson-1851-t2512.html>). Our sample was also compared with the fossil records of Chirli (2009) and looks quite similar to *M. lactea* (Grateloup, 1838).

Euspira sp. (Fig. 9e, f). One live individual and 1 shell (17.10 and 21.30 mm high, 14.75 mm 18.15 mm wide, respectively). Shell resembles that of *Euspira guillemini* (Payraudeau, 1826) in the shape the colour and the corneous operculum but differs in: a. has a longer parietal callus; b. a smaller aperture; c. a more oblique parietal wall; d. a characteristic notch at the lower part of the parietal callus by its border with the spire.

Rissoella sp. 1 (Fig. 13d-f). Two live individuals and 1 shell (1.00 – 1.15 mm high, 0.75 – 0.85 mm wide). Shell globose, thin, fragile and transparent. Protoconch of 0.75 whorls, nearly 270 µm maximum diameter and a nucleus of approximately 140 µm. Teleoconch of 2 1/2 highly convex and smooth whorls the last of which occupies some 80% of the total shell length. Umbilicus conspicuous, elongated, limited externally by a fine cord and exhibiting diagonally arranged fine wrinkles (Fig. 13e). Aperture semicircular, nearly 55%, columella inclined and slightly curved, external lip fine, peristome continuous. Animal of blackish-brown color and cream-yellow with dark brown speckles on the lighter area towards the foot (Fig. 13f), turning black when dead. Operculum corneous ovoid. *R. sp. 1* strongly resembles *R. contrerasi* Rolán & Hernández, 2004 in its outlook but has a larger protoconch (220 µm in *R. contrerasi*), has wrinkles in the umbilicus and also differs in the colour of the animal. It also differs from the similar in its outlook *R. trigoi* Rolán & Hernández, 2004 in its larger protoconch (180 µm in *R. trigoi*), the wrinkles in the umbilicus and the animal colour (Rolan & Hernandez, 2004; Segers *et al.*, 2009; Caballer *et al.*, 2011). The shells of our specimens look similar in their outlook to *Rissoella cf. confusa* Ponder & Yoo, 1977 Maui, Oahu and Midway, western and central Pacific while the animal of *R. confusa* is black, spotted with chrome-yellow (<http://seaslug-sofhawaii.com/species/Rissoella-confusa-a.html>).

Rissoella sp. 2 (Fig. 13g). One shell (0.70 mm high, 0.50 mm wide). Shell ovate-globose, translucent white, with obtuse apex and protoconch of 215 µm in diameter. Body whorl 75%. Aperture nearly 50%, ovate with columella forming an angle with the parietal wall by the slit umbilicus, and thin and prosocline outer lip. The rough surface covered with spiral series of dimples distinguishes the specimen from the cogenates.

Rissoella sp. 3 (Fig. 14a, b). One live individual (1.00 mm high, 0.75 mm wide). Shell smooth, ovate-globose, transparent and bright, with obtuse apex and protoconch of 230 µm in diameter. Body whorl 80%. Aperture 55%, semi-circular with oblique columella forming an angle with the parietal wall by the wide and deep umbilicus, and thin and prosocline outer lip. Upper part of the animal dark chest-nut brown, lower part lighter to beige. Operculum corneous, straw-yellow. The angular inner lip distinguishes the specimen from similar in shell outlook cogenates. The specimen was photographed live (Fig. 14a) and dry (Fig. 14b).

Rissoella sp. 4 (Fig. 14c). One shell (1.15 mm high, 0.80 mm wide). Shell turritid-globose, translucent and bright, with obtuse apex and depressed whorls. Body whorl 75%. Aperture

50%, ovate, with oblique columella forming an angle with the parietal wall by the wide and deep umbilicus, thin and prosocline outer lip, inner lip slightly reflected. Conspicuous growth marks and very thin and dense spiral lines. Protoconch smooth, 0.5 whorls, approximately 230 µm in diameter.

Ammonicera lignea (Palazzi, 1988) (Fig. 15a). Two live individuals and two shells (0.30 - 0.35 mm high, 0.80 - 1.00 mm wide). The planispiral, minute, pinkish-beige shell bears 3 carinae and 5 insized spiral striae fading out towards the aperture. Protoconch 200 µm in diameter with two ridges on the ½ of the protoconch, teleoconch 0.82 mm in diameter at 2.75 total whorls, animal light beige, operculum corneous. Less rough and more uniformly coloured than the congeneric sibling *A. fisheriana* (Monterosato, 1869). The holotype and paratype of *A. lignea* illustrated by Palazzi (1988, Fig. 9, 18) measure 0.92 mm at 3.24 whorls, and 0.82 mm at 3.13 whorls, respectively (also in Sartori & Bieler, 2014), and Segers *et al.* (2009, p. 488) illustrated a specimen of *A. lignea* measuring 0.8 mm at 2.94 whorls.

Omalogyra disculus Palazzi, 1988 (Fig. 15b). Three live individuals and four shells (0.20 - 0.35 mm high, 0.50 - 1.00 mm wide). Shell planispiral, tightly coiled, with thin wall, opaque, glossy, dark amber in color. Protoconch I 130 µm, of circa 1.00 whorls, protoconch II nearly 0.10 whorls, both sculptured uniformly with raised nodules. Boundary to protoconches I and II well marked. Teleoconch of 2 whorls, with dense growth marks. Inner lip concave, outer lip sharp and orthocline. Aperture sub-circular. *O. disculus* differs from *O. atomus* (Philippi, 1841) in its flatter spire and the rough protoconch (Palazzi, 1988; Rolán, 1992; Segers *et al.*, 2009; Gofas *et al.*, 2011).

Omalogyra sp. (Fig. 15c, d). Two live individuals (0.20 and 0.25 mm high, 0.55 and 0.65 mm wide, respectively). Shell planispiral, tightly coiled, with thin wall, opaque, glossy, light amber in color with 3 spiral dark brown bands on the top, the periphery and the base. Protoconch 140 µm, globose and granulate, of 0.75 whorls. Teleoconch of 1.75 round whorls with dense and thin growth lines, aperture sub-circular, inner lip concave, outer lip slightly projecting, sharp, and orthocline. *O. sp.* strongly resembles *O. atomus* (Philippi, 1841) but the later bears a smooth protoconch (Palazzi, 1988).

Discussion

53 species are identified up to the species level and 9 up to the genus level. Out of the 53, 34 are referred for the first time for the Hellenic fauna raising its documented gastropod biodiversity from 654 species (Manousis *et al.* 2018b) plus 13 rissoids (Manousis *et al.*, 2019) to 701 or by more than 5%. The current improvements for the Hellenic Seas (with the vast majority of them being minute in size and collected from a variety of both substrates and depth range 0-400 m) is attributed to all those collection and handling parameters already mentioned (Manousis & Galinou-Mitsoudi, 2014).

From the above 53 species, 3 [*Melanella sp. 1*, *Ammonicera lignea* (Palazzi, 1988) and *Omalogyra disculus* Palazzi, 1988] are new records for the Mediterranean Sea. The two later very small species have been reported from the E Atlantic. 18 species that are new for the Eastern Mediterranean Sea have been collected from the whole Greek territory.

Viriola cf. bayani Jousseaume, 1884 and *Cerithiopsis pulvis* (Issel, 1869)] are previously reported Lessepsian migrants. *V. cf. bayani*, in particular, has been recorded from SE Aegean [Karthos Island (Micali *et al.*, 2017) and Astypalaia Island (Angelidis & Polyzooulis, 2018)] and now from Saronikos Gulf. The almost simultaneous findings of many species from different areas of Greece indicates once again that they are wider

distributed in the Hellenic Seas and the Eastern Mediterranean Sea, and that independent searches from the same type of substrates and direct sampling might bring to light more species that could otherwise be lost during the collecting procedure and handling.

Field observations and the gross anatomy of their alimentary systems indicate that ptenoglossans are parasites (Fretter & Graham, 1962). Among them, cerithiopsids are usually associated with sponges while eulimids have a strict preference for individual classes of echinoderms (Warén, 1983). At the same time the identification of cerithiopsids, in particular, necessitates the presence of intact protoconches and/or the observation of the color of the living animal and thus the collection of fresh specimens. In the present study we have met those prerequisites by means of brushing their hosts and by keeping the animals alive until they were photographed. The collection and the complete/partial identification lead to the recording of 4 Cerithiopsidae and 12 species of Eulimidae.

Going on with the recording of new species for the Hellenic Seas, we, as well as others in numerous works, face the challenge of the recognition of members of certain difficult families, such as Eulimidae or Rissoellidae. This leads initially to the photographic and descriptive demonstration of the specimens awaiting the scientific community to solve the problems via revisions, DNA analysis and collaborations.

The work continues on other molluscan families and expands in more areas of the Hellenic Seas. We estimate that the Hellenic molluscan biodiversity is not explored yet. The clean oligotrophic waters of E Mediterranean, the plethora of substrates, depths and costal length and diversity, the climate change as well as the human activities (e.g. navigation, expansion of the Suez Canal) seem to be in support of our anticipations.

Acknowledgements

The authors are grateful to the anonymous referees for their useful contribution to improve the publication, to Paolo Russo for aiding them with the identification of *Aegeofusinus margaritae* and to Tassos Porfiris and Giannis Zaminos for entrusting to them their specimens of *Cerithiopsis pulvis* and *Fusinus parvulus*, respectively.

Erratum

In a previous publication of ours (Manousis *et al.*, 2018a) we have by mistake characterized the finding of *Rhinoclavis kochi* (Philippi, 1848) as R1 (first record for Greece). We wish to correct that to R2 (second record for Greece) as the species was previously reported from Greece by D. Poursanidis & G. Zaminos in Lipej *et al.* (2017).

References

- ABDALLA A., LINDEN O., 2008. Maritime traffic effects on biodiversity and potential mitigation measures: a synthesis. In: Abdulla A, Linden O, eds. Maritime traffic effects on biodiversity in the Mediterranean Sea: Review of impacts, priority areas and mitigation measures. IUCN Centre for Mediterranean Cooperation Malaga, Spain: 160-168.
- ALBANO P.G., BAKKER P.A.J., SABELLI B., 2019. Annotated catalogue of the types of Triphoridae (Mollusca, Gastropoda) in the Natural History Museum of the United Kingdom, London. *Zoosyst. Evol.*, 95 (1): 161–308.
- ANGELIDIS A., POLYZOULIS G., 2018. New distributional records of four indo-Pacific species from Astypalaia Island, Greece. *Xenophora*, 21(3): 1-10.
- ARDOVINI R., 2011. *Calliostoma funiculatum* n. Sp. (Gastropoda, Callostomatidae) Sicilia occidentale, Isole Egadi. *Malacologia*, 19-20.
- ASLAN-CIHANGIR H., OVALIS P., 2013. Seasonal Variations and Structure of the Molluscan Assemblage in the Canakkale Strait (Turkey). *Acta zoologica bulgarica*, 65(2): 233-250.
- BOUCHET P., WARÉN A., 1986. Revision of the northeast Atlantic bathyal and abyssal Acilidae, Eulimidae, Epitoniidae (Mollusca, Gastropoda). *Boll. Malacol.*, 1:299-576.
- BOYER F., RENDA W., 2018. About the alleged endemism of marine gastropods in the Strait of Gibraltar. *Xenophora Taxonomy*, 18: 24-36.
- BUZZURRO G., RUSSO P., 2007. *Fusinus* del Mediterraneo/Mediterranean *Fusinus*. Milano, 280 pp. Pubblicato dagli Autori, Milano
- CABALLER M., ORTEA J., NARCISO S., 2011. Description of two new species of *Rissoella* Gray, 1847 (Mollusca, Gastropoda, Heterobranchia) from Venezuela, with key to the Caribbean species known for the genus. *ZooKeys*, 115: 1-18.
- CACHIA C., MIFSUD C., SAMMUT PM., 2001. The Marine Mollusca of the Maltese Islands (part III: sub-class Prosobranchia to sub-class Pulmonata, order Basommatophora). Leiden: Backhuys Publishers.
- CAMPANI E., 2009. Eulimidae Mediterranee. Cocumenti Del Gruppo Malacologico Livornese.
- CAMPANI E., PRKIĆ J., 2009. On *Melanella stalioti* (Brusina, 1869) (Gastropoda: Eulimidae). *Iberus*, 27: 77-83.
- CHIRLI C., 2009. Malacofauna pliocenica Toscana V 7. Firenze: Tavernelle Val di Pesa.
- COSSIGNANI T., ARDOVINI R., 2011. Malacologia Mediterranea. Atlante delle conchiglie del Mediterraneo. Ancona: L' Informatore Piceno.
- DELONGUEVILLE C., SCAILLET R., 2009. *Melanella boscii* (Payraudeau, 1826) parasite de *Ocnus planci* (Brandt, 1835) à Djerba. *NOVAPEX/ Société*, 10: 102-103.
- DONEDDU M., TRAINITO E., 2005. Conchiglie del Mediterraneo: guida ai molluschi conchigliati. Castello, Trezzano sul Naviglio.
- FRETTER V., GRAHAM A., 1962. British Prosobranch Molluscs: their functional anatomy and ecology. Ray Society, London.
- GALIL BS., ZENETOS A., 2002. A sea change - exotics in the Eastern Mediterranean. In: Leppäkoski E, Gollasch S, Olenin S, eds. Invasive aquatic species of Europe. Distributions, impacts and management. Kluwer Academic Publishers, Dordrecht: 325-336.
- GALIL BS., OCCHIPINTI-AMBROGI A., GOLLASCH S., 2008. Biodiversity impacts of species introductions via marine vessels. In: Abdulla A, Linden O, eds. Maritime traffic effects on biodiversity in the Mediterranean Sea: Review of impacts, priority areas and mitigation measures. IUCN Centre for Mediterranean Cooperation, Malaga, Spain: 117-157.
- GIANNUZZI-SAVELLI R., PUSATERI F., PALMERI A., EBREO C., 1999. Atlante delle conchiglie marine del Mediterraneo, Vol. 3. Roma: Evolver.
- GIANNUZZI-SAVELLI R., PUSATERI F., MICALI P., NOFRONI I., BARTOLINI S., 2014. Atlante delle conchiglie marine del Mediterraneo, Vol. 5. Palermo: Edizioni Danaus.
- GOFAS S., MORENO D., SALAS C., 2011. Moluscos Marinos de Andalucía, Vol. 1. Málaga: Universidad de Málaga.
- <http://calphotos.berkeley.edu/>
- https://science.mnhn.fr/institution/mnhn/collection/f/item/r07692?lang=en_US
- <https://services.ath.hcmr.gr>
- <http://tolweb.org/Atlanta/28752>
- <http://www.mamias.org>
- <http://www.marbef.org>
- <http://www.marinespecies.org>

- <http://www.naturamediterraneo.com>
- http://www.somali.asso.fr/clemam/biota_xis.php
- <https://www.tapataalk.com/groups/conchologistforum/melanella-conoidea-kurtz-stimpson-1851-t2512.html>
- KAY EA., 1979. Hawaiian Marine Shells. Reef and Shore fauna of Hawaii. Section 4: Mollusca. Bernice P. Bishop Museum Special Publication 64(4), Bishop Museum Press, Honolulu, Hawaii, 653 pp.
- KOUKOURAS A., 2010. Check-list of marine species from Greece. Aristotle University of Thessaloniki. Assembled in the framework of the EU FP7 PESI project. <http://www.marinespecies.org/aphia.php?p=sourcedetails&id=142068>.
- LIPEJ L., ACEVEDO I., AKEL EHK., ANASTASOPOULOU A., ANGELIDIS A., AZZURRO A., CASTRIOTA L., ÇELİK M., CILENTI L., CROSETTA F., DEIDUN A., DOGRAMMATZI A., FALAUTANO M., FERNÁNDEZ-ÁLVAREZ FÁ., GENNAIO R., INSACCO G., KATSANEVAKIS S., LANGENECK J., LOMBARDO BM., MANCINELLI G., MYTILINEOU Ch., PAPA L., PITACCO V., PONTES M., POURSANIDIS D., PRATO E., RIZKALLA SI., RODRIGUEZ-FLORES PC., STAMOULI C., TEMPESTI J., TIRALONGO F., TIRNETTA S., TSIRINTANIS K., TURAN C., YAGLIOGLU D., ZAMINOS G., ZAVA B., 2017. New Mediterranean Biodiversity Records (March 2017). *Mediterr. Mar. Sci.*, 18: 179–201, <https://doi.org/10.12681/mms.2068>
- MANOUSIS T., MPARDAKIS G., ZAMORA SILVA A., PARASKEVOPOULOS C., MANIOS D., GALINOUMITSOUDI S., 2012. New findings of Gastropods in the Hellenic seas with emphasis on their origin and distribution status. *J Biol Res Thessalon.*, 18:249–64.
- MANOUSIS T., GALINOUMITSOUDI S., 2014. New gastropod records for the Eastern Mediterranean Sea and one new alien (*Emarginula decorata* Deshayes, 1863) for the Mediterranean Sea from NW Aegean Sea, Greece. *J Biol Res Thessalon.*, 21: 1-20.
- MANOUSIS T., KONTADAKIS C., MBAZIOS G., POLYZOULIS G., GALINOUMITSOUDI S., 2017. Possible poecilogony due to discontinuous multifactorial inheritance in some Mediterranean species of Raphitoma (Mollusca, Conoidea, Raphitomidae). *Organismal and Molecular Malacology*, Prof. Sajal Ray (Ed.), InTech, DOI: 10.5772/67847. Available from: <https://www.intechopen.com/books/organismal-and-molecular-malacology/possible-poecilogony-due-to-discontinuous-multifactorial-inheritance-in-some-mediterranean-species-o>
- MANOUSIS T., KONTADAKIS C., POLYZOULIS G., MBAZIOS G., GALINOUMITSOUDI S., 2018a. New marine gastropod records for the Hellenic waters. *J Biol Res Thessalon.*, 25:6.
- MANOUSIS T., KONTADAKIS C., POLYZOULIS G., MBAZIOS G., 2018b. The family Raphitomidae (Mollusca: Gastropoda: Conoidea) in the Greek Seas with the description of two new species. *J Biol Res Thessalon.*, 25: 14.
- MANOUSIS T., KONTADAKIS C., MBAZIOS G., GALINOUMITSOUDI S., 2019. New records of Rissoidae (Mollusca: Gastropoda) for the Hellenic Seas with the description of *Rissoa electrae* n. sp.. *Xenophora Taxonomy*, 26: 1-11 (in press).
- MARSHALL BA., 1983. A revision of the Recent Triphoridae of southern Australia. Records of the Australian Museum, supplement, 2: 1-119.
- MICALI P., SIRAGUSA F., AGAMENNONE F., GERMANÁ F., SBRANA C., 2017. Karpathos Island (Greece) and its Indo-Pacific alien species. Part 1. *Boll. Malacol.*, 53: 40-48.
- MNHN/Paleontology(F)/R07692
- OLIVERIO M., BUZZURRO G., VILLA R., 1994. A new Eulimid Gastropod from the Eastern Mediterranean sea (Caenogastropoda, Ptenoglossa). *Boll Malacol.*, ;30: 211-215.
- PALAZZI S., 1988. Note sugli Omalogyridae Mediterranei e Maderensi. *Boll Malacol.*, 24(5-8): 101-111.
- POR FD., 1990. Lessepsian migration. An appraisal and new data. *Bulletin de l'Institut Oceanographique Monaco*, 7: 1-10.
- REITANO A., BUZZURRO G., 2006. Descrizione di una nuova specie di Cerithiopsidae per le coste della Sicilia Orientale. *Naturalista sicil.*, 4: 549-554.
- REPETTO G., ORLANDO F., ARDUINO G., 2005. Conchiglie del Mediterraneo. Alba: Amici del Museo "Federico Eucebio".
- ROLÁN E., 1992. The family Omalogyridae G. O. Sars, 1878 (Mollusca, Gastropoda) in Cuba with description of eight new species. *APEX*, 7(2): 35-46.
- ROLÁN E., HERNÁNDEZ JM., 2004. Dos nuevas especies de *Risoella* (Mollusca: Rissoellidae) de las Islas Canarias y Senegal. *Rev. Acad. Canar. Cienc.*, 15(3-4): 229-235.
- ROMANI L., RAVEGGI A., SCAPERROTTA M., BARTOLINI S., 2017. Nota sui micromolluschi marini conchiferi rinvenuti nei dintorni di Paleokastritsa (Corfù [Kerkyra] Grecia, Mar Ionio Nord-Orientale). *Alleryana*, 35(1): 24-46.
- RUSSO P., 2018. Il genere *Ocenebra* Gray, 1847 (Gastropoda: Muricidae) nel Mare Mediterraneo. *Alleryana*, 36(2): 68-85.
- SARTORI AF., BIELER R., 2014. Three new species of *Ammonicera* from the Eastern Pacific coast of North America, with redescrptions and comments on other species of Omalogyridae (Gastropoda, Heterobranchia). *Zootaxa*, 3872(1): 001–021.
- SCAPERROTTA M., BARTOLINI S., BOGI C., 2011. Stadi di Accrescimento dei Molluschi Marini del Mediterraneo/Stages of Growth of Marine Molluscs of the Mediterranean, Volume 4. Ancona: L'Informatore Piceno.
- SCAPERROTTA M., BARTOLINI S., BOGI C., 2015. Stadi di Accrescimento dei Molluschi Marini del Mediterraneo/Stages of Growth of Marine Molluscs of the Mediterranean, Volume 7. Ancona: L'Informatore Piceno.
- SCUDERI D., CRISCIONE F., 2011. New ecological and taxonomical data on some Ptenoglossa (Mollusca, Caenogastropoda) from the Gulf of Catania (Ionian Sea). *Biodiversity Journal*, 2(1): 35-48.
- SEGRS W., SWINNEN F., DE PRINS R., 2009. Marine Mollusks of Madeira. Zwijndrecht: Snoeck Publications.
- SMRIGLIO C., MARIOTTINI P., BUZZURRO G., 1998. The *Trivia spon-gicola* complex, with the description of a new species (Caenogastropoda Triviidae). *Boll Malacol.*, 33: 161-8.
- STEGER J., STOCKINGER M., IVKIĆ A., GALIL BS., ALBANO PG., 2018. New records of non-indigenous molluscs from the eastern Mediterranean Sea. *Bioinvasions Rec.*, 7(3): 245–257.
- STREFTARIS N., ZENETOS A., PAPATHANASSIOU E., 2005. Globalisation in marine ecosystems: the story of non-indigenous marine species across European seas. *Oceanography and Marine Biology: an Annual Review*, 43: 419-453.
- STREFTARIS N., ZENETOS A., 2007. Molluscan diversity in the N. East Aegean-Greece. Rapport de la Commission Internationale pour l'Exploration Scientifique de la Mer Méditerranée, 38: 607.
- WARÉN A., 1983. A generic revision of the family Eulimidae (Gastropoda, Prosobranchia). *J Mollus Stud.*, 13: 1-96.
- VERDUIN A., 1976. On the systematics of recent *Rissoa* of the subgenus *Turboella* Gray, 1847, from the Mediterranean and the European Atlantic coasts. *Basteria*, 40: 21–73.
- ZENETOS A., KOUTSOUBAS D., VARDALA-THEODOROU E., 2005. Origin and vectors of introduction of exotic molluscs in Greek waters. *Belgian Journal Zoology*, 135(2): 279-286.
- ZENETOS A., VASSILOPOULOU V., SALOMIDI M., POURSANIDIS D., 2008. Additions to the marine alien fauna of Greek waters (2007 update). *Mar Biodiv Records*, 1:e91. <https://doi.org/10.1017/S1755267207009281>.

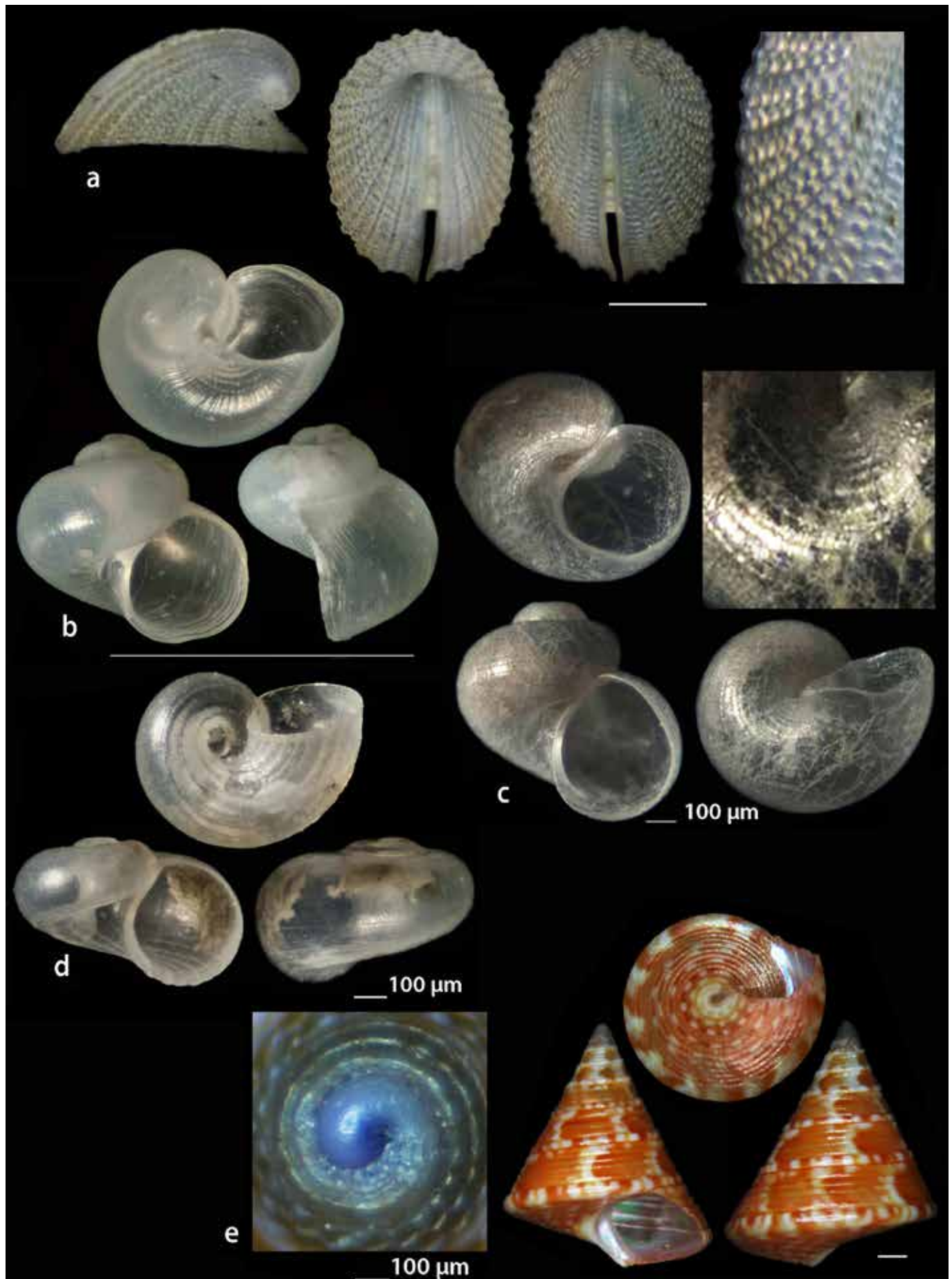


Figure 1: a. *Emarginula tenera* Locard, 1892, b. *Dikoleps marianae* Rubio, Dantart & Luque, c. *Dikoleps templadoi* Rubio, Dantart & Luque, 2004, d. *Skenea serpuloides* (Montagu, 1808), e. *Calliostoma funiculatum* Arduvini, 2011. Bar = 1 mm, unless otherwise indicated.

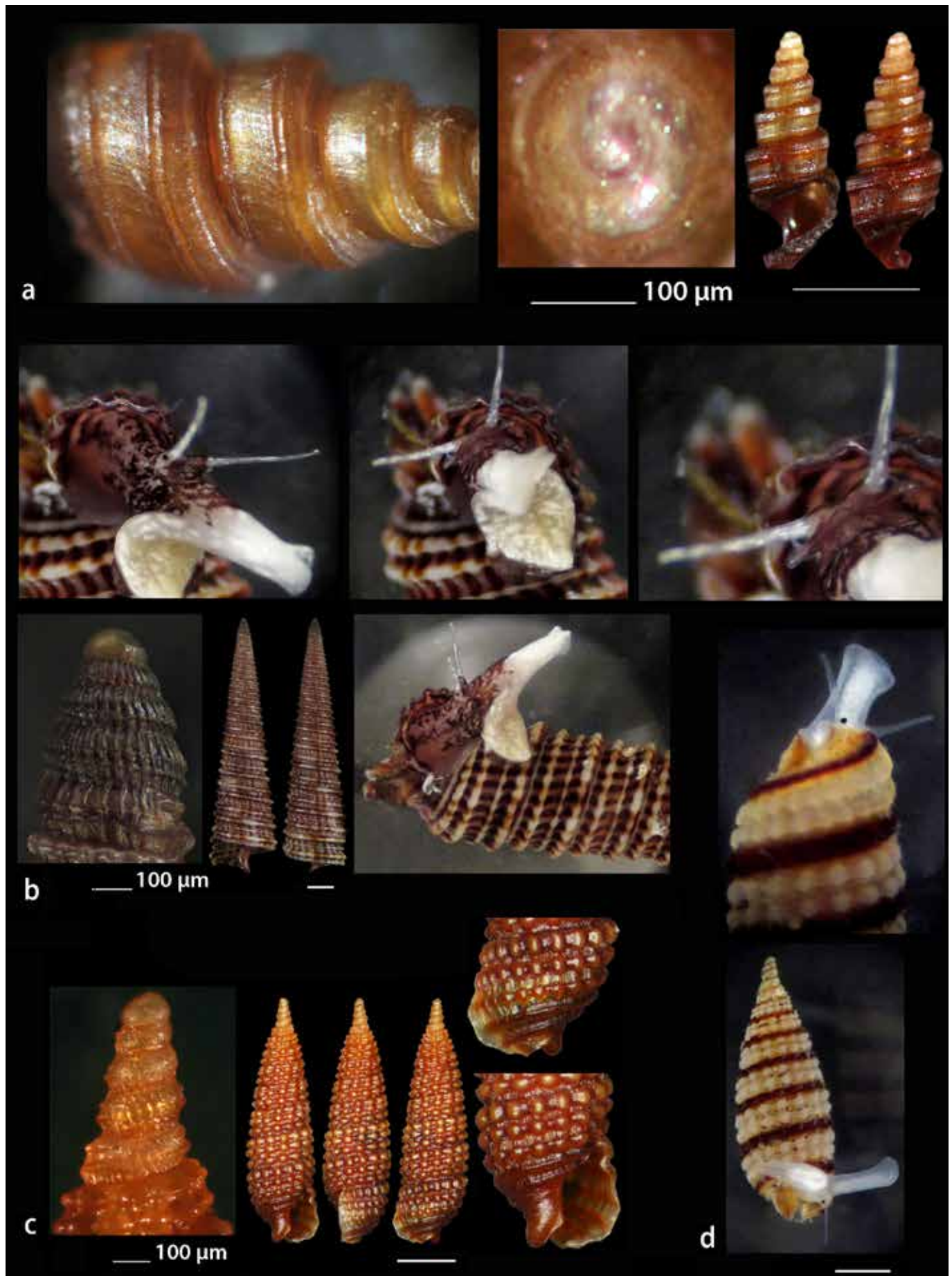


Figure 2: a. *Turritella* sp., b. *Viriola* cf. *bayani* Jousseaume, 1884, shell and live individual, c. *Cerithiopsis iudithae* Reitano & Buzzurro, 2006, d. *Cerithiopsis pulvis* (Issel, 1869) live. Barr = 1 mm, unless otherwise indicated.

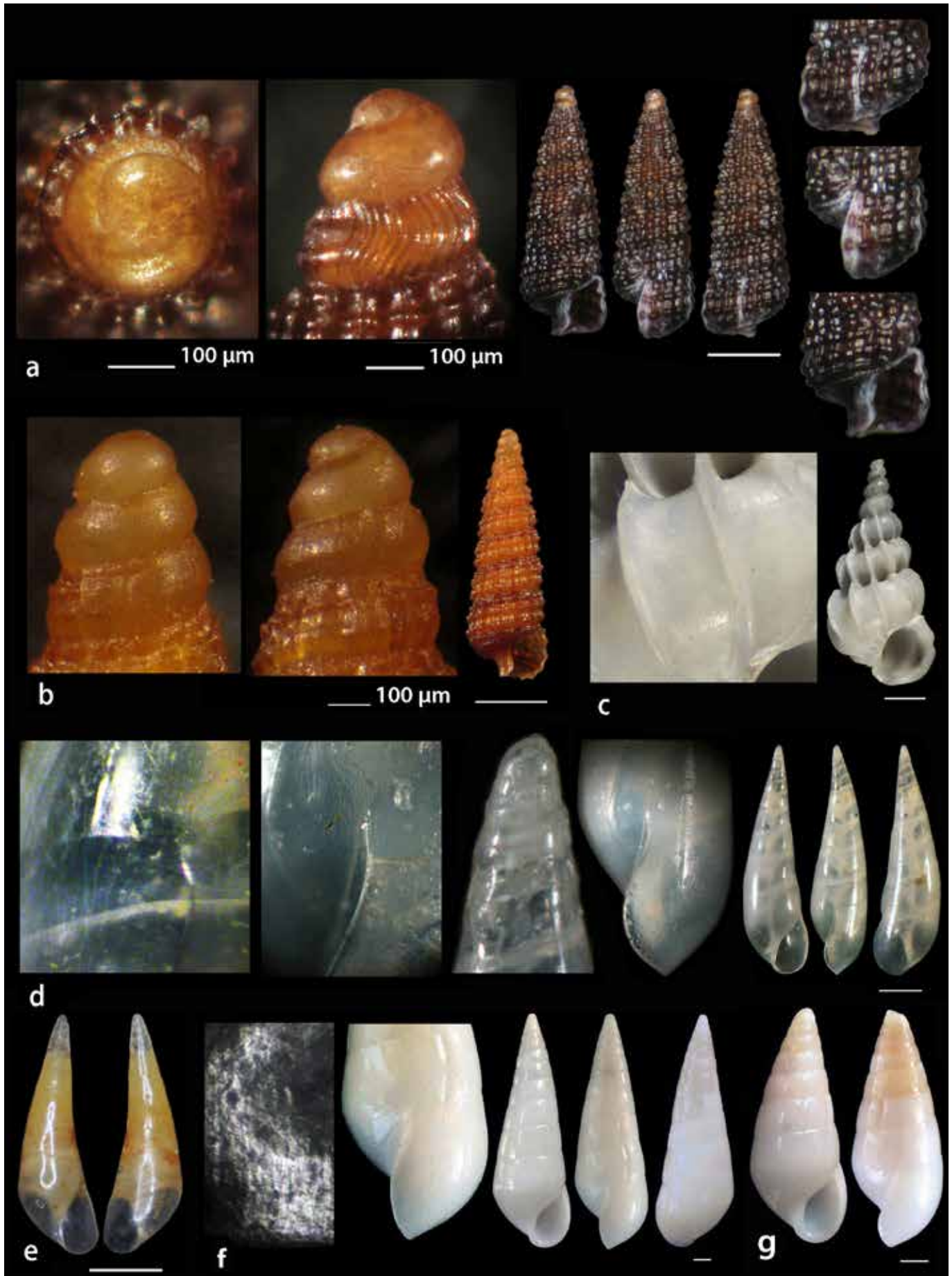


Figure 3: a. *Krachia cylindrata* (Jeffreys, 1885), b. *Krachiopsis giannuzzii* Smriglio & Mariottini, 1999, c. *Epitonium jolyi* (Monterosato, 1878), d. *Campylorhaphion famelicum* (R. B. Watson, 1883), e. *Curveulima devians* (Monterosato, 1884), f. *Melanella alba* (da Costa, 1778), g. *Melanella boscii* (Payraudeau, 1826). Barr = 1 mm, unless otherwise indicated.

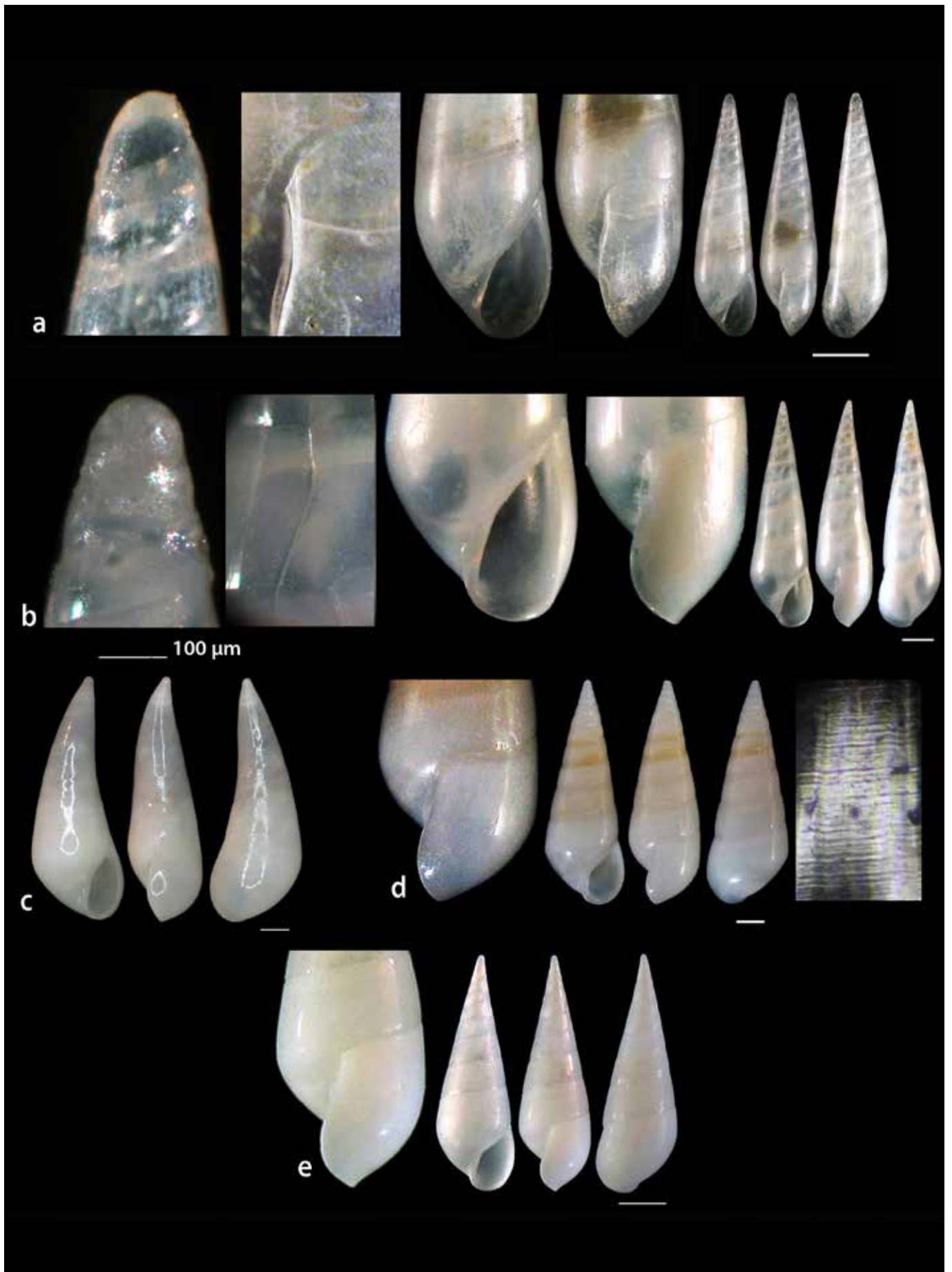


Figure 4: a. *Melanella compactilis* (Locard, 1892), b. *Melanella frielei* (Jordan, 1895), c. *Melanella levantina* (Oliverio, Buzzurro & Villa, 1994), d. *Melanella lubrica* (Monterosato, 1890) mature female, e. *M. lubrica*, mature male. Barr = 1 mm, unless otherwise indicated.

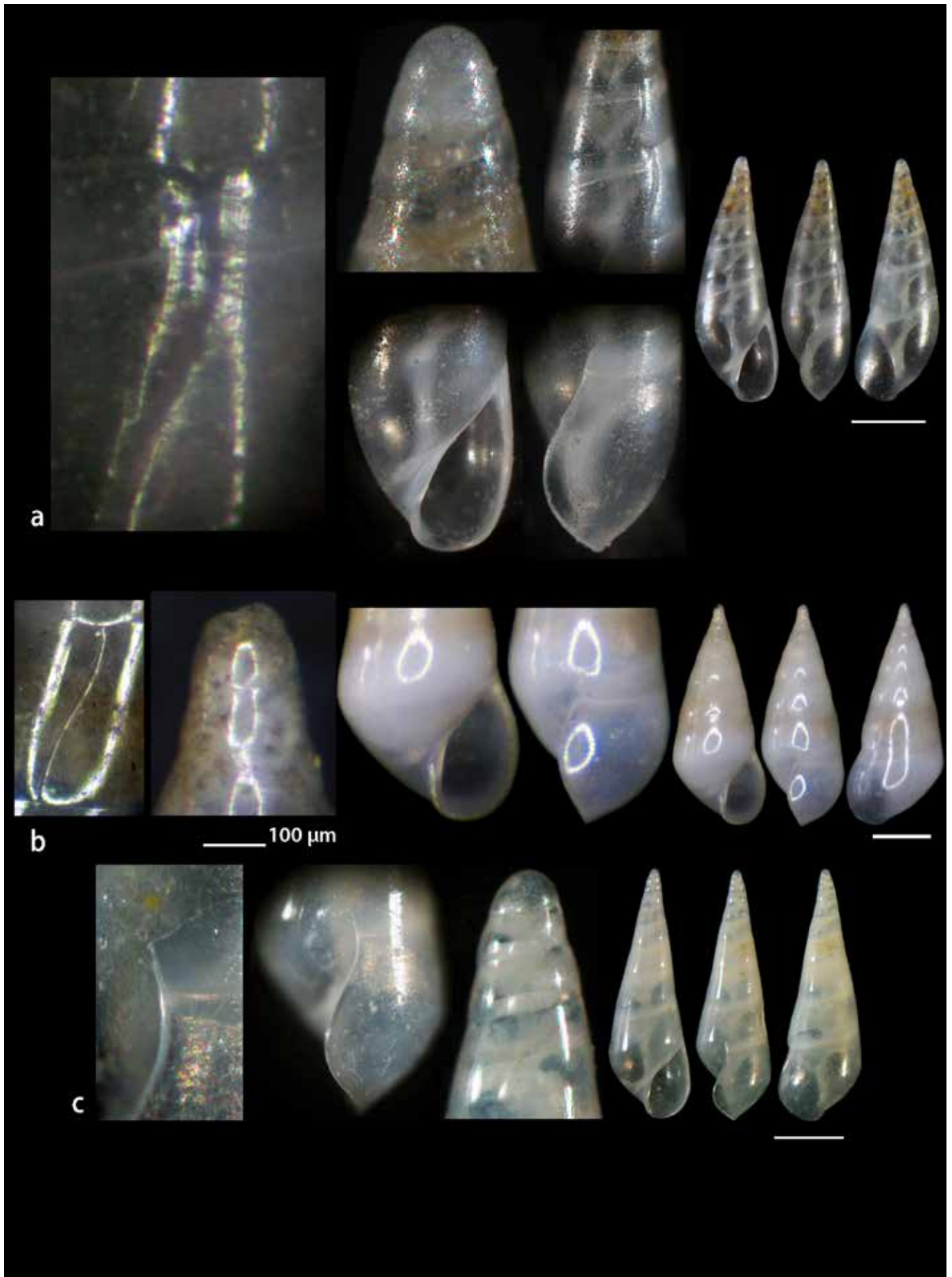


Figure 5: a. *Melanella monterosatoi* (Monterosato, 1890), b. *Melanella petitiana* (Brusina, 1869), c. *Melanella translucens* (Monterosato, 1890). Barr = 1 mm, unless otherwise indicated.

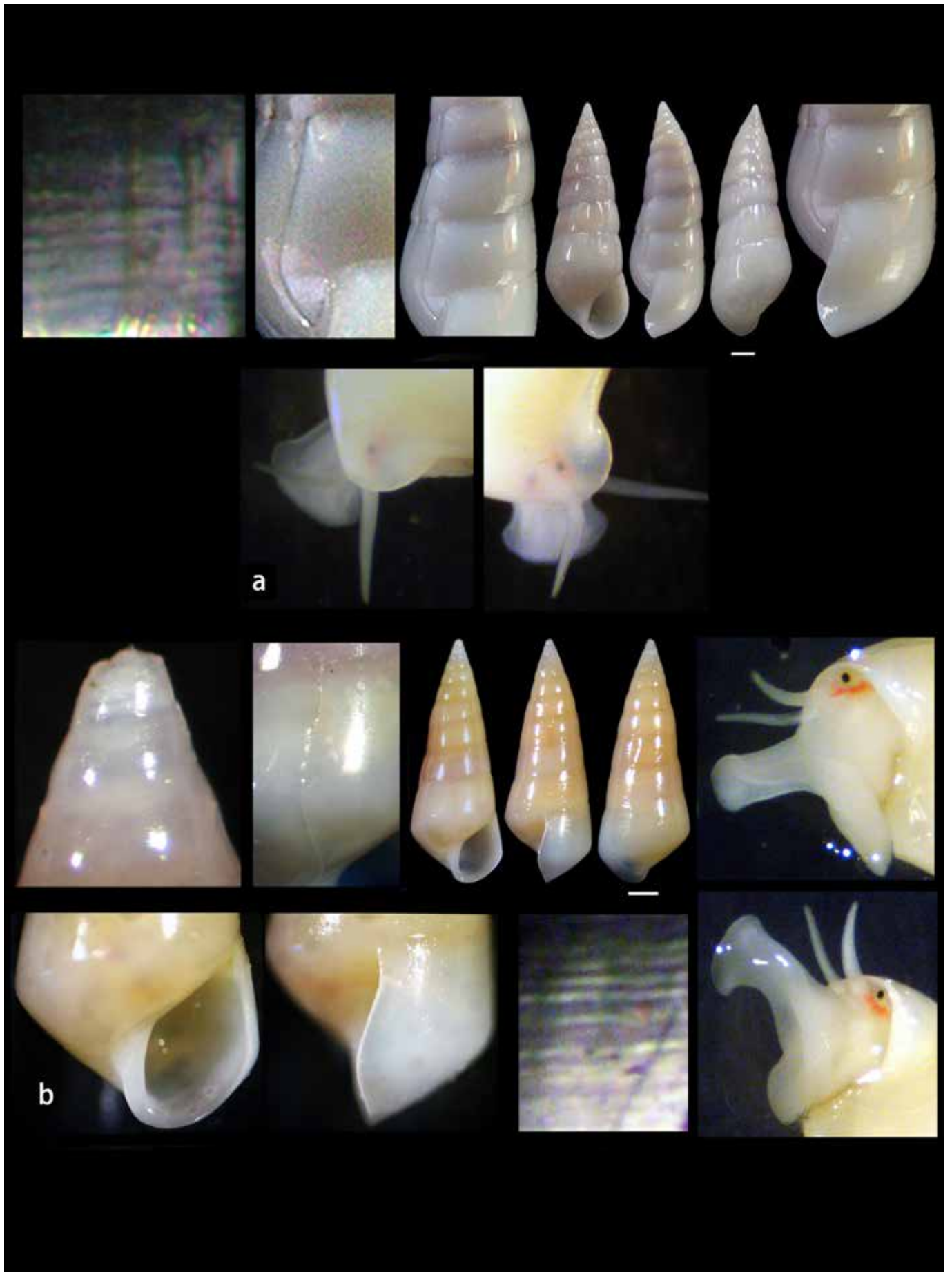


Figure 6: a. *Melanella* sp. 1. "female", b. *Melanella* sp. "male". Barr = 1 mm.



Figure 7: a. *Melanella* sp. 2, b. *Parvioris ibizenca* male, c. *Vitreolina perminima* (Jeffreys, 1883). Barr = 1 mm, unless otherwise indicated.

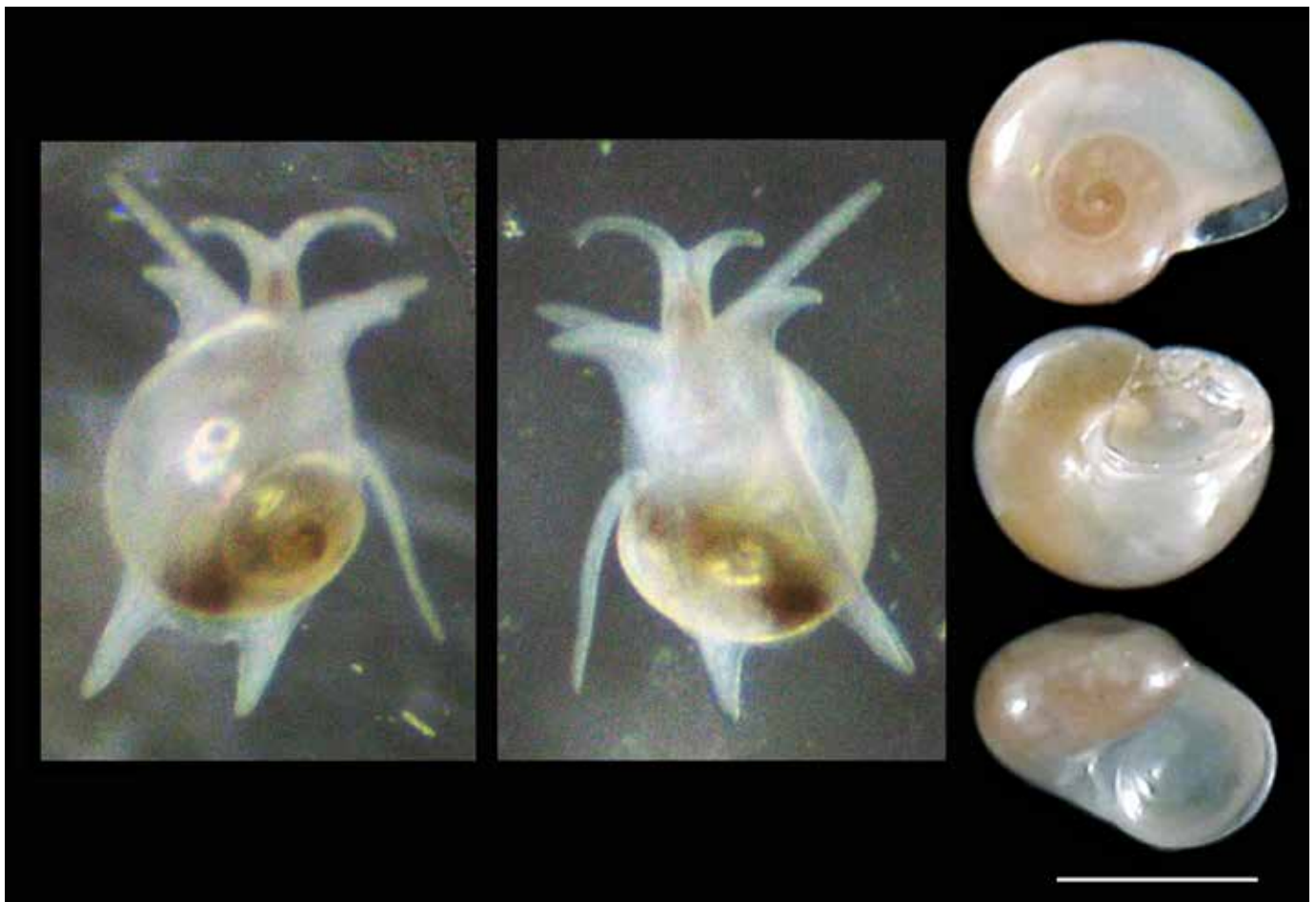


Figure 8: *Tomura depressa* (Granata-Grillo, 1877). Barr = 1 mm.

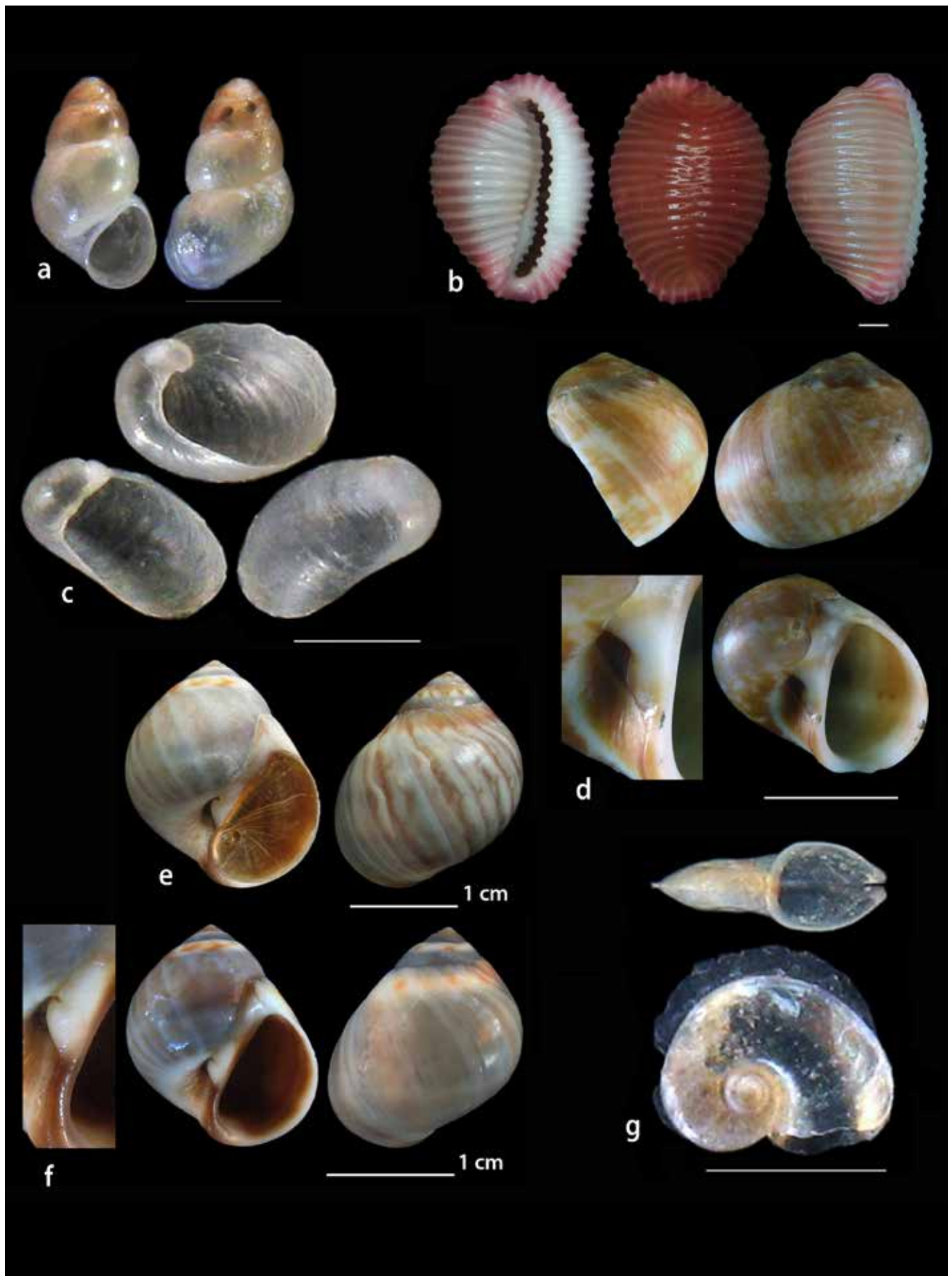


Figure 9: a. *Hydrobia glyca* (Servain, 1880), b. *Trivia levantina* Smriglio, Mariottini & Buzzurro, 1998, c. *Lamellaria latens* (Müller O.F., 1776), d. *Natica prietoi* Hidalgo, 1873, e. *Euspira* sp., f. *Euspira* sp., g. *Atlanta inflata* J.E. Gray, 1850. Barr = 1 mm, unless otherwise indicated.



Figure 10: a. *Atlanta selvagensis* de Vera & Seapy, 2006, b. *Protatlanta souleyeti* (E. A. Smith, 1888), c. *Gibberula jansseni* van Aartsen, Menkhorst & Gittenberger, 1984, d. *Gibberula simonae* Smriglio in Giannuzzi-Savelli, Pusateri, Palmeri & Ebreo, 2003, e. *Granulina boucheti* Gofas, 1992, f. *Granulina gofasi* Smriglio & Mariottini, 1996, g. *Granulina melitensis* Smriglio, Mariottini & Rufini, 1998, h. *Granulina torosa* Gofas, 1992. Barr = 1 mm, unless otherwise indicated.

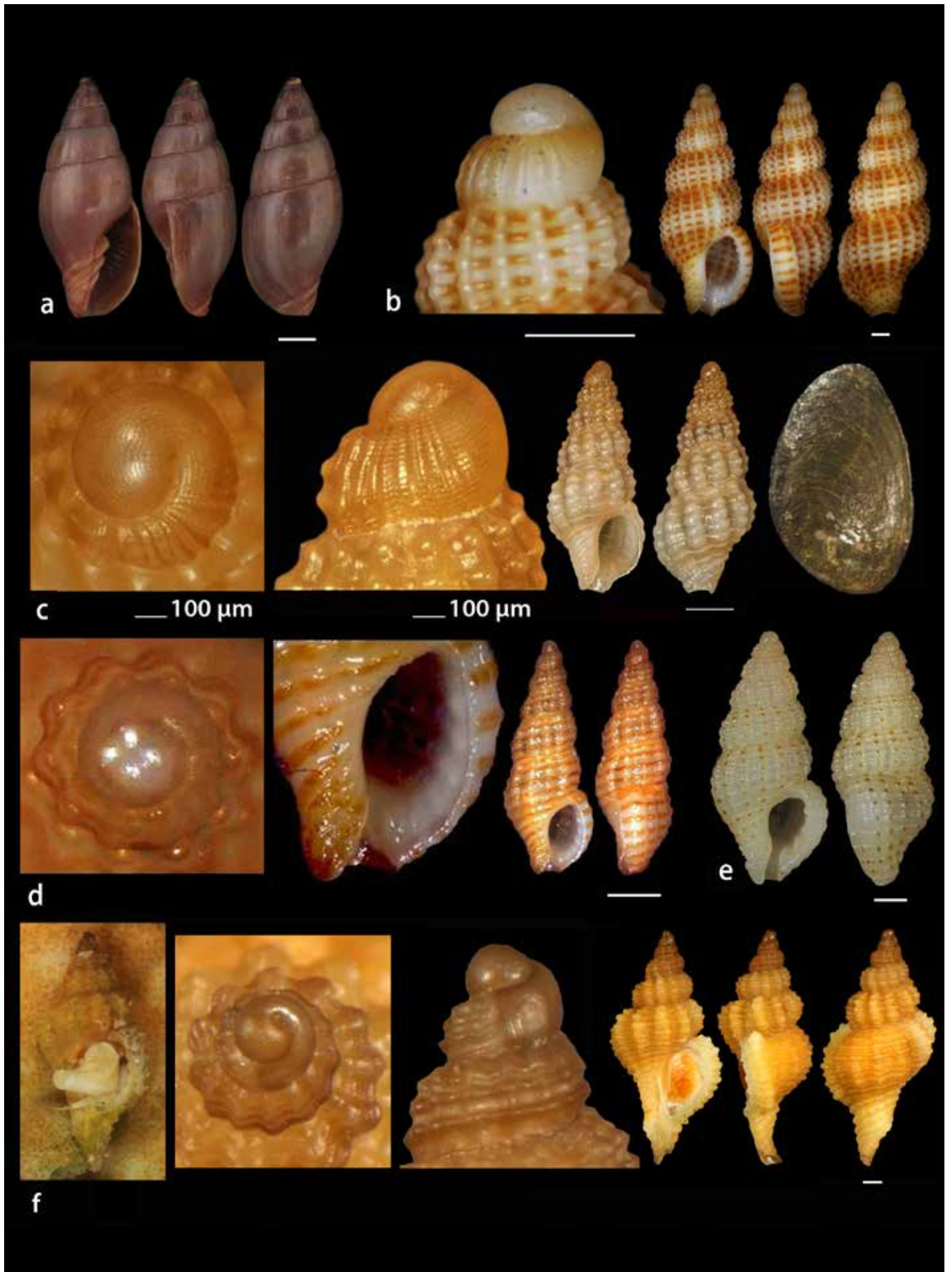


Figure 11: a. *Vexillum hypatiae* (Pallary, 1912), b. *Chauvetia lineolata* (Tiberi, 1868), c. *Chauvetia procerula* (Monterosato, 1889), d. *Chauvetia turritellata* (Deshayes, 1835), e. *Chauvetia ventrosa* Nordsieck, 1976; f. *Ocenebra helleri* (Brusina, 1865). Barr = 1 mm, unless otherwise indicated.

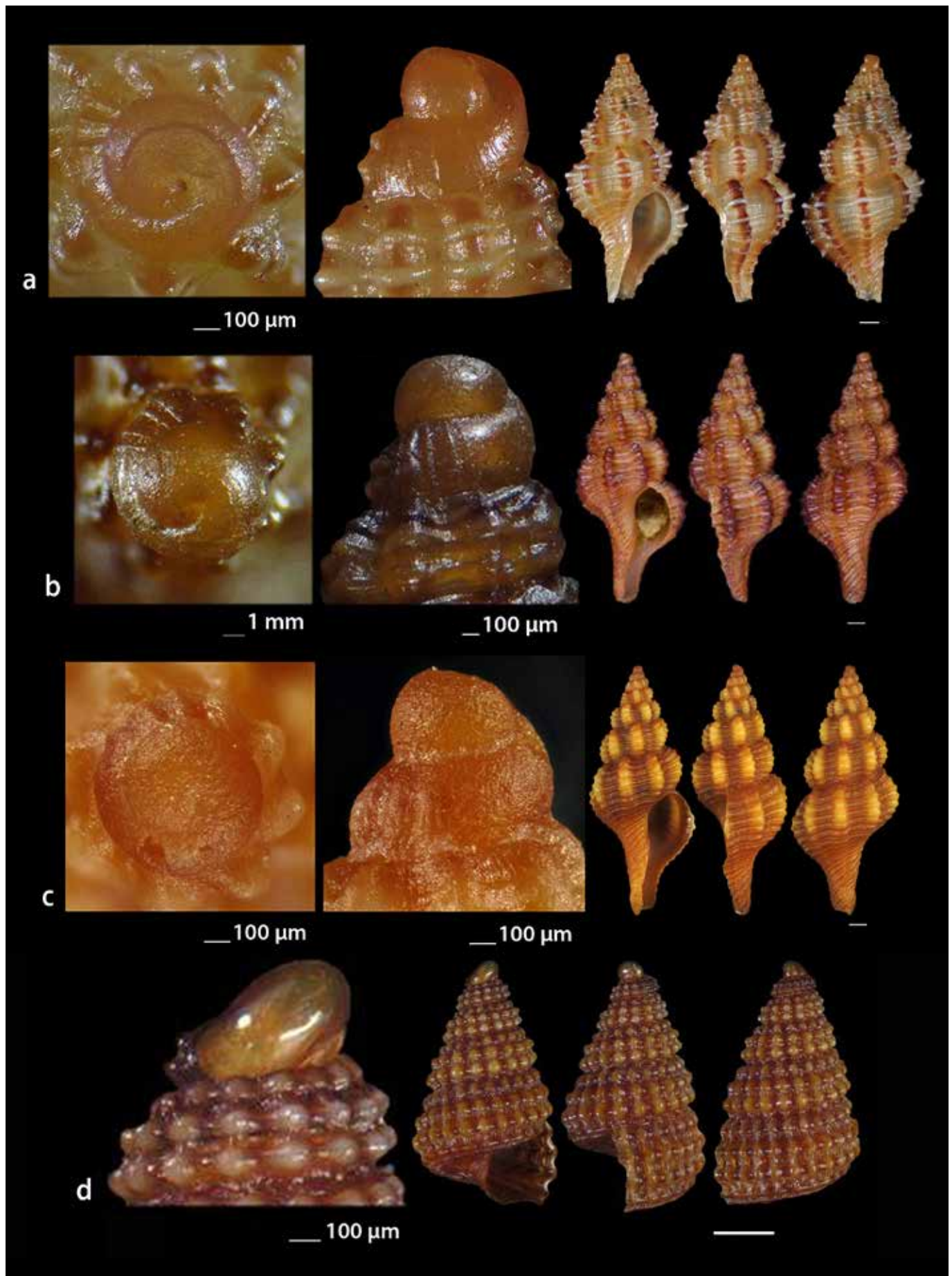


Figure 12: a. *Aegeofusinus margaritae* (Buzzurro & Russo, 2007), b. *Fusinus alternatus* Buzzurro & Russo, 2007, c. *Fusinus parvulus* (Monterosato, 1884), d. *Mathilda retusa* Brugnone, 1873. Barr = 1 mm, unless otherwise indicated.

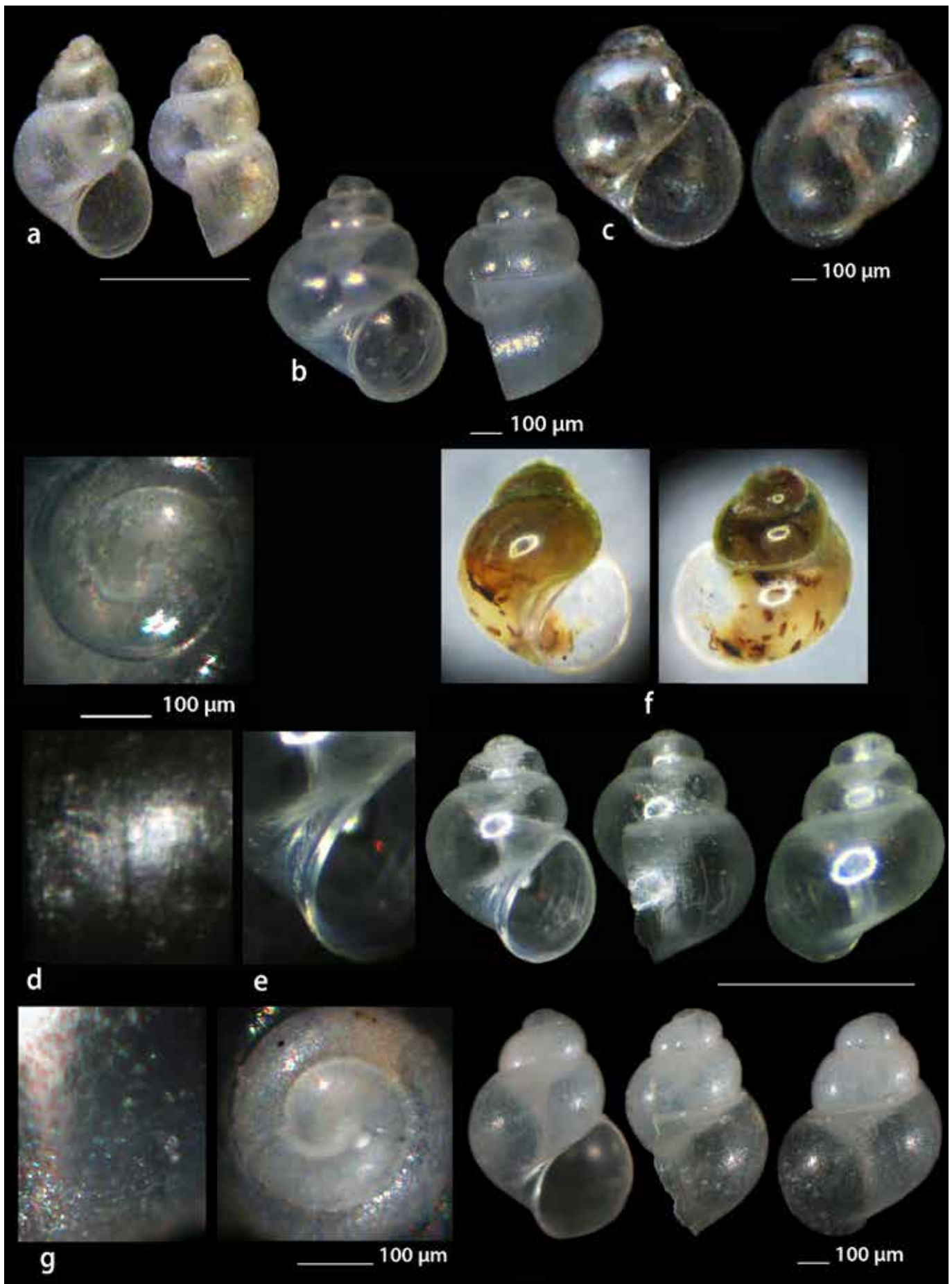


Figure 13: a. *Rissoella diaphana* (Alder, 1848), b. *Rissoella globularis* (Forbes & Hanley, 1853), c. *Rissoella opalina* (Jeffreys, 1848), d-f. *Rissoella* sp. 1, g. *Rissoella* sp. 2. Barr = 1 mm, unless otherwise indicated.

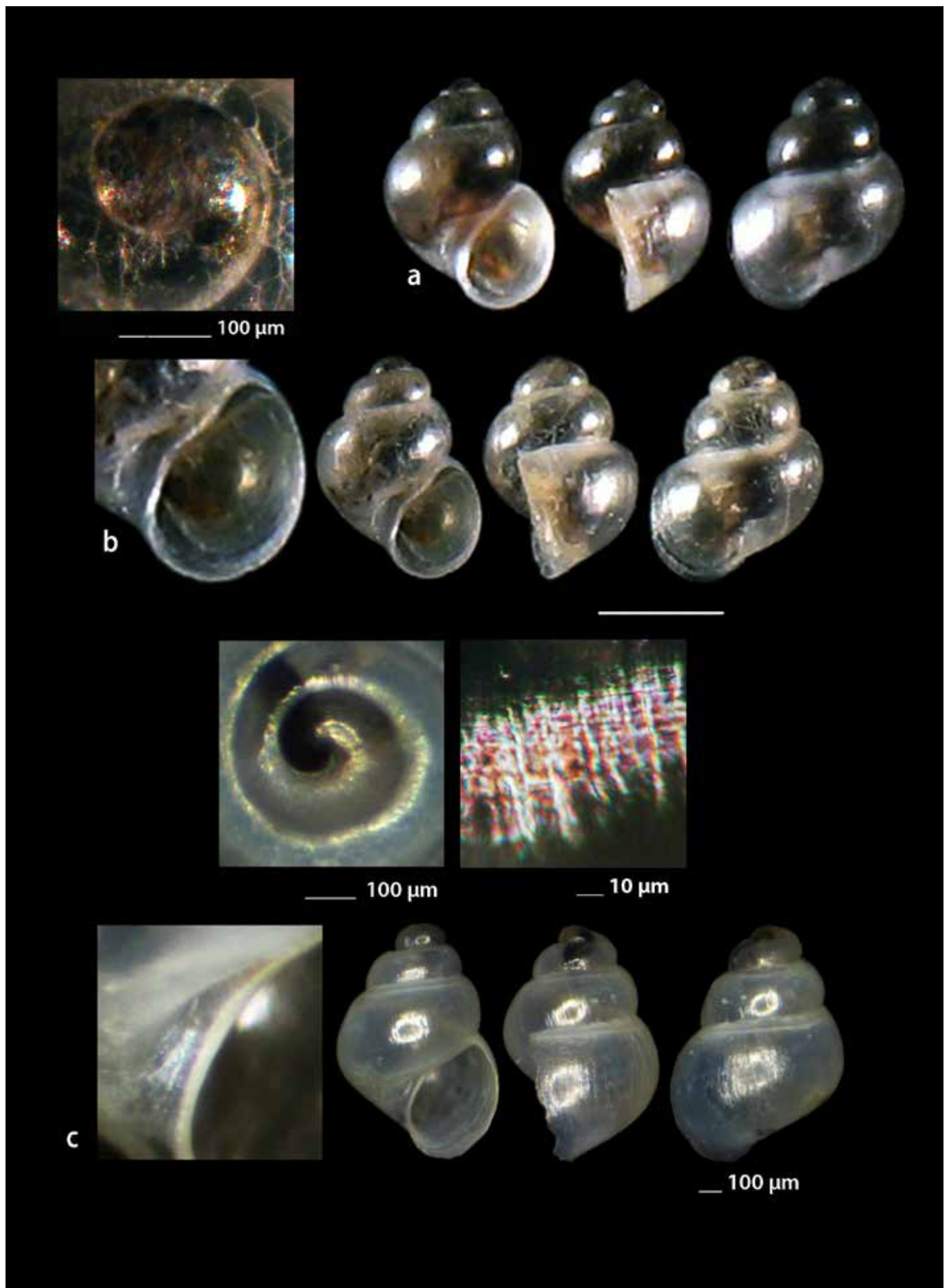


Figure 14: a and b. *Rissoella* sp. 3, live (a) and shell (b), respectively, c. *Rissoella* sp. 4,. Barr = 1 mm, unless otherwise indicated.



Figure 15: a. *Ammonicera lignea* (Palazzi, 1988), b. *Omalogyra disculus* Palazzi, 1988, c and d. *Omalogyra* sp. specimens 1 and 2, respectively, e. *Retrotortina fuscata* Chaster, 1896. Barr = 1 mm, unless otherwise indicated.

Table 1: The recorded species of the study. In the Literature column, helpful references for each species identification are included. Dash (-) indicates lack of information.

Family	Species	Figure	Shells	Live	Depth m	Bottom	Area	Global coordinates	Rarity	Origin	Record	Literature
Fissurellidae	<i>Emarginula tenera</i> Locard, 1892	1a	1		10	MB	Paralia, Epanomi	40°21'N - 22°50'E	Co	MS	G2	Repetto et al., 2005 Scaperrotta et al., 2011 Romani et al., 2017
Skeneidae	<i>Dikoleps marianae</i> Rubio, Dantart & Luque, 1998	1b	1		40 100	MB MB	Anafi Island C Siggitikos Gulf	36°20'N - 25°46'E 40°11'N - 24°02'E	Ra	WMS	G2, EMS2	Repetto et al., 2005 Gofas et al., 2011 Romani et al., 2017
	<i>Dikoleps templadoi</i> Rubio, Dantart & Luque, 2004	1c	3		400	CB	Lemnos Island	40°05'N - 25°12'E	Ra	WMS	G2, EMS2	Romani et al., 2017
	<i>Skenea serpuloidea</i> (Montagu, 1808)	1d	1		80	MB	Damatria, Karpathos Island	35°23'N - 27°08'E	Un	MS	G2, EMS2	Repetto et al., 2005 Romani et al., 2017
Calliostomatidae	<i>Calliostoma funiculatum</i> Ardovini, 2011	1e	2	2	10 10 80	MB MB MB	Paralia, Epanomi Nea Kalikratia Ammouliani, Chalkidiki	40°21'N - 22°50'E 40°18'N - 23°03'E 40°15'N - 23°51'E	Un	CMS	G1, EMS1	Ardovini, 2011
Turritellidae	<i>Turritella</i> sp., description in text	2a	1		20	MB	Nea Michaniona	40°27'N - 22°50'E				MNH/Paleontology(F)/ R07692
Triphoridae	<i>Viriola</i> cf. <i>bayani</i> Jousseaume, 1884, expansion, live animal, in text	2b	2	1	50	MB	C Saronikos Gulf	37°54'N - 23°39'E	Ra	LM	expanded	Micali et al., 2017 Angelidis & Polyzoulis, 2018 Albano et al., 2019
Cerithiopsidae	<i>Cerithiopsis iudithae</i> Reitano & Buzzurro, 2006	2c	2		80	BB	Skyros Island	38°50'N - 24°30'E	Un	CMS	G1, EMS1	Reitano & Buzzurro, 2006
	<i>Cerithiopsis pulvis</i> (Issel, 1869), live animal	2d		1	3	MB	Saronikos Gulf	37°45'N - 23°54'E	Ra	LM	G2	Manousis et al., 2018a
	<i>Krachia cylindrata</i> (Jeffreys, 1885)	3a	1		80	BB	Skyros Island	38°50'N - 24°30'E	Un	CMS	G1, EMS1	Giannuzzi-Savelli et al., 1999 Repetto et al., 2005 Romani et al., 2017, without photographic documentation
	<i>Krachiopsis giannuzzi</i> Smriglio & Mariottini, 1999	3b	1		50	MB	C Saronikos Gulf	37°54'N - 23°39'E	Ra	CMS	G1, EMS1	Giannuzzi-Savelli et al., 1999 Repetto et al., 2005
Epitoniidae	<i>Epitonium jolyi</i> (Monterosato, 1878), comment in text	3c	1		5	MB	S Evoikos Gulf	38°07'N - 24°00'E	Ra	WCMS	G1, EMS1	Repetto et al., 2005 Cossignani & Ardovini, 2011 Gofas et al., 2011
Eulimidae	<i>Campylorhaphion famelicum</i> (R. B. Watson, 1883)	3d	2		100	MB	C Siggitikos Gulf	40°11'N - 24°02'E	Un	MS	G1	Repetto et al., 2005 Cossignani & Ardovini, 2011

	<i>Curveulima devians</i> (Monterosato, 1884)	3e		1	40	MB	Kartalia, Sithonia	39°56'N 23°58'E	Un	WCMS	G1	Campani, 2001 Cossignani & Ardovini, 2011 Gofas et al., 2011
	<i>Melanelia alba</i> (da Costa, 1778)	3f	5		3 0,2	MB ZB	Palioura, Epanomi Cape, Epanomi	40°25'N - 22°52'E 40°23'N - 22°53'E	Ra	MS	G1	Gofas et al., 2011
	<i>Melanelia boscii</i> (Payraudeau, 1826)	3g	4	2	10 0,2 70	MB ZB MB	Paralia, Epanomi Cape, Epanomi C Saronikos Gulf	40°23'N - 22°52'E 40°23'N - 22°53'E 37°54'N - 23°39'E	Co	MS	G1	Repetto et al., 2005 Delongueville & Scaillet, 2009 Gofas et al., 2011
	<i>Melanelia compactilis</i> (Locard, 1892)	4a	2		20 0,2	Mu ZB	Chalastra, Thessaloniki Bay Cape, Epanomi	40°31'N - 22°46'E 40°23'N - 22°53'E	Un	MS	G1	Repetto et al., 2005
	<i>Melanelia frielei</i> (Jordan, 1895)	4b	5		15 12	MB MB	Paralia, Epanomi Anavyssos, Attiki	40°21'N - 22°50'E 37°41'N - 23°55'E	Un	MS	G1	Bouchet & Waren, 1986 Repetto et al., 2005 Gofas et al., 2011
	<i>Melanelia levantina</i> (Oliverio, Buzzurro & Villa, 1994)	4c	3	1	6 70	MB MB	Kaspakas, Lemnos Island Diakoftis, Karpathos Island	39°54'N - 25°03'E 35°23'N - 27°09'E	Co	EMS		Oliverio et al., 1994 Campani, 2009 Koukouras, 2010 as Melanella stalioi (Brusina, 1869) Campani & Prkić, 2009, for M. stalioi
	<i>Melanelia lubrica</i> (Monterosato, 1890), mature female	4d	1		60	MB	C Thermaikos Gulf	40°09'N - 23°01'E	Un	MS	G2, EMS2	Gofas et al., 2011
	<i>Melanelia lubrica</i> (Monterosato, 1890), mature male	4e	2		0,2	ZB	Cape, Epanomi	40°23'N - 22°53'E				Repetto et al., 2005 Romani et al., 2017 Scuderi & Criscione, 2011
	<i>Melanelia monterosatoi</i> (Monterosato, 1890)	5a	1		40	MB	Paralia, Epanomi	40°23'N - 22°51'E	Un	MS	G1	Repetto et al., 2005 Koukouras, 2010 questioned by MarBEF Gofas et al., 2011
	<i>Melanelia petithana</i> (Brusina, 1869)	5b	3		10	MB	Amooopi, Karpathos Island	35°28'N - 27°11'E	Un	MS	G2	Repetto et al., 2005 Romani et al., 2017
	<i>Melanelia translucens</i> (Monterosato, 1890)	5c	1		100	MB	C Siggitikos Gulf	40°11'N 24°02'E	Ra	Unk	G1	Gofas et al., 2011
	<i>Melanelia</i> sp. 1 description in text	6a, b		2	0,2	ZB	Cape, Epanomi	40°23'N - 22°53'E	-	Unk	G1, MS1	http://www.naturamediterraneo.com
	<i>Melanelia</i> sp. 2, description in text	7a	1		50	MB	C Saronikos Gulf	37°54'N - 23°39'E				http://calphotos.berkeley.edu/
	<i>Parvioris ibizenca</i> (Gofas et al., 2011), for comparison	7b										

	<i>Vitreolina perminima</i> (Jeffreys, 1883)	7c		2	70	MB	C Thermaikos Gulf	40°09'N – 23°01'E	Un	MS	G2, EMS2	Repetto et al., 2005 Gofas et al., 2011 Romani et al., 2017
Cornirostridae	<i>Tomura depressa</i> (Granata-Grillo, 1877), live animal	8		6	2	Roots	Cape, Epanomi	40°23'N 22°53'E	Un	MS	G2	Manousis et al., 2012
Hydrobiidae	<i>Hydrobia glyca</i> (Servain, 1880)	9a	1		0.2	ZB	Cape, Epanomi	40°23'N - 22°53'E	Co	WMS	G1, EMS1	Gofas et al., 2011
Triviidae	<i>Trivia levantina</i> Smriglio, Mariottini & Buzzurro, 1998	9b	14		3	MB	Agia Anna, Naxos Island	37°03'N – 25°21'E	Un	CEMS	G1	Smriglio et al., 1998 Repetto et al., 2005
Velutinidae	<i>Lamellaria latens</i> (Müller O.F., 1776)	9c		1	10	MB	Paralia, Epanomi	40°23'N – 22°52'E	Un	MS	G1	Repetto et al., 2005
Naticidae	<i>Natica prietoi</i> Hidalgo, 1873	9d	1		0	Be	Kanali, Preveza	39°03'N – 20°41'E	Un	WMS	G1, EMS1	Gofas et al., 2011
	<i>Euspira</i> sp., description in text	9e, f	1	1	20	MB	Palioura, Epanomi	40°25'N - 22°52'E	-	-	-	
Atlantidae	<i>Atlanta inflata</i> J.E. Gray, 1850	9g	1		400	BB	Lemnos Island	40°06'N – 25°17'E	Un	Cos	G1, EMS1	Repetto et al., 2005
	<i>Atlanta selvagensis</i> de Vera & Seapy, 2006	10a	2 1		400 120	BB MB	Lemnos Island Paxoi Island	40°06'N – 25°17'E 39°10'N – 20°08'E	Un	Cos	G1	Gofas et al., 2011 http://tolweb.org/Atlanta/28752
	<i>Protatlanta sauleyetti</i> (E. A. Smith, 1888)	10b	12		70 400	Ro CE	Cape, Epanomi Lemnos Island	40°17'N – 22°49'E 40°06'N – 25°17'E	Co	Cos	G2	Gofas et al., 2011 Romani et al., 2017
Cystiscidae	<i>Gibberula jansseni</i> van Aartsen, Menkhorst & Gittenberger, 1984	10c	3		60	MB	C Siggitikos Gulf	40°18'N - 23°45'E	Un	WMS	G1, EMS1	Repetto et al., 2005 Gofas et al., 2011 Scaperrotta et al., 2011
	<i>Gibberula simonae</i> Smriglio in Giannuzzi-Savelli, Pusateri, Palmeri & Ebreo, 2003	10d	4		60	MB	C Siggitikos Gulf	40°18'N - 23°45'E	Un	CMS	G1, EMS1	Repetto et al., 2005 Cossignani & Ardovini, 2011
Marginellidae	<i>Granulina bouchetti</i> Gofas, 1992	10e	3	1	60	MB	C Siggitikos Gulf	40°09'N – 24°01'E	Co	WCMS	G2, EMS2	Repetto et al., 2005 Cossignani & Ardovini, 2011 Romani et al., 2017
	<i>Granulina gofasi</i> Smriglio & Mariottini, 1996	10f	1		80	BB	Skyros Island	38°50'N - 24°30'E	Un	CMS	G1, EMS1	Repetto et al., 2005 Cossignani & Ardovini, 2011
	<i>Granulina melitensis</i> Smriglio, Mariottini & Rufini, 1998	10g	18		350 80 70	CB BB MB	Lemnos Island Skyros Island C Saronikos Gulf	40°02'N – 25°11'E 38°50'N - 24°30'E 37°39'N – 23°35'E	Un	CEMS	G1, EMS1	Cachia et al., 2001 Repetto et al., 2005 Cossignani & Ardovini, 2011
	<i>Granulina torosa</i> Gofas, 1992	10h	1		40	MB	N Thermaikos Gulf	40°22'N - 22°45'E	Un	WMS	G1, EMS1	Repetto et al., 2005 Cossignani & Ardovini, 2011 Gofas et al., 2011 Boyer & Renda, 2018
Costellariidae	<i>Vexillum hypatiae</i> (Pallary, 1912)	11a	1		10	MB	Amoopi, Karpathos Island	35°28'N – 27°11'E	Ra	EMS	G1	Repetto et al., 2005 Cossignani & Ardovini, 2011

Buccinidae	<i>Chauvetia lineolata</i> (Tiberi, 1868)	11b	44	6	300 120	CB MB	Kythnos Island C Siggitikos Gulf	37°26'N – 24°28'E 40°06'N – 24°04'E	Un	MS	G2	Repetto et al., 2005 Romani et al., 2017
	<i>Chauvetia procerula</i> (Monterosato, 1889)	11c	25	1	10 100 50 80	MB BB MB BB	Pyrgadikia, Chalkidiki C Saronikos Gulf Amoopi, Karpathos Isl. Skyros Island	40°18'N - 23°45'E 37°36'N – 23°39'E 35°28'N – 27°11'E 38°50'N - 24°30'E	Un	MS	G2, EMS2	Repetto et al., 2005 Gofas et al., 2011 Scaperrotta et al., 2011 Romani et al., 2017
	<i>Chauvetia turritellata</i> (Deshayes, 1835)	11d	48		5 5	MB MB	Xygia, Zakynthos Island Pantokratoras, Preveza	37°51'N – 20°44'E 38°94'N - 20°73'E	Un	MS	G2, EMS2	Repetto et al., 2005 Cossignani & Ardovini, 2011 Scaperrotta et al., 2011 Romani et al., 2017
	<i>Chauvetia ventrosa</i> Nordsieck, 1976	11e	1 1 5 2 2		3 3 50-80 80-120	MB Be MB Ma Ma	Pantokratoras, Preveza Legrena, Attica Agia Anna, Naxos Island W Saronikos Gulf Lavrio, Attica	38°94'N - 20°73'E 37°39'N - 23°58'E 37°03'N - 25°21'E 37°49'N - 23°09'E 37°41'N - 24°05'E	Ra	MS	G2, EMS2	Repetto et al., 2005 Cossignani & Ardovini, 2011 Romani et al., 2017
Muricidae	<i>Ocenebra helleri</i> (Brusina, 1865)	11f		2	80	MB	Preveza	38°57'N - 20°41'E	Ra	CMS	G1, EMS1	Repetto et al., 2005 Cossignani & Ardovini, 2011 Russo, 2018
Fascioliidae	<i>Aegofusinus margaritae</i> (Buzzurro & Russo, 2007)	12a		13	100-120	CB	Karpathos Island	35°33'N – 27°13'E	Un	KI	G2, EMS2	Buzzurro & Russo, 2007
	<i>Fusinus alternatus</i> Buzzurro & Russo, 2007	12b	41	28	50-100	BB	C Saronikos S Saronikos W Saronikos C Korinthiakos Alonnisos Island C Siggitikos Gulf	37°43'N – 23°36'E 37°30'N – 23°34'E 37°52'N – 23°06'E 38°16'N – 22°09'E 39°08'N – 23°55'E 40°06'N – 24°04'E	Un	MS	G2	Buzzurro & Russo, 2007
	<i>Fusinus parvulus</i> (Monterosato, 1884)	12c		12	50-100	BB	Pantokratoras, Preveza	38°94'N - 20°73'E	Un	MS	G2	Koukouras 2010, as F. rudis Cossignani & Ardovini, 2011 Romani et al., 2017, without documentation
Mathildidae	<i>Mathilda retusa</i> Brugnone, 1873 verification by image	12d	1		50-80	Ma	W Saronikos Gulf	37°49'N - 23°09'E	Un	MS	G2	Koukouras, 2010, questioned by Marbef
Rissoellidae	<i>Rissoella diaphana</i> (Alder, 1848)	13a	2		80	MB	C Theraikos Gulf	39°44'N – 23°08'E	Un	WCMS	G1, EMS1	Repetto et al., 2005 Cossignani & Ardovini, 2011 Gofas et al., 2011 Giannuzzi-Savelli et al., 2014
	<i>Rissoella globularis</i> (Forbes & Hanley, 1853)	13b	3		0,2	ZB	Cape, Epanomi	40°23'N - 22°53'E	Un	WCMS	G1, EMS1	Repetto et al., 2005 Scaperrotta et al., 2011
	<i>Rissoella opalina</i> (Jeffreys, 1848)	13c	1	6	25 70	MB MB	Palioura, Epanomi C Theraikos Gulf	40°21'N – 22°48'E 40°09'N – 23°01'E	Un	MS	G1	Repetto et al., 2005 Gofas et al., 2011

	<i>Rissoella</i> sp. 1, description in text	13d-f	1	2	80 120	MB	C Thermaikos Gulf Tristinka, Chalkidiki C Siggitikos Gulf	39°44'N – 23°08'E 39°58'N – 23°52'E 40°06'N – 24°04'E	Un	WMS	G1, EMS1	Rolan & Hernandez, 2004 Segers et al., 2009 Caballer et al., 2011
	<i>Rissoella</i> sp. 2, description in text	13g	1		80	MB	Anafi Island	36°20'N – 25°47'E	-	-	-	
	<i>Rissoella</i> sp. 3, description in text	14a, b		1	120	MB	C Siggitikos Gulf	40°06'N – 24°04'E	-	-	-	
	<i>Rissoella</i> sp. 4, description in text	14c	1		20	MB	Nea Michaniona	40°26'N – 22°49'E	-	-	-	
Omalogyridae	<i>Ammonicera lignea</i> (Palazzi, 1988), description in text	15a	2	2	40 40 60	MB	Nea Michaniona Paralia, Epanomi C Thermaikos Gulf	40°24'N – 22°47'E 40°23'N – 22°51'E 40°08'N – 22°52'E	Un	EA	G1, MS1	Palazzi, 1988 Segers et al., 2009
	<i>Omalogyra disculus</i> Palazzi, 1988, description in text	15b	4	3	0,2	ZB	Cape, Epanomi	40°23'N - 22°53'E	Un	EA	G1, MS1	Palazzi, 1988 Rolán, 1992 Segers et al., 2009
	<i>Omalogyra</i> sp., description in text	15c, d		2	40 1	MB Sh	Paralia, Epanomi Cape, Epanomi	40°23'N – 22°51'E 40°23'N 22°53'E	-	-	-	Palazzi, 1988
	<i>Retrotortina fuscata</i> Chaster, 1896	15e	1		10	MB	Palioura, Epanomi	40°25'N – 22°52'E	Ra	MS	G1	Repetto et al., 2005 Gofas et al., 2011
Cornirostridae	<i>Tomura depressa</i> (Granata-Grillo, 1877), live animal	15		6	2	Roots	Cape, Epanomi	40°23'N 22°53'	Un	MS	G2	Manousis et al., 2012

Darioconus cathyae sp. nov. & *Darioconus michelcharlesi* sp. nov. (Gastropoda: Conidae), two new species from the *D. aulicus/auratinus* complex

ERIC MONNIER

Département Chimie, Vivant, Santé (EPN7) Conservatoire National des Arts et Métiers (CNAM),
292, rue Saint-Martin, 75003 Paris, France

eric.monnier@cnam.fr

LOÏC LIMPALAËR

11, rue de la Poste, 60510 Haudivillers, France

loiclimpalaer@gmail.com

FABRICE PRUGNAUD

23, rue des Bons Raisins 92150 Suresnes, France

fprugnaud@gmail.com

ABSTRACT

Darioconus cathyae sp. nov. from the tropical north west to south central Pacific ocean is described and compared to *Darioconus auratinus* (da Motta, 1982) from Tuamotu & Society archipelagoes and to *D. aulicus* (Linnaeus, 1758) from the tropical Indo-Pacific.

Darioconus michelcharlesi sp. nov. from south western Madagascar is described from material obtained from local fishermen in the lagoon in the north of Toliara. The new species is compared to *D. gracianus* (da Motta & Blöcher, 1982) from the same area, *D. auricomus* (Hwass in Bruguière, 1792) and *D. aulicus* (Linnaeus, 1758) both from tropical Indo-Pacific.

RESUME

Darioconus cathyae sp. nov. du nord-ouest au sud central de l'Océan Pacifique tropical est décrit et comparé à *D. auratinus* (da Motta, 1982) des archipels des Tuamotu et de La Société et à *D. aulicus* (Linnaeus, 1758) de l'Indo-Pacifique.

Darioconus michelcharlesi sp. nov. du sud-ouest de Madagascar est décrit à partir de matériel provenant de pêcheurs locaux dans le lagon au nord de Toliara. Il est comparé à *D. gracianus* (da Motta & Blöcher, 1982) de même provenance, *D. auricomus* (Hwass in Bruguière, 1792) et *D. aulicus* (Linnaeus, 1758), les deux de l'Indo-Pacifique tropical.

INTRODUCTION

MATERIAL AND METHODS

We describe shell morphology using the terminology established in Röckel, Korn & Kohn. (1995) and modified in Monnier, Limpalaër, Robin & Roux (2018). Adult shells were measured with digital calipers, most of the time the measurements were rounded to 0.01 millimeter.

Manuel J. Tenorio performed analysis of the covariance (ANCOVA) for different shell parameters using species hypothesis as factor and shell length (SL) as covariate in order to test the statistical significance of the observed differences in shell morphometry. Additionally, the differences in the mean values of SL were assessed by the corresponding *t*- and *U*-tests. All statistical tests were carried out using STATGRAPHICS XVII-X64, after all the measurements sets passed the normality tests. The specimens used for this analysis are mostly adults but also subadults.

Museums and private collections

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

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

MSNP: Museo di Storia Naturale, Università di Pisa, Italy.

NMWC: National Museum of Wales, Cardiff, Wales.

SMNS: Collection da Motta and collection Röckel in the collection of the Staatliches Museum für Naturkunde, Stuttgart, Germany.

EM: Eric Monnier, Paris, France.

FP: Fabrice Prugnaud, Suresnes, France

LL: Loïc Limpalaër, Haudivillers, France

AJM: Antonio J. Monteiro, Lisbon, Portugal

BA: Bob Abela, Guam

BG: Bernard Goudey

CBL: Carlos B. Leobrera, Philippines

CR: Christophe Roux, Ivry-sur-Seine, France

DP: Don Pisor, San Diego, USA

EG: Emilio Garcia, Lafayette, Louisiana, USA

FS: Fred Schroder, Guam

GH: Gérard Hervillard, Maisons-Alfort, France

GR: Georges Richard, Aytte, France

JPL: Jean Paul Lapalu, Lavigny, France

PC: Pierre Capier, Douai, France

PQ: Philippe Quiquandon, Mouans-Sartoux, France

SN: Steve Norby, Guam

TJ: Thierry Joly, Saint Cyr-sur-Mer, France

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

RESULTS

SYSTEMATICS

Family CONIDAE Fleming, 1822

Genus *Darioconus* Iredale, 1930

Darioconus cathyae sp. nov.

(Plate 1, Figs.1-9 ; Plate 2, Figs.1-9, Plate 3, Figs.1-5)

Type material: Holotype and 22 paratypes. The holotype is deposited in the Muséum National d'Histoire Naturelle, Paris, France, under the number MNHN-IM-2000-34743. (ex- Fabrice Prugnaud's collection). Paratype 1 is stored in Stuttgart SMNS-ZI0091167. The other paratypes are coming from private collections. (See Table 1 for details)



Figure 1: Holotype of *Darioconus cathyae* sp. nov. MNHN-IM-2000-34743 104.08 mm, Manus Isl. PNG.

Material examined: 26 specimens of *Darioconus cathyae* sp. nov. have been examined, measured and studied.

Type locality: Manus Island, Papua New Guinea.

Distribution and habitat: The species has been collected at Ontong Java (Solomon Islands), Eniwetok, North Central Mili Atoll & Kwajalein (Marshall Islands), Tutuila (American Samoa), Guam (Marianas Islands, Micronesia), New Ireland & Manus Island (Papua New Guinea) & East Samar and Sulu Sea (Philippines). In Marshall Is., Röckel, Korn & Kohn (1995, p. 289 as *Conus auratinus*) mention: "it is found at 13-18 m on lagoon pinnacles and at the ocean-side of coral reefs, in cave and coral rubble". A report at a depth of 160 m in Aliguay is dubious.



Figures 2 a & b: Living *Darioconus cathyae* sp. nov. 93.2 mm, paratype 15, Guam, 20 m, (pictures and coll. courtesy of BA)

Type	Institution	Dimensions - Weight S _L x MD x W (mm x mm x g)	Locality
Holotype	MNHN-IM-2000-34743	104.08 x 39.67 x 35.6	Manus Isl., PNG
Paratype 1	coll. da Motta, SMNS-ZI0091167	77.10 x 28.10 x ?	Kwajalein, Marshall Isl.
Paratype 2	EM coll.	124.68 x 42.73 x 59.9	Samar, Philippines, 25 m
Paratype 3	EM coll.	105.91 x 36.79 x 47.7	Samar, Philippines ?
Paratype 4	EM coll.	77.21 x 24.53 x 20.3	Philippines ?
Paratype 5	EM coll.	70.87 x 24.67 x 14.3	Coron, Palawan, 25 m
Paratype 6	FP coll.	115.48 x 39.95 x 41.7	Zunes, Bougainville Isl., PNG, 15 m
Paratype 7	FP coll.	107.70 x 42.40 x 56.5	Kavieng, PNG
Paratype 8	DP coll.	111.80 x 37.58 x ?	Ontong Java Atoll, Solomon
Paratype 9	PC coll.	122.80 x 42.70 x 56.0	Samar, Philippines
Paratype 10	TJ coll.	85.45 x 29.94 x 26.1	Luminao Reef, Guam, Mariannes Arch.
Paratype 11	TJ coll.	103.59 x 39.20 x 43.7	Vanuatu
Paratype 12	FL coll.	82.30 x 30.2 x 30.1	Falealupo, Savai'i Isl., Western Samoa
Paratype 13	priv. coll. (ex PQ coll.)	134.90 x 50.16 x ?	Aliguay, Philippines, 160 m
Paratype 14	FS coll.	113.5 x 44 x ?	Luminao Reef, Guam, Mariannes Arch., 20 m
Paratype 15	BA coll.	93.20 x 34.20 x ?	Luminao Reef, Guam, Mariannes Arch.
Paratype 16	SN coll.	103.50 x 35.27 x ?	Magundas, Luminao Reef, Guam, Marianas Arch., 20 m
Paratype 17	EG 12391 coll.	105.70 x 37.60 x ?	Fatufatufi, Fagaalu Bay, Tutuila, Samoa
Paratype 18	EG 14146 coll.	82.60 x 28.40 x ?	Ajelleran Islet, N. central Miti Atoll, Marshall Isl.
Paratype 19	EG 14146 coll.	83.00 x 26.10 x ?	Ajelleran Islet, N. central Miti Atoll, Marshall Isl.
Paratype 20	EG 14147 coll.	110.50 x 36.50 x ?	Kirenkan Islet, N. central Miti Atoll, Marshall Isl.
Paratype 21	GH coll.	95.50 x 35.36 x 42.9	Efate Isl., Vanuatu
Paratype 22	LL coll.	125.01 x 43.69 x 58.5	Samar, Philippines

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



Figure 3: Distribution map of *Darioconus cathyae* sp. nov. (blue: confirmed localities and pink: unconfirmed localities) and of *Darioconus auratinus* (da Motta, 1982) (green).

Records from Futuna, New Caledonia and Moluccas need further confirmations.

A picture of a specimen of *Darioconus* from Futuna Island (in Rossiniana Vol. 32, p. 11; 1986) is difficult to identify: it may be a *D. cathyae* sp. nov.

Etymology: *D. cathyae* sp. nov. is named after Cathy Monnier (1955–2004), late sister of the first author. She held a doctorate degree in astrophysics, she was a botany lover and a mushrooms specialist. Cathy was also acting with “Médecins du Monde” for humanitarian causes in the world.



Description of the shell of *Darioconus cathyae* sp. nov.

Morphometric parameters: $S_L = 71\text{--}135$ mm (mean $S_L = 100.8$ mm); $RD = 0.37\text{--}0.47$ (mean $RD = 0.42$); $PMD = 0.61\text{--}0.77$ (mean $PMD = 0.71$); $RSH = 0.12\text{--}0.22$ (mean $RSH = 0.15$); $RW = 2.0\text{--}5.2$ g/cm (mean $RW = 3.9$ g/cm) & $RW' = 0.25\text{--}0.46$ g/cm³ (mean $RW' = 0.34$ g/cm³).

Description: Shell large sized, narrowly conoid cylindrical to narrowly ovate (in few specimens), somewhat slender, elongate or cigar shaped in profile. The shell is solid to moderately solid (in few specimens). The protoconch is not known. The adult shell has about 11–12 whorls. Larval whorls (frequently eroded) and about first four postnuclear whorls are white and patternless. The spire is of moderate height with straight outline. The spire whorls are juxtaposed and the suture is narrow, smooth and well-marked. Teleoconch sutural ramps are slightly convex with very weak spiral striae and very weak radial growth lines. The shoulder is smoothly rounded. The last whorl is slightly convex with somewhat parallel sides. The outline is straight at adapical 2/3 of the last whorl. The last whorl is apparently smooth of a

moderately silky texture. With slight magnification it appears sculptured with numerous weak spiral threads regularly spaced. The columellar fold is strong and white to ivory coloured. The siphonal lip outline is subrounded. The aperture is wider at base than near shoulder, whitish to peach cream coloured. The outer lip is clearly convex and the profile of the origin of the lip is receding.

The ground colour of the last whorl is reddish brown and irregularly interrupted by numerous small variably sized white (rarely suffused with light pink) tents. These tents are forming 3 wide irregular spiral bands at the shoulder, at the 2/3 of the total length and at the basal part. There are but irregular axial groupings of the tents. The pattern and colour of the spire is matching with that of the last whorl.

Living animal and radula:

Periostracum is thin and translucent. Dorsum and sole of the foot are white in background maculated with large blotches of the same reddish brown colour as the shell and mottled with dark brown. The proboscis is white mottled with light brown. The siphon is also white mottled with light brown and displays a black band and a salmon red tip. DNA and morphology of the radular teeth of the new species are not yet known.

Comparisons:

Darioconus cathyae sp. nov. has often been confused in literature with both *D. auratinus* (da Motta, 1982): Springsteen & Leobrera (1986) and Goldberg (2011) and with *D. aulicus* (Linnaeus, 1758) particularly with the forma *aurantia* Dautzenberg, 1937: Poppe / G. Raybaudi Massilia (2008).

So the new species must be compared with these two species: *D. auratinus* from Tuamotu and Society islands and *D. aulicus* from tropical Indo-Pacific.

The morphometric and weight parameters for adult specimens are summarized in Table 2 (vide infra).

Species		SL	RD	PMD	RSH	RW (g/cm)	RW' (g/cm ³)
<i>Darioconus cathyae</i> n.sp.	our values	71 - 135	0.37 - 0.47	0.61 - 0.77	0.12 - 0.22	2.0 - 5.2	0.25 - 0.46
	medium value	100.8	0.42	0.71	0.15	3.9	0.34
<i>Darioconus auratinus</i>	our values	64 - 107	0.39 - 0.51	0.65 - 0.75	0.14 - 0.21	2.1 - 4.5	0.27 - 0.51
	medium value	85.7	0.44	0.71	0.17	3.3	0.40
<i>D. auratinus</i> + <i>D. cathyae</i> n.sp.	RKK	55-102	0.40 - 0.55	0.56 - 0.65	0.14 - 0.18	1.2 - 3.5 (SL : 55-90 mm)	-
<i>Darioconus aff. auratinus</i> (golden)	our values	103 - 105	0.40 - 0.42	0.71 - 0.73	0.17 - 0.18	2.7 - 3.3	0.27
	medium value	103.6	0.41	0.72	0.17	3.0	0.27
<i>Darioconus aulicus</i>	our values	74 - 150	0.42 - 0.50	0.61 - 0.79	0.09 - 0.16	2.9 - 10.9	0.26 - 0.45
	medium value	114.8	0.46	0.69	0.14	6.7	0.36
<i>Darioconus aulicus</i>	RKK	66- 163	0.40 - 0.51	0.63 - 0.75	0.11 - 0.17	2.0 - 10.0	-
<i>Darioconus aff. aulicus</i> (Somalia)	our values	70 - 110	0.44 - 0.49	0.68 - 0.75	0.12 - 0.17	3.4 - 6.9	0.43 - 0.49
	medium value	84.9	0.47	0.72	0.15	5.0	0.46
<i>Darioconus michelcharlesi</i> n.sp.	our values	44 - 82	0.41 - 0.52	0.64 - 0.81	0.12 - 0.19	1.4 - 3.7	0.35 - 0.55
	medium value	59.0	0.46	0.71	0.16	2.3	0.48
<i>Darioconus gracianus</i>	our values	31 - 61	0.40 - 0.45	0.65 - 0.80	0.12 - 0.20	0.6- 1.4	0.37 - 0.60
	medium value	43.5	0.42	0.73	0.16	1.0	0.48
<i>D. gracianus</i> + <i>D. michelcharlesi</i> n.sp.	RKK	30 - 60	0.40 - 0.51	0.63 - 0.75	0.11 - 0.17	1.0 - 2.5	-
<i>Darioconus auricomus</i>	our values	31 - 66	0.40 - 0.46	0.61 - 0.82	0.11 - 0.18	0.5 - 2.1	0.34 - 0.60
	medium value	43.8	0.42	0.73	0.15	1.2	0.52
<i>Darioconus auricomus</i>	RKK	40 - 69	0.40 - 0.46	0.69 - 0.78	0.12 - 0.18	1.0 - 3.1	-

Table 2: Morphometric and weight parameters including SL, RD, PMD, RSH, RW & RW' for adult specimens of *D. cathyae* sp. nov., *D. auratinus*, *D. aff. auratinus* "golden", *D. aulicus*, *D. aff. aulicus* "Somalia", *D. michelcharlesi* sp. nov., *D. gracianus*, & *D. auricomus*.

-1- *Darioconus auratinus* (da Motta, 1982)

(Plate 3, Figs.6-7; Plate 4, Figs.1-9, Plate 5, Figs.1-11)

D. cathyae sp. nov. differs from *D. auratinus* by its much finer pattern of tents and a larger average size and more elongate shape. The colour of the pattern is quite constant: reddish brown while the colour of *D. auratinus* is variable from orange to reddish brown or dark chocolate brown.

In the new species the small and numerous tents are white and only very occasionally light pink while in *D. auratinus* the tents are always pinkish.

The size of *D. auratinus* is smaller than in the new species with 85.7 mm. in average against 100.8 mm in the new species. The shape is similar with sub-parallel sides but the new species is more elongated with an average Relative Diameter of 0.42 against 0.44 in *D. auratinus*.

The geographical ranges of the two species are also allopatric with *D. auratinus* found to be restricted to the waters of Society and Tuamotu archipelagoes while *D. cathyae* sp. nov. has a westerner range from Southern Philippines to Micronesia.

D. auratinus is only occasionally collected in the Society Islands (volcanic islands) where it is found at the external slope, while it is more frequently found in Tuamotu Islands (coral atolls) where it is present in the lagoons at 10 to 20 m. deep.

D. auratinus is most often collected dead on the foreshore after severe depressions.

-2- *D. aulicus* (Linnaeus, 1758)

(Plate 6, Figs.1-12; Plate 7, Figs.1-10)

The colour of the background of *D. aulicus* is most often darker than that of *D. cathyae* sp. nov. In *D. aulicus* the tents are most

of the time white as in most of the shells of the new species. The shell length of *D. aulicus* is larger than the one of the new species with an average of 114.8 mm. in our sample of adult specimens.

The pattern of the new species is much finer with many very small triangles. In *D. aulicus* the tents may reach great sizes. The sides of the last whorl of *D. aulicus* are regularly convex over the whole last whorl in contrast with the sub-parallel sides of the new species ending with an abrupt change of slope at the two thirds of the last whorl.

D. cathyae n. sp. is only known from the tropical western and central Pacific Ocean where it cohabits with *D. aulicus*. The latter species is also well known from the tropical Indian Ocean, China Sea, Indonesia, Arafura Sea, Coral Sea, Society and Tuamotu archipelagoes where the new species is so far unknown. *D. aulicus* is rarer than *D. auratinus* in French Polynesia (Georges Richard, pers. comm.). They are quite easily recognized by their different shape and pattern.

Graphical morphometric comparisons

We produce two graphs: SL = f (MD) (maximum shell length versus maximum diameter) and RD = f (PMD) (relative diameter versus relative position of the maximum diameter) for comparison of shell morphometry of the 3 similar species (including the new species).

1. Graph of SL = f (MD)

Figure 4 shows that the plotting area of each of the 3 related species represented on the graph are partially separated: the shells of the new species *D. cathyae* being on average narrower than those of *D. auratinus* and of *D. aulicus*.

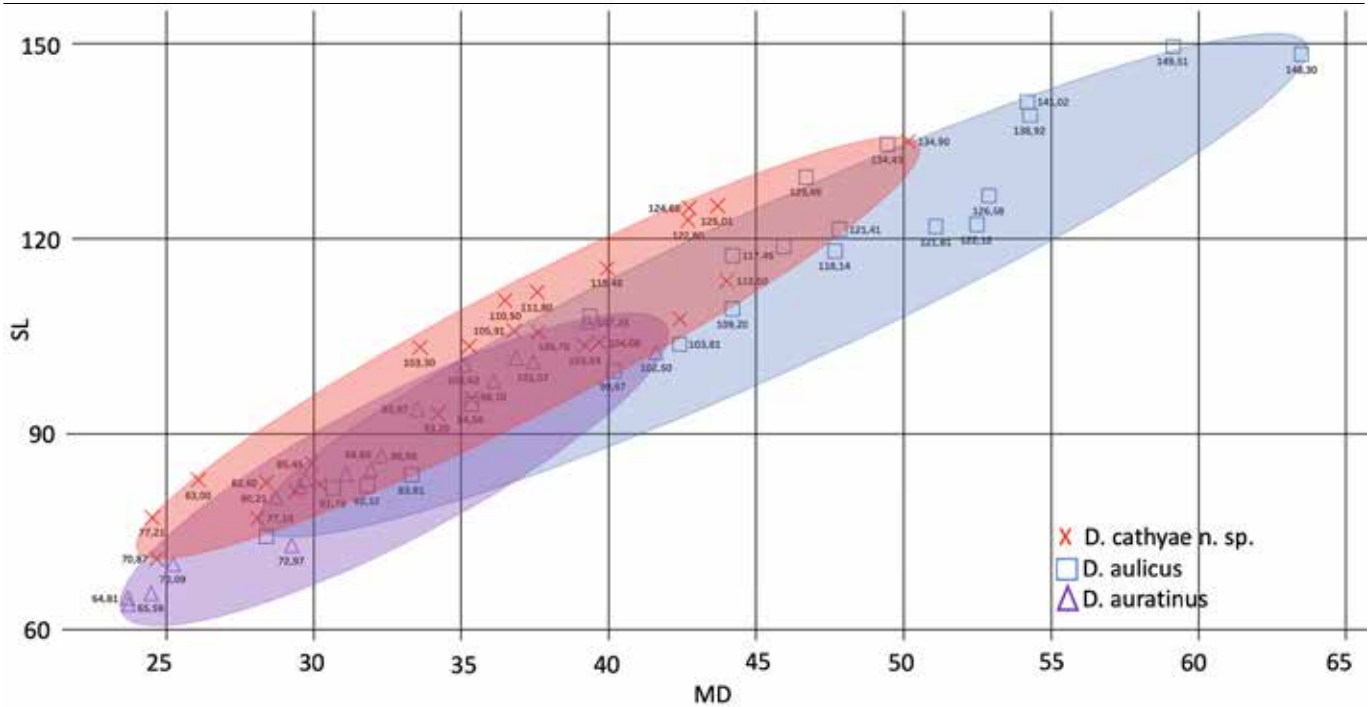


Figure 4: Graph of $SL = f(MD)$ for *Darioconus cathyae* sp. nov., *D. aulicus* and *D. auratinus*

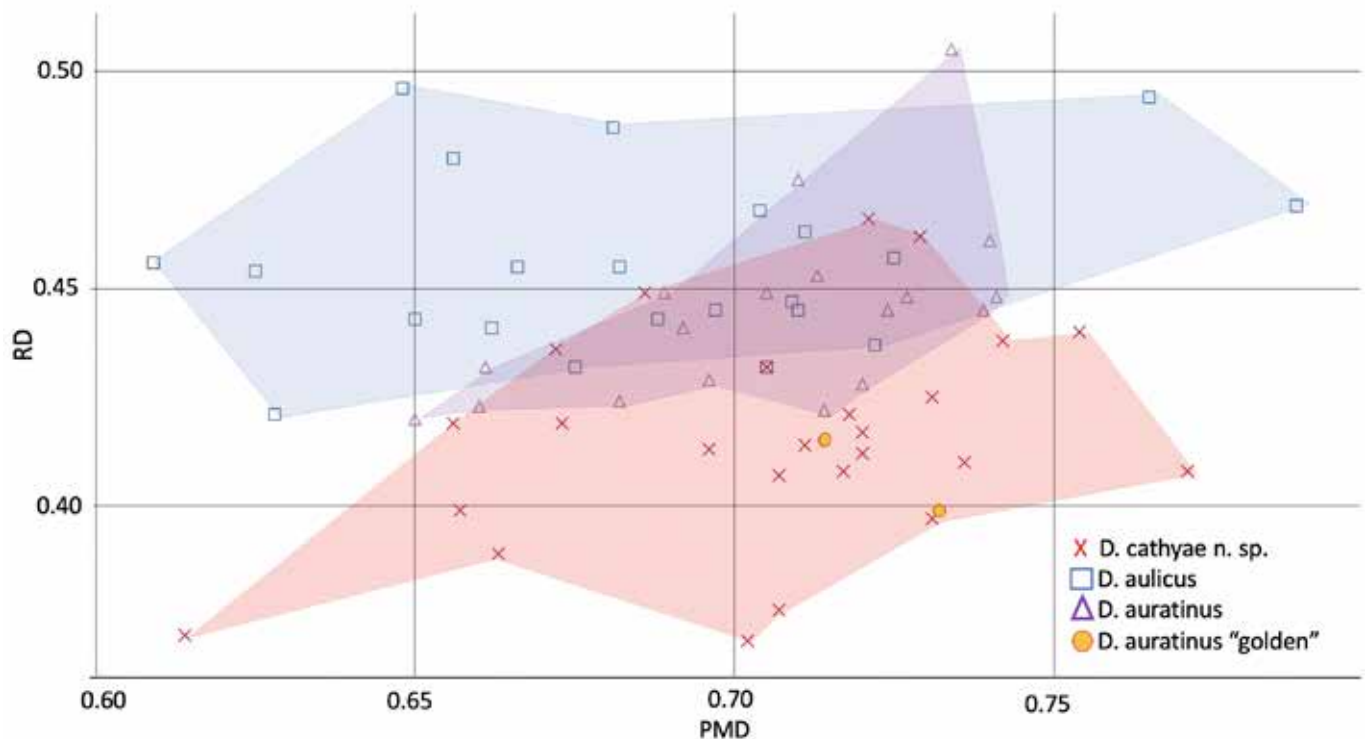


Figure 5: Graph of $RD = f(PMD)$ for *Darioconus cathyae* sp. nov., *D. aulicus* and *D. auratinus*

2. Graph of $RD = f(PMD)$

Figure 5 shows the plotting areas of the 3 related species: *D. cathyae* sp. nov. area is morphologically closer to *D. auratinus* than to *D. aulicus*. The 2 specimens of *D. aff. auratinus* "golden" are similar in shape to *D. cathyae* sp. and fall outside of the variation range of the other *D. auratinus* studied shells.

The shells of *D. aulicus* are most often wider than the new species while the position of Maximum Diameter is not discriminating.

Analysis of the covariance performed by Manuel J. Tenorio

The mean shell length of *D. cathyae* sp. nov. (94.25 mm.) is significantly larger than for *D. auratinus* (77.25 mm.) (comparison

of means: $t = -2.4408$, $p = 0.018385$, $U = 444.5$, $p = 0.007859$). *D. cathyae* sp. nov. is slightly narrower-bodied than *D. auratinus* as inferred from ANCOVA on MD using taxon as factor, and SL as co-variate. The differences are subtle (least-squares mean MD: 30.59 mm for *D. cathyae* versus 31.78 mm for *D. auratinus*) but statistically significant ($F = 5.15$, $p = 0.0279$). The differences in SH and HMD are not statistically significant ($p > 0.05$ in both cases).

The mean shell length of *D. aulicus* (114.79 mm.) is significantly larger than for *D. cathyae* sp. nov. (94.25 mm.) (comparison of means: $t = 3.00152$, $p = 0.00425$; $U = 170.0$, $p = 0.007203$). *D. cathyae* sp. nov. is narrower-bodied and higher-spined than *D. aulicus* as inferred from ANCOVA on MD ($F = 32.64$, $p = 0$) and

SH ($F = 8.40$, $p = 0.0057$) using taxon as factor, and SL as co-variate. There is no statistically significant difference in HMD between the two taxa ($p = 0.6253$).

REMARKS

Linnaeus introduced *Conus aulicus* in the tenth edition of *Systema Naturae*. The short descriptive text is uninformative (Kohn, 1992) and could apply to several species. This is why a figure by Gualtieri (1742) was selected by Kohn and the shell was later discovered in MSNP (Pisa, Italy) that helped to stabilize the species concept. Coomans, Moolenbeek & Wils (1981) designated Moluccas, Indonesia as type locality.



Figure 6: Lectotype of *Darioconus aulicus* (Linnaeus, 1758) (MSNP) 96 mm.

This handsome species is a classic favorite of shell collectors due to its handsome size and colorful pattern. It is often illustrated in books and is a well known and documented species. It is therefore unnecessary to discuss it at length.

Some synonyms are still used in literature or price list like *Conus auratus* Hwass in Bruguière, 1792 that is often inappropriately used for “golden” or orange brown shells or *Conus aulicus propenudus* Melvill, 1900 for shells with big white tents.



Figure 7: Lectotype of *Conus auratus* Hwass in Bruguière, 1792 MHNG.

Walls (1979) recognized *Conus auratus* Hwass in Bruguière,



Figure 8: Syntype of *Conus aulicus propenudus* Melvill, 1900.

1792 as valid, stating however that this was “for no real reason”! He used Hwass’ name with many doubts for a species endemic from Society and Tuamotu Islands. He gives a detailed description that states how “the regular curving of shoulder and base seem to be fairly distinct and gives a shell an appearance different from most *C. aulicus* of similar size.”. He was right in recognizing the French Polynesian species but the name was – as he felt – incorrect. Da Motta finally gave a name in 1982 to these shells: *Conus auratinus*.

The first illustration of the species we could find is in *The Conchological Illustrations* by G.B. Sowerby in 1834 (pl. 55, fig. 71). The short text accompanying the excellent figure allows to recognize *D. auratinus* without any doubt. The type locality is Anaa in the Tuamotu Archipelago. Unfortunately, the specific epithet “*roseus*” was twice preoccupied by G. Fischer (1807) and Lamarck (1810) and it cannot be retained. In 1841, in the index, Sowerby changed the entry to “*C. auratus* Lam (*C. aulicus*, var ?)”. This is certainly the reason why the name of *Conus auratus* has been used in many occasions for this species after



that (for instance: Reeve, 1843, Marsh & Rippingale, 1964 and later editions, Hinton, 1972, Mayissian, 1974, Salvat & Rives, 1975). Other authors considered that *C. auratus* was a mere synonym for *Darioconus aulicus* (Tryon, 1884).

Figure 9: *D. aulicus* var. *roseus* Sowerby, 1834 *The Conchological Illustrations* pl. 55 fig. 71.

Da Motta gave an identity to the unnamed population from the Tuamotu in 1982. He compares the species with Dautzenberg’s *Conus aulicus* forma *aurantia* and *Darioconus auricomus*. Dautzenberg’s name cannot be retained in nomenclature because it is preoccupied (several times). Moreover, da Motta explains that it is a paler color form of *D. aulicus*. He also indicates that the described type is “peculiar to the Tuamotu” and that “a form with smaller tenting pattern has been found in Kwajalein” and also “a chestnut-colored form from Samar, Philippines”. These last localities refer to the new species *D. cathyae* sp. nov.



Figure 10: *Darioconus auratinus* (da Motta, 1982) Holotype MHNG 82 mm Fakarava Is. Tuamotu Archipelago (Credit: A. J. Kohn)

Richard (1985), in his work on the French Polynesian Conidae treats *Conus auratinus* da Motta, 1982 as a valid species. However, he doubts about the localities outside of French Polynesia. He extends the range to other archipelagoes: Society, Australes Islands and says that it is whispered it could be found in Marquesas. There is no confirmation up till now in this last archipelago. He also confirms the presence of *Conus aulicus* in the Tuamotu only. Finally, he states about *Conus auratus* that it is a strict synonym of *C. aulicus* and that the references to this taxon in French Polynesia most often refer to *D. auratinus*. We fully agree with Richard's conclusions.

Lauer (1986) examines, in his study of the tented cones, under the numbers 63 to 66 the taxa *aulicus*, *aurantia*, *auratinus*, and *auratus* respectively with his usual meticulous attention. He fails to recognize *D. auratinus* as a valid species and places it as a form of *D. aulicus*. He also carefully checks the status of *C. auratus* and correctly considers it as a form of *D. aulicus* although he thinks that it is an extremely rare variant.

Hinton (1972) illustrate a magnificent specimen (107.95 mm) of *D. cathyae* sp. nov. under the name of *C. auratus* (p. 79 n°1) from New Ireland. Mayissian (1974) also represents the new species, under the same name (p. 33 n°6 and reversed picture on the plate 10) from New Caledonia. Both authors recognize the species as distinct from *D. aulicus*.

Springsteen & Leobrera (1986) illustrate another nice specimen of *D. cathyae* sp. nov. under the name of *C. auratinus* (p. 248 n°4 and plate 70 n°4) originating from Samar, thus confirming da Motta's data in the description of *D. auratinus*.

Röckel, Korn & Kohn (1995) recognize the validity of *D. auratinus* and illustrate two shells (one paratype from da Motta's collection and one shell from Röckel's collection (plate 61 figs. 7-9). Both are from the Tuamotu Islands and represent *D. auratinus*. They state in the text that the species is also collected in Philippines, Solomon Islands, Vanuatu and Marshall Islands. These localities refer to *D. cathyae* sp. nov.

Touitou and Balleton (2005) show a specimen of *D. auratinus* (fig. 5) and state that the species is most often found in Tuamotu but also that the species may be found in other regions of the Pacific. These refer to the new species. They do not cite *D. aulicus* from French Polynesia.

Balleton and Marti (2011) give several pictures of live specimens of *D. auratinus* but, again, do not illustrate or cite *D. aulicus* from French Polynesia. It is possible that some of the pictures of live specimens on page 15 are from *D. aulicus* actually. They state that the species is found in the four Polynesian archipelagoes including Marquesas Islands. However we do not have confirmations of its occurrence from there.

Gabriella Raybaudi in Poppe (Philippines Marine Mollusks, Vol II, 2008) identifies on plate 652, fig. 2A and 2b as *Conus aulicus* forma *aurantia* a specimen of the new species.

In the Web magazine "The Cone Collector" Richard Goldberg published in 2011 an exhaustive review of the literature about *D. auratinus* under the well inspired title "*The conus auratinus con(e)undrum*". His main aim is to differentiate *D. aulicus* from what he thinks to be a unique species *D. auratinus* and he gives many useful informations. He first gives the keys to separate the two species: *D. auratinus* being slender, straight sided, higher spired, etc. He also finds that the end of the siphonal fasciole of *D. aulicus* points "beyond the basal curve of the outer lip" while it is not the case in *D. auratinus*. He also reviews in detail all previous literature and personal communications he received from various dealers in order to ascertain localities where his concept of *D. auratinus* has been collected. Finally, he illustrates many specimens from all known localities. When the authors of the present study read this paper, they were already thinking that the French Polynesian *D. auratinus* was distinct from more western shells. The rich iconography of Goldberg confirmed our impression that two species were involved. It helped greatly in ascertaining their disjunct range. Strangely, neither of the two species have been collected in Cook Islands. This absence needs confirmation but seems to confirm the separation of the two species.

In "A Taxonomic Iconography of Living Conidae" the new species is shown on pp. 932 & 933 with 10 specimens and was provisionally labeled as *Darioconus* aff. *auratinus*.

The two specimens of *Darioconus* aff. *auratinus* "golden" from Tahiti Island seem to be different in:

- **colour:** vivid orange instead of reddish brown to dark brown,
- **size:** average total length is 103.6 mm for *D. aff. auratinus* "golden" instead of 85.7 mm for *D. auratinus*,
- **shape:** average relative diameter is 0.41 for *D. aff. auratinus* "golden" and 0.44 for *D. auratinus*
- **weight:** *D. aff. auratinus* "golden" is lighter than *D. auratinus* (respectively: $RW = 3 \text{ g/cm}^3$ & $RW' = 0.27 \text{ g/cm}^3$ instead of $RW = 3.3 \text{ g/cm}^3$ & $RW' = 0.40 \text{ g/cm}^3$).
- **geographical distribution:** Society Islands (Tahiti) for *D. aff. auratinus* "golden" and mostly Tuamotu Islands for the "classic" *D. auratinus*.

The specimen of 104.2 mm (n°7 Plate 3) was dived alive by day in 1985 by the third author at 20 m deep, in coral sand in an islet off Papeari, Tahiti. We don't have the exact data of the other specimen.

We need more specimens than the two ones available in this study to conclude on their status. Family CONIDAE Fleming, 1822 Genus *Darioconus* Iredale, 1930

Darioconus michelcharlesi sp. nov.

(Plate 8, Figs. 1-10; Plate 9, Figs. 1-15)

Type material: Holotype and 24 paratypes. The holotype is deposited at the Muséum National d'Histoire Naturelle, Paris,

France, under the number **MNHN-IM-2000-34744**. (ex-Eric Monnier's collection). The paratypes are stored in private collections. (See Table 3 for details)



Figure 11: *Darioconus michelcharlesi* sp. nov. Holotype MNHN-IM-2000-34744

49.44 mm, 20 m, Toliara, S.W. Madagascar.

Material examined: 25 specimens of *Darioconus michelcharlesi* nov. sp. have been examined, measured and studied.

Type locality: Toliara, SW Madagascar, 15-20 m

Distribution and habitat:

D. michelcharlesi sp. nov. is distributed in the north of the great lagoon of Toliara from Andavadoaka to Manombo and Tsifota. It lives under coral slabs in shallow water.

Etymology: *D. michelcharlesi* sp. nov. is named after our friend and former shell dealer Michel Charles who gathered material from the Toliara area in S.W. Madagascar. He played an important role in the discovery of the high molluscan endemism in the South of Madagascar. He was the first to see and explain to the first author the differences between the true *D. gracia-nus* (da Motta & Blöcher, 1982) and the new species that is dedicated to him.

Description of the shell of *Darioconus michelcharlesi* sp. nov.

Morphometric parameters:

$S_L = 44\text{--}82$ mm (mean $S_L = 59.0$ mm); $RD = 0.41\text{--}0.52$ (mean $RD = 0.46$); $PMD = 0.64\text{--}0.81$ (mean $PMD = 0.71$); $RSH = 0.12\text{--}0.19$ (mean $RSH = 0.16$); $RW = 1.4\text{--}3.7$ g/cm (mean $RW = 2.3$ g/cm); $RW' = 0.35\text{--}0.55$ g/cm³ (mean $RW' = 0.48$ g/cm³).

Description:

The shell is moderately large, narrowly cylindrical conical to narrowly ovate in overall shape and moderately solid. The protoconch (of about 2 whorls) is paucispiral. The adult shell

Type	Institution	Dimensions - Weight $S_L \times MD \times W$ (mm x mm x g)	Locality
Holotype	MNHN-IM-2000-34744	49.44 x 19.08 x 9.2	Toliara, SW Madagascar, 15-20 m
Paratype 1	EM coll.	48.00 x 18.11 x 7.2	Toliara, SW Madagascar
Paratype 2	EM coll.	63.63 x 22.79 x 18.9	Andavadoaka, SW Madagascar
Paratype 3	EM coll.	55.32 x 22.38 x 12.2	Toliara, SW Madagascar, 4-5 m
Paratype 4	EM coll.	53.03 x 20.75 x 10.4	Salary, SW Madagascar
Paratype 5	EM coll.	62.47 x 22.31 x 12.7	Toliara, SW Madagascar
Paratype 6	EM coll.	58.51 x 21.96 x 10.0	Toliara, SW Madagascar
Paratype 7	EM coll.	64.36 x 23.38 x 11.7	Toliara, SW Madagascar
Paratype 8	EM coll.	57.61 x 22.09 x 14.2	Toliara, SW Madagascar
Paratype 9	EM coll.	60.56 x 23.89 x 14.8	Toliara, SW Madagascar
Paratype 10	EM coll.	64.78 x 24.98 x 18.1	Toliara, SW Madagascar
Paratype 11	EM coll.	81.91 x 29.28 x 26.4	Toliara, SW Madagascar
Paratype 12	EM coll.	68.68 x 27.34 x 25.4	Toliara, SW Madagascar
Paratype 13	EM coll.	64.62 x 23.71 x 15.5	Toliara, SW Madagascar
Paratype 14	LL coll.	59.51 x 21.90 x 13.6	Toliara, SW Madagascar
Paratype 15	LL coll.	43.90 x 16.34 x 6.1	Toliara, SW Madagascar
Paratype 16	FP coll.	58.27 x 23.70 x 14.9	Toliara, SW Madagascar, 4-5 m
Paratype 17	FP coll.	49.43 x 18.56 x 8.8	Toliara, SW Madagascar
Paratype 18	FP coll.	72.59 x 29.53 x 25.1	Toliara, SW Madagascar
Paratype 19	FP coll.	55.97 x 21.40 x 12.7	Toliara, SW Madagascar
Paratype 20	FP coll.	45.44 x 18.65 x 7.5	Toliara, SW Madagascar
Paratype 21	CR coll.	52.37 x 21.23 x 10.8	Toliara, SW Madagascar
Paratype 22	TJ coll.	58.60 x 23.10 x 14.0	Toliara, SW Madagascar
Paratype 23	JKT coll.	63.20 x 25.33 x ?	Toliara, SW Madagascar, 10-15 m
Paratype 24	JPL coll.	64.00 x 24.38 x ?	Toliara, SW Madagascar

Table 3: Types of *Darioconus michelcharlesi* nov. sp. (estimated values in red).

has about 12 whorls, 6 of which (the protoconch and the first four postnuclear whorls) are immaculate white. The spire is of moderate height with straight outline. The spire whorls are juxtaposed and the suture is narrow and well-marked. Sutural lines are quite linear. The teleoconch sutural ramps are straight to slightly convex with very weak spiral striae and weak radial growth lines. The shoulder is smoothly rounded. The last whorl is convex. The columellar fold is strong and white. The siphonal lip outline is subrounded. The aperture is wider at base than near shoulder. Its colour is white near the outer lip and transitions to pale orange towards the interior. The outer lip is convex and the profile of the origin of the lip is receding.

The ground colour of the last whorl is dark reddish brown with white tents that are grouped in three extremely variable large spiral bands disposed respectively: at the shoulder; at the 2/3 of the total length and at the basal part. Some tents are coalescing forming large tents or ziczac axial flames. The last whorl is covered with many narrow and slightly elevated dark brown spiral lines that are irregularly interrupted by the variably sized white tents. The pattern and colour of the spire are the same than that of the last whorl.

Living animal and radula:

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

Comparisons:

Darioconus michecharlesi sp. nov. must be compared with *D. gracianus* (da Motta & Blöcher, 1982) from the same area, *D. auricomus* (Hwass in Bruguière, 1792) and *D. aulicus* (Linnaeus, 1758) both from tropical Indo-Pacific.

-1- *D. gracianus* (da Motta & Blöcher, 1982).
(Plate 10, Figs. 1-13)

D. michecharlesi sp. nov. is more ventricose and reaches greater sizes (82 mm. vs 60 mm). The colour of the pattern is darker in fresh specimens than in *D. gracianus* which is reddish brown (dead specimens of the new species may have the same colour than fresh *D. gracianus*). The white tents are small and tend to form axial bands in which each tent remains independent. In the new species, tents are often of big size and often coalesce together forming irregular and geometrical white zones. In the original description, the species is said to come from "greater depths at the fringes of the "Grand Récif". This habitat is different from the shallower waters where the new species is found.

-2- *D. auricomus* (Hwass in Bruguière, 1792).
(Plate 11, Figs. 1-18)

This species is closest in shape to the true *D. gracianus*. Its pattern varies from orange to reddish brown but is never as dark as that of the new species. The white tents are grouped in three crowded spiral zones and never form axial bands. Its shape is distinctly cylindrical and the spire is convex in profile instead of straight in the new species. *D. auricomus* is found around Toliara, in South West Madagascar (Pl. 11 figs. 8, 10 and 18) but is always easily identified. Röckel, Korn & Kohn (1995) describe the habitat as "in 3-40 m. on coral reefs, on sand slopes, in sand pocket and in caves".

-3- *D. aulicus* (Linnaeus, 1758) is a much larger species than *D. michecharlesi* sp. nov. although the shape is mostly identical. The pattern is similar. Nevertheless in some specimens (e.g. paratypes 2, 3 and 22) the new species has a pattern never found in *D. aulicus*. The main difference resides in size: *D. michecharlesi* sp. nov. is smaller at adult size than *D. aulicus*. In the vicinity of Toliara, regular sized *D. aulicus* are found (pl. 6 fig. 7) although rarely. They do not have the same axially coalescing white tents and are much greater in size.

-4- *D. aff. aulicus* "Somalia". We possess a few shells from a Somalian population that are similar with *D. aulicus*. The maximum length is inferior and the shells are less elongated than the "classic" *D. aulicus*. Pending the study of more material they are considered as belonging to *D. aulicus*. This population is greater in average size and more ventricose than *D. michecharlesi* sp. nov.

Graphical morphometric comparisons

We produce graphs: SL = f (MD) (maximum shell length versus maximum diameter) and

RD = f (PMD) (relative diameter versus relative position of the maximum diameter) for comparison of shell morphometry of *D. michecharlesi* sp. nov. with its compared species *D. gracianus*.

Analysis of the covariance performed by Manuel J. Tenorio

The mean shell length (SL) of *D. michaelcharlesi* sp. nov. (59.05 mm) is larger than for *D. gracianus* (43.51 mm) (comparison of means: $t = -5.65656$, $p = 2.188 \times 10^{-6}$; $U = 322.0$, $p = 1.795 \times 10^{-5}$). *D. michaelcharlesi* sp. nov. is slightly broader than *D. gracianus* (Least-squares mean maximum diameter (MD) is of 20.79 mm for *michaelcharlesi* versus 19.06 mm for *gracianus*). The differences are small but highly significant ($F = 13.97$, $p = 0.0007$). The differences in spire height (SH) and position of the maximum diameter (PMD) are not statistically significant ($p > 0.05$ in both cases).

The mean shell length of *D. michaelcharlesi* sp. nov. (59.05 mm) is larger than for *D. auricomus* (43.16 mm) (comparison of means: $t = -6.10715$, $p = 6.152 \times 10^{-7}$; $U = 453.0$, $p = 3.739 \times 10^{-6}$). *D. michaelcharlesi* sp. nov. is clearly broader than *D. auricomus* ($F = 18.16$, $p = 0.0001$). There are no statistically significant differences in SH and PMD ($p > 0.05$ in both cases). The mean shell length of *D. aulicus* (114.79 mm) is much larger than for *D. michaelcharlesi* sp. nov. (59.05 mm) (comparison of means: $t = 11.7225$, $p = 0$; $U = 2.0$, $p = 6.277 \times 10^{-9}$). However, there are no statistically significant differences in any of the morphometric parameters MD, SH or PMD between these two taxa ($p > 0.05$ in all cases).

REMARKS

D. michecharlesi n. sp. has been mostly ignored in literature. It only reached collections about 30 years ago quite some time after the description of – the then mysterious – *D. gracianus*. For years it was sold from Toliara by local fishermen or dealers either as *Conus aulicus* (dwarf or juvenile) or as *Conus gracianus*. The description of *D. gracianus* by da Motta and Blöcher, issued in 1982, is short but gives all important features and a useful comparison with *D. auricomus*. The picture of the type specimen is small but of good quality and should have allowed the identification of the species.

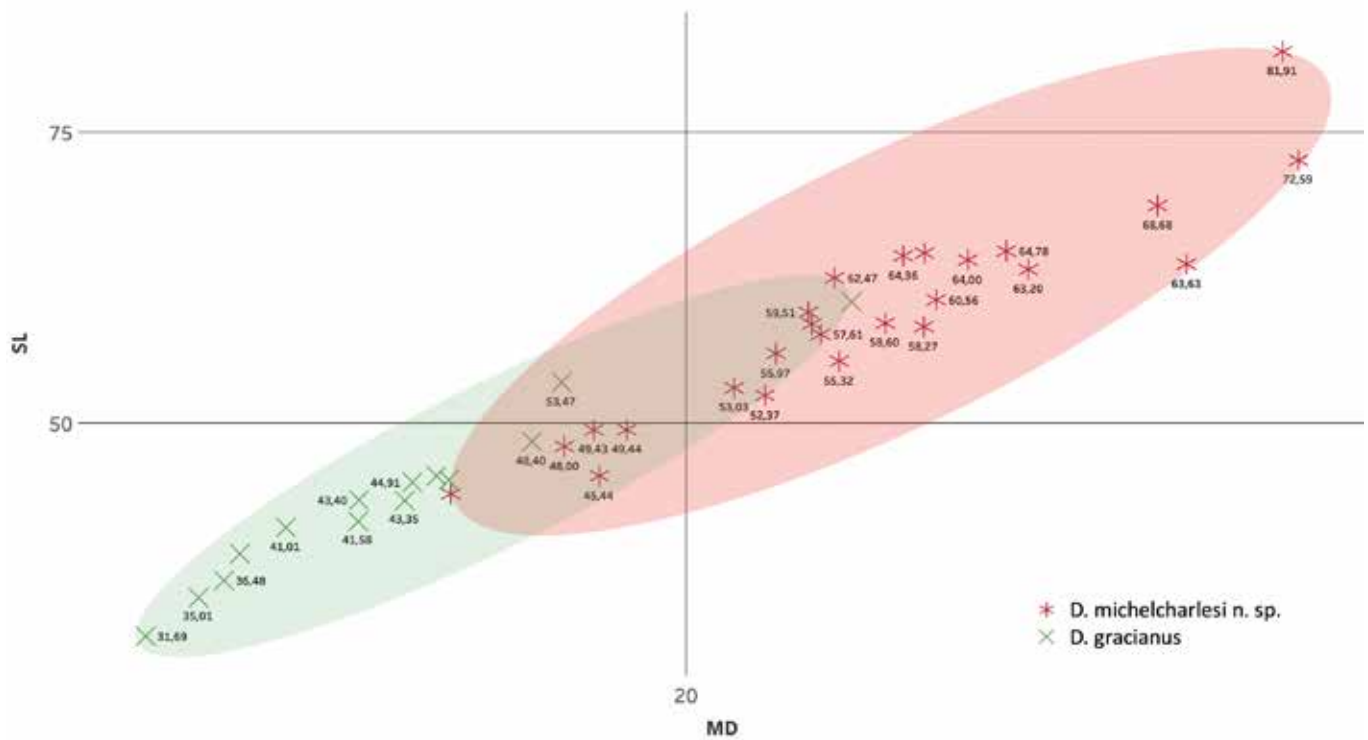


Figure 12: Graph of $SL = f(MD)$ for *Darioconus michelcharlesi* sp. nov. and *D. gracianus*

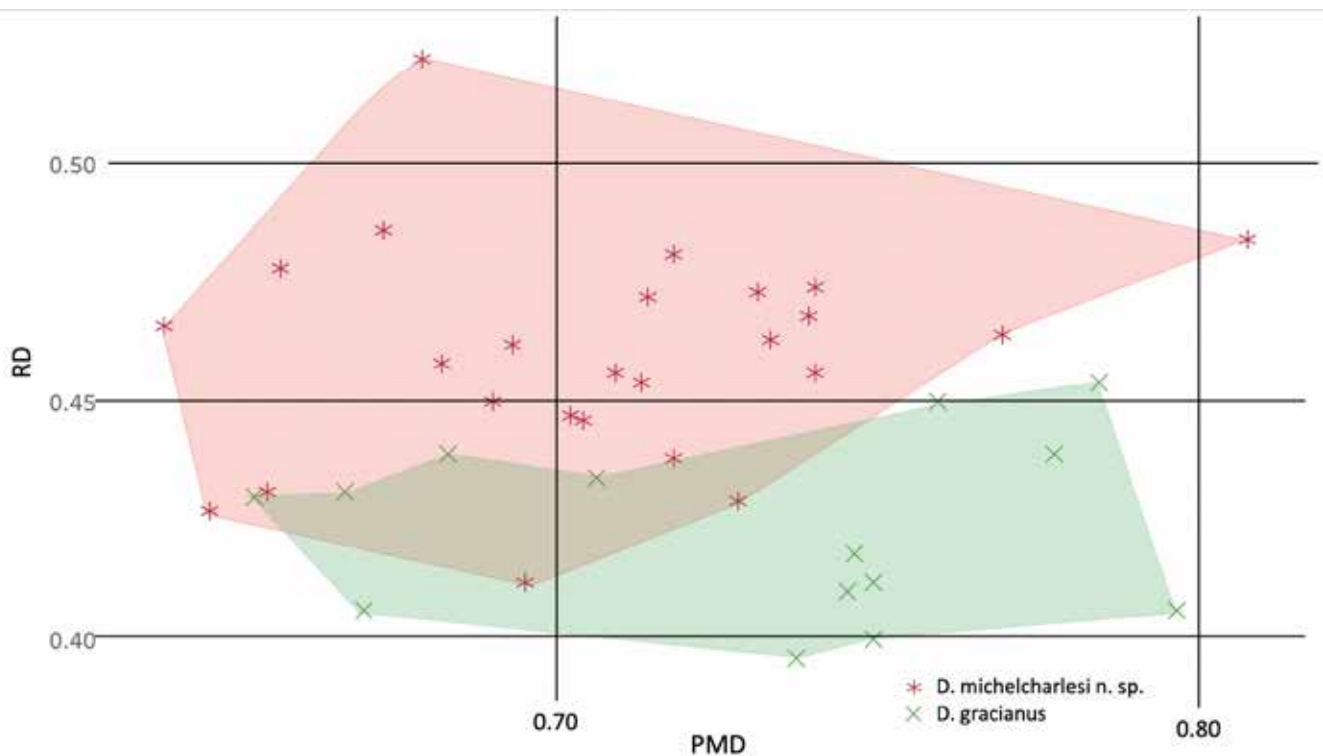


Figure 13: Graph of $RD = f(PMD)$ for *Darioconus michelcharlesi* sp. nov. and *D. gracianus*.

In 1983, Dieter Röckel issues a card (#420) in which he shows two specimens from Tuléar and also a small shell from Jeddah (Red Sea off Saudi Arabia) that seems to match with the two other shells. Röckel then expresses his doubts (translated from German): “The species status of *gracianus* is very doubtful, because it is not convincingly proven that this population may be a juvenile *aulicus* or a dwarf form of *aulicus*... Further series studies are needed to validate the species status”. The two depicted shells are true *D. gracianus* while the shell in the middle may well be a young *D. aulicus* from the Red Sea: its sides are more convex and the shoulder is less conspicuous.

In a paper published in *World Shells* (1993) Felix Lorenz shows 5 specimens of *Conus aulicus* var. *gracianus*. He writes that “the shell... is broader and heavier than that of typical *aulicus*. The fine transversal sculpturing is slightly more prominent...”. This statement is not in agreement with the indications of the original description and the type specimen illustrated by da Motta and Blöcher. Lorenz states that his opinion follows that of Röckel.

In 1995, Röckel, Korn & Kohn state that “The conchological differences between *C. aulicus* and *C. gracianus* do not justify separation at the species level. The latter shells match subadults of *C. aulicus* in morphometry, sculpture and coloration”. They



Figure 14: Röckel's pictures of *D. gracianus* (left and right) and *D. aulicus* (middle).

show (pl. 61 fig. 6) only one shell of *D. gracianus* from "Tuléar" which is labelled as *Conus aulicus* f. *gracianus*.

A few months later, Blöcher published a paper in which he refutes RKK synonymy. He shows how *D. gracianus* is closer to *D. auricomus* and differs mostly by spire shape and organization of the tents on the body whorl. He also shows - for the first time in literature - as *D. gracianus* several specimens of *D. michelcharlesi* sp. nov. (fig. D right, fig. E 3, 4 and 5) and explains how his concept of *D. gracianus* differs from the bigger *D. aulicus* by the wider aperture and more bulbous shape of the latter. He also states that young *D. aulicus* at the size of 70 to 80 mm. have "fragile shells with paper thin outer lips". All these publications set the foundations for the current opinions about these small *Darioconus* species from South Western Madagascar:

A form of *Darioconus aulicus* if one follows the Röckel, Korn and Kohn point of view;

A valid species related to *Darioconus auricomus* and differing by its straighter spire outline and more axially displayed tented pattern if one follows Blöcher's opinion.

It is only with sufficient material at hand that the differences between the real *D. auricomus* and the new species appear. Our study was fostered by the observations of Michel Charles based on the many specimens he could handle. He made the first author aware of the existence of two forms confused within *D. gracianus*. From the samples we could get of each of the putative species, morphometric analyses show statistically significant differences that are confirmed by pattern elements.

In our opinion there are four distinct species in the South West of Madagascar:

D. aulicus ranges in most of the Tropical Indo Pacific region. It commonly reaches sizes of more than 100 mm;

D. auricomus also ranges in most of the Tropical Indo Pacific region. Its spire outline is convex and the white tents are mostly arranged in spiral bands;

D. gracianus is restricted to South Western Madagascar. Its spire outline is straight and the white tents are often forming axial waving bands;

D. michelcharlesi n. sp. is also only known from South Western Madagascar. The pattern is darker than that of *D. gracianus* in fresh shells, the shell is smaller and slender than *D. aulicus* but wider than *D. gracianus*. The tents are bigger and form amorphous patches and sometimes blend together.

In "A Taxonomic Iconography of Living Conidae" the four species are presented from p. 934 to p. 940. The new species is shown on p. 938 with 9 specimens and was provisionally labeled as *Darioconus* aff. *gracianus*. We give it a name after having studied a more important material.

ACKNOWLEDGEMENTS

Our most sincere thanks go to: Alain Robin for his essential assistance with the photography of almost all the specimens illustrated. Thanks to Museums and the collectors who helped us with the photos of their specimens: MNHN, SMNS, MHNG, Manuel J. Tenorio for the Statistical Analysis, Felix Lorenz, Thierry Joly, Christophe Roux, Gérard Hervillard, Pierre Capier, Bob Abela, Fred Schroder, Steve Norby, Emilio Garcia, Don Pisor, Antonio J. Monteiro, Georges Richard, Philippe Quiquandon and Jean-Paul Lapalu.

BIBLIOGRAPHY

- BALLETON, M. & MARTI, P., 2018. Conidae de Polynésie Française. 1-96 pp.
- BLÖCHER, M., 1996. About the validity of *Conus gracianus* da Motta & Blöcher, 1982. World Shells, Roma (Italy). 19: p. 44-47.
- COOMANS, H. E., MOOLENBEEK, R. & WILS, E., 1981. Alphabetical revision of the (sub)species in recent Conidae 4. *Aphrodite* to *azona* with the description of *Conus arenatus* bizona, nov. subspecies. Basteria Vol. 45(3), Amsterdam (Netherlands), p. 3-55.
- DA MOTTA, A. J., 1982. Seventeen New Cone Shell Names (Gastropoda: Conidae). Publicações Ocasionais da Sociedade Portuguesa de Malacologia, 1, Lisboa (Portugal). p. 1-20, 3 pl.
- FILMER, R. M., 2001. A Catalogue of Nomenclature and Taxonomy in the Living Conidae 1758-1998. Backhuys Publishers, Leiden (Netherlands). 1-388 pp.
- GOLDBERG, R. L., 2011. The *Conus auratinus* Con[e]undrum. The Cone Collector, Vol. 16, p. 72-86.
- HINTON, A., 1972. Shells of New Guinea and the Central Indo-Pacific. The Jacaranda Press, Brisbane (Australia). 1-94 pp.
- KOHN, A. J., 1992. A Chronological Taxonomy of Conus, 1758-1840. Smithsonian Institution Press, Washington (U.S.A.) & London (United Kingdom). 1-315 pp.
- LORENZ, F., 1993. The tented cones from Tanzania. World Shells, Roma (Italy). 5: p. 44-47.
- MARSH, J. A., RIPPINGALE, O.H., 1968. Cone Shells of the World. The Jacaranda Press, Brisbane (Australia). 1-185 pp.
- MAYISSIAN, S., 1974. Coquillages de Nouvelle-Calédonie et de Mélanésie. Imprimeries Réunies de Nouméa, New Caledonia. 1-72 pp.
- MONNIER, E., LIMPALAËR, L., ROBIN, A., & ROUX, C., 2018. A Taxonomic Iconography of Living Conidae. AFC, Paris, France & ConchBooks, Harxheim, Germany, Vol.1 (1-604 pp) & Vol.2 (605-1207 pp).
- POPPE, G. T., 2008. Philippine marine Mollusks - Volume II, Conchbooks, Hackenheim (Germany), 1-848 pp.
- PRIGENT, J., 1986. Faire La Wallis et partir à Futuna. Rossiniana Vol. 32, Noumea, (New Caledonia), p. 11.
- REEVE, L. A., 1843. Conchologia Iconica, a complete repertory of species. Vol. 1. Reeve Brothers, London (United Kingdom). Unnumbered.
- RÖCKEL, D., 1979-1988. Die Familie Conidae. Privately Issued, Darmstadt (Germany). 1-606 cards.
- RÖCKEL, D., KORN, W. & KOHN, A.J., 1995. Manual of the Living Conidae - Volume 1: Indo-Pacific Region. Verlag Christa Hemmen, Wiesbaden (Germany). 1-517 pp.

- RICHARD, G., 1985. Conidae de Polynésie Française (1). Xenophora n° 26, A.F.C., Paris (France). 9 - 20 pp.
- SALVAT B., RIVES, C., 1975. Coquillages de Polynésie. Editions du Pacifique, Papeete (Polynésie Française). 1-391 pp.
- SOWERBY, G. B. I., 1833-1841. The Conchological Illustrations, or Coloured Figures of all the hitherto Unfigured Recent Shells. G.B. Sowerby, London (United Kingdom).
- SPRINGSTEEN, F. J. & LEOBRERA F. M., 1986. Shells of Philippines. Carfel Seashell Museum, Manila, Philippines. 1-377 pp.
- SALVAT, B. & RIVES, C., 1975. Coquillages de Polynésie. Les éditions du pacifique Papeete, Tahiti, 1-392 pp.
- TOUITOU, D. & BALLETON, M., 2005. Conidae de Polynésie. Xénophora N° 111, A.F.C., Paris (France). 27-42 pp.
- TRYON, G. W., 1884. Manual of Conchology, structural and systematic, with illustrations of the species. Conidae, Pleurotomidae. Vol. 6. Tryon, Philadelphia (U.S.A.). 1-413 pp.
- TUCKER, J. K. & TENORIO, M. J. 2009. Systematic classification of Recent and fossil Conoidean gastropods, with keys to the genera of cone shells. ConchBooks, Hackenheim, Germany, 1-295 pp.
- TUCKER, J. K. & TENORIO, M. J. 2013. Illustrated catalog of the living cone shells. MdM Publishing, Wellington FL, USA, 1-517 pp.
- WALLS, J. G., 1979. Cones Shells. A synopsis of the living Conidae. T.F.H. Publications, Inc., Neptune City, New Jersey, 1-1011 pp.



Plate 1 *Darioconus cathyae* n. sp.

1 104.1 mm Manus Island, PNG Holotype MNHN IM-2000-34743 ex Coll. FP

2 77.1 mm Kwajalein SMNS ZI0091167 Coll. BdM Paratype 1

3 124.7 mm Samar, Philippines 25 m Coll. EM Paratype 2

4 105.9 mm Samar, Philippines Coll. EM Paratype 3

5 77.2 mm Coll. EM Paratype 4

6 70.9 mm Coron, Palawan, Philippines Coll. EM Paratype 5

7 115.1 mm Zunes, Bougainville Island, PNG Coll. FP

Paratype 6

8 107.7 mm Kavieng, PNG Coll. FP Paratype 7

9 111.8 mm Ontang Java Atoll, Solomon Islands Coll. DP

Paratype 8



Plate 2 *Darioconus cathyae* n. sp.

- 1 122.8 mm Samar, Philippines Coll. PC Paratype 9
 2 85.5 mm Luminao Reef, Guam Coll. TJ Paratype 10
 3 103.6 mm Vanuatu Coll. TJ Paratype 11
 4 81.7 mm Falealupo, W. Samoa Coll. FL Paratype 12
 5 134.9 mm Aliguay, Philippines Priv. Coll. (ex Coll. PQ) Paratype 13

- 6 113.5 mm Guam 20 m Coll. FS Paratype 14
 7 93.2 mm Guam Coll. BA Paratype 15
 8 103.5 mm Luminao Reef, Guam Coll. SN Paratype 16
 9 105.7 mm Faagalu Bay, Tutuila, Samoa Coll. EG 12391 Paratype 17



Plate 3 *Darioconus cathyae* n. sp.

- 1 82.6 mm Ajelleran Islet, Miti Island, Marshall Islands
Coll. EG 14146 Paratype 18
- 2 83.0 mm Ajelleran Islet, Miti Island, Marshall Islands
Coll. EG 14146 Paratype 19
- 3 110.5 mm Kirenkan Islet, Miti Island, Marshall Islands
Coll. EG 14147 Paratype 20

- 4 94.4 mm Vanuatu Coll. GH Paratype 21
- 5 125.0 mm Samar, Philippines Coll. LL Paratype 22

Darioconus aff. *auratinus*

- 6 102.9 mm French Polynesia Coll. EM
- 7 104.2 mm Papeari, Tahiti, French Polynesia Coll. FP



Plate 4 *Darioconus auratinus*

- 1 82.0 mm Fakarava, Tuamotu, French Polynesia
Holotype MHNG 982-118
- 2 84.6 mm Coll. BdM Paratype 1 SMNS ZI 91167
- 3 83.0 mm Fakarava, Tuamotu, French Polynesia Coll. BdM
MHNG
- 4 100.6 mm Tuamotu, French Polynesia Coll. EM

- 5 86.7 mm Rangiroa, Tuamotu, French Polynesia Coll. EM
- 6 83.9 mm Tuamotu, French Polynesia Coll. EM
- 7 64.8 mm Fakarava, Tuamotu, French Polynesia Coll. EM
- 8 55.2 mm Fakarava, Tuamotu, French Polynesia
10-12 m Coll. EM
- 9 43.9 mm Tuamotu, French Polynesia Coll. EM



Plate 5 *Darioconus auratinus*

- 1 70.1 mm Tuamotu, French Polynesia Coll. FP
- 2 63.8 mm Tuamotu, French Polynesia Coll. FP
- 3 65.6 mm Ahe, Tuamotu, French Polynesia Coll. FP
- 4 94.0 mm Ahe, Tuamotu, French Polynesia Coll. FP
- 5 80.2 mm Anaa, Tuamotu, French Polynesia Coll. CR

- 6 101.1 mm Tuamotu, French Polynesia Coll. PQ
- 7 102.5 mm Takapoto, Tuamotu, French Polynesia Coll. GR
- 8 107.2 mm French Polynesia Coll. LL
- 9 98.1 mm Tahiti, French Polynesia Coll. AJM
- 10 101.6 mm Tuamotu ex. Coll. BG
- 11 60.0 mm Rangiroa, Tuamotu, French Polynesia Coll. PK



Plate 6 *Darioconus aulicus*

- 1 149.5 mm Philippines Coll. EM
- 2 122.1 mm South China Sea Coll. FP
- 3 118.1 mm Philippines Coll. EM
- 4 109.5 mm Philippines Coll. EM
- 5 118.8 mm Philippines Coll. EM
- 6 134.4 mm Dzamandzar, Nosy Be, Madagascar Coll. EM

- 7 129.4 mm Andavadoaka, Madagascar Coll. EM
- 8 141.0 mm New Caledonia Coll. EM
- 9 121.8 mm Solomon Islands Coll. FP
- 10 103.8 mm Phuket, Thailand 10-15 m Coll. EM
- 11 99.7 mm Phuket, Thailand 10-15 m Coll. EM
- 12 108.1 mm Philippines Coll. CR



Plate 7 *Darioconus aulicus*

- 1 94.6 mm Faaa, Tahiti Coll. FP
- 2 74.4 mm Australia Coll. FP
- 3 126.6 mm Sri Lanka Coll. FP
- 4 82.1 mm Aratika, Tuamotu 10-15 m Coll. EM
- 5 83.8 mm Rabaul, PNG Coll. EM

Darioconus aff. *aulicus*

- 6 74.5 mm Sambusi, Merka, Somalia Coll. EM
- 7 90.5 mm Somalia Coll. EM
- 8 109.9 mm Somalia 55 m Coll. EM
- 9 70.0 mm Pozzo, Merka, Somalia 4-5 m Coll. LL
- 10 79.6 mm Quissimanjul Bay, Mozambique Coll. EM



Plate 8 *Darioconus michelcharlesi* n. sp.

- | | |
|---|--|
| 1 49.4 mm Toliara, Madagascar 15-20 m Holotype MNHN ex Coll. EM | 6 62.5 mm Toliara, Madagascar Coll. EM Paratype 5 |
| 2 48.0 mm Toliara, Madagascar Coll. EM Paratype 1 | 7 58.5 mm Toliara, Madagascar Coll. EM Paratype 6 |
| 3 63.6 mm Andavadoaka, Madagascar Coll. EM Paratype 2 | 8 64.4 mm Toliara, Madagascar Coll. EM Paratype 7 |
| 4 55.3 mm Salary, Madagascar Coll. EM Paratype 3 | 9 57.6 mm Toliara, Madagascar Coll. EM Paratype 8 |
| 5 53.0 mm Salary, Madagascar Coll. EM Paratype 4 | 10 60.6 mm Toliara, Madagascar Coll. EM Paratype 9 |



Plate 9 *Darioconus michelcharlesi* n. sp.

- 1 64.8 mm Toliara, Madagascar Coll. EM Paratype 10
- 2 81.9 mm Toliara, Madagascar Coll. EM Paratype 11
- 3 68.7 mm Toliara, Madagascar Coll. EM Paratype 12
- 4 64.6 mm Toliara, Madagascar Coll. EM Paratype 13
- 5 59.5 mm Toliara, Madagascar Coll. LL Paratype 14
- 6 43.9 mm Toliara, Madagascar Coll. LL Paratype 15
- 7 58.3 mm Toliara, Madagascar Coll. FP Paratype 16
- 8 49.4 mm Toliara, Madagascar Coll. FP Paratype 17

- 9 72.6 mm Toliara, Madagascar Coll. FP Paratype 18
- 10 56.0 mm Toliara, Madagascar Coll. FP Paratype 19
- 11 45.4 mm Toliara, Madagascar Coll. FP Paratype 20
- 12 52.4 mm Toliara, Madagascar Coll. CR Paratype 21
- 13 58.6 mm Toliara, Madagascar Coll. TJ Paratype 22
- 14 63.2 mm Toliara, Madagascar 10-15 m Coll. JKT 4698
Paratype 23
- 15 64.0 mm Toliara, Madagascar Coll. JPL Paratype 24



Plate 10 *Darioconus gracianus*

- | | |
|---|--|
| 1 43.4 mm Toliara, Madagascar 15-20 m Holotype MHNG 968-112 Coll. BdM | 7 45.1 mm Toliara, Madagascar Coll. EM |
| 2 48.4 mm Toliara, Madagascar Coll. DM Paratype 1 | 8 45.5 mm Toliara-Salary, Madagascar Coll. EM |
| 3 60.4 mm Toliara, Madagascar Coll. DM Paratype 3 | 9 38.8 mm Toliara, Madagascar Coll. EM |
| 4 35.0 mm Toliara, Madagascar Coll. EM | 10 41.6 mm Toliara, Madagascar Coll. EM |
| 5 36.5 mm Toliara, Madagascar Coll. EM | 11 41.0 mm Toliara-Salary, Madagascar Coll. EM |
| 6 53.5 mm Toliara, Madagascar Coll. EM | 12 31.7 mm Toliara, Madagascar Coll. LL |
| | 13 44.9 mm Toliara, Madagascar Coll. FP |



Plate 11 *Darioconus auricomus*

- 1 56.5 mm Sulu Sea, Philippines Holotype MHNG
- 2 41.7 mm Philippines Coll. EM
- 3 41.2 mm Madagascar Coll. EM
- 4 51.7 mm Maldives Islands 12 m Coll. EM
- 5 43.7 mm Philippines Coll. EM
- 6 35.4 mm Nacala, Mozambique Coll. EM
- 7 58.2 mm Tawi Tawi, Philippines 20-35 m Coll. EM
- 8 39.9 mm Toliara, Madagascar 10-12 m Coll. EM
- 9 34.2 mm Poindimié, New Caledonia 20 m Coll. EM

- 10 39.6 mm Toliara, Madagascar Coll. FP
- 11 65.1 mm Phuket, Thailand Coll. BdM SMNS
- 12 43.8 mm Mozambique Coll. EM
- 13 42.9 mm Anakao, Madagascar Coll. FP
- 14 42.6 mm Vanuatu Coll. CR
- 15 39.9 mm Madagascar Coll. CR
- 16 51.4 mm La Réunion Coll. CR
- 17 31.6 mm Tefarerii, Huahine Coll. JPV
- 18 32.9 mm Toliara, Madagascar Priv. Coll.

Annex 1: Measurements and calculations

* subadult
 ** juvenile
 *** freak aperture or eroded apex
 estimated values

N°	SL mm	MD mm	H Height mm	AH mm	HMD mm	RD	PMD	RSH	W g	RW = W/SL g/cm	V Vol- ume cm3	RW' = W/V g/cm3	Repository	Locality
<i>Darioconus cathyae n.sp.</i>														
H 0	104,08	39,67	34,12	85,85	62,58	0,462	0,729	0,175	35,6	3,42	141	0,25	Holotype MNHN- IM-2000-34743	Manus Isl., PNG
P1	77,10	28,10	-	66,82	47,97	0,421	0,718	0,133	-	-	-	-	coll. Da Motta, SMNS	Kwajalein, Marshall Isl.
P2	124,68	42,73	40,21	103,81	74,75	0,412	0,720	0,167	59,9	4,80	214	0,28	coll. EM	Samar, Philippines, 25 m
P3	105,91	36,79	35,02	88,89	63,16	0,414	0,711	0,161	47,7	4,50	136	0,35	coll. EM	Samar, Philippines ?
P4	77,21	24,53	23,22	65,17	46,07	0,376	0,707	0,156	20,3	2,63	44	0,46	coll. EM	Philippines ?
P5	70,87	24,67	23,54	62,08	45,35	0,397	0,731	0,124	14,3	2,02	41	0,35	coll. EM	Coron, Palawan, 25 m
P6	115,48	39,95	34,48	95,75	68,95	0,417	0,720	0,171	41,7	3,61	159	0,26	coll. FP	Zunes, Bougainville Isl., PNG, 15 m
P7	107,70	42,40	36,98	94,44	64,78	0,449	0,686	0,123	56,5	5,25	169	0,33	coll. FP	Kavieng, PNG
P8	111,80	37,58	-	94,20	61,85	0,399	0,657	0,157	-	-	-	-	coll. DP	Ontong Java Atoll, Solomon
P9	122,80	42,70	40,00	104,56	80,60	0,408	0,771	0,149	56,0	4,56	210	0,27	coll. PC	Samar, Philippines
P10	85,45	29,94	26,24	73,02	53,74	0,410	0,736	0,145	26,1	3,05	67	0,39	coll. TJ	Luminao reef, Guam, Mariannes Arch.
P11	103,59	39,20	33,70	89,18	67,27	0,440	0,754	0,139	43,7	4,22	137	0,32	coll. TJ	Vanuatu
P12***	82,30	30,20	26,80	72,04	47,250	0,419	0,656	0,125	30,1	3,66	67	0,45	coll. FL	Falealupo, Savai'i Isl., Western Samoa
P13	134,90	51,46	-	113,16	84,54	0,455	0,747	0,161	-	-	-	-	priv. coll. (ex PQ coll.)	Aliguay, Philippines, 160 m ?
P14	113,5	44	-	94,36	68,01	0,466	0,721	0,169	-	-	-	-	coll. FS	Guam, Mariannes Arch., 20 m
P15	93,20	34,20	-	79,09	55,77	0,432	0,705	0,151	-	-	-	-	coll. BA	Guam, Mariannes Arch.
P16	103,50	35,27	-	85,40	59,41	0,413	0,696	0,175	-	-	-	-	coll. SN	Magundas, Luminao Reef, Guam, Mariannes Arch., 20 m
P17	105,70	37,60	-	85,88	63,69	0,438	0,742	0,188	-	-	-	-	coll. EG 12391	Fatumafuti, Fagaalu Bay, Tutuila, Samoa
P18	82,60	28,40	-	69,61	49,89	0,408	0,717	0,157	-	-	-	-	coll. EG 14146	Ajelleran Islet, N. central Miti Atoll, Marshall Isl.

P19	83,00	26,10	-	70,74	49,68	0,369	0,702	0,148	-	-	-	coll. EG 14146	Ajelleran Islet, N. central Miti Atoll, Marshall Isl.
P20***	110,50	36,50	-	85,83	62,70	0,425	0,731	0,223	-	-	-	coll. EG 14147	Kirenkan Islet, N. central Miti Atoll, Marshall Isl.
P21***	95,50	35,36	33,49	84,31	51,76	0,419	0,614	0,117	42,9	4,49	113	coll. GH	Efate Isl., Vanuatu
P22	125,01	43,69	40,79	107,23	75,83	0,407	0,707	0,142	58,5	4,68	223	coll. LL	Samar, Philippines
23	103,30	33,60	-	86,27	57,21	0,389	0,663	0,165	-	-	-	coll. CBL	Samar, Philippines
24**	29,77	9,85	9,20	24,38	16,85	0,404	0,691	0,181	1,3	0,44	3	coll. EM	Vanuatu
25**	50,74	18,41	17,40	44,25	29,94	0,416	0,677	0,128	9,1	1,79	16	coll. EM	Sulu Sea
26**	37,64	13,42	12,76	32,52	23,45	0,413	0,721	0,136	3,7	0,98	6	coll. EM	Balicasag, Bohol, Philippines, 100-120 m
Average	101,7					0,42	0,71	0,16		3,9		0,34	
<i>D. auratinus</i>													
H 0	82,00	29,50	-	69,78	46,05	0,423	0,660	0,149	-	-	-	Holotype MHNG 982-118	Fakarava, Tuamotu
P1	84,60	31,93	-	70,47	50,28	0,453	0,713	0,167	-	-	-	coll. BdM, SMNS ZI 91167	Fakarava, Tuamotu
2	83,00	29,71	-	70,79	46,03	0,420	0,650	0,147	-	-	-	coll. BdM, MHNG	Fakarava, Tuamotu
3	100,62	35,09	33,37	83,10	59,33	0,422	0,714	0,174	44,2	4,39	118	coll. EM	Tuamotu
4	86,66	32,30	30,51	73,18	50,63	0,441	0,692	0,156	38,7	4,47	85	coll. EM	Rangiroa, Tuamotu
5	83,92	31,09	29,27	69,34	51,37	0,448	0,741	0,174	28,6	3,41	76	coll. EM	Tuamotu ?
6	64,81	23,69	22,33	52,75	37,18	0,449	0,705	0,186	16,9	2,61	34	coll. EM	Farakava, Tuamotu
7*	55,19	17,93	17,20	45,83	34,36	0,391	0,750	0,170	7,2	1,30	17	coll. EM	Farakava, Tuamotu, 10-12 m
8**	43,85	14,25	13,39	35,95	26,93	0,396	0,749	0,180	2,8	0,64	8	coll. EM	Tuamotu
9**	35,90	12,36	11,47	29,93	20,90	0,413	0,698	0,166	1,8	0,50	5	coll. EM	French Polynesia
10**	21,85	7,40	7,01	18,47	12,02	0,401	0,651	0,155	0,5	0,23	1	coll. EM	Takapoto, Tuamotu
11	70,09	25,23	21,42	56,64	41,85	0,445	0,739	0,192	14,8	2,11	38	coll. FP	Tuamotu
12	63,82	23,72	20,53	52,89	38,44	0,448	0,727	0,171	15,6	2,44	31	coll. FP	Tuamotu
13	65,59	24,49	21,18	53,17	39,32	0,461	0,740	0,189	17,3	2,63	34	coll. FP	Arutua, Tuamotu

14	72,97	29,25	25,17	57,89	42,47	0,505	0,734	0,207	24,0	3,29	54	0,45	coll. FP	Tuamotu
15	93,87	33,52	29,12	78,34	56,40	0,428	0,720	0,165	27,8	2,96	92	0,30	coll. FP	Ahe, Tuamotu
16	80,21	28,73	26,93	66,98	46,61	0,429	0,696	0,165	24,2	3,02	62	0,39	coll. CR	Anaa, Tuamotu
17	101,07	37,45	-	83,41	57,45	0,449	0,689	0,175	-	-	-	-	coll. PQ	Tuamotu
18	102,50	41,61	-	87,61	62,20	0,475	0,710	0,145	-	-	-	-	coll. GR	Takapoto, Tuamotu
19	107,23	39,27	37,55	90,99	60,18	0,432	0,661	0,151	42,7	3,98	158	0,27	coll. LL	French Polynesia
20	98,10	36,10	31,80	81,20	58,75	0,445	0,724	0,172	40,0	4,08	113	0,36	coll. AJM	Tahiti, French Polynesia
21	101,60	36,87	-	86,90	59,25	0,424	0,682	0,145	-	-	-	-	ex coll. BG	Tuamotu
22	-	-	-	-	-	-	-	-	-	-	-	-	coll. PK	Rangiroa, Tuamotu
Average	85,7					0,44	0,71	0,17		3,3		0,40		
<i>D. aff. auratinus</i> "golden"														
1	102,93	35,65	33,35	85,91	61,30	0,415	0,714	0,165	33,5	3,25	122	0,27	coll. EM	French Polynesia
2	104,20	33,92	29,86	85,07	62,28	0,399	0,732	0,184	28,5	2,74	106	0,27	coll. FP	Papeari, Tahiti, French Polynesia
Average	103,6					0,41	0,72	0,17		3,0		0,27		
<i>D. aulicus</i>														
1	149,51	59,13	56,03	129,49	93,86	0,457	0,725	0,134	128,5	8,59	495	0,26	coll. EM	Philippines
2	122,12	52,48	45,08	105,90	68,59	0,496	0,648	0,133	90,6	7,42	289	0,31	coll. FP	Nin Thuan, South China Sea
3	118,14	47,67	44,23	107,12	74,64	0,445	0,697	0,093	99,7	8,44	249	0,40	coll. EM	Philippines
4	109,20	44,20	41,90	94,50	66,55	0,468	0,704	0,135	78,1	7,15	202	0,39	coll. EM	Pemba Isl., Mozambique, 10-15 m
5	118,78	45,94	43,61	100,88	67,16	0,455	0,666	0,151	77,6	6,53	238	0,33	coll. EM	Philippines
6	134,43	49,46	47,06	114,53	77,29	0,432	0,675	0,148	98,2	7,30	313	0,31	coll. EM	Dzamandzar, Nosy Bé, NW Madagascar
7	129,49	46,70	43,95	111,03	69,68	0,421	0,628	0,143	97,4	7,52	266	0,37	coll. EM	Andavadoaka, SW Madagascar
8	141,02	54,20	51,61	121,27	85,97	0,447	0,709	0,140	138,2	9,80	394	0,35	coll. EM	New Caledonia

9	121,81	51,10	44,78	103,35	79,07	0,494	0,765	0,152	82,3	6,76	279	0,30	coll. FP	Guadacanal Solomon Islands 5-8 m on sand
10	103,81	42,40	39,33	88,35	57,96	0,480	0,656	0,149	59,5	5,73	173	0,34	coll. EM	Phuket, Thailand, 10-15 m
11	99,67	40,16	38,23	88,22	60,16	0,455	0,682	0,115	59,8	6,00	153	0,39	coll. EM	Lone Isl., Phuket, Thailand, 10-15 m
12	108,09	39,36	36,88	91,13	64,22	0,432	0,705	0,157	61,6	5,70	157	0,39	coll. CR	Philippines
13	81,73	30,67	28,46	68,92	48,90	0,445	0,710	0,157	30,1	3,68	71	0,42	coll. EM	New Guinea
14	121,41	47,83	45,20	105,37	65,86	0,454	0,625	0,132	108,1	8,90	262	0,41	coll. EM	Philippines
15	138,92	54,28	51,04	117,19	83,35	0,463	0,711	0,156	103,9	7,48	385	0,27	coll. EM	Philippines
16	117,46	44,19	42,20	100,22	66,36	0,441	0,662	0,147	70,3	5,99	219	0,32	coll. EM	Philippines
17	83,81	33,31	31,14	72,98	44,48	0,456	0,609	0,129	37,8	4,51	87	0,43	coll. EM	Rabaul, PNG
18	82,12	31,81	30,03	71,83	46,72	0,443	0,650	0,125	35,3	4,30	78	0,45	coll. EM	Aratika, Tuamotu, 10-15 m
19	94,59	35,33	30,74	80,91	58,43	0,437	0,722	0,145	39,2	4,14	103	0,38	coll. FP	Faaa, Tahiti, French Polynesia
20	74,35	28,39	24,09	64,02	44,02	0,443	0,688	0,139	21,5	2,89	51	0,42	coll. FP	Swain Reef, Queensland, Australia
21	126,58	52,89	44,89	108,54	73,90	0,487	0,681	0,143	92,6	7,32	301	0,31	coll. FP	Trincomalee, Sri Lanka, 30-50 m
22	148,30	63,50	53,03	135,30	106,56	0,469	0,788	0,088	161,8	10,91	499	0,32	coll. FP	Madagascar
Average	114,8					0,46	0,69	0,14		6,7		0,36		
<i>D. aff. aulicus</i> "Somalia"														
1	74,48	28,66	27,61	62,80	47,00	0,456	0,748	0,157	29,0	3,89	59	0,49	coll. EM	Sambusi, Merka, Somalia, 5 m
2	90,51	38,02	35,69	79,25	57,50	0,480	0,726	0,124	56,0	6,19	123	0,46	coll. EM	Somalia
3	109,90	41,25	38,73	93,13	63,35	0,443	0,680	0,153	75,6	6,88	176	0,43	coll. EM	Somalia, 55 m
4	70,01	27,24	25,73	58,25	41,70	0,468	0,716	0,168	23,7	3,39	49	0,48	coll. LL	Pozzo, Merka, Somalia, 4-5 m
5	79,58	33,42	31,93	67,91	48,09	0,492	0,708	0,147	38,8	4,88	85	0,46	coll. EM	Quissimanjul Bay, Mozambique, 10-15 m
Average	84,9					0,47	0,72	0,15		5,0		0,46		

<i>D. michelcharlesi</i> n.sp.														
H0	49,44	19,08	17,91	41,20	30,19	0,463	0,733	0,167	9,2	1,86	17	0,54	Holotype MNHN-IM-2000-34744	Toliara, SW Madagascar, 15-20 m
P1	48,00	18,11	16,28	39,06	30,04	0,464	0,769	0,186	7,1	1,48	14	0,50	coll. EM	Toliara, SW Madagascar
P2	63,63	27,79	22,75	53,19	36,13	0,522	0,679	0,164	18,9	2,97	40	0,47	coll. EM	Andavadoaka, SW Madagascar
P3	55,32	22,38	20,85	46,54	33,4	0,481	0,718	0,159	12,2	2,21	26	0,47	coll. EM	Toliara, SW Madagascar, 4-5 m
P4	53,03	20,75	19,51	44,96	31,17	0,462	0,693	0,152	10,4	1,96	21	0,48	coll. EM	Salary, SW Madagascar
P5	62,47	22,31	21,20	50,90	36,56	0,438	0,718	0,185	12,7	2,03	30	0,43	coll. EM	Toliara, SW Madagascar
P6	58,51	21,96	21,00	48,41	34,51	0,454	0,713	0,173	10,0	1,71	27	0,37	coll. EM	Toliara, SW Madagascar
P7	64,36	23,38	22,11	54,70	35,36	0,427	0,646	0,150	11,7	1,82	33	0,35	coll. EM	Toliara, SW Madagascar
P8	57,61	22,09	20,21	48,43	34,32	0,456	0,709	0,159	14,2	2,46	26	0,55	coll. EM	Toliara, SW Madagascar
P9	60,56	23,89	22,09	50,53	36,93	0,473	0,731	0,166	14,8	2,44	32	0,46	coll. EM	Toliara, SW Madagascar
P10	64,78	24,98	23,74	54,84	40,56	0,456	0,740	0,153	18,1	2,79	38	0,47	coll. EM	Toliara, SW Madagascar
P11	81,91	29,28	27,05	71,09	49,44	0,412	0,695	0,132	26,4	3,22	65	0,41	coll. EM	Toliara, SW Madagascar
P12	68,68	27,34	25,79	58,36	43,15	0,468	0,739	0,150	25,4	3,70	48	0,52	coll. EM	Toliara, SW Madagascar
P13	64,62	23,71	22,38	55,30	40,24	0,429	0,728	0,144	15,5	2,40	34	0,45	coll. EM	Toliara, SW Madagascar
P14	59,51	21,90	20,99	49,04	34,43	0,447	0,702	0,176	13,6	2,29	27	0,50	coll. LL	Toliara, SW Madagascar
P15	43,90	16,34	15,33	36,63	25,8	0,446	0,704	0,166	6,1	1,39	11	0,55	coll. LL	Toliara, SW Madagascar
P16	58,27	23,70	22,38	49,61	32,58	0,478	0,657	0,149	14,9	2,55	31	0,48	coll. FP	Toliara, SW Madagascar, 4-5 m
P17	49,43	18,56	17,60	43,03	28,18	0,431	0,655	0,129	8,8	1,77	16	0,54	coll. FP	Toliara, SW Madagascar
P18	72,59	29,53	27,00	60,79	40,89	0,486	0,673	0,163	25,1	3,46	58	0,43	coll. FP	Toliara, SW Madagascar
P19	55,97	21,40	20,21	46,74	31,87	0,458	0,682	0,165	12,7	2,27	24	0,53	coll. FP	Toliara, SW Madagascar
P20	45,44	18,65	17,53	40,02	25,59	0,466	0,639	0,119	7,5	1,64	15	0,50	coll. FP	Toliara, SW Madagascar
P21	52,37	21,23	19,75	44,82	33,18	0,474	0,740	0,144	10,8	2,06	22	0,49	coll. CR	Toliara, SW Madagascar
P22	58,60	23,10	20,60	48,90	34,93	0,472	0,714	0,166	14,0	2,39	28	0,50	coll. TJ	Toliara, SW Madagascar
P23	63,20	25,33	-	52,30	42,22	0,484	0,807	0,172	-	-	-	-	coll. JKT	Toliara, SW Madagascar, 10-15 m
P24	64,00	24,38	-	54,22	37,4	0,450	0,690	0,153	-	-	-	-	coll. JPL	Toliara, SW Madagascar

Average	59,0					0,46	0,71	0,16		2,3		0,48		
<i>D. gracianus</i>														
H0	43,40	14,91	-	36,74	29,25	0,406	0,796	0,153	-	-	-	-	Holotype coll. BdM MHNG 982/112	Toliara, SW Madagascar
P1	48,40	17,60	-	38,76	30,38	0,454	0,784	0,199	-	-	-	-	Paratype 1 coll. BdM SMNS ZI 91324	Toliara, SW Madagascar
P2	60,40	22,58	-	50,16	38,08	0,450	0,759	0,170	-	-	-	-	Paratype 3 coll. BdM SMNS ZI 91324	Toliara, SW Madagascar
3	35,01	12,41	11,60	28,28	21,97	0,439	0,777	0,192	2,6	0,74	5	0,52	coll. EM	Toliara, SW Madagascar
4	36,48	12,81	12,02	31,11	23,31	0,412	0,749	0,147	2,5	0,69	6	0,45	coll. EM	Toliara, SW Madagascar
5	53,47	18,06	17,03	45,64	33,64	0,396	0,737	0,146	6,4	1,20	16	0,39	coll. EM	Toliara, SW Madagascar
6	45,08	16,31	15,24	37,57	26,53	0,434	0,706	0,167	5,5	1,22	11	0,49	coll. EM	Toliara, SW Madagascar
7	45,49	16,12	15,20	38,53	28,74	0,418	0,746	0,153	5,9	1,30	11	0,53	coll. EM	Toliara - Salary, SW Madagascar
8	38,80	13,05	12,38	32,65	24,46	0,400	0,749	0,159	2,3	0,59	6	0,37	coll. EM	Toliara, SW Madagascar
9	41,58	14,89	13,95	36,63	24,56	0,406	0,670	0,119	4,1	0,99	9	0,47	coll. EM	Toliara, SW Madagascar
10	41,01	13,77	12,90	33,59	25,03	0,410	0,745	0,181	3,2	0,78	7	0,44	coll. EM	Toliara - Salary, SW Madagascar
11	31,69	11,59	11,13	26,38	18,03	0,439	0,683	0,168	2,0	0,63	4	0,49	coll. LL	Toliara, SW Madagascar
12	44,91	15,74	14,91	36,54	24,36	0,431	0,667	0,186	5,5	1,23	11	0,52	coll. FP	Toliara, SW Madagascar
13	43,35	15,62	14,92	36,31	23,70	0,430	0,653	0,162	6,0	1,39	10	0,60	coll. FP	Toliara, SW Madagascar
Average	43,5					0,42	0,73	0,16		1,0		0,48		
<i>D. auricomus</i>														
H0	56,50	21,00	-	48,53	37,01	0,433	0,763	0,141	-	-	-	-	Holotype MHNG	Sulu Sea, Philippines
1	41,68	16,05	15,24	35,15	25,16	0,457	0,716	0,157	5,7	1,37	10	0,56	coll. EM	Philippines
2	47,17	17,02	16,00	39,88	30,1	0,427	0,755	0,155	6,4	1,36	13	0,50	coll. EM	Madagascar
3	51,70	17,91	17,04	42,78	27,56	0,419	0,644	0,173	8,6	1,66	16	0,55	coll. EM	Maldives, 12 m
4	43,69	15,92	15,07	37,63	23,1	0,423	0,614	0,139	5,2	1,19	10	0,50	coll. EM	Philippines

5	35,41	12,85	12,06	30,27	21,45	0,425	0,709	0,145	2,6	0,73	5	0,47	coll. EM	Nacala Bay, Mozambique
6	58,24	20,51	19,52	49,31	36,86	0,416	0,748	0,153	12,2	2,09	23	0,52	coll. EM	Tawi-Tawi, Bongao, Philippines, 20-35 m
7	39,90	15,09	14,17	34,50	24,92	0,437	0,722	0,135	4,3	1,08	9	0,50	coll. EM	Toliara, SW Madagascar
8	34,23	12,81	12,08	29,64	22,02	0,432	0,743	0,134	3,0	0,88	5	0,57	coll. EM	Poindimié, New Caledonia, 20 m
9	44,04	15,60	14,71	37,11	26,39	0,420	0,711	0,157	5,5	1,25	10	0,54	coll. EM	Samar, Philippines
10	31,14	11,33	10,70	26,75	20,93	0,424	0,782	0,141	1,4	0,45	4	0,37	coll. EM	Rangiroa, Tuamotu
11	39,63	15,09	14,21	34,16	21,88	0,442	0,641	0,138	5,1	1,29	8	0,60	coll. FP	Toliara, SW Madagascar
12	42,88	16,01	15,05	37,11	26,33	0,431	0,710	0,135	5,4	1,26	10	0,52	coll. FP	SW Madagascar
13	42,64	15,63	14,99	37,06	25,7	0,422	0,693	0,131	-	-	10	-	coll. CR 02952	Vanuatu
14	39,90	14,25	13,85	34,91	26,14	0,408	0,749	0,125	4,3	1,08	8	0,55	coll. CR 02192	Madagascar
15	51,42	17,78	17,03	42,14	29,08	0,422	0,690	0,180	9,0	1,75	16	0,58	coll. CR 02951	Reunion Isl.
16	31,64	10,76	-	26,19	18,98	0,411	0,725	0,172	-	-	-	-	coll. JPV	Tefarerii, Huahine, Société Arch.
17	65,10	23,11	-	53,83	40,86	0,429	0,759	0,173	-	-	-	-	coll. BdM SMNS ZI 91180	Phuket, Thailand
18	32,90	12,14	-	29,15	23,55	0,416	0,808	0,114	-	-	-	-	priv. coll.	Toliara, SW Madagascar
19	46,20	16,56	-	40,29	31,64	0,411	0,785	0,128	-	-	-	-	priv. coll.	Toliara, SW Madagascar
20	43,77	15,16	14,37	37,94	31,27	0,400	0,824	0,133	4,9	1,12	10	0,51	coll. EM	Mozambique
21**	18,79	7,03	6,75	15,77	12,37	0,446	0,784	0,161	0,3	0,16	1	0,34	coll. CR	Mozambique
Average	43,8					0,42	0,73	0,15		1,2		0,52		