

A new species of the genus *Schileykiella* Manganelli, Sparacio et Giusti, 1989 from Sicily (Italy) (Gastropoda Pulmonata Canariellidae)

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ABSTRACT

Schileykiella mariarosariae n. sp. (Gastropoda Pulmonata Canariellidae) is described from Mount Pecoraro, Cinisi (Palermo, Sicily, Italy). The new species is characterized by lenticular shell with keeled whorls and very short hairs, genitalia with long penis, short epiphallus, long flagellum, very flared initial portion of the duct of bursa copulatrix. Additional ecological, biological and taxonomic notes are provided.

KEY WORDS

Canariellidae; *Schileykiella*; taxonomy; new species; Mount Pecoraro; Sicily.

Received 06.02.2019; accepted 28.03.2019; published online 18.04.2019

INTRODUCTION

Malacological research carried out in the mountains of Palermo (Sicily, Italy) allowed us to identify a new population of small terrestrial molluscs.

Already from the examination of the shell, it appeared different from the other Sicilian populations, and, the study of the genital morphology, revealed its belonging to a new species of the genus *Schileykiella* Manganelli, Sparacio et Giusti, 1989 (Gastropoda Pulmonata Canariellidae).

This genus includes, at moment, three species from Sicily and Maltese Islands (Manganelli et al., 1989; Giusti et al., 1995; Cianfanelli et al., 2004): *S. parlatoris* (Bivona, 1839) widespread in Sicily and Gozo Island, *S. reinae* (Pfeiffer, 1857) widespread in north-western and central Sicily, and *S. bodoni* Cianfanelli, Manganelli et Giusti, 2004 en-

demic of Marettimo Island (Aegadian Archipelago, North Western Sicily).

In the present work, this new species of *Schileykiella* is described.

MATERIAL AND METHODS

Empty shells and live specimens were collected in the field by eye-sight, on the ground and under stones and various debris, at daylight, but also sifting debris samples in laboratory. The study area was examined from a geological and botanical point of view. The specimens were studied as regards size, colour, external morphology and genitalia. The measurements were made with digital gauge and micrometer. The shells have been immersed for less than two minutes in a solution with 60% of water (H₂O), and 40% of NaClO, and sub-

sequently clean with water and a flattipped and hard bristles paintbrush. Some specimens were fixed in 80% ethanol and reproductive apparatus was extracted by means of scalpel, scissors and needles. The samples were observed through the Optika stereomicroscope and Scanning Electron Microscope HV: 20.00 kV at the Department of Geological Sciences of the University of Catania. Illustrations of genitalia were sketched using a camera lucida. The photos were taken with a Nikon D3100 18-55 camera, with a Canon EOS 100D camera. A single specimen was also examined uncoated under a Tescan Vega 2 LMU Scanning Electron Microscope in Low Vacuum modality to investigate shell micromorphology. All images were acquired at the Department of Biological, Geological and Environmental Sciences (University of Catania).

To study the biological cycle, two adult specimens were bred in the laboratory, from December 2017 to December 2018, in a small terrarium (13 cm long x 9 cm wide x 4 cm high) with a layer of soil 15 mm deep, small calcareous rocks and organic debris.

The toponyms are reported following the “Geoportale Nazionale, Map IGM 1: 25000”. Each sampling site is denominated in the original language (Italian).

Taxonomical references are based on the checklist of land and freshwater Gastropoda of Europe (Bank & Neubert, 2018) and other cited papers. The average temperatures and humidity concern the months of January and February 2018 (<https://www.ilmeteo.it/portale/archivio-meteo>). The voucher specimens are deposited in the following Museums and private collections: CG (S. Giglio collection, Cefalù, Italy); CL (F. Liberto collection, Cefalù, Italy); MCZR (Museo Civico di Zoologia collection, Roma, Italy); MZP (Museo di Zoologia “Pietro Doderlein” collection, Palermo, Italy); CR (A. Reitano collection, Catania, Italy); CS (I. Sparacio collection, Palermo, Italy); CV (Viviano collection, Palermo, Italy).

Unless otherwise stated, the collector of the molluscs in the field is the owner of the collection where the specimens are preserved.

ABBREVIATIONS AND ACRONYMS. A: atrium; BC: bursa copulatrix; DBC: duct of bursa copulatrix; E: epiphallus; F: flagellum; FO: free oviduct; LDL: left dorsal lobe; LLL: left lateral

lobe; P: penis; PR: penial retractor; RDL: right dorsal lobe; RLL: right lateral lobe; SL: subpneumostomal lobe; UOS: uterine ovispermiduct; V: vagina; VD: vas deferens; ex/x: specimen/s; T: Temperature.

RESULTS

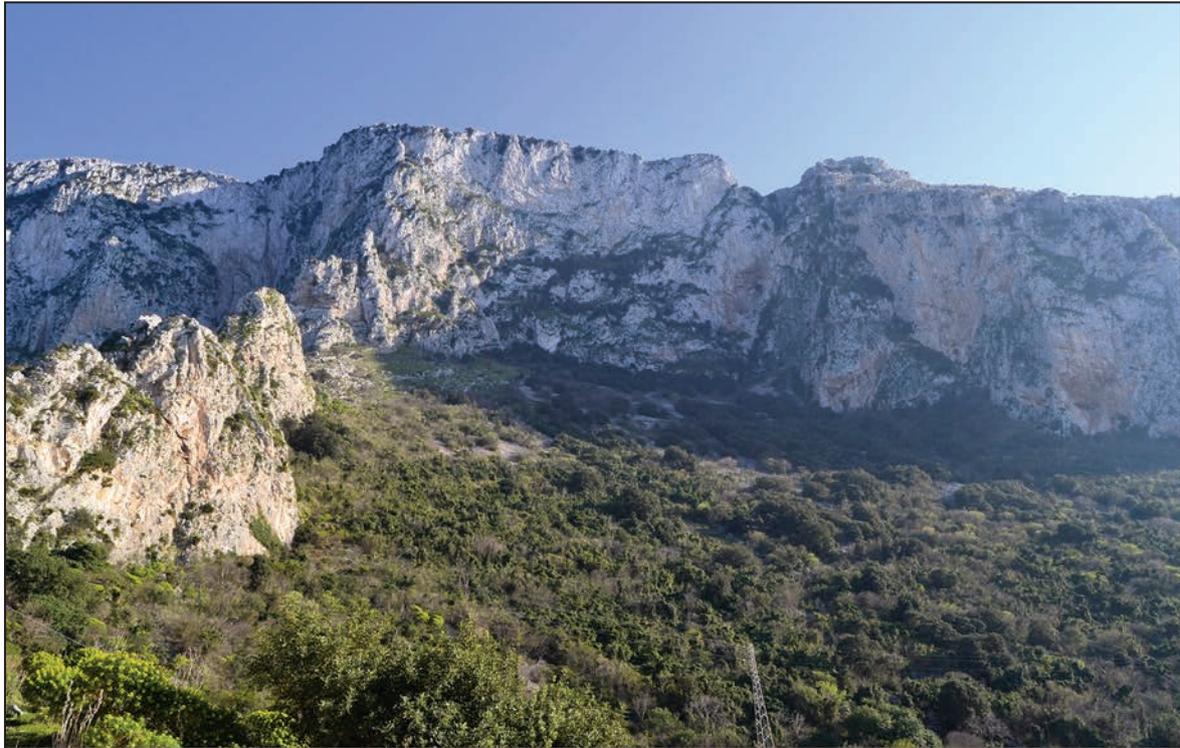
Systematics

Phylum MOLLUSCA Cuvier, 1795
 Classis GASTROPODA Cuvier, 1795
 Infraclassis PULMONATA Cuvier in Blainville, 1814
 Ordo STYLOMMATOPHORA A. Schmidt, 1855
 Subordo HELICINA Rafinesque, 1815
 Infraordo HELICOIDEI Rafinesque, 1815
 Superfamilia HELICOIDEA Rafinesque, 1815
 Familia CANARIELLIDAE Schileyko, 1991
 Genus *Schileykiella* Manganelli, Sparacio et Giusti, 1989

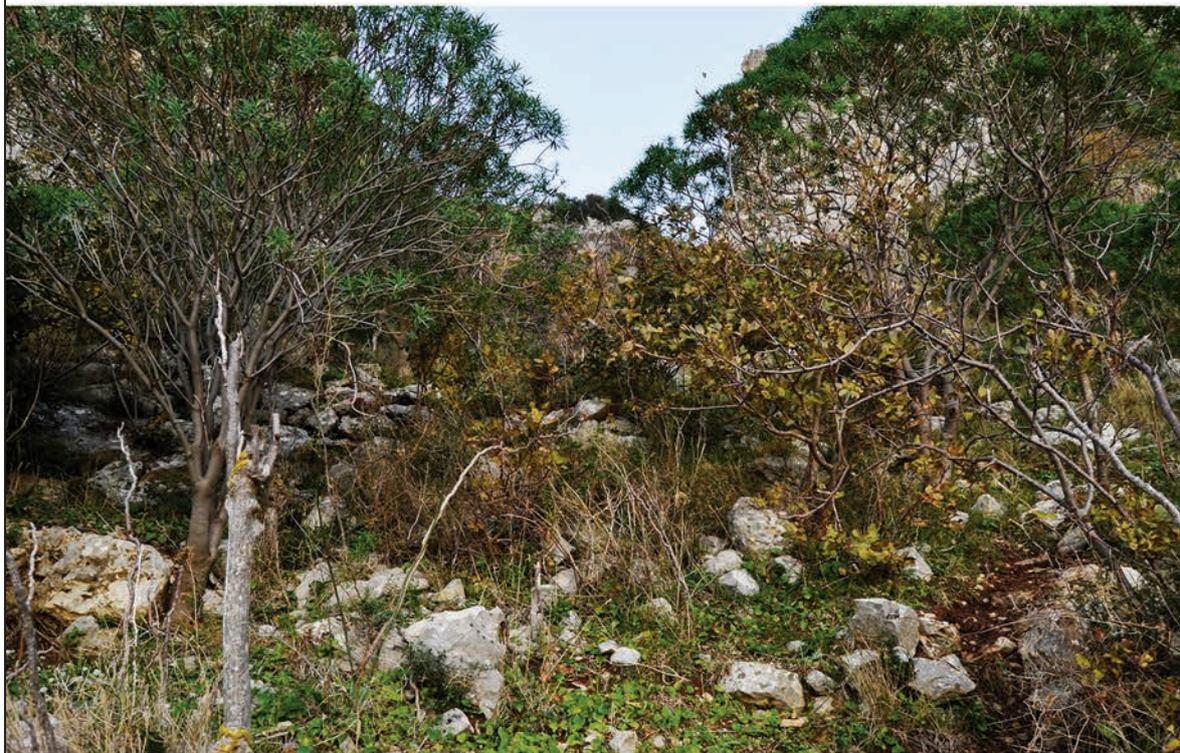
Schileykiella mariarosariae n. sp. (Figs. 3–18)

TYPE LOCALITY. North side of Mount Pecoraro, Cinisi (Palermo, Sicily, Italy).

TYPE MATERIAL. Holotype (Figs. 3–6): North side of Mount Pecoraro, Cinisi, above Portella Scaletti (Palermo, Sicily, Italy), 38°10'214"N 13°07'26"E, 230 m, legit R. Viviano & A. Viviano, 10.II.2019, 1 ex (MCZR). Paratypes: above Portella Scaletti, 230 m, 24.XII.2017, 4 shells, 2 exx (CV0078); idem, 230–250 m, 02.III.2018, 14 shells (CV0100); idem, leg. R. Viviano (Figs. 9–12) (CR); garigue above the rock spur, 38°10'13.7"N 13°07'26"E, 340–360 m, 02.III.2018, 9 shells (CV0121); above Portella Scaletti, 275 m, 02.III.2018, 1 shell (CV0129); NE side of Pizzo Angelelli, 38°10'09"N 13°07'26"E, 420 m, 02.III.2018, 2 shells (CV0145); garigue above the rock spur, 360 m, legit R. Viviano & A. Viviano, 05.XI.2018, 11 shells (CV0166); idem, 340 m, 05.XI.2018, 3 shells (CV0168); Portella Scaletti, 38°10'25"N; 13°07'25"E, 195 m, 6.I.2018, 1 shell (CL17739); above Portella Scaletti, 292 m, 30.XII.2018, 3 exx, 29 shells (CL18066–18097, Fig. 7); idem, 30.XII.2018, 30 shells (CG); idem, 230 m, legit R. Viviano & A. Viviano, 10.II.2019, 7 shells, 2 exx (CV0176); idem, 230 m, legit R. Vi-



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Figure 1. Northern side of Monte Pecoraro and Portella Scaletti (north-western Sicily, Italy).
Figure 2. Study area: detritus slopes, at the base of limestone walls, with Mediterranean maquis.

viano & A. Viviano, 10.II.2019, 1 shell (MZP); NE side of Pizzo Angelelli, 38°10'14"N 13°07'19"E, 275–300 m, 10.II.2019, 1 shell (CV0177); idem, 240 m, 23.III.2019, 6 shells (CR); above Portella Scaletti, 230 m, 02.I.2018, 2 shells (CS5045/2); idem, 245 m, 24.III.2019, 9 shells (CS5046/9).

DESCRIPTION OF HOLOTYPE. Shell dextral, small (diameter 9 mm, height 2.7 mm, umbilicus diameter 3.5 mm, aperture diameter 3.8 mm, aperture height 3 mm), lenticular, scalariform in frontal view, little raised above and convex below, yellowish in colour, opaque, with microscopic hairs; spire formed by 4.5 increasing whorls separated by deep sutures; the last two whorls with keel on external margin (0.7 wide on the last whorl); umbilicus deep and wide 1/3 of shell maximum diameter; aperture oblique, strongly keeled at its external margin, with slightly inclined upper edge and convex lower edge; peristome not thickened, little reflexed at its columellar margin; the protoconch measure 1.5 mm; suture slightly furrowed; surface with longitudinal furrows and some growth lines; periostracal surface of teleoconch, with impressions of hair roots and scarce and irregular hairs from 50 to 130–150 μm in length; microsculpture consisting of very fine grooves that follow the spiral (Figs. 9–12).

Body. Animal yellowish-white with brownish-black spots, not particularly extensive; the internal viscera reddish-brown. Mantle border (Fig. 7) sub-oval in contour, very protruding at left upper vertex in correspondence of the shell keel, with five lobes: right and left dorsal lobes bordering upper margin of small pneumostome; subpneumostomal lobe sub-rectangular; right lateral lobe is very large, triangular, wider at the base; left lateral lobe elongated. Eye tentacles extensible up to 3 mm, tactile tentacles up to 0.8 mm, both contractile, rounded ends, simple pupils; foot extensible up to 6.5–7 mm with yellowish and non partite sole; pneumostome with a diameter of 0.2–0.3 mm with adjacent anal orifice; both orifices are surrounded by a lighter mantle margin.

Genitalia. Female distal genitalia include free oviduct, bursa copulatrix and its duct, and vagina. Vagina very short (1.6 mm) without accessory organs (dart-sac complex, digitiform glands); internal wall of vagina with very thin parallel pleats. Duct of bursa copulatrix long (6 mm) with initial portion very flared; bursa copulatrix rounded-oval; free oviduct long (3.1 mm), slender, sub-cylindrical.

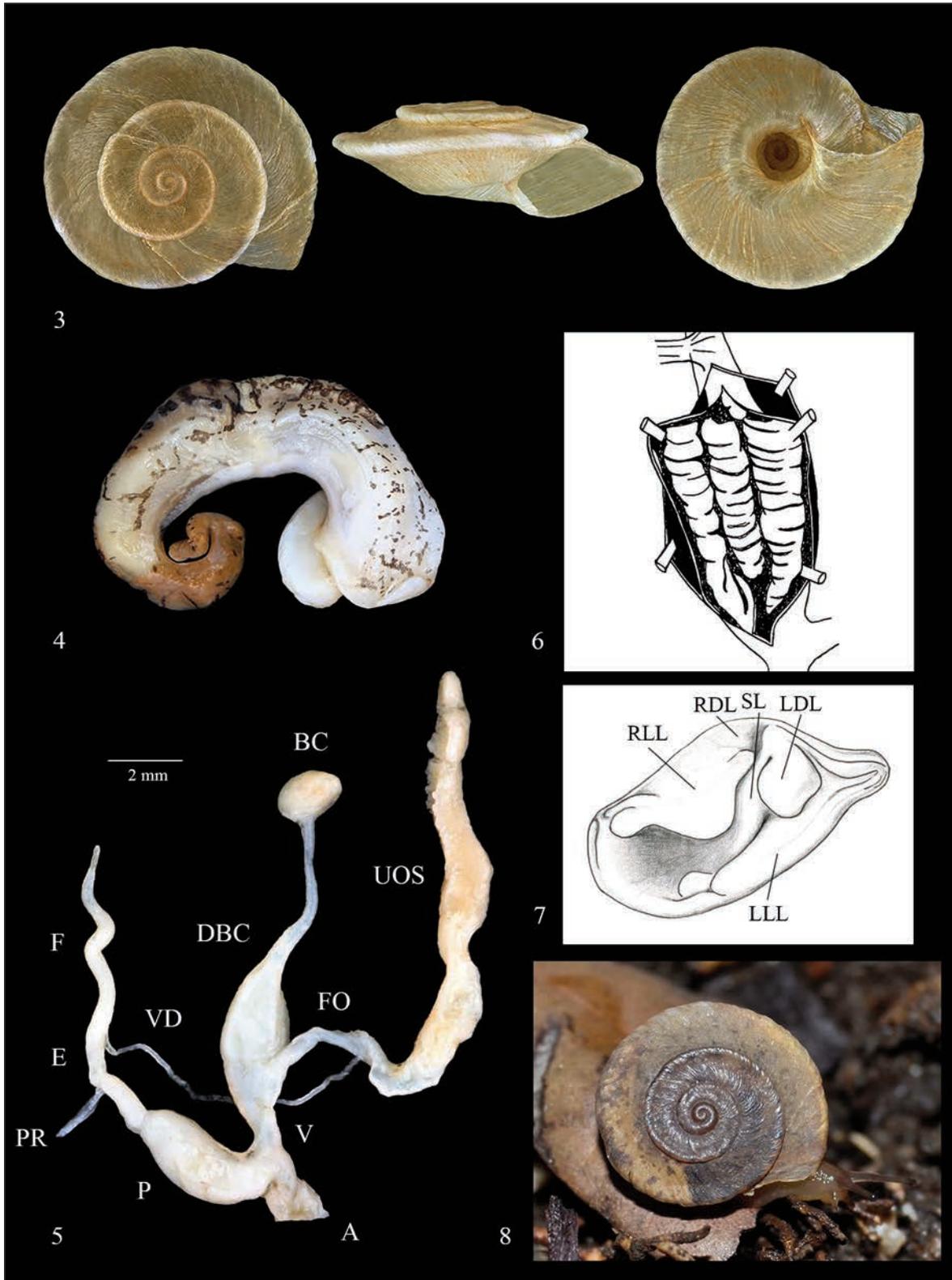
Male genital complex consists of flagellum, epiphallus, and penis. Flagellum long (4.8 mm), thin at the apex and wider at the base where it is equal in calibre to the epiphallus which follows; epiphallus short (2.1 mm), extending from the end of the vas deferent to the point of attachment of the penial retractor muscle; penis (extending from penial retractor muscle to genital atrium) long (4.5 mm), flared and wider at the distal portion and thinned towards the proximal portion, connected to the atrium by a large opening. Internal wall of penis with series of parallel pleats, also interrupted, larger inside distal part of penis; in particular, one large and central swollen folds has the base at the end of the proximal penis and is interrupted distally, and an other lateral swollen fold forms a pillar structure. Penial retractor muscle long and wide, inserted on penial sheath and ending on diaphragm walls. Vas deferens is ribbon-like, partly sub-transparent, not very long, connected to the proximal portion of the free oviduct. Genital atrium wide with slight strangulation on the aperture of the genital complexes.

VARIABILITY. Paratypes: shell with maximum diameter of 9–9.8 mm; maximum height of 2.7–3.6 mm; aperture height of 2.1–2.5 mm, aperture width of 3.7–4.2 mm; umbilicus wide from 1.5 mm to 2.1 mm; keel from 0.5 to 0.8 mm; yellowish in colour, sometimes whitish-brown or whitish, if partially or totally deperiostracated; keel little jagged and undulating in some points, hollow inside, sometimes slightly raised or slightly curved downwards, it has a quicker discoloration. In the second specimen examined anatomically, the internal wall of the penis showed the two main folds that are joined distally. In juvenile specimens, the aperture is flat and with acute angle. Some paratypes have large fractures and holes in the shell caused by natural occurrences.

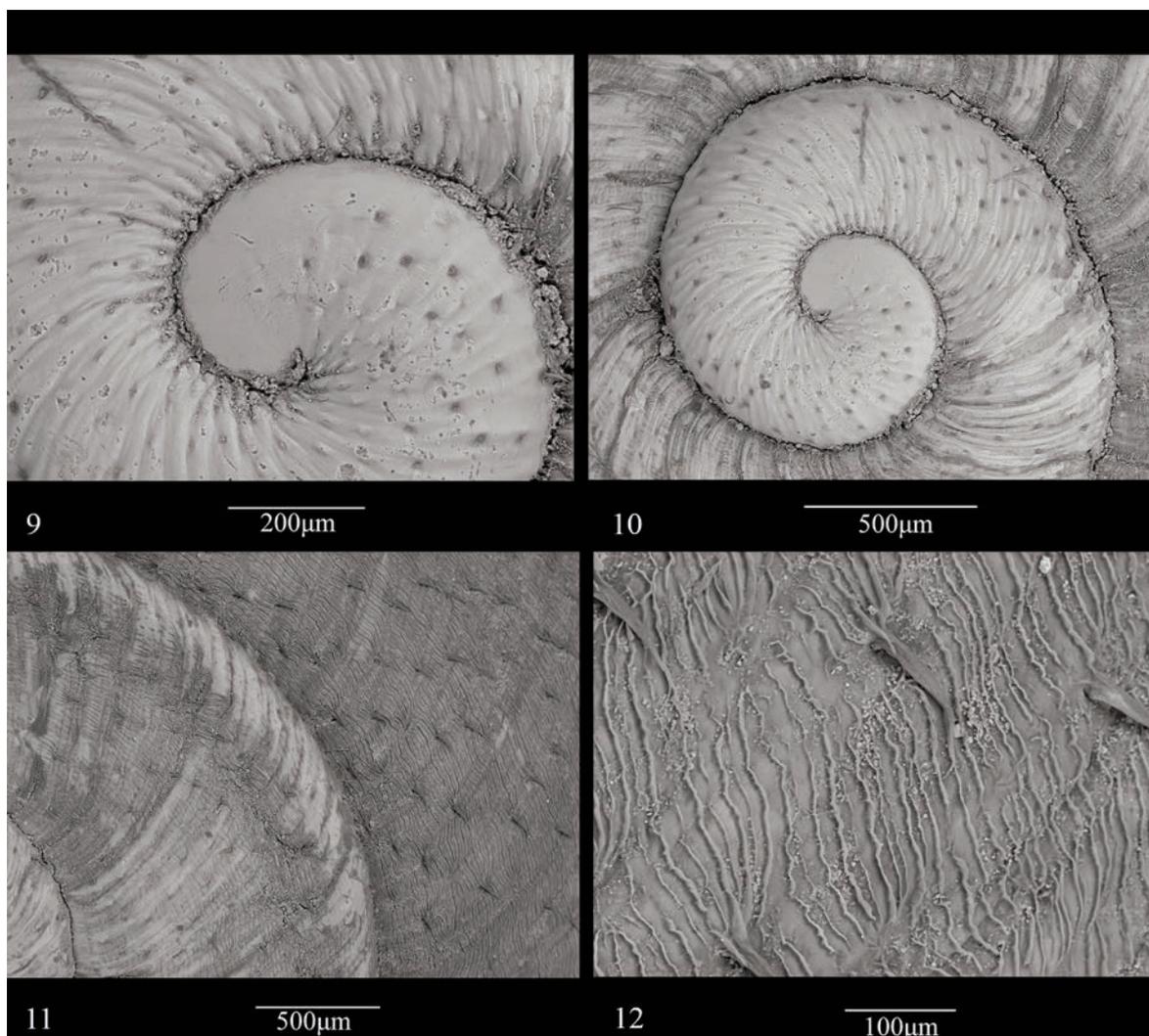
ETYMOLOGY. The new species is dedicated to the dear memory of Viviano's mother (Maria) and to their maternal grandmother (Rosaria) for her dedication to the family: Maria + Rosaria (-ae), used as a noun in apposition.

DISTRIBUTION AND BIOLOGY. This new species is spread in the northern slope of Mount Pecoraro.

Mount Pecoraro falls within Meso-Cenozoic calcareous rocks of the Panormide Units, a carbonate platform constituting the skeleton of the northernmost sector of Palermo Mountains. These are



Figures 3–6. *Schileykiella mariarosariae* n. sp. from Portella Scaletti, Mount Pecoraro (Cinisi, Italy), holotype, diameter 9 mm. Fig. 3: shell. Fig. 4: body. Fig. 5: distal genitalia. Fig. 6: internal wall of penis. Fig. 7: idem, paratype, mantle collar. Fig. 8: idem, paratype, living specimen.



Figures 9–12. Detail of shell microsculpture (Scanning Electron Microscope) of *Schileykiella mariarosariae* n. sp., paratype, from Portella Scaletti, Mount Pecoraro, Sicily, Italy) (explanations in the text).

part of the Sicilian “Fold and Thrust Belt”, which, at the boundary between the African and the European plates, links the African Maghrebides to the Calabrian arc subduction complex and to the southern Apennines (Catalano et al., 2013).

This northern side, extended 1.4 km, is bordered to the West by Portella del Trono and to the East by Casa Abbate, while, in the central part, it is cut by the limestone crest of Portella Scaletti. The two principal peaks are Cima Bosco Tagliato and Pizzo Angelelli. They are two vertical limestone walls 700 m high with a steep detritus slope colonised by vegetation which descends from 400 m to 100 m. They are almost always in the shade and, due to the

northern exposure, have a more humid microclimate than the neighboring areas.

This mountain also falls into the Mediterranean pluviaseasonal oceanic bioclimate (Rivas-Martínez et al., 2008), with lower mesomediterranean thermotype (Bazan et al., 2015). These bioclimatic conditions, however, are buffered and cooled by a daily moisture condensation, often forming a very dense fog, due to the humid sea breeze arising from the Tyrrhenian Sea (Cusimano et al., 2017).

The study area is affected by a zonal vegetation with *Quercus ilex* L. wood on calcareous lithotypes along the slopes characterized by screes and by the sub-mountain belt grassland (Maurici & Manfrè

Scuderi, 2001; Gianguzzi & Papini, 2015). These environments are characterized by Mediterranean maquis with *Euphorbia dendroides* L., *Rhus coriaria* L., *Fraxinus ornus* L., *Phyllirea latifolia* L., *Rhamnus alaternus* L., *Crataegus* sp., *Foeniculum vulgare* L., *Ruta chalepensis* L., *Micromeria graeca* sp. *fruticulosa* (Bertol.) Guinea, *Asparagus acutifolius* L., *Smilax aspera* L., and herbaceous plants such as *Cynodon* sp., *Arisarum vulgare* Targ. Tozz., *Arum italicum* Mill., *Allium* sp., *Medicago* sp., or from grassland on semi-rocky slope with predominance of *Charybdis pancration* (Steinh.) Speta, *Smyrniolum olusatrum* L., *Elaeoselinium asclepium* (L.) Bertol., *Asphodelus ramosus* L., *Hyparrhenia hirta* L. and various herbaceous essences (Asteraceae), mixed with a few shrubs such as *Rhus coriaria* L. and *Euphorbia dendroides* L. Other plant species gregariously distributed that can be found on the slope are *Ampelodesmos mauritanicus* (Poir.) Dur. et Schinz and *Ailanthus altissima* (Mill.) Swingle, the latter non-native and invasive.

Schileykiella mariarosariae n. sp. has sciaphilous, sublapidicolous and detriticolous biology; the most numerous samples have been found under accumulations of small and medium-sized stones, separated by interstices where vegetable debris accumulates. Often these clasts are dominated by a large rock, or are located at the base of a low rocky outcrop. This new species prefers ventilated environments, sunny for a few hours a day, characterized by Mediterranean maquis.

In this same habitat, other endemic species have been found: *Cochlostoma paladilhanum* (Saint-Simon, 1869) (Megalomastomatidae), *Hypnophila cylindracea* (Calcara, 1840) (Azecidae), *Ceciloides raphidia sicula* Beckmann et Falkner, 2008 (Ferussaciidae), *Hohenwartiana aradasiana* (Benoit, 1862) (Ferussaciidae), *Siciliaria tiberii scalettensis* Beckmann, 2004 (Clausiliidae), *Vitrea cf. contracta* (Westerlund, 1871) (Pristilomatidae), and *S. reinae*.

The biological cycle was observed in laboratory (Palermo) (Figs. 8–14). At the beginning of January with a T of 17° C and a humidity of 59%, one of the two specimens slightly inflates the cephalic region and, partially, also the atrial region, as a sign of pre-courtship; the other specimen seems to ignore this signal. The specimen suitor does not move away from the partner, and is kept for about 30 minutes within a 25–35 mm radius, without obtaining any results. No courtships shared by both partners

or matings were observed. Both specimens have laid a group of eggs. The first specimen released a total of 15 eggs, for about 4 hours, at a depth of 12 mm in the soil; the hatches were recorded on 01–02.II.2018 after an incubation period of 22–23 days. The second specimen released a total of 22 eggs, for about 7 hours, at a depth of 10 mm in the soil; the hatches were recorded on days 06–07.II.2018 after an incubation period that lasted 21–22 days. During oviposition, both specimens placed the shell vertically, with the aperture immersed in the soil and the remaining part exposed to the air. No incubation chambers were observed. In laboratory (Palermo), during the incubation period of both ovipositions, the T ranged from 11° C to 18° C with minimums of 6° C and 16° C and maximums of 14° C and 20° C, while humidity ranged from 60% to 84%. At the same time, in the field (Cinisi), the T ranged from 9° C to 17° C with minimums of 5° C and 15° C and maximums of 13° C and 19° C, while humidity ranged from 60% to 84%. Description of the eggs: 1 mm in diameter, spherical or oval, whitish, opaque, consisting of a membranous envelope covered by a poorly sticky mucus, which tends to make adhere small aggregates of soil. When they are close to hatching, the unborn embryo gives them an amber hue. The hatching was asynchronous: the young were born in 1–2 days. The protoconches of the young specimens measure 1.1 mm in diameter, amber in color with poorly hairy periostracum; whitish hairs, approximately 0.1 mm long; aperture with angled edges, both on the lower and upper margin; body light gray in color on neck, sides and sole, and dark gray on the cephalic area. Pseudoepifragma formation observed in a short period between January and February, during which the terrarium was exposed to wind conditions, and therefore, to a dehumidification of the soil. In this species, the pseudoepifragma appears as a transparent mucous formation with a whitish portion at the pneumostome; small soil aggregates have been found. The animal, retreating into its shell, carries with it small aggregates of soil that partially cover the outer mantle. The cryptic coloring of the inner mantle and of the periostracum camouflages the animal with the surrounding detritus and the soil on which it lives. Furthermore, the carinate and lenticular structure has an affinity with the fruits of the plant belonging to the genus *Medicago* (Fabaceae). Detritivorous diet: in addi-



Figures 13–18. The biological cycle of *Schileykiella mariarosariae* n. sp. observed in laboratory (Palermo). Fig. 13: during oviposition. Fig. 14: camouflaged specimen. Fig. 15: epifragma detail. Fig. 16: eggs in the soil. Fig. 17: juveniles newborn. Fig. 18: detail of the outer mantle and pneumostome.

tion to appreciating occasional pieces of vegetables such as cucumber in the laboratory, the specimens were mainly fed with fragments of dead and moistened leaves of *Asphodelus ramosus* L.

COMPARATIVE NOTES. *Schileykiella* is a genus of hygromiids characterized by the shell with pilose, yellowish or brown periostracum, right omatophore retractor between penis and vagina, distal female genitalia without accessory organs (digitiform glands and dart-sac complex) and distal male genitalia with penial sheath and without penial papilla (Manganelli et al., 1989; Giusti & Manganelli, 1989; Cianfanelli et al., 2004).

Currently (Bank & Neubert, 2018), this genus is listed in the Canariellidae family which also includes the following genera: *Canariella* P. Hesse, 1918 (Canary Islands), *Debeauxhelix* Bacci, 1943 (Ethiopia), *Montserratina* Ortiz de Zárate López, 1946 (Spain and France mainland), and *Tyrrheniellina* Giusti et Manganelli, 1992 (Sardinia and Tuscan Archipelago: Islet of La Praiola, Capraia Islet) (see also Schileyko, 2006; Razkin et al., 2015; Bank, 2017).

Schileykiella is very close to *Tyrrheniellina* which would result from the loss of the penial papilla (Giusti & Manganelli, 1989, 1992).

The *Schileykiella* species, including *S. mariarosariae* n. sp., can be distinguished, morphologically and anatomically, as follows:

1. Shell discoidal, low conical above, with whorls, particularly the last, not or little angled. Genitalia with a very long flagellum and a very long duct of bursa copulatrix.....*S. reinae*

-. Shell lenticular or contabulate, flat or little elevated above, with whorls angled or keeled, particularly the last. Genitalia with flagellum and duct of bursa copulatrix shorter.....2

2. Shell lenticular, bigger, diameter 9–9.8 mm, yellowish in colour, with whorls strongly keeled, particularly 2–4, scanty pilose with hairs very short. Genitalia with penis long (4.5 mm), epiphallus short, flagellum long, duct of bursa copulatrix with a very flared initial portion...*S. mariarosariae* n. sp.

-. Shell contabulate, smaller, diameter 6.5–8.6 mm, brown in colour, with whorls angled, particularly 4, pilose with hairs longer. Genitalia with penis and flagellum shorter, duct of bursa copulatrix with little flared initial portion.....3

3. Shell with hairs long. Genitalia with epiphallus longer (2.5–2.9 mm), knob at base of flagellum absent, internal structure bordering vas deferens opening into penis absent.....*S. parlatoris*

-. Shell with hairs shorter. Genitalia with epiphallus short (1–1.6 mm), knob at base of flagellum present, internal structure bordering vas deferens opening into penis present.....*S. bodoni*

According to these taxonomic keys, it is possible to distinguish two main groups in *Schileykiella* genus: one that includes only *S. reinae*, and the second group with *S. mariarosariae* n. sp. that clearly differs from *S. parlatoris* and *S. bodoni*, more similar to each other.

STATUS AND CONSERVATION. The restricted distribution, with other obvious threats such as the nearby human presence and the fires that often flare up in these places, make *S. mariarosariae* n. sp. “Vulnerable”, according to the Categories and Criteria of the IUCN Red List of Threatened Species (IUCN, 2017).

REMARKS. *Schileykiella mariarosariae* n. sp. is added to the long list of endemisms known for the Sicilian malacofauna. Like the other *Schileykiella* species, it can be considered a paleoendemism.

According to Giusti & Manganelli (1984) and Manganelli et al. (1989), these species had a Miocene origin, a subsequent differentiation in separate areas during the Pliocene and a dispersion, from their original sites, during the Pleistocene phases, when Sicily was again a single island.

The two genera with greater affinity, *Schileykiella* and *Tyrrheniellina*, could be descended, in turn, “from an unique ancestral group of palaeoeuropean origin” (Giusti & Manganelli, 1989).

Further research will allow us to expand our knowledge of these interesting Sicilian hygromiids and better understand the real phylogenetic and biogeographic relationships.

ACKNOWLEDGEMENTS

Thanks are due also to Mr. Alfio Viola (Electronic Microscopy Laboratory, University of Catania, Italy) for SEM photos assistance, Salvo Giglio (Cefalù, Italy) and Maria Stella Colomba (University of Urbino, Italy). Roberto and Arturo Viviano, fur-

ther, thank their father Antonino for the support and all their family.

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