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A new Vermetidae from the Eastern Atlantic: *Vermetus bieleri* n. sp. (Gastropoda Caenogastropoda)

Danilo Scuderi[1*], Frank Swinnen[2] & Josè Templado[3]

[1]IISS "E. Majorana", via L. Capuana 36, 95048 Scordia, Catania, Italy; e-mail: danscu@tin.it
[2]Lutlommel 10, 3920 Lommel, Belgium; e-mail: f.swinnen@skynet.be
[3]Museo Nacional de Ciencias Naturales, Madrid, Spain; e-mail: templado@mncn.csic.es
[*]Corresponding author

ABSTRACT A new species of the worm-snail *Vermetus* Daudin, 1800, *V. bieleri* n. sp. (Gastropoda Caenogastropoda), is here described as new for Madeira and the Canary Islands. The species morphologically resembles the Mediterranean congener *V. triquetrus* Bivona, 1832, from which it is here distinguished on the basis of morphological characters of the shell, the protoconch and the external soft parts. Comparisons of the new vermetid with other similar species are hereafter reported.

KEY WORDS *Vermetus*; new species; Canary Islands; Madeira; littoral; endemism; phenetic plasticity.

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INTRODUCTION

Vermetidae is a family of sessile gastropods, whose systematic and ecologic knowledge is far to be fully understood. Useful characters for the identification of species of Vermetidae are the shell sculpture, the protoconch features, the form of the first tele-whorl, the colour pattern of external soft parts, the shape of operculum. The so called phenetic plasticity (Via et al., 1995) allows the vermetids high possibilities to produce different morphs according to environmental conditions (Scuderi, 2003), which impose to taxonomists to study a great number of specimens to have a precise idea of the range of variability of a species. The exam of the radula is a useful character for genus classifications.

The european malacofauna comprises a ten of still taxonomically debated species of this family, mainly distributed into the Mediterranean, because of their warm-water preference.

Despite being a common and well known species, no complete and detailed description of *Vermetus triquetrus* Bivona, 1832 is reported in modern times. Some partial descriptions are scattered in several publications (Lacaze-Duthiers, 1860; Morton, 1965; Bandel, 1984: radula; Schiaparelli, 1996; Calvo & Templado, 2004).

In the Eastern Atlantic, apart the four species reported from Madeira by Segers et al. (2009), the Azorean vermetids were studied in detail only by Bieler (1995), who examined and figured the shell characters, the protoconch and the anatomical characters of what he called "*Vermetus* cfr. *triquetrus*", which he associated to a simply morphological variation of the Mediterranean form. New finding of materials from other Eastern Atlantic archipelagos allowed us to conduct more accurate studies on this species, which is here regarded as new to science and distinguished by the morphologically similar Atlantic and Mediterranean con-

geners. Here follows the description of the new vermetid, which enlarges the number of the European species of Vermetidae to 11 extant species.

MATERIAL AND METHODS

Dry materials of the new species of *Vermetus* Daudin, 1800 were collected by undermining the shells from hard substrates at a depth of 0 to 5 m; empty shells were found beached along lava sand beaches or were collected among the shell grit collected handily with ARA. Some specimens were collected alive and preserved in 90° ethanol. From this latter material informations on the external soft parts were obtained for drawings and future genetic studies could be conducted.

Juveniles were found inside egg capsules of some living collected specimens. Protoconchs were obtained by extracting them from the brooding females, as in the holotype, and by digging them with a needle from the base of empty specimens.

The selection of type materials deposited in the under reported Institutions was fundamentally based on living specimens at our disposal, even if they had almost corroded and not fully grown shells. The reasons of this choice depended on the necessity by us to have the absolutely certainty of the correspondence of juveniles and external soft parts, reported in the pictures of the plate, to the shells. This material was incremented with additional not living collected shells. The holotypus was slightly handily cleaned with a needle from the encrusting algae to make visible characters of the shell, but it was not immersed in any cleaning solutions to preserve juveniles attached on it. It bears all the characters described and the presence of the living animal containing juveniles (stored in a separated vial) and other specimens in different growing stages on it facilitate their observation and evaluation.

The private collections of Authors and of Museums allowed comparisons of the new species with the most similar congeners.

ABBREVIATIONS AND ACRONYMS. Museuo Municipal do Funchal, Madeira (MMF); Museo Nacional de Ciencias Naturales, Madrid, Spain (MNMS); Royal Belgian Institute of Natural Sciences, Brussels, Belgium (RBINS); Roland De Prins collection, Mechelen, Belgium (RDPC); Danilo Scuderi collection, Catania, Italy (DSC); Frank Swinnen collection, Lommel, Belgium (FSC); d: diameter; h: high; pro: protoconch; sh: empty shell; spec: live taken specimen; w: wide; Ø: external diameter of the tube.

RESULTS

Systematics

Subclassis CAENOGASTROPODA Cox, 1960
Ordo LITTORINIMORPHA Golikov et Starobogatov, 1975
Superfamilia VERMETOIDEA Rafinesque, 1815
Familia VERMETIDAE Rafinesque, 1815
Genus *Vermetus* Daudin, 1800
Type species: *Vermetus adansonii* Daudin, 1800

Vermetus bieleri n.sp. (Figs. 1–21)

Vermetus triquetrus Bivona, 1832 (Watson, 1897);
Bivonia triquetrus Bivona, 1832 (Talavera, 1978; Nordsieck & Talavera, 1979);
Vermetus cfr. *triquetrus* Bivona-Bernardi, 1832 (Bieler, 1995).

EXAMINED MATERIAL. Holotype (Fig. 1): Funchal, Madeira, -10 m, on a lava rock, 30/VII/2017; length 12.1 mm, Ø 2.4 mm (MNMS: 46277), P. Wirtz legit. Paratypes. Paratype 1 (Fig. 2): same data of holotype, length 21.4 mm, Ø 3.8 mm (MMF). Paratype 2: same data of holotype, length 20.2 mm, Ø 5.4 mm (RBINS: I.G.33286/MT.3427). Paratype 3: same data of holotype, length 19.9 mm, Ø 3.8 mm (RDPC). Paratype 4: same data of holotype, length 20.1 mm, Ø 5.0 mm (MNMS). Paratype 5: Caniçal, Madeira, -10 m, on lava rocks, 16/IV/2017, length 21.5 mm, Ø 4.9 mm (MMF). Paratype 6 (Fig. 3): Las Palmas, Gran Canaria, Playa del Hombre, beached. I/1998: length 22.0 mm, Ø 3.8 mm (DSC). Paratype 7 (Fig. 4): same data of paratype 6, length 33.5 mm, Ø 7.1 mm (FSC). Paratype 8 (Fig. 5): same data of paratype 6, length 25.1 mm, Ø 7.0 mm (RBINS). Paratype 9 (Fig. 6): same data of paratype 6, length 38.0 mm (cluster of a ten of sh.), Ø (of the bigger sh.) 6.0 mm (RDPC). Paratype 10

(Fig. 7): same data of paratype 6, length 14.0 mm, Ø 3.1 mm (RBINS).

All the other unnumbered paratypes are in the collection of the Authors and the above reported Institutions.

Other examined material. Madeira: Reis Magos, intertidal, on volcanic rocks, 10 spec (Peter Wirtz legit); Porto Santo: south coast, -14/100 m, 10 sh.; Calheta, 2 sh and 5 juv sh, 1 spec. Selvage Is.: Selvagem Pequena, 20 sh, tidal pools; Selvagem Grande, -10 m, 1 sh.

Canary Islands. Las Palmas, Gran Canaria, Playa del Hombre, beached. I/1998, 48 sh. (DSC). La Graciosa: volcanic sand, beached, 4 sh, 4 pro, (DSC); Tenerife: 1 sh on *Stramonita haemastoma* (DSC); Lanzarote: 58 sh, 1 little cluster (2/3 sh), 18 pro (DSC).

Description of holotype (MNMS). Length 21.4 mm, Ø 3.8 mm. Shell solid, irregularly coiling, tube-like, with one main dorsal keel, which give the shell a triangular cross section, and more smaller carinae mainly in the outer part of the tube in each whorl (Fig. 8). Apart the spiral keels, dense growing lines are present over all the tube surface. They are not homogenous: some lines are slightly more relieved alternated to other more faint. The last whorls appear mainly sculptured by a distinct dorsal chord, which become more marked on the last whorls. The colour of the entire shell is almost brownish, stripped by darker lines.

Protoconch inflated, rather as wide as high, constituted by little less than 2 mainly smooth whorls, 0.75/0.8 mm high and 0.6/0.7 mm wide (Figs. 9, 10, 16, 19). The surface appear almost smooth, apart the growing lines. A spiral chord is present at the base of the last whorl. Sometimes the basal chord of the protoconch is well marked, while in other specimens it could appear only as a faint trace, constituted by two poorly visible spiral threads. The first teleoconch whorl is ribbed by not marked axial chords, almost entirely chestnut in colour, rounded in shape (Fig. 9). In the following whorls, in addition to the spirals, the axial lines starts to run over the entire shell surface, particularly in the external side of the whorl, giving sculpture a cancellated weave.

External soft parts of the living animal (Fig. 21) dark greyish-brown or blackish in colour with numerous minutes orange and whitish spots over the metapodium, head and part of cephalic tentacles, almost paler brownish in the remaining parts. Mesopodium whitish like the central region of the mesopodium, just over the operculum, where a series of 3–4 minute black spots is present in a single line, which encircles operculum on the upper side. Mantle edge with alternated black and white stains. Nuchal region with the same colour of the metapodium, which blend to almost pale orange, without giving rise to any particular pattern. A white band is present over the cephalic tentacles. Pedal tentacles almost transparent with yellowish-orange spots.

Operculum (Fig. 12) thin, on the upper centre of the semi-circular podalic disc, 1/3 of the total aperture of the tube, with an internal spiral keel of approximately 1 and ½ coil on the upper slightly concave side, almost smooth and glossy on the lower side.

Egg capsule containing eggs (Fig. 17) and embryos (Fig. 18) were found in two living specimens of the lot in which the holotype was selected. They are 4–5 mm in length and white-yellowish in colour. They perfectly match with the protoconchs of all the other shells studied.

Radula (Figs. 13–15) with laterals (Figs. 13, 14) hook shaped, bicuspidate, with the proximal cusp shorter than the distal, and rachidian (Fig. 15) with one coarse central cusp and two smaller for each side.

Variability. The maximum dimensions measured of a full extended specimen is 37 mm in length and 22 mm wide, with an external diameter of the tube of 7 mm. Apart the irregular mode of coiling, intraspecific variability regards the shell colour, which ranges from almost entirely purplish-brown to creamy, with some darker lines. Judging from our observations and from literature data, the colour pattern of the living animal seem subjected to a range of variety. As in other species of Vermetidae, the shell sculpture in adult specimens could be more or less marked, depending on environmental conditions (Scuderi, 2003). In full grown specimens, which often are eroded by wave action, the spiral sculpture is often faint or absent, in particular if the specimen produce a feeding tube.

Etymology. The name is after the malacologist and vermetids expert Rudiger Bieler, who reported

the species at the Azores for the first time as *V.* cfr. *triquetrus*.

DISTRIBUTION AND BIOLOGY. The species is currently known only from the Azores, Madeira Archipelago and Canary Islands. On the basis of the material described by Monterosato (1892) specimens found along the Atlantic side of Spain is attributable to *V. triquetrus*. The species is able to form little clusters of specimens (Figs. 6–20).

COMPARATIVE NOTES. The new species is similar to some morphologically close similar species, to which it is here compared:

Vermetus triquetrus Bivona, 1832. The Mediterranean *V. triquetrus* has great shell resemblance with the new one for the triangular shape of the section of the tube, due to the presence of a main and marked crest on the top. But in the new species some other less marked spiral chords are present too, mainly on the external side of the shell, better visible in not fully grown specimens. The living animal colour of *V. triquetrus* (Fig. 22) is quite variable, ranging from entirely yellow to completely dark grey, with white dots and strips. But some populations show external soft parts with a similar colour pattern of the new species. The most useful and invariable character to discriminate these two species is the protoconch, which is completely smooth in *V. triquetrus* (Schiaparelli, 1996; Calvo & Templado, 2004).

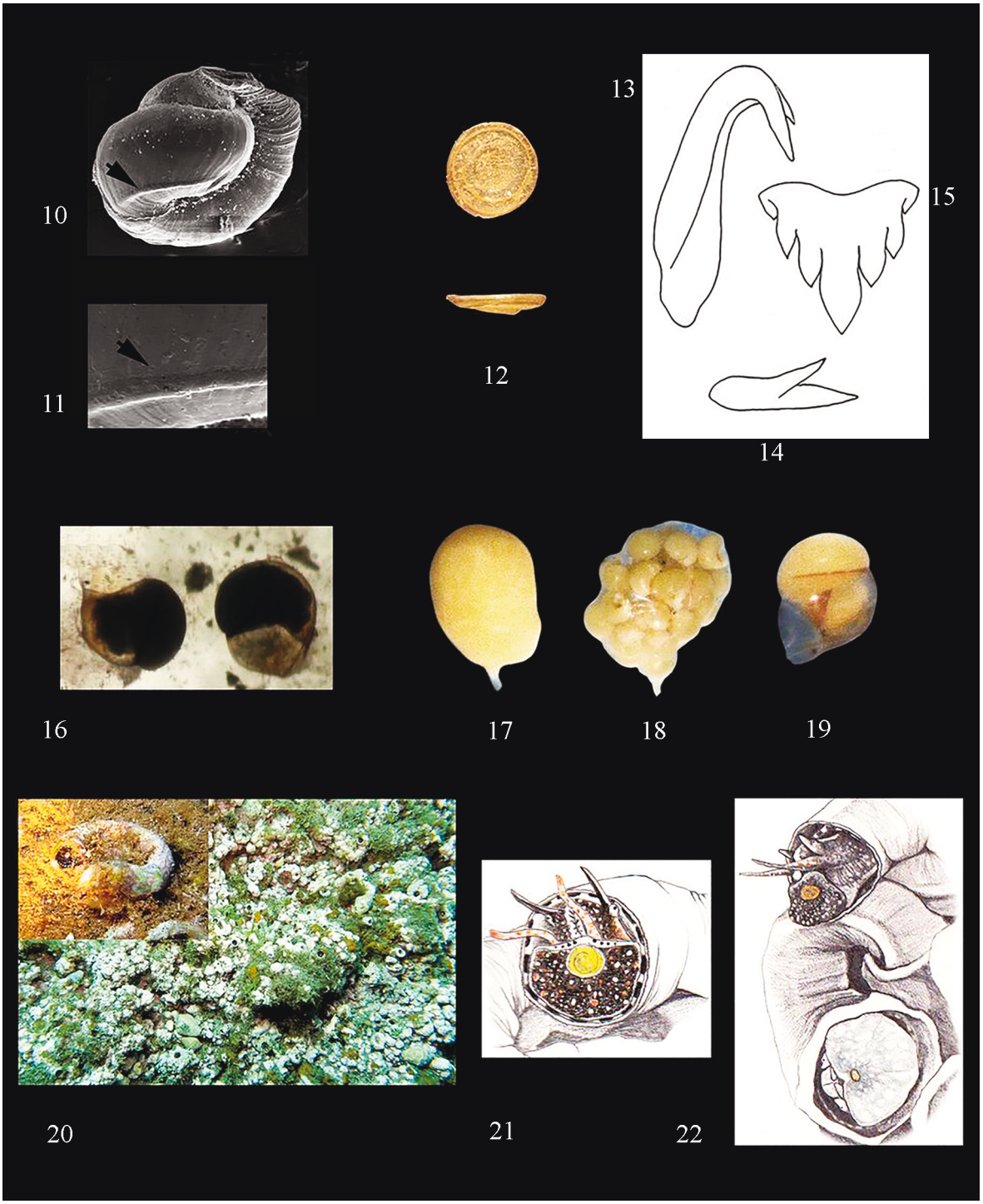
Vermetus adansoni Daudin, 1800. This is an Atlantic species mainly distributed along the W-African rocky shores and the type species of *Vermetus*. The shell morphology of this species is similar to a morpho of the Mediterranean *V. granulatus* called "form A" (Scuderi, 1999), being the spiral sculpture very marked and predominant over the axial ribs. Only young specimens of *V. bieleri* n. sp. could be confused with *V. adansoni* due to the cancellated shell sculpture, but *V. bieleri* n. sp. has a less marked sculpture and protoconch of different shape and with the characteristic basal spiral chords.

Vermetus granulatus (Gravenhorst, 1831). This Mediterranean species shares with *V. bieleri* n. sp. the presence of less marked spiral chords mainly on the external side of the tube, but specimens with almost equally marked spirals are not infrequent. These lines cross the axial sculpture giving it a cancellated aspect. Not fully grown specimens of *V. bieleri* n. sp. are thus similar in shell sculpture and in the almost brownish colour (Figs. 7, 8) to *V. granulatus*. The operculum is similar too, being smaller than the metapodium. Anyway *V. granulatus* has smaller dimensions, reaching 2–3 mm in diameter of the tube and 10–20 mm in length in adult specimens and the protoconch is quite different in general shape and completely smooth; the external soft parts have a different colour pattern (Scuderi, 1999).

Vermetus gaederopi (Mörch, 1861). This species is only recently re-discovered after hits original description and its distribution is known with certainty only after the new recent finding, some Sicilian localities, being the type material doubtfully reported as coming "*probably from Spain*" (Scuderi, 2015). Notwithstanding it is collocated in *Dendropoma* Mörch, 1861 by the presence of a complete operculum, which occupies all the entire aperture, the shell of young *D. gaederopi* could, in some ways, recalls that of the new species. It is sculptured by spiral chords, almost all equally marked, and robust axial ribs too. The lack of a complete operculum in the new species is useful for a quick distinction from *D. gaederopi*. The protoconch is different in general shape and sculpture. The external soft parts have a different colour pattern (Scuderi, 2015).

Protoconchs of the new species could be confused with those of some species of the genus *Petaloconchus* Lea, 1843, like the Indo-Pacific *P. cereus* Carpenter, 1857, the Mediterranean *P. laurae* Scuderi, 2012 or the European fossil *P. intortus* (Lamarck, 1818). They share with *V. bieleri* n. sp. a well-developed keel at the base but are less blunt and inflated in general outline. Another species of this latter genus, recently described for the Mediterranean, *P. laurae* Scuderi, 2012, is characterized by a protoconch with a single spiral chord at the base. But the latter has a more elongated general shape, different sculpture, a bigger nucleus (290 μm in *P. laurae* vs. 250 μm in *V. bieleri* n.sp.) and a surface covered by microscopic spiral lines. Moreover the first teleoconch whorl is sculptured by heavy ribs just in the early trait. Adult shells are very different.

Figures 1–9. *Vermetus bieleri* n. sp. Fig. 1: holotype, Funchal, Madeira, length 12.1 mm. Fig. 2: paratype 1, same data of holotype, length 21.4 mm (MMF). Fig. 3: paratype 6, Las Palmas, Gran Canaria, Playa del Hombre, length 22.0 mm (DSC). Fig. 4: paratype 7, same data of paratype 6, length 33.5 mm (FSC). Fig. 5: paratype 8, same data of paratype 6, length 25.1 mm (RBINS). Fig. 6: paratype 9, cluster of a ten of sh from Las Palmas, Gran Canaria, Playa del Hombre, length 38.0 mm, (RDPC). Fig. 7: shell of a not fully grown specimen, paratype 10, same data of paratype 6, length 14.0 mm, external Ø of the tube 3.1 mm (RBINS). Fig. 8: detail of the shell sculpture of a not fully grown specimen. Fig. 9: detail of the first teleo-whorl, same data of paratype 6, length 1.2 mm, Ø of the tube 0.5 mm (DSC).



Figures 10–21. *Vermetus bieleri* n. sp. Funchal, Madeira. Figs. 10–11. SEM photographs of the protoconch and first tele-whorl, with detail of the basal chord (black arrow), same data of the specimen in figure 9, h 0.8 mm and w 0.7 mm (MNMS). Fig. 12: operculum, upper and lateral view; d 1.2 mm. Figs. 13–15: drawings of radular teeth: lateral tooth in frontal view (13), lateral tooth in upper view (14), rachidian (15). Fig. 16: phase-contrast photograph of two full grown embryos near to hatch, h 0.8 mm each. Fig. 17: photograph of an egg capsule containing eggs, h 4 mm. Fig. 18: photograph of an egg capsule containing embryos near to hatch, h 5 mm. Fig. 19: photograph of a single embryos, h 0.8 mm. Fig. 20: living specimens in their environment (magnification of a specimen in the upper-left corner). Fig. 21: drawing of the living animal, Ø of pedal disc 2.6 mm. Figure 22. *Vermetus triquetrus*. Drawing of the living animal, from Ganzirri, Messina (Sicily), length 16.5 mm, external Ø of the tube 4.0 mm (DSC).

DISCUSSION AND CONCLUSIONS

The genus *Vermetus* is currently insufficiently well characterised as an homogeneous group. It comprises a series of species which, on the basis of morphological differences, could be better assigned to different genera, representing a "genus-tank", which need a good modern definition. The new species is here grouped within *Vermetus* s. st. on the basis of analogies to the type species, *V. adansonii*, which had a troubled taxonomic history, resolved only in recent time (Keen, 1961). Moreover, the form and dimensions of the central and lateral radular tooth, which seem to have a good value in genus characterization (Scuderi, 2003), in the new species are of the same shape of those known for other similar congeners, i.e. *V. triquetrus*, *V. semisurrectus* or *V. granulatus*. Even some other anatomical characters, i.e. the presence of a reduced operculum on a semi-circular pedal disc, which constitutes the propodium, seem to state its relation to the typical *Vermetus* s. st. species.

The most similar species to *V. bieleri* n. sp. is the Mediterranean *V. triquetrus*. But this resemblance is limited to almost adult specimens, which share with the latter species similar shell sculpture. The protoconch is very distinct from that of all other species of *Vermetus*. When young, the shell of *V. bieleri* n. sp. is more similar in sculpture to another Mediterranean species, *V. granulatus*, which is smaller and have different protoconch and external soft parts.

Concerning maximum dimensions in length, width and diameter of the tube reached by the new species, our specimens seem bigger than those observed by Bieler (1995). The maximum dimensions of *V. bieleri* n. sp. are larger than those reported and personally observed in *V. triquetrus*.

Compared to the width of the foot, the operculum of *V. bieleri* n. sp. seem proportionally rather bigger than in *V. triquetrus*. Soft-body coloration is similar to that of some populations of *V. triquetrus*, although this latter is highly polymorphic in color too, ranging from almost black, with coloured dots and strips, to completely grey and yellow specimens (Scuderi, 2003).

The distribution of the new species seem limited to the Eastern Atlantic archipelagos and materials of the *V. triquetrus* studied from the Mediterranean confirm the absence of the new species inside this basin.

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