

A new species of the genus *Milax* Ellis, 1926 (Gastropoda Pulmonata, Milacidae) from Lampedusa Island (Sicilian Channel, Italy)

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ABSTRACT

Milax lopadusanus n. sp. (Gastropoda Pulmonata Milacidae) is described from Lampedusa Island, the biggest of the islands of the Pelagie Archipelago (Sicilian Channel, Italy). The new species is characterized by: greyish-brown body, with distinct yellowish keel; conical, smooth stimulator, with a raised crest along one side and spermatophore characterized by conic anterior part, covered on one side by bifurcated spines with the two apices thorny; posterior part cylindrical, covered by smaller and most dense spines on all sides. Additional faunistic, biological and taxonomical notes are provided.

KEY WORDS

New slug; morphology; taxonomy; systematics.

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INTRODUCTION

The slug genus *Milax* Ellis, 1926 (Gastropoda Pulmonata Milacidae) has Euro-Mediterranean-Caucasian distribution. In Italy two *Milax* species are reported: *M. nigricans* (Philippi, 1836) with a Western Mediterranean and Western European distribution and *M. gagates* (Draparnaud, 1801) only found in Sardinia and Sicily, which occurs as well in Western Europe, Western Mediterranean and Canary Islands, (Wiktor, 1987a; Manganelli et al., 1995; Bank, 2017).

In North Africa, in addition to *M. nigricans* and *M. gagates*, two more species were so far reported: *M. gasulli* Altona, 1974 endemic of northeastern Tunisia and *M. ater* (Collinge, 1895) endemic of

northern Algeria. These four species are very similar in external characters of the black or greyish body and such a strong resemblance led to confusion where they coexist. Nevertheless, they are well distinguishable once dissected, i.e. by the shape of the genitalia and the spermatophore.

The genus *Milax* was reported for Lampedusa Island (Pelagie Archipelago, Sicilian Channel, Italy) by Alzona (1961) who mentioned *M. gagates* and by Beckmann (1992, 1998) and Cianfanelli (2002) that reported *M. nigricans*, however no description or illustration of genitalia was provided by these authors.

Lampedusa Island is 20.2 Km² wide and is 195 Km far from the Sicilian coast and 120 Km from Tunisia. Lampedusa is an emerged portion of the

African Continental shelf and it consists of a succession of limestone-dolomite rocks of the upper Miocene age.

The absence of Pliocene and Pleistocene marine sediments suggested that it was emerged for a very long time; marine deposits of Tyrrhenian age are present, on limited extensions, only on the eastern side of Lampedusa (Grasso & Pedley, 1985). It is, therefore, of ancient origin and it has been connected to African continent during the glaciations (Burgio & Catalisano, 1994).

The research activities carried out on this island and the morphological analysis of the collected *Milax* specimens allowed us on one hand to confirm the presence of *M. nigricans* and on the other to ascertain the presence of a second species with a set of characters which have never been previously observed in other representatives of the genus. Thanks to these result a new species is here described.

MATERIAL AND METHODS

All specimens were collected by eye-sight on the ground and under rocks, preferably at night but also in daylight. Four specimens were bred in captivity from October 2017 to November 2017. In the laboratory they were normally kept in plastic boxes containing ground, limestone rocks and lettuce or carrot. Observations on ecology of these slugs were made both directly in the field and in laboratory. The specimens were studied as regards size, colour, external morphology and morphology of genitalia. Photographs were taken with a digital camera. In order to study and illustrate genitalia, the specimens were fixed in 75% ethanol. Reproductive apparatus was extracted by means of scalpel, scissors and needles. Illustrations of genitalia were sketched using a camera lucida. All the specimens were studied and observed at the stereomicroscope (Leica MZ 7.5). Height and maximum diameter of the shell along with some parts of genitalia were measured (in millimeters) by a digital gauge. Voucher specimens were stored in collections indicated below. Toponyms (place-names) are reported following the “Geoportale Nazionale, Map IGM 1:25000, <http://www.pcn.minambiente.it/viewer/>. Each locality and/or collection site is named in the original language (Italian). Taxono-

mical references are based on the checklist of the fauna europaea (Bank, 2017) and other cited papers.

The materials used for this study are deposited in the following Museums and private collections: NMBE = Natural History Museum Bern, Switzerland; CL = Liberto Fabio collection, Italy, Cefalù; CS = Sparacio Ignazio collection, Italy, Palermo; CV = Viviano Roberto collection, Italy, Palermo.

ACRONYMS. AG = albumen gland; AAG = atrial accessory glands; BC = bursa copulatrix; DBC = duct of the bursa copulatrix; DP = distal penis; E = epiphallus; FO = free oviduct; G = penial papilla; GA = genital atrium; HD = hermaphrodite duct; O = ovotestis; OV = ovispermiduct; P = penis; PR = penial retractor muscle; S = stimulator; V = vagina; VD = vas deferens. ex/x = specimen/s.

RESULTS

Systematics

Classis GASTROPODA Cuvier, 1795
 Infraclassis PULMONATA Cuvier in Blainville, 1814
 Ordo STYLOMMATOPHORA A. Schmidt, 1855
 Familia MILACIDAE Ellis, 1926
 Genus *Milax* Ellis, 1926

Milax lopadusanus n. sp. (Figs. 1–11, 15–16)

TYPE LOCALITY. Lampedusa Island (Sicily, Italy) (Fig. 13).

TYPE MATERIAL. Holotype: Italy, Sicily, Lampedusa Island, Vallone dei Conigli, 35°30'55"N 12°33'20"E, 55 m, legit R. Viviano, 13.X.2017 (NMBE 553145). Paratypes: Italy, Sicily, Lampedusa Island, legit A. Corso, 17.X.2012, 1 ex (CL 13437); idem, Valle Imbriacole, 35°30'40"N 12°36'17"E, 18 m, legit A. Corso, XI.2012, 2 exx (CL 13407–13408); idem, surroundings of the town, legit T. La Mantia, 12.III.2015, 1 ex (CS); idem, near Vallone dei Conigli, legit G. Maraventano, 28.XII.2016, 4 exx (CS); idem, 1 ex (CL 17519); idem, Vallone Terranova, 35°30'50"N 12°34'18"E, 53 m, legit E. Schifani, 8.X.2017, 1 ex (CV); idem, Costa Tabaccara, Vallone, 35°30'47"N 12°33'46"E, 44 m, legit R.

Viviano, 9.X.2017, 1 ex (CV); idem, Dammuso, Casa Teresa, 35°31'27"N 12°32'23"E, 116 m, legit R. Viviano, 9.X.2017, 2 exx (CV); idem, Vallone dell'Acqua, 35°31'05"N 12°31'53"E, 83 m, legit R. Viviano, 11.X.2017, 1 ex (CV); idem, Valle Imbriacole, 35°30'56"N 12°35'45"E, 34 m, legit R. Viviano, 12.X.2017, 1 ex (CL 17520); idem, Vallone dei Conigli, 35°30'55"N 12°33'20"E, 55 m, legit R. Viviano, 13.X.2017, 2 exx (CL 17517–17518); idem, 1 ex (CV).

OTHER EXAMINED MATERIAL. *Milax nigricans*. Italy, Sicily, Lampedusa Island, legit A. Corso, XI.2012, 2 exx (CL 13404–13405); idem, legit G. Maraventano, III.2013, 3 exx, ex coll. I. Sparacio, (CL 13690–13692); idem, legit G. Maraventano, 18.XI.2014, 6 exx, ex coll. I. Sparacio (CL 17263–17268); idem, legit T. La Mantia, 28.X.2016, 2 exx, ex coll. I. Sparacio (CL 17428–17432); idem contrada Cozzo Monaco, T. La Mantia, 28.X.2016, 4 exx (CS); idem, Cala Galera, legit G. Maraventano and E. Prazzi, 26.XI.2016, 6 exx (CS).

Italy, Sicily, Palermo, Parco della Favorita, 11.XI.1995, 2 exx (CS); idem, Catania, Fontanarossa, 19.XII.1998, 2 exx (CS); idem, Sant'Agata di Militello, 21. XI. 1999, 2 ex (CS); idem, Palermo Ponte delle Grazie on the river Oreto, 28.XII.2002, 5 exx (CS); idem, Custonaci, southern slopes of Pizzo Monaco, 360 m, 38°02'44" N 12°48'11" E, 19.IV.2009, 3 exx (CL 4801–4803); Idem, Enna, M. del Barone, 37°30'58"N 14°13'58"E, 500 m, 07.II.2010, 1 ex (CL 6135); idem, Melilli, Sorg. Belluzza, 37°13'16"N 15°06'21"E, 104 m, 21.XI.2010, 4 exx (CL 8783–8786); idem, Caltanissetta, Ponte Capodarso, 37°29'43"N 14°08'41"E, 285 m, 08.XII.2012, 2 exx (CL 13073–13074); idem, Sambuca di Sicilia, C. Catenana, 37°38'40"N 13°08'35"E, 280 m, 23.XII.2012, 1 ex (CL 13520); Tunisia, Utica, 37°03'17"N 10°03'44"E, 18 m, legit G. Sabatinelli, 25.I.2015, 4 exx (CL 220–223).

Milax gagates. France, Marsiglia, Plaine Maures, Le Canal des Maures, 43°20'N 5°21'E, 40 m, legit D. Pavon, 07.III.2009, 1 ex (CL); France, Salon-de-Provence, Boulevard des Alpilles, jardin au 222, 43°38'52"N 05°05'16"E, 85 m, legit D. Pavon, 12.IV.2010, 1 ex (CL); France, Marsiglia, Châteauneuf les Martigues, La Glaciere, 43°23'38"N 05°07'23"E, 33 m, legit, D. Pavon, 3.III.2013, 1 ex (CL).

Milax gasulli. Tunisia, Carthage, legit G. Sabatinelli, 30.XI.2015, 2 exx (CL 258–259); Tunisia, Boukornine, legit G. Sabatinelli, 30.XI.2015, 2 exx (CL 296–297).

DIAGNOSIS. Grey-brownish slug with genitalia characterized by elongated conical stimulator with a longitudinal crest along one side, spermatophore with conic anterior part, covered by bifurcated spines on one side and cylindrical posterior part covered by smaller and most dense spines on all sides.

DESCRIPTION OF HOLOTYPE. Slug medium-small sized, length 25.3 mm, maximum width: 6.3 mm after preservation. Narrow and pointed at its rear end, with distinct dorsal carina (kell) running from posterior apex of body to clypeus (mantel); shallow skin grooves; foot sole tripartite, with chevron pattern. When living the holotype had the yellow-greenish back and the brownish cypelio covered by numerous very small gray dots, yellowish dorsal carina, gray neck and head, grey-yellowish foot sole; after preservation the specimen is uniformly black on the upper part with yellowish keel and brown-greyish sides and sole. Clypeus shield-shaped, superficially granulated, with rhomboidal groove and a hollow near keel; pneumostome on right side of clypeus, postmedial; yellowish mucus.

Shell (limacella) nail-like, oval, well calcified, white in colour, with apex posterior and situated on major axis, at the highest point, rather flat dorsally and slightly convex ventrally (Fig. 5); length: 4 mm; diameter: 2.5 mm, height: 1 mm.

Genitalia (Figs. 8–10). General scheme of semi-dialucic monotrematic type, consisting of ovotestis with many close acini; long hermaphrodite duct, entering base of small talon (Fig. 8); large albumen gland; well developed ovispermiduct; long free oviduct (5.5 mm), arising from vagina side by side with the very short duct of the bursa copulatrix (1.4 mm); large and roundish bursa copulatrix; short vagina (2 mm); a gelatinous substance envelops the distal part of the female genitalia. Vas deferens double length than penis + epiphallus, ending laterally at epiphallus tip; epiphallus cylindrical (2.5 mm) with a slight lateral swelling at its tip, a slight constriction separates the epiphallus from the penis; penis rather short (2 mm) and fusiform, divided by a faint constriction in a proximal part with

a short and flat penial papilla inside and a distal part with some longitudinal pleats on the inner wall (Fig. 9); penial retractor muscle ending laterally at the transition of the epiphallus to the penis; vagina and penis open into a wide genital atrium; mass of atrial accessory glands very large in relation to body size, communicating via multiple ducts with atrium. The stimulator contained inside genital atrial cavity, is conical, 3 mm long, with base oval in section, pointed apex, and an evident crest rises to half length of the stimulator, along one side.

Only a spermatophore was found in the examined specimens (Fig. 11), it is elongated, spiral, with conic anterior part, covered by spines on one side, the other side being smooth; four spines for each circular row; spine bifurcated with the two apexes multi-thorny; posterior part cylindrical, covered by smaller and most dense spines on all sides. The anterior part is broken, it was found in the duct of burs copulatrix and the anterior part coil in burs copulatrix. The reddish color of the spermatophora is due to the preservation of the specimens in denatured alcohol immediately after sampling.

VARIABILITY. Length of living adult specimens 45–55 mm, width 5–6 mm. The constriction separating the distal penis from the proximal penis may be more or less evident; apex of the stimulator more or less pointed.

ETYMOLOGY. The specific name refers to the Latin name of type locality: *lopadusanus*, that lives in Lampedusa.

BIOLOGY AND DISTRIBUTION. *Milax lopadusanus* n. sp. is until now known only from the type locality Lampedusa Island (Fig. 12), where it lives in sympatry with *M. nigricans*.

It occurs in natural habitats and it seems to prefer dark, damp sites with mediterranean maquis: *Thymbra capitata* (L.) Cav., *Pericloca laevigata angustifolia* (Labill.) Markgr., *Euphorbia dendroides* L., Graminaceae, etc. (Figs. 13–14). It may be found under stones, decaying plant material and similar debris, but it is very skilled at digging tunnels in the wet soil. Sexual activity occurs in autumn (November) and spring (March). We found juvenile or sub-adult specimens of *M. lopadusanus* n. sp. in October, adult specimens in November, only one adult was found in March. The examined specimens of *M. nigricans* of Lampe-

dusa were juveniles in October and November and adults in December and March. *Milax nigricans* have larger populations that are closer to the inhabited center.

STATUS AND CONSERVATION. The restricted distribution makes *M. lopadusanus* n. sp. “Vulnerable”, according to the Categories and Criteria of the IUCN Red List of Threatened Species (IUCN, 2017). Urbanisation and tourism development as well as agriculture could most probably be affecting the species diffusion and population richness.

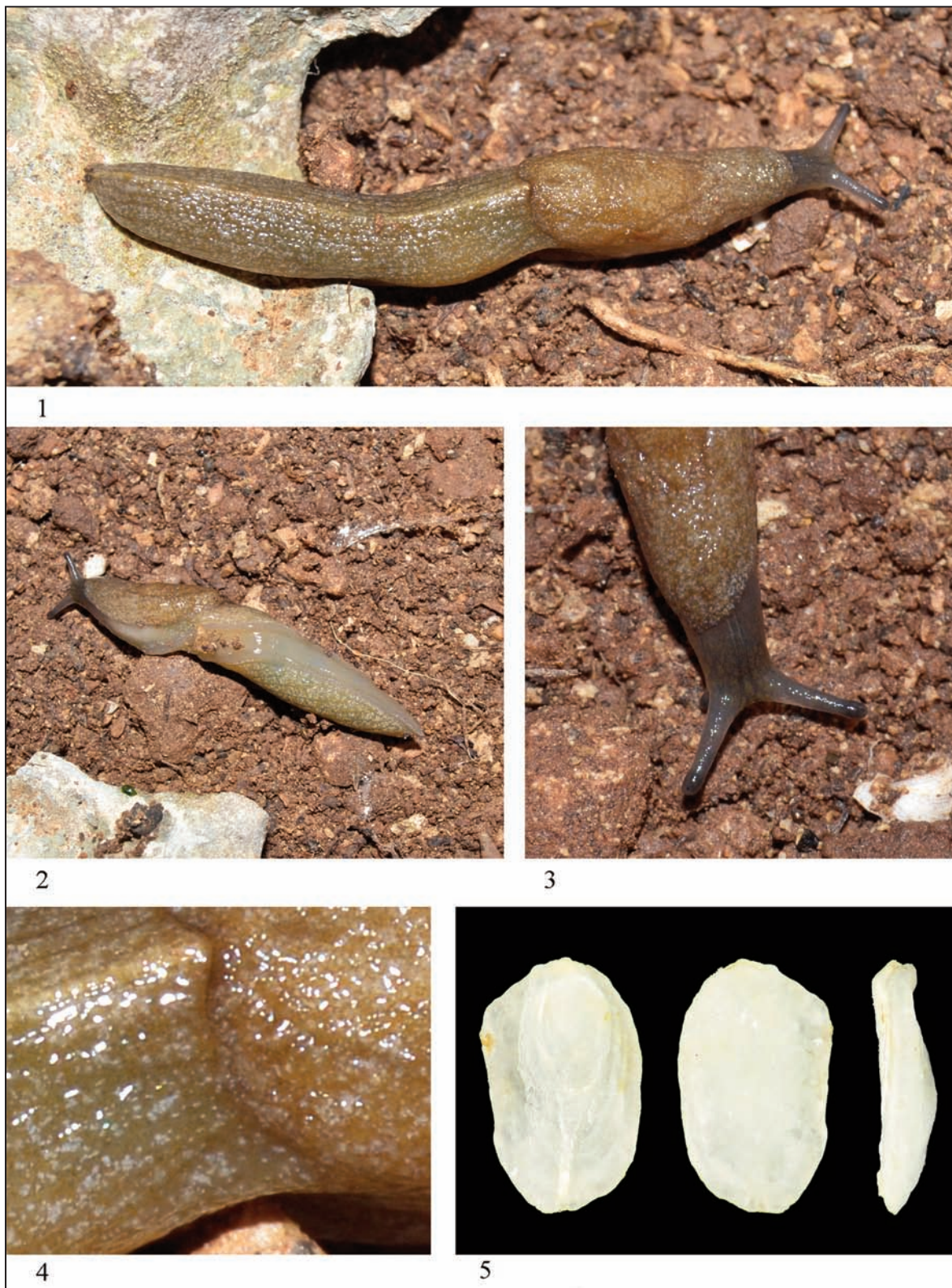
COMPARATIVE NOTES. To date, only two species of *Milax* are reported from Sicily: *M. nigricans* and *M. gagates* (Wiktor, 1987a; Manganelli et al., 1995; Bank, 2017), but many species of this genus were described in the past for several Sicilian localities.

Amalia insularis Lessona et Pollonera, 1882 (Lessona & Pollonera, 1882, type locality: Sassari in Sardinia and Palermo in Sicily), *A. doderleini* Lessona et Pollonera, 1882 (Lessona & Pollonera, 1882, type locality: Palermo in Sicily), *A. sicula* Lessona et Pollonera, 1882 (Lessona & Pollonera, 1882, type locality: Palermo in Sicily), *A. gagates benoiti* Lessona et Pollonera, 1882 (Lessona & Pollonera, 1882, type locality: Messina and Catania in Sicily), *A. mediterranea similis* Cockerell, 1891 (Cockerell, 1891, type locality: Catania in Sicily).

These taxa were described only on some external characters. Further, no type or syntypes are found in the Lessona and Pollonera’s collections at the “Museo Regionale di Scienze Naturali di Torino”, Italy (E. Gavetti *in verbis*), at the moment, or in the British Museum (Natural History) (see Altena Van Regteren, 1974).

Lessona & Pollonera (1882, Pl. II, figs 6-7) illustrate the genitalia of a specimen of *M. insularis* from Sardinia: the stimulator appears similar to that of *M. nigricans*. In addition Quick (1960: 150) examined some specimens of *Milax* sampled near Catania reporting “to be the species with a papillate stimulator”.

We have examined numerous specimens of *Milax* sampled from many Sicilian localities and the islands surrounding Sicily (for a representative see examined material) and all these specimens show the typical characters of *M. nigricans*. For these reasons we agree with Giusti (1973), Wiktor



Figures 1–5. *Milax lopadusanus* n. sp. (Sicilian Channel, Italy). Fig 1: specimen in natural habitat. Fig. 2: colour of the foot. Fig. 3: colour of the head and the clypeus. Fig. 4: colour of the back and clypeus. Fig. 5: shell (holotype NMBE 553145).



Figures 6–10. Genitalia of *Milax lopadusanus* n. sp. from Lampedusa Island (Sicilian Channel, Italy) without the “gelatinous substance”. Fig. 6: genitalia (CL 17517). Fig. 7: idem, with stimulator outside the genital atrium. Fig. 8: genitalia (holotype NMBE 553145). Fig. 9: idem, internal structure of atrium, penis, vagina and duct of the bursa copulatrix; Fig. 10: penial papilla of holotype (NMBE 553145). Fig. 11: spermatophore of *M. lopadusanus* n. sp. with enlargements of some isolated spines (CL 13406).

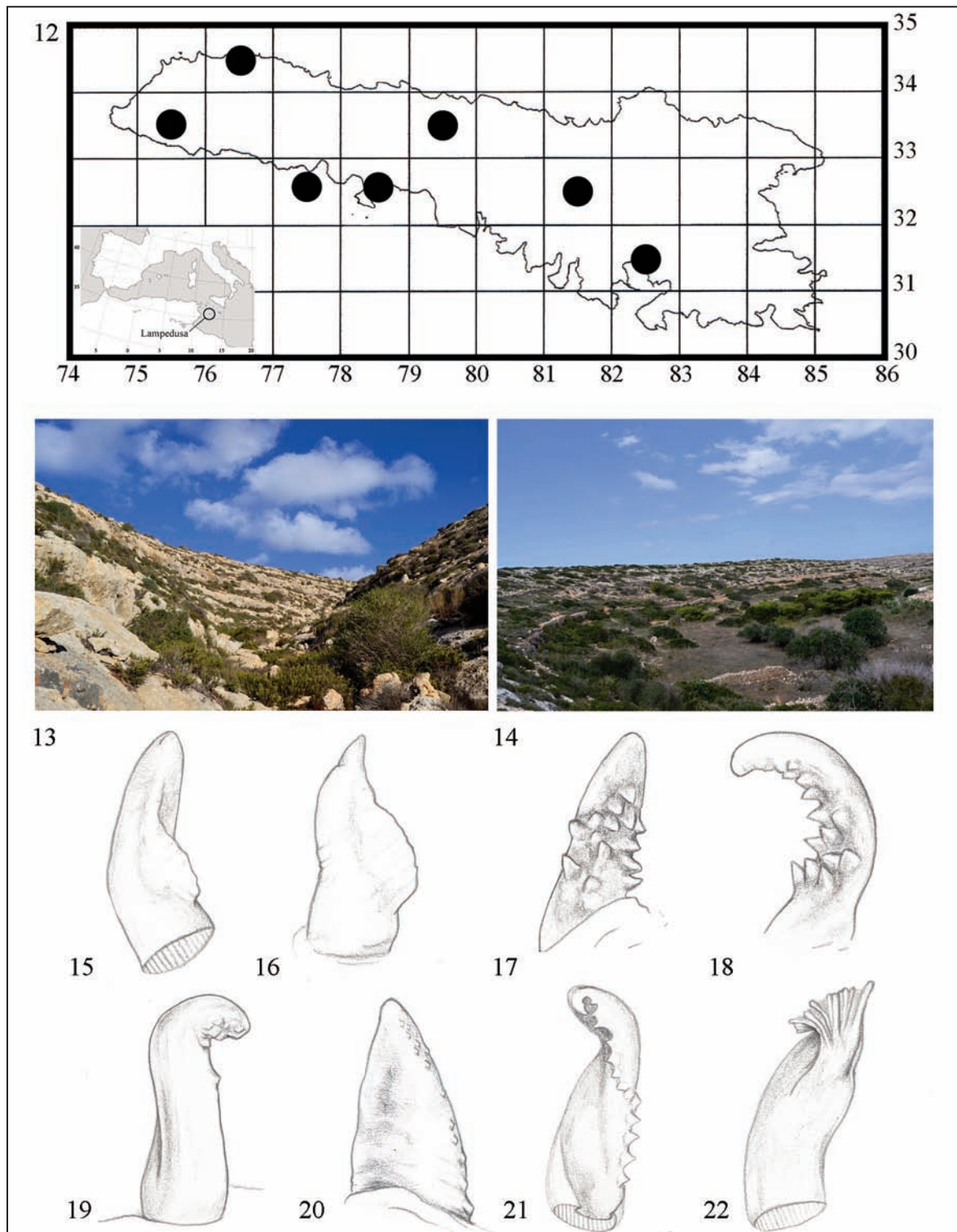


Figure 12. Distribution map of *Milax lopadusanus* n. sp. on a UTM map (1x1 square km) of Lampedusa. Figures 13–14. Landscape of Lampedusa Island. Fig. 13: Vallone dei Conigli. Fig. 14: Valle Imbriacole. Figures 15–22. Stimulators of *Milax* species. Fig. 15: *M. lopadusanus* n. sp., Lampedusa (CL 17517). Fig. 16: idem (CL 13407). Fig. 17: *M. nigricans*, Italy, Sicily, Custonaci (CL 4801). Fig. 18: *M. nigricans*, Italy, Sicily, Melilli (CL 8783). Fig. 19: *M. gagates* France, Salon-de-Provence (CL). Fig. 20: *M. gasulli* Tunisia, Boukornine (CL 297). Fig. 21: *M. gasulli* by Wiktor & Abbas (2008), modified. Fig. 22: *M. ater* by Wiktor & Abbas (2008), modified.

(1987a), Manganelli et al. (1995) and Bank (2017) in considering *A. benoiti*, *doderleini*, *insularis*, *sicula*, *similis*, all synonyms of *M. nigricans*.

Four species of *Milax* are currently considered valid from North-West Africa (Libya, Tunisia, Algeria, Morocco): *M. nigricans*, *M. gagates*, *M. gasulli* (endemic of North-East Tunisia) and *M. ater* (endemic of Northern Algeria) (Wiktor, 1987a; Nair et al., 1996; Borredà & Martínez-Ortí, 2017).

Nevertheless, other species names of Milacidae are reported in literature regarding the North Africa taxa: *Limax scaptobius* Bourguignat, 1861 (Bourguignat, 1861, type locality: Bougie and Constantine, Algeria), *Amalia cabiliana* Pollonera, 1891 (Pollonera, 1891, type locality: El-Hammam in Kabylie, Algeria), *A. gagates mediterranea* Cockerell, 1891 (Cockerell, 1891, type locality: Algeria) and *M. collingei* Hesse, 1926 (Hesse, 1926, substitute name of *A. maculata* Collinge, 1895, type locality: Algiers).

We did not have the opportunity to examine topotypic specimens, however Wiktor (1983, 1987a), based on examination of specimens from Algeria, puts *L. scaptobius* in synonymy with *M. gagates*, both *A. cabiliana* and *A. mediterranea* in synonymy with *M. nigricans* and *M. collingei* in synonymy with *T. sowerbyi*. In addition, Altena Van Regteren (1974) and Wiktor & Abbes (2008) did not find any type material of these taxa.

Milax lopadusanus n. sp. is well distinct from the sympatric *M. nigricans* by the greyish-brown external colour, with yellowish keel (black or greyish colour with more raised keel in *M. nigricans*), by the smooth stimulator with a crest along one side (stimulator conical with several rows of spines or papillae in *M. nigricans*, Figs. 17–18) and by spermatophore with anterior part covered by spines only on one side, the largest spines are on the central part (in *M. nigricans* spermatophore covered by spines on all sides and along its whole length, with larger and strongly bifurcated spines on the anterior part (Wiktor, 1987a, b).

M. lopadusanus n. sp. is distinct from *M. gagates* for the greyish brown external colour, with yellowish dorsal carina (uniformly dark grey or blackish in *M. gagates*) for the conical stimulator with a crest (in *M. gagates* the stimulator is flattened, gradually narrowing towards its end, smooth or with several very small papillae on its

tip, Fig. 19) and for the spermatophore with the posterior part cylindrical, covered by spines on all sides (in *M. gagates* the longer spermatophore is covered by spines only on one side, the other side being smooth (Wiktor, 1987a, b).

Milax lopadusanus n. sp. is clearly distinguishable from *M. gasulli* by virtue of its greyish brown colour (black or grey with yellowish spots in *M. gasulli*), stimulator conical, with a crest (in *M. gasulli* stimulator is flated, with row of spines on a whole edge, Figs. 20–21). Spermatophore with anterior part covered by spines only on one side (covered on all sides by more strongly bifurcated spines in *M. gasulli*) (Wiktor & Abbes, 2008; Abbes et al., 2010)

Milax lopadusanus n. sp. is distinguishable from *M. ater* for its greyish brown colour (uniformly blackish in *M. ater*), penis shorter than epiphallus, (penis equal in length to epiphallus in *M. ater*), stimulator with an evident crest to half of its length and apex smooth (stimulator with smooth body and striped apex ornate by a sort of fan or small processes in *M. ater*, Fig. 22). The spermatophore in *M. ater* is unknown up to date (Collinge, 1895; Wiktor, 1987a).

REMARKS. *Milax lopadusanus* n. sp. seems similar to *M. gagates* for the spermatophora with bifurcated spines, that arise on the anterior part only on one side. Moreover it shares with *M. gasulli* the presence of a gelatinous substance that envelops the the distal part of the female genitalia. This gelatinous tissue is known only for *M. gasulli* and *M. lopadusanus* n. sp. (Altena van Regteren, 1974; Wiktor & Abbes, 2008).

The invertebrate fauna of Lampedusa includes many endemic species. They are mainly of African origin and they have differentiated for allopatric speciation. *Milax lopadusanus* n. sp. may have reached Lampedusa, possibly from North Africa, when emerged connections were established during glaciations or earlier.

Milax lopadusanus n. sp. is added to the endemic terrestrial molluscs of Lampedusa that include four other endemic species: *Lampedusa lopadusae lopadusae* (Calcara, 1846), *Oxychilus (Oxychilus) diductus* (Westerlund, 1886), *Trochoida cumiae* (Calcara, 1847) and *Cernuella metabola* (Westerlund, 1889) (Cianfanelli, 2002; Muscarella & Baragona, 2017).

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