

The Slugs of the Former Yugoslavia (Gastropoda terrestria nuda – Arionidae, Milacidae, Limacidae, Agriolimacidae)

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Abstract. All previously known former Yugoslavian terrestrial slugs of the families Arionidae, Milacidae, Limacidae and Agriolimacidae have been discussed in this paper. The author conducted his research in the former Yugoslavia's territory in 1982–1983. He has also examined material from museums and private collections. The taxa, from the family to the species, are provided with full synonymy, more important references, descriptions of the external appearance and systematically useful anatomical characters, information on ecology and distribution in the world, list of new and already known localities, and comments, which – e.g. – help to distinguish a particular taxon from other ones. There are also keys to all the families and species, characteristics of the former Yugoslavia's slug fauna, figures of all the species (nearly all made by the author himself) and distribution maps on a simplified UTM grid.

The occurrence of 48 species has been established. Six other, in the author's opinion, were erroneously recorded in literature and should not be reckoned among the fauna of this area. Besides, 11 species mentioned by former authors still have a completely unclear status. Two species new to science have been described, i.e. *Tandonia rara* and *Deroceras maasseni*, and 20 names synonymized.

Key words: Gastropoda, Pulmonata, slugs, Arionidae, Milacidae, Limacidae, Agriolimacidae, former Yugoslavia, taxonomy, morphology, distribution.

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INTRODUCTION

When I was conducting my field study, Yugoslavia was a federation of several republics. After its disintegration new self-dependent countries have arisen, which are currently in conflict with one another. Because of the war, the borderlines between those new countries have not been finally drawn yet. The unrest in this area will certainly pose a serious obstacle to studying thoroughly the slugs of this, so zoogeographically important, region of Europe. Although my research was not completed, at least not

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to the extent I meant, for the above mentioned reasons, I have decided to publish the hitherto obtained results, which, though incomplete, essentially change the present knowledge of the slugs inhabiting the area concerned.

In spite of Yugoslavia being divided, the former geographical names have been preserved. The boundaries of the new independent countries, at least partly, correspond to those of the former federal republics. It is unknown when the new borders get stable. That is why I have retained the names (Map 1) that were used at the time of my study and are available on maps from the 80s. The borderlines marked should be treated as points of reference for zoogeographic purposes. Although invalid, they will be helpful while reading the paper.

My research was conducted in 1982–1983, mainly in mountain regions that have the most diverse fauna. I did not manage to collect any material in northern Serbia and north-eastern Croatia. These areas are less interesting, both because they are usually flat and because they are under strong anthropopressure. Before I studied slugs in Yugoslavia, I had had an opportunity to get familiar with the slug fauna of the neighbouring countries. I myself researched Bulgaria (Wiktor 1983), Greece (Wiktor in print), Hungary (Wiktor, Szigethy 1984) and the adjacent areas of Italy (Wiktor, Milani 1995, also own unpubl. mat.). As a result, beside that on Yugoslavia, I have at my disposal my own studies concerning other south-European regions. As far as Roumania is concerned, its slugs have been studied by Grossu and Lupu (see References) for many years and copious literature on the malacofauna of this country exists. Albania is the only country neighbouring on Yugoslavia that has not been devoted a monograph so far.

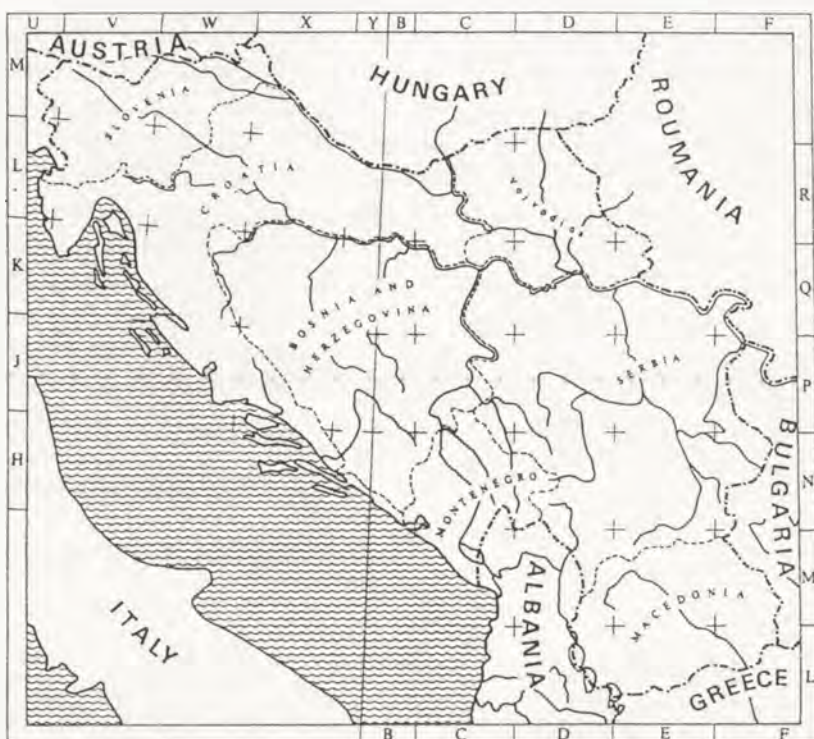
I was not the only person to study the Yugoslavian slugs. After World War II S. Jaeckel (sen.), in cooperation with W. Klemm and W. Meise, published an extensive compilatory paper, comprehensively discussing the Balkan malacofauna and the literature concerning this group of animals. The names of other authors, mostly specialists, who published on slugs or collected material, i.e. A.C.O. van Regteren Altena, J. Bole, E. Gittenberger, A.V. Grossu, D. Lupu, W.J.M. Maassen, A. Norris, W. Rähle, P.L. Reischütz, A.J. de Winter and M. Wolf, are also

worth mentioning. All of them have substantially contributed to a better knowledge of the Yugoslavian slugs. Summing up, one can say that the present-day knowledge of the Balkan slugs, taking into account also my current paper, can be regarded as fairly complete.

The terrestrial slug fauna of the Balkans belongs to the most abundant in species and hence the most diversified in the whole world. There is no doubt that here the great speciation centres were located, the reason being most probably the geological past and an especially wide geological and climatic diversity, and, related to it, variety of habitat types. Compared with other parts of the world, the former Yugoslavia's territory has the highest number of milacid species (particularly of the genus *Tandonia*, of which a considerable part are endemics). The number of species recorded from this area, i.e. 48, yields precedence only to Greece, where the occurrence of the record number of 56 slug species has been recorded recently (Wiktor in print). The slug fauna of all the remaining European countries, irrespective of their surface, consists of merely c. 30 species. Therefore, investigation of the Yugoslavian territory is of paramount importance to the knowledge of the slugs of the whole northern hemisphere. Obviously, its different parts differ with respect to fauna. For the sake of comparison, it is worth mentioning the centres important for all the families discussed in this paper. These are: for Agriolimacidae – mainly the south-western Palearctic (particularly the Balkans, Asia Minor and the Caucasus), for Limacidae – southern Europe, for Milacidae – the Mediterranean (the former Yugoslavia and Greece in particular), for Arionidae – the western Palearctic (particularly the Iberian Peninsula).

MATERIAL

I myself collected slugs in all the localities where the name of the collector is not provided. In other cases the collector's name is mentioned with the locality. The material I collected is accumulated in the main section of the Museum of Natural History, Wrocław University (Wrocław, Poland) and, partly, in the Field Museum of Chicago (U.S.A.). The slugs collected by Prof. Riedel are deposited in the Wrocław Museum too, labelled "Property of the Museum



Map. 1. Regions of the former Yugoslavia, used in the paper.

and Zoological Institute of the Polish Academy of Sciences in Warsaw". The material that was loaned to me by Dr. A.J. de Winter is available in Nationaal Natuurhistorisch Museum of Leiden (former Rijksmuseum van Natuurlijke Historie) (The Netherlands), the remaining in private collections.

During my study I had an opportunity to examine nearly all the types kept in collections. The places where they are deposited are mentioned in the text.

SYSTEMATIC CHECK-LIST OF THE SLUGS OF THE FORMER YUGOSLAVIA (Doubtful species unnumbered)

Family: Arionidae Gray, 1840	4	5. <i>Arion fasciatus</i> (Nilsson, 1823)	11
Genus: <i>Arion</i> Férussac, 1819	5	6. <i>Arion alpinus</i> Pollonera, 1887	13
1. <i>Arion lusitanicus</i> Mabilie, 1868	6	7. <i>Arion distinctus</i> Mabilie, 1868	15
– <i>Arion rufus</i> (Linnaeus, 1758)	7	– <i>Arion hortensis</i> Férussac, 1819	16
2. <i>Arion subfuscus</i> (Draparnaud, 1805)	7	– <i>Arion veydovskyi</i> Babor et Košťál, 1893	16
3. <i>Arion circumscriptus</i> Johnston, 1828	9	Family: Milacidae Ellis, 1926	16
4. <i>Arion silvaticus</i> Lohmander, 1937	11	Genus: <i>Milax</i> Gray, 1855	18
		8. ? <i>Milax gagates</i> (Draparnaud, 1801)	19
		9. <i>Milax nigricans</i> (Schulz, 1836)	20
		Genus: <i>Tandonia</i> Lessona et Pollonera, 1882	21
		10. <i>Tandonia albanica</i> (Soós, 1924)	22
		11. <i>Tandonia bosnensis</i> Wiktor, 1986	23
		12. <i>Tandonia budapestensis</i> (Hazay, 1881)	26
		13. <i>Tandonia cavicola</i> (Simroth, 1916)	28
		– <i>Tandonia cretica</i> (Simroth, 1885)	29
		14. ? <i>Tandonia croatica</i> (Wagner, 1929)	29
		15. ? <i>Tandonia dalmatina</i> Simroth, 1900	31
		16. <i>Tandonia fejervaryi</i> (Wagner, 1929)	31
		17. <i>Tandonia jablanacensis</i> (Wagner, 1930)	32
		18. <i>Tandonia kusceri</i> (Wagner, 1931)	33
		19. ? <i>Tandonia lagostoma</i> (Wagner, 1940)	35

20. *Tandonia macedonica* (Rähle, 1974) 35
 – ?*Tandonia montenegrina* (Simroth, 1900) 36
 21. *Tandonia rara* n. sp. 39
 22. *Tandonia reuleauxi* (Clessin, 1887) 43
 23. *Tandonia robici* (Simroth, 1885) 45
 24. *Tandonia rustica* (Millet, 1843) 46
 25. *Tandonia serbica* (Wagner, 1931) 48
 26. *Tandonia simrothi* (Hesse, 1923) 50
 27. *Tandonia sowerbyi* (Férussac, 1823) 53
- Family: Limacidae Rafinesque, 1815 55
 – "*Gigantomilax Csikii* Soós, 1924" 56
 – "*Gigantomilax occidentalis* Hesse, 1928" 57
 Genus *Malacolimax* Malm, 1868 57
 28. ?*Malacolimax kostali* Babor, 1900 57
 29. *Malacolimax mrazeki* Simroth, 1904 58
 – *Malacolimax tenellus* (Müller, 1774) 62
 Genus: *Lehmannia* Heynemann, 1862 62
 30. *Lehmannia brunneri* (Wagner, 1931) 63
 – *Lehmannia janetscheki* Forcart, 1966 65
 31. *Lehmannia marginata* (Müller, 1774) 65
 32. *Lehmannia nyctelia* (Bourguignat, 1861) 68
 33. *Lehmannia szigethyae* Wiktor, 1975 68
 Genus: *Limax* Linnaeus, 1758 69
 Subgenus: *Limax* s. str. 69
 – "*Limax* aff. *albipes* Dumont et Mortillet, 1852"
 70
 – *Limax (Limax) bielzi* Seibert, 1873 70
 34. *Limax (Limax) cephalonicus* Simroth, 1886 70
 35. *Limax (Limax) cinereoniger* Wolf, 1803 72
 36. *Limax (Limax) conemenosi* Boettger, 1889 75
 – *Limax dofleini* Hesse, 1928 76
 37. *Limax (Limax) graecus* Simroth, 1889 77
 – *Limax illiricus* Simroth, 1907 78
 38. *Limax (Limax) maximus* Linnaeus, 1758 78
 – *Limax (Frauenfeldia) montenegrinus* Boettger,
 1885 79
 – *Bielzia moellendorffi* (Kimakowicz, 1890) 80
 39. *Limax (Limax) wohlberedti* Simroth, 1900 81
 Subgenus: *Limacus* Lehmann, 1864 82
 40. *Limax (Limacus) flavus* Linnaeus, 1758 82
 – "*Bielzia montenegrina* (Boettger, 1885)" 83
 – "*Limacopsis coeruleans* Bielz" 83
- Family: Agriolimacidae Wagner, 1935 84
 Genus: *Deroceras* Rafinesque, 1820 85
- *Deroceras absoloni* (Simroth, 1916) 85
 41. ?*Deroceras agreste* (Linnaeus, 1758) 86
 – *Deroceras attemsi* (Simroth, 1905) 87
 42. *Deroceras laeve* (Müller, 1774) 87
 43. *Deroceras lothari* Giusti, 1971 88
 44. *Deroceras maasseni* n. sp. 89
 45. *Deroceras reticulatum* (Müller, 1774) 92
 46. *Deroceras rodnae* Grossu et Lupu, 1965 92
 47. *Deroceras sturanyi* (Simroth, 1894) 94
 – *Deroceras subagreste* (Simroth, 1892) 96
 48. *Deroceras turcicum* (Simroth, 1894) 97

Family Arionidae Gray, 1840

Subfamily Arioninae Gray, 1840

References: Riedel and Wiktor 1974: 85; Likharev and Wiktor 1980: 380; Wiktor 1983: 81.

Slugs differing in size. Mantle small, covered with a granular sculpture. Pneumostom antemedial. Body gently rounded (not pointed) posteriorly. Sole broad, not divided by longitudinal grooves.

Coloration varied. Body unicolour or with two stripes on mantle and sides.

Kidney annular. Musculature of the right and left part of head with two independent posterior insertions. Jaw odontognathic. Broad marginal teeth of radula with short, wide basal plates and one or several cusps. Intestine forms two loops. In the European species penis entirely reduced but epiphallus present. Sperm transferred by spermatophores.

The distribution range covers nearly the whole Palearctic though most species occur in its western margins, on the Iberian Peninsula in particular. With its southern range border the subfamily reaches northern Greece and Bulgaria. In the Balkans only one genus, *Arion*, occurs. The majority of species are widely distributed, *Arion alpinus* being the only species known from the former Yugoslavia which has a small range.

Key for identification of the species of Arionidae

1. Big slugs, c. 50 mm in length or even more, skin sculpture made of big, strongly arched wrinkles. 2.

- Smaller slugs, skin sculpture fine, wrinkles poorly arched. 3.
- 2. Atrium small. Inside oviductus, near the opening an elongated ligula. Oviductus thick, cylindrical. *Arion lusitanicus* (p. 6).
- Atrium large, pear-shaped. Inside it, near the oviductus opening a tongue-shaped ligula. Oviductus small, thin. *Arion rufus* (p. 7).
- 3. Spermatheca elongated, narrowed at its loose end. Juvenile slugs have an inconspicuous keel on back. 4.
- Spermatheca oval or spherical. Juveniles have their back gently rounded. 6.
- 4. Atrium flat, longer than wide. Epiphallus small, usually not swollen, often dark-pigmented in mid-section. Usually black spotting on mantle. Lateral stripes with blurred bottom edges. *Arion circumscriptus* (p. 9).
- Atrium shorter, at most its length equals the width. Epiphallus larger, most often with a small swelling near the junction with atrium. No spots on mantle. Lateral stripes with distinct bottom edges. 5.
- 5. Atrium flat, rectangular or square. Epiphallus of a medium size (in comparison with those of *A. circumscriptus* and *A. fasciatus*). Oviductus short. Coloration dark grey. Lateral stripes with the bottom edges distinct and the upper ones blurred. *Arion silvaticus* (p. 11).
- Atrium roughly conical or funnel-shaped. Epiphallus very large. Oviductus thin and long. Coloration as if faded. Lateral stripes grey with both the upper and bottom edges distinct. Beneath them, in live slugs, a yellow or orange streak (fading away in alcohol!). *Arion fasciatus* (p. 11).
- 6. Right lateral stripe runs above pneumostom. No dark pigment beneath pneumostom. Coloration as if faded, brownish in hue. Mucus yellow in live slugs. Sole yellow or orange. Length up to 20 mm. *Arion alpinus* (p. 13).
- Dark pigment of the lateral stripe spreads also beneath pneumostom. Body coloration very bright. 7.
- 7. Slug attaining 40 mm in length, or even more. Body rust-coloured, brown or even chocolate. Lateral stripes distinct unless the whole of back is very dark and sharply contrasts with pale sides. Sole cream in live and preserved specimens. Mucus orange, particularly in juveniles. *Arion subfuscus* (p. 7).
- Slug up to c. 17 mm. Back dark, black or of a brown hue, grey-blue after preservation in alcohol. Lateral stripes indistinct from the bottom, the dark pigment reaching as far as the sole edge. Mucus yellow-orange. *Arion distinctus* (p. 15).
Arion hortensis (p. 16).

Genus *Arion* Férussac, 1819

Arion Férussac, 1819: 50. Spec. typ.: *Arion empiricorum* Férussac, 1819 (= *Arion rufus* (Linnaeus, 1758) or *Arion ater* (Linnaeus, 1758)).

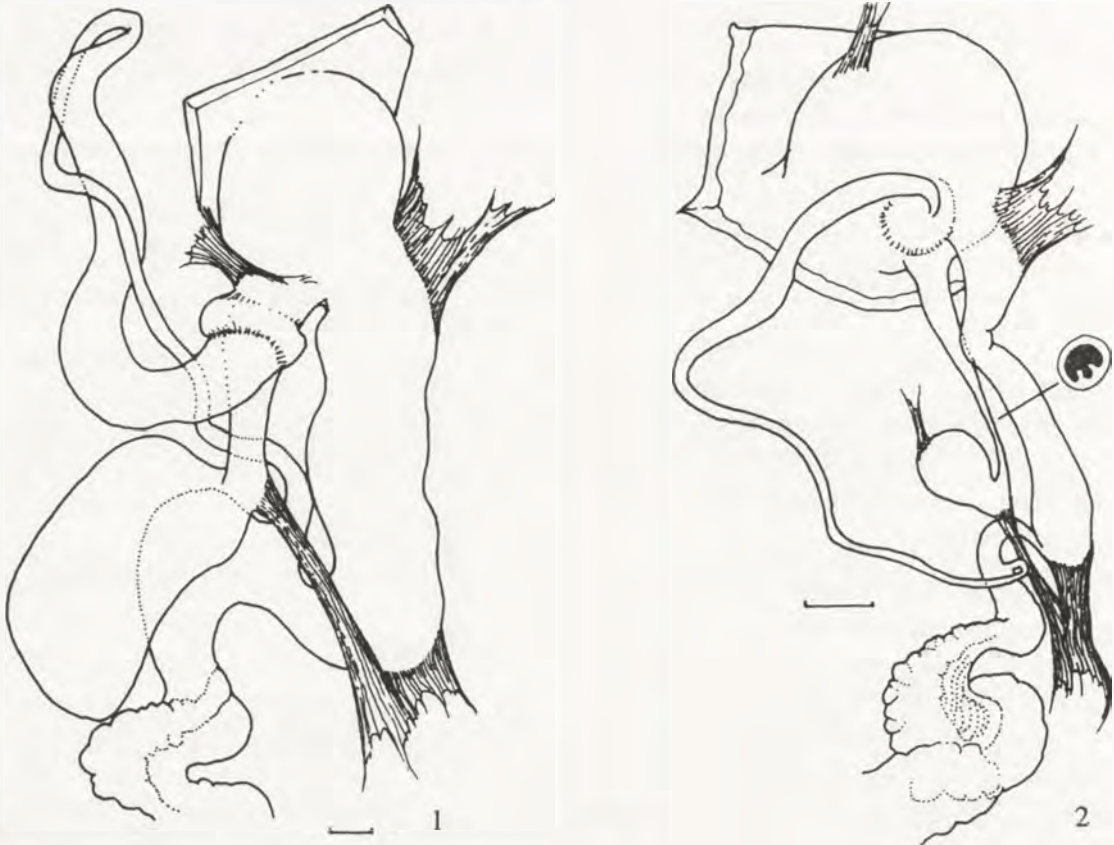
References: Hesse 1926: 63; Quick 1960: 124; Likharev and Wiktor 1980: 387; Backeljau and Bruyn 1990: 35.

Shell in the form of loose crystals. Oviductus, spermatheca duct and epiphallus – each opens into atrium separately. No penis.

About 30 species of *Arion* are known. The distribution range is nearly the same as the subfamily's. Most of the species occur on the Iberian Peninsula.

The taxonomy at the level of subgenus within the genus *Arion* Férussac, 1819 requires a revision as many doubts surround this problem. It has recently been explored by Backeljau and De Bruyn (1990) and I refer those who are interested in details to their paper.

In the present paper I do not intend to discuss thoroughly the systematics of this group. The few species that occur here I will only rank within the genus of *Arion*, without entering the discussion on the subgeneric level of systematics. The species are not treated alphabetically but grouped according to their mutual similarity.



Figs 1–2. Copulatory organs. 1 – *Arion lusitanicus* Mabille, 1868, specimen from Delnice (Croatia). 2 – *Arion subfuscus* (Draparnaud, 1805), specimen from Vojnik Mt., Njegoš Mts (Montenegro).

1. *Arion lusitanicus* Mabille, 1868

Arion lusitanicus Mabille, 1868: 134. Terra typica: Portugal (La Serra d'Arribada near Lisbon). Typus: probably does not exist.

References: Likharev and Wiktor 1980: 395; v. Proschwitz 1992: 35; Quick 1960: 135; Wiktor 1983: 83.

The only known from the former Yugoslavia representative of big slugs of the genus *Arion*. The specimens I had at my disposal were (after preservation) c. 53 mm long, 13 mm wide, mantle length being 21 mm. When alive all the slugs were brightly orange in colour. With respect to coloration and morphology they do not differ from specimens collected anywhere else.

Genitalia (Fig. 1). Terminal section of oviductus being long, fleshy and the thin section of this organ considerably shorter are diagnostic features in the structure of genitalia. Inside the thick, fleshy section

a narrow, elongated ligula. Epiphallus slightly shorter than oviductus, surrounded with a ring-like swelling in its anterior part on the borderline with atrium.

Ecology

A slug of a great ecological tolerance. Originally, it was probably a forest species. Now, however, it displays a particular preference for biotopes strongly degraded due to human activities. Most often it occurs in great numbers.

Distribution

In all likelihood, the original distribution range of this slug covered the Iberian Peninsula as well as certain areas of France, Ireland and Great Britain. For a long time it has been known from Algeria, Italy and West Germany. As definitely introduced, the species has been recorded from Switzerland and Bulgaria (Wiktor 1983), where it has isolated insular localities. For the last several years it has been inten-

sively spreading as a synanthrope. This case concerns Slovenia and Sweden in particular (von Proschwitz 1992).

So far the species has not been recorded from the area of the former Yugoslavia. The localities in Slovenia and Croatia that are mentioned below are probably insular. The slug occurs there as a synanthrope in extremely degraded biotopes.

Examined material from Yugoslavia: 9 specimens.

Slovenia: Postojna, synanthropic biotopes.

Croatia: Delnice, in the village, 600 m a.s.l.

– *Arion rufus* (Linnaeus, 1758)

The occurrence of this species should be confirmed. I did not encounter this slug during my field studies. Nor have I succeeded in finding the source of the information given by Jaeckel et al. (1958) who mention *A. rufus* from Bosnia and Albania. Bole (1962, 1976b, 1977, 1979) lists it from Slovenia.

Slovenia: after Bole (1962): Triglav Nat. Park; Bole (1976b): Notranjski Snežnik; Bole (1977 as *A. ater rufus*): Šmarni gore; Bole (1979): vicinity of the lake Cerkniško Jezero).

Bosnia and Herzegovina: after Jaeckel et al. (1958).

Comments

The distribution range of *A. rufus* has its eastern borderline in Poland. Besides, the species occurs in this country in isolated localities as a synanthrope. It is possible that it has also been introduced in the Balkans. However, it is more probable that this information rather concerns *A. lusitanicus*, which resembles *A. rufus* externally and hence only a few malacologists can distinguish between these two slugs in the field. Considering the doubts mentioned, I maintain that without confirmation *A. rufus* should not be reckoned in the slug fauna of the former Yugoslavia.

2. *Arion subfuscus* (Draparnaud, 1805)

Arion subfuscus Draparnaud, 1805: 125, Pl. 9, Fig. 3. Terra typica: France. Typus: probably not preserved.

Synonyms found in earlier literature: ?*Limax fuscus* Müller, 1774; *Arion subfuscus* Johnston, 1838 (nomen nudum); *Arion cinctus* Dumont et Mortillet, 1857; *Arion euthymeanus* Florence, 1836; ?*Arion olivaceus* Kotula, 1884. (For more detailed data on the synonyms see Hesse 1926).

References: Quick 1960: 133, Figs 6D,F,G, Pl. 1, Figs 1–2; Li-

kharev and Wiktor 1980: 396, Figs 548–553; Wiktor 1983: 86, Figs 3–4.

Body length c. 40 mm, width 12 mm, mantle length 11 mm. Variable coloration, often characteristic of a whole population. Most often the general coloration of various hues of russet-brown, russetish or olive. In the majority of specimens lateral, darker stripes are present. The pigment of the mantle stripes forms a dark triangle running posteriorly under pneumostom, which is very typical (!), especially of specimens preserved. There are specimens with their back evenly chocolate or brown-grey and their sides pale (without lateral stripes). All slugs have pale, creamy sole. Most specimens, juvenile in particular, secrete a bright orange mucus when irritated. It is best visible on the sole which then becomes orange as well. Some specimens, especially big, have their mucus colourless.

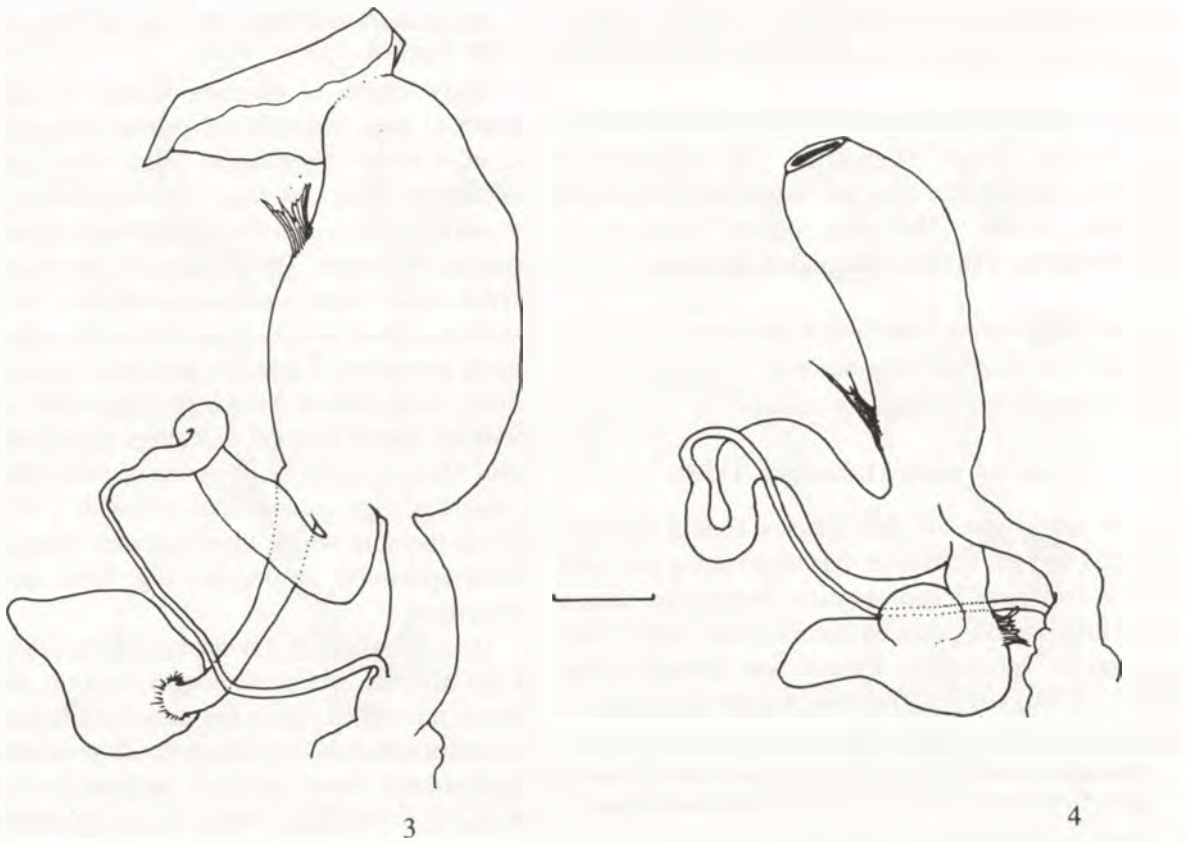
Genitalia (Fig. 2). Oviductus tubular, thick-walled in the anterior, definitely longer, section. Inside oviductus no typical ligula but only longitudinal ridges. Retractor attached to oviductus and spermatheca duct. Spermatheca round or oval. Spermatheca duct thin and long, surrounded with a ring of cylindrical swelling at the spot where it adjoins atrium. Epiphallus strongly elongated, bent, in its posterior part turning, without any distinct borderline, into a slightly thinner vas deferens. Anteriorly it gradually widens and, at the junction with atrium, swells into a circuitous ring-like form. Atrium medium in size, rounded.

Ecology

A species of a great ecological tolerance. Most often it is found in forests, both deciduous, coniferous and mixed. It lives in leaf litter, under wood pieces and bark of dead tree snags. As one of very few representatives of this genus, the slug crawls over the bottom parts of moss-grown tree trunks when it rains. Occasionally, it occurs in ruderal habitats of graveyards, ruins, parks etc. It does not, however, show a discernible tendency towards synanthropization. In the mountains it crosses the timberline, e.g. in the Alps it reaches 2900 m a.s.l. It feeds on mushrooms.

Distribution

Of the whole family this one is the species of the widest range. It inhabits almost the whole of Europe



Figs 3–4. *Arion circumscriptus* Johnston, 1828 – copulatory organs. 3 – specimen from the Plješevica Massif, Plitvice Nat. Park (Croatia). 4 – specimen from Kremna (Serbia).

from the Iberian Peninsula up to the Ural Mountains. It is known from northern Greece and Bulgaria where it reaches the Black Sea (Wiktor 1983, Wiktor in print). Its range probably covers the whole area of the former Yugoslavia.

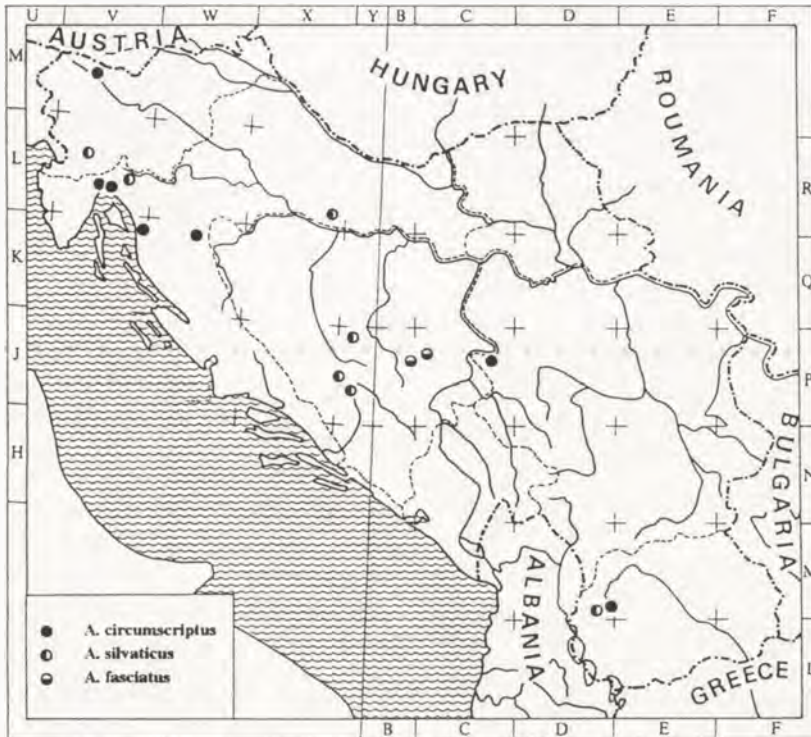
Examined material from the former Yugoslavia: 64 specimens.

Slovenia: Šoriška planina, pass 1280 m, SE of Banijska Bistrica, *Abies-Fagus* forest, limestone, leg. A. Riedel; Radeče (between Zagreb and Ljubljana), Massif Kum, 700–1000 m a.s.l., *Fagus* forest; Julijske Alpe (= Julian Alps), between Dom Savica (at the W end of Lake Bohinj) and Triglav Mt., near the 7th Triglav Lake, 750–1500 m a.s.l., limestone, *Fagus-Abies* forest; Triglav Mt., Park Pakljuka, *Picea-Fagus* forest, limestone; Julijske Alpe, Vintgar Canyon near Bled, on rocks and in leaf litter, *Fagus-Acer* forest, 700–750 m a.s.l.; Massif near Rozdrto (SW of Postojna), *Fagus-Acer* forest, limestone, 1100–1300 m a.s.l.; Rozdrto, SW of Postojna, in the village, below 500 m a.s.l.

After Bole (1962): Triglavski National Park. Bole (1966): Rakov Škocjan. Bole (1976a): Soteska, near Bled; Smrečje, Trnovski gozd Mts; Lenaršica, Velika Drnuljica, Laška kukava and Unška koliševka, near Legatec; Grda draga, near Snežnik Mt.; Prelesnikova koliševka, Kočevski Rog Mts. Bole (1976b): vicinity of Notranjski Snežnik. Bole (1977): Šmarne gore. Bole (1979): vicinity of the lake Cerkniško Jezero. Wiktor (1982): Soriška Planina Pass SE of Bohinjska Bistrica (Julijske Alpe), NW of Leskova Dolina at the foot of Snežnik Mt.

Croatia (Hrvatska): N of village Bihać, Plješevica Mts, shrubs, 650 m a.s.l., limestone; Plitvice Lakes National Park, area in the mountain massif Plješevica, wet *Fagus* forest, 600 m a.s.l., limestone; village Senj, coast, (S of Rjeka), Senjsko Bilo Mts, humid *Pinus-Ulmus* forest; NE slopes of the Velebit Mts, Sveti Rok village, limestone; above Sveti Rok vill., Voganski Vrh, NE slopes, *Fagus* forest, above 1000 m a.s.l., limestone; near village Delnice, *Fagus-Picea* forest, limestone, 700–900 m a.s.l.

After Wagner (1936): Crna Rieka, Kik Mt., Devcicevac, all near



Map 2. Distribution of *Arion circumscriptus*, *A. silvaticus* and *A. fasciatus*.

Plitvice, Mali Alan (= Halan). Wagner (1937b): near Plitvice, Mali Halan (? Mali Alan, Velebit Mts), between Apatisan and Lomska dubia. Wiktor (1982): Plitvice, at the lakes.

Bosnia and Herzegovina: Sarajevo, Jahorina Mts, 800–1200 m a.s.l., limestone, partly synanthropic, on rocks partly covered with *Pinus* forest; Raduša Mts, 1200–1900 m a.s.l., *Fagus* forest, limestone; N of Travnik, Babanovac Mt., Vlašić Massif, *Pinus-Abies* forest, 1700–1800 m a.s.l., limestone; N of Travnik, Babanovac Mt., Vlašić Massif, *Fagus* forest, limestone, 1940 m a.s.l.

After Wagner (1937b): Prenj; Plas near Jablanica; Djeh Mt. in the Baba Mts; near Gacko; Cemerno (?), near Foča Coinsko Polje; Trebović; Pasaric Mrtvanje (?). Jaekel et al. (1958): Kraina. Wiktor (1982): Zvezda; near Sarajevo.

Serbia: Kremna (W of Titovo Užice), Tara planina Mts, 1200–1300 m a.s.l., humid biotope; between Surdulica and Vlasina, stream, valley, leg. Mikulska, Sipos, Szigethy, Topal (coll. Budapest).

Montenegro: Durmitor Mts, on the path from Žabljak to Bobotov Kuk Mt., 1600–1700 m a.s.l., *Abies-Picea-Fagus* forest, limestone; Vojnik Mt., Njegoš Mts, NW of Nikšić, *Fagus* forest, 1200–1300 m a.s.l., limestone; Žabljak, Durmitor Mts, 1450–1500 m a.s.l.; forest and glades Majkovac, Bigorski Nat. Park, Bjelasica Mts, 1000–1500 m a.s.l., slate, *Fagus-Acer-Ulmus* forest.

After Simroth (1909): Montenegro. Wiktor (1982): Mavrovo.

Macedonia: Tajmište between Gostivar and Kičevo, 700–1000 m a.s.l., *Fagus* forest with *Corylus*, metamorphic rocks; Pe-sočeni, N of Ohrid (ca. 30 km), by the Sateska river, *Alnus*, 700 m a.s.l.; Mavrovo Nat. Park, *Fagus* forest slate, 1500 m a.s.l.; Babuna Mts, near Prilep, herbs near stream, 1500 m a.s.l.

After Hesse (1928): Liseč Mt. in the Golešnica Mts (= Golesniza). Jaekel (1954): Ljubotin, 1600 m a.s.l. (? Ljuboten Mt.). Jaekel et al. (1958): Macedonia.

Comments

A species of a great variability range and for this reason difficult to identify. This variability is present throughout the whole wide distribution range of this slug. According to some specialists, it is possible that the name has been used for several distinct species. No essential difference distinguishes the specimens collected in the former Yugoslavia.

3. *Arion circumscriptus* Johnston, 1828

Arion circumscriptus Johnston, 1828: 76. Terra typica: Europe (? Great Britain). Typus: probably does not exist.

More important synonyms: see Hesse (1926). *Arion Bourguignati* Mabile, 1868 is the name frequently used in earlier literature.

The specimens from the former Yugoslavia reach: 27 mm in length, 7 mm in width, mantle length up to 7 mm. With respect to coloration the Yugoslavian slugs differ quite considerably from those known from Central and North Europe. The typically coloured specimens from Central Europe have their lateral stripes with fairly distinct upper edges, while the bottom ones are more blurred, the dark pigment as if flowing downwards nearly to the very verge of sole. Another distinctive characteristic is irregular dark spotting on mantle. The general coloration of the back dark grey, in live slugs with a bluish shade. The Yugoslavian specimens have their lateral stripes more or less clear-cut from the bottom, only below them irregular accumulations of pigment occur, which are dispersed in the skin grooves (it makes these specimens very similar to a very close species, *Arion silvaticus* – see below). Mantle of the Yugoslavian specimens is dark spotted, though rather poorly in comparison with specimens from the North. The general coloration of the back also considerably lighter than in other specimens, e.g. from Poland.

Genitalia (Figs 3–4). Diagnostic features are the following: atrium very long, at least twice as long as wide, flat; epiphallus small, thin, scarcely broadened in the region of its junction with atrium, in typical forms from the North it is provided with a dark-pigmented band. In the Yugoslavian specimens atrium slightly shorter and wider whereas epiphallus, in proportion to the rest of genitalia, slightly larger, with no widening of the "bulbus" type in its anterior part, the dark, vestigial, band being found only in one specimen.

Ecology

A slug hiding in leaf litter, never climbing plants. It occurs in deciduous forests, usually in wet, shady places, e.g. at valley bottoms, by rivers etc. It seems to be primarily a species of the lowlands, in the mountains giving way to *A. silvaticus*.

Distribution

At present it is difficult to establish its range for the fact that until today many authors have not distinguished this slug from two related species, i.e. *A. silvaticus* and *A. fasciatus*. Undoubtedly, the slug discussed inhabits North and Central Europe. The localities in the south of Europe need to be con-

firmed, though it is certain that in this area *A. circumscriptus* becomes a rare species.

The localities in the former Yugoslavia are scarce (Map 2), scattered over nearly the whole area, which makes their interpretation difficult.

Material examined collected in the former Yugoslavia: 17 spec. (without juveniles, whose identification is doubtful).

Slovenia: ? juv. spec. Julijske Alpe, Vintgar Canyon near Bled, *Fagus-Acer* forest, limestone; 700–750 m a.s.l.

Croatia: Plitvice Lakes National Park, Plješevica massif, *Fagus* forest, 600 m a.s.l., limestone; village Senj (S of Rjeka), Senjsko Bilo Mts, *Pinus-Ulmus* forest, limestone, below 650 m a.s.l.

After Wagner (1931c): Volosca, Wrutki spring near Opatija. Wagner (1932): Volosko, Opatija.

Serbia: Kremna (W of Titovo Užice), Tara planina Mts, 1200–1300 m a.s.l., humid *Abies-Fagus* forest.

Bosnia and Herzegovina: after Wagner (1937b): Prnj.

Macedonia: ? Tajmište, between Gostivar and Kičevo, *Fagus* forest with *Corylus*, metamorphic rocks, 700–1000 m a.s.l.

Comments

The whole group of species so far comprised within *Carinarion* Hesse, 1926 still create difficulties. A common feature is the presence of an elongated, narrowed at the loose end, spermatheca. Another typical character, discernible in young specimens, is a distinct ridge, a kind of keel, running medially along the whole back. In this group three species can be distinguished. These are: *Arion circumscriptus*, *A. silvaticus* and *A. fasciatus* (see below). No doubts arise about some specimens, while there are whole populations difficult to identify and include in any of the species. It is usually the case with *A. silvaticus*, which, in respect of most characters, is placed between the two other slug species. In earlier literature it was very common to refer to these three species as *Arion circumscriptus* or any of the synonyms. Thus, the hitherto mentions of *A. circumscriptus* from Yugoslavia might have concerned any of at least three species. All those data need to be revised.

It was Lohmander (1937) to notice the existence of three distinct, though similar, species. This fact was confirmed by many studies including those that made use of electrophoretic analyses (Backeljau et al. 1987, Backeljau, De Bruyn 1990). Juvenile specimens, if they do not have the typical coloration, are

morphologically undistinguishable. In the case of the Yugoslavian slugs this difficulty in identification is particularly manifest. I have never found specimens showing all the characters typical of *A. circumscriptus*. All display similarity to *A. silvaticus*, mostly with respect to coloration. The geographically scattered localities bring about other doubts. The biotopes where the occurrence of *A. circumscriptus* was ascertained do not indicate that the slug had been introduced there.

4. *Arion silvaticus* Lohmander, 1937

Arion circumscriptus var. *silvaticus* Lohmander, 1937: 98 and 111, Figs 10–11. Terra typica: southern Sweden (? and Denmark). Typus: I have no information whether any has been preserved.

Dimensions of the specimens from the former Yugoslavia: body length up to 22 mm, width 6 mm, mantle length 7 mm. The Yugoslavian specimens do not differ from the Central-European ones with respect to coloration. Back is dark ashen, sometimes with a light, brownish hue. In the Central-European specimens mantle without dark spotting while in the Yugoslavian it is sometimes slightly spotted. In most cases the lateral stripes have their edges clearly marked, and, if there is the dark pigment below them, it is accumulated only in the skin grooves and only in small quantities.

Genitalia (Figs 5–6). The species is distinguishable either by flat atrium, the length of which approximates to its width, or that assuming the shape of a short square. Epiphallus large, near the junction with atrium it may be distended into a conspicuous bulb. In comparison with other organs and the body dimensions, it is bigger than in *A. circumscriptus* but smaller than in *A. fasciatus*. Moreover, the size and shape of this organ may considerably vary.

Ecology

A forest, mesophilic species, occurring in different forest types, most often in deciduous forests with a great share of *Fagus* in particular. The slug hides in leaf litter, snags and under wood pieces. It is not very agile. It shows a great ecological tolerance.

Distribution

It requires detailed investigation. The slug seems

to inhabit the whole area in the past related to *A. circumscriptus*. It is the widest distributed species of the *Carinarion* group. It has its localities widely scattered over the former Yugoslavia's territory (Map 2), also in the area where *A. circumscriptus* is found.

Material examined collected in the former Yugoslavia: 15 spec. Slovenia: Postojna (synanthropic).

Croatia: near village Delnice (W Croatia), *Fagus-Picea* forest, limestone, 700–900 m a.s.l.

Bosnia and Herzegovina: N of Travnik, Babanovac Mt., Vlašić Massif, *Pinus-Abies* forest, 1700–1800 m a.s.l., limestone; Vran Mts, above Jablanica in the Doljanka valley, *Fagus* forest, limestone, 1000–1700 m a.s.l.; Prozor, Raduša Mts, meadow above the town, limestone.

Macedonia: ? Mavrovo Nat. Park, *Fagus* forest, slate, 1500 m a.s.l.

Juvenile specimens (17) of doubtful identification (!): Slovenia: Julijske Alpe, Triglav Nat. Park, mountain meadows near the hotel, limestone, 1000 m a.s.l.

Croatia: Rysnjak Nat. Park, near Crni Lug (near Delnice), meadows; Strumac Mt., Psunj Massif (N of Nova Gradiška), slate, *Petasites* and *Urtica* near the stream; Bihać, ruins of a mediaeval castle beyond the town, 700 m a.s.l.

Serbia: Kremna (W of Titovo Užice), Tara planina Mts, *Pinus* forest, 1300–1400 m a.s.l.

Bosnia: Konjuh Mts, near Kladnj (N of Sarajevo), humid *Fagus* forest, limestone, 650 m a.s.l.

Montenegro: Mojkovac, Bigorski Nat. Park, Bjelasica Mts, *Fagus-Acer-Ulmus* forest, slate, 1000–1500 m a.s.l.

Macedonia: Tajmište, between Gostivar and Kičevo, *Fagus* forest, limestone, 1000 m a.s.l.

Comments

See the note on *A. circumscriptus*.

5. *Arion fasciatus* (Nilsson, 1823)

Limax fasciatus Nilsson, 1823: 3. Terra typica: ? Sweden. Typus: probably does not exist.

Dimensions: length up to c. 31 mm, width 8 mm, mantle length up to 11 mm. General coloration pale, as if faded, especially when the slug is compared with *A. circumscriptus* or *A. silvaticus*. It concerns specimens live as well as preserved in alcohol. Back light grey, beige, in live slugs occasionally yellowish. Mantle not spotted. Dark lateral stripes have their upper and bottom borders distinct, i.e. not blurred.



Figs 5–6. *Arion silvaicus* Lohmander, 1937 – copulatory organs. 5 – specimen from Prozor, Raduša Mts (Bosnia and Herzegovina). 6 – specimen from Vran Mt., Doljanka valley (Bosnia and Herzegovina).

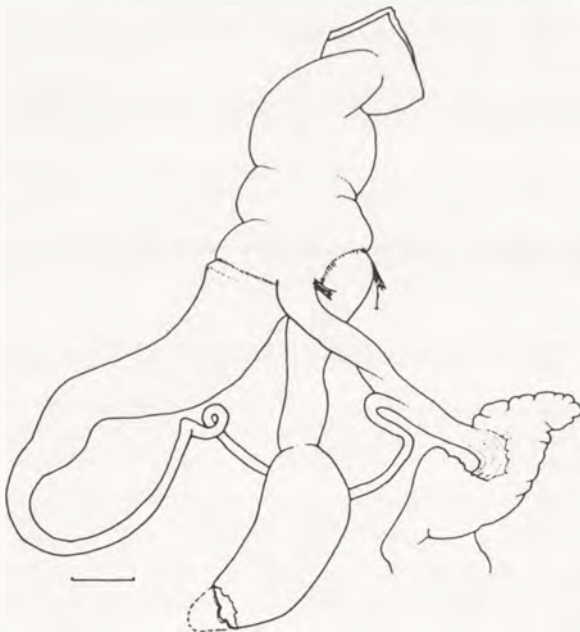


Fig. 7. *Arion fasciatus* (Nilsson, 1823) – copulatory organs, specimen from Sokolac (Bosnia and Herzegovina).

They are as if smoked, not quite black but rather dark ashen. In live slugs a yellow, orange or reddish streak detectable on the sides below the dark stripes. Caution! This pigment disappears during preservation in alcohol (!).

Genitalia (Fig. 7). Atrium scarcely flattened, or almost round in section, anteriorly funnel-shaped (it is most perceivable in juvenile specimens), sometimes roughly triangular. Epiphallus very big in comparison with the other components of copulatory organs. At times a fairly detectable band of a dark pigment on epiphallus. A conspicuous distension often present on the border between spermatheca duct and atrium.

Ecology

It is difficult to establish the original biotopes inhabited by this species. All the localities I know show obvious effects of anthropopressure. The species is found as a synanthrope in the neighbourhood of buildings, in ruins, particularly of old castles, in cemeteries, gardens and parks, on fallow grounds,

composts, refuse dumps. It is most often accompanied by other synanthropic species.

Distribution

The original distribution range needs further study and precise determination. As a synanthrope the species has its localities widely dispersed in Europe. In the former Yugoslavia it is an introduced species of scarce localities (Map 2).

Material examined collected in the former Yugoslavia: 5 spec.

Croatia: Strumac Mt., Psunj Massif (N of Nova Gradiška), 350–500 m a.s.l., slate, *Petasites-Urtica*, near a stream (? 1 juv.).

Bosnia and Herzegovina: Jahorina Mts, near Sarajevo, 800–1200 m a.s.l., limestone, partly synanthropic, on rocks partly covered with *Pinus* forest; village Sokolac (E of Sarajevo), Romanija Mts.

6. *Arion alpinus* Pollonera, 1887

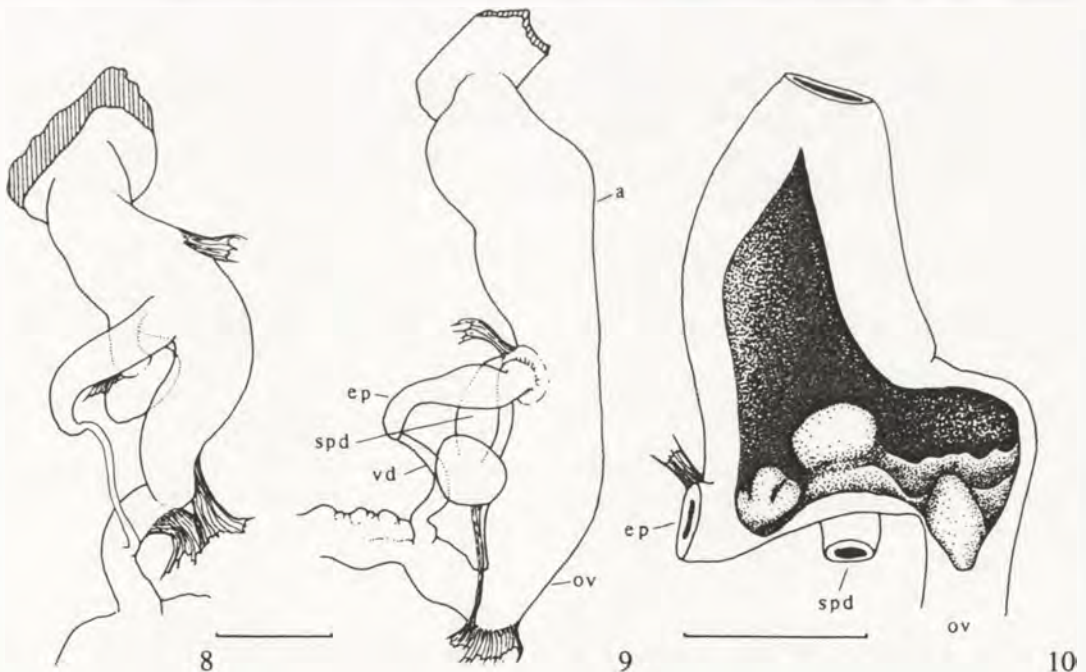
Arion alpinus Pollonera, 1887: 305, Pl. 3, Figs 25–26. Terra typica: the South Alps (Le Alpi del Piemonte della Lombardia).

Typus: no information.

References: Falkner 1980: 295, Fig. 1; Reischütz 1973: 229, Fig. 1; Reischütz 1980: 261, Fig. 2; Reischütz 1986: 96.

Body dimensions (after preservation in alcohol): length up to 21 mm, width up to 4 mm, mantle length up to 6.5 mm. Coloration of live slugs: the upper part russet-brown, as if faded (slightly resembles *A. subfuscus*); the lateral stripes brown, sides below them yellow, a yellow streak above them; sole clearly yellow or almost orange. Mucus pale yellow. After preservation in alcohol: back (including mantle) pale brownish, as if faded, with a light creamy zone between the darker mid-back and dark stripes. The lateral stripes brown, slightly darker than the back, the right one forming a soft bow over pneumostom. A small accumulation of grey pigment around pneumostom. Body sides as well as sole pale creamy. Head ashen.

Genitalia (Figs 8–10). Vas deferens short. Epiphallus in the shape of a narrow cone without any conspicuous distensions, opening to atrium with a



Figs 8–10. *Arion alpinus* Pollonera, 1887 – copulatory organs. 8 – specimen from Vintigar Canyon (Slovenia). 9 – specimen from the Plješevice Massif, Plitvice Lakes Nat. Park (Croatia). 10 – structures inside atrium, specimen from Plješevice (Croatia). ep – epiphallus, ov – oviductus, sp – spermatheca, spd – spermatheca duct, vd – vas deferens.

flattened papilla (see Fig. 10). Oviductus composed of two distinct parts: posterior – thinner, and anterior – wider and larger. The posterior part has hard, fleshy and thick walls. In its front section there is an oval, sharp papilla. Spermatheca in the shape of a mushroom with a rounded or flattened container and a thick, tubular spermatheca duct opening to atrium in the direct neighbourhood of epiphallus. Atrium long, in the form of an irregular tube. It has smooth walls inside, except for a mamilliform swelling between the openings of oviductus and spermatheca duct (Fig. 10). Musculus retractor genitalis short but broad and strong. It is attached to oviductus on the border between its thinner and thicker parts. From it a muscle strand runs, which is attached to the base of spermatheca, i.e. on the borderline between spermatheca and spermatheca duct.

Ecology

A forest species inhabiting different types of forest. Most often I collected it in spruce forests. It frequently occurs in the edges of woods, finds shelter

under wood pieces and stones. This slug reaches sexual maturity in autumn (Reischütz 1986).

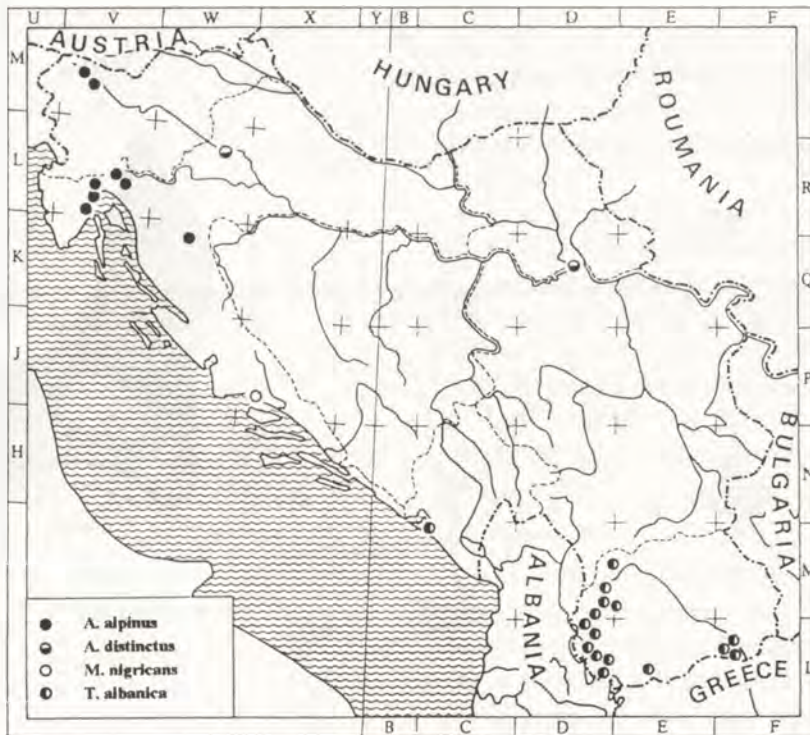
Distribution

Its distribution range has not been thoroughly determined yet. What has only been known is that the species occurs in the regions of Piedmont and Lombardy, the Julian Alps, both within the Slovenian and Italian borderlines (own studies), as well as almost in the whole area of Austria (Reischütz 1986). It has also been recorded from Bavaria and Baden Württemberg (Falkner 1980).

Material examined collected in the former Yugoslavia: 18 spec. (Map 3).

Slovenia: Julijske Alpe, Vintgar Canyon, near Bled, on rocks and in leaf litter, *Fagus-Acer* forest, 700–750 m a.s.l.; Julijske Alpe, valley N of Triglav Mt., near village Dovie, 700–1000 m a.s.l., *Fagus-Picea* forest.

Croatia: Opatija, *Carpinus-Quercus* forest, above the town, 500–700 m a.s.l., limestone; S of Opatija, bush in the canyon, limestone, 50 m a.s.l.; Istria, Lavran, Voljak Mt. in the Učka Mts, 600–1100 m a.s.l., *Fagus-Castanea* forest, lime



Map 3. Distribution of *Arion alpinus*, *A. distinctus*, *Milax nigricans* and *Tandonia albanica*.

stone; Učka, near Opatija, 950 m a.s.l., leg. W.J.M. Maassen; near village Delnice, *Fagus-Picea* forest, limestone, 700–900 m a.s.l.; Nat. Risnjak Park, near Crni Lug (near Delnice), *Fagus-Picea* forest, limestone, 1000–1200 m a.s.l.; Plitvice Lakes Nat. Park, area in the mountain massif Pleševica, wet *Fagus* forest, 600 m a.s.l., limestone.

Comments

In the structure of copulatory organs it shows numerous features relating it to the complex of species included within the group *Kobeltia* Seibert, 1873. With regard to the external appearance it resembles very much juvenile specimens of *A. subfuscus*, differing, however, in its "faded" coloration, a slimmer body and a different shade of the mucus colour.

7. *Arion distinctus* Mabille, 1868

Arion distinctus Mabille, 1868: 137. Terra typica: "environs of Sevres". Neotypus: Nat. Natuurhist. Mus., Leiden, no alc. 9120 (De Winter 1984).

References: Davies 1977: 174 and many figures; Davies 1979: 124; De Wilde 1983: 88, Figs 1 (3–4), 2 (6,8), 3 (12–15), 4; De Winter 1984: 7, Figs 2, 4, 5, 7–9, 11; Bäckeljau and Van Beeck 1986: 61, Figs 1A, 2A–C; Bäckeljau and De Bruyn 1990: 35 and many figures.

Body length 17 mm, width 4 mm, mantle length 6 mm. Specimens preserved in alcohol are blackish-bluish. The lateral stripes with distinct upper limits and the bottom ones blurred, the dark pigment reaching nearly the edge of foot. Pneumostom within the dark stripe. The species is known to be unrecognizable in field conditions. With respect to the external appearance, the specimens I collected in the former Yugoslavia did not differ from the representatives of this species occurring in Poland.

Genitalia (Fig. 11). The free oviduct section very long when compared with other *Arion* species of the former Yugoslavia. It is thin in its posterior section, abruptly widening at the retractor insertion. The broader part of oviductus is composed of two sections: one is short, soft-walled, adjacent to atrium, while the other has thick walls, is not everted but interiorly ended in a papilla. In the Yugoslavian specimens the soft section of oviductus is very short in proportion to the stiff, thick-walled one. Vas deferens long, gradually, though conspicuously, widening and opening into a long cone-shaped

epiphallus. This organ is slightly anteriorly swollen into a "bulbus", and terminates inside atrium with a conical papilla (Fig. 11), the latter being typical of this species. Spermatheca roughly spherical. Spermatheca duct clearly bent at the attachment of the main retractor muscle bunch. In its anterior part the canal is strongly broadened. Musculus retractor genitalis very short and wide, attached to oviductus. A muscle strand running from it is attached to spermatheca duct partly at the spermatheca base and partly at its junction with atrium. Atrium shapeless and short.

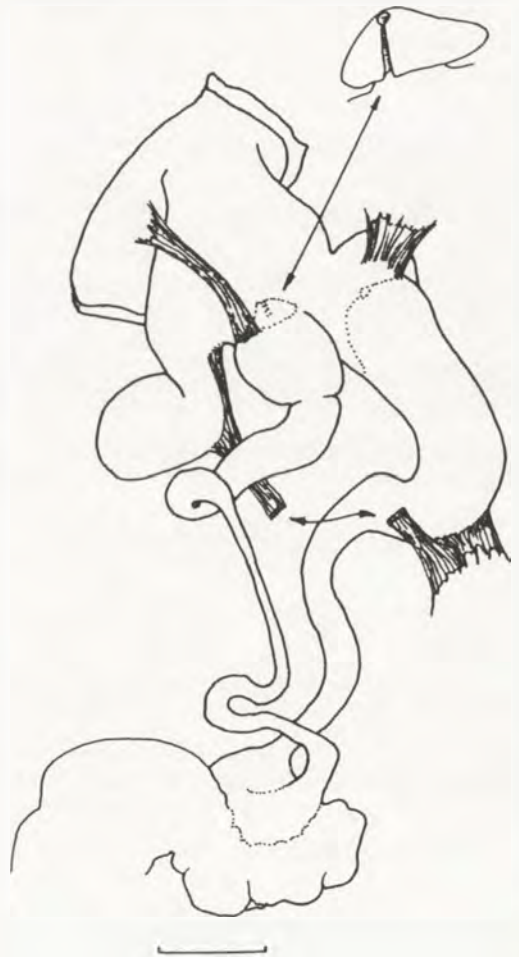


Fig. 11. *Arion distinctus* Mabille, 1868 – copulatory organs, specimen from Belgrade (Serbia).

Ecology

The former Yugoslavian localities that I know are biotopes strongly degraded as a result of anthropopressure. Like in the majority of other known localities, also in the former Yugoslavia this slug is a synanthrope.

Distribution

Poorly examined. The hitherto existing knowledge about it has been accumulated in a paper by De Winter (1984), which is also provided with a map of localities. From the revision mentioned it appears that this slug has its localities scattered from the foot of the Pyrenees in France up to western Poland. In the South its occurrence has been ascertained in the region bordering on Italy and northern Austria. Currently it is recorded from the former Yugoslavia (Map 3). I also know specimens from Bulgaria and Hungary. *A. distinctus* probably has more dispersed localities in Italy and Ukraine etc. It is not possible, however, to establish where its original distribution range was and where the species has been introduced. Its predisposition to synanthropization is evident. Moreover, I have got an impression that the slug is presently taking over new and new areas.

Material examined collected in the former Yugoslavia: 11 spec. (Map 3).

Croatia: Zagreb, city park, 135 m a. s. l.

Serbia: Beograd, old fortifications and park.

Comments

In earlier literature the species was most often referred to as *Arion hortensis*. Davies (1977, 1979) proved the existence of a complex of, at least, three slugs that had not been distinguished by most authors before. It regards the following species: *A. hortensis*, *A. distinctus* and *A. owenii* Davies, 1979. The outcome of her research was confirmed, among others, by De Wilde (1983) and De Winter (1984), who provided original detailed descriptions. Such a position is taken by many other malacologists as well. Nowadays it is necessary that all the quotations from reference sources concerning the occurrence of *A. distinctus* and *A. hortensis*, at least those written before 1978, should be verified. One may assume that at least a part of the information on the occurrence of

A. hortensis (see below) in the former Yugoslavia actually concerns *A. distinctus*, but it cannot be taken for granted.

– *Arion hortensis* Férussac, 1819

The data quoted below require confirmation. They may be related to *A. distinctus* (see the above comments on this species) or other species including *A. hortensis*, the latter species having never been recorded from the area of the former Yugoslavia.

Slovenia: after Bole (1962): Triglav. Nat. Park. Bole (1979): vicinity of the lake Cerknjško Jezero.

? Bosnia and Serbia: after Jaeckel et al. (1958).

– *Arion vejvodskyi* Babor et Košťal, 1893

Arion Vejvodskýi Babor et Košťal, 1893: 1, Figs 1–3. Locus typicus: "Jarov prope Závist" (Czech Republic). Typus: no information about its existence.

A taxon of an unclear taxonomic position. Probably a synonym of another name.

Croatia: after Wagner (1937b): Istra, Učka (= Monte Maggiore).

Comments

The species Wagner actually dealt with is unknown. It may have been *A. alpinus* or *A. distinctus*, or any other species.

Family Milacidae Ellis, 1926

This family has been devoted a separate systematic monograph (Wiktor 1987a), in which I present my opinions with respect to taxonomical and other problems associated with Milacidae. The work mentioned, supplemented with a key for identification of all the species, provides also data on morphology and bionomics as well as ample references.

Key for identification of the species of Milacidae¹

1. Single accessory gland, situated beside copulatory organs, opens to atrium through numerous small ducts. Stimulator inside atrium (*Milax*). . . . 2.

¹The key does not comprise the species of doubtful taxonomical status, neither those of unconfirmed occurrence in the area, namely *Tandonia cretica*, ?*T. croatica*, ?*T. dalmatina*, ?*T. montenegrina*.

- Accessory glands encircling vagina and opening to this organ. Stimulator in atrium lacking (*Tandonia*). 3.
- 2. Interior wall of stimulator covered with numerous, big spines (Figs 17–18).
 *Milax nigricans* (p. 20).
- Interior wall of stimulator completely smooth or, at the very most, covered with a few papillae or, less frequently, with small spines (Fig. 13).
 *Milax gagates* (p. 19).
- 3. Back and sides evenly black. 4.
- Back and sides not black, of uniform colour or dark spotted. 11.
- 4. Spermatheca together with spermatheca duct c. 1.5 times longer than spermoviductus, no distinct border between spermatheca and spermatheca duct (Fig. 35).
 *Tandonia jablanacensis* (p. 32).
- Spermatheca with spermatheca duct shorter than spermoviductus, in mature specimens spermatheca container usually clearly distinguishable from spermatheca duct. 5.
- 5. Inside atrium or oviductus hard structures with spines or teeth. 6.
- No hard structures inside genitalia. 7.
- 6. Numerous hard structures with spines or small teeth inside genitalia on the border between vagina and atrium (Figs 49, 52–54).
 *Tandonia rara* (p. 39).
- Inside atrium, between the openings of vagina and penis, a ctenoid structure with papillae or spines on the edges, which is accreted to the atrium wall (Fig. 70).
 *Tandonia simrothi* (p. 50).
- 7. A big slug, over 60 mm long. Accessory glands in the shape of small rolls transverse to vagina (Figs 55–56).
 *Tandonia reuleauxi* (p. 43).
- A considerably smaller slug. Accessory glands different in shape. 8.
- 8. Vagina several times longer than wide. Accessory glands long, digitate, adherent to vagina (Fig. 33).
 *Tandonia fejervaryi* (p. 31).
- Vagina shorter, only a little longer than wide. Accessory glands not digitate. 9.
- 9. Papilla inside penis in the shape of a mushroom (Figs 43–44, 46). Penis and epiphallus strongly elongate. Caution! The slug is not always black, spotted specimens are also found!
 *Tandonia macedonica* (p. 35).
- Papilla inside penis half-spherical. Penis and epiphallus thick, squabby. 10.
- 10. Spermatophore cigar-like, at one end narrowed and covered with fine spines, at the other – as if truncated, with big hooks (Fig. 22). Spermatheca strongly elongated, most often tapered at the end. Spermatheca duct broad, thick-walled, usually longer than spermatheca. Caution! A slug not always black, spotted specimens occur as well.
 *Tandonia albanica* (p. 22).
- One end of spermatophore flagellum-like elongated. Spermatheca oval or roughly spherical. Spermatheca duct thinner, with thinner walls, usually shorter than spermatheca. Caution! A species known from Epir (N Greece). It may prove to occur in border-close regions of the former Yugoslavia. See Wiktor: 1986a: 157 or 1987a: 265.
 *Tandonia melanica* Wiktor, 1986.
- 11. Body ochre-creamy with dark, usually not numerous, dots resembling ink splashes (Fig. 30). Body length c. 65 mm. Epiphallus 3–4 times longer than penis. Accessory glands very small (Figs 31–32).
 *Tandonia cavicola* (p. 28).
- Different coloration. Compare also the appearance of genitalia. 12.
- 12. A very big slug, over 70 mm long, ochre or reddish, mantle beige-violetish, darker pigment accumulations in the skin grooves produce a kind of reticulum. The appearance of genitalia is known only in juvenile specimens (Figs 39–40).
 *Tandonia lagostoma* (p. 35).
- A smaller slug, less than 65 mm long. 13.
- 13. Body fairly even in colour, greenish-olive (live specimens), dirty yellowish or blackish-beige, only mantle may be slightly spotted. Spermatheca oval, poorly distinguishable from spermatheca duct, the two organs together hardly longer than

- atrium. Atrium large, oval (Figs 60–61).
 *Tandonia robici* (p. 45).
- . Body conspicuously spotted, of variable coloration, with distinct streaks along the mantle grooves. Atrium small. 14.
14. Spermatheca duct and spermatheca without a clear borderline between, together c. 2.5 times longer than penis with epiphallus (Figs 24–25).
 *Tandonia bosnensis* (p. 23).
- . Spermatheca and spermatheca duct more or less distinct from each other, never so long. ... 15.
15. Spermatheca elongate, tubular, rounded at the end. Epiphallus with two retentors. Between the openings of penis and spermatheca duct the atrium wall is distinctly thickened, usually with a lobe-shaped structure directed inward. Keel very strongly arched, body nearly triangular in cross-section (Fig. 71).
 *Tandonia sowerbyi* (p. 53).
- . Spermatheca oval, roughly spherical or rounded. Epiphallus without retentors. No thickened wall nor the lobe-shaped structure between the openings of penis and spermatheca duct. Body smoothly arched from the top. 16.
16. Epiphallus roughly equalling penis in length.
 17.
- . Epiphallus considerably longer than penis. . 19.
17. Papilla inside penis mushroom-shaped. Spermatheca duct longer than spermatheca. Body blackish-coffee, occasionally reddish. Reticulate pattern on the body. The whole body often evenly black (!) (Figs 41–46).
 *Tandonia macedonica* (p. 35).
- . Papilla inside penis more or less half-spherical.
 18.
18. Spermatheca duct wide, thick-walled, usually longer than spermatheca. Epiphallus cylindrical, slightly narrowed in its posterior section, usually with two nodulous protuberances at the posterior end. Penis irregular with numerous distensions. Coloration grey-brown-beige with darker spots or evenly black (!). Sole pale. Spermatophore cigar-like (Figs 20–22).
 *Tandonia albanica* (p. 22).
- . Spermatheca duct thin, thin-walled, usually shorter than spermatheca or equal in length. Epiphallus club-shaped, i.e. slightly widened in its medial or posterior section. No nodulous protuberances on epiphallus. Penis more or less rounded. Coloration dark, chocolate-blackish. The pigment distributed in the skin assumes the form of fine granules, body never being black. No distinct spotting whatsoever. Sole dark: grey, orange-grey etc. Spermatophore strongly elongate (Figs 28–29).
 *Tandonia budapestensis* (p. 26).
19. Epiphallus 5–7 times longer than penis, thin, coiled, smoothly extending into a long and coiled vas deferens (Figs 37–38).
 *Tandonia kusceri* (p.).
- . Epiphallus 2–3 times longer than penis, the border between thin vas deferens and considerably thicker epiphallus very clear. 20.
20. Penis large, pear-shaped, with a wide retractor and wide membranaceous retentor, which fasten this organ to body integuments. Spermatheca spherical (Fig. 67). Live slugs brownish-reddish in colour, after preservation brownish-blackish with a dark reticulate pattern and, most often, a few bigger, dark spots as well. Caution! Externally very similar to *T. kusceri*, the two species often co-occurring!
 *Tandonia serbica* (p. 48).
- . Penis not pear-shaped, smaller, with a distension roughly in the mid-section, retractor narrow, no wide retentor present. Spermatheca tapered or even sharpened posterad. Body brownish in live slugs, whitish after preservation, with numerous fine dots (Figs 63–64).
 *Tandonia rustica* (p. 46).

Genus *Milax* Gray, 1855

Milax Gray, 1855: 174. Spec. typ.: *Limax gagates* Draparnaud, 1801.

Synonyms: *Lallemantia* Mabilie, 1868; ?*Palizzolia* Bourguignat, 1877; ?*Sansania* Bourguignat, 1881; *Pirainea* Lessona et Pollonera, 1882; *Cypria* Simroth, 1910; *Micromilax* Hesse, 1926.

For literature, including that on the synonyms, see Wiktor 1981: 145; Wiktor 1983: 96; Wiktor 1987a: 184(!).

Keel strongly arched, discernible along the whole back. Accessory gland, in the form of lumped mass usually situated below pharynx, i.e. certain distance off copulatory organs, is connected to atrium through numerous ducts or only one such (!). Atrium large in comparison with other organs, most often with one, but occasionally even three (!), stimulators inside (*Milax verrucosus* Wiktor, 1969, which has no stimulator, is the exception).

The genus comprises 13 species. They inhabit the Mediterranean region in its broad sense, i.e. from the Caspian Sea up to the Canary Islands. Besides, a few species have been introduced not only into other areas of Europe but also to other continents.

8. ?*Milax gagates* (Draparnaud, 1801)

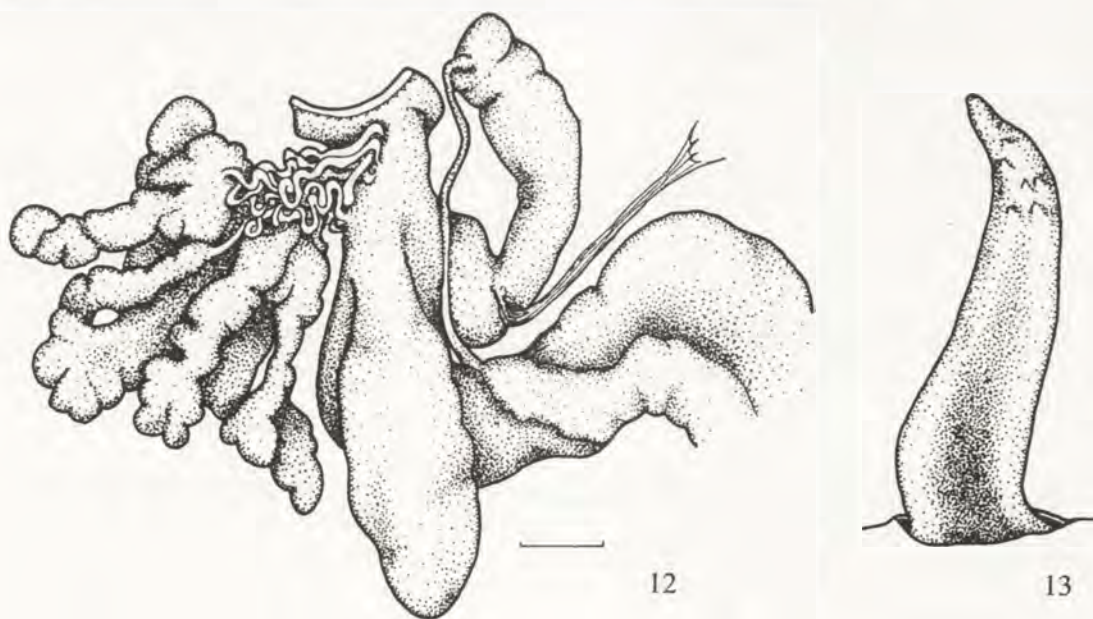
Limax gagates Draparnaud, 1801: 100. Locus typicus: presumably an area near Montpellier (France). Typus: probably has not been preserved.

Synonyms: *Limax maurus* Quoy et Gaimard, 1824; ?*Milax scapto-bius* Bourguignat, 1861; *Limax pectinatus* Selenka, 1865; *Limax (Amalia) Hewstoni* Cooper, 1872; *Milax nigricolus* Tate, 1881; *Milax atratus* Mabille, 1868; *Milax tasmanicus* Tate, 1881; *Amalia antipodorum* var. *pallida* Cockerell, 1891; *Amalia parryi* Collinge, 1895; *Amalia Babori* Collinge, 1897 (for bibliographic data on the synonyms see Wiktor 1987a).

Body dimensions: length up to 35 mm, width up to 8 mm, mantle length c. 13 mm. Coloration evenly ashen-grey, blackish or even black with slightly paler body sides.

Genitalia (Figs 12–13). Vas deferens, roughly equalling epiphallus in length, opens to the latter organ clearly asymmetrically. Epiphallus claviform, posteriorly as if truncated. Penis irregular in shape, rounded. Inside it a small half-spherical papilla. Musculus retractor thin and relatively long, attached to the anterior part of epiphallus near its border with penis. The free oviduct section as well as vagina form a tube without a distinct borderline between. Spermatheca elongate, oval, usually posteriorly narrowed, faintly separated from a short spermatheca duct. Spermatheca duct opens directly to atrium, without connection through oviductus. Atrium small, tubular, constituting as if a natural extension of vagina. Inside it a narrow tongue-shaped stimulator of smooth surface, at most with a few small papillae situated only near the loose end (!). Atrial accessory glands in the shape of a large lumped structure which, at the stimulator insertion, joins atrium through numerous (16–18) silk-glittering ducts.

Spermatophore (Fig. 14).



Figs 12–13. *Milax gagates* Draparnaud, 1801. 12 – copulatory organs. 13 – stimulator. (After Wiktor 1987a).



Fig. 14. *Milax gagates* Draparnaud, 1801 – spermatophore. (After Wiktor 1987b, specimens from Algeria).

Ecology

The species inhabits different types of biotope, open in particular. It is especially fond of wet biotopes and those situated in the neighbourhood of water. It is often found in different kinds of cultivation, on compost heaps, refuse dumps as well as in debris, e.g. rubble, ruins.

Distribution

The original habitat of this species is unknown. It probably comes from NW Africa, SW Europe and the Canary Islands. It has been introduced into different parts of Spain and Portugal as well as to France, Belgium, the British Isles, Germany and Finland. It is also recorded from Australia, New Zealand, Polynesia, America and South Africa.

Croatia: after Wagner (1935): Brač Isl., Mljet Isl. Jaeckel (1954): Pocala cave near Trst (= Trieste, former Yugoslavia's border area). Jaeckel and Meise (1956): Solin near Split. Jaeckel et al. (1958): Istra, Dalmatia.

Comments

A species easily introduced, most often occurring as a synanthrope. I myself did not collect it in the area of the former Yugoslavia, although its occurrence, as a synanthrope, in this region is very probable. All the literature data on the species occurrence in Yugoslavia need to be revised for two reasons: synanthropic populations easily come into existence and easily vanish too; besides, the species discussed is often confused with an allied, similar slug, namely *Milax nigricans* (see below).

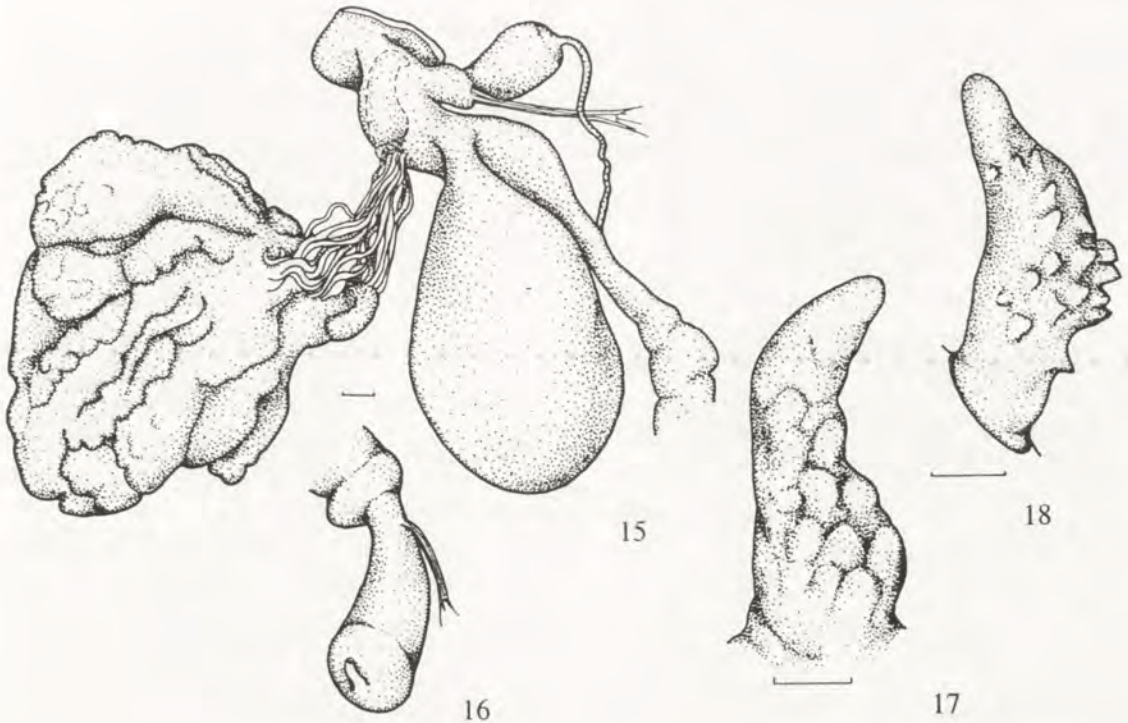
9. *Milax nigricans* (Schulz, 1836)

Parmacella nigricans Schulz (in Philippi), 1836: 125, Pl. 8, Fig. 1. Terra typica: Panormi (Palermo, Sicily). Typus: no information on whether it has been preserved.

Synonyms: *Amalia* (*Pirainea*) *insularis* Lessona et Pollonera, 1882; *Amalia* (*Pirainea*) *ichnusae* Lessona et Pollonera, 1882; ?*Amalia doderleini* Lessona et Pollonera, 1882; *Amalia sicula* Lessona et Pollonera, 1882; ?*Amalia gagates benoti* Lessona et Pollonera, 1882; *Amalia cabiliana* Pollonera, 1891; ?*Amalia mediterranea* Cockerell, 1891; ?*Amalia mediterranea* f. *similis* Cockerell, 1891; *Milax nigricans praiolae* Giusti, 1968 (for data on bibliography see Wiktor 1987a).

Body dimensions: length up to 65 mm, width 13 mm, mantle length 17 mm. Body evenly black or blackish, sides usually inconspicuously paler. Sole dirty cream.

Genitalia (Figs 15–18). Vas deferens longer than penis and epiphallus together. The remaining copulatory organs very similar to those of *M. gagates*. An essential difference exists in stimulator, situated inside atrium, the surface of which is covered with big "spines", or at least multiple papillae, that are present also in the region of the stimulator base.



Figs 15–18. *Milax nigricans* (Schulz, 1836). 15 – copulatory organs. 16 – penis. 17–18 – stimulators. (After Wiktor 1987a, specimens from Algeria).

Spermatophore (Fig. 19), entirely covered with spines, evidently differs from those of all the other slugs of this genus.

Ecology

Poorly investigated. The species seems to have similar requirements as those of *M. gagates*, particularly when it occurs as a synanthrope.

Distribution

It requires a special study in consideration of frequent confusion between *M. nigricans* and *M. gagates*. The species discussed is recorded from Tunisia, Morocco, Malta, Egypt, Sicily, Corsica, Majorca, Italy, France, Great Britain, Spain.

Croatia: after Wiktor (1982): Split (Map 3).

Comments

See the comments on *M. gagates*.

Genus *Tandonia* Lessona et Pollonera, 1882

Tandonia Lessona et Pollonera, 1882: 54. Species typica: *Amalia marginata* (Draparnaud, 1805) (= *Limax marginatus* Draparnaud, 1805 = *Limax rusticus* Millet, 1845, non *Limax marginatus* Müller, 1774).

Synonyms: *Subamalia* Pollonera, 1887; *Macrothylacus* Wagner, 1930; *Promilax* Wagner, 1930; *Aspidoporus* sensu Babor 1898 (for bibliography see Wiktor 1987a).

In some species keel is poorly arched and, occasionally, after preservation seems not to reach the posterior edge of mantle. Accessory glands different in appearance, always composed of at least two structures surrounding vagina and, often, a fragment of oviductus and spermatheca duct as well. Those glands open through numerous ducts to vagina (!). Atrium small, without a stimulator inside (!).

About 30 species of this genus are known. Their distribution range covers the Black Sea area and the European coast of the Mediterranean Sea, including islands, partly also SE and W Europe. The greatest number of species occur in the Balkans.



Fig. 19. *Milax nigricans* (Schulz, 1836) – spermatophore. (After Wiktor 1987a, specimen from Sardinia).

10. *Tandonia albanica* (Soós, 1924)

Amalia (*Malinastrum*) *albanica* Soós, 1924: 191, Figs 10–12. Terra typica: Albania (Koprivnik Mts and Korab Mt.). Syntypi: destroyed.

Amalia (*Malinastrum*) *adelpha* Soós, 1924: 192, Fig. 13. Terra typica: Albania (Koprivnik Mts and Korab Mt.). Syntypi: destroyed.

Milax clerxi Rähle 1977b: 275, Figs 1a–g. Locus typicus: Ohrid, Macedonia. Holotypus: Nat. Natuurhist. Mus., Leiden (Moll. alc. 9030).

Body dimensions: length c. 60 mm, width 13 mm, mantle length 18 mm. Keel scantily arched, sometimes, especially after preservation, it makes an impression of being confined to the posterior body section. Coloration of two kinds. Some specimens, particularly these occurring on rocks and in rubble, are deeply black. Whereas others, those living by water in particular, are grey-brown-beige with a darker, most often black, pattern on mantle and back. The darker pigment is concentrated mainly in the skin grooves. The latter specimens have their keel pale. These two colour forms are not only anatomically similar but also they copulate with each other. Mucus colourless, on irritation an additional, milky secretion is produced.

Genitalia (Figs 20–21). A thin, long vas deferens opens asymmetrically at the apical end of epiphallus. Epiphallus more or less cylindrical though slightly narrowed in its terminal section. Its posterior end, rounded or bluntly cut, is most often provided with two inconspicuous protuberances. Penis of irregular shape, usually with several lateral distensions. At the slight constriction between epiphallus and penis a very small retractor attaches. Oviductus tubular, relatively long in comparison with the rest of genitalia. Spermatheca oval, elongated. Its posterior end, rounded when the organ is empty, is conspicuously narrowed when it is filled with spermatophore. Spermatheca duct thick, longer than spermatheca itself. Vagina very short. Accessory glands large, lobe-shaped, surrounding vagina from all sides. Atrium short, tubular.

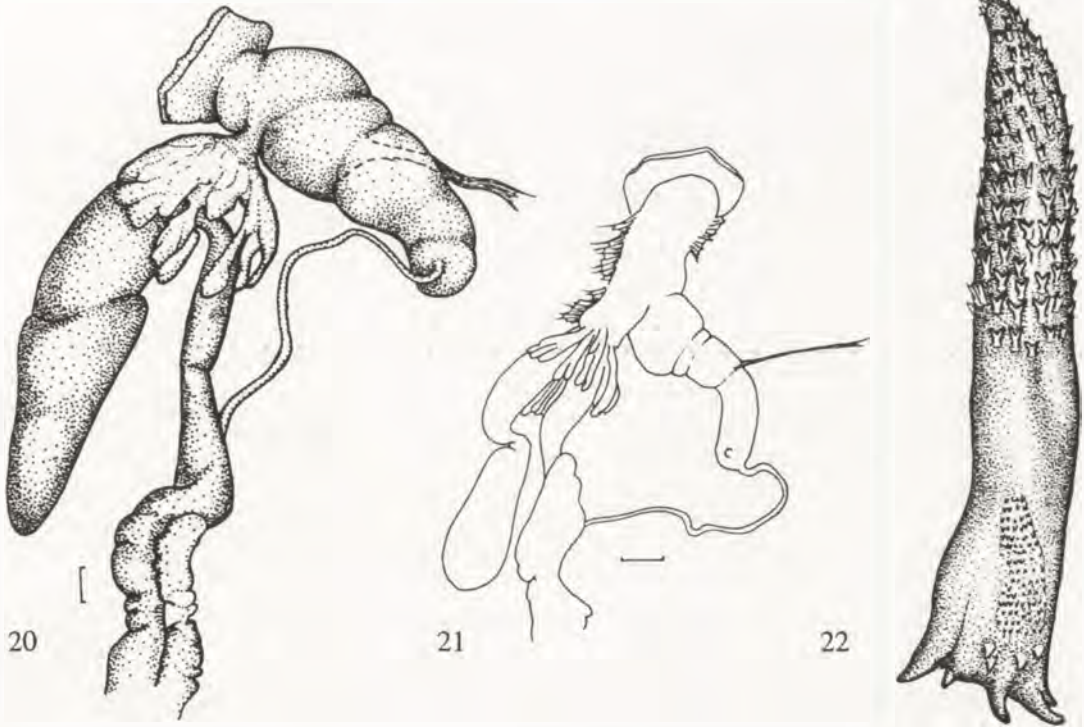
Spermatophore (Fig. 22) very characteristic in shape, resembling a short cigar, devoid of the flagellate part. Its wider segment is equipped with big hooks whereas in the narrowing one the surface is covered with fine spines.

Ecology

The species occurs mainly in rocky areas, in rock debris, especially when screened by shrubs. It is frequent by streams. It usually occurs in large populations, which is most visible after rain. In the mountains it can reach 2400 m a.s.l.

Distribution

The species distribution range is confined to a small border area between Macedonia and Albania.



Figs 20–22. *Tandonia albanica* (Soós, 1924). 20 – copulatory organs, specimen from Trnica (Macedonia). 21 – copulatory organs, specimen from Lukovo (Macedonia). 22 – spermatophore, specimen from Mavrovi Hanovi (Macedonia). (After Wiktor 1982).

In Greece its occurrence has not been established so far (my previous records on *T. albanica* from Greece (Wiktor 1987b) have been revised, having probably concerned a similar species, i.e. *T. melanica* Wiktor, 1986 – see Wiktor 1987a).

Examined material collected in the former Yugoslavia: over 130 spec. (Map 3).

Croatia: after Jaeckel et al. (1958): Dalmatia (as *M. albanicus* and *M. adelphus* (Soós, 1924)).

Macedonia: Popova Šapka, Šar Planina Mts (near Tetevo), 1800–1840 m a.s.l., leg. A. Riedel; Tajmište, between Gostivar and Kičevo, 700–1000 m a.s.l.; Padalište, S of Gostivar, on the road to Kičevo, in a deep valley, 750 m a.s.l.; Branište, near Debar, synanthropic, near the stream; Mavrovo Nat. Park, *Abies* forest, 1700–1900 m a.s.l.; Sv. Jovan Bigorski monastery in the Radica valley; Bitola, E slope of the Baba Massif above the town, 700–1500 m a.s.l.; Slatyni, c. 35 km N of Ohrid, in the Stogovo Massif, 700–900 m a.s.l.; above village Lukovo (between Debar and Struga), in the Cmi Drim valley, 700–1000 m a.s.l.; Sv. Bogorodica Monastery, near Struga; Ohrid, in the town, the hill with a fort; in

a valley in the Galičica Massif near Ohrid; Kožuf Massif, Ametkova Glava Mt., 25 km S of Krnjevo "Korito Cesma", leg. A. Riedel; between Musov Grob and Kamienište, Kožuf Massif, 750 m a.s.l., leg. A. Riedel; Stara Reka valley, 6 km SW of Konopište, 760 m a.s.l., leg. A. Riedel.

After Wiktor (1982): 3 km before Mavrovi Hanovi on the road to Debar, 6 km before Trnica (the road to Debar), Sv. Jovan Bigorski monastery, Lukovo (N of Ohrid), ? Tresanie.

Montenegro: after Wiktor (1982): environs of the spring of Ljuta near Dobrota.

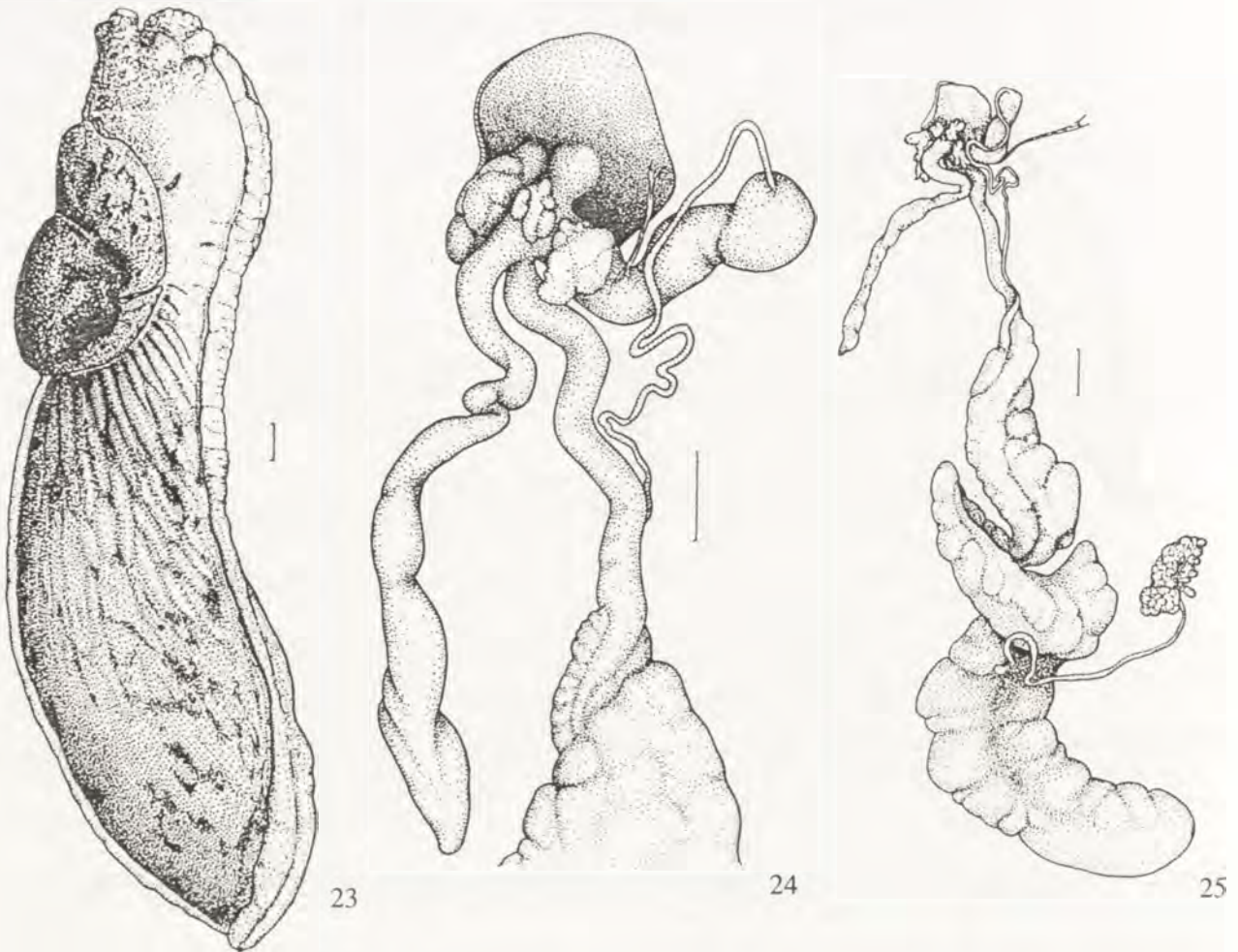
Comments

Compare the description of *T. macedonica* and comments on this species.

11. *Tandonia bosnensis* Wiktor, 1986

Tandonia bosnensis Wiktor 1986a: 162, Figs 11–13. Locus typicus: Trebević Mt. above Sarajevo (Bosnia and Herzegovina). Holotypus: Nat. Hist. Mus., Wrocław, no. MP 570.

Body dimensions after preservation: length c. 30 mm, width 12 mm, mantle length 8 mm. The species

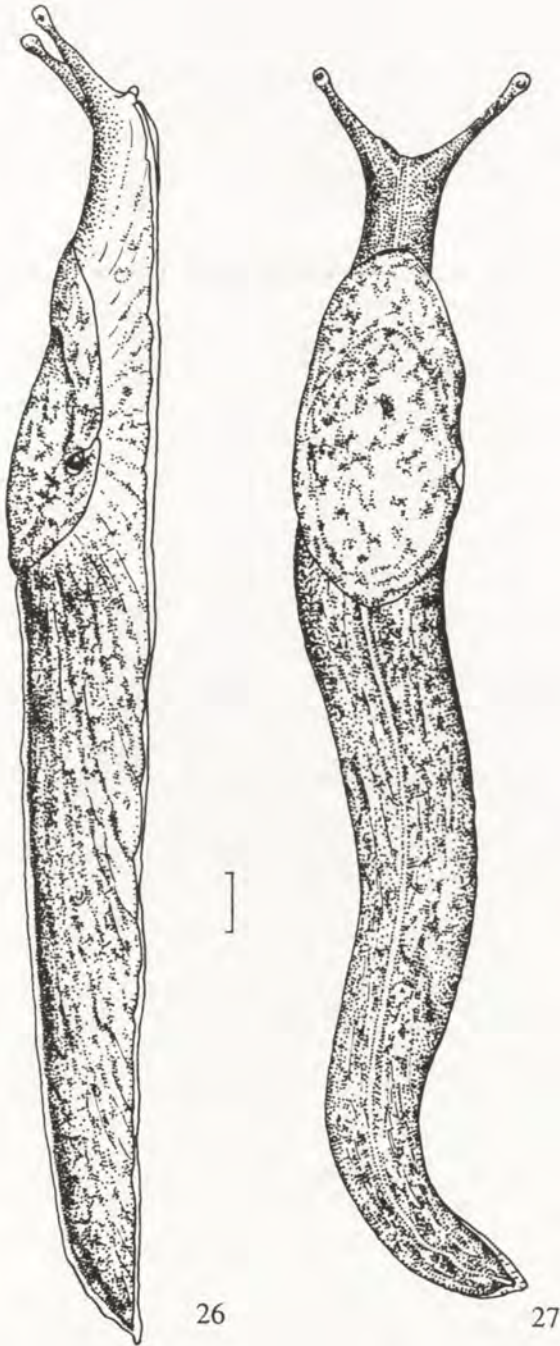


Figs 23–25. *Tandonia bosnensis* Wiktor, 1986 – holotype, collected on Trebević Mt. (Bosnia and Herzegovina). 23 – lateral view. 24 – copulatory organs. 25 – reproductive system. (After Wiktor 1986a).

is conspicuous by its comparatively small mantle (Fig. 23). The widest body part is not the section covered by mantle but the posterior end (however, this might be an artifact, a result of wrong preservation). General coloration of live slugs brownish-pink. Back and head blackish, mantle and sides with a blackish pattern. The pattern on mantle composed of irregular dots, on sides blurred dots form an irregular reticulum. Keel pinkish, sole creamy. After preservation in alcohol the general coloration becomes creamy whereas the pattern – blackish. Mucus colourless. The slug secretes also an additional, milky-white mucus when irritated. Externally, this

species is not well distinguishable, its identification requiring anatomical study.

Genitalia (Figs 24–25). Copulatory organs relatively small in comparison with the whole of the reproductive system. A long, thin, coiled vas deferens opens somewhat asymmetrically but apically to epiphallus. Epiphallus and penis together form an elongated, tubular, or rather club-shaped, structure; no distinct border exists between those two organs. The posterior end of epiphallus rounded. Musculus retractor penis thin and long. Oviductus in the shape of a long folded tube, clearly thinner than penis. Spermatheca so strongly elongated that it is difficult



Figs 26–27. *Tandonia budapestensis* (Hazay, 1881) – dorsal and lateral view. (After Wiktor 1973, specimen from the Czech Republic).

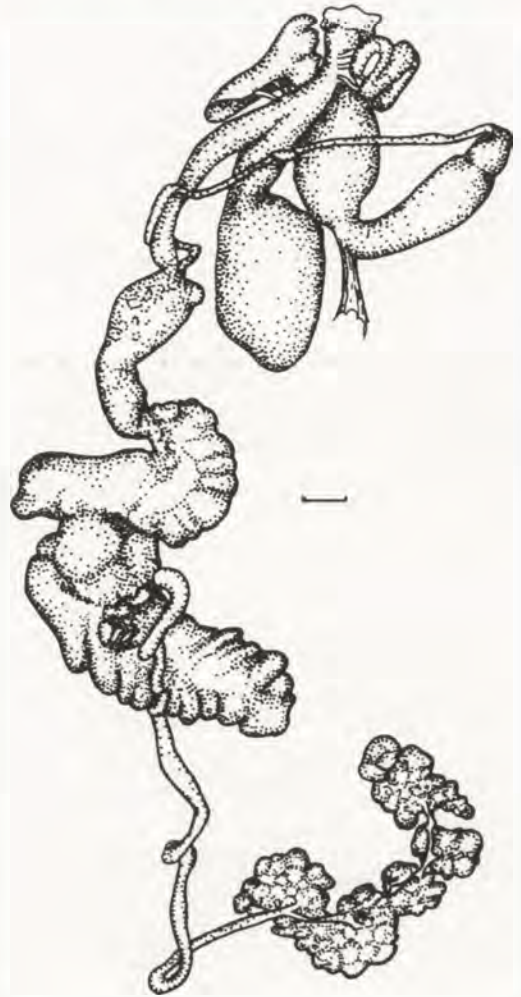


Fig. 28. *Tandonia budapestensis* (Hazay, 1881) – reproductive system. (After Wiktor 1973, specimen from the Czech Republic).

to define the borderline between this organ and spermatheca duct. They both, i.e. spermatheca and spermatheca duct, make up an organ which is 2.5 times longer than penis along with epiphallus (!). Vagina very short, surrounded by lobe-shaped accessory glands. Arium very short as well.

Spermatophore unknown so far.

Ecology

The specimens examined were found in fallen leaves, mainly of beech (*Fagus*), on limestone rocks.



Fig. 29. *Tandonia budapestensis* (Hazay, 1881) – spermatophore, specimen from Belgrade (Serbia). (After Wiktor 1987b).

Distribution and material

Up until now the only known material are the types and the only known locality – locus typicus.

12. *Tandonia budapestensis* (Hazay, 1881)

Limax gagates Menegazzi, 1855: 64, Pl. 2, Figs 1–7 (non *gagates* Draparnaud, 1801) (after Hesse 1926). Typus; no information.

Limax gracilis Leydig, 1876: 276, Pl. 12, Fig. 22. Terra typica: environs of Tübingen (Germany) (non *gracilis* Rafinesque, 1820). Typus: no information.

Amalia budapestensis Hazay, 1881: 37. Locus typicus: Budapest. Typus: no information.

Amalia Cibiniensis Kimakowicz, 1884: 103. Terra typica: Transylvania. Typus: no information.

Milax gracilis valachicus Grossu et Lupu, 1961b: 133. Locus typicus: Bucharest (Roumania). Holotypus: Mus. Nat. Hist. "Gr. Antipa", Bucharest, no. 13105.

Body length of fully stretched, live specimens up to 70 mm, after preservation c. 40 mm, width 5 mm, mantle length 11 mm. Body slim (Figs. 26–27). General coloration blackish-chocolate. Skin covered with a blurred, darker pattern composed of blackish dots scattered over a creamy or orange background and forming a close reticulum. A dark pigment, present also on mantle, on sides produces indistinct dark streaks. Head blackish. Sole orange or ashen. Caution! During preservation alcohol rinses away the yellow and orange hues, the specimens becoming more ashen or blackish. Mucus thick, transparent. On irritation the slug secretes also an opaque milky liquid.

Genitalia (Fig. 28). Vas deferens opens asymmetrically on the apical end of epiphallus. The latter is club-shaped, equalling or slightly exceeding penis in length. Penis rounded in shape. Retractor penis well developed. Papilla inside penis of uncomplicated structure. Spermatheca elongated, rounded at its loose end. Spermatheca duct fleshy, thick, tubular. Oviductus tubular as well. Vagina very short, vaginal accessory glands in the form of two lobe-shaped structures connected with vagina through several thin canals. Atrium very short, tube-shaped.

Spermatophore (Fig. 29) strongly elongated, flagellate, covered with spines throughout the length.

Ecology

An eurytopic species, most often occurring as a synanthrope.

Distribution

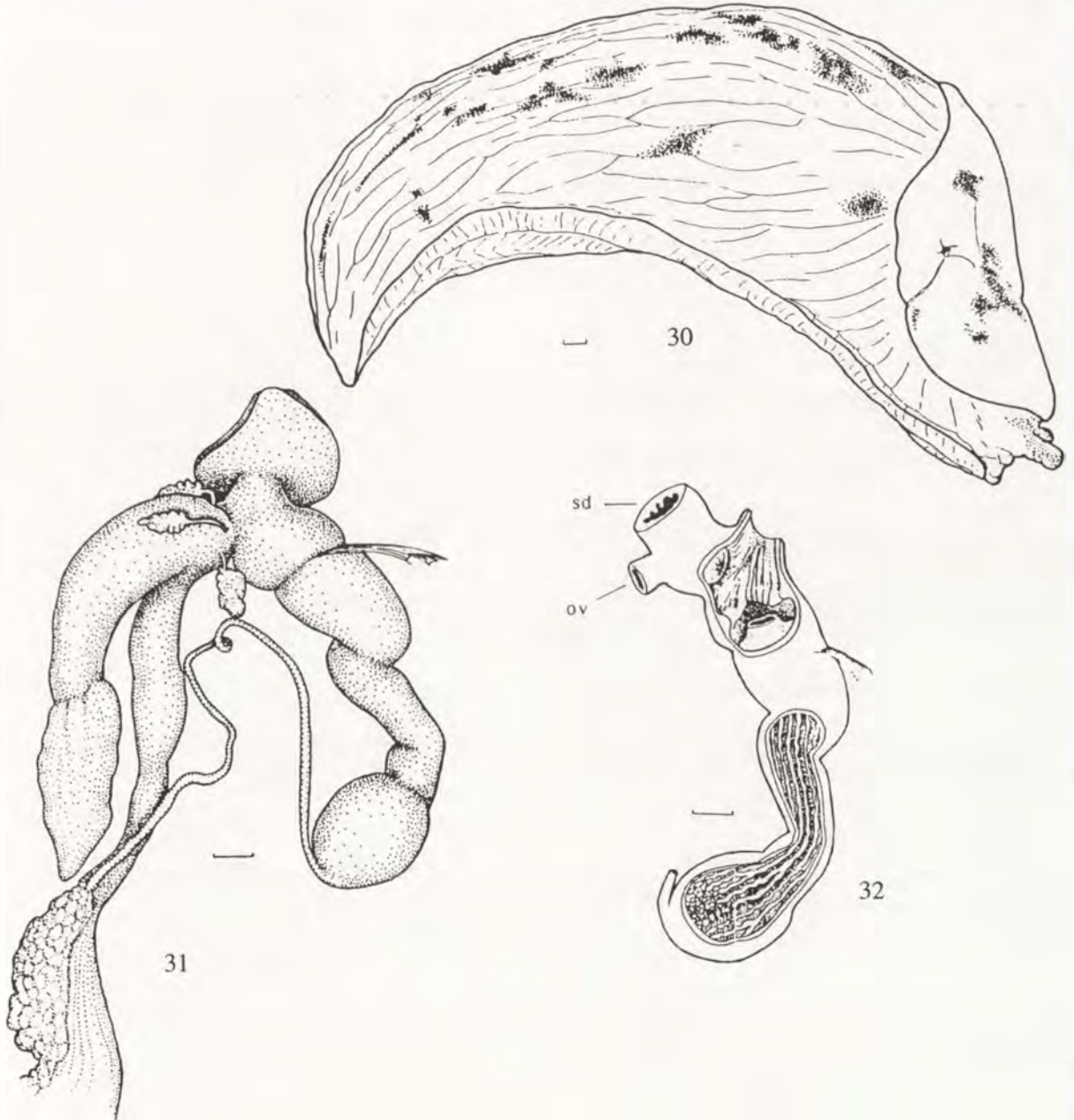
The species is widely spread over the globe, often occurring as a synanthrope. Among other areas, it

inhabits almost the whole of South Europe and partly Central and West Europe.

Examined material collected in the former Yugoslavia: 27 spec.

? Croatia: after Jaeckel et al. (1958): Istra.

Serbia: Beograd, in old fortifications and in a park.



Figs 30–32. *Tandonia cavicola* (Simroth, 1916). 30 – lateral view, specimen from Zavala (Herzegovina). 31 – copulatory organs, specimen from Šipan Isl. (Croatia). 32 – fragment of copulatory organs with structures discernible inside penis and atrium, specimen from Šipan Isl. (Croatia). sd – spermatheca duct, ov – oviductus. (After Wiktor 1982).

Macedonia: Skopje, in the fort ruins in the town; Ohrid, on a town hill with a fort and on rocks; Ohrid, on the lake shore (synanthropic); valley E of Ohrid in the Galičica Massif (synanthropic).

After Wiktor (1982): Sv. Jovan Bigorski monastery.

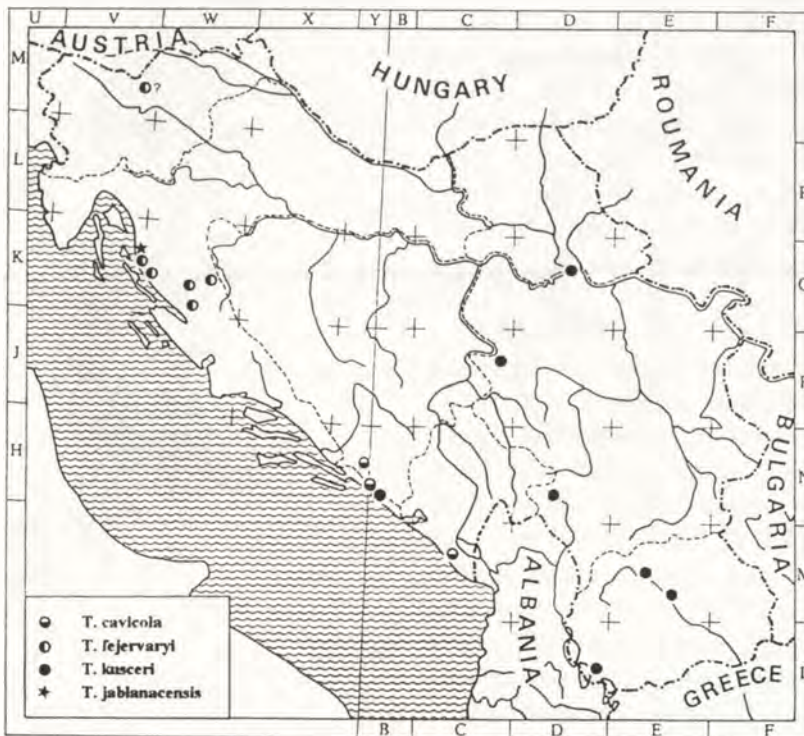
13. *Tandonia cavicola* (Simroth, 1916)

Amalia cavicola Simroth, 1916: 4, Figs 1–2A–C. Locus typicus: Jama na Visokoj (? Dalmatia). Syntypi: no information about preserved syntypes.

The size it can attain is unknown as all the specimens collected are immature. The biggest I know is 65 mm long, 12 mm wide, mantle length 12 mm. According to Simroth (1916), the slug attains up to 72 mm in length. Body rather stocky, skin thick, skin grooves shallow and poorly discernible, 14 of them present between keel and pneumostom. Keel poorly arched, well visible only in the posterior body section. Back and mantle creamy-white, dull creamy, ochreous-creamy, mantle being somewhat darker. On this background darker spots of different intensity, resembling ink splashes, are observable (Fig. 30). Specimens which have no spots, or such in which the

dark brownish pigment is accumulated only in the skin grooves thus forming a reticulate pattern, are also found. Head and tentacles brown. Sole creamy-white.

Genitalia (Figs 31–32). The types have not probably been preserved and the drawing in the paper by Simroth (1916) is very simplified. The specimens I examined that, in my opinion, belonged to this species had a thin vas deferens, which was longer than penis together with epiphallus. Epiphallus elongate, cylindrical, posteriorly club-like enlarged, with many longitudinal folds inside (Fig. 32). Penis short, spherically cylindrical, c. 3.5 times shorter than epiphallus. Papilla penis simple in structure (Fig. 32). A delicate retractor penis attached in a shallow constriction separating penis from epiphallus. Oviductus in the shape of an almost straight tube. In all the specimens I examined the spermatheca was empty, elongated, tapered and sharply ended. According to Simroth (1916), in this species spermatheca may be variable in shape, also spherical. In the specimens I had at my disposal spermatheca duct was thick-walled, longer



Map 4. Distribution of *Tandonia cavicola*, *T. fajervaryi*, *T. kusceri* and *T. jablanacensis*.

than spermatheca container and easy to delimit. Besides, it was discernibly wider than oviductus. Vagina very short, opening to atrium through an inconspicuous papilla (Fig. 32). Accessory glands flat, leaf-shaped, adhering to vagina on its border with atrium.

Spermatophore unknown.

Ecology

Unknown. According to Simroth (1916), the species inhabits caves. The specimens I examined, however, had not been collected in caves.

Distribution

Hardly known, probably confined to the area of the former Yugoslavia (Map 4).

Examined material from the former Yugoslavia: 13 spec.

Croatia: Šipan Isl., leg. L. Drimmer (Nat. Mus., Budapest).

After Wiktor (1982): Šipan Isl. Jaeckel et al. (1958): Dalmatia.

Wagner (1931a and 1931b): S Dalmatia "Vitalin" (?).

Herzegovina: after Wiktor (1982): Zavala.

Montenegro: after Wiktor (1987): Stari Bar.

Comments

Compare the descriptions of *Tandonia croatica*, *T. dalmatina* and *T. lagostoma*.

– *Tandonia cretica* (Simroth, 1885)

Amalia cretica Simroth, 1885: 231 and 339, Pl. 7, Fig. XIX/22A and Pl. 10, Figs XIX/17B, 18C. Locus typicus: Canea (= Khania = Chania, Crete, Greece). Typus: probably does not exist.

Synonyms: *Amalia hellenica* Simroth, 1886; *Milax (Subamalia) taygeticus* Wagner, 1931; *Milax (Subamalia) athenensis* Wagner, 1931 – for more detailed data see Wiktor 1987a.

Wagner (1935) records this species, as *Milax (Subamalia) hellenicus*, from Ragusa (= Dubrovnik). Probably on this basis Jaeckel et al. (1958) mention the slug from Dalmatia (as *M. hellenicus* (Simroth, 1886)). My own research, however, has not confirmed its occurrence in the area of the former Yugoslavia. The species is rather unlikely to occur in this region. If it does, at most it must have been introduced and it is unknown whether it has survived there. Its known distribution range covers the Greek islands, Peloponnesus and southern part of continental Greece, more or less up to the Parnassus Mts (Wiktor in print). Whether the slug occurs in Dalma-

tia needs confirmation. In all likelihood it was a wrong information and that is why I do not include *T. cretica* within the slug fauna of the former Yugoslavia.

14. ?*Tandonia croatica* (Wagner, 1929)

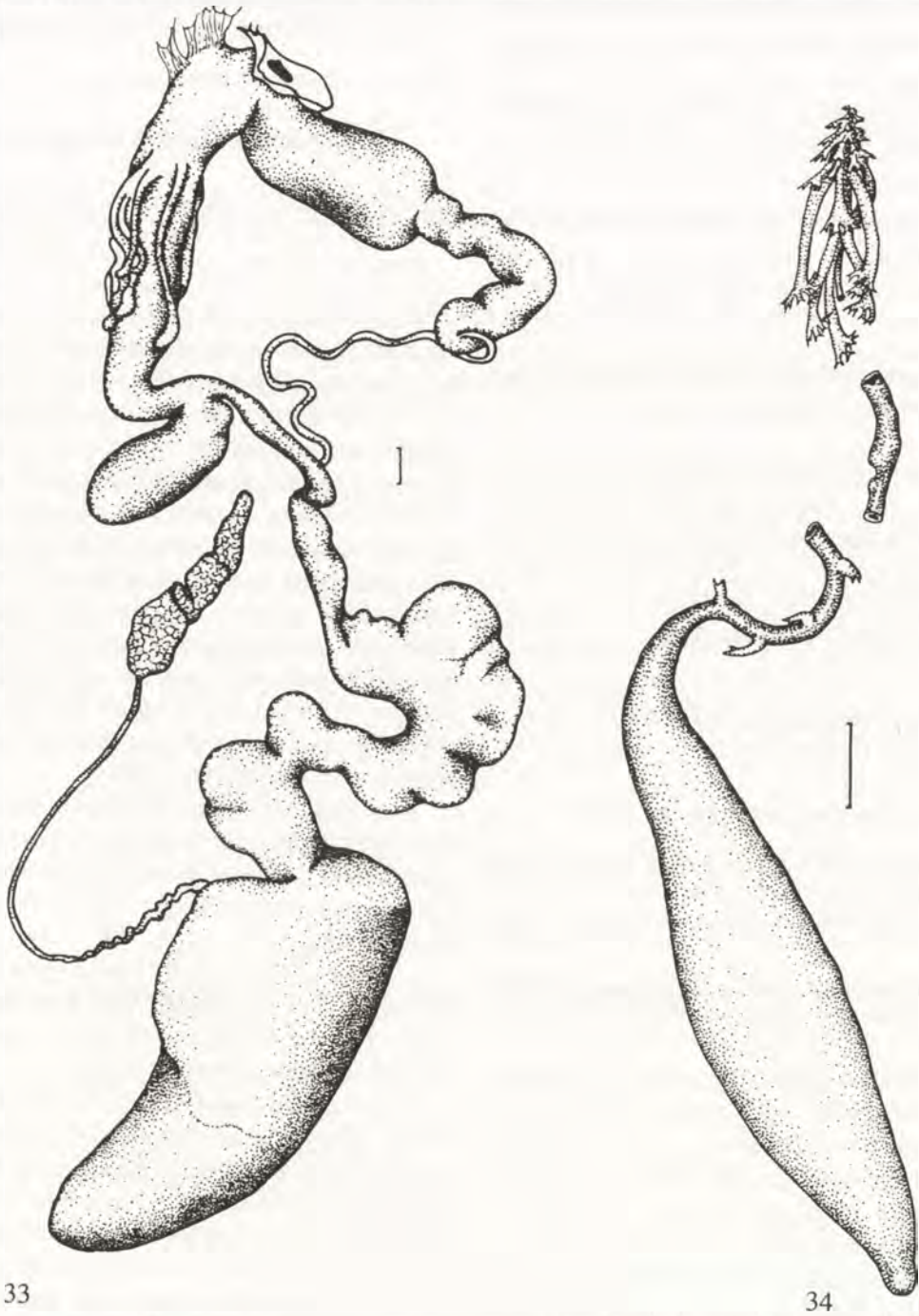
Milax (Milax) croaticus Wagner, 1929: 333, Fig. 3. Locus typicus: Mali Alan Mt. (= Mali Halan, Velebit Mts, Croatia). Holotypus: probably burnt with the Budapest collection.

A taxon of very unclear systematic position. Its description concerned only the external appearance, the anatomy still being unknown. It is even difficult to establish whether the slug described and drawn by Wagner was a *Tandonia* or *Milax*. I failed to find the holotype, which had probably got burnt with the Budapest collection. However, I managed to find one juvenile specimen identified by Wagner, which had been preserved in a small collection kept with his family. Still, it is not the type. It is a juvenile, collected near the type locality 8 days after the type had been collected, which was not dissected by Wagner (Wiktor 1987a). I was looking for this slug in the region of terra typica in vain; I failed to collect any specimen of similar characters.

At present, before the anatomy of specimens from locus typicus referable to Wagner's description (1929) is examined, it cannot be established whether *T. croatica* is a distinct species or whether the name is merely a synonym.

In order to make identification easier, I quote the distinctive characters mentioned by Wagner (1929), which may be helpful when further attempts to resolve this problem are undertaken.

Slug with back uniformly dark grey-brown (grau-braun). Sides downwards becoming gradually paler to yellow. Body parts under mantle also light yellow. Mantle dark-coloured like back. Keel visible on the whole back from mantle to the body end, the same colour as back. Sole divided by deep grooves (Furchen), its mid-band coffee-brown (kaffeebraun), lateral stripes ochrous (ocker), of the same colour as lower side parts. Wagner states that the species he describes is similar to *M. dalmatinus* (*Tandonia dalmatina*) but devoid of spots that are characteristic of the latter slug.



Figs 33–34. *Tandonia fejevaryi* (Wagner, 1929). 33 – reproductive system, specimen from Jablanac, Velebit Mts (Croatia).
34 – spermatophore, specimen from Jablanac (Croatia). (After Wiktor 1987a, 1987b).

Sources that mention this slug are the following: Wagner (1930a and 1935): Mali Alan. Jaeckel et al. (1958): Croatia. Wiktor (1987a).

15. ?*Tandonia dalmatina* Simroth, 1900

Amalia dalmatina Simroth, 1900: 106. Locus typicus: Ragusa (= Dubrovnik, Hrvatska = Croatia). Syntypi: probably do not exist.

The slug was described only in respect of its external appearance. What is more, no drawing was provided. All the subsequent records on this slug are not certain and do not contribute, except for the information about new localities. The systematic position of this species is unclear and its distinctness doubtful. The information on this slug may actually concern a non-typical colour form of another species. During my own research conducted in the environs of Dubrovnik I failed to collect any slug with characters described by Simroth (1900).

The data below are quoted after Simroth (1900). The biggest specimen used for the purpose of description of the species was sexually immature. It was 47 mm long. Body narrowed only at the very posterior end (bis hinten gleichmässig dick). Coloration: reddish-ochrous (fleischig ockerig). Mantle unicolour (without lateral streaks or any other pattern!). Back and sides covered with small, sharply outlined many-sided (eckige) black spots (Spritzflecken), bigger than in "*Amalia marginata*" (*Tandonia rustica*), looking like fly specks, loosely scattered in grooves of the skin sculpture, occurring at $\frac{1}{3}$ of the length.

Genitalia, spermatophore, bionomics, distribution – unknown.

Mentions of this taxon can be found in the following publications: Simroth 1909 (Dubrovnik), Wagner 1931b (Dubrovnik), Wagner 1940 (Croatia – Curzola = Korčula Isl.; Torcola = Šćedro Otok Isl.; Lesina = Hvar Isl., near the spring of Ombla = Dubrovnika rijeka near Gruž), Jaeckel 1954 (Sabioncello = ? Orebić on Pelješac Peninsula, Dalmatia), Jaeckel et al. 1958 (Dalmatia), Wiktor 1982 (? Macedonia – S of Ohrid).

Comments

See the comments and description on *T. cavicola*, *T. croatica* and *T. lagostoma*.

16. *Tandonia fejervaryi* (Wagner, 1929)

Milax (Submalia) Fejervaryi Wagner, 1929: 331. Figs 1–3. Terra typica: Velebit Mts (Croatia). Lectotypus: a specimen from Mali Alan (= Mali Halan) in coll. J. Wagner, Budapest.

Milax (Milax) Adensameri Wagner, 1931b: 62, Figs 6–7. Locus typicus: Obrovazzo (= Obrovac, S Velebit Mts, Dalmatia, Croatia). Lectotypus: Naturhist. Mus., Wien, no. 41217.

Body length up to 52 mm, width to 12 mm, mantle length to 16. Body nearly cylindrical, terminally abruptly narrowed. Keel poorly marked, sometimes detectable only at the posterior body end. Skin sculpture delicate. The whole body, including head, dorsally deeply black. In some specimens sides slightly paler. Sole whitish, creamy or light-coffee. Mucus colourless, irritated slugs additionally secreting a thick, opaque, light aquamarine slime.

Genitalia (Fig. 33). Vas deferens very thin. Epiphallus cylindrical, sometimes with small swellings, its posterior end narrowing abruptly. Vas deferens opens apically to epiphallus. Inside the latter organ dense, sharp-pointed papillae. Penis elongated, roughly cylindrical. Papilla inside penis half-spherical, uncomplicated in structure. The interior penis walls covered with papillae that are similar, though finer, to those occurring inside epiphallus. Retractor, which in Milacidae is usually attached at the constriction on the border between epiphallus and penis, in *T. fejervaryi* is very delicate and inserted a little more posterad and to the epiphallus wall. Oviductus short, tubular. Spermatheca thick-walled, elongated, without a distinct spermatheca duct (!). Vagina very long (!) with longitudinal wrinkles inside its posterior half. Their arrangement suggests that functionally one part of this section is connected with oviductus while the other with spermatheca (Fig. 33). The inside walls in the anterior part of vagina are padded with dense, sharp-pointed papillae. Accessory glands, in the form of thin filamentous tubes (!) adhering closely to vagina walls, open on the border between vagina and atrium. The latter organ is so short that it is difficult to establish its confines. A well developed musculus retractor penis is partly attached to vagina.

Spermatophore (Fig. 34). The very typical spines, in a part elongated, occur only in the anterior, flagelliform section of spermatophore while a slightly wider container has a completely smooth surface, devoid of any spines.

Ecology

The hitherto made observations reveal that *T. fejevaryi* is a lowland species, associated with the Mediterranean climate. It inhabits the utmost xerothermic biotopes on calcareous substratum, where the vegetation cover is very poor. It is active at night and, as I have established, even at places where it is relatively abundant during the night mist, in the daytime it is extremely difficult to find. It hides in rock crevices.

Distribution

All the localities confirmed are in the Velebit Mts area or in the close vicinity of this mountain range (Dalmatia, Croatia) (Map 4).

Examined material: 45 spec.

? Slovenia: after Altena (1977 as *Milax* cf. *adensameri* H. Wagner) – Kamniška Alpe, northern slope along the path eastward of Cajzova Koča to Kamniška Bistrica, 1550 m a.s.l. See the comments!

Croatia: Jablanac, Velebit Mts, in a narrow bay, on a cliff (reservation), limestone, extremely dry biotope; above Karlobag in a dry gorge, Velebit Mts, Ulmus forest, limestone; Obrovac, Velebit Mts, in the ruins of a mediaeval castle, 300–500 m a.s.l., limestone, very dry biotope.

After Wagner (1929): Dalmatia – Mali Alan (= Mali Halan), Velebit Mts; Karlobag, Velebit Mts; Basača Mt., SE of Nebljusi. Wagner (1931b): Obrovac. Wagner (1935): Obrovazzo (= Obrovac – as *M. adensameri*). Jaeckel et al. (1958): Dalmatia (as *M. adensameri*) and Istra (as *T. fejevaryi*).

Comments

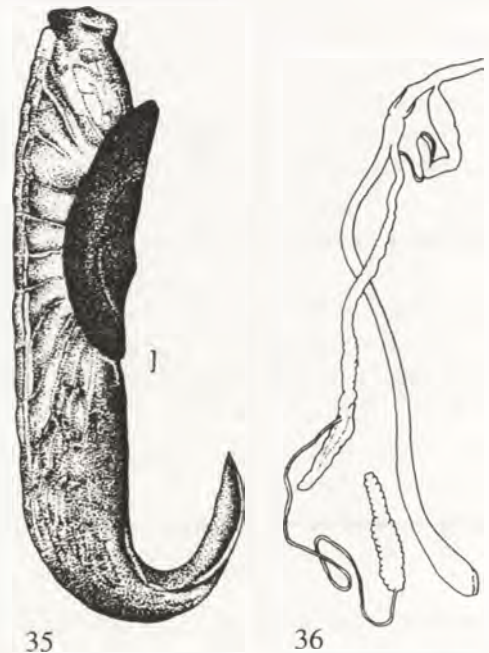
The occurrence of *T. fejevaryi* in the Velebit Mts has been unequivocally confirmed during my own field research. The locality on Basača Mt., a small distance NE of the Velebit Mts, creates no doubts. I doubt, however, the information by Jaeckel et al. (1958), who record this species from the Istra Peninsula. I suppose it is a pure misprint, i.e. placement of the mark in a wrong, neighbouring section of the table.

As far as the locality in Slovenia (after Altena 1977) is concerned, I have no decided opinion. Altena himself (1977) had some doubts. It is still unknown which species he actually examined. Judging from the drawings, it may have been quite a different slug, e.g. *T. robici* or *T. simrothi*.

17. *Tandonia jablanacensis* (Wagner, 1930)

Milax (Macrothylacus) jablanacensis Wagner, 1930a: 46, Figs 1–3. Locus typicus: Jablanec, Živi bunari (Velebit Mts, Croatia). Syntypi: 2 specimens probably burnt with the Budapest collection where they were kept.

A slug known only from the description by Wagner (1930a, 1930c, 1935). All former mentions and descriptions (including mine: Wiktor 1981, 1987a) are based exclusively on Wagner's observations. I do not know the source of the information given by Jaeckel et al. (1958) about the occurrence of this species in the area of Istra. My own search in the region of locus typicus as well as in the preserved collections has been unsuccessful.



Figs 35–36. *Tandonia jablanacensis* (Wagner, 1930). 35 – lateral view. 36 – reproductive system. (After Wagner 1930c; slightly changed, types).

After Wagner: body slender, up to 48 mm in length, width measured at mantle to 9.5 mm, mantle length to 13.5 mm. Keel well-developed and distinct along the whole of back (Fig. 35). Mantle and back medially black. Outer edges of mantle grey-yellow. Neck and the part covered by mantle ochrous, body

sides downwards gradually lighter, also ochrous-coloured. Sole medially yellowish (blassgelb), its edges grey-yellow.

Genitalia (Fig. 36). Glandula hermaphroditica, ductus hermaphroditicus and glandula albuminalis strongly elongate. Epiphallus cylindrical, longer than penis. The latter organ also cylindrical, about twice wider than epiphallus. Oviductus short, tubular. Spermatheca monstrous, almost twice longer than spermoviductus, and somewhat wider, gradually widening posteriorly and ending with an oval distension (!). Yet clear distinction into container and spermatheca duct is lacking. Vagina tubular, long in comparison with this organ in other species. Accessory glands like small tubular processes. Atrium tube-shaped.

Spermatophore, ecology and distribution (see Map 4) unknown.

Comments

In the small collection preserved by Wagner's family, there was a container with a juvenile slug

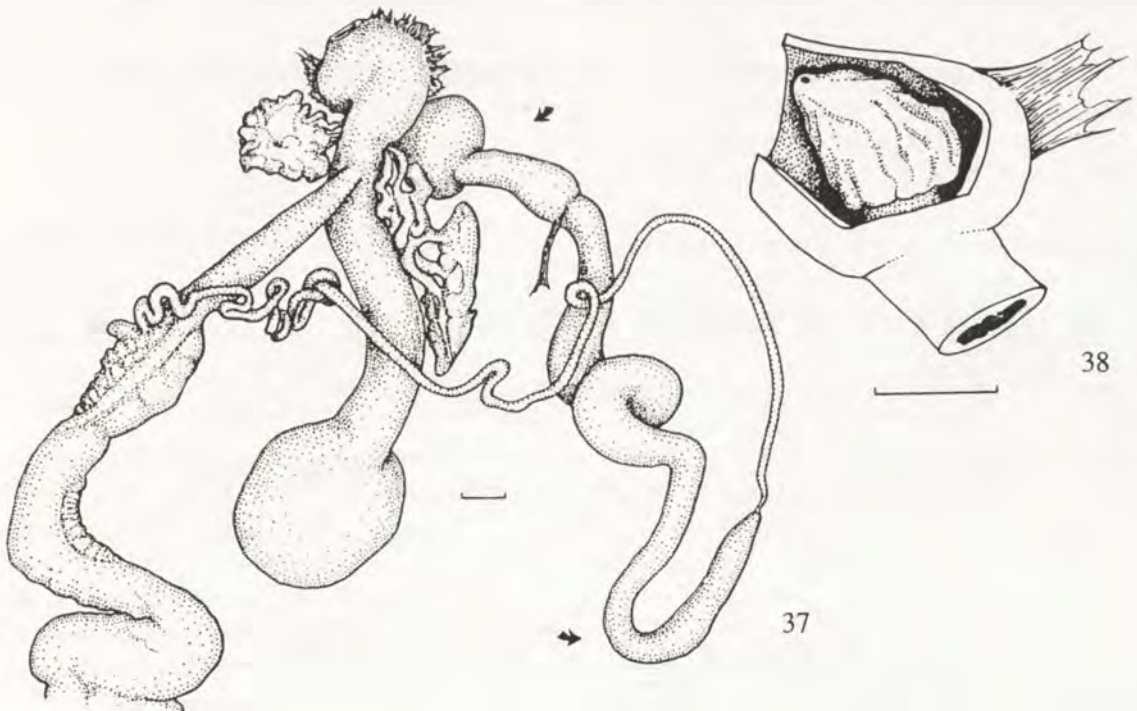
from Jablanac. In the container there were two labels, written in the same (? Wagner's) handwriting, one of them reading: "*Milax jablanacensis* H. Wagn., Jablanac, leg. Pedewieth", the other: "*Milax reuleauxi*". The slug had no characters of *T. jablanacensis*, and it was probably *T. fejervaryi* (see Wiktor 1987a).

When compared with other representatives of the family, *T. jablanacensis* is a species of exceptionally marked distinctive features. What is more, there is nothing about the specimen from Wagner's collection that might seem anomalous. The drawing of the genitalia suggests that the specimen described was relatively young and had probably not copulated yet.

T. jablanacensis is species typica for the subgenus *Macrothylacus* Wagner, 1931. Having revised the whole family, I can see no grounds for such a subgenus to be distinguished (Wiktor 1981, 1987a).

18. *Tandonia kusceri* (Wagner, 1931)

Milax (Milax) Kusceri Wagner 1931b (Nachtrag): 72, Figs 1-2.



Figs 37-38. *Tandonia kusceri* (Wagner, 1931). 37 - copulatory organs. (After Wiktor 1983, specimen from Bulgaria). 38 - papilla inside penis. (After Likharev, Wiktor 1980, specimen from Bulgaria).

Locus typicus: Svetka Petka (Sveta Petka), near Niš (Serbia).
Holotypus: Naturhist. Mus., Wien, no. 50450(1) (see also
Wagner 1931a: 200).

Milax rusticus longipenis Grossu et Lupu, 1961b: 137, Figs 6–7.
Locus typicus: Babadag (N Dobrudzha, Roumania). Holo-
typus: Mus. Nat. Hist. "Gr. Antipa", Bucharest, no. 13109.

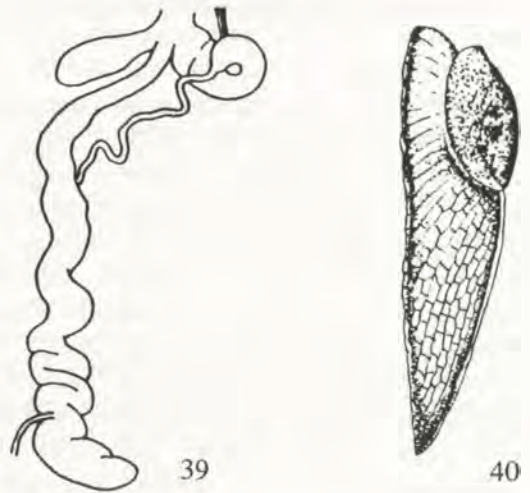
Milax rusticus f. *balcanicus* Grossu et Lupu, 1961b: 139. Locus
typicus: Comorova (SW Dobrudzha = Dobrudja, Roumania).
Holotypus: Mus. Nat. Hist. "Gr. Antipa", Bucharest, no.
13126.

Milax (Milax) bojanensis Hudec, 1964: 187, Fig. 1. Locus typi-
cus: the garden near Bojanska cerkva, Bojana (near Sofia,
Bulgaria). Holotypus: Senckenberg Mus., Frankfurt a/M., no.
175690.

References – see Wiktor 1987a.

Body length up to 65 mm, width 15 mm, mantle
length c. 20 mm. Big specimens can stretch up to
c. 100 mm when crawling. Keel, quite distinct in live
slugs, after preservation may become poorly detect-
able. Coloration of live slugs pink-brown or ash-grey-
pink with many small blackish spots of diffuse edges.
During preservation the coloration changes: it fades
becoming yellowish or brownish and the blackish
pattern gets still more diffuse. Granules of the dark
pigment are concentrated in the skin grooves which
results in a dark reticulate pattern on body. Keel al-
ways pale (without spots), owing to which it con-
trasts with a slightly darker back. Irregular dark lat-
eral streaks well distinguishable on mantle. Sole
mucky creamy. Caution! The hue of coloration as
well as the type of pattern widely varied, even within
the same population. Mucus thick, colourless. When
the slug is irritated an opaque, milky-white secretion
appears on its whole body.

Genitalia (Figs 37–38). Vas deferens very long,
thin and coiled. It opens apically and symmetrically
to epiphallus. Epiphallus tubular, occasionally incon-
spicuously broadened medially, very long and coiled.
It is usually 5–6 times longer than penis (!). A slight
constriction present on the border between epiphallus
and penis. Penis divided in two parts: the posterior
one is cylindrical or club-like while the anterior –
more or less spherically distended. The distended part
confines a typical, cone-shaped, plicate papilla (Fig.
38). Musculus retractor penis very thin, easy to over-
look during dissection, attached in the constriction
between epiphallus and penis. Oviductus straight,
long, tubular. Spermatheca roughly spherical, sperma-



Figs 39–40. *Tandonia lagostoma* (Wagner, 1940), speci-
mens from Lastovo Isl. (Croatia). 39 – reproductive sys-
tem. 40 – lateral view. (After Wagner 1940).

theca duct thick, tubular. Vagina short but well
marked. Lobe-shaped accessory glands open into it
through thin ducts. Atrium very short.

Spermatophore so far not described in spite of the
fact that I have myself examined rich material of this
slug.

Ecology

A species of a great ecological tolerance. It occurs
in environments of different humidity, in bush thick-
ets, forests and open biotopes, most willingly among
rubble. Most often it is found in great numbers. It
has a clear predisposition towards synanthropization.
In the mountains it reaches 1250 m a.s.l.

Distribution

The species inhabits mainly Bulgaria and Rouma-
nian Dobrudja, is also recorded from Turkey and
Odessa (Ukraine). In the area of the former Yugosla-
via it seems indigenous only to Serbia and Macedo-
nia, particularly the regions bordering on Bulgaria
(Map 4). In the remaining parts of the former Yugo-
slavia it is found as an introduced synanthrope.

Examined material from the former Yugoslavia: 28 spec.

Serbia: Beograd, old fortifications and a park; Titovo Užice, en-
vironments of the city, 600 m a.s.l., limestone; Peć (Kosovo), in
the town (synanthropic).

After Jaeckel et al. (1958): Serbia. Frank (1991): Niš.

Macedonia: Skopje, fort ruins in the town; Jakupica Mts, in the Kadina river valley above village Zelnikovo.

After Jaeckel et al. (1958): Macedonia. Wiktor (1982): Ohrid, in a park.

Croatia: after Wiktor (1982): Dubrovnik, Lapad, garden.

Comments

See the comments on *T. serbica*.

19. ?*Tandonia lagostoma* (Wagner, 1940)

Milax lagostomus Wagner, 1940: 138, Figs 5.8. Locus typicus: Lagosta Isl. = Lastovo (Croatia). Syntypi: probably do not exist.

A species described on the basis of a juvenile specimen. Afterwards it has never been collected again. I have failed to find the type. I have not collected in locus typicus.

According to Wagner (1940), it is a big slug, up to 70 mm long (although it was not sexually mature yet), to 17 mm wide, mantle length to 22 mm. Coloration reddish-ochrous (fleisch-ockerig) with a darker, brownish-violet (bräunlich-violett) back. Sides downwards gradually paler, but the dark pigment is accumulated in the skin grooves producing a reticulum which Wagner compares with the body pattern in *Deroceras reticulatum* (Fig. 40).

Genitalia (Fig. 39). Both syntypes were juvenile. Vas deferens opens apically, nearly symmetrically. Epiphallus cylindrically conical, spirally coiled. Penis rounded. Oviductus tubiform. Spermatheca elongatedly oval, set on a very short spermatheca duct. Nothing is known about the structure of accessory glands and the place where they are situated. Atrium very short.

Information on mucus, spermatophore, ecology and distribution is lacking.

Comments

For the present nothing concrete can be said about this taxon. Judging from the description, it must bear a similarity to *T. cavicola* (see above), which is manifest in the case of some specimens from Šipán Island. Moreover, a similarity in the genitalia of juveniles exists as well. Compared with Wagner's description, *T. croatica* and *T. dalmatina*, other mysterious species, seem also similar to *T. lagostoma* (see above).

During my field studies I found big (35–40 mm long after preservation), flesh-orange or beige slugs between the town of Knin and village of Krčić in the Krka river valley, and above the town of Makarska in the Biokovo Massif (both are Dalmatian localities). Although they were big, all the specimens were juvenile, with their genitalia not yet developed, and thus I was unable to identify them. They may have been the slugs Wagner had called *M. lagostomus*.

20. *Tandonia macedonica* (Rähle, 1974)

Milax (Subamalia) macedonicus Rähle, 1974: 51, Figs 1a–f. Locus typicus: N slope of the Galičica Mts, S of Peštani (Mace-



Fig. 41. *Tandonia macedonica* (Rähle, 1974) – lateral view, specimen from Trepka, Galičica Mts (Macedonia).

donia). Holotypus: Senckenberg Mus., Frankfurt a/M., no. 230842.

Body length of preserved specimens up to c. 35 mm, width up to 10 mm, mantle length to 12 mm. Body slim. Keel, though relatively low, well discernible along the whole back. Coloration variable, also within a population. The commonest colour form is black. Such slugs have no pattern on the body, although when back is deeply black, sides get downwards paler, greyish, sole being creamy (Fig. 41). Apart from the dark forms, there are also coffee-coloured, blackish-coffee and brown-reddish ones, in all of them sides being lighter as well. In the lighter forms, i.e. not deeply black, a dark, black or blackish, pattern is most often present on back and mantle and partly on sides too. The pattern results from accumulation of pigment in the skin grooves, which produces a kind of reticulum. One can also find specimens in which, beside the pattern described above, there are irregular, bigger dots on the body as well. Sole creamy in colour. In the black forms keel is not distinguishable by colour from the rest of back whereas in the lighter ones it is most often paler than the rest of back. Mucus colourless, irritated slugs producing also an opaque, white secretion.

Genitalia (Figs 42–45). Vas deferens opens apically and symmetrically. Epiphallus cylindrically claviform, thick-walled. Penis of irregular shape, cylindrical. Inside epiphallus longitudinal structures. Inside penis, on the borderline between epiphallus and penis, there is a typical papilla in the shape of a mushroom on a long stem (!) (Figs 43–45). The opening of the papilla is situated laterally, at the base of the "cap". Retractor delicate, easy to overlook, attached to the epiphallus wall. Oviductus longer than epiphallus, in the shape of a tube. Spermatheca oval, usually tapering posteriorly. Spermatheca duct longer than penis and epiphallus together, forming a tube slightly widened anteriorly. Vagina very short. Accessory glands in the form of 3–5 lobe-shaped structures, adherent to spermatheca duct and oviduct, that are connected with vagina by means of thin canals. Atrium very short, irregular in shape.

Spermatophore (Fig. 46) with a long flagellate part and at least three different types of hooks.

Ecology

It occurs in rocky, calcareous and bush-covered environments. In the mountains it was collected up to 1700 m a.s.l. The fact that I found spermatophores in May indicates that in this period copulation must take place.

Distribution

It is probably an endemic of the environs of Lake Ohrid (S Macedonia) (Map 5) as its occurrence has been ascertained only in this region so far.

Examined material: 90 spec.

Macedonia: Lake Ohrid shore, synanthropic; shoulder and slope of the Galičica Massif above Lake Ohrid, 900–1560 m a.s.l., limestone; Gola Buka, Galičica Massif (SE of Lake Ohrid), *Fagus* forest, 800–1700 m a.s.l., limestone.

After Rähle (1974): N slopes of the Galičica Massif. Wiktor (1982): Galičica Mts – near Lake Prespansko, near Trepka, environs of Lake Ohrid; Sv. Stefan, S of Lake Ohrid.

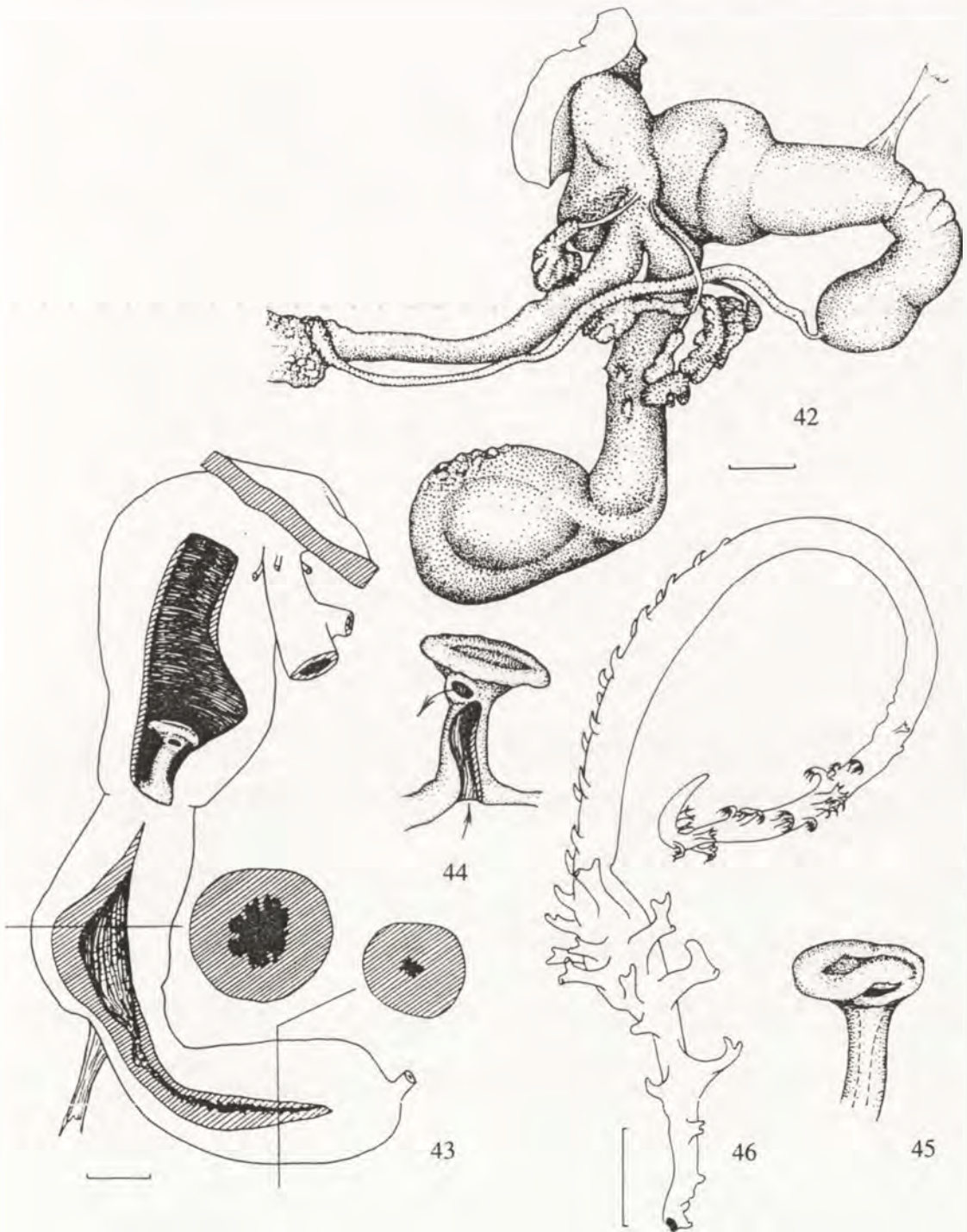
Comments

A slug very similar to several other *Tandonia* species, especially to *T. albanica* (from which it does not differ externally); the two species may co-occur. *T. macedonica* definitely differs from all the other species of the genus in its mushroom-shaped papilla inside penis and in the appearance of spermatophore. In comparison with *T. macedonica*, *T. albanica* has a shorter and thicker, in proportion to other organs, epiphallus, which most often is provided with two nodules at the posterior end (compare the descriptions and drawings).

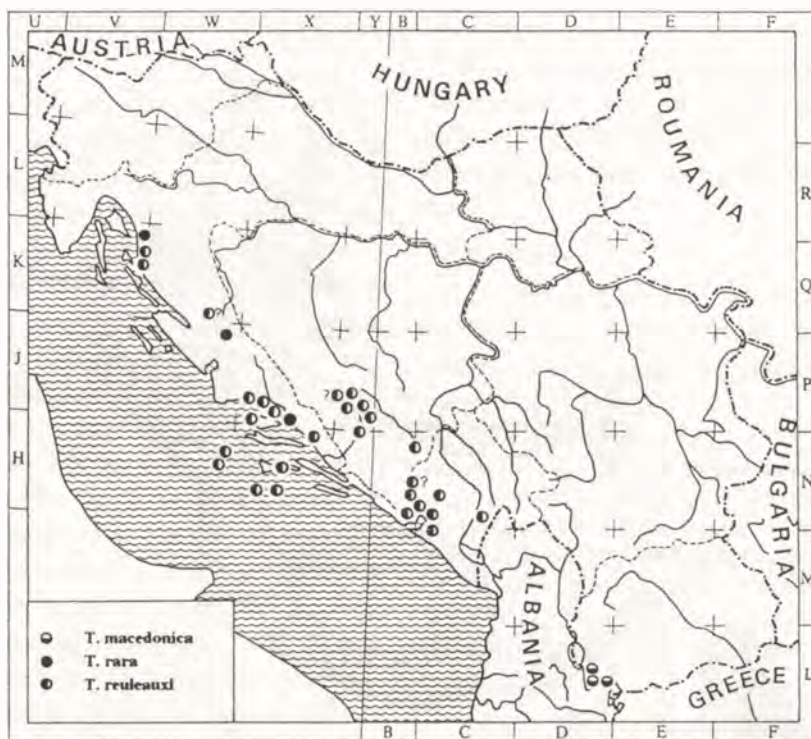
– ?*Tandonia montenegrina* (Simroth, 1900)

Amalia montenegrina Simroth, 1900: 107. Terra typica: Dalmatia and Montenegro (Kotor, Žabljak. ? Bazar, Rijeka). Syntypi: probably do not exist.

I have failed to find out which slug was named so by Simroth. The description by this malacologist (Simroth 1900) is completely unclear, i.e. it may also concern several other slugs, those later named as well. The author did not enclose drawings into his paper, and I have not succeeded in finding the types. My own search for a slug which would entirely correspond to the description of *T. montenegrina* conducted in the environs of all the localities mentioned by Simroth (except for Bazar) was unsuccessful.



Figs 42–46. *Tandonia macedonica* (Rähle, 1974). 42 – copulatory organs, specimen from Trepka, Galičica Mts (Macedonia), spermatophore visible inside spermatheca. 43 – epiphallus and penis with discernible internal structures (inside penis a mushroom-like papilla), and cross-sections of penis and epiphallus, specimen from Trepka (Macedonia). 44–45 – penial mushroom-like papillae, the same specimen from Trepka and a specimen from Gola Buka (Macedonia). 46 – spermatophore, specimen from Galičica Mts (Macedonia).



Map 5. Distribution of *Tandonia macedonica*, *T. rara* and *T. reuleauxi*.

Thus, the status of this name still remains unclear to me. Neither can I say whether it is a synonym of another species or whether it has been named again afterwards. It is very probable that the slugs Simroth dealt with were juvenile forms.

In Simroth's description (1900) the following distinctive characters of this slug were mentioned among others: body length at least up to 42 mm, keel detectable along the whole back, coloration different in hue depending on the locality: from evenly black (reinschwarz), blackish-grey (grauschwarz) to dirty grey (schmutziggrau) and brownish (bräunlich), the latter two without accumulations of the dark pigment in the grooves on mantle.

Genitalia (according to Simroth). Vas deferens varied in length. Epiphallus evenly cylindrical, straight or bent. Penis in all specimens very short. Spermatheca (receptaculum) proportionally big, rounded, thick-walled, in some specimens set on a relatively long spermatheca duct whereas in others on a flagellate organ of that type. Oviductus laterally connected to that organ. Accessory glands (Drüsen-

schlauche des Atriums) (Simroth defines as atrial glands all the accessory glands in this part of genitalia, no matter if they open to atrium, to vagina or to the border area between those organs) in the shape of very small skeins (Päckete) resembling entomological pinheads (Insektennadelkopf) (!).

Distribution

Bosnia: after Wagner 1931b: Čelebić, Koinsko polje.

Croatia: after Wohlberdt 1901: Rijeka. Wagner 1935: Rijeka, Vir Bazar. Jaeckel et al. 1958: Dalmatia.

Montenegro: after Wohlberdt 1901: Žabljak, ? Vir Bazaar (? Virpazar). Simroth 1909: Medun near Podgorica (= Titograd), Bioče near the Morača river valley. Wagner 1931b: Ivanova Aluga near the Lovćen Mts. Wagner 1935: Kotor, Žabljak; Wagner 1940: Lovćen Mts. Jaeckel et al. 1958: Montenegro.

Comments

Simroth (1900) notes that the anatomy of *T. reuleauxi* is not known. Mentioning this species, he clearly implies a similarity between the newly described slug, i.e. *T. montenegrina*, and *T. reuleauxi*. Nowadays, the anatomy of *T. reuleauxi* is already well

known and the description by Simroth suggests that it was this species (juvenile specimens) that he actually dealt with. Obviously, there is no absolute certainty about it and the issue will probably never be resolved entirely. Therefore, in my opinion, the name "*T. montenegrina*" should be treated as a probable synonym of *T. reuleauxi* (see the description of this species on p. 43).

21. *Tandonia rara* n. sp.

Caution! As *Tandonia schleschi* partim in Wiktor 1982: 475, Fig. 13 and Wiktor 1987a: 292, Figs 201–203, 205–207.

Diagnosis: A black slug with creamy sole. Accessory glands in the shape of digitate processes. Spermatheca oval, set on spermatheca duct, the latter organ roughly equalling spermatheca container in

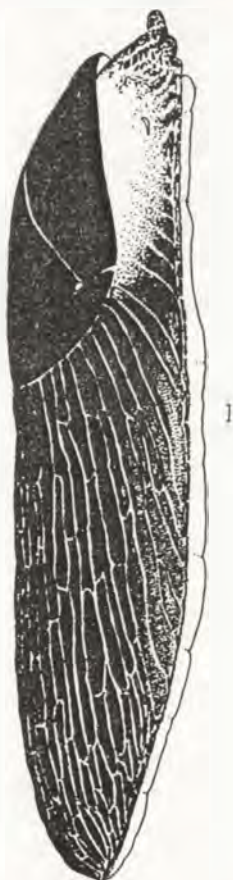


Fig. 47. *Tandonia rara* n. sp., paratype from Makarska (Croatia) – external appearance. (Caution! The drawing was published in Wiktor 1987 as *Tandonia schleschi*!).

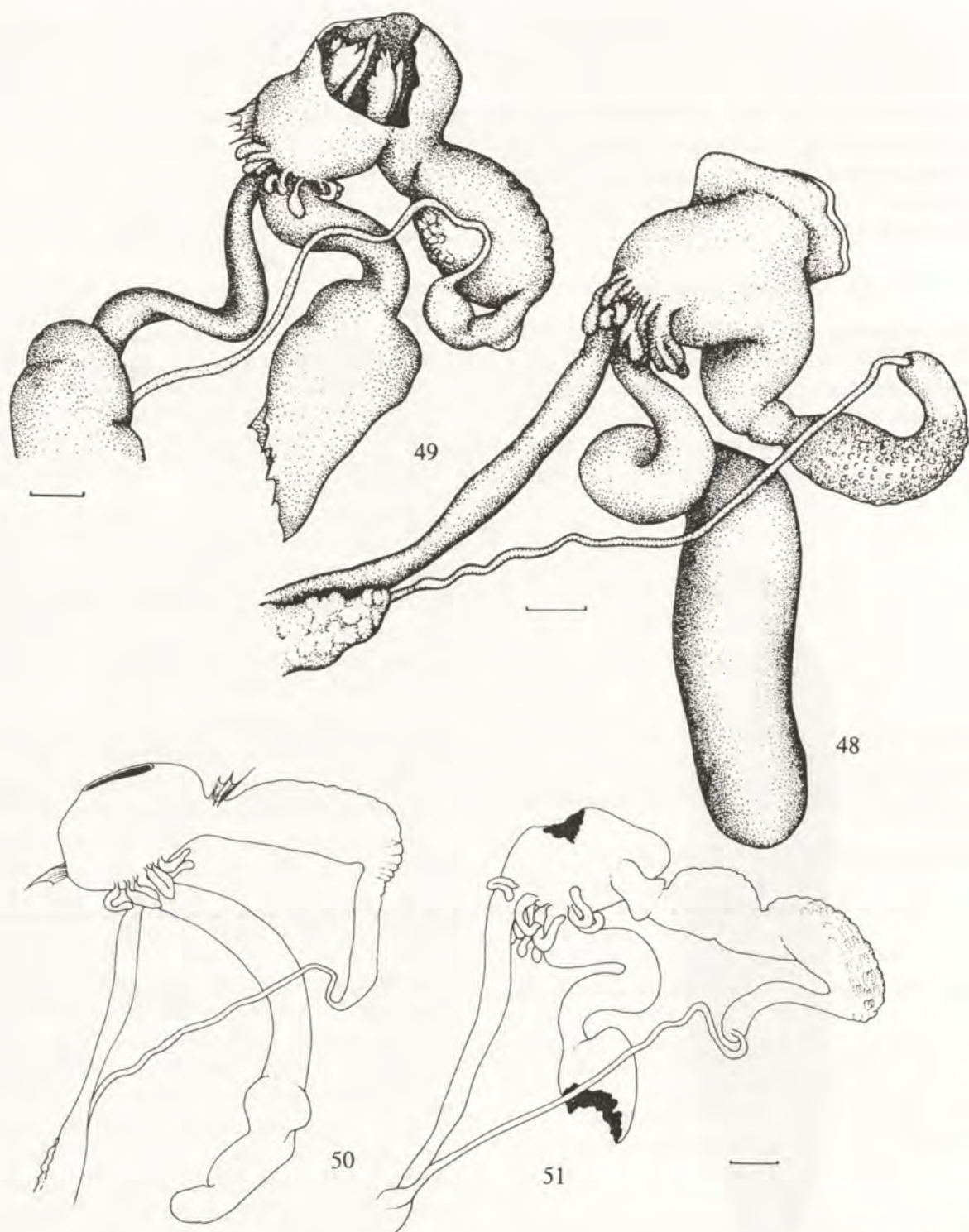
length. The two organs, i.e. spermatheca and spermatheca duct, are almost twice as long as penis along with epiphallus. Inside oviductus on the border with atrium large, hard, flattened structures with one side serrated, the sharp endings directed towards atrium (!)

Holotypus: town Knin, Croatia, c. 200 m a.s.l., limestone, synanthropic. Leg. A. Wiktor 31.05.1982. Mus. Nat. Hist., Wrocław, no. MP 647.

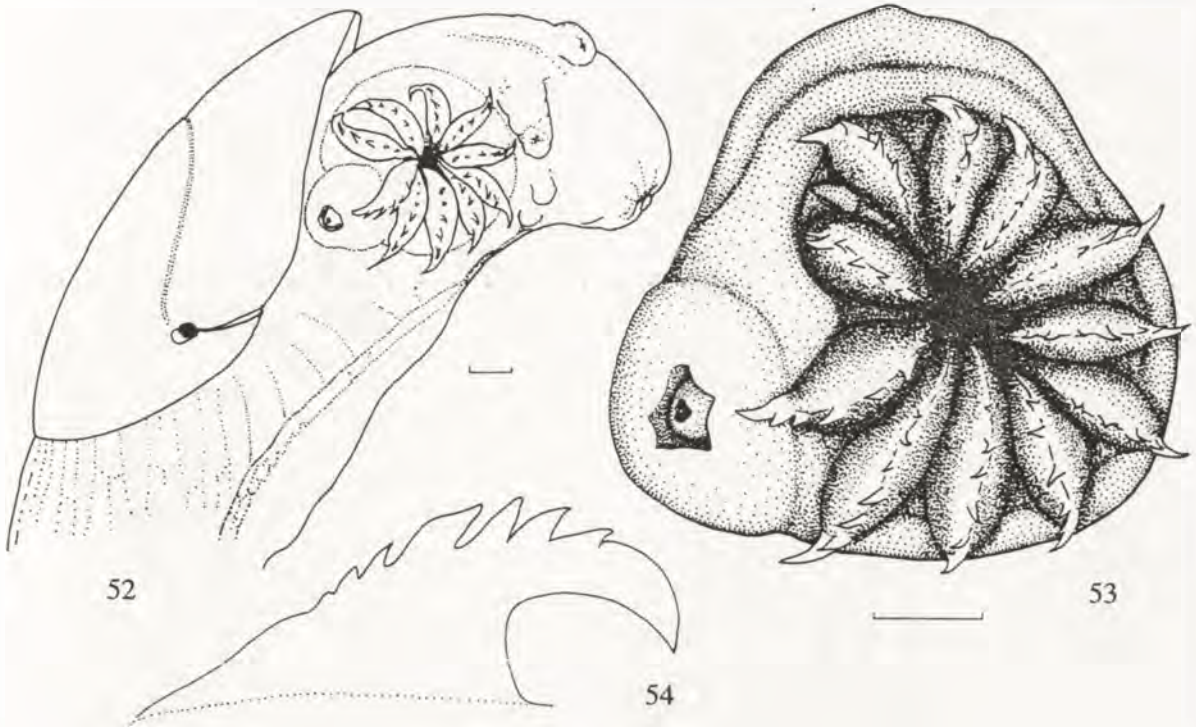
Paratype: in Mus. Nat. Hist., Wrocław – collected with the holotype – 5 specimens; Makarska (Croatia, Dalmatia), Biokovo Massif above the village, c. 600 m a.s.l., limestone, leg. A. Wiktor 2.06.1982 – 3 + 7 juv. specimens; Senj (Croatia, Dalmatia), Senjsko Bilo Mts. above the town, *Pinus-Ulmus* forest, below 650 m a.s.l., limestone, leg. A. Wiktor 25.05.1982 – 2 juv. spec.; in Mus. and Inst. Zool. Pol. Ac. Sc., Warsaw – Makarska (Croatia), leg. A. Jankowski 3.07.1929 – 2 + 1 juv. spec.

The length of preserved specimens up to 45 mm, width 9 mm, mantle length 15 mm. Body slim, keel poorly developed, in some preserved specimens discernible only on a part of back. Back, sides and head evenly black, sole creamy but often with blackish fringes (Fig. 47). Juveniles occasionally blackish. Mucus coloration unknown.

Genitalia (Figs 48–54). A thin vas deferens opens apically and symmetrically. Epiphallus cylindrical, less commonly insignificantly club-like widened, usually bent. Its borderline with penis difficult to define as different types of constriction may be present on this organ at different places. In a number of specimens inconspicuous papillae (!) discernible on the exterior walls of epiphallus, in some slugs it is evident that they are involved with the process of spermatophore production. Occasionally, the papillae show through (even the structures of spermatophore, Figs 48, 51). It is worth noting that these structures are formed not in the posterior but medial section of epiphallus and are visible only on one, convex side of the bent epiphallus (or penis). Penis opens laterally into atrium. It is variable in shape, cylindrical or more or less barrel-distended. I failed to find musculus retractor penis. It seems to be too delicate to be detected. Oviductus tubular, roughly equalling in length penis together with epiphallus. In the specimens I examined spermatheca was empty and elongate in shape, in juveniles being very thin while in mature specimens oval. Spermatheca duct with thick



Figs 48–51. *Tandonia rara* n. sp. – copulatory organs. 48 – holotype, collected in Knin (Croatia). 49 – paratype from Makarska (Croatia); inside atrium visible spines. (Caution! Drawings published in Wiktor 1982 and 1987a as *Tandonia schleschi*). 50 – subadult specimen from Knin (Croatia). 51 – specimen from Makarska (Croatia).



Figs 52–54. *Tandonia rara* n. sp., specimens from Knin (Croatia). 52 – anterior body section with a partly everted atrium (discernible spines arranged in a rosette) and a fragment of penis with a papilla inside. 53 – the same under magnification. 54 – magnified fragment of an everted spine. (Caution! Drawings published in Wiktor 1987a as *Tandonia schleschi*).

walls, often coiled. Spermatheca along with spermatheca duct about twice as long as penis with epiphallus. Vagina fuses with atrium forming a bulky, broad organ. Unbranched accessory glands, resembling fingers or noodles, open into vagina around oviductus and spermatheca duct. Inside them, on the border between oviductus-vagina and atrium, there are flat lamellar hard structures of sharp verges covered with dagger-like spines (!) (Fig. 49) which are either deflected or more or less straight. When everted with atrium, they are arranged in a kind of rosette (Figs 52–53). Atrium, whose borders are difficult to define, is short and rounded.

Spermatophore so far unknown.

Ecology

I collected it exclusively on limestone rocks at low altitudes, up to c. 600 m a.s.l. It was hiding in

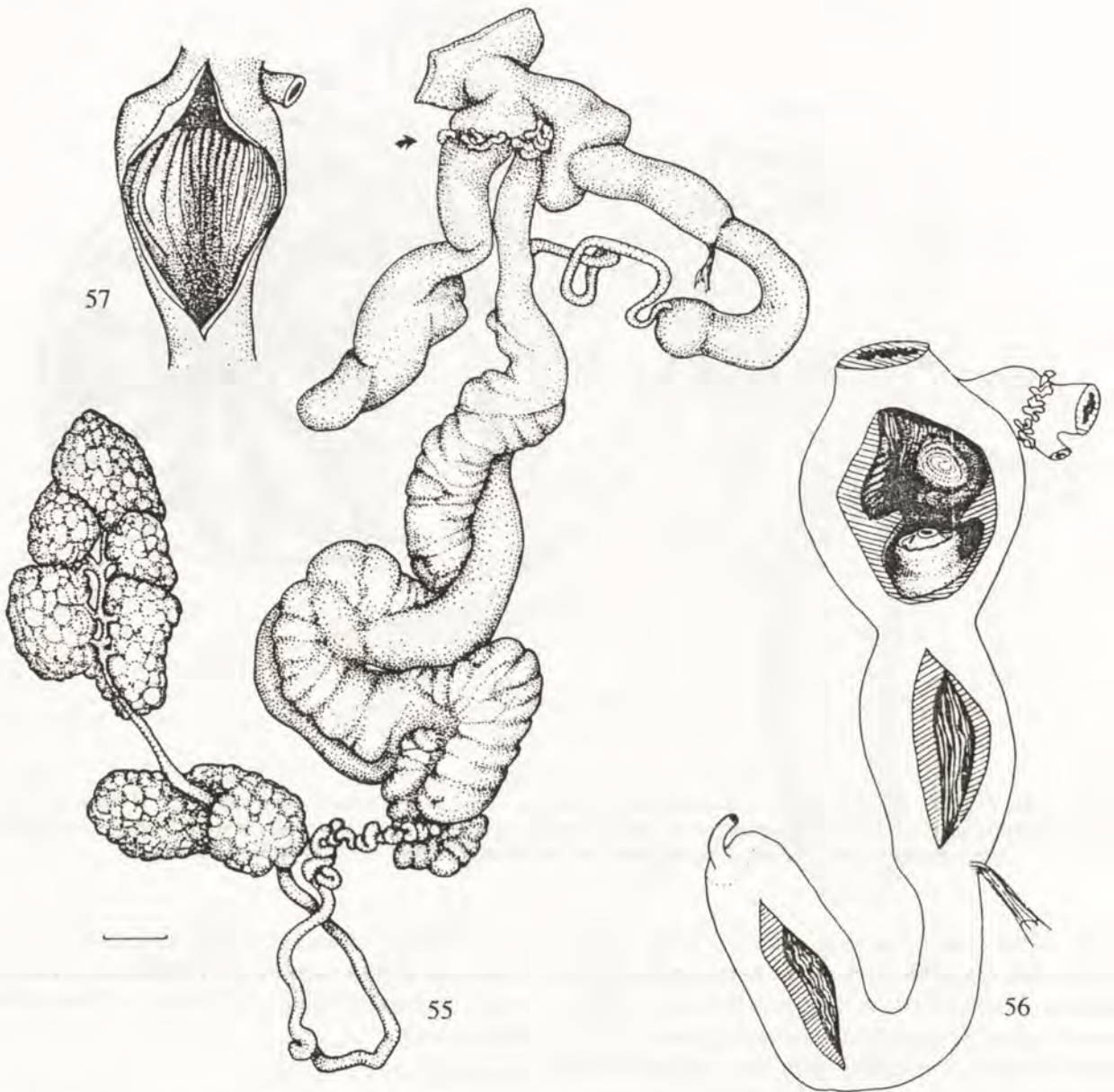
places difficult of access, usually deeply in crevices, at the base of dry rocky walls (Makarska, Knin), juvenile specimens being also found in *Pinus-Ulmus* forest (Senj).

Distribution

The Velebit Mts in Dalmatia (Croatia) (Map 5).

Comments

Before I managed to examine a rich material of *Tandonia* from the Alps I had thought that the black slugs from Dalmatia and those of the Alpine frontier-close areas of Yugoslavia and Italy are the same species (Wiktor 1982, 1987), i.e. the slug named by Wagner as *Milax (Milax) Schleschi*. I had used this name in my papers on the slug fauna of Dalmatia, also in the captions underneath drawings of anatomy (Wiktor 1982: 475, Fig. 13; Wiktor 1987a: 292, Figs



Figs 55–57. *Tandonia reuleauxi* (Clessin, 1887). 55 – reproductive system, the arrow indicating accessory glands, specimen from Krskak (Montenegro). 56 – epiphallus and penis with visible internal structures, specimen from Kotor (Montenegro). 57 – structures inside spermatheca duct, specimen from Krskak (Montenegro). (After Wiktor 1979).

202–203, 205–207; Caution! Fig. 204 depicts another species, probably *T. simrothi*, see Comments in Wiktor 1987a: 295). It proved, however, that in the Alps a different slug occurs, *Tandonia simrothi*, the name "*Tandonia schleschi*" being a younger synonym of *T. simrothi* (Wiktor, Milani 1995, see also p. 50).

Only when this problem had found its resolution I became convinced that the Dalmatian slugs having very characteristic structures on the border between atrium and oviductus are a distinct species, then unnamed although its morphology had already been described by me before.

22. *Tandonia reuleauxi* (Clessin, 1887)

Amalia Reuleauxi Clessin, 1887: 46. Terra typica: Montenegro (Cattaro = Kotor, Cetina = Cetinje) and Croatia (Dalmatia "Yedrothale bei Salona" near Split). Syntypus: only shell from Kotor in Staatl. Mus. für Naturkde, Stuttgart, no. 17088. Neotypus: from Kotor, design. by Altena (1975), in Nat. Natuurhist. Mus., Leiden.

Aspidoporus limax: see Wiktor 1979: 43, Figs 1–6 (taxonomic status).

?*Amalia montenegrina* Simroth, 1900: 107. Terra typica: Montenegro and Dalmatia. Syntypi: probably do not exist (see the description of this taxon p. 36).

Body length up to 55 mm (live, entirely stretched specimens reach up to 100 mm), width to 13 mm, mantle length to 20 mm. Keel prominent, visible along whole back. Skin grooves shallow. Mantle grooves anteriorly connected, forming an almost closed circle, shallow. Genital opening moved far anterad. Coloration even, i.e. without spots, black, sometimes with a chocolate tint. Back is the darkest part, whereas sides get gradually paler downwards, being often even beige-coloured. Juvenile specimens may be wholly beige but have their back darker as well. Sole in live specimens, both darker and lighter, white-grey, after preservation becoming beige-creamy, only in very dark specimens it may have blackish edges. Mucus colourless, irritated slugs producing also an opaque, milky or light aquamarine secretion.

Genitalia (Figs 55–57). Ductus hermaphroditicus long and coiled. Vas deferens opens asymmetrically but apically. Epiphallus roughly cylindrical, posteriorly a little distended. The border between penis and epiphallus indistinct, and it is difficult to define which organ some of the segments belong to. The anterior penis section considerably, quite irregularly swollen. Inside epiphallus longitudinal striation. Papilla in penis as depicted in Fig. 56. Spermatheca elongatedly oval. Spermatheca duct tubular, thick-walled, thicker but shorter than oviductus. Spermatheca walls covered with longitudinal folds from the inside. Oviductus tube-shaped. Vagina and atrium very short. Accessory glands very small, in the shape of thin rods, surrounding the junction of spermatheca duct, vagina and atrium. In preserved specimens they are often situated in the fold of the contracted genitalia, hence they are easy to overlook then.

Spermatophore (Fig. 58). The surface of the anterior, flagelliform, section is in a considerable part covered around by bifurcated spines. The mid-part is

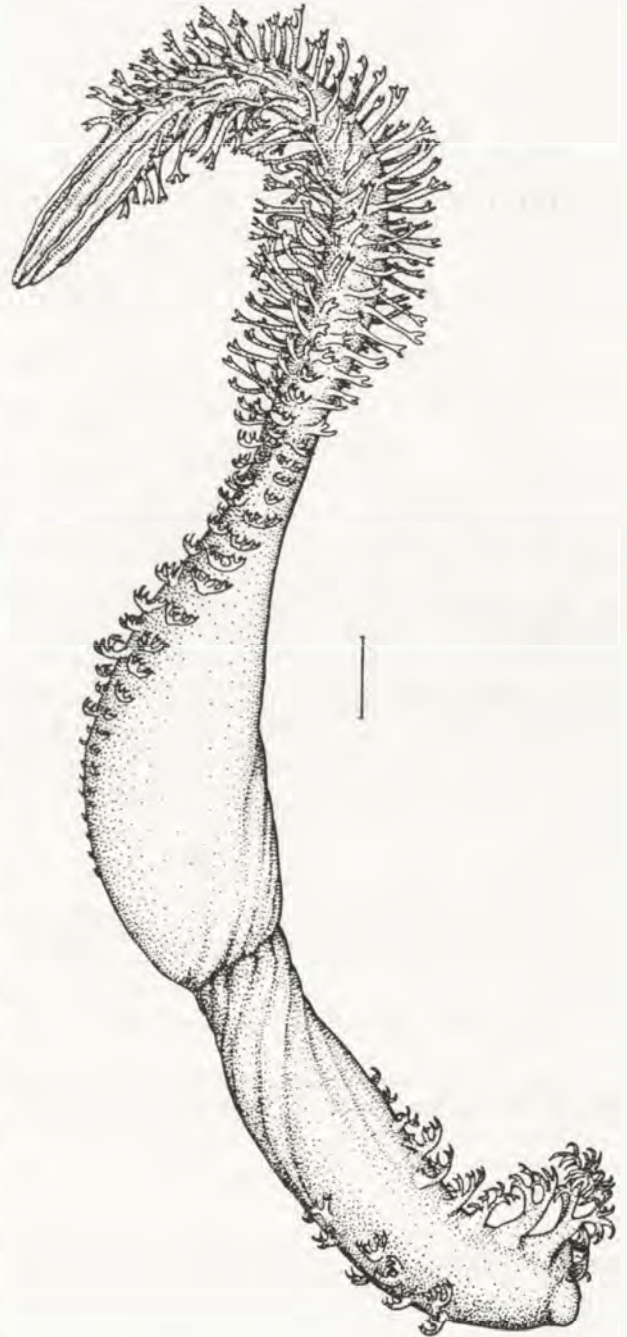
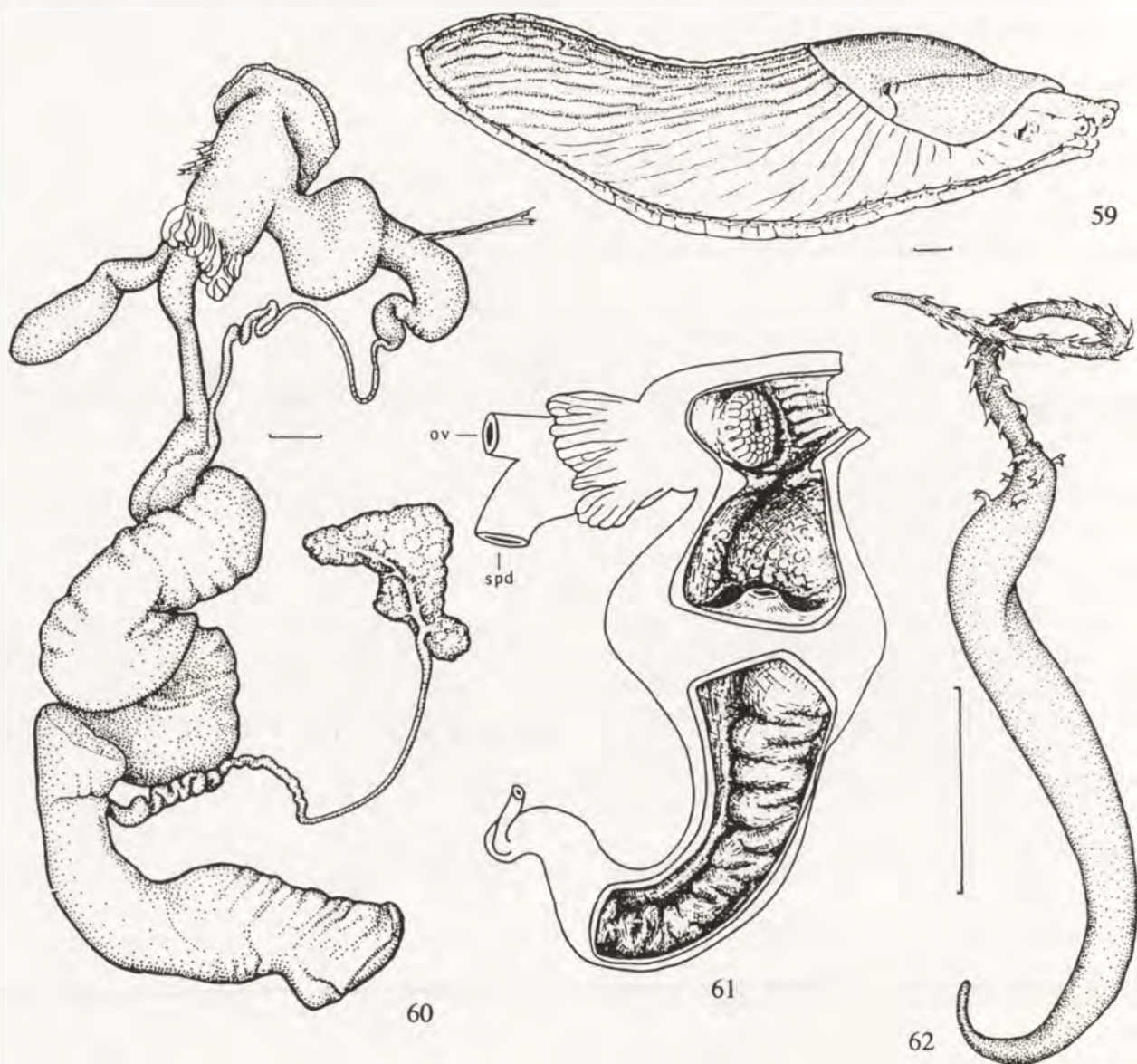


Fig. 58. *Tandonia reuleauxi* (Clessin, 1887) – spermatophore, specimen from Kotor (Macedonia). (After Wiktor 1987).



Figs 59–62. *Tandonia robici* (Simroth, 1885), specimen from Soriška (Slovenia). 59 – lateral view. 60 – genitalia. 61 – copulatory organs with structures inside. a – atrium, ov – oviductus, spd – spermatheca duct. 62 – spermatophore, specimen collected near Rozdrto (Slovenia).

bare while the terminal one covered from two different sides with several rows of fruticose spines.

Ecology

Most often it occurs in mesophilic, shaded biotopes in valleys or at places shadowed by trees. It hides

under stones. I observed it copulating in November (Wiktor 1987a).

Distribution

The species is known only from the southern part of the former Yugoslavia, i.e. from Dalmatia, Bosnia and Herzegovina, and from Montenegro (Map 5).

Examined material: about 60 spec.

Slovenia: after Wagner 1931b: ? Kraina (as *Aspidoporus limax*).

Croatia: after Simroth 1886b: Dalmatia (?). Simroth 1909: Rjeka. Wagner 1929: ? Gračac (there are several places of this name), (information of the locality in Jablanac is wrong – it concerns a juvenile *T. fejevaryi*), Živi Bunari, Omiš. Wagner 1931b: Split, Biševo Isl. (= Busi), between Omiš and Makarska, Makarska, Korčula Isl., Supetar on Brač Isl., Sušac Isl., Lastovo Isl., Vis Isl., and (? as *Aspidoporus limax*) Salona, Split. Wagner 1939: Omiš, Salona, Split. Jaeckel et al. 1958.

Bosnia and Herzegovina: ? Trebinje, at the stream (juv. spec.); Mostar, above the town, limestone; Grabovica in a canyon in the Prenj Mts, 400 m a.s.l., limestone; above Jablanica in the Doljanka valley, Vran Mts, 1000–1700 m a.s.l., *Fagus* forest, limestone; ? Gacko (juv. spec.).

After Wagner 1931b: Baba Mt., Orjen Mt. and (? as *Aspidoporus limax*) Tisovica, Prenj (? Prenj Mts), ? Plesa near Jablanica. Wiktor 1979: Plesa near Jablanica, Tisovica, Prenj planina.

Montenegro: Kotor, above the town, 50–450 m a.s.l., in ruins and on rocks, limestone; NE of Kotor (black specimens); Nikšić, on the rocks and castle ruins near the town, 650–750 m a.s.l., limestone (brownish specimen); Titograd, in the city park (greyish-brown specimen).

After Simroth 1909: Njeguš (as *Aspidoporus limax*), Orjen pass on the border between Montenegro and Herzegovina. Wohlberedt 1901: Njeguš (as *Aspidoporus limax*). Wagner 1929: Kotor. Wagner 1931a,b: Hercegnovi, Njegoš (Njeguš) Mts. Jaeckel et al. 1958. Wiktor 1979: Krskak, "Njegoš" (?), Herceg Novi.

Comments

As I have proved (Wiktor 1979), Fitzinger (1833), when describing the genus and species *Aspidoporus limax*, was basing only on one character which is almost sure to be an artefact. Moreover, the only preserved specimen which is an unquestionable syntype is juvenile and hence difficult to classify among any of the species known. Thus, those taxa, i.e. the names of the genus and species, should be considered as nomina dubia. The anatomical description by Babor (1898) did not concern the descriptive type and contains evident errors. This description must have mislead many later malacologists. I have got an impression that a substantial part of the information on *Aspidoporus limax* available actually concerns *T. reuleauxi*.

Altena (1975) described a neotype of *T. reuleauxi*, thinking that nothing had been preserved from the original material. Later I succeeded in finding the shell of the specimen Clessin had had at his disposal. Thus, beside the type (the shell) there also exists

a neotype with a good detailed anatomical description by Altena.

Information from former (pre-war) literature concerning *T. reuleauxi* needs revising. Before it is done the geographical distribution range of this slug should not be defined. Within the chapter on this species I also mention localities recorded for "*Aspidoporus*". It is for the sake of order and to call the attention of future researchers on this slug species. In my opinion, the range of *T. reuleauxi* may be considerably smaller than the literature records suggest.

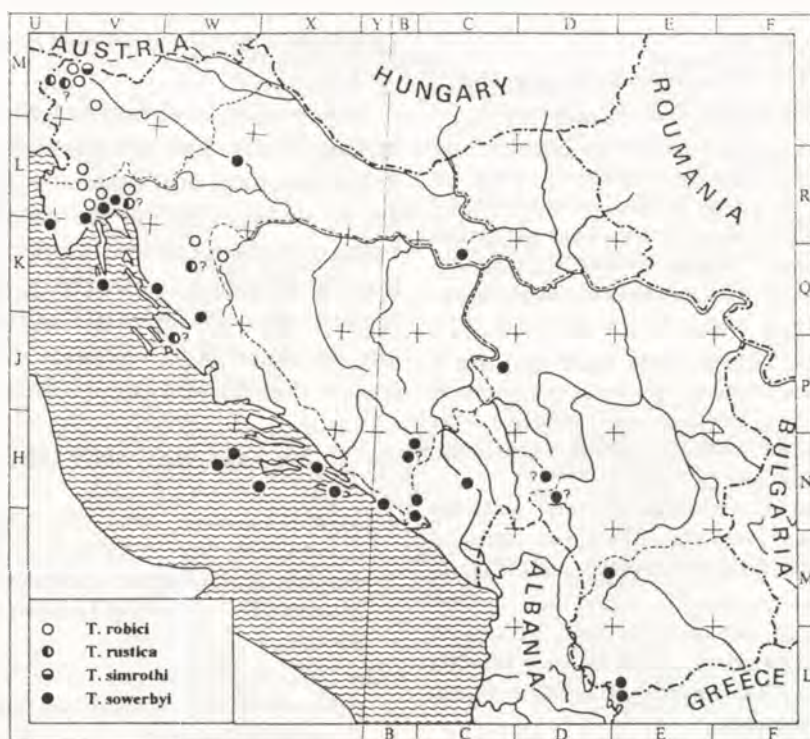
23. *Tandonia robici* (Simroth, 1885)

Amalia Robici Simroth, 1885a: 230, 339, Pl. 7, Fig. 21 XVIII A, B and Pl. 10, Figs 15 XVIII C, 16 XVIII D. Terra typica: Slovenia (Suhodolnikthal = probably Grintovac Massif, and Mokrica Alpe – vicinity of Ljubljana). Typus: probably does not exist.

Milax (Milax) plöbsti Wagner, 1931c: 47, Pl. 4, Fig. 1. Locus typicus: Volosca (= Volosco, Istra Peninsula, Croatia). Syntypi: probably destroyed.

Body length up to 28 mm, width to 8.5 mm, mantle length 9 mm. Body rather stocky, especially after preservation (Fig. 59). Skin sculpture subtle, grooves shallow. Coloration: live specimens are green-olive or beige, without spots. Back darker than sides. Head and tentacles black, sole whitish. After preservation body becomes dirty yellowish, reddish in undertone, often also blackish-beige. Mucus yellow, transparent.

Genitalia (Figs 60–61). Vas deferens thin, opening to epiphallus apically but at an angle, partly adhering to this organ. Epiphallus cylindrical-conical, most often coiled. Inside it a big, bent fold (Fig. 61). Penis rounded, in the shape of a very short club. Papilla penis of variable shape, probably depending on the degree of its eversion inward penis. Occasionally, it assumes the shape of a flat, truncate cone whereas at times it is big with an ornamented surface. Musculus retractor small, attached laterally to epiphallus. Spermatheca elongated, turning into spermatheca duct without a distinct borderline. Oviductus thin, tubular. Vagina broad, about 4 times wider than oviductus, with papillae inside. Occasionally, a very typical, flat papilla occurs on the extension of vagina, probably as a result of its part being everted to atrium (Fig. 61). Vaginal accessory glands in the form of multiple, unbranched, digitate processes. Atrium short, approxi-



Map 6. Distribution of *Tandonia robici*, *T. rustica*, *T. simrothi* and *T. sowerbyi*.

mating to vagina in section, being its natural extension.

Spermatophore (Fig. 62) narrow, in the flagelliform section covered with small, single or furcated spines. Container, constituting c. $\frac{2}{3}$ of the length, is flagellate, devoid of any spines.

Ecology

A woodland species, occurring mainly in deciduous forests, sometimes also in bush copses. Often hiding in leaf litter and under stones.

Distribution

It occurs in the border area between the former Yugoslavia, Italy and Austria. In the east it reaches Bihać and Delnice (Map 6). Besides, it occurs in Istra, frequently in the Julian Alps on both sides of the border, also in the Karavanke Ridge.

Examined material from the former Yugoslavia: 24 spec.

Slovenia: Nanos Massif near Rozdrto (SW of Postojna), *Fagus-Acer* forest, 1100–1800 m a.s.l., limestone; Snežnik Massif, *Fagus* bush, 1000 m a.s.l., limestone.

After Wagner 1931b: Julijske Alpe. ? Crna Mt., Prst Mt. Wolf and Rähle 1987: N of Vrišič pass. Wiktor 1982: Soriška Planina pass, SE of Bohinjska Bistrica.

Croatia: Opatija, above the town; Delnice, *Fagus-Picea* forest near the village, 700–900 m a.s.l.; Bihać, ruins of a mediæval castle beyond the town, 700 m a.s.l.; Lavran, Voljak Mt, Učka Massif, 600–1000 m a.s.l., *Fagus-Castanea* forest, limestone.

After Wagner 1931b: Devčicevac near the lakes Plitvicke Jezera. Wagner 1931c: Volosca (= Volosco). Wagner 1932: Volosko, Opatija (as *M. plöbsti*). Jaekel et al. 1958: Kraina and Istra.

Comments

I have synonymized the name "*T. plöbsti*" – see Wiktor 1987 where I also quote more reference sources.

24. *Tandonia rustica* (Millet, 1843)

Limax marginatus Draparnaud, 1805: 124, Pl. 9, Fig. 7. Terra typica: probably France. Typus: probably does not exist. (Non *Limax marginatus* Müller, 1774).

Limax marginatus rusticus Millet, 1843: 1, Pl. 63, Fig. 1. Terra typica: France. Typus: probably does not exist.



63



64

Figs 63–64. *Tandonia rustica* (Millet, 1843) – lateral view and genitalia. (After Wiktor 1973, specimens from Poland).

Body dimensions after preservation in alcohol: length up to 45 mm, width c. 12 mm, mantle length c. 12 mm. When crawling the slug can extend the body even to 100 mm. Body elongated, abruptly tapering posterad. Keel well discernible, also after preservation. Body light in colour, whitish, cream or with a slight brownish shade, sometimes also pinkish or violetish in shade, in all the colour forms back always being somewhat darker than sides. Live specimens as if covered with a white powder. On this pale background fine black dots always plentifully occur (Fig. 63). Strongly contrasting, irregular, black, lateral streaks are present on mantle, sides and in the region of horse-shoe groove. Sole and keel more or less cream, completely devoid of black dots. During preservation the pale coloration of the background darkens, becoming more brownish, at the same time the effect of "powdering" disappears. Mucus very thick, colourless, on irritation an additional, milky-white secretion appears.

Genitalia (Fig. 64). Vas deferens opens apically and symmetrically at the top of a strongly elongated epiphallus. There are some doubts concerning the borderline between penis and epiphallus as those two organs are not divided by a clear constriction. In the anterior section there is a distinct swelling, which is, undoubtedly, a part of penis. Inside this enlargement there is a typical papilla. Musculus retractor delicate and small, attached laterally at the place which may be considered the posterior penis limit. The segment behind the insertion of this muscle (epiphallus) is 2–3 times longer than the anterior one (penis). Oviductus in the shape of a coiled tube, widened at some places. It opens to vagina, which is roughly of the same breadth but slightly shorter. Accessory glands in the shape of small ducts clumped in bundles, which as "skeins" surround vagina. Spermatheca elongate, terminally sharpened (not rounded). Spermatheca duct a little shorter than spermatheca itself. Most often medially thickened.

Spermatophore still needs to be examined and described.

Ecology

Most frequently it occurs in deciduous and mixed forests abundant in rock rubble and leaf litter. Presumably, it is associated with calcareous soil or ruins,

e.g. of old castles. In Central Europe it chooses warm places and most often occurs insularly. It is frequent in biotopes strongly degraded due to human activity, e.g. on refuse and rubble dumps.

Distribution

The distribution range is not known precisely. This species is confused with others, particularly with *T. kusceri*. Besides, most probably some of its synanthropic localities are of secondary character and are situated beyond the primaevial distribution of this species.

T. rustica inhabits vast areas of Germany (southern and western part in particular), south-eastern France, where it reaches the Mediterranean Sea and Corsica, as well as Italy, reaching the mid-Appenines and the Elbe, Switzerland and Austria. In south-western Poland (Sudete Mts) it has its north-eastern range limits. Besides, it is spread in the Czech Republic, inhabits Hungary, in the south reaching Central Roumania. As far as the former Yugoslavia is concerned, it was recorded only from Slovenia, from the border areas between Austria and Italy in particular. The south-eastern border of this species distribution range probably runs through Slovenia, and its localities are of insular or ephemeral character.

This species is fairly familiar to me, however, I have neither found nor seen any live specimen from the area of the former Yugoslavia. Only the localities recorded by Wolf and Rähle (1987) can be considered doubtless. The remaining data should be confirmed (Map 6).

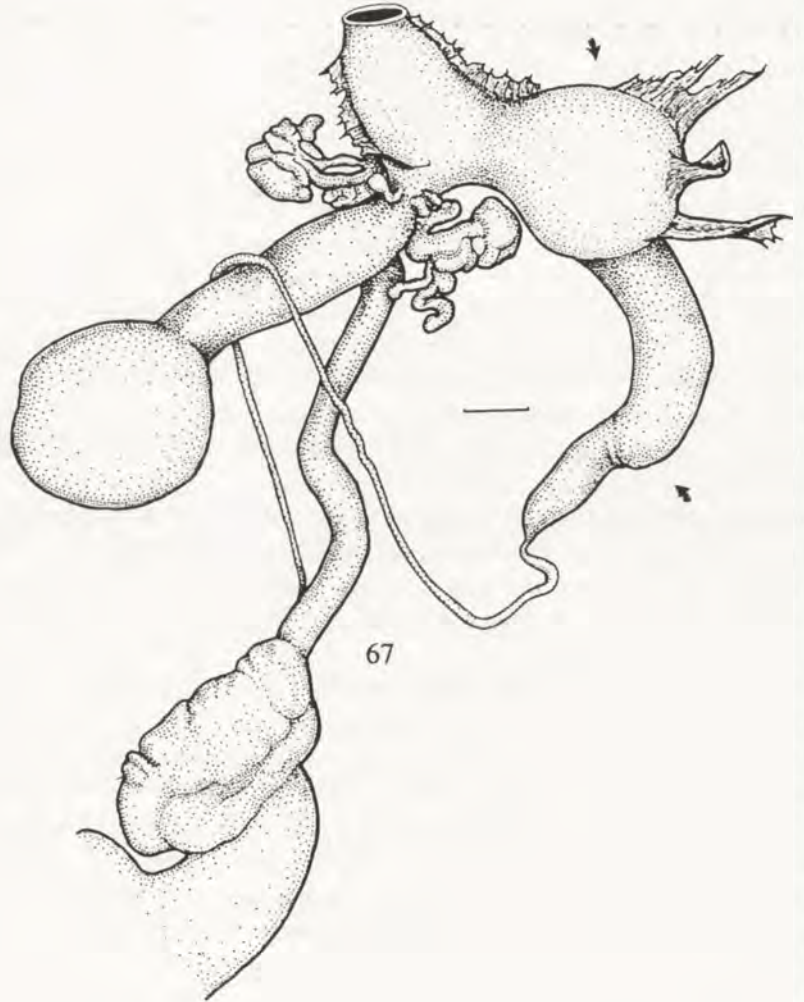
Slovenia: after Bole 1962: Triglav Nat. Park. Bole 1979: environs of the lake Cerkniško Jezero (as *M. marginatus*). Wolf and Rähle 1987: Česzoča (S of Bovec), valley of the Slatenic river (S of Bovec).

Croatia: after Wagner 1931b: Zara Vecchia – Dalmatia (? Zadar). Wagner 1932: Volosco, Opatija (as *M. (M.) marginatus*). Wagner 1935: Devcicevac near Plitvice. Jaekel et al. 1958: Istra.

25. *Tandonia serbica* (Wagner, 1930)

Milax (Milax) serbicus Wagner, 1931a: 63, Figs 8–10. Locus typicus: Svetka Petka (= Sveta Petka) near Niš, Serbia. Syn-typi: Naturhist. Mus., Wien.

Body length up to 45 mm, width to 11 mm, mantle length 15 mm. In live specimens keel always well



Figs 65–67. *Tandonia serbica* (Wagner, 1931). 65 – lateral view. 66 – spermatophore. 67 – copulatory organs. (After Wiktor 1983, specimens from Bulgaria).

discernible along the whole length, in preserved slugs sometimes limited only to the posterior body section. Coloration brownish, mucky creamy with a blackish reticulate pattern on back, sides and mantle (Fig. 65). The reticulum results from accumulation of the blackish or black pigment mainly in the skin grooves. Besides, here and there on back and sides bigger, of 1–2 mm, spots occur, which resemble ink-stains (!). Keel pale, without spots. Mantle darker than the rest of back, with irregular black streaks on its sides. Head blackish. Mucus colourless, transparent.

Genitalia (Fig 67). Vas deferens thin and long, opening apically, symmetrically. Epiphallus clearly delimited (!) from vas deferens and considerably thicker than the other organ. Penis about twice shorter than epiphallus, rounded, pear-shaped or in the form of a short bludgeon. Its narrower part directed anterad. Inside penis a big ornamented papilla. Musculus retractor penis very wide and strong (!). It is somewhat laterally attached to the broadened part of penis. Apart from this muscle, there is also a group of membranaceous retentors (?) connecting the penis walls with body integuments. Oviductus tubular, roughly equalling penis with epiphallus in length. Spermatheca, when empty, more or less spherical and set on a fleshy spermatheca duct the length of which approximates to that of epiphallus. Vagina very short. Atrium, being a natural extension of penis, does not significantly differ in section from the latter organ. A wide membranaceous retentor is attached to the atrium wall. Accessory glands in the shape of lobular structures surrounding vagina.

Spermatophore (Fig. 66). Strongly elongated, coiling into a regular spiral. It is lengthwise covered with dichotomously multi-furcated spines of variable shape and size. They circumscribe the anterior, flagellate, part, in the remaining ones running in two rows.

Ecology

Most often it occurs in rock rubble sheltered by bushes, usually on limestone, recorded up to 1200 m a.s.l. The presence of spermatophores in spermathecas was established in June and October.

Distribution

It mainly occurs in Bulgaria, reaching Prazhda and the Vracanska Planina in the north, Shipka pass in the Stara Planina range and Kharmanli in the east,

the Rila and Piryn mountain massifs in the south. Its western border runs somewhere in Serbia. The type locality near Niš may even belong to the species natural distribution range. Considering the ecological requirements of *T. serbica*, one should not disregard the fact that, as a synanthrope, it can undergo introduction, the locality in Dubrovnik being probably of such a character.

I examined rich material of this slug from Bulgaria (Wiktor 1983) whereas from the area of the former Yugoslavia I had at my disposal only 2 juvenile specimens, collected in Dubrovnik (Wiktor 1982).

Croatia: after Wiktor 1982: Dubrovnik, Lapad, in a garden.

Serbia: after Jaeckel et al. (1958).

Comments

A species very similar to *T. kusceri* (see the description on p. 33), the two slugs often occurring sympatrically. Also their geographical ranges overlap to a high degree. Among essential differences between those species the following should be mentioned: with regard to external appearance – smaller size of *T. serbica* and spots resembling ink-stains present in this slug. As far as the structure of genitalia is concerned, *T. serbica* differs in a shorter, markedly delimited from epiphallus, vas deferens, shorter epiphallus and in penis, which is larger and different in appearance. As I have already pointed out (Wiktor 1983), there are certain doubts. The two slugs discussed often occur sympatrically. Spermatophores have been found only in *T. serbica*, while in a considerably more frequent *T. kusceri* no one has ever observed them. The question is whether the differing, yet similar, slugs are dimorphic forms of one species or whether the differences observed can be accounted for by changes involved with different stages of sexual activity in the same specimens.

26. *Tandonia simrothi* (Hesse, 1923)

Amalia Kobelti Simroth, 1910a: 333, Fig. 10. Locus typicus: Manhart Mt. (= Mongart = Mangart), Julijske Alpe on the border between Italy and Slovenia. Typus: probably does not exist. Homonym of *Amalia kobelti* Hesse, 1882.

Milax simrothi Hesse, 1923: 195, nom. nov. for *Amalia Kobelti* Simroth, 1910.

?*Amalia Ehrmanni* Simroth, 1910a: 334, Fig. 12. Locus typicus: Forni Alvoltri, Alpi Dolomitiche (? Alpi Carniche), Italy. Typus: probably non-existent.

Milax (Milax) Schleschi Wagner, 1930a: 48 Fig. 5. Terra typica: Kraina (nowadays the majority of this area belongs to Slovenia); Wagner did not know exactly where the slug had been collected. Syntypi (2 spec.): probably destroyed with the mollusc collection of the Nat. Mus., Budapest. See also Wagner 1930c: 101, Figs 3–4, Pl. 1, Fig. 1, and Wiktor 1987: 292.

Milax simrothi: Forcart 1959: 195.

Milax (Tandonia) simrothi: Gittenberger 1967: 74.

Tandonia ehrmanni: Kofler 1970: 191; Kofler 1986: 76, Fig. 1.

Tandonia simrothi: Reischütz 1986: 107; Wiktor 1987: 299, Figs 212–213.

Tandonia schleschi: Wiktor 1987: 294 partim! and Fig. 204.

See also Wiktor and Milani 1995.

Body after preservation up to 37 mm long, to 9 mm wide, mantle length to 9 mm. Mantle, head and back with keel unicolour, black. Sides lightening downwards, especially anteriorly. Sole and neck, covered with mantle, creamy. Mucus colourless, milky secretion produced on irritation.

Genitalia (Figs 68–70). Vas deferens opens at an angle, at the apical end of epiphallus. Epiphallus usually bent, club-shaped, widening posteriad. Inside it longitudinal wrinkles. Penis more or less distended, sometimes nearly spherical, only in juveniles occasionally cylindrical. Inside penis a half-spherical papilla with a smooth surface and longitudinal, creviced opening. The penis walls close to the papilla and atrium covered with longitudinal wrinkles. In mid-penis the walls are usually smooth. Musculus retractor attached laterally to the anterior section of epiphallus (!). Spermatheca oval, almost completely devoid of spermatheca duct. In juvenile specimens it may be elongated. Oviductus tube-shaped, at times slightly anteriorly widened. Vagina very short with longitudinal folds inside. Atrium very short. Inside it, between the openings of vagina and penis, a very typical ctenoid organ occurs, on the top of which there are papillae with small spines (!) (Fig. 70). On the border between atrium and the female organs opening to it there is a very strong, wide, membranaceous musculus retentor holding genitalia to body integuments (!). When the copulatory organs are everted, different components get outside. Usually these are atrium and penis, that is roughly spherical in shape, which get everted. When everted, the ctenoid organ having papillae with spines on the surface is visible as half-spirally surrounding the base of the

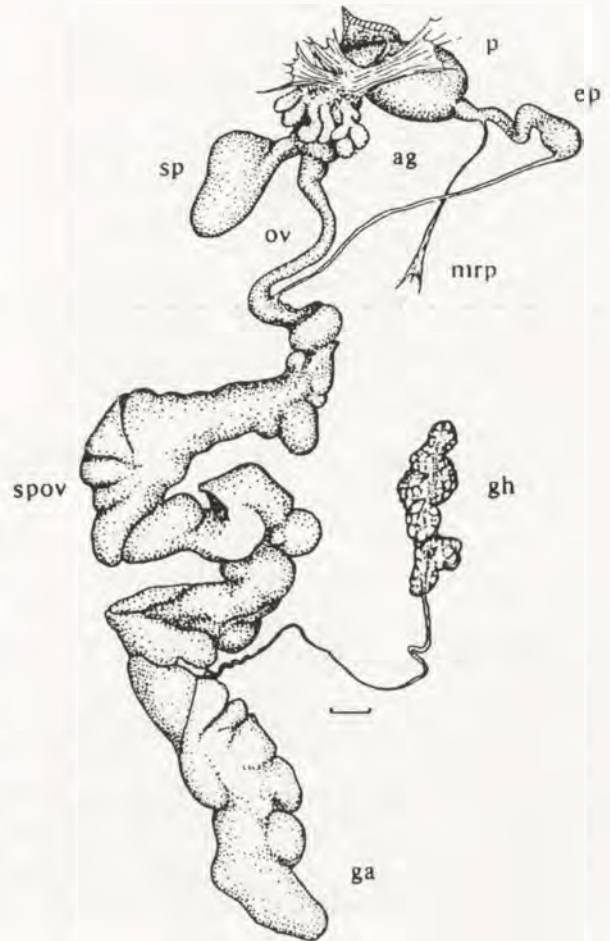


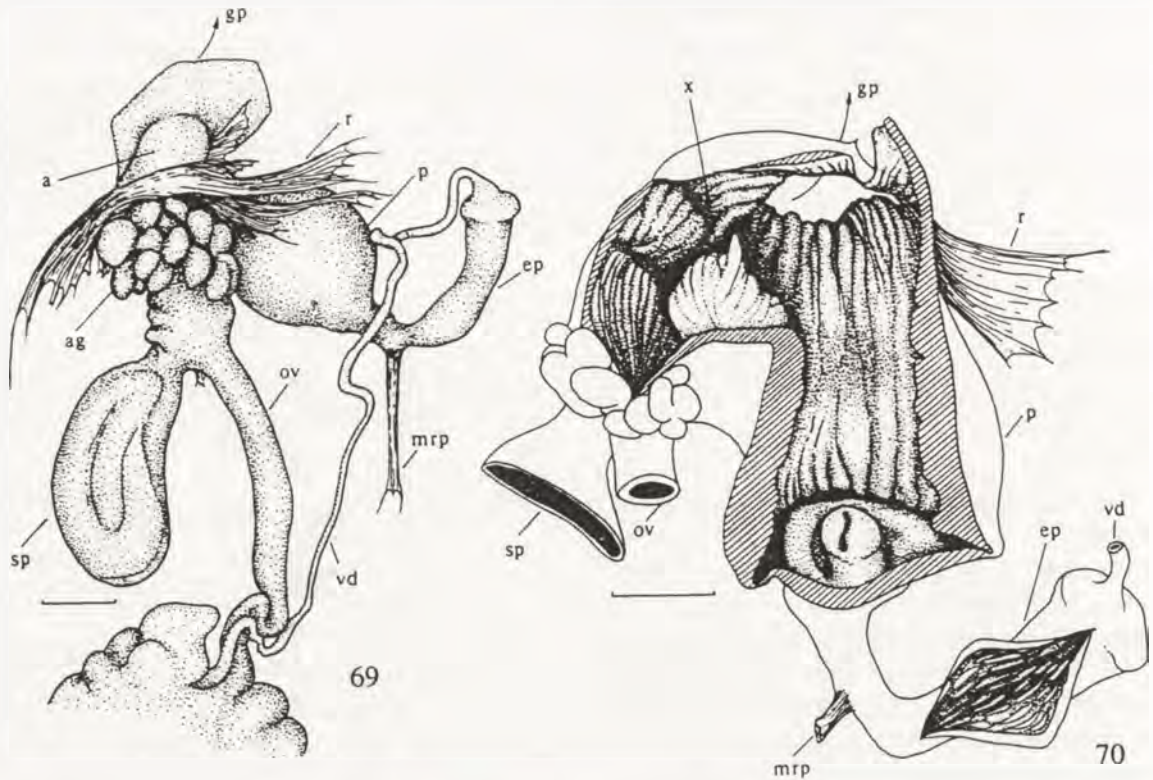
Fig. 68. *Tandonia simrothi* (Hesse, 1923) – genitalia (after Wiktor, Milani 1995, specimens from Italy). ag – accessory glands, ep – epiphallus, ga – glandula albuminalis, gh – glandula hermaphroditica, mrp – musculus retractor penis, ov – oviductus, p – penis, sp – spermatheca, spov – spermoviductus.

everted penis. Sometimes atrium and vagina are everted, the latter organ with numerous wrinkles one of which is considerably bigger and provided with spined papillae, that being the specific organ mentioned before, typical of this species.

Spermatophore has not been described yet.

Ecology

The species occurs in the mountains, above the timberline, above 800 m a.s.l., reaching even as high as 2000 m a.s.l. It is usually found in cirques covered



Figs 69–70. *Tandonia simrothi* (Hesse, 1923). 69 – copulatory organs. 70 – structures inside copulatory organs. (After Wiktor, Milani 1995, specimens from Italy). a – atrium, gp – gonoporus, r – retentor. The remaining denotations as in Fig. 68.

with poor gramineous vegetation, also in the neighbourhood of *Pinus mughus*. It hides under stones, seems to be associated with limestone.

Distribution

Up until now the slug is known only from the Italian Alps (Alpi Giulie, Alpi Carniche, Alpi Dolomitiche), from Tyrol (Austria) and Slovenia.

The material I had at my disposal was exclusively from Italy and Austria. Besides, I also examined a number of specimens from Slovenia, but only from Kamniška Alpe (= Planine), S slope, on a foot-way eastward of Cojzova Koca (= Zoishütte), 1500 m a.s.l., leg. A. et E. Gittenberger VIII.1971 (published as *T. schleschi* – Wiktor 1982), only one juvenile of which showed all the typical characters.

After Wolf and Rähle 1987: Slovenia – N of Vrišič pass, between Mojstrovka Mt. and Robičje Mt., in the region of Krnsko Jezero (lake).

Comments

The systematic position of this taxon is thoroughly discussed in a paper by Wiktor and Milani 1995.

The character that unmistakably distinguishes this slug is a ctenoid organ situated in atrium between the openings of penis and vagina.

Wiktor (1987) used the name "*Tandonia schleschi* (Wagner, 1930)" for the Dalmatian slug in the belief that it was actually the species described under that name by Wagner. It proved, however, that in Dalmatia another species occurs, in this paper referred to as *Tandonia rara* n. sp., while the name "*Tandonia schleschi*" has turned out to be a synonym of *T. simrothi* (Wiktor, Milani 1995).

A great similarity of a poorly known species, *Tandonia nigra* (Pfeiffer, 1894), to *T. simrothi* is worth noting as well. The former is also a black slug,

known from the area between Lakes Como and Lago di Garda in Italy. The types of this species have got dried hence it is impossible to examine them. However, the topotypes were examined by Altena (1953) and Wiktor (1987). In the light of the studies mentioned *T. nigra* and *T. simrothi* seem distinct species, though there exists certain similarity between them. *T. nigra* has a large vagina, covered inside with sharply terminating papillae, and its atrium lacks the ctenoid organ between the openings of penis and vagina.

A strong similarity to *T. simrothi* is also perceivable in *Tandonia baldensis* (Simroth, 1910), another species known from the environs of the lake Lago di Garda in Italy. This slug may also be black. Besides, it is poorly known as well, at least its variability range is still unclear. I examined only one juvenile specimen of this species (Wiktor 1987), earlier studied by Altena (1977), from the environs of Lago di Garda. It differs from *T. simrothi* in its long vagina, longer spermatheca duct, smaller accessory glands and in lack of the ctenoid organ at the openings of vagina and penis to atrium.

27. *Tandonia sowerbyi* (Férussac, 1823)

Tandonia sowerbyi Férussac, 1823: 96, Pl. 8D, Figs 5–6. Locus typicus: vicinity of London. Opinion ICZN 336. 1955: 107. Typus: probably does not exist.

Synonyms: *Limax carinatus* Risso, 1826 (non Leach, 1847); *Limax agrillaceus* Gassies, 1856; *Limax marginatus* Jeffreys, 1862 (non Draparnaud, 1805; nec Müller, 1774); *Limax etruscus* Issel, 1868; *Milax barbatus* Mabille, 1869; *Amalia marginata* var. *fulva* Paulucci, 1879; *Amalia marginata* var. *Mangianensis* Paulucci, 1879; *Amalia pratensis* Torez Minguéz, 1923; *Amalia Hessei* Boettger, 1882; *Amalia Kobelti* Hesse, 1882; *Amalia tyrrena* Lessona et Pollonera, 1882; *Amalia carinata pallida* Cockerell, 1890; *Amalia maculata* Collinge, 1895 (non Koch et Heynemann, 1874); *Milax collingei* Hesse, 1926 (for more detailed data on the synonyms see Wiktor 1987a, p. 300–301).

Body length c. 60 mm, width 16 mm, mantle length c. 18 mm. Keel very well discernible along the whole back, body roughly triangular in cross section. Coloration and the pattern of spotting widely varied. General coloration usually brown-yellow but very different in hue, sometimes more orange or else greyish. In preserved specimens the yellow or orange pigment is rinsed away, the body turning dirty cream.

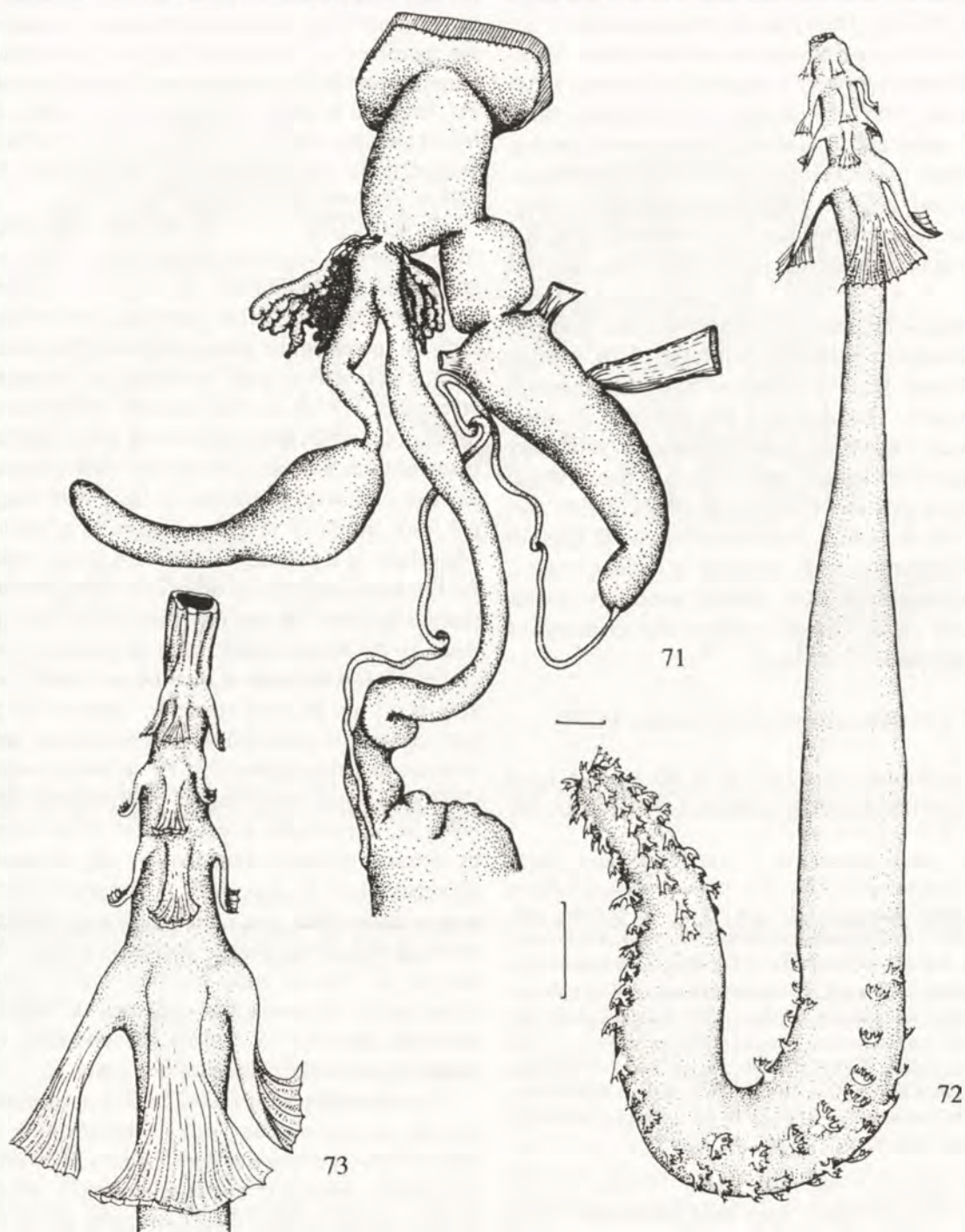
On this background irregular, diffuse, blackish spots occur, most often forming a reticulum. Occasionally the spotting is so dense that the body looks blackish-brown. Apart from the reticulum, distinct lateral streaks, irregular in shape, on mantle. Keel light, yellowish or orange. Sole in live specimens yellowish or orange, in preserved in alcohol – dirty cream. Mucus yellow and very thick, tenacious.

Genitalia (Fig. 71). Vas deferens thin, long and coiled, opening asymmetrically at the apical end of epiphallus. Epiphallus and penis of a different appearance than in the other *Tandonia* species and it is difficult to define the particular parts. The posterior-most, thick-walled part, undoubtedly belonging to epiphallus, is club-shaped, slightly wider anteriorly. Inside it the walls are covered with close papillae. As many as three muscles are attached to this organ. The anterior part, with walls thin, is lined with longitudinal folds inside. It is constricted at $\frac{2}{3}$ of its length. The whole of it probably constitutes penis. Inside, on the border between the posterior, thick-walled section (epiphallus) and the anterior, thin-walled one (penis) there is an inconspicuous papilla penis of smooth surface. It is worth noting that the part which is probably penis has no own retractor, whereas the posterior segment is provided with one retractor and two muscles that should probably be defined as retentors. Oviductus long, tube-shaped. Spermatheca strongly elongate, in juveniles nearly tubular. When expanded by spermatophore, it remains strongly elongate but becomes more or less oval. Spermatheca duct 2–3 times shorter than spermatheca. Vagina short, surrounded with thin, elongate accessory glands. Atrium roughly as long as wide, covered with longitudinal folds inside. Between the openings of vagina and penis the atrium wall is thick, occasionally a lobe-shaped structure occurring at this place.

Spermatophore (Figs 72–73). Its appearance is so typical that no problem of misidentification of the slug exists. The anterior top is provided with symmetrically arranged, membranaceously extending hooks. Almost a half of this structure has a smooth surface. At the posterior end there are several rows of fine, dichotomously branching hooks.

Ecology

An eurytopic species, occurring both in open biotopes and sheltered with bushes. A species of the



Figs 71–73. *Tandonia sowerbyi* (Férussac, 1823). 71. – copulatory organs. (After Wiktor 1987a, specimen from Greece). 72 – spermatophore. 73 – anterior fragment of spermatophore under magnification. (After Wiktor 1987b, specimen from Zagreb (Croatia)).

lowlands and lower mountain parts. Most often it occurs as a synanthrope. In the former Yugoslavia I collected specimens with spermatophores in October and November.

Distribution

Its original habitat is not established definitely. It must have been somewhere in the Mediterranean. The species occurs or has isolated, clearly synanthropic, localities in the seaside area from Greece to the Netherlands and British Isles. The distribution covers also islands in this region, including Crete, Sicily, Corsica etc. Only in a few places, as evidently introduced, *T. sowerbyi* reaches farther inland. It has also been introduced into South America and New Zealand. In the former Yugoslavia it occurs as a synanthrope in isolated areas and everything suggests the case of it having been introduced there as well.

The material, collected in the former Yugoslavia, that I examined consisted only of 24 specimens.

Croatia: Istra (= Istria), Medveja, S of Opatija, bush in the canyon, limestone, 50 m a.s.l.; Karlobag (Velebit Mts); Obrovac (Velebit Mts), ruins of a mediaeval castle. 100–500 m a.s.l.; Zagreb, city park.

After Simroth 1909: Dubrovnik, Vrbanje, Orien (= Orjen) pass on the border between Montenegro and Herzegovina (as *A. carinata*). Jaekel 1954: Rovigno (= Rovinj, Istra). Wagner 1929: Rijeka, Opatija. Wagner 1931b: Lovran, Opatija, ? Camno (S Dalmatia), Sušac Isl. (as Cazza), Dubrovacka (= Ombla), Orebić on Pelješac Isl., Brač Isl. (S Pietro = ? Supetar), Mljet Isl. (as Meleda), Mtković, Vis Isl. (= Lissa), Biševo Isl. (Busi), Lušinj Isl. (Lussin). Wagner 1931c: Volosko. Wagner 1932: Volosko, Opatija. Wagner 1939: Rovinj. Jaekel et al. 1958: Istra. Dalmatia, Macedonia. Wiktor 1982: Split.

Serbia: Titovo Užice, environs of the city, 800 m a.s.l., limestone, *Fraxinus-Corylus* shrubs.

Montenegro: after Wagner 1931b: Korito (? Korita), Gacko, Vrbanje (?), Bileća (= Bilek), Plana, Kobilja (= Kobilja) Glava, Radovac near Konjic. Wagner 1931b: Hercegnovi (as Castelnovo).

Macedonia: Tetovo, slope above the monastery, leg. A. Riedel 11.05.1984 – 10 spec.

After Hesse 1928: Kaluckova. Wiktor 1982: Ohrid, Sv. Naum S of Ohrid.

Family Limacidae Rafinesque, 1815

Subfamily Limacinae Rafinesque, 1815

References: Likharev and Wiktor 1980: 221; Wiktor 1983: 123; Wiktor 1989: 144.

Pneumostom postmedial or medial. Intestine forming three loops. Vas deferens opens into penis, the latter organ being cylindrical or spadiceous, sometimes with a flagelliform penial gland. The distribution range, as that of the whole family, covers Europe, the Mediterranean areas of Africa, Asia Minor, Central Asia and the Caucasus.

Key for identification of the species of Limacidae

1. Last (third) intestine loop short, connected with long caecum which is tightly adherent to body walls. 2.
- Last intestine loop long, lacking caecum. 6.
2. Big slug, usually over 60 mm, sometimes even over 100 mm in length. Live specimens yellow, yellowish, orangish or greenish, nearly always alternatingly light- and dark-spotted. Spermatheca duct connected with oviductus. *Limax flavus* (p. 82).
- Smaller slug, usually less than 60 mm long. Live specimens covered with a blackish pattern, having at least two longitudinal streaks on mantle, or body evenly black. Spermatheca duct connected with penis. 3.
3. Penial gland in the shape of a nodule, cone or flagelliform process present at the rear end of penis. 4.
- No penial gland in the form of a process at the rear end of penis. 5.
4. Spermatheca along with spermatheca duct shorter than penis or equalling it. Spermatheca duct usually shorter than spermatheca. Penial gland mostly long, sometimes approximating to ½ penis length. *Lehmannia brunneri* (p. 63).
- Spermatheca with spermatheca duct longer than penis. Spermatheca duct usually equal to or longer than spermatheca. Penial gland most often smaller, often nodulous or conical. (Caution! This organ widely varies, in mountain forms sometimes being long!). *Lehmannia marginata* (p. 65).

5. Penis long, vermiform, usually spirally coiled, posteriorly slightly clavately distended (exceptionally with a small nodule, i.e. penial gland).
 *Lehmannia nyctelia* (p. 68).
- Penis short, not coiled spirally, at most S-like bent. Posterior penis end sometimes with small protuberances, at times it is separated by a slight constriction.
 *Lehmannia szigethyae* (p. 68).
6. Slug small, after preservation up to c. 35 mm. Skin thin and limp, with a poorly marked sculpture. Live specimens nearly always canary-yellow. Penis short, clavate or oval. 7.
- Slug big, mature ones usually over 60 mm long. Skin thick with a distinct sculpture. Coloration different, never canary-yellow. Penis elongate, coiled or in the shape of a long cudgel. 8.
7. Penis longer than half mantle and c. 2.5 times longer than pharynx.
 *Malacolimax mrazeki* (p. 58).
- Penis shorter than half mantle and only slightly longer than pharynx.
 *Malacolimax tenellus* (p. 62).
 ?*Malacolimax kostali* (p. 57).
8. At posterior penis end, above vas deferens opening, a distinct big pocket, or conically bent process being an extension of penis. 9.
- No distinct blind pocket at posterior penis end as vas deferens opens apically, though usually asymmetrically, i.e. slightly laterally. 11.
9. General coloration pale, body covered with more or less loose, not merging with one another, round dots c. 1 mm in diameter. They may cover the whole of back or there may be merely a few of them, e.g. only on mantle. Penis tubular, roughly equalling a body half.
 *Limax conemenosi* (p. 75).
- General coloration varying, pale or dark. Spotting, if any, irregular, spots partly fusing with one another, or forming rows. 10.
10. Penis shorter than a body half, even in adults only slightly exceeding the length of mantle, usually clavate, straight or inconspicuously irregularly bent. Vas deferens opens to penis at c. $\frac{1}{3}$ its length as measured from its posterior end. Posterior, blind penis section usually in the shape of a pocket or straight tapering horn.
 *Limax cephalonicus* (p. 70).
- Penis more or less equalling $\frac{2}{3}$ body length, spirally coiled or strongly irregularly bent. Vas deferens opens laterally at c. $\frac{1}{7}$ penis length when measured from its posterior end. Posterior, blind penis section usually spirally coiled.
 *Limax graecus* (p. 77).
11. Penis approximating to the body length. Mantle unicolour, the rest of body varying in colour: often striped or spotted. Keel pale. Sole of mature specimens with lateral zones black, and the medial one light.
 *Limax cinereoniger* (p. 72).
- Penis shorter than or equal to a body half. . 12.
12. Mantle covered with irregular, black or black-navy blue spots, partly merging with one another. Keel pale. Sole unicolour, pale. Penis spirally coiled, equalling c. half the body length.
 *Limax maximus* (p. 78).
- Body evenly deeply black. Keel of the colour of back, i.e. black. Lateral sole zones blackish, middle one light. Penis shorter than mantle.
 *Limax wohlberedti* (p. 81).

– "*Gigantomilax Csikii* Soós, 1924"

Gigantomilax Csikii Soós, 1924: 188, Figs 7–9. Terra typica: Banijska in the former Sansak Novipazar (? Albania), Ipek (= Peć, Serbia), Dečani (Serbia), Belgrade. Syntypi: have probably got burnt.

I am unable to establish what slug Soós dealt with when describing this species. He classifies it among *Gigantomilax* Boettger, 1883 but the drawings enclosed evidently disprove it. The malacologist states that intestine consists of 6 loops, although there are only 2 in the drawing (Soós 1924, Fig. 8). In *Gigantomilax* 3 loops occur, the third one being situated, like in *Limax*, beyond the crossing with the main retractor. In such a situation 6 intestine segments, ascending and descending, can be distinguished. However, in the Figure there are only 4 (!) such segments distinguishable. Judging from the description and drawings of the slug's external appearance

(Fig. 7) and genitalia (Fig. 9), nothing justifies the author's decision to classify the slug described as *Gigantomilax*; after all, this genus does not occur in Europe. The slug Soós describes is most probably a species of the genus *Deroceras*, yet I cannot establish which one. It may be, for example, *Deroceras turcicum*.

– "*Gigantomilax occidentalis* Hesse, 1928"

Gigantomilax occidentalis Hesse, 1928: 15, Pl. 2, Figs 11a–b. Locus typicus: Pepelak, 2000 m a.s.l. (Macedonia, probably the Baba Mts). Syntypi: I do not know whether they exist and, if so, where they are kept.

According to the description (Hesse 1928), it is a deeply black slug, up to 33 mm long, with a short keel and postmedial pneumostom. Hesse compares its intestine to that organ in *Gigantomilax talyschanus* Simroth, 1912 (= *Gigantomilax (Monochroma) lenkoranus* Simroth, 1912). The drawing of the genitalia, however, indicates that it is rather a species of *Lehmannia* concerned. The slug has a massive, club-shaped penis with a small conical penial gland. Small, oval spermatheca, along with spermatheca duct are at least half shorter than penis. At the end of the description the author states that until recently *Gigantomilax* has been known only from the Caucasus. Yet, Soós has lately described *Gigantomilax csikii* from the Balkans (see the above notes on this species).

It does not follow from the description and drawings of *G. occidentalis* that there are any grounds for classifying this slug as *Gigantomilax*. Hesse, in all likelihood influenced by Soós's recent classification of this genus among the Balkan fauna, may have overlooked the transparent, poorly visible caecum. The slug he examined may have been the melanistic form of *Lehmannia*. It seems highly probable that it was *Lehmannia brunneri* (see its description p. 63). This species should be expected to occur in this region, especially in high mountains where its colour form is black. It has a small spermatheca and penial gland often small as well. When during preservation its penis gets strongly contracted, it resembles that shown in the drawing in Hesse's paper. It is worth noting that Urbański and Wiktor (1968) recorded *Gigantomilax occidentalis* from Bulgaria. At that

time we were influenced by Hesse's drawings and description. Later I rectified this information (Wiktor 1983), having found in the course of my further study that it was *Lehmannia brunneri* concerned.

Genus *Malacolimax* Malm, 1868

Malacolimax Malm, 1868: 66. Species typica: *Limax tenellus* O.F. Müller 1774.

Microheynemannia Simroth, 1891: 302. Species typica: *Limax tenellus* Nilsson, 1822 = *L. tenellus* O.F. Müller 1774.

References: Hesse 1926: 12; Likharev and Wiktor 1980: 258; Wiktor 1983: 160; Wiktor 1989: 144.

Slugs of medium size: live specimens up to c. 60 mm, preserved c. 35 mm long. Keel poorly arched. Pneumostom postmedial. Skin thin and soft. Live slugs evenly coloured, preserved may have scarcely visible, blurred, grey streaks on mantle. Sole unicolour. Mucus thin and transparent, colourless or yellow.

Genitalia. Vas deferens slanting but opening apically. Penis short, spadiceous or, at the very least, cylindrically short. Inside it a complex system of folds. Spermatheca connected with penis. Right omatophore retractor crosses right tentacle (or its retractor), the latter running between penis and oviductus.

Central and lateral teeth of radula with two or three cusps, marginal with two or four cusps. Digestive system forms three loops, the last one reaching as far as gonad and hence nearly the body end. Caecum lacking. The rear part of viscera made up of the left liver lobe.

Slugs of one-year cycle, crawling on the ground.

Distribution

The genus inhabits West and Central Europe and the Canary Islands. It was also recorded from North Africa.

28. ?*Malacolimax kostali* Babor, 1900

Malacolimax n. sp.: Babor and Košťál 1894: 4.

Malacolimax Kostalii Babor, 1900: 149. Terra typica: East Alps up to the Czech Republic ("Grimming... sonst überhaupt in Ostalpen, im Karst und selten in Böhmen"). Typus: no information.

The status of this taxon is completely unclear. It seems to be a synonym of *Malacolimax tenellus* (for

notes on this species see below). Judging from the descriptions available, this slug is to differ from *M. tenellus* in smaller size, pale grey coloration, in the colour of mantle being darkened in its medial part, penis being longer than oviductus and – in the structure of radula – in an additional cusp on marginal teeth. The above mentioned characters, however, seem to come within the variability range of *M. tenellus*, this being an opinion shared by the majority of the present-day malacologists (Likharev, Wiktor 1980 p. 261; Wiktor 1989 p. 148; Kerney et al. 1983 p. 186; Reischütz 1986 p. 124). Nevertheless, none of them has managed to finally settle this issue. Reports on the occurrence of this taxon come also from the territory of the former Yugoslavia but in this case another species, namely *Malacolimax mrazeki*, should be taken into consideration. All the specimens of *Malacolimax* from Yugoslavia that I examined myself belonged to *M. mrazeki* (see below).

Below I quote the records of *Malacolimax kostali* from literature. Although I cannot unequivocally interpret them, in all likelihood all of them concern *M. mrazeki*. My former information about *M. kostali* from Yugoslavia (Wiktor 1982) ought to be rectified as it concerned not *M. kostali* but *M. mrazeki*!

Slovenia: after Wiktor 1982: Laskova Valley at the foot of Snežnik Mt. E of Ilirjska Bistrica (false information – it actually concerns *M. mrazeki*).

Croatia: after Wagner 1934c: Kik Mt., Plitvice. Wagner 1937a: lakes Plitvicke Jezera, Mali Halan. Wagner 1937b: Kik Mt., Leskovac near Plitvicke Jezera, Mali Halan. Wiktor 1982: environs of lakes Plitvicke Jezera, near Lake Koziak and Vilni Dvor (concerns *M. mrazeki*).

Bosnia and Herzegovina: after Wagner 1937b: Djed Mt., Vucija, Bara in the Baba Mts, near Gacko, Prenj Mts, Pazaric-Mrtvanje, Imagan near Ilidze (? Ilidža S of Sarajevo). Jaeckel et al. 1958: Kraina. Wiktor 1982: Sarajevo (concerns *M. mrazeki*).

Serbia: after Wiktor 1982: Avala Mt. near Belgrade (concerns *M. mrazeki*).

29. *Malacolimax mrazeki* (Simroth, 1904)

Limax Mrazeki Simroth, 1905 (1904): 12, Figs 1–14. Locus typicus: Durmitor Mts (Montenegro). Typus: no information.

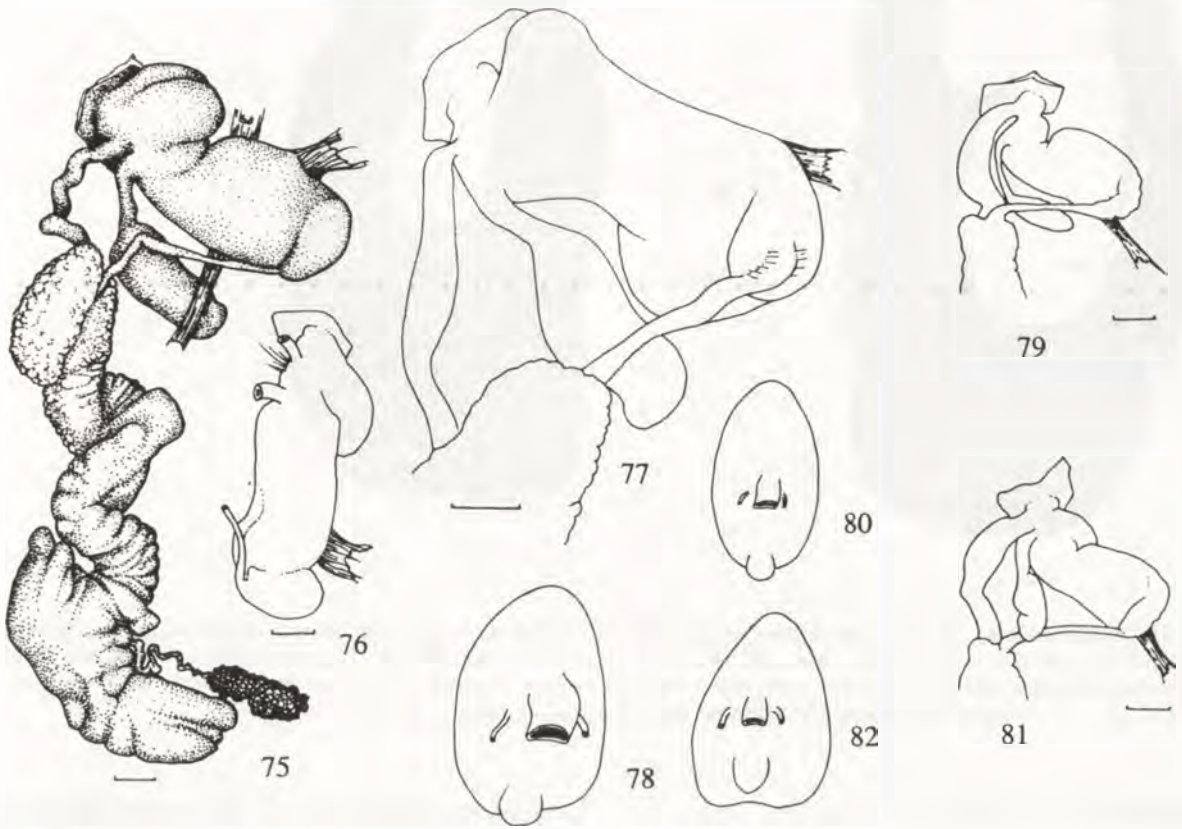
Specimens preserved in alcohol up to 38 mm long, to 8.5 mm wide, mantle length up to 14 mm. General coloration of live slugs dark canary-yellow.



Fig. 74. *Malacolimax mrazeki* (Simroth, 1904) – dorsal view, specimen from Kremna (Serbia) after preservation.

On mantle two blackish streaks, between which a darker mid-mantle (Fig. 74). The dark pigment present also in the posterior part, behind mantle, is concentrated in two darker, blurred streaks, between which a slightly paler keel occurs and a streak of the keel's colour on its extension. Sides dark canary-coloured. Sole whitish. Tentacles black. During preservation in alcohol head as well as the streaks on mantle and back become brown-blackish of different colour intensity. Specimens from Slovenia are somewhat lighter in colour than those from more southerly areas of the former Yugoslavia, which have markedly darker streaks. Tentacles blackish or black. The rest of the body whitish. Mucus yellow-orange.

Genitalia (Figs 75–77). Penis short, club-shaped or nearly oval, narrowing anterad, sometimes so considerably that it becomes S-like bent. Irregular swellings present in its anterior section. The length of penis



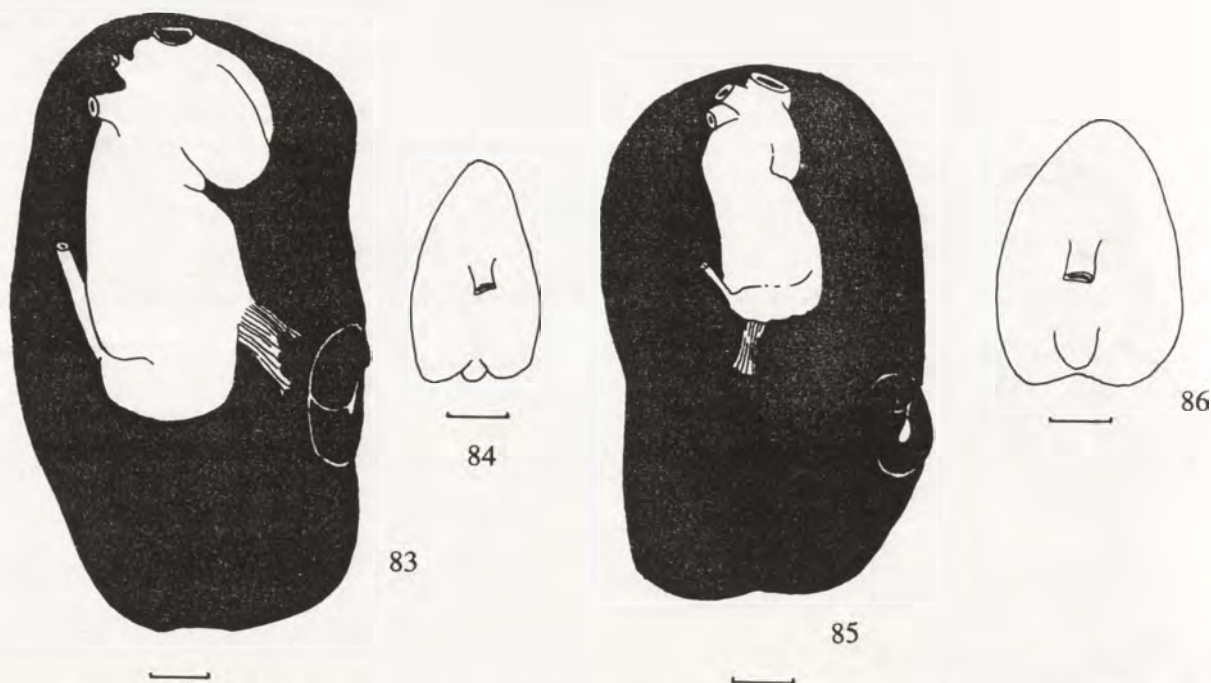
Figs 75–82. *Malacolimax*. 75–78 – *Malacolimax mrazeki* (Simroth, 1904). 75 – reproductive system, specimen from Žabljak (Montenegro). 76 – penis, specimen from Žabljak. 77 – copulatory organs, another specimen from Žabljak. 78 – pharynx, the same specimen as in Fig. 77). 79–82 – *Malacolimax tenellus* (Müller, 1774) – copulatory organs and pharynx. 79–80 – specimen from Boguszów, Sudete Mts (Poland). 81–82 – specimen from Trójihrad Mt, Sudete Mts (Poland).

markedly exceeds half of the mantle length (Fig. 83) (! important – see the comments), being c. 2.5 times longer than pharynx (Figs 77–78, 83–84). In the posterior section a dark coloured part is distinguishable. Seen from one side, it resembles a sort of a little cap set on this organ. When seen from another, it turns to be a crescent-shaped distension being as if an extension of the laterally opening vas deferens. Yet, it is already integrally connected with penis. Musculus retractor penis strong, laterally set at c. $\frac{2}{3}$ penis length. Inside penis a complex, variable in appearance system of folds, one of which is often tongue-shaped. Spermatheca duct connected with penis.

Spermatheca container elongated, oval in outline, more or less as long as spermatheca duct. Spermatheca and spermatheca duct together c. $\frac{1}{3}$ shorter than penis. Oviductus shorter than half penis. Right omatophore or its muscle crosses penis, running between this organ, spermatheca and oviductus.

Ecology

The species occurs in forests, most often with an admixture of the beech-tree, rarely in open areas and then always sheltered by vegetation. (It seems to live in similar conditions as those preferred by *Malacolimax tenellus*).



Figs 83–86. *Malacolimax*. 83–84 – *Malacolimax mrazeki* (Simroth, 1904). 83 – proportion between the size of mantle (black) and penis (white), specimen from Žabljak, Durmitor Mts (Montenegro). 84 – pharynx, the same specimen as in Fig. 83. 85–86 – *Malacolimax tenellus* (Müller, 1774). 85 – proportion between the size of mantle (black) and penis (white), specimen from Trójgrad Mt., Sudete Mts (Poland). 86 – pharynx, the same specimen as in Fig. 85.

Distribution

It requires investigation. So far the species has been known exclusively from the area of the former Yugoslavia (Map 7). Its localities, however, are scattered from the base of the Istra Peninsula and the SE Alps down to Montenegro in the south.

Examined material: 69 spec.

Slovenia: Julijske Alpe, valley N of Triglav Mt., near Dovie village, 700–1000 m a.s.l., *Fagus-Picea* forest; Snežnik Massif, *Fagus* bush, limestone, 1000 m a.s.l.

Croatia: Istra (Istria), Lavran Voljak Mt. in the Učka Massif, 600–1100 m a.s.l., *Fagus-Castanea* forest, limestone; near vill. Delnice, *Fagus-Picea* forest, limestone, 700–900 m a.s.l.; Strumac Mt., Psunj Massif (N of Nova Gradiška), 350–500 m a.s.l.; slate, *Petasitis-Urtica*, near a stream; Zagreb, city park, 135 m a.s.l.

Serbia: Kremna, W of Titovo Užice (= Užice), Tara Planina Mts, 1200–1300 m a.s.l., *Abies-Fagus* forest, humid habitat.

Montenegro: Mojkovac, Sinjajevina Mts, 700–800 m a.s.l., slate, meadows and shrubs; Žabljak, Durmitor Mts, 1450–1550 m a.s.l., forest and glades; Durmitor Mts, on the path from Žabljak to Bobov Kuk Mt., 1600–1700 m a.s.l., *Abies-Picea*

forest; Durmitor Mts, lake Črno Ozero, near Žabljak, 1450 m a.s.l., leg. W.J.M. Maassen; Njegoš Mts, Vijnik Mt., NW of Nikšić, *Fagus* forest, 1200–1300 m a.s.l., limestone.

After Simroth 1909: between Kolašin and Andrijevica. Jaekel et al. 1958: Montenegro. Bole 1984: Žabljak, Poljanak.

Kosovo: Rugovska Klissura, 25 km W of Kučište, 1300 m a.s.l., leg. W.J.M. Maassen.

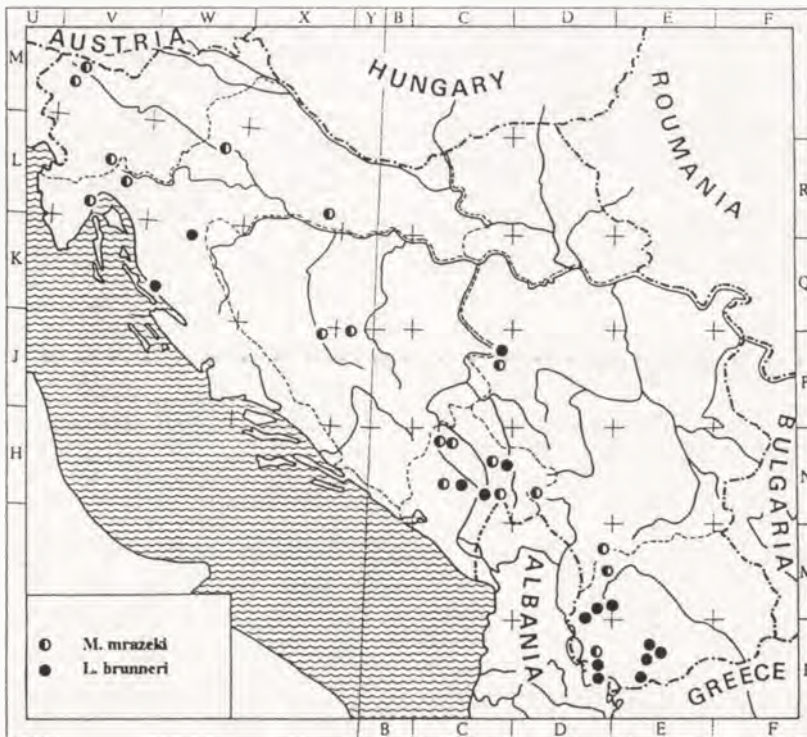
Bosnia and Herzegovina: N of Travnik, Babunovac Mt. in the Vlašić Massif, *Pinus-Abies* forest, 1700–1800 m a.s.l., limestone; Babunovac Mt. in the Vlašić Massif, *Fagus* forest, limestone, 1800–1940 m a.s.l.; near Jajce, *Fagus* forest, limestone, 500–700 m a.s.l.

Macedonia: Lake Ohrid shore, synanthropic.

Comments

I have examined specimens from Durmitor, i.e. locus typicus. The above described distinctive characters are entirely stable in all specimens from the former Yugoslavia.

The slug bears such a close similarity to *Malacolimax tenellus* that distinguishing between the two species is hardly possible. They seem to be geographically separated. I have not established the occurrence of *M. tenellus* in the former Yugoslavia.



Map 7. Distribution of *Malacolimax mrazeki* and *Lehmannia brunneri*.

Malacolimax tenellus is smaller and of a lighter shade of yellow. In live slugs the dark pigmentation on mantle and back is rudimentary, usually invisible. After preservation, when the yellow pigment is rinsed away, only inconspicuous, darker, greyish streaks are perceivable. Their distribution, however, resembles that seen in *M. mrazeki*. A manifest difference in the structure of genitalia concerns penis, which is considerably smaller and shorter in *M. tenellus*. In the latter slug this organ is shorter than half of mantle and insignificantly longer than pharynx, while in *M. mrazeki* it is markedly longer than half mantle and c. 2.5 times longer than pharynx (c.f. Figs 83–84 and 85–86). There also exists a small difference with regard to the musculus retractor penis insertions. In *M. tenellus* this muscle is attached to penis closer to the side where vas deferens opens. Therefore, when body integuments are cut aside on the left side and genitalia disclosed, retractor is visible on the extension of penis, nearly on its longitudinal axis, or to the left of it (from the side of vas deferens, see Figs 79, 81). In *M. mrazeki*, with the same location of copula-

tory organs, retractor is visible on the right side of penis (i.e. from the opposite side than vas deferens, see Figs 75–77). It seems to be a result of different location of the two insertions, the anterior and the posterior one. It is a feature difficult to describe but plain when the topographies of two specimens lying side by side are compared. There is one more character: in proportion to the body size pharynx is considerably bigger in *M. tenellus* than in *M. mrazeki*. When the two slugs, one by the other, are compared, the differences between them are completely clear.

The distribution ranges of the above discussed species should be thoroughly investigated in order to establish whether there are any transitional forms between them. My hitherto made observations and comparisons between material from Poland, Spain and the former Yugoslavia suggest that there are no transitional forms between those slugs and that their ranges do not overlap. Besides, one must not ignore the fact that in older literature the names "*M. tenellus*", "*M. kostali*" and "*M. mrazeki*" were used for at least two different taxa, and it may not

only concern slugs from the former Yugoslavia's territory but from other areas as well. Thus, these are the data about the occurrence of these slugs in the areas of Austria, Italy, Hungary and Greece bordering on the former Yugoslavia that particularly need to be verified.

It also seems highly probable that *Limax tigvenius* Grossu, 1968 (see also Grossu 1983) is a junior synonym of *M. mrazeki*.

– *Malacolimax tenellus* (Müller, 1774)

Limax tenellus O.F. Müller, 1774: 11. Opinion ICZN 336, 1955. Locus typicus: Frideriksdal in the neighbourhood of Copenhagen. Typus: I have no information about it; probably not preserved.

Synonyms: *Limax tenellus* Nilsson, 1822; *Limax serotinus* Schrenk, 1848; *Limax cereus* Held, 1849; *Limax collinus* Normand, 1952; *Limax silvaticus* Dumont et Mortillet, 1852; *Limax fulvus* Normand, 1852; *Limax cinctus* Heynemann, 1862; *Limax xanthius* Bourguignat, 1866; ?*Limax Kostálii* Babor, 1900 (for bibliographic data on these taxa see Hesse 1926).

The occurrence of this species in the former Yugoslavia needs a confirmation.

Body thickset, soft. The length of live specimens up to c. 50 mm, after preservation up to c. 35 mm, width up to c. 8 mm, mantle length 18 mm. Keel hardly discernible. Coloration evenly canary-yellow, sometimes with an orange or greenish tint. Only occasionally in live slugs barely perceptible, delicate, somewhat darker streaks on mantle. After preservation body creamy or whitish, with blurred, very light, grey streaks. Head and tentacles black. Sole and the region of pneumostom, also in live specimens, whitish. Mucus watery, transparent, yellow.

Genitalia (Figs 79, 81). Penis spadiceous, pear-shaped or short cylindrical, anteriorly with irregular distensions. Vas deferens, opening laterally at the posterior end of penis, extends on this organ as a crescent-shaped, often corrugated, swelling. It looks as if the distended vas deferens were there accreted to the rear penis wall. This part can be dark-pigmented. Penis small, shorter than half mantle and a little longer than pharynx. Retractor penis laterally attached in the posterior half of penis. Inside penis a system of folds and pockets of complex structure. Spermatheca elongatedly oval, set on a thin, approxi-

mately of the same length, spermatheca duct, and connected with penis. Oviductus thick, tubular, shorter than penis.

Ecology

A species occurring mainly in forests, particularly with deciduous, most often beech, trees. It may be found in urban parks and graveyards. It finds shelter in leaf litter and under wood pieces. At times it crawls to small heights up tree trunks. Most frequently it lives in humid or mesophilous habitats. *M. tenellus* feeds on mushrooms. It has a life cycle of around one year. The species winters in the egg stage.

Distribution

The slug was recorded nearly from whole Europe. Its occurrence in Central and North Europe raises no doubts. In the west it reaches the Spanish Pyreneese, where it has recently been discovered, in the east Kiev, Kazan'. In the north its distribution border lies half-way across the Scandinavian Peninsula and crosses Karelia. Its range south of the Alps should still be studied, regarding the similarity of *M. tenellus* to *M. mrazeki* and *M. tigvenius* (see the notes on *M. mrazeki* p. 60).

I did not have at my disposal any material of this species from the former Yugoslavia, the literature data available probably concerning *M. mrazeki*.

Literature records of *M. tenellus* from the area of the former Yugoslavia:

Slovenia: after Wolf and Rähle 1987: N of Vrišič pass.

Croatia: after Wagner 1937a: Devčevac near lakes Plitvice Jezera; Crnopac; Volosco (= Opatija – Istra).

Bosnia and Herzegovina: after Wagner 1937a: Plasa near Jablanica. Jaeckel et al. 1958: Bosnia.

Serbia: after Jaeckel et al. 1958: Kraina.

Macedonia: after Hesse 1928: Liseč.

Comments

See the comments on *M. mrazeki*.

Genus *Lehmannia* Heynemann, 1862

Lehmannia Heynemann, 1862: 211. Species typica: *Limax marginatus* O.F. Müller, 1774.

Synonyms: *Ambigolimax* Pollonera, 1887; *Melitolimax* Pollonera, 1891 (for bibliographic data see Hesse 1926).

References: Forcart 1966; Likharev and Wiktor 1980; Wiktor and Likharev 1980; Jungbluth et al. 1981; Wiktor 1983.

Slugs of medium size, live up to 80 mm, after preservation c. 40 mm long. Body markedly slender. Mantle small, covering only $\frac{1}{3}$ of the total length, with delicate, concentric wrinkles in live slugs. Pneumostom postmedial. Keel only in the posterior body section. On its extension, however, usually a light streak occurs, which may be misleading. Sole grooves between the zones anteriorly parallel, posteriorly a little convergent. Coloration varying, usually also within particular species, most often dirty cream with darker streaks on the sides of mantle. At times a few streaks, more or less parallel, present on mantle. In the posterior body section usually several rows of dark dots, sometimes streaks, or combination of both. Unicolour black forms are often found. In the case of some slugs this colour is a species-specific character whereas in others the black individuals are only melanistic forms living in the mountains. Mucus colourless, highly watery.

Genitalia. Penis short, usually smaller than $\frac{2}{3}$ mantle length, crossing right tentacle retractor. Almost in all species at the penis end, or near it, there is an unbranched penial gland in the shape of a nodule or

a flagelliform process (!). Inside penis a tongue-shaped fold. Spermatheca duct connected with penis.

Alimentary canal forms three loops. The last one is short and equipped with a very long, reaching the end of viscera (!), caecum. It is translucent, never filled with intestinal contents, tightly adhering to the body walls. Radular marginal teeth sabre-like and S-like bent (!).

Very agile slugs, the majority crawling up tree bark or on rocks. They feed mainly on lichens. The life cycle lasting more than a year. A dozen or so species known. The range of the genus covers Europe and North Africa.

30. *Lehmannia brunneri* (Wagner, 1931)

Agriolimax Brunneri Wagner, 1931a: 197. Locus typicus: "Rilo Vr." (probably Rilets Vukhr) – Bulgaria. Syntypi: Naturhist. Mus., Wien.

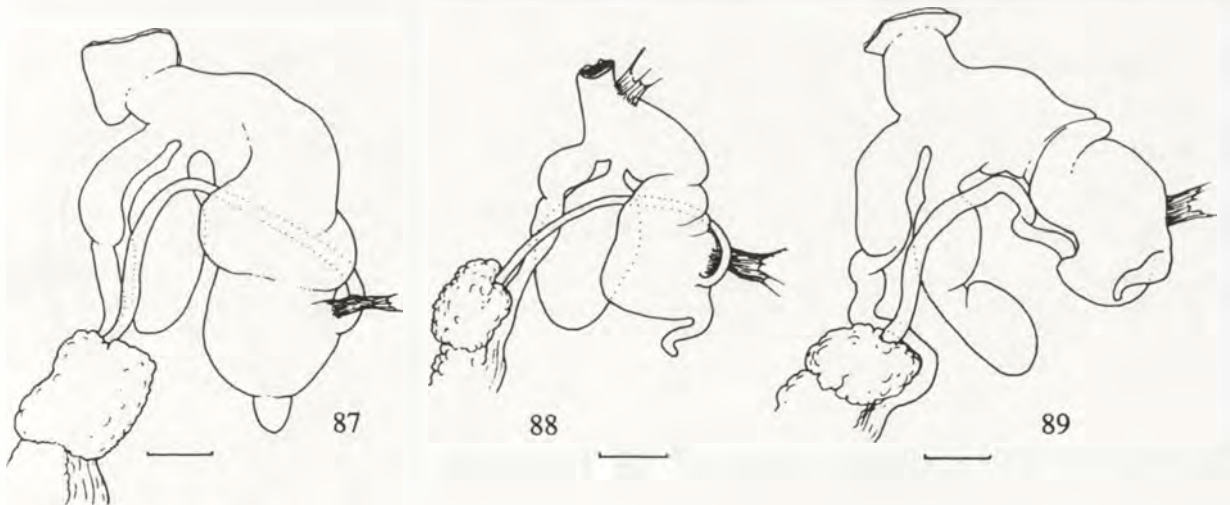
Agriolimax Brunneri: Wagner 1937a: 386, Fig. 11.

Deroceras brunneri: Jaeckel et al. 1957: 161.

Deroceras brunneri = *Lehmannia brunneri*: Urbański and Wiktor 1968: 75.

Gigantomilax occidentalis: Urbański and Wiktor 1968: 79.

Limax (Lehmannia) macroflagellatus (partim): Damjanov and Likharev 1975: 314, Fig. 244.



Figs 87–89. *Lehmannia brunneri* (Wagner, 1931) – copulatory organs. 87 – specimen from Peštani (Macedonia). 88 – specimen from Mavrovo (Macedonia). 89 – specimen from Mojkovac (Macedonia).

Body length up to 50 mm, width to 8–9 mm, mantle length to 16 mm. Coloration varied, from evenly black with a navy-blue shade to uniformly light ashen, the latter specimens being rare. The most frequent colour form in the former Yugoslavia is grey-creamy with a darker, usually black or black-grey pattern. The body pattern resembles that of some other species of the genus *Lehmannia* (e.g. *L. macroflagellata* Grossu et Lupu, 1962). Most often there are 5 dark streaks on mantle and 4 on the rest of the body. In the part behind mantle the streaks are usually dashed or made up of rows of dots.

Genitalia (Figs 87–92). Prostate poorly developed, not anteriorly enlarged as it is the case in many other species. Penis elongatedly cylindrical, often S-like bent, sometimes with lateral swellings. The posterior penis section is not distended but forms a sort of pocket, to which vas deferens opens asymmetrically and apically. Before it joins penis, the latter organ is funnel-like broadened (!). The posterior penis section is usually dark-pigmented. Conical or flagellate penial gland, laterally connected to penis, can attain the length equalling a half of penis. The gland is most often directed posterad. Musculus retractor penis is

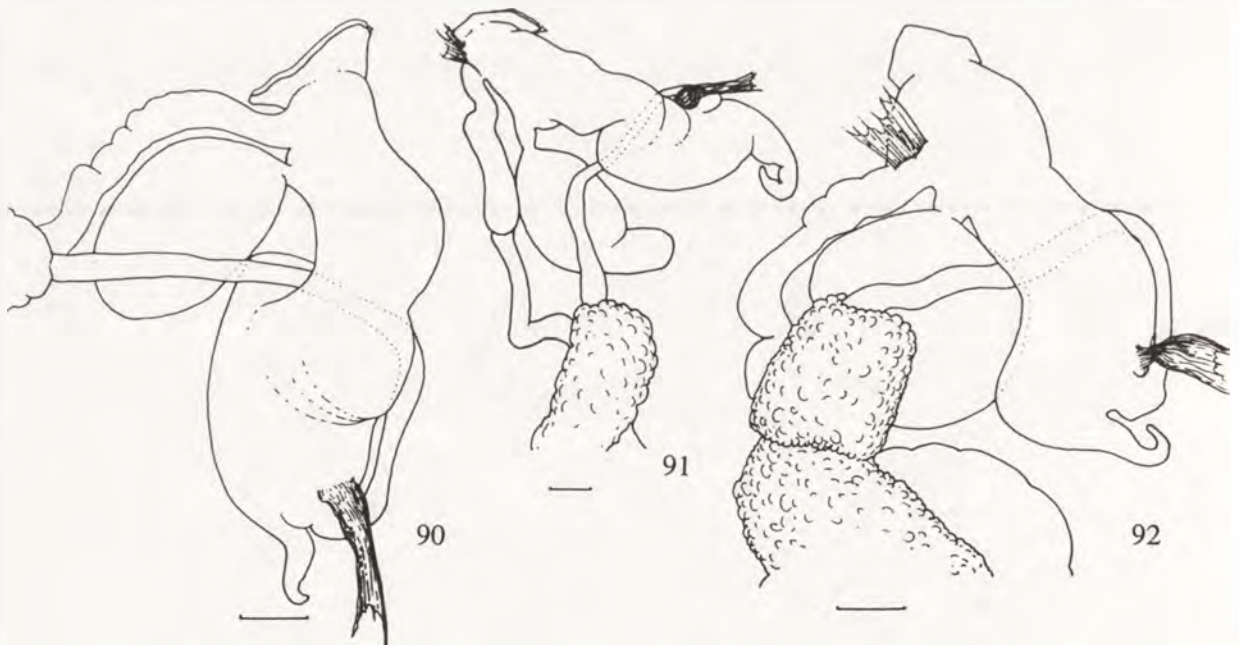
laterally (not apically) attached. Spermatheca oval or a little tapering posterad, set on a short spermatheca duct. They both, i.e. spermatheca and spermatheca duct, together are shorter than penis (!). The connection between spermatheca duct and penis is situated at a certain distance from atrium. In the natural location of genitalia, spermoviductus nearly adheres to atrium and, as oviductus is relatively long, the latter organ forms a loop aside.

Ecology

A mountain species, most frequently occurring above 600 m a.s.l. and exceeding the timberline. It lives on rocks, shelters in rock crevices and feeds on rock lichens. I have never found it on trees (!). The slug, though difficult to find, after rain appears in great numbers. The majority of specimens collected are practically always juveniles with only a few adults among them. The two generations are found together both in spring and autumn.

Distribution

A Balkan species. Its range covers almost all the Bulgarian mountains. Within the former Yugoslavia's territory it occurs in Macedonia, Montenegro, Serbia



Figs 90–92. *Lehmannia brunneri* (Wagner, 1931) – copulatory organs. 90 – specimen from Prilep (Macedonia). 91 – specimen from Mavrovo (Macedonia). 92 – another specimen from Prilep (Macedonia).

and Croatia (Map 7). In Greece recorded from north-western continental regions (the vicinity of Florina – Wiktor in print) up to the region of Zitsa in the Epir Mts (Reischütz, Sattmann 1990). The distribution range probably reaches more southerly areas, where I also found similar slugs but, since all of them were juvenile, I was unable to identify them.

Examined material collected in the former Yugoslavia – over 150 spec.

Croatia: Plitvice Lakes National Park in the Pleševica Massif, *Fagus* forest, limestone, 600 m a.s.l.; Baške Oštarije in the Velebit Mts, 900 m a.s.l., leg. W.J.M. Maassen.

Serbia: Partizanske vode (SW of Titovo Užice = Užice), Zlatibor Mts, *Fagus* forest, 1350–1400 m a.s.l.

After Rähle 1977a (as *Lehmannia* sp.): Šar Planina Mts, Prevalec pass near Brezovica. Wiktor 1982: Muglič Mt.

Montenegro: Mojkovac, Bigorski National Park, Bjelasica Mts, *Fagus* forest, slate, 1000–1500 m a.s.l.; Mojkovac in Sinjajevina, on rocks, limestone, 1000–1500 m a.s.l.

After Rähle 1977a: Trašnjevik pass between Kolašin and Andrijevica.

Macedonia: Popova Šapka near Tetevo in the Šar Planina Mts, under stones, metamorphic and crystalline rocks, 1800–1840 m a.s.l., leg. A. Riedel; Jakupica Mts (S of Skopje), in the Kadine river valley above Zelnikovo village (between Titov Vales and Skopje), *Alnus* forest, slate; Padalište, Jakupica Mts (S of Skopje), slope of Solunska Glava; Padalište, SE of Gostivar, near the railroad to Kičevo, in a deep valley, limestone, 750 m a.s.l.; Tajmište, between Gostivar and Kičevo, *Fagus* forest with *Corylus*, metamorphic rocks, 700–1000 m a.s.l.; Mavrovo, Mavrovo National Park, *Abies* forest, green slate, 1700–1900 m a.s.l.; Peštani, N of Ohrid (c. 30 km), by the Sateska river, *Alnus* forest, 700 m a.s.l.; ? juv. spec. – S of Peštani, *Quercus* forest, 900 m a.s.l.; ? juv. spec. – Peštani, on the rocks near Lake Ohrid, leg. L. Pintér, E.P. Subai, A. Szigethy; Baba Mts near Bitola, above the town, gneiss, *Fagus* forest, 700–1500 m a.s.l.; Baba Mts above Magarevo village (near Bitola), on rocks in *Pinus* forest, granite and gneiss, 700–2000 m a.s.l.; Prilep, hills above the town, ruins, granite, 700–800 m a.s.l., dry biotope with a poor plant cover; Babuna Mts near Prilep, dry naked rocks, 1000–1650 m a.s.l.; Carevec Mt. in the Bistra Planina Mts, mountain meadows, limestone, leg. A. Riedel.

– *Lehmannia janetscheki* Forcart, 1966

Lehmannia janetscheki Forcart, 1966: 230, Fig. 3. Locus typicus: Trotter Alm, S Tirol (Austria). Holotypus: Naturhist. Mus., Basel, no. 9616–b.

A species of a very unclear taxonomic status. It seems probable that here it is only one of the mountain forms of *L. marginata* concerned.

The only record of this slug from the former Yugoslavia's area is mine (Wiktor 1982: 483, Fig. 19). It was based only on one specimen collected between Karlobag and Gospać (Croatia). Now that I have failed to find any slugs recognizable as *L. janetscheki* in the material from Croatia and from other parts of the area discussed, I have to change my opinion. At present I am even highly doubtful whether such a species actually exists as, by any means, it cannot be distinguished on the basis of the material I have at my disposal. Hereby withdrawing the information given in 1982, I classify the slug I was then describing as *L. marginata*.

Comments

According to Forcart, *L. janetscheki* is a small slug, c. 30 mm long, of brownish general coloration. It has two paler stripes in mid mantle and two darker ones on sides. In the structure of genitalia it is conspicuous by a short oviductus (Forcart calls this part of genitalia "uterus"), notably swollen prostate and vermiform, tapering penial gland (Forcart calls it "Penisflagellum").

The above mentioned characters seem to fall within the variability range of *L. marginata*, particularly of its forms occurring in the mountains. It is also worth adding that Forcart used different preservation methods than the majority of other collectors did. As the malacologist states in his paper, he used to kill his slugs in a 4% formalin solution, and then preserved them in alcohol. This method results in numerous deformations within the soft organs, the shape of copulatory organs being completely incomparable with the genitalia of specimens preserved in alcohol. Besides, Forcart often described genitalia basing on slides embedded in the Canada balsam. It is just the case with the figure in his paper (Forcart 1966, Fig. 3), which seems to be slide-based.

31. *Lehmannia marginata* (Müller, 1774)

Limax marginatus O.F. Müller, 1774: 10. Locus typicus: Fridriksdal in the vicinity of Copenhagen (Denmark). Typus: not preserved.

Synonyms: *Limax scopulorum* Fabricius, 1779; *Limax salicium* Bouillet, 1836; *Limax limbatus* Held, 1837; *Limax arborum* Bouchard-Chantreaux, 1838; *Limax livonicus* Schrenck, 1848; *Limax scandens* Normand, 1852; *Limax arboreus* Clerke, 1853; *Limax glaucus* Clerke, 1853; *Limax silvaticus*

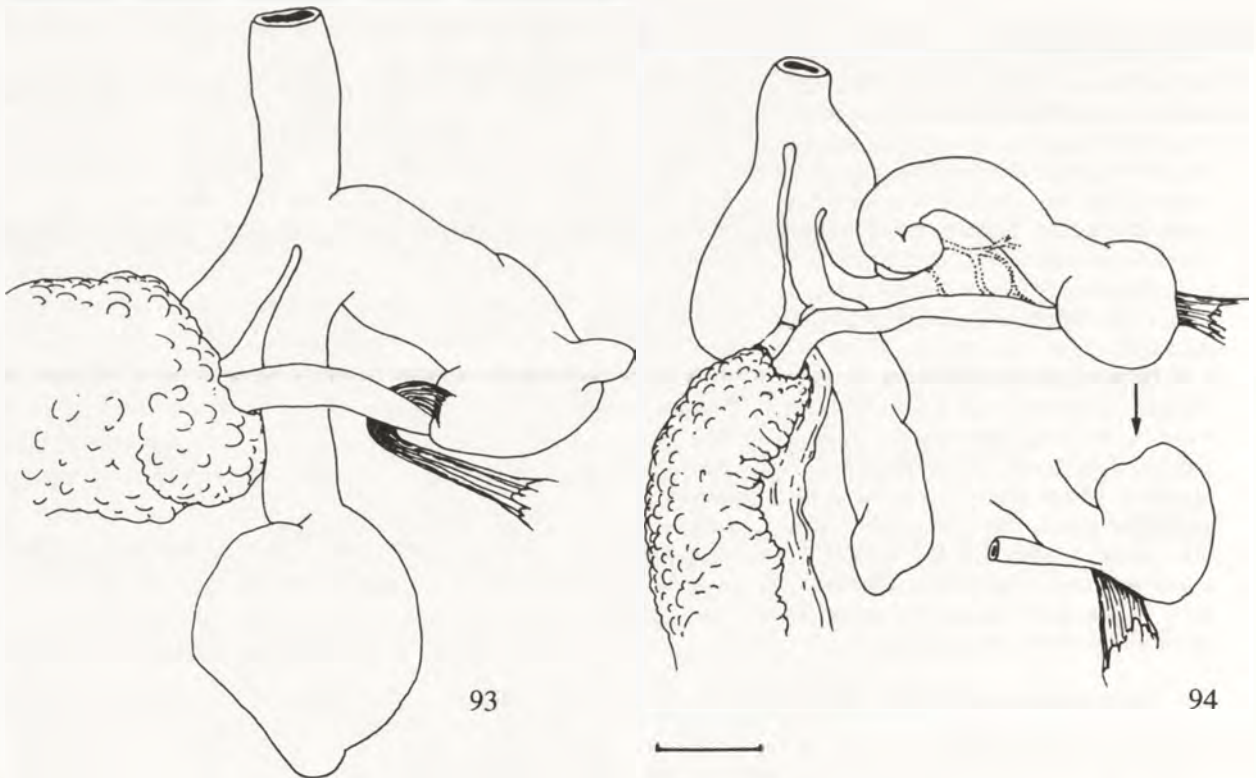
Goldfus, 1856 (non Draparnaud); *Limax arboreum* Gray, 1857; *Limax helveticus* Bourguignat, 1862; *Limax altilis* Fischer, 1877; *Lehmannia bielzi* Lupu, 1973 (bibliographic data for most of the synonyms are available in Hesse 1926).

References: Forcart 1966: 226, Fig. 1; Wiktor 1973: 88, Figs 31–32, 121–128, 234, 253–254; Likharev and Wiktor 1980: 263, Figs 319–323; Kerney et al. 1983: 186, Pl. 13, Fig. 6, Map 204; Wiktor 1989: 149, Figs 185–186, 189–196.

Body length after preservation up to 65 mm, specimens from the former Yugoslavia up to 56 mm long, to 12 mm wide, mantle length 18 mm. With respect to coloration specimens from the area concerned do not differ from those from other regions. Body usually grey, ashen, occasionally with a creamy shade on sides. On this background dark or simply black streaks and blurred-edged spots occur. The dark pattern is more intense in specimens living in the mountains. Sometimes the streaks are present only on the sides of mantle. There are usually only two such

streaks and a less distinct, third one in the medial part of mantle. The part beyond mantle may be unicolour or covered with a pattern. Identification on the grounds of coloration is always uncertain.

Genitalia (Fig. 93). Penis clavately distended posterad. Vas deferens short and thick, opening laterally at the end of penis. Near the former organ there is the insertion of retractor penis. Penial gland connected to penis on the opposite side of the distension than it is the case with the vas deferens outlet. The gland assumes the shape of a conical nodule or elongated, even flagelliform, process but it is always shorter than penis (!). The length of this organ varies, mountain populations usually having their penial gland longer than those of the lowlands. Spermatheca of varied shape, set on a thick stalk. Along with spermatheca duct it approximates to penis in length or is at most c. $\frac{1}{3}$ longer than the latter organ (!).



Figs 93–94. Copulatory organs. 93 – *Lehmannia marginata* (Müller, 1774), specimen from Rozdrto (Slovenia). 94 – *Lehmannia nyctelia* (Bourguignat, 1861), specimen from Mojkovac (Montenegro).

Ecology

An arboreal slug, preferring beech and hornbeam trees, found also on rocks. It shelters under bark, in tree-holes and rock crevices. Its life-cycle lasts c. 3 years, sexual maturity being reached in the second one.

Distribution

The species inhabits nearly the whole of Europe and N Africa. The distribution border in S Europe is not clear, probably the numerous reports on *L. marginata* in this area pertain to other species. Within the former Yugoslavia's territory its occurrence has been confirmed only in Slovenia and Croatia, and in one locality in Bosnia.

Examined material collected in the former Yugoslavia: over 40 specimens.

Slovenia: Julijske Alpe, Pakljuka in the Triglav National Park, *Picea* forest, limestone, c. 1000 m a.s.l.; Julijske Alpe, Vintgar canyon near Bled, *Fagus-Acer* forest, on rocks and in litter, limestone, 700–750 m a.s.l.; Rozdrto in the Nanos

Massif (SW of Postojna). *Fagus-Acer* forest, limestone, 1100–1300 m a.s.l.; Radeče (between Zagreb and Ljubljana) in the Kum Massif, *Fagus* forest, 700–1000 m a.s.l.

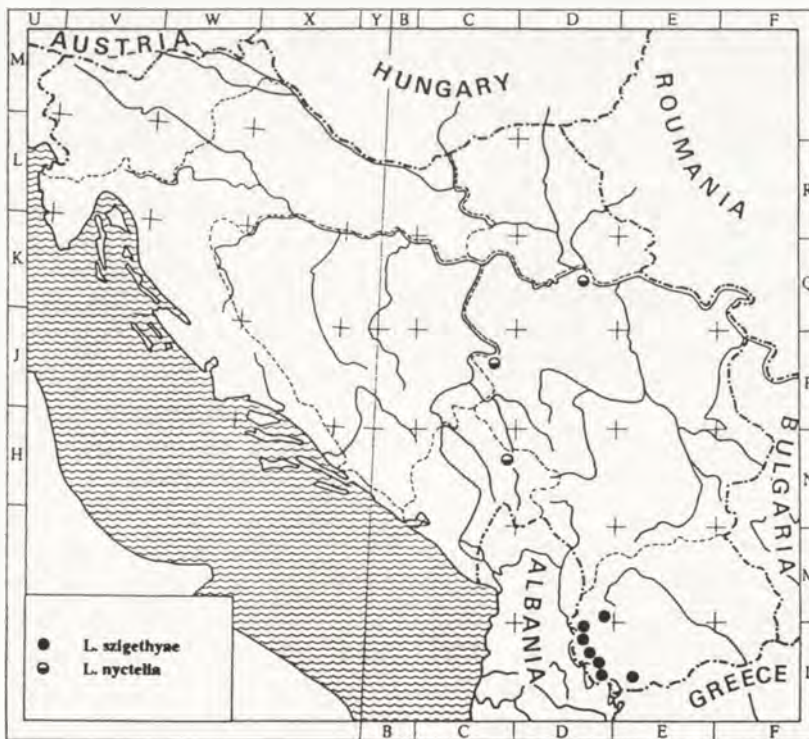
After Bole 1962: Triglav National Park. Bole 1976a: Smrkov draga in Trnovski gozd, Grda draga near Snežnik. Bole 1977: Šmarne gore. Wolf and Rähle 1987: N of Vrišič pass, Lepenja valley, Slatenik river valley (S of Bobovac).

Croatia: Lavran, Voljak Mts in the Učka Massif (Istra), *Fagus-Castanea* forest, limestone, 600–1100 m a.s.l.; Risnjak National Park, near Črny Lug (near Delnice), *Fagus-Picea* forest, limestone, 1000–1200 m a.s.l.; Zagreb, city park, 135 m a.s.l.; Strumac Mt in the Psunj Massif (N of Nova Gradiška), *Petasites* and *Urtica* thickets near stream, slate, 350–500 m a.s.l.; ? Velebit Mts, above Sv. Rok village, on Voganski Vrh (= Mt.), NE slope, *Fagus* forest, above 1000 m a.s.l.

After Sturany 1895: near Plitvice Jezera. Wagner 1937a: Devcičevac near Plitvice Jezera, Črna Rieka, Kik Mt. 1084 m a.s.l., S of Plitvice Jezera, Mali Halan, Biela stiecec near Jesenak, Apatisan (?), W of Krasno, Lomska duliba (?). Wagner 1939: Rovinij (Istra). Jaekel et al. 1958: Croatia.

Bosnia and Herzegovina: near Jajce, *Fagus* forest, 500–700 m a.s.l.

After Wagner 1937a: Plasa near Jablanica, near Celebic and Foča, Warda near Bjelabrdo. Jaekel et al. 1958: Bosnia.



Map 8. Distribution of *Lehmannia szigethyae* and *Lehmannia nyctella*.

32. *Lehmannia nyctelia* (Bourguignat, 1861)

Limax nyctelius Bourguignat, 1861: 305, Pl. 2, Figs 3–4. Terra typica: Algeria. Typus: I have no information about it.

Agriolimax (Malacolimax) Kervillei Germain, 1907: 154. Terra typica: "Khroumirie" (NW Tunisia). I have got no information whether the types have been preserved.

References: Quick 1960: 200, Figs 17B–E; Grossu and Lupu 1963: 141, Figs 1–37; Altena 1967: 25; Urbański and Wiktor 1968: 51, Figs 1A–C; Wiktor 1973: 99, Figs 29–30, 143–149, 237, 259–260; Damjanov and Likharev 1975: 309 (as *Limax (Limacus)*); Likharev and Wiktor 1980: 271, Figs 237–342; Kerney et al. 1983: 186, Map 203; Wiktor 1983: 150, Figs 68–70, map 19; Wiktor 1989: 161, Figs 210–211, 222–230.

Live slugs up to 50 mm long, after preservation to 46 mm, width up to 9 mm, mantle length to 16 mm. Coloration varying, which prevents unmistakable identification under field conditions. Most often body grey or brown-ashen, with blackish or dark brown spots and streaks on this background. On mantle more or less distinct streaks occur, while beyond it there are usually spots assuming the shape of rows or blurred streaks. The melanistic forms found in the mountains are entirely black or chocolate-black. Sole creamy.

Genitalia (Fig. 94). Penis cylindrical, irregularly multifold bent or spirally coiled (!), clavately broadening posterad, the posterior part of penis being usually dark pigmented. A thick vas deferens and musculus retractor penis are asymmetrically connected with penis, the junctions lying next to each other. Penial gland lacking (!) (only in a few specimens from Poland a smallish nodule is distinguishable). Spermatheca elongate, not clearly delineated from spermatheca duct, the two organs together approximating to penis in length or being slightly shorter. Oviductus thick, c. twice shorter than penis.

Ecology

It inhabits forests and bush thickets, most often crawling up and finding shelter in trees but, high in the mountains, hiding also under stones and in rock crevices. The species frequently occurs in large numbers (e.g. in Bulgaria). In the mountains it reaches at least 2700 m a.s.l.

Distribution

The species is indigenous to Roumania, Bulgaria,

the former Yugoslavia (Map 8), Hungary, the Czech Republic, Slovakia, Poland, Austria and Germany. It seems to be most widely spread in Bulgaria (Wiktor 1983, Map 19) and Roumania. In the remaining regions, particularly in the mountains, it has scarce localities, which might be indicative of its relict character. Although the slug was also recorded from Great Britain, Egypt, Algeria, South Africa and the USA, it seems to have been introduced in all these areas.

Examined material from the former Yugoslavia: 4 spec.

Serbia: Kremna (W of Titovo Užice = Užice) in the Tara planina Mts, *Pinus* forest, 1300–1400 m a.s.l.

After Wiktor 1982: Avala near Beograd.

Montenegro: Mojkovac in the Bigorski National Park (Bjelasic Mts), 1000–1500 m a.s.l.

33. *Lehmannia szigethyae* Wiktor, 1975

Lehmannia szigethyae Wiktor, 1975a: 87, Figs 13–20. Locus typicus: Carina Sv. Naum in the Galičica Mts (in the description the names are misspelled as Galačica and Carino) (Macedonia). Holotypus: Nat. Mus., Budapest.

Lehmannia galiciensis Rähle, 1977a: 236, Figs 8, 9d. Terra typica: Galičica Mts (Macedonia). Holotypus: Senckenberg Mus., Frankfurt a/M., no. 244997.

Lehmannia ohridiana ohridiana Rähle, 1977a: 239, Figs 11–13a–b. Locus typicus: Peštani on Lake Ohrid (Macedonia). Holotypus: Senckenberg Mus., Frankfurt a/M., no. 244990.

Lehmannia ohridiana bigorski Rähle, 1977a: 243, Fig. 13b. Locus typicus: Sv. Jovan Bigorski monastery between Gostivar and Debar (Macedonia). Holotypus: Senckenberg Mus., Frankfurt a/M., no. 244994.

Body length 42 mm, width 8.2 mm, mantle length 18 mm. General coloration creamy with a varied pattern of dark stripes and spots, or evenly black, including keel. Externally, it is difficult to distinguish this species from others.

Genitalia (Fig. 95). A relatively long vas deferens opens apically but asymmetrically into penis. The latter organ long, cylindrical, straight or bent, anteriorly usually somewhat narrowed (!). The posterior section of penis sometimes separated by a slight constriction, or else near the opening of vas deferens some protuberances and dark pigmentation are noticeable. No penial gland (!). Spermatheca oval, well separable from a comparatively long spermatheca

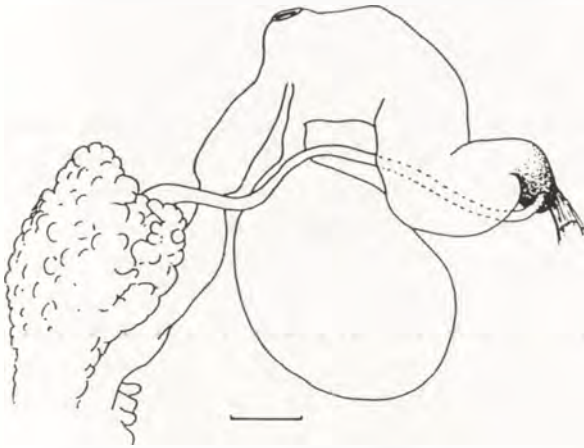


Fig. 95. *Lehmannia szigethyae* Wiktor, 1975, specimen from Lukowo (Macedonia).

duct. The two organs together are hardly longer than a half of penis. Oviductus thin, more or less equaling the length of penis.

Ecology

The species occurs mainly on rocks and in mixed or deciduous forests. In the mountains it reaches c. 1700 m a.s.l.

Distribution

So far it has been known exclusively from Macedonia and the border-close regions of Greece.

Examined material from Macedonia: over 100 spec. (Map 8).

Macedonia: Sv. Jovan Bigorski monastery in the Radika valley (S of Mavrovo), deciduous forest, 750–1000 m a.s.l., limestone; near Struga, limestone, c. 500 m a.s.l.; Debar in the Dešat Massif, limestone and slate, 1200–1500 m a.s.l.; near village Lukovo (between Debar and Struga), in the Crni Drim valley, limestone, on stones, 700–1000 m a.s.l.; Galičica Massif, Gola Buka Mt. (SE of Ohrid), *Fagus* forest, 800–1700 m a.s.l., limestone; Palister Mt. in the Baba planina Mts, 2000 m a.s.l., leg. ?.

After Wiktor 1975: Sv. Jovan Bigorski monastery in the Radika valley, on the road Carina – Sv. Naum monastery in the Galičica Mts (wrongly spelled "Carino", "Galačica"), Sv. Naum monastery on Lake Ohrid. Rähle 1977a (see the synonyms): Galičica Mts, Peštani on Lake Ohrid, Sv. Jovan Bigorski monastery between Gostivar and Debar, Ohrid. Wiktor 1982: Sv. Naum monastery on Lake Ohrid, environs of Kallista (W of Lake Ohrid), Galičica Mts.

Comments

A very characteristic species, easily identifiable due to its penis appearance and lack of penial gland. It has presumably a small range covering southern Macedonia though it probably enters deeply inland Greece, where I used to find many black juveniles of *Lehmannia* sp. (Wiktor in print).

Genus *Limax* Linnaeus, 1758

Limax Linnaeus, 1758: 652. Typus: *Limax maximus* Linnaeus, 1758.

Synonyms: *Limacella* Brard, 1815 (non Blainville); *Eulimax* Moquin-Tandon, 1855 (for bibliography see Hesse 1926 or Wiktor 1989).

Big or medium-sized slugs. Mantle covering c. ¼ of the body. Pneumostom postmedial. Keel well discernible but short.

Genitalia. Penis cylindrical or tubular, most often long, irregularly multiply bent or coiled, crossing right ommatophore or its retractor. No external accessory organs on penis, only in some species a blind pocket-shaped segment can be distinguishable in the posterior penis part. Inside penis longitudinal folds.

The distribution covers mainly Europe and the Mediterranean areas of Asia Minor and North Africa.

About 40 species known, the numerous names found in literature being probably synonyms.

Subgenus *Limax* s. str.

Synonyms: *Heynemannia* Malm, 1870; *Gastroa* Pini, 1876; *Chromolimax* Pini, 1876; *Opilolimax* Pini, 1876; *Stabillea* Pini, 1876; *Macroheyemannia* Simroth, 1891 (for bibliography see Likharev and Wiktor 1980 or Wiktor 1989).

Big slugs, over 100 mm in length. Keel always well-developed, at times reaching half the body part behind mantle. Coloration varied: body unicolour, striped or spotted.

The free oviduct section short, many times shorter than vas deferens. The free section of vas deferens not surrounded by prostate or, at the very most, prostate encloses only a short part of the former organ. Penis, most often (but not always!) longer than a body half or equalling it, without external appendages, at most its posterior end provided with a blind pocket. Spermatheca duct connected with penis.

No caecum present. The last (third) intestine loop long, usually reaching as far as the end of viscera.

A group still needing a systematic revision, the more so that many of these species have been described only on the basis of their external appearance and all are characterized by a great individual and populational coloration variability. The subgenus comprises species with or without a pocket in the posterior penis section. Although about 30 *Limax* species are distinguished, actually there are probably much fewer. Most occur in the Mediterranean.

– "*Limax* aff. *albipes* Dumont et Mortillet, 1852"

Limax albipes Dumont et Mortillet, 1852: 13. Terra typica: Savoie (France). Typus: no information whether it has been preserved.

Jaeckel (1954) mentioned this species from Ljubotin (1600 m a.s.l.), having examined only 1, wrongly preserved, specimen. The slug had a unicolour black mantle, lighter sides and a unicolour sole. The "aff." testifies to the author's doubts. Jaeckel's information is confirmed by Jaeckel et al. (1958), who record this slug from Bosnia.

I do not reckon this slug with the fauna of the former Yugoslavia as, in my opinion, there are no grounds for it. For a long time *Limax albipes* has been included within *L. cinereoniger*. It seems, however, that the former is a distinct species. Yet the issue needs to be further investigated. The slug concerned is slightly smaller than *L. cinereoniger*, has no spotting on the body but finer skin wrinkles and a unicolour, light sole. Its penis is short, shorter than ½ body length.

The slug occurs in the Italian Alps and E Tirol (Kerney et al. 1983). I did not find among the material collected in the former Yugoslavia any specimen of characters allowing to confirm the occurrence of *L. albipes* in that territory. However, it is worth noting that also juveniles of *L. cinereoniger* have a unicolour sole and may be similar in colour. I quote Jaeckel (1954) for the sake of completeness, although his information raises too many doubts to justify establishing the occurrence of this slug in Bosnia, an area so distant from the Alps.

– *Limax (Limax) bielzi* Seibert, 1873

Limax Bielzi Seibert, 1873: 195. Locus typicus: Mistek (? the Czech Republic or Slovakia). Typus: no information.

The only available information on this slug comes from Jaeckel et al. (1958), who record it from Bosnia. The authors seem to have relied on literature but I have failed to establish the exact source.

The status of this taxon is very unclear (Wiktor 1973; Kerney et al. 1983; Wiktor 1989). It is a slug similar in the external appearance and structure of genitalia to *Limax cinereoniger*, but it is evenly cream-, reddish-ochre- or beige-coloured, and has a somewhat smaller body and genitalia.

It has been recorded from the Carpathian Mountains.

In my opinion, as long as the distinctness of this taxon and the occurrence in the area of the former Yugoslavia have not been credibly confirmed, the slug should not be ranked with the slug fauna of this territory.

34. *Limax (Limax) cephalonicus* Simroth, 1886

Limax cephalonicus Simroth, 1886a: 329, Pl. 11, Figs 15–16. Locus typicus: Ainosberg (= Óros Ainos), Kefallinia Isl. (Greece). Lectotypus: Zool. Mus. Humboldt Univ., Berlin.

?*Limax maxinus* var. *carbonaria* Boettger, 1885: 159. Locus typicus: "Kokkino vracho" and Plaka in the Ossa Mts (Thessaly, Greece). Typus: probably does not exist.

Limax corcyrensis Simroth, 1905: 10. Locus typicus: H. Déka (= Ag. Déka), Kerkira Isl. (= Corfu, Greece). Syntypi: probably not preserved.

Limax (Limax) Beieri Wagner, 1930b: 556, Fig. 1. Locus typicus: Enkluvi, Levkas Isl. (Greece). Lectotypus: Naturhist. Mus., Wien, no. 77606.

Limax (Limax) scupicus Wagner, 1931a: 194. Locus typicus: "Treska-Schlucht, westlich von Úszküb" (= W of Skopje, Macedonia, former Yugoslavia). Holotypus: Naturhist. Mus. Wien, no. 52370. **Syn. n.**

Limax Kühneli Wagner, 1940a: 145. Locus typicus: Pantokrator, Kerkira Isl. (= Corfu, Greece). Typus: no information.

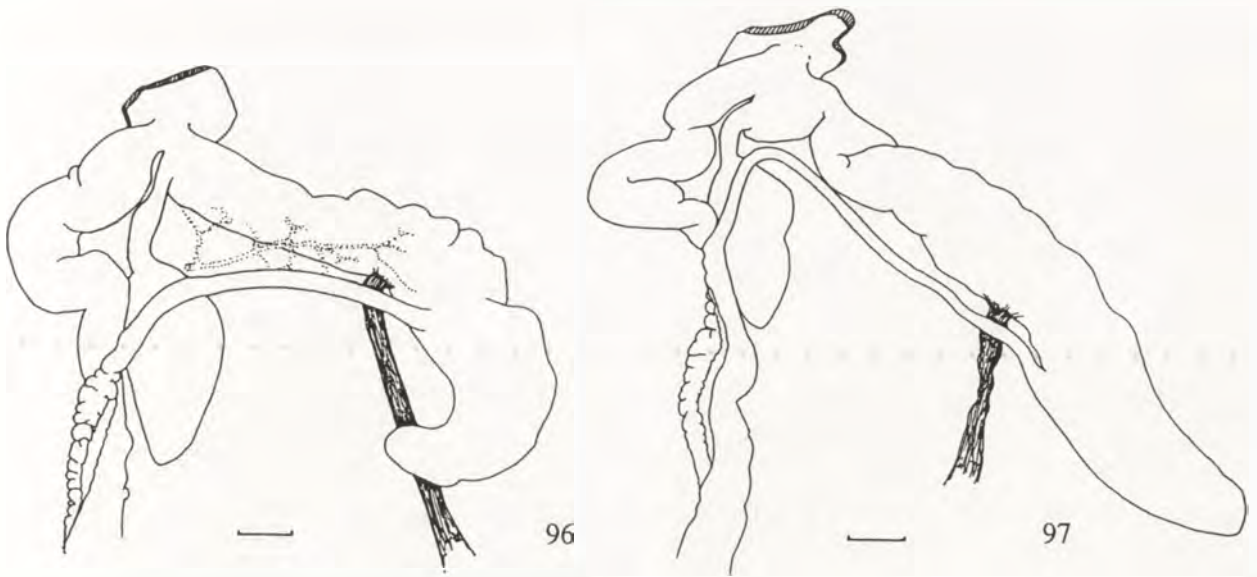
Limax cephalonicus: Rähle 1977a: 230, Figs 5a–c; Rähle 1980: 211, Figs 3a–e; Rähle 1986: 6.

Limax (Limax) scupicus: Wagner 1937a: 377, Pl. 27, Fig. 3; Wiktor 1982: 480, Figs 14–16.

Limax corcyrensis: Rähle 1981: 37, Figs 1, 2a–b.

Limax kuehneli: Rähle 1981: 39, Figs 2c–e.

Limax macedonicus: Wiktor 1986b: 295, Map 3 (partim).



Figs 96–97. *Limax cephalonicus* Simroth, 1886 – copulatory organs. 96 – specimen from the environs of Prilep, Babuna Mts (Macedonia). 97 – specimen from Gola Buka, SE of Ohrid (Macedonia).

Body length up to 78 mm, width up to 20 mm, mantle length to 22 mm. Keel short, visible only in $\frac{1}{7}$ body length. Between the medial line of back and pneumostom 20–25 wrinkles (in Yugoslavian specimens 20–21).

Coloration varying. Most often body evenly black, chocolate or dark ashen. Some have a light streak in mid back, which covers also keel. Quite frequently specimens covered with an intricate pattern of blackish, ashy or brown spots are found, these alternating with lighter ones, mucky-creamy or whitish. The pattern is a kind of reticulum, or the spots are arranged in a sort of indistinct streaks running in the posterior body part. In such specimens also mantle is spotted, especially its margins. In the spotted forms keel is always light in colour. Sole creamy and mucus colourless in all colour forms.

Genitalia (Figs 96–97). Penis shorter than half of the body. In mature specimens it is insignificantly longer than mantle, in juveniles even shorter. This organ is straight or at most irregularly bent. Retractor penis attached at c. $\frac{2}{3}$ penis length. More posterad vas deferens opens. The posterior, blind penis section in adult well-preserved specimens gradually narrows, assuming the shape of a slightly bent cone. In juve-

niles this blind part is shorter and may get partly or entirely inverted into penis during preservation. Inside the latter organ, a well discernible fold running half-way from its posterior end.

Ecology

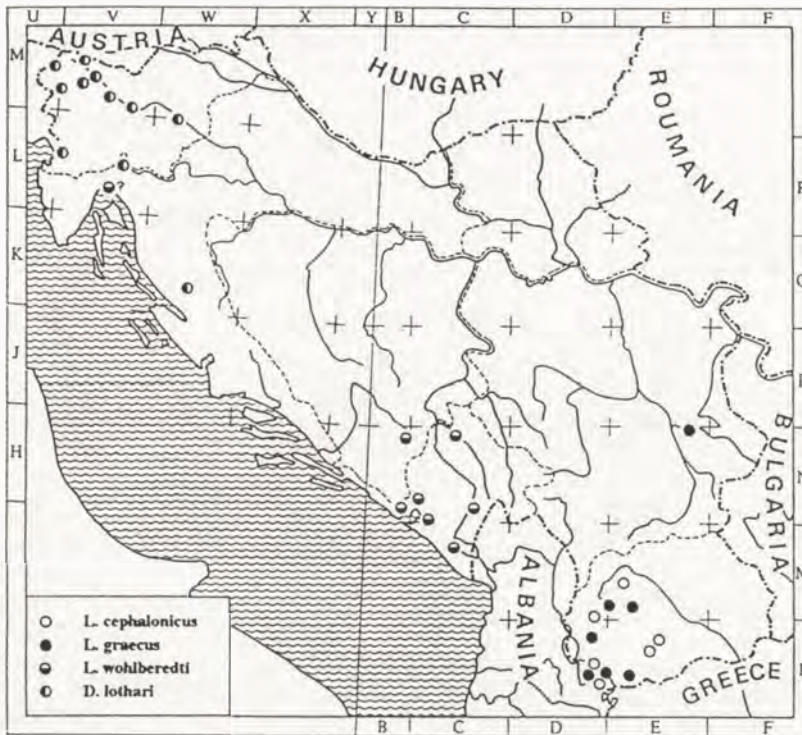
A mountain species, reaching 2000 m a.s.l., inhabiting open habitats and deciduous forests. It crawls up rocks and tree trunks, hiding under tree bark and in rock crevices.

Distribution

The species has its northern distribution border in Macedonia. Besides, it probably inhabits the whole continental Greece up to the Parnon Mts on Peloponnese. It is also known from Ionian Isl. (Wiktor in print).

Examined material collected in the former Yugoslavia: 8 spec. (Map 9).

Macedonia: Sv. Jovan Bigorski monastery in the Radika valley (SW of Mavrovo), slate and limestone, deciduous forest, 700–1000 m a.s.l.; Prilep, hills with ruins above the town, granite, dry habitat with a poor plant cover, 700–800 m a.s.l.; near Prilep in the Babuna Mts, dry bare rocks, granite, 1000–1600 m a.s.l.; Galičica Mts, Gola Buka Mt. (SE of Ohrid), *Fagus* forest, limestone, 800–1700 m a.s.l.; Peštani (S of Ohrid), Galičica Mts, 800 m a.s.l., leg. A. Riedel.



Map 9. Distribution of *Limax cephalonicus*, *L. graecus*, *L. wohlberedti* and *Deroceras lothari*.

After Wagner 1937a: Treska W of Skopje (as *L. scupicus*). Wiktor 1982: Galičica Mts (as *L. scupicus*). Rähle 1977a: Peštani, Galičica Mts (as *L. carbonarius*).

Comments

A taxon creating difficulties considering its numerous names introduced without detailed descriptions. I discuss more thoroughly the synonymy of this species in my monograph on the slugs of Greece (Wiktor in print). Beyond all doubt, *L. cephalonicus* and *L. graecus* are distinct species, though they are easily confused with each other. It has not been unequivocally established to which species the oldest name "*Limax maximus* var. *carbonaria* Boettger, 1885" should be referred; its anatomy has not been described nor has any slug with dark sole margins been found that would fully correspond with the description. Simroth (1889: 7) presents an opinion that var. *carbonaria* Boettger is just a juvenile form of *L. graecus*.

35. *Limax (Limax) cinereoniger* Wolf, 1803

Limax cinereo-niger Wolf, 1803: 7. Terra typica: Germany. Typus: probably does not exist.

?*Limax Dacampi* Menegazzi, 1855: 63, Pl. I, Figs 1–4. Locus typicus: Verona (Italy) (= *L. Da-Campii* = *L. Da-Campoi* = *L. dacampoi*; see Hesse 1926: 82 and 135, and Comments below). Typus: probably does not exist.

?*Limax (Bielzia) Möllendorffi* Kimakowicz, 1890: 154 (= 20 – double page numbering). Terra typica: Bosnia. No information about the types available. See also p. 80.

Synonyms: *Limax maximus* Linnaeus, 1758 (partim); *Limax antiquorum* Férussac, 1819 (partim); *Limax Cyreneus* Campano, 1837; *Arion lineatus* Dumont, 1849; *Limax bilobatus* Ray et Drouët, 1851 (non Férussac); *Limax Claravallensis* Drouët, 1851; *Limax lineolatus* Dumont et Mortillet, 1852; *Limax coeruleus* Strobel, 1857 (non *coeruleus* Bielz); *Limax cinereus* var. *intermedia* Bravière, 1881; *Limax cinereoniger schulzei* Gerhardt, 1941; *Limax (Limax) zilchi* Grossu et Lupu, 1960 (for more detailed data see Hesse 1926, Wiktor 1983, Wiktor 1989).

A big slug, up to 200 mm when crawling, after preservation up to c. 110 mm long, 20 mm wide, mantle length c. 38 mm. Keel limited to c. 1/3 body length. Skin sculpture delicate, 22–23 wrinkles present between the medial line and pneumostom. Coloration widely varying. It is typical of this slug that adult specimens (!) have an evenly coloured (not

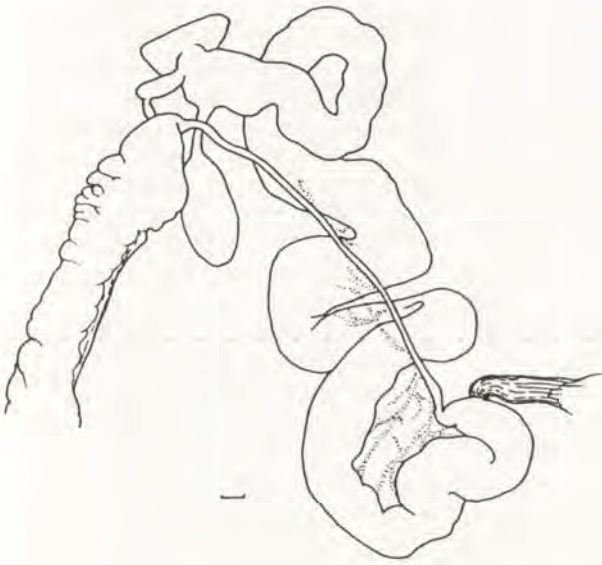


Fig. 98. *Limax cinereoniger* Wolf, 1803 – copulatory organs, specimen collected between Knin and Krčić (Croatia).

spotted) mantle, pale keel and the lateral sole zone nearly always dark-pigmented whereas the medial one is pale. Juveniles (!) may have blurred streaks on mantle, the whole of sole being, in principle, evenly light (!). The part beyond mantle may be uniformly coloured or covered with stripes that may be dashed. Apart from stripes, rows of spots may occur too. General coloration usually combining different hues of cream, beige, brown, ashen to deep black. In some specimens a tomato-red colour appears on sides that may be dark-striped (see the comments). Within a population the slugs are usually similar in colour. Specimens from the former Yugoslavia are most often evenly blackish, ashen or black. In the vicinity of Bihać (Croatia) slugs with a blackish mantle and tomato-red part beyond it are found. Some of them are even in colour while in some others on this vivid background there are dark, blackish or black, stripes which may be interspersed with lighter ones, however. A number of specimens from this area are blackish when preserved, the red colour showing through only at the bottom edge of the body. With time passing this red pigment gets rinsed away by alcohol(!). Mucus colourless, of medium density, in juveniles may be watery.

Genitalia (Fig. 98). A strongly coiled penis, longer than a body half, is a distinctive character of this species. After preservation, however, this organ is usually almost as long as the whole body.

Ecology

A forest species, most frequently found in deciduous and mixed forests, also in coniferous stands, especially in the mountains. It also occurs above the timberline, particularly often in rocky terrain. After rain it climbs up trees (true mainly for juveniles) and feeds scraping algae and lichens off the bark. It finds shelter in stumps and under wood pieces, where it lays eggs. It may be also found in leaf litter and rock crevices, under stones and tree bark or in tree holes. It feeds on mushrooms. Its life-cycle lasts 2.5–3 years. It is a species rather avoiding anthropogenic habitats, though it may occur – e.g. – in the ruins of houses or castles beyond housing estates.

Distribution

The species inhabits a vast area of Europe, in the south reaching Sardinia and the Appeninian Peninsula. It reaches as far as the Greek regions bordering on Bulgaria, a country where it is common throughout. In the east it reaches Crimea, Kazan' and Kishyniov, in the north, in Norway – 67°. It probably inhabits the whole area of the former Yugoslavia.

Examined material collected in the former Yugoslavia: 90 specimens.

Slovenia: Radeče (between Zagreb and Ljubljana), *Ulmus-Fagus-Castanea* forest, limestone, 600–800 m a.s.l.; Radeče in the Kum Massif, 700–1000 m a.s.l., *Fagus* forest; Postojna; Julijske Alpe, valley N of Triglav Mt., near Dovie village, 700–1000 m a.s.l., *Fagus-Picea* forest; Julijske Alpe, Bled, N of the castle above the town, limestone, 550 m a.s.l.; Julijske Alpe, Triglav Massif, Pakljuka, *Picea-Fagus* forest, limestone; Nanos Massif, near Rozdrto (SW of Postojna), *Fagus-Acer* forest, limestone, 1100–1300 m a.s.l.

After Bole 1962: Triglav Nat. Park. Bole 1966: Rakov Škocjan. Bole 1976a: Soteska near Bled, Smrkova draga and Smrečje in the Trnovski gozd Mts, Lanaršca, Velika Drnuljica and Laška kukava near Lagatec, Unška koliševka near Planina, Grda draga near Snežnik olišvka in the Kočevski Rog Mts. Bole 1976b: Notranjski Snežnik, Prelesnikova. Bole 1977: Šmarne gore. Bole 1979: environs of lake Cerkniško Jezero. Wolf and Rähle 1987: N of Vrišič pass, Móżnica (N of Bovec), Korytnica valley (N of Bovec), valley of the Slatenik river (S of Bovec). Wiktor 1982: Leskovo Valley at the foot of Snežnik Mt. E of the Ilirska Bistrica river.

Croatia: Risnjak National Park, near Črny Lug (near Delnice), *Fagus-Picea* forest, limestone, 1000–1200 m a.s.l.; near Delnice, *Fagus-Picea* forest, limestone, 700–900 m a.s.l.; Strumac Mt., Psunj Massif (N of Nova Gradiška), slate, *Petasites* and *Urtica*, near a stream, 350–500 m a.s.l.; National Park of the Plitvice Lakes area in a mountain massif Plješevica Mts., *Fagus* forest, 600 m a.s.l., limestone; vill. Senj, coast S of Rijeka, Senjsko Bilo Mts, *Pinus-Ulmus* forest, limestone, below 650 m a.s.l.; Velebit Mts, above Svety Rok village, Voganski Vrh, NE slope, *Fagus* forest, limestone, above 1000 m a.s.l.; village Senj, coast S of Rijeka, Senjsko Bilo Mts, *Pinus-Ulmus* forest, limestone, below 650 m a.s.l.; N of village Bihać, Plješevica Mts, scrubs, limestone, 650 m a.s.l.; Dalmatia, between town Knin and village Krčić in the Krka river valley, limestone, 300 m a.s.l.

After Wagner 1934c: Kik, Devcicevac, Jasenak, Bela Lasica, Krasno, Apatisan, Mali Halan (= Alan), Sv. Brdo, Gračac, Crnopac. Wagner 1937a: Leskovac and Devcicevac near Plitvice Jezera, Crnopac Mt. Wiktor 1982: Zagreb, ? Dalmatia – Senožeće.

Serbia: between Surdulica and Vlasina, valley, leg. Mikuska, Sipos, Szigethy, Topal 28.09.1975 (coll. Budapest); Prijepolje (E of Plevlia), Zlatar Mts, *Ulmus* shrubs, 600–700 m a.s.l.; Kremna (W of Titovo Užice = Užice), Tara planina Mts, *Pinus* forest, 1300–1400 m a.s.l.; Titovo Užice, environs of the city, 800 m a.s.l., limestone, *Fraxinus-Corylus* shrubs; Partizanske vode (SW of Titovo Užice), Zlatibor Mts, 1350–1400 m a.s.l. (? serpentine stone), *Fagus* forest.

After Jaekel et al. 1954: Ljubotin (? Ljubotin Mt.). Jaekel et al. 1958: Serbia. Rähle 1977a: Gornje Selo S of Prizren. Wiktor 1982: Kosovo – Čakar pass, Avala Mt. near Beograd. Frank 1991: Vranje, Morava.

Bosnia and Herzegovina: near Jajce, *Fagus* forest, limestone, 500–700 m a.s.l.; Travnik, limestone, *Carpinus-Quercus* bush, 700–800 m a.s.l.; Sutjeska Nat. Park, Voljak Massif, N of Gacko, *Fagus* forest; Prozor, Raduša Mts, meadows above the town, limestone; Raduša Mts, *Fagus* forest, limestone, 1200–1900 m a.s.l.; Jablanica, synanthropic; Vran Mts above Jablanica in the Doljanka river valley, *Fagus* forest, limestone, 1000–1700 m a.s.l.; in the Konjuch Mts near Kladnj (N of Sarajevo), *Fagus* forest, limestone, 650 m a.s.l.; in the Zvezda Mts near Olovo (N of Sarajevo), limestone, 800–1000 m a.s.l.; Zvezda Mts, under stones on a glade near Kladnj (N of Sarajevo); Jahorina Mts, partly synanthropic, on rocks partly covered with *Pinus* forest, limestone, 800–1200 m a.s.l.; Sarajevo.

After Wagner 1937a: Podajse in the Prenj Mts, Plasa near Jablanica, Camen, Čemerno, Vucija bara on Baba Mt. in Bjelasica (? Bjelašnica Mts) near Gacko, Bjelašnica Mts, Celebic near Foča. Jaekel et al. 1958: Bosnia. Wiktor 1982: between Sarajevo and Vasin Han, Han Stjenice in the Rabar Mts, Dživarско Polje near Trebinje, Pečina Zazubak Velki.

Macedonia: Debar in the Dešat Massif, limestone and green slate, 1200–1500 m a.s.l.; Sv. Jovan Bigorski monastery in

the Radika valley (S of Mavrovo), slate and limestone, deciduous forest, 750–1000 m a.s.l.; Sv. Jovan Bigorski monastery near Debar, leg. L. Pintér, E.P. Subai, A. Szigethy (coll. Budapest); Bitola, slope of the Baba Massif above the town, gneiss, *Fagus* forest, 700–750 m a.s.l.; E of Ohrid, valley in the Galičica Massif, anthropogenic habitats, limestone, 700–900 m a.s.l.; Peštani, N of Ohrid (c. 30 km), by the Sateska river, *Alnus* forest, 700 m a.s.l.; Gostivar, W of the town, barren lots, limestone; Lukovo in the Crni Drim valley, c. 1000 m a.s.l., 1 km towards Debar, near the road, leg. A. Riedel; Jablanica Mts; Kožuf Mts, valley of the Stara Reka stream, 6 km S of Konopište, 750 m a.s.l., andesite rocks, leg. A. Riedel; Kožuf Mts, between Mušov Grob and Konopište, near a stream, volcanic rocks, c. 750 m a.s.l.

After Rähle 1977a: Galičica Mts. Wiktor 1982: Galičica Mts – Trepka.

Montenegro: Mojkovac, Bigorski Nat. Park, Bjelasica Mts, 1000–1500 m a.s.l., slate, *Fagus-Acer-Ulmus* forest; Durmitor Mts, lake Črno Jezero near Žabljak, leg. W.J.M. Maassen.

After Simroth 1909: between Kolašin and Andrijevica. Wagner 1937a: Priboj (?), Stolac Mt., Njeguši. Bole 1984: Durmitor Mts – Žabljak, Črno Jezero, Zminje Jezero, Poljanak. Rähle 1977a: Lovčen – Pass.

Comments

At times identification of the species presents difficulties. The reason is a great variety of coloration as well as a high number of synonyms and colour forms distinguished. One should be aware that young specimens of *L. cinereoniger* with blurred lateral stripes and thin mucus are very often determined as *Lehmannia*. This error quite frequently, also recently, appears in beautiful photographic field guides. In the case of doubts, even if the slug is still lacking fully developed genitalia, the presence of caecum is decisive for its affiliation to the genus *Lehmannia*. Distinguishing colour forms is nonsense from the point of view of taxonomy. Nevertheless, there exist at least a few species that are similar with respect to coloration but anatomically different, e.g. *L. maximus*, *L. punctulatus* Sordelli, 1870 (see Wiktor 1983) or *L. albipes*. Moreover, slugs of extremely different coloration but very similar anatomy are also observed. The whole group needs a detailed revision and thorough study.

As regards the former Yugoslavia's fauna, there are certain doubts concerning the tomato-red colour form. It is a conspicuous, locally occurring slug that attains a very large size. Everything, however, suggests that it is merely a colour form of *L. cinereo-*

niger. Such a slug has been described as *Limax dacampi* Menegazzi, 1855. The name "*L. geographicus* Renier, 1804" (see Hesse 1926) and a whole series of names of subspecies and varieties can probably be referred to it as well. The red form mentioned occurs in northern Italy (Lessona, Pollonera 1882). Having been given an opportunity to examine a number of museum specimens from Italy, I have got an impression that they are identical to those that I collected in Bihać (Croatia). They are not only of the same colour but also very large in size, as alcohol-preserved specimens reach 110 mm in length. All other characters that I have managed to establish do not depart from those of *L. cinereoniger*. It makes me suppose that *L. dacampi* is nothing more but a synonym of one of the numerous forms of *L. cinereoniger*. I wish to point out hereby that in Poland, where *L. cinereoniger* is one of the commonest slugs, several times I found single specimens with red sides, and once a whole large such population in the Sudete Mts region. What is more interesting, all the specimens that I collected in the same place after a couple of years were devoid of this red pigment. These Polish specimens, however, do not attain such a large size as those from Italy and Bihać (see also *Bielzia möllendorffi* Kimakowicz, 1890 p. 154).

Among the allied species from the former Yugoslavia's territory *L. maximus* is the most similar one to *L. cinereoniger*. The former slug is best distinguishable by the spotting on mantle. In Bulgaria, Italy and Switzerland another similar species occurs, i.e. *Limax punctulatus* Sordelli, 1870 (syn. *L. redii* Gerhardt, 1933). It mostly differs in its monstrously large penis, which may be 2.5 times longer than the whole body. Besides, when alive the slug has a tomato-red spot under the anterior, not accreted fragment of mantle. *L. albipes* is also a similar species, though its penis is shorter and sole is not black and white. The remaining big Yugoslavian *Limax* species are distinguishable by a blind pocket on the posterior penis end.

36. *Limax (Limax) conemenosi* Boettger, 1882

Limax Conemenosi Boettger, 1882: 100. Locus typicus: Prévesa (= Préveza, Greece). Typus: I have no information about its existence.

Limax (Heynemannia) Conemenosi var. *multipunctata* Boettger,

1885b: 158, Figs 1–3. Typus: I have no information about its existence.

Limax pestaniensis Rähle 1977a: 228, Figs 2b, 3b, 4b. Locus typicus: Macedonia, Peštani (on Lake Ohrid). Holotypus: Nat. Natuurhist. Mus., Leiden, no. 2570/14.

Body dimensions of slugs preserved in alcohol: length c. 80 mm, width 12 mm, mantle length 22 mm. Keel short, discernible at most at $\frac{1}{4}$ body length, back softly arched. General body coloration quite varying in hue, but always light: creamy, creamy-yellowish or creamy-ashen. Back usually slightly darker. On this background, both on mantle, the rest of back and sides, numerous well-delineated black dots, roundish in outline, c. 1 mm in diameter. The density and size of the dots may be different and, like the hue of general coloration, seems to be an effect of individual variability. Sole light, creamy. Mucus colourless.

Genitalia (Fig. 99). Penis tubular, coiled, equalling c. half of the body length. Musculus retractor penis

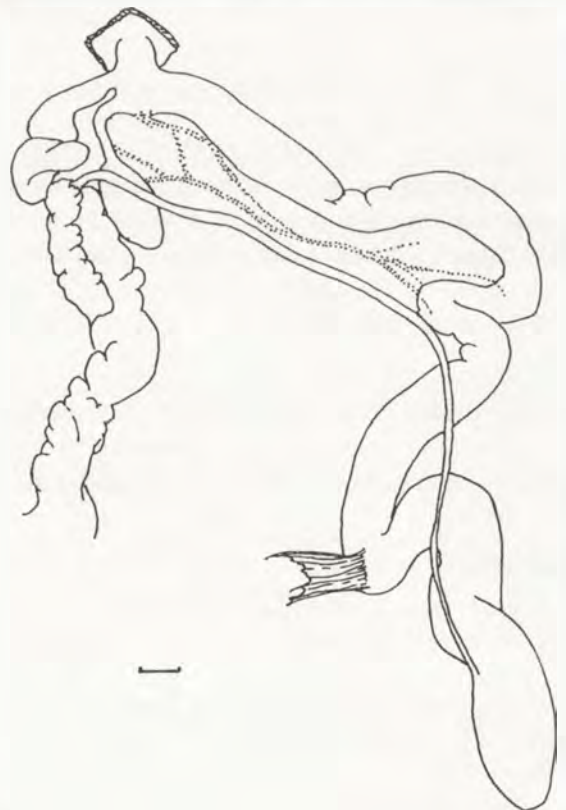


Fig. 99. *Limax conemenosi* Boettger, 1889 – genitalia, specimen from town Ohrid (Macedonia).



Map 10. Distribution of *Limax conemenosi*, *Deroceras maasseni* and *D. rodnae*.

inserted laterally at c. $\frac{2}{3}$ of the penis length, when measured from the forepart. Also vas deferens connected to penis laterally, but more posterad. The posterior penis end is a narrowed pocket in the shape of – as if – a crescent.

Ecology

The species occurs mainly in bush thickets, on rocks, and in open habitats, less frequently in forests. It crawls up tree trunks, finds shelter under stones, often occurring as a synanthrope.

Distribution

Greece, both continental and insular, is presumably its original distribution range. The species penetrates into the neighbouring areas of Bulgaria, Macedonia, and Kosovo, though, probably, it lives as an introduced synanthrope there.

Examined material collected in the former Yugoslavia: 4 spec. (Map 10).

Kosovo: Peć, in the town, synanthropic, 600 m a.s.l.

Macedonia: Struga, on Lake Ohrid, synanthropic; Ohrid, in the

town, hill with forest, on rocks and under stones, refuse heaps.

After Hesse 1928: Macedonia (?) – "Kluckova"? (as *Limax* n. sp. aff. *L. conemenosi*). Jaeckel 1954: Hudova, Skoplje (= Skopje, as *L. conemenosi multipunctatus*). Wiktor 1982: Ohrid. Rähle 1977a: between Ohrid and Peštani, and – as *Limax pestaniensis* – Peštani, slope Rača S of Ohrid.

Comments

The species belongs to the group with a blind pocket at the end of penis. The group includes also *L. cephalonicus* and *L. graecus*. The species discussed is easily distinguishable from the other two on the basis of its external appearance, namely due to its typical spotting. There also exist differences in the shape of penis (see the drawings and descriptions). Sometimes a certain similarity of *L. conemenosi* to *L. maximus* may also create difficulties in identification, the latter species, however, lacks the narrowing conical blind pocket at the end of penis.

– *Limax dofleini* Hesse, 1928

Limax dofleini Hesse, 1928: 13. Locus typicus: Pepelak (Macedonia). Syntypi: I have no information about their existence.

After Jaeckel et al. 1958: Macedonia.

A species described only on the grounds of its external appearance. It was 55 mm long (the other, smaller, specimen was 45 mm long), black, had a fine skin sculpture, the evidence of which being 28 wrinkles between the medial zone of back and pneumostom. It was found at 2000 m a.s.l.

Comments

I am not able to state what Hesse dealt with. Neither have I seen any material from the region of locus typicus. At the altitude of 2000 m most slugs are black. This, however, may be the effect of melanism, not necessarily a species-specific character. A fine skin sculpture is typical of some other species, e.g. *L. graecus*, a slug found in this area, which is often black coloured in the mountains. In my opinion, the name "*Limax dofleini* Hesse, 1928" should be treated as nomen dubium and – if it is not univocally established what slug was concerned – omitted in the former Yugoslavia's fauna.

37. *Limax (Limax) graecus* Simroth, 1889

Limax graecus Simroth, 1889: 7, Figs 1, 9–10. Terra typica: "Mittel-Griechenland, Koraxgebirge (?)". Lectotype: Senckenberg Mus., Frankfurt a/M., no. 4035.

?*Limax taygetes* Gratenloup, 1855 = *Limax taygetes* Desh. auct. (see Hesse 1883 and Reischütz 1985 as nomen oblitum). Typus: I have no information about its existence.

Limax macedonicus Hesse, 1928: 10, Pl. 2, Fig. 10. Terra typica: Golešnica Planina (= Golezniza Mts, Macedonia). Typus: I have no information about its existence. **Syn. n.**

Limax macedonicus leucopus Hesse, 1928: 12, Pl. 1, Fig. 8. Locus typicus: Peristeri (Greece). Typus: I have no information about its existence. **Syn. n.**

A slug attaining up to 95 mm in length, 23 mm in width, up to 35 mm in mantle. Skin sculpture delicate (19–25 wrinkles between the medial line and pneumostom). Coloration different, from pinkish-creamy through greyish and brownish to entirely black. Apart from unicolor forms, specimens dark-spotted or dark with light spotting are also found. The light forms occur in warmer habitats whereas in the mountains, at considerable heights, the slugs are dark in colour. It is not possible to identify the slug on the basis of its coloration. It is worth noting, however, that its keel is of the same colour as the

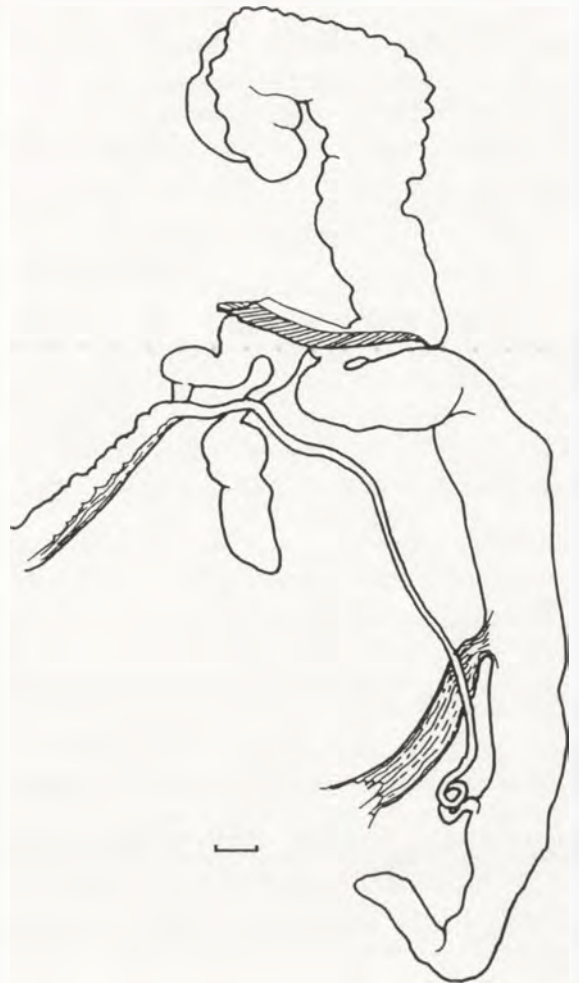


Fig. 100. *Limax graecus* Simroth, 1889 – copulatory organs (penis partly everted), specimen from the Galičica Mts (Macedonia).

rest of back (!), which is a feature typical of only some species of the genus. Sole unicolor, pale. Mucus colourless.

Genitalia (Fig. 100). Penis vermiform, tubular, irregularly bent or coiled, its length approximating $\frac{2}{3}$ body length or more. Musculus retractor penis inserted laterally at c. $\frac{1}{7}$ penis length as seen from its loose end (!). Vas deferens connected to penis also laterally, but more posterad. In mature slugs this posterior, i.e. situated more posteriorly than the vas deferens opening, blind part of penis is in the shape of a narrowing, crescent structure. In adults it is most often strongly bent or even curved. Inside this section

of penis there is a longitudinal fold. Caution! Sometimes, when the slug is being drowned or preserved this blind part gets inverted into penis, thus making the posterior part of this organ club-shaped, the inversion still being visible at the apical penis end (it is better revealed when the penis wall is cut off).

Ecology

The slug occurs in deciduous and mixed forests. Most often, especially at night, it is found on tree trunks. It is also frequent in rocky areas, where it crawls up rocks and hides in crevices. In the mountains I collected the species up to c. 1000 m a.s.l. It often occurs as a synanthrope, e.g. in the neighbourhood of wells, on camping-sites, in ruins etc.

Distribution

A Balkan species, whose original range is difficult to define precisely as, presumably, nearly in this whole area it occurs as a synanthrope, in natural habitats being found only in a part of the Balkans. The species inhabits the continental Greece with Peloponnesus and the nearby islands of Euboea and Kythira (Wiktor in print). In Bulgaria it has scattered localities in the south up to the Stara Planina Mts, in the east reaching the Black Sea coasts (Wiktor 1983 as *L. (L.) macedonicus*). In the former Yugoslavia it has been noted in Macedonia and one locality in Serbia.

Examined material from the former Yugoslavia: 6 spec. (Map 9).

Macedonia: ? Tajmište, between Gostivar and Kičevo, 700–1000 m a.s.l., *Fagus* forest with *Corylus*, metamorphic rocks; village Slatyni, c. 35 km N of Ohrid, in the Stogovo Massif, limestone, 700–800 m a.s.l.; shoulder and slope of the Galičica Massif above Lake Ohrid, limestone, on dry rocks, 900–1560 m a.s.l.; Baba Mts, near village Magarevo (W of Bitola), in a valley, granite, under stones, 700–1000 m a.s.l.

After Jaeckel 1954: (as *Limax macedonicus leucopus*) Pepelac, 30 km S of Skopje. Jaeckel et al. 1958: as *Limax macedonicus*. Wiktor 1982: Peštani, Trpka, Galičica Mts, Tresania (geographical location not established).

Serbia: after Wiktor 1982: Marina Kutina, between Gadžik Han and Gornji Dušnik.

Comments

See Comments to *Limax cephalonicus* p. 72.

– *Limax illyricus* Simroth, 1907

Limax illyricus Simroth, 1907: 16 (514) (see also Simroth 1909).

Locus typicus: Vjeternik in the Morača valley (Montenegro).

Typus: I have no information about this material.

After Jaeckel et al. 1958: Montenegro.

The species is known only from the original, very unclear, description. It was based on two specimens that the author compared with *Limax wohlberedti*. The specimens were black in colour with the medial sole zone dark (dunkle Mittelsohle). It is the main distinctive character in the external appearance that allows to distinguish between the two taxa mentioned, unless it is an artefact arisen during preservation (which was stated by Simroth himself). The slug described had 14–17 wrinkles between the medial body line and pneumostom. The length of its penis was $\frac{1}{4}$ – $\frac{2}{7}$ body length, this feature being another one that makes the two taxa similar. The difference in the structure of genitalia noted by Simroth was the presence of an undefined swelling in the form of a cudgel (derbe kugelige Endkeule) in the rear part of penis, beyond the outlet of vas deferens. Thus, the slug belonged to the group with a blind pocket at the end of penis. There are no drawings available.

Comments

It is impossible to decide whether it is justifiable to distinguish this taxon. The description by Simroth may concern – e.g. – *L. cephalonicus* or *L. graecus*. The two slugs have a blind section of penis, both may be black and may occur in the region mentioned. They have, however, a delicate skin sculpture made of fine wrinkles (more than 19) whereas Simroth wrote about a well-marked skin sculpture, defining it as "grob gerunzelt". The slugs he described may have been atypical specimens of *L. wohlberedti*, as the small number of wrinkles suggests, but this slug does not have a blind penis section. Finally, the existence of a distinct species we know nothing more about should not be disregarded. As unclear, I reckon this taxon among species dubia.

38. *Limax (Limax) maximus* Linnaeus, 1758

Limax maximus Linnaeus, 1758: 652. Terra typica: Sweden. Typus: probably does not exist.

Synonyms: *Limax cinereus* Lister, 1678; *Limax cinereus* O.F. Müller, 1774 (partim); *Limacella parma* Brard, 1815; *Limax antiqorum* Férussac, 1819 (partim); *Limax maculatus*



Fig. 101. *Limax maximus* Linnaeus, 1758 – copulatory organs, specimen from Bihać (Croatia).

Nunneley, 1837 (non *maculatus* Kaleniczenko, 1851); *Limax cellarius* (D'Argenville) Lessona et Pollonera, 1882 (for more detailed data on the synonyms see Hesse 1926 or Wiktor 1989).

A big slug, up to 200 mm long when crawling. After preservation up to c. 130 mm long, 23 mm wide, mantle length c. 40 mm. Keel poorly developed, reaching at most $\frac{1}{3}$ body length. Between the medial line of back and pneumostom 21–36 wrinkles. General body coloration dirty cream with a widely varying black, often navy-blue-black in live slugs, pattern. On mantle spots of different shape. Spots are present also in the part beyond mantle, where they are arranged in rows or fused in stripes. Keel always light. The forms described were unicolour. Sole evenly light, creamy. Mucus colourless.

Genitalia (Fig. 101). Penis tubular, coiled, its length approximating half that of the body. Its posterior end is inconspicuously spadiceously distended.

Both vas deferens and musculus retractor penis connected to penis apically, i.e. there is no blind process (pocket) at the penis end.

Ecology

The species is most often found as a synanthrope, also in the former Yugoslavia. It occurs in ruderal habitats, parks, gardens, cemeteries, refuse dumps, composts, in the neighbourhood of wells, in cellars, greenhouses, ruins and forest edges, finding shelter under stones and wood pieces. It lives for a few years.

Distribution

Its original distribution range is unknown. It was probably an area in south-western Europe. The species has spread not only throughout the whole of Europe but has also been introduced to other continents, e.g. America and Australia, and to numerous islands, including Tasmania and New Zealand.

Examined material from the former Yugoslavia's territory: 20 specimens.

Croatia: town Bihać, garden; Delnice, in the village, 600 m a.s.l. After Sturany 1895: near lakes Plitvicke Jezera. Wagner 1931c: Volosco, Opatija. Wagner 1932: Volosco, Opatija. Wagner 1934c: Kik, Devcicevac, Gračac, Sveto Brdo, Crnopać. Wagner 1937a: Devcicevac and Leskovac near Plitvicke Jezera. Wagner 1939: Rovinj (Istra). Jaeckel et al. 1958: Croatia.

Serbia: after Wagner 1937a: Sveta Petka near Niš. Jaeckel et al. 1958: Serbia.

Bosnia and Herzegovina: Jablanica, synanthropic.

After Boettger 1885: Nemila and Vranduk defile (N of Zenica). Wagner 1937a: ? Bjelašnica Mts (there are three mountain ranges bearing that name), Prenj Mts. Jaeckel et al. 1958: Bosnia.

Montenegro: after Boettger 1885: (as *L. maximus* var. *ater* Raz.) Babuna and Budua (= Budva). Boettger 1885: Budua. Wohlberedt 1901: S Montenegro. Simroth 1905: (?*L. cinereoniger*) Bjelasica, Savnik, Žabljak. Simroth 1909: Montenegro. Jaeckel et al. 1958: Montenegro. Bole 1984: Žabljak, Poljanak.

Macedonia: Skopje, park-forest Vodno, above the town, *Castanea-Mirtus*, 700–900 m a.s.l., slate.

After Jaeckel et al. 1958: Macedonia. Wiktor 1982: S of Lukovo on the Drim river N of Ohrid, Galičica Mts. Rähle 1977a: Galičica.

– *Limax (Frauenfeldia) montenegrinus* Boettger, 1885

Limax (Frauenfeldia) Montenegrinus Boettger, 1885a: 66–68.

Locus typicus: Budua (= Budva, SW Montenegro). Typus: probably does not exist.

The description (Boettger 1885a) lacks any information on the structure of genitalia of this species. The author stated that the slugs were up to 30.5 mm long after preservation, mantle length was 19.8 mm, maximum mantle width 6.5 mm. Keel well discernible, body slim. Between the medial line of back and pneumostom 17–19 wrinkles. General coloration blackish, keel of the same colour as back, sole in the medial part yellow-white, black on sides.

Boettger compared this slug with several other species, namely *L. maximus*, *L. coerulans* (= *Bielzia coerulans* (Bielz, 1851)) and *Agriolimax Dymczewiczi* Kaleniczenko, 1851.

Comments

Since the time it was described the slug has been creating difficulties. Having examined one specimen obtained from Boettger, Simroth (1885b) stated that the slug was juvenile. In his opinion, there were neither grounds for describing a new species nor for giving that idea up. Once again he expressed his doubts (Simroth 1909), emphasizing that there was no reason to compare the slug concerned with *Limax coerulans* Bielz or *L. Schwabi* von Frauenfeld, i.e. with the Carpathian genus and species *Bielzia coerulans* (Bielz, 1851), of which the above quoted names are synonyms.

Hesse (1926) reckons this species among the genus *Bielzia* Clessin, 1887, a monotypic genus that, undoubtedly, is an endemic of the Carpathians. Since Boettger (1885a) no other malacologist has ever ascertained the occurrence in the mentioned area of any slug classifiable among the genus *Bielzia* ("Frauenfeldia" is one of the names used for the genus *Bielzia*; quite confusing synonymy – see Wiktor 1989).

Conclusions: the fate of the types is unknown and the description unclear. What Boettger dealt with while describing this taxon is impossible to establish and, probably, it will never be attained. The external appearance and locus typicus suggest that it may have been the slug later described as *Limax wohlberedti* Simroth, 1900. However, synonymizing this name would be senseless since it has not been authoritatively made clear what *L. montenegrinus* actually is, the more so that Simroth himself could not do it

either, having doubts even though he had at his disposal one of the syntypes of this taxon. In my opinion, the name "*Limax (Frauenfeldia) Montenegrinus* Boettger, 1885" should be treated as nomen dubium.

– *Bielzia moellendorffi* (Kimakowicz, 1890)

Limax (Bielzia) Möllendorffi Kimakowicz, 1890: 154 (= 20 – double page numbering). Terra typica: Bosnia. Typus: no information available.

Hesse 1926: 93 and 137! Bosnia (as *Bielzia möllendorffi*).

Jaeckel et al. 1958: Bosnia (as *Bielzia moellendorffi*).

The anatomy unknown. The description of the coloration suggests that Kimakowicz dealt with *Limax cinereoniger*, the form defined as *Limax Dacampi* Menegazzi, 1885. In my opinion, it is only a colour form, not a distinct species. Kimakowicz stated that the slugs were orange or brick-red in colour, very rarely black with an orange keel. Some had lateral stripes and spots of the same colour as mantle, which was grey or brown-black. The lateral sole zones were grey-black in most specimens (see *L. cinereoniger* p. 72).

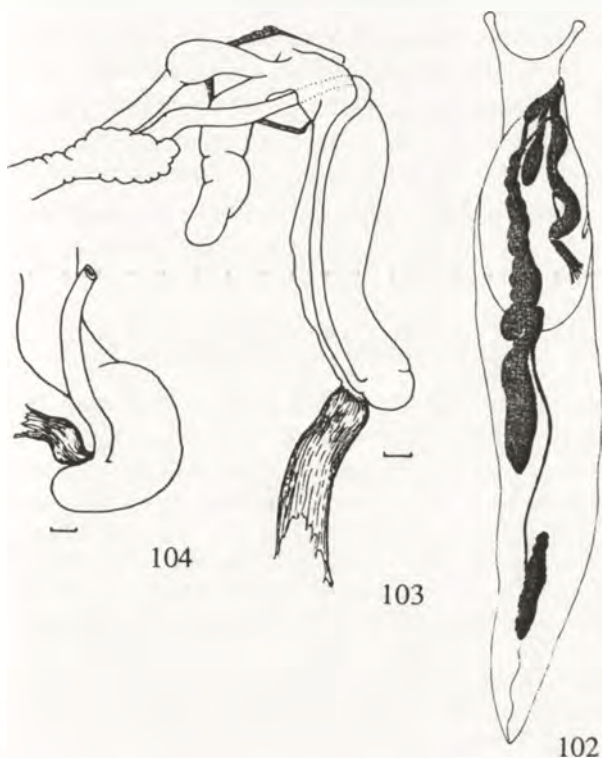
39. *Limax (Limax) wohlberedti* Simroth, 1900

Limax wohlberedti Simroth, 1900: 98. Terra typica: Montenegro. Neotypus: design. Altena 1975: 17, a specimen from Trnovo, 6 km NW of Virpazar (Montenegro); in Nat. Natuurhist. Mus., Leiden.

?*Limax (Frauenfeldia) Montenegrina* Boettger, 1885: 66. Locus typicus: Budua (= Budva, SW Montenegro). Typus: probably does not exist (see the comments on *Limax montenegrinus*, above).

Limax wohlberedti: Altena 1975: 15–18, Figs 1–3.

A large slug, after preservation up to 100 mm long, 22 mm wide, mantle length 34 mm. Keel mobile, usually corrugated, in live specimens reaching as far as the posterior edge of mantle. In preserved slugs it remains well visible in $\frac{2}{3}$ of the length of back. Skin thick, with thick and strongly arched wrinkles, the number of which between the medial back line and pneumostom being 20–23. Pneumostom large, in most specimens with a flat ring discernible around it. Except for sole, the whole body deeply black (also keel). The lateral sole zones evenly blackish-grey. Here and there, additionally, on this blackish background black granules of pigment



Figs 102–104. *Limax wohlberedti* Simroth, 1900. 102 – schematic diagram showing the proportions between genitalia and body size. 103 – copulatory organs, specimen from Gacko (Montenegro). 104 – posterior penis section, specimen from Jakubov Pečina (Montenegro).

occur. The medial zone is markedly lighter, dirty creamy. Mucus colourless.

Genitalia (Figs 102–104). Prostate, enclosing vas deferens, separates from spermoviductus along a fairly long section, thus making oviductus free. Penis short, shorter than mantle. In preserved specimens, in the natural position of copulatory organs it reaches up to c. $\frac{2}{3}$ mantle length. It is a thick organ, of the shape of a slightly corrugated cylinder. Musculus retractor penis very wide, inserted into penis nearly apically, but laterally, i.e. asymmetrically. Somewhat anterad, clearly laterally, vas deferens opens into penis. In some specimens, owing to the lateral connections of the two organs with penis, the latter's hind end may form a small pocket (Fig. 104).

Inside penis there is one distinct corrugated fold running along the whole organ. Vas deferens, adherent to penis, approximates to it in length. The vascularized membrane connecting vas deferens with the penis wall is very narrow (not as it is the case in – e.g. – *L. cinereoniger*, where it is very wide). Spermatheca container elongated. Spermatheca duct thick but only slightly differing in width from the former organ. The two organs are jointly about half the penis length. Spermatheca duct opens to atrium between penis and oviductus. The free oviduct section, like in other members of the genus, consists of two parts: a narrow and a broad one. Atrium reduced to such an extent that it is hardly distinguishable.

Ecology

I collected this species only once, in the environs of Gacko, after a strong storm, on rocks still wet after the rain. The slug appeared then in masses. The habitat was extremely dry – open limestone rocks, not even shaded by bushes. I suppose that under other weather conditions it would be very difficult to find this slug.

Distribution

An endemic inhabiting a small area, mainly in Montenegro and Herzegovina, and – which needs a check – also Croatia. It is known only from a few localities (Map 9).

Examined material: 29 spec.

Croatia: after Wohlberedt 1901: Rijeka. Simroth 1909: Rijeka (Simroth probably means a specimen labelled "Rjeka Mont., Wohlb. 1905 nr. 3492" and kept in the Philetisches Museum, Jena).

Montenegro: Jakubov Pečina, near Komarno; Virpazar on lake Skadarsko jezero, leg. W.J.M. Maassen; Madulina pečina, S of Njegoš, leg. L. Pintér, E.P. Subai and A. Szigethy; "Žabljak, Wohl. 1905" – 1 spec. in the coll. of the Philetisches Museum, Jena.

After Simroth 1900: Montenegro. Wohlberedt 1901: ? Vir Bazaar (? Virpazar). Simroth 1909: Virpazar. Wagner 1937a: Orjen Mts (on the border between Montenegro and Herzegovina). Jaeckel et al. 1958: Montenegro. Altena 1975: Ljuta (Dobrota, N of Kotor), Tološi (4 km NE of Titograd = Podgorica).

Herzegovina: Gacko, limestone.

Comments

The species may have been recorded before and named differently. It is difficult, however, to

unequivocally prove it and to establish which the oldest name was (see *Limax (Frauenfeldia) montenegrinus* Boettger, 1885).

In my opinion, the information about the locality in Rijeka (Croatia) needs a confirmation. Admittedly, in the Museum of Jena there is a specimen with a label saying: "Rjeka Mont.". However, the abbreviation "Mont." suggests Montenegro. It was also used with another specimen from the same museum, collected in Žabljak (it is situated in Montenegro). Thus, "Mont." added to "Rjeka" points out to a possible mistake.

Subgenus *Limacus* Lehmann, 1864

Limacus Lehmann, 1864: 154. Species typica: *Limax breckworthianus* Lehmann, 1864 (= *L. flavus* Linnaeus, 1758).

Plepticolimax Malm, 1868: 62. Species typica: *Limax breckworthianus* Lehmann, 1864.

Simrothia Clessin, 1884: 62. Species typica: *Limax breckworthianus* Lehmann, 1864.

Big slugs, up to c. 120 mm in length. External appearance resembling that of *Limax* s. str., but keel is less arched and body more cylindrical. Body usually spotted: pale spots occur on a darker background. At times back and mantle fairly evenly coloured, sole always light.

Spermoviductus divides into a free oviductus and vas deferens in relative proximity to glandula albuminalis. Prostate enclosing a considerably long section of vas deferens. Penis cylindrical, irregularly coiled, without external appendages.

The last, short intestine loop equipped with a very long, reaching the posterior body end, caecum. The latter connected with rectum, i.e. not at the end of the third loop but in a farther part of alimentary canal, on the ascending section, that is rectum. Caecum is tightly adherent to body integuments, translucent, not filling with faeces.

Slugs living on trees and hiding under stones, in rock crevices etc. The original distribution range difficult to establish considering their introduction. It probably covered the Mediterranean sensu lato.

Comments

Malacologists differ on the issue concerning the distinctness of this taxon. Some regard it as a subgenus within the genus *Limax*, while others classify

these slugs with the genus *Lehmannia*. One may also encounter the opinion that *Limacus* should be treated as a distinct genus (Forcart 1986). The problem is that the slugs described here have a long caecum, like the *Lehmannia* species. However, with their external appearance and the shape of penis they rather correspond with *Limax*. An additional complication is the fact that the two species concerned differ from each other in the connection between spermatheca duct and the remaining organs (see Comments to *L. flavus* below).

40. *Limax (Limacus) flavus* Linnaeus, 1758

Limax flavus Linnaeus, 1758: 652. Terra typica: (?) Sweden. Information about the types lacking.

Synonyms: It has been recently found that two similar species, *L. flavus* and *L. maculatus* (Kaleniczenko, 1851), have been confused with each other for a long time. It is now difficult to establish to which one the particular synonyms referred. The problem is discussed in detail by Likharev and Wiktor (1980) and Wiktor (1989). The following synonyms seem referable to the name "*L. flavus*": *Limax variegatus* Draparnaud, 1801; *Limax unguicula* Brard, 1815; *Limax megalodontes* Quoy et Gaimard, 1814; *Limacellus unguiculus* Turton, 1831; *Limax umbrosus* Philippi, 1844; *Limax Ehrenbergi* Bourguignat, 1853; *Limax Deshayesi* Bourguignat, 1861; *Limax Companoi* Bouguignat, 1863; *Limax eubalius* Bourguignat, 1864; *Limax breckworthianus* Lehmann, 1864; *Limax*

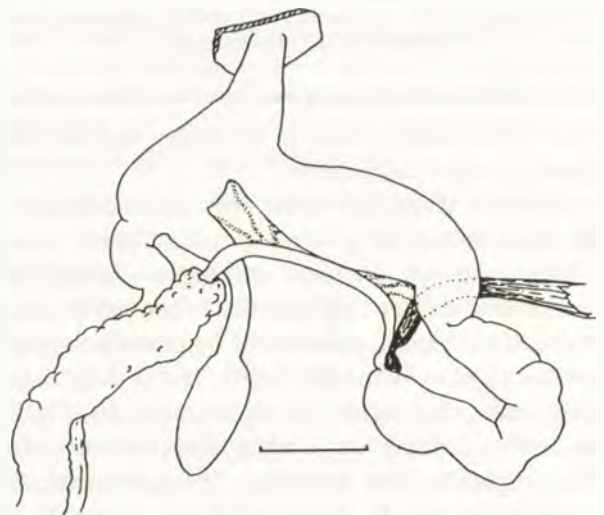


Fig. 105. *Limax flavus* Linnaeus, 1758 – genitalia, juvenile specimen from Skopje (Macedonia).

baeticus Mabille, 1868 (for bibliographic data see Hesse 1926 and Likharev and Wiktor 1980).

Body of live slugs up to 120 mm long, after preservation c. 80 mm, width 19 mm, mantle length 23 mm. General body coloration olive, grey greenish, grey yellowish or grey orange. Coloration uneven: dark and light spotting occur alternatingly, or there are lighter spots on a darker background. Back and only a part of sides darker in colour. Above sole a light stripe. Sole unicolour, pale, creamy yellowish. Head and tentacles black or blackish. Mucus yellow or orange, transparent and watery.

Genitalia (Fig. 105). Spermoviductus short. A very long section of vas deferens surrounded by prostate. The free oviductus also long, adherent only to vas deferens. The latter organ opens into penis apically, but asymmetrically. Similarly, musculus retractor penis attaches asymmetrically. Penis cylindrical, equalling c. $\frac{1}{6}$ body length, usually bent and forming the letter S or E. Spermatheca oval with a short spermatheca duct that is connected with an enlarged, anterior oviduct section (!). It is a rare exception in Limacidae. Oviductus tubular in considerable part, anteriorly abruptly widening before the connection with spermatheca duct. Atrium very short.

Ecology

The original requirements of this slug are hardly known. It is probably a species of forests and lowlands. It prefers highly degraded ruderal habitats, greenhouses, different cultivations, cellars, vegetable storage places. The slug hides under stones, in crevices, tree holes etc. It is often found in the neighbourhood of wells and in other places moistened by water, frequent also in towns, even of dense structure, in dairies, fruit and vegetable warehouses etc.

Distribution

The original distribution range of this species was probably in south-eastern Europe and Asia Minor. At present, as a synanthrope, it is found nearly in whole Europe. It has also been introduced into Africa, Australia and oceanic islands.

Examined material from the former Yugoslavia: 5 specimens, all juvenile.

Slovenia: after Wolf and Rähle 1987: Bovec.

Croatia: village Obrovac, Velebit Mts, limestone, 300 m a.s.l., anthropogenic habitats.

After Wagner 1931c: Volosco, Opatija. Wagner 1932: Volosco, Opatija. Wagner 1937a: Rijeka. Jaeckel et al. 1958: Istra, Dalmatia. Bole 1958: Krk Isl. Wiktor 1982: Split.

Serbia: after Rähle 1977a: Niš (as *Lehmannia flava*).

Macedonia: Štip, on a hill with ruins and in other anthropogenic habitats in the town; Skopje, fort ruins in the town.

After Jaeckel et al. 1958: Macedonia. Hesse 1928: Liseč Mt., 1800 m a.s.l. – location undefinable as there are several mounts bearing that name.

Comments

There exists a species, i.e. *Limax (Limacus) maculatus* (Kaleniczenko, 1851) (sensu Likharev and Wiktor 1980), very similar to *L. flavus* and frequently confused with it. The former is a slightly smaller slug, most often less distinctly spotted, but very similar in coloration. It obviously differs only in the connection between spermatheca duct and penis, which is like in the other *Limax* species except *L. flavus*. *L. maculatus* has not been noted in the former Yugoslavia's territory so far. It has been recorded from the Black Sea area (the Caucasus, S Ukraine, S Roumania, E Bulgaria), Ireland and Great Britain (for more detailed data see also Likharev and Wiktor 1980, Wiktor and Norris 1982, Forcart 1986).

The fact that the name "*Limax maculatus*" was earlier used by Nunneley (1837; see Hesse 1926) and is synonymous with "*L. maximus*", is an additional complication. Chronologically, the oldest available name for *L. maculatus* sensu Kaleniczenko 1851 is "*Limax ecarinatus* Boettger, 1881" (Wiktor in print).

– "*Bielzia montenegrina* (Boettger, 1885)"

This taxon is mentioned by Jaeckel et al. (1958) from Montenegro. See Comments to *Limax (Frauenfeldia) montenegrinus* p. 80.

– "*Limacopsis coerulans* Bielz"

Wohlberedt (1901) records this species from SW Montenegro. "*Limacopsis coerulans*" is one of the synonyms of *Bielzia coerulans* (Bielz, 1851) – a glaring misunderstanding, see Comments to *Limax (Frauenfeldia) montenegrinus* p. 80.

Family Agriolimacidae Wagner, 1935

Synonyms: Deroceratinae Wagner, 1935; Derocerasinae Hudec, 1972.

References: Likharev and Wiktor 1980: 123; Wiktor 1989: 100.

Small or medium-sized slugs, up to c. 60 mm long. Usually, however, their length is smaller – 20–30 mm. The posterior body end narrowed. Keel poorly developed, short. Mantle large, most often covering c. $\frac{2}{3}$ body length or even slightly more. In live slugs concentric wrinkles on mantle. Pneumostom usually postmedial, but in some genera antemedial. Most frequently around pneumostom a flat, soft, sort of plate with a smooth surface. Sole tripartite. Wrinkles in its medial zone in the shape of a widely obtuse letter V, on the lateral zones nearly transverse.

Coloration varying from white to black, although it is most often cream, beige or of different hues of brown. Body evenly coloured or covered with spots, which in most species tend to merge, thus producing a reticulate pattern as the darker pigment is accumulated mainly in the skin grooves. Mucus colourless. In many slugs, when irritated, also an opaque white mucus is secreted.

Digestive canal coiled into two loops, the second being moved posterad relative to the first one. In many species there is a short caecum on rectum.

Penis short, usually round-shaped or vermiform. In many species at the rear end of penis a single or branched penial gland. Stimulator inside penis occurs in many of these slugs as well. No additional glands present in the region of atrium and female reproductive organs.

The distribution range covers nearly the whole Holarctic Region, although most species occur in the southern and western Palearctic. In the family Agriolimacidae 7 genera and c. 100 species are known.

Key for identification of the species of Agriolimacidae

1. Caecum on rectum entirely lacking. Penis lacking or strongly reduced, if present – vermiform, coiled or irregularly bent. Penial gland at the very most in the shape of two small papillae on the penis end. On mantle fine dark dots. Mucus colourless. *Deroceras laeve* (p. 87).
- Caecum on rectum well-developed or in the form of a pocket. Penis well-developed, oval or laterally constricted in outline. Penial gland exceptionally in the shape of small nodules, usually as a single process or twig. Mantle unicolour or covered with distinct, seen with the unaided eye, spots. Mucus colourless or milky on irritation. 2.
2. Caecum on rectum longer than wide. 3.
- Caecum on rectum vestigial, in the shape of a pocket, the length of which equals or exceeds the width. 7.
3. Stimulator narrowly conical. 4.
- Stimulator with a wide base, in the form of an irregular flattened (i.e. oval in cross-section) cone. Penial gland in the shape of a single bent twig with distinct papillae and, at the least, with a very small lateral offshoot. Penis without a lateral pocket posteriorly. Body unicolour, creamy, or dark spotted. *Deroceras lothari* (p. 88).
4. Penial gland in the shape of a single nodule or short finger-like process of smooth surface. Body white, creamy, without spots. *Deroceras agreste* (p. 86).
- Penial gland nearly always branched, in the shape of a bunch of twigs, or – in the vestigial form – as a few short knots. Stimulator conical, more or less circular in section. 5.
5. Body graphite-black. *Deroceras maasseni* (p. 89).
- Body creamy, whitish or brownish, intensely spotted on mantle and in the posterior body section. 6.
6. Slugs usually big, over 30 mm long. Vas deferens opens to penis on the side of body integuments. Penial gland large, in the shape of one big branch or multiply branching. Inhabitants of open habitats, most often as synanthropes. *Deroceras reticulatum* (p. 92).
- Smaller slugs. Vas deferens opens to penis on the side of viscera or on its posterior end between inconspicuous swellings. Penial gland small, vestigial, in the shape of short branches or nodules.

A species frequent in forests, also as a synanthrope in other habitats.

..... *Deroceras turcicum* (p. 97).

7. Penis hammer-shaped, i.e. with two lateral pockets usually bent anterad but different in shape. No distinct penial gland or, at the very least, either of the lateral penis pockets is divided into several small lobes. Stimulator cone-shaped. Body evenly cream, brown or black. Skin thin, transparent. Mucus exclusively colourless.

..... *Deroceras sturanyi* (p. 94).

- . Penis not in the shape of a hammer. Posteriorly with a blind pocket or transverse process. Penial gland large, branched. Stimulator of a narrow base, completely flat, fan-shaped. Body white or cream, often spotted. Skin thick, not transparent. When irritated, the slug secretes a milky mucus.

..... *Deroceras rodnae* (p. 92).

Genus *Deroceras* Rafinesque, 1820

Deroceras Rafinesque, 1820: 10. Species typica: *Limax gracilis* Rafinesque, 1820 = *D. laeve* (O. F. Müller, 1774).

Agriolimax Mörch, 1865: 378. Species typica: *Limax agrestis* Linnaeus, 1758 = *D. agreste* (Linnaeus, 1758).

References: Hesse 1926: 21; Likharev and Wiktor 1980: 125; Wiktor 1989: 101.

Small slugs, up to c. 45 mm in length, with a large mantle that covers more or less $\frac{1}{3}$ body length. Skin wrinkles large. Coloration different, widely varying within a population. Body unicolour or spotted. Penis and its retractor do not cross either right ommatophore or its retractor (penis and ommatophore are situated close to each other). Penis usually ovate, often laterally constricted, less frequently shortly cylindrical. A large, usually branched, rarely nodular, penial gland is nearly always present. Irrespectively, different distensions or appendices may occur in the posterior penis section. Nearly always inside this organ there are complex structures of striated surface, the pattern of the striae resembling human fingerprints. Among these structures, a stimulator in the shape of a cone or flat fan-like organ is distinguishable. In most species there is a short, reduced to different extent, caecum on rectum.

Slugs living on the ground, mostly not climbing

plants, occurring both in open habitats and forests. They are herbi- or omnivorous. Their life cycle lasts from 1 month to around a year.

The distribution range covers practically the whole Holarctic.

Of all slugs this genus has the greatest number of species. Several dozen species are already known and new ones are still described. The infrageneric systematics is very difficult. A few subgenera are distinguished, the criterion being the appearance of penis, stimulator and caecum on rectum. Recently many authors have questioned the existing systematic division, hence it requires a fresh, profound analysis. Definitely, one subgenus should be distinguished, namely *Liolytopelte* Simroth, 1901, which has a hard, partly calcified lamella on stimulator. In the remaining genera such a lamella is missing, all the other characters seeming to occur in different combinations. For that reason, in this paper I do not group the remaining species into subgenera. Until now the following ones have usually been distinguished: *Deroceras* s. str., *Agriolimax* Mörch, 1865 and *Plathystimulus* Wiktor, 1973. I treat them as a whole, without providing subgeneric names as the taxon *Deroceras* s. str. has also had its tradition and includes only some of the slugs concerned.

The difficulties in recognizing the particular species stem from the small number of the known distinctive characters, from great intra- and interpopulation variability, and also from the uniparental reproduction capabilities of many species, which results in duplication of characters of one parent.

– *Deroceras absoloni* (Simroth, 1916)

Agriolimax Absoloni Simroth, 1916: 13, Fig. 3. Locus typicus: unknown – Dalmatia or Herzegovina. Typus: probably does not exist.

A taxon that has been creating difficulties since the time it was described and therefore has not been reliably confirmed. In the introduction to his paper Simroth (1916) states that the slugs he had at his disposal had, in all likelihood, been killed in formalin. This method leads to many deformations, which makes future detailed examination of the anatomical characters very difficult.

Simroth's description (1916) includes the following information: body length 18 mm, mantle length 6.5 mm. Coloration yellow-grey (gelbgrau), the upper part and sole ochreous. The anterior part of a particularly bright colour – almost orange (one may suppose that a piece of food present in the alimentary canal was responsible for that colour, which is often observable). On mantle, especially above pneumostom, traces of blackish or brownish infiltration.

Gonad large, blackish-brown. Penis with a deep lateral constriction dividing this organ into two, roughly equal in size, parts that Simroth defines as sacks (Säcke). It is illustrated in a small, very basic, doubtless freehand, drawing. The anterior penis part includes a wide lobe-shaped stimulator (... der vordere Säck enthielt bloss eine breite, wenig abgelöste Reizfalte, im hinteren treten einige scharfe Wülste hervor). One of the drawings presents a lateral view of penis with an apically opening vas deferens and slightly laterally attached retractor. The other drawing is unclear to me. It seems to depict the anterior penis part with stimulator advanced during preparation. However, it is equally probable that this is the whole of penis when seen from the other side. The only distinctive character is lack of penial gland. Yet, it is known that a) in juveniles this organ is often present at the stage of germ, and it should be remembered that the examined specimen was juvenile as it had a large hermaphroditic gland; b) during preservation penial gland often gets inverted into penis thus giving the impression that it is completely lacking, and – additionally – in formalin it may be seen through. Simroth may have overlooked it!

Distribution

Croatia: Wagner 1936: Dalmatia. Jaeckel et al. 1958: Dalmatia.

Comments

Neither the types nor locus typicus is known. Since Simroth (1916) no other malacologist has ever noted a slug of the above described characters (later records on this species were merely quotations after Simroth).

In my opinion, it is nomen dubium of a completely unclear systematic position, and nothing remains but not to mention it in the fauna composition of the former Yugoslavia.

41. ?*Deroceras agreste* (Linnaeus, 1758)

Limax agrestis Linnaeus, 1774: 652. Terra typica: Sweden. Typus: probably do not exist.

Synonyms: *Limacella obliqua* Brard, 1815; *Limax bilobatus* Ferrussac, 1819; *Limax pallidus* Schrenk, 1848; *Krynickyllus montanus* Kaleniczenko, 1851; *Limax varanyanus* Bourguignat, 1861; *Agriolimax Fedschenkoni* Koch et Heynemann, 1974 (nom. err.); *Agriolimax agrestis* var. *Fedschenkoi* Koch et Heynemann, 1874; *Agriolimax transcaucasicus* Simroth, 1901; *Agriolimax transcaucasicus coeciger* Simroth, 1901 (for literature see Hesse 1926, Likharev and Wiktor 1980).

Body length c. 35 mm. Mantle covers c. 1/3 body length. Body unicolour, i.e. without spots, white or pale creamy, with a slightly darker back. Mucus colourless, on irritation a milky white secretion appearing.

Genitalia. Gonad never reaching the posterior end of viscera. Penis ovate in juveniles, with a lateral constriction in mature individuals. Penial gland in the shape of a nodule or a short finger-like process, without glandular papillae. Stimulator in the shape of a cone narrow at the base.

Caecum on rectum well-developed, clearly longer than wide.

Ecology

A species of open habitats, less frequently found in bush thickets. An eurytopic species, occurring in some cultivations but not in greenhouses. In the mountains reaching 2500 m a.s.l. (the Alps). The slug lives for around a year. It is herbi- or omnivorous, may cause harm to cultivated fields.

Distribution

In spite of all appearances and numerous records in literature, the distribution range of the species is not precisely known because of its frequent misidentification. The slug probably inhabits whole Europe, a part of Central Asia and Crimea, in the north reaching the Kola Peninsula, in the east, in Asia, Sakhalin. Everywhere it occurs the species seems to have scattered, isolated, though probably natural, localities.

I have not had at my disposal any material from the former Yugoslavia (see the comments).

Slovenia: after Bole 1962: Triglav Nat. Park. Bole 1976b: No-tranjski Snežnik.

Croatia: after Wohlberedt 1901: Rijeka. Simroth 1909: Rijeka, Dubrovnik. Wagner 1935: Devčevac, Plitvice. Wagner 1937a: Lušinj, S. Pedro (= Supetar) on Brač Isl., Molat Isl. (= Mola = Melada), Vrana. Wagner 1931c: Volosco, Opatija. Wagner 1932: Volosco, Opatija. Wagner 1939: Omiš, Rovinj, Split. Jaeckel et al. 1958: Istra, Dalmatia.

Serbia: after Jaeckel et al. 1958.

Bosnia and Herzegovina: after Wagner 1937a: Bjelasica Mts near Gacko, (? Bosnia) Radovina and Ljubnica. Jaeckel and Meise 1956: ? Dub (there are several places bearing that name in different parts of the former Yugoslavia). Jaeckel et al. 1958: Bosnia, Herzegovina.

Montenegro: after Simroth 1900: Montenegro. Simroth 1909: Kotor, Žabljak, Virpazar, Kolašin, Andrijevića. Wohlberedt 1901: Žabljak, ? Vir Bazaar (? Virpazar). Wagner 1937a: Aluga in the Lovćen Mts, Herceg-Noví. Wagner 1940b: Lovćen Mts. Bole 1984: in the Durmitor Mts – Žabljak, Pitomine and Bosača. Jaeckel et al. 1958: Montenegro.

Macedonia: after Hesse 1928: Liseč. Jaeckel et al. 1958: Macedonia.

Comments

A species that has very often been erroneously recorded, especially in old literature where it was confused with other species. Particularly, these were young specimens with a poorly developed penial gland that were identified as *D. agreste*. That might concern – e.g. – *D. reticulatum*, *D. lothari* and *D. turcicum*. It was Wagner in particular to do it, which is evidenced by his drawings that show the variability of penial gland (Wagner 1935).

– *Deroceras attemsi* (Simroth, 1905)

Agriolimax Attemsi Simroth, 1905 (1904): 18, Figs 16–18. Locus typicus: "Hochebene von Pantokrator", Corfu (= Kerkyra) Isl. (Greece). Typus: probably does not exist.

Simroth described this species on the basis of a single specimen. Later it has not been recorded from this island (Wiktor in print).

According to Simroth (1905), it is a grey-brown (graubraun Grund) slug with numerous fine dark spots. Penis pear-shapedly oval (kolbig-oval) in its anterior part, the posterior one being narrow, cylindrical, bent (sich knieförmig umbiegt), with 5 tubular processes (Schläuchen) of penial gland. Musculus retractor penis inserted in the anterior (dilated) penis part. In this part there is a broad fold with its anterior end bent (eine breite Reizfalte mit umgeschlagenem

vorderen Zipfel). It follows from the drawing that this is a stimulator, which is probably flat.

No rectal caecum.

Distribution

Macedonia: Hesse 1928: Pepelak Mt. (as *Agriolimax* n. sp.? aff. *Agriolimax attemsi*). Jaeckel et al. 1958: Macedonia.

Comments

The status of this taxon is entirely unclear. Simroth (1905) compares it with the group "*D. agreste*" with respect to genitalia and with *D. laeve* considering lack of caecum. In his paper Hesse (1928) provides a drawing and description of the slug's external appearance. However, in the case of *Deroceras* species it is not sufficient for identification. Jaeckel et al. (1958) are known not to have examined these slugs as they only quote information on them after other authors.

It is certain that there are no grounds to still mention this taxon in the slug fauna of the former Yugoslavia. I have failed, however, to ascertain whether the species *D. attemsi* exists at all (Wiktor in print), and this question can be answered only after topotypes are collected and examined.

42. *Deroceras laeve* (Müller, 1774)

Limax laevis O.F. Müller, 1774: 1. Verm. terr. II. Locus typicus: Frideriksdal in the vicinity of Copenhagen. I have no information about the types.

Synonyms: *Limax brunneus* Draparnaud, 1801; *Limax gracilis* Rafinesque, 1820; *Limax campestris* Binney, 1842; *Limax parvulus* Normand, 1852; *Limax winladii* Heynemann, 1862; *Limax araneus* Gessies, 1867; *Agriolimax bovenoti* Collinge, 1870; *Limax montanus* Ingersoll, 1875; *Limax castaneus* Ingersoll, 1875; *Limax ingersolli* Binney, 1875; *Limax hyperboreus* Westerlund, 1876; *Krynckillus mentonicus* Nevill, 1880; *Limax Hemphilli* Binney, 1890; *Limax berndti* var. *pictus* Cockerell, 1897; *Agriolimax pseudodioicus* Veliczko-wski, 1910; *Agriolimax renschi* Wagner, 1934; *Agriolimax schultzi* Matiokin, 1946 (for bibliography see Hesse 1926, Likharev and Wiktor 1980, Wiktor 1989).

A small slug, after preservation up to 22 mm in length, usually smaller, however. Mantle roughly equalling half the body length (!). Body slim. General coloration from dirty cream to dark chocolate. On mantle irregular darker fine spotting (usually perceivable only after preservation). Mucus colourless.



Fig. 106. *Deroceras laeve* (Müller, 1774) – copulatory organs (aphalic) and fragments of caecum, specimen from Trebinje (Herzegovina).

Genitalia (Fig. 106). Euphalic forms (with formed penis) are usually considerably less numerous than aphalic ones (with entirely reduced penis) or forms with partly reduced male copulatory organs. If well-developed, penis is elongated, anteriorly dilated, posteriorly vermiform, irregularly bent. Vas deferens opens laterally, at c. $\frac{1}{3}$ penis length as measured from its rear end. Two glandular papillae of penial gland usually present on the posterior penis end. Retractor insertion also lateral, situated roughly in the middle of penis. Stimulator in the shape of a small, half-spherical papilla. The reduction of male copulatory organs involves a part of vas deferens, penis and retractor. The extent of reduction is different, in the extreme case there is no free section of vas deferens and no penis with its appendages at all.

Ecology

A hydrophilous slug, occurring in very different types of habitat if only high humidity is ensured. In

flooded areas it can stay in low temperatures under water for many hours. The species often occurs as a synanthrope, also in greenhouses. Its life cycle is very short, lasting merely around a month.

Distribution

A species of the Holarctic, introduced nearly in the whole world, both in the tropical and subarctic zone, which is rendered possible by its short life cycle.

Examined material from the former Yugoslavia: 10 spec.

Slovenia: Bled, Julijske Alpe, on rocks, 500–600 m a.s.l.

Croatia: after Wagner 1931c: Wrutki spring near Opatija.

Wagner 1932: Volosco, Opatija. Wagner 1939: Split. Jaeckel et al. 1958: Istra, Dalmatia.

Herzegovina: Trebinje, by a stream.

After Jaeckel et al. 1958: Istria, Dalmatia.

Montenegro: after Bole 1984: in the Durmitor Mts – Barice, Modro Jezero, Velika Kalica, Lokvice. Jaeckel et al. 1958: Montenegro.

Macedonia: Mavrovo, Mavrovo Nat. Park, lake shore; Gostivar, W of the town, barren lots, limestone.

After Wiktor 1982: Lukovo in the Drim valley.

43. *Deroceras lothari* Giusti, 1971

Deroceras lothari Giusti, 1971: 491. Figs 14A–D, 15A–D. Locus typicus: Terminillo Mt. (Central Appenines, Italy). Holotypus: in coll. F. Giusti, Siena.

Deroceras klemmi Grossu 1972: 642, Figs 2a–h. Locus typicus: Trieste (Boschetto). Holotypus: Naturhist. Mus., Wien, no. 50598.

Deroceras dalmatinum Grossu, 1972: 647, Fig. 5. Locus typicus: "Karst doline" in the vicinity of Trieste (? Italy). Holotypus: Naturhist. Mus., Wien, no. 50605. Syn. n.

References: Altena 1973; Reischütz 1978; Reischütz 1986.

Slugs 36 mm long, up to 9 mm wide, mantle length up to 16 mm. Coloration dirty cream or brownish cream. Body unicolour or poorly darker spotted, the spotting often forming a reticulate pattern as these are skin grooves that are darker in colour.

Genitalia (Figs 107–108, 110–112). In respect of shape penis is not conspicuous. It is elongated, in adult specimens usually constricted. Penial gland single, long, most often bent, provided with glandular papillae. At times it has small lateral branches, usually stemming from one side only. Stimulator of a broad base and a brink mildly slanting from the apex

towards posterior penis (Fig. 108). Thus, this organ is neither in the shape of a regular cone nor that of a flat fan. It may be defined as a flattened, bluntly terminating cone. Stimulator so shaped is also found in the holotype of *D. dalmatinum* (Fig. 112).

Caecum on rectum comparatively large (Fig. 109).

Ecology

So far hardly known. I collected the slug in open habitats, particularly in mountain meadows, where it goes beyond the timberline up to 1500 m a.s.l. at least.

Distribution

The distribution of this species was the subject of concern to Reischütz (1978, Map 1). His observations suggest that the slug's localities are scattered about an area stretching from the Hungarian-Austrian borderland through Austria, Slovenia and Croatia (Map 9) to north-eastern Italy, Hungary and southern Germany in the north. The southern range limit is not determined. The slug has been described fairly recently. Its identification may present difficulties and many malacologists must have not identified it as a distinct species. That is why it is difficult to discuss its distribution range in detail.

Examined material from the former Yugoslavia: 59 spec.

Slovenia: Ljubljana, city park, under stones and on castle ruins, 300 m a.s.l.; Kranj, under stones, in the Sava valley, 385 m a.s.l., conglomerate rocks; Julijske Alpe, Bled, on rocks, 500–600 m a.s.l.; Julijske Alpe, valley N of Triglav Mt. near Dovie vill., 700–1000 m a.s.l., limestone, *Fagus-Picea* forest; Julijske Alpe, Triglav Mt., Pakljuka, limestone, 1000 m a.s.l., mountain meadows near the hotel; Radeče (between Zagreb and Ljubljana) in the Kum Massif, 700–1000 m a.s.l., *Fagus* forest.

After Altena 1973: NNE of Tolmin, valley of the Kokra. Forcart 1973: NNE of Tolmin, valley of the Kokra, W of Kokra (as *D. cf. klemmi*). Wolf and Rähle 1987: (as *D. klemmi*) N of Vrišič pass. On the border with Croatia but in Italy – Grossu, 1972: Trieste (Boschetto, ? Italy) (as *D. klemmi* and *D. dalmatinum*).

Croatia: Velebit Mts, NE slopes of Vaganski Vrh, above Svjetly Rok village, above timberline, limestone, 1300–1500 m a.s.l., steep rocky slopes with grass vegetation; Nat. Park Rysnjak, near Crny Lug (near Delnice), meadow.

Comments

The species has been described recently, almost simultaneously by two authors under two names. Rei-

schütz (1978) stated that the name "*D. klemmi*" should be synonymized with "*D. lothari*". I share this opinion. However, having examined the holotype of *D. klemmi*, I think that Reischütz unjustifiably compared the appearance of stimulator in *D. klemmi* with the stimulator of the type of a cone as that in *D. reticulatum*. In this respect, I agree with Grossu (1972); stimulator in the holotype of *D. klemmi* is strongly flattened (see below). Having examined the holotype of *D. dalmatinum* (Figs 110–112), I have come to the conclusion that this name too is a synonym of *D. lothari*.

Still, it should be pointed out that in *D. lothari* (= *D. klemmi* = *D. dalmatinum*) stimulator assumes quite a peculiar shape. It is fleshy, so not strongly flattened as shown in Grossu's picture or as may be the case in – e.g. – *D. rodnae*. Neither is this organ in the shape of a regular cone as in *D. reticulatum*, for example. Instead, it has a broad base, an asymmetrically set apex and is oval in cross-section.

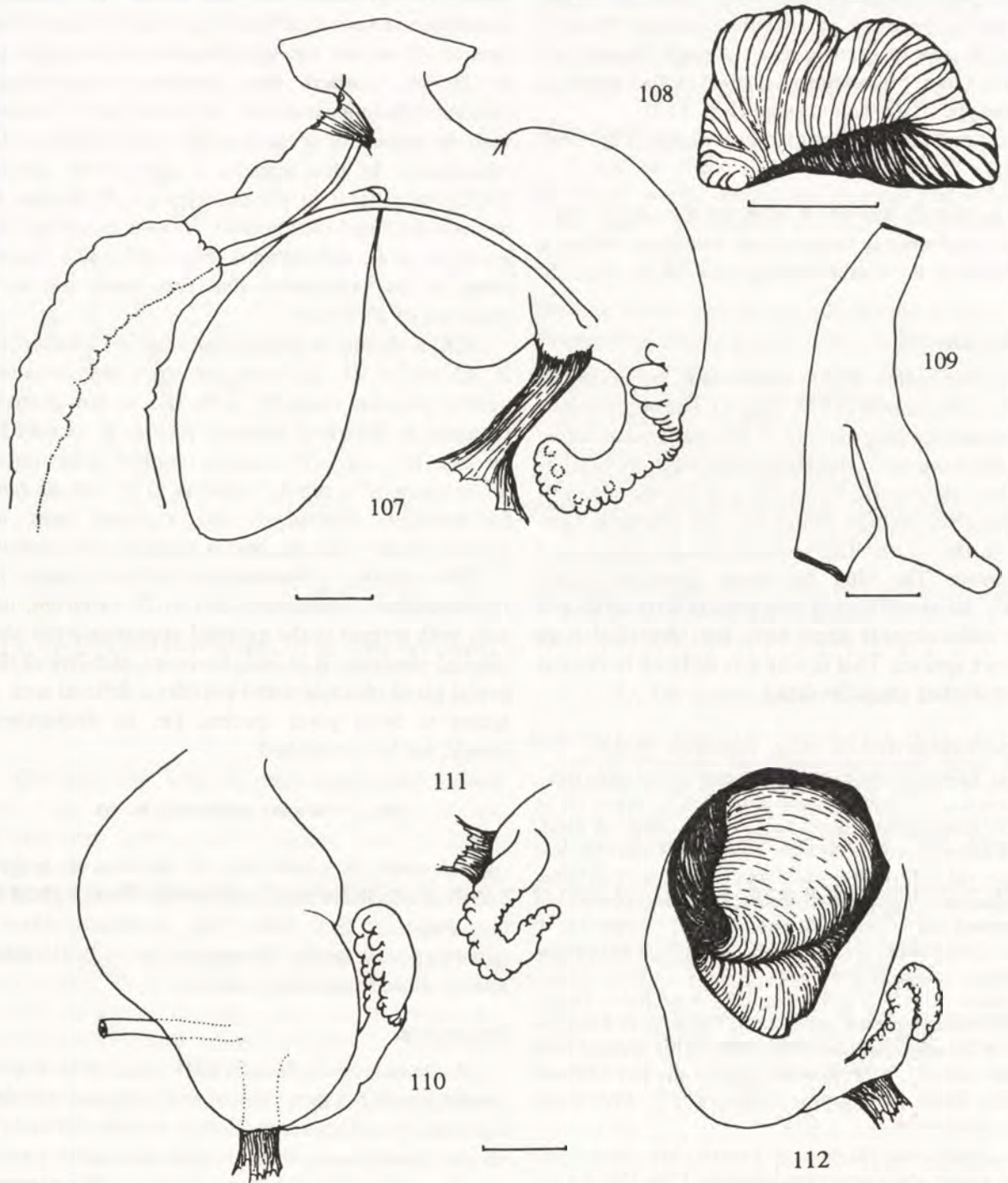
This species is similar to different forms of *D. reticulatum*, sometimes also to *D. turcicum*, not only with respect to the external appearance but also internal structure. It shows, however, stability of the penial gland characters and inhabits a defined area. It seems to be a good species, i.e. its distinctness should not be questioned.

44. *Deroceras maasseni* n. sp.

Diagnosis: A small slug, c. 20 mm in length, evenly blackish on back and mantle. Penial gland in the shape of 3–4 thin, long processes directly connected with penis. Stimulator laterally flattened and as if perpendicularly cut.

Description

The length of the holotype 21 mm, width 4 mm, mantle length 8.5 mm. One of the paratypes matches it in size, the others being slightly smaller. Coloration of specimens preserved in alcohol: the medial part of mantle and back blackish, nearly black. The pigment is almost evenly distributed (i.e. there are no spots). It gradually lessens towards body sides and mantle edges. In some paratypes sides are entirely pale, creamy. In the holotype only a half of body sides is creamy whereas in the anterior and posterior part



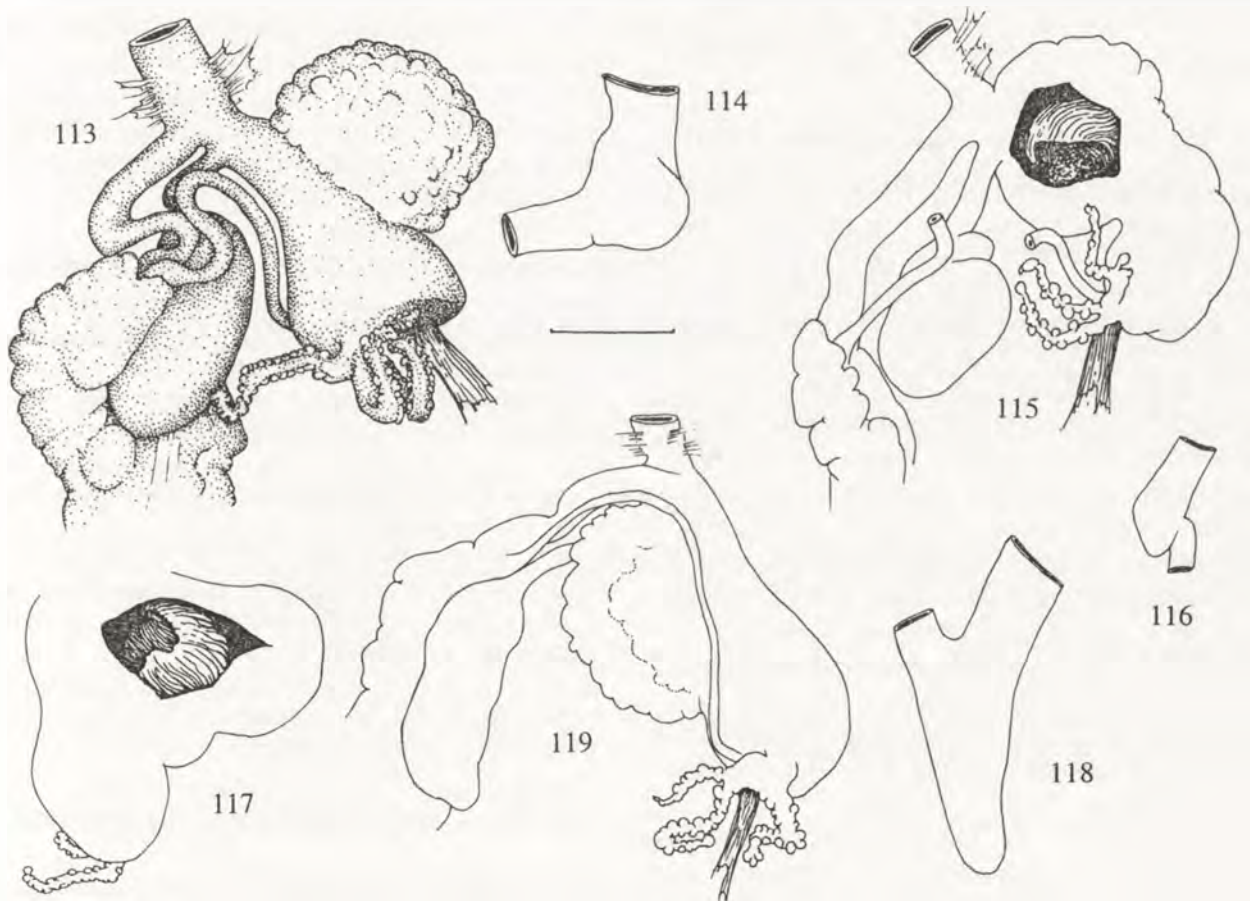
Figs 107–112. *Deroceras*. 107–109 – *Deroceras lothari* Giusti, 1971. 107 – copulatory organs. 108 – stimulator. 109 – fragment of rectum, specimen from Črny Lug, near Delnice (Croatia). 110–112. *Deroceras dalmatinum* Grossu, 1972 – holotypus (= *D. lothari*) (drawings made by me!). 110 – penis. 111 – penial gland. 112 – stimulator inside penis.

a darker pigment is visible, even in the region of suprapedal grooves where body integuments are grey. Head and tentacles blackish, though lighter than mid-mantle. Sole pale. The colour of mucus has not been noted. In the external appearance of the slug no distinctive characters allowing to identify it in field conditions have been observed.

Genitalia (Figs 113, 115, 117, 119–121). Penis elongated, inconspicuously medially constricted. The lateral wall in the anterior penis section glandular. The posterior part asymmetrical as one side is slightly swollen, there is no lateral pocket or appendix, however (Figs. 113, 121). The opening of

vas deferens almost apical. In its close vicinity there is the retractor insertion and connection penis-penial gland. The posterior penis section dark-pigmented. Penial gland composed of 3–4 thin twigs united at the base (in the holotype there are three of them) and connected to penis without a distinct common stalk. Glandular papillae on penial gland usually fine. Stimulator inside penis not large, flattened but fleshy (Figs 115, 117, 121). Its free end broad and as if perpendicularly cut.

Caecum on rectum in the holotype and most paratypes in the shape of a small, shallow, but clear, pocket (Figs 114, 116, 122), only in the paratype



Figs 113–119. *Deroceras maasseni* n. sp. 113 – copulatory organs (holotype). 114 – fragment of the holotype's rectum. 115 – copulatory organs, paratype from Aluga (Montenegro). 116 – fragment of rectum, the same paratype as in Fig. 115. 117 – penis with stimulator inside, paratype from Donia Dobrilovina (Montenegro). 118 – fragment of rectum, the same paratype as in Fig. 117. 119 – copulatory organs, the same paratype as in Figs 117–118.

from the Tara valley near Dania Dobrilovina being markedly longer. This may, however, be an artefact as the caecum was accreted to the membrane covering viscera and it was difficult to set it apart (Fig. 118).

Material:

All the examined specimens were collected in Montenegro, in the region neighbouring with the Tara river valley (Map 10).

Holotypus: Montenegro, 11 km N of Kolašin, 900 m a.s.l., leg. W.J.M. Maassen 22.09.1980, in Nat. Natuurhist. Mus., Leiden.

Paratypes: 1 spec. collected with the holotype, kept in W.J.M. Maassen's private collection; 1 km W of Aluga, c. 10 km E of Žabljak, 1150 m a.s.l., leg. W.J.M. Maassen et A.J. de Winter 21.09.1980 – 2 spec. (including one with a partly inverted penial gland); valley of the Tara river, 12 km N of Dania Dobrilovina, 650 m a.s.l., leg. A.J. de Winter 22.09.1980 – 1 spec., in Mus. Nat. Hist., Wrocław, no. MP 648.

45. *Deroceras reticulatum* (Müller, 1774)

Limax reticulatus O.F. Müller, 1774: 10. Locus typicus: Frideriksdal near Copenhagen. For descriptions of topotypes see Altena 1969: 102 Figs, 1a–c.

Deroceras altenai Lupu, 1976: 10, Figs 1–9. Locus typicus: Bucharest. Holotypus: Mus. Nat. Hist. "Gr. Antipa", Bucharest, no. 13204.

Body length up to c. 45 mm (though usually less), mantle length in specimens from the former Yugoslavia reaches 30 mm, width 7.5 mm, mantle length 12 mm. Nearly always dense spots of a blackish pigment occurring against a dirty cream or brown-cream background. The spotting intensity widely different. The spots fuse resulting in a reticulate pattern as the dark pigment is accumulated mainly in the skin grooves. Keel always without spots. Juveniles are devoid of spots or have considerably less pigment. Mucus colourless, on irritation highly milk-coloured. Basing only on its external appearance it is not possible to identify the species.

Genitalia (Fig. 123). In sexually mature specimens penis divided by a constriction in two distinct parts, in juveniles elongated. Vas deferens opens on the lateral penis wall (cf. *D. turcicum*). An unbranched musculus retractor penis inserts in the region of the penial constriction. Penial gland widely varied in shape, always well-developed. The organ may take the form of a single twig with glandular papillae but

usually it is divided into several branches. Stimulator in the shape of a narrow cone.

Caecum on rectum large, many times longer than wide (Fig. 123).

Ecology

A species of open habitats. Currently almost exclusively found as a synanthrope in gardens, fields, on fallow land, refuse heaps etc, hiding under stones, wood pieces, clods of earth. It occurs in abundance, being often a galling pest. Its life cycle lasts for around a year. Most often individuals mature sexually in autumn but in a mild climate some winter over and may be found also in spring.

Distribution

It is unknown where its original distribution range was. At present the species inhabits almost whole Europe, though in the south, including the Balkans, it seems to be an introduced synanthrope. It has been introduced with cultivated plants e.g. to Peru, Australia, New Zealand and Tasmania.

Examined material from the former Yugoslavia: 37 specimens.

Slovenia: Julijske Alpe, Bled, on rocks, 500–600 m a.s.l.

Croatia: Zagreb, city park, 185 m a.s.l.; Nat. Park Rysnjak near Črny Lug (near Delnice), meadow.

After Wagner 1931c: Volosco, Opatija. Wagner 1932: Volosco, Opatija. Jaeckel et al. 1958: Istra, Dalmatia.

Serbia: Beograd, in old fortifications and park; ? Kremna (W of Titovo Užice), Tara planina Mts, 1200–1300 m a.s.l., *Abies-Fagus* forest, humid.

After Jaeckel et al. 1958: Serbia.

Montenegro: after Jaeckel et al. 1958: Montenegro. Norris 1986: Durmitor Nat. Park – Poljanak, Poljana, Lakat, grounds of the Hotel Jezera, Žabljak.

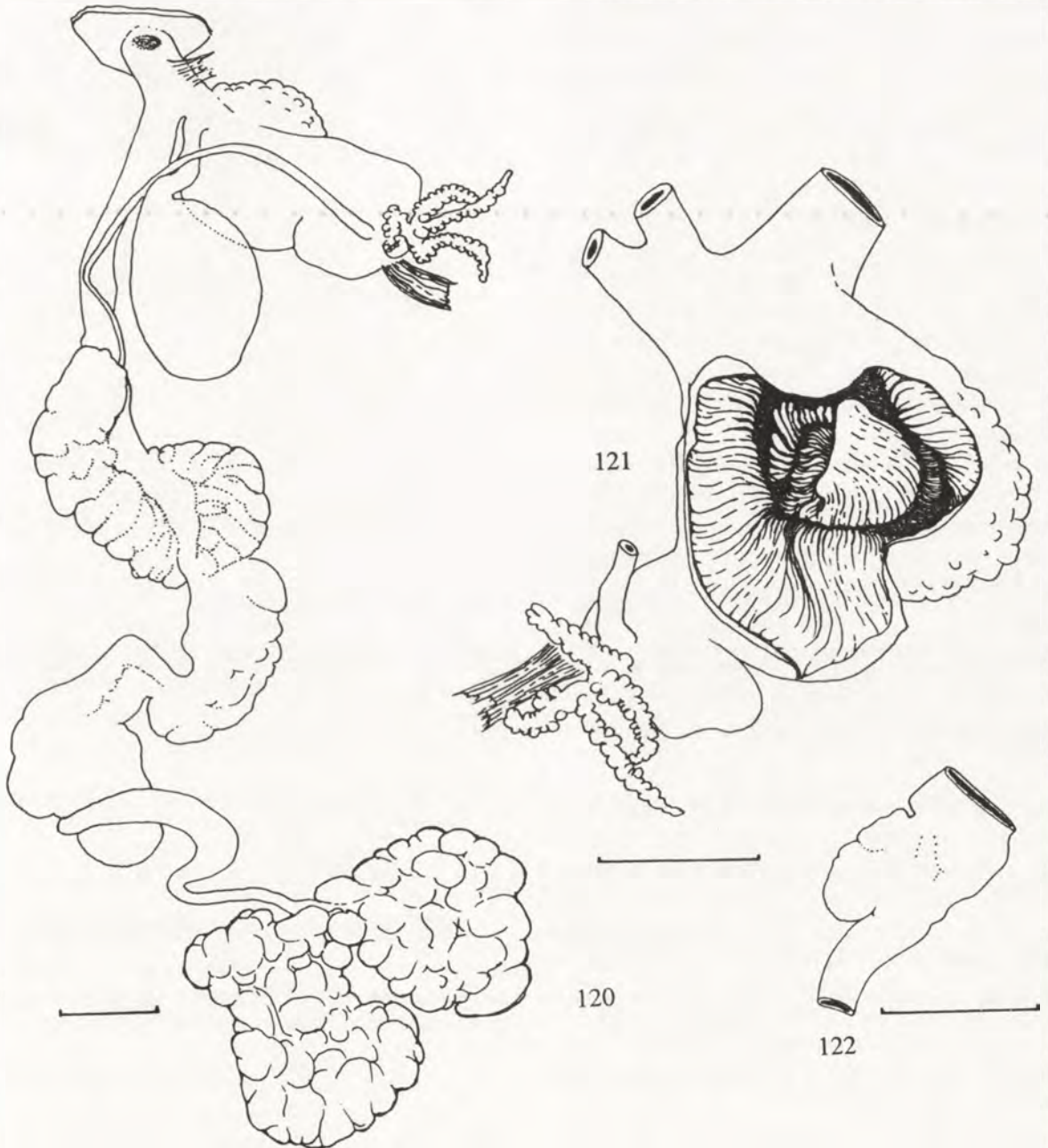
Macedonia: Lake Ohrid shore, synanthropic; Sv. Jovan Bigorski monastery near Struga, limestone.

After Jaeckel et al. 1958: Macedonia.

46. *Deroceras rodnae* Grossu et Lupu, 1965

Deroceras rodnae Grossu et Lupu, 1965b: 28, Figs 2A–C. Locus typicus: Inău Mt. in the Rodna Mts (Roumania). Holotype: Mus. Nat. Hist. "Gr. Antipa", Bucharest, no. 13135.

Deroceras (Plathystimulus) fatrense Macha, 1981: 97, Figs 1–8. Locus typicus: at the base of a rock, 300 m S of the shelter-home near Suchý Mt., Malá Fatra Mts. (Slovakia). Holotypus: Slezské Museum, Opava, no. SM 2874. **Syn. n.**



Figs 120–122. *Deroceras maasseni* n. sp., paratypus from Kolašin (Montenegro). 120 – reproductive system. 121 – penis with stimulator discernible inside. 122 – fragment of rectum.

Body length up to c. 35 mm (the specimen from Croatia is 32 mm long), width c. 7 mm, mantle length 10 mm. Body coloration cream or dirty cream, at times white, usually dark brown-spotted. The spots often merge in a reticulum. Unicolour, i.e. without spots, individuals are also found. Mucus colourless, on irritation milky white.

Genitalia (Fig. 124). A thin vas deferens opens on the posterior penis end hence nearly apically. Penis irregular in shape: anteriorly dilated, laterally constricted, the posterior part being clearly narrower. The latter usually provided with a short, pocket-shaped appendix or there is a distinct swelling, most often directed towards body integuments, sometimes several swellings are present. In this part of penis a dark spot usually occurs. In the neighbourhood of the swelling a firm unbranched retractor is attached. Penial gland set apically, branched. In the anterior, broad, penis section there is an utterly flat stimulator with a relatively narrow base. Towards its free end stimulator fan-shapedly widens.

Caecum on rectum vestigial, merely pocket-like (Fig. 124).

Ecology

The slug occurs in forests, beech ones in particular, in thickets of lush herbs, especially preferring the neighbourhood of springs. It climbs up plants.

Distribution

The species is widely spread from Ukraine and Roumania to the Vogeses in France and Austria, in Spain. It is recorded also from Poland, the Czech and Slovak Republic, Hungary, Austria, Germany and Switzerland, never noted before in the former Yugoslavia's territory, the below mentioned being its southernmost locality (Map 10).

Examined material from the former Yugoslavia: 1 spec.

Croatia: Nat. Park Plitvice Lakes, Plješevica Mts, *Fagus* forest, 600 m a.s.l., limestone – 1 spec.

Comments

Admittedly, I had at my disposal only one specimen, but it was fully grown and showed all the morphological characters typical of this species. Also the habitat where it was collected was characteristic of this slug. I have the impression that the slug is native, not introduced, here.



Fig. 123. *Deroceras reticulatum* (Müller, 1774) – copulatory organs and fragments of caecum, specimen from Ohrid (Macedonia).

47. *Deroceras sturanyi* (Simroth, 1894)

Agriolimax Sturanyi Simroth, 1894: 393, Pl. 19, Figs 6–9. Locus typicus: Ochrida (= Lake Ohrid), Macedonia. Lectotypus: Naturhist. Mus., Wien, no. 19493b.

Agriolimax murinus Simroth, 1894: 393, Pl. 19, Figs 10–11. Locus typicus: Ochrida (= Lake Ohrid), Macedonia. Holotypus: Naturhist. Mus., Wien, no. 19494(1). **Syn. n.**

Deroceras romanicus Grossu et Lupu, 1959: 46, Figs 6a–f. Locus typicus: Sibiu (Roumania). Paratypes: Senckenberg Mus., Frankfurt a/M., no. 161648/6.

A slug after preservation c. 25–28 mm long, 6 mm wide, mantle length 11 mm. Skin thin, limp, with viscera showing through. Skin sculpture delicate. Body unicolour, only back being slightly darker.

Coloration from dirty cream to chocolate or black. Dark-coloured specimens prevail in locus typicus, where the slug occurs in great numbers, whereas in Central Europe almost exclusively cream or brownish forms are found. Mucus colourless and watery.

Genitalia (Fig. 125). Viscera nearly always surrounded by a dark-pigmented fine membrane. Penis hammer-shaped as its anterior part is elongated while the posterior one made of two pockets that are different in size and shape but almost always bent anterad. One of the pockets is homologous to penial gland. It is larger than the other one, hook-like bent or straight and narrowed at the free end, sometimes being divided in a few small lobe-shaped or papillary processes. The other, smaller, pocket is rounded, sometimes hardly perceptible. Musculus retractor penis unbranched, attached to penis at the opening of a thin vas deferens, i.e. near the posterior penis end, on penis wall between the two pockets. Stimulator in the shape of a fleshy, bluntly ending, regular cone.

Caecum on rectum vestigial, pocket-shaped (Fig. 126).

Ecology

A species of the lowlands, inhabiting open, most often humid or moderately humid, habitats, e.g. meadows, neighbourhood of water reservoirs, ditches, also gardens and cultivated fields sheltered by thick vegetation. It is often found as a synanthrope, particularly in Central Europe, where it prefers parks, cemeteries, gardens etc. Its life cycle lasts for around a year. Considering life cycle, the slug is the best known representative of the genus *Deroceras* owing to a publication by Kosińska (1980).

The species is most often found in small populations. Nevertheless, by Lake Ohrid (locus typicus) it is abundant. After rain I happened to observe thousands of individuals crawling along an asphalt road that was running through wet areas covered with thick grass vegetation.

Distribution

The species origin was presumably in south-eastern Europe, from where it has expanded its range by synanthropic localities. It is noted from Turkey and Bulgaria up to Holland and Helgoland Isl. on the Baltic Sea, and from the former Yugoslavia to the European parts of the former USSR. No doubt, it has been introduced to Kazakhstan. The range is not pre-

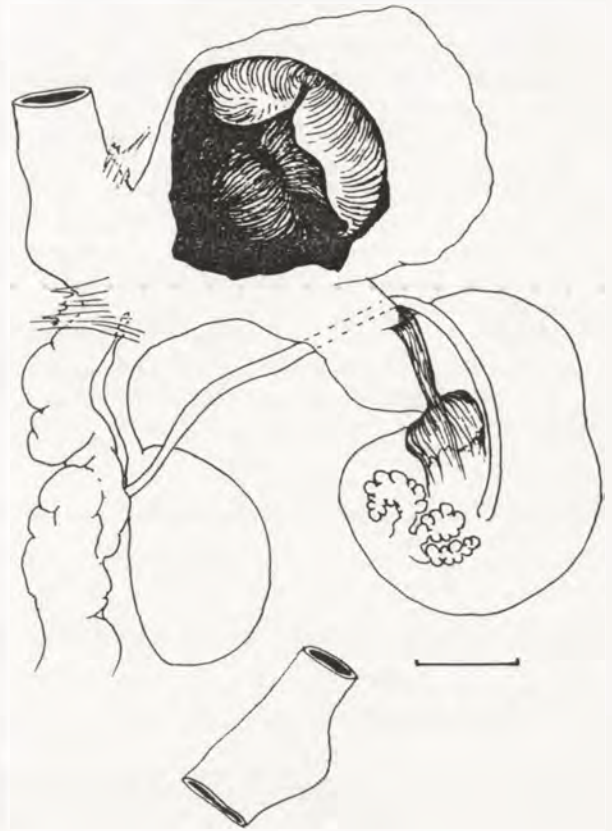


Fig. 124. *Deroceras rodnae* Grossu et Lupu, 1965, – copulatory organs and fragments of caecum, specimen from the environs of Plitvice (Croatia).

cisely known considering the fact that most, particularly earlier, malacologists, including Simroth (the author of the species *D. sturanyi*), commonly mistook this species for *D. laeve* and recorded as such in their papers.

Examined material collected in the former Yugoslavia: over 230 spec. (Map 11).

Slovenia: Julijske Alpe, Bled, on rocks, 500–600 m a.s.l.

Croatia: Delnice, in a valley, 600 m a.s.l.

Bosnia: Šipovo, in the Pilva river valley, SW of Jajce, Vitorog, 500–600 m a.s.l., meadows near the river.

Serbia: Beograd, in old fortifications and park.

After Frank 1991: Niš.

Montenegro: Mojkovac, Biogradski Nat. Park, Bjelasica Mts (NE

Montenegro), 750–1500 m a.s.l., glades; Visitor Mts (E Montenegro), by the lake near Plav, 700–1000 m a.s.l.; near Nikšić (S Montenegro), humid meadow near a river.

Macedonia: Skopje, fort ruins in the town; Titov Vales, dry marble rocks above the town, 280 m a.s.l.; Padalište, S of Gostivar, near the railroad to Kičevo, in a deep valley, limestone, 750 m a.s.l.; Mavrovo Nat. Park, lake shore; above Lukovo (between Debar and Struga), on limestone, under stones, in the Crni Drim valley, 700–1000 m a.s.l.; Peštani, N of Ohrid (c. 30 km), by the Sateska river, *Alnus*, 700 m a.s.l.; Lake Ohrid shore, synanthropic; Štip, on the hill with ruins and in other anthropogenic habitats in the town; Struga, Lake Ohrid shore, synanthropic, 700 m a.s.l.

After Hesse 1928: "Kaluckova" (?). Wagner 1937a: (as *A. murinus*) near Sv. Naum (Ohrid). Wagner 1937b: near Lake Ohrid, Ohrid. Wiktor 1982: Kalista (? Kališta) W of Lake Ohrid.

Comments

In the Natural History Museum collection in Vi-

enna there is a specimen labelled as the holotype of *Agriolimax murinus* (Figs 127–128). It is a small slug, c. 12 mm in length. At present it is unicolour, creamy. The specimen has a large glandula hermaproditica, which points to the fact that it is in the male phase of reproductive development. The holotype is badly damaged, lacking – e.g. – spermoviductus and glandula albuminalis. I have failed to establish what caecum looks like. The specimen seems to be the one Simroth writes about, its penis being shown in two drawings by this author (Simroth 1894). However, the drawings are very much simplified and therefore I have made my own figure. Having examined the holotype of *A. murinus* and collated it with Simroth's description, I have come to the conclusion that this name should be synonymized with "*D. sturanyi*", the latter being pronounced in the paper mentioned, on the same page but slightly above.

– *Deroceras subagreste* (Simroth, 1892)

Agriolimax subagrestis Simroth, 1892: 43. Locus typicus: the environs of Maikop (= Maykop, S Russia). Syntypi: dried up, Zool. Mus. Humboldt Univ., Berlin, no. 45704.

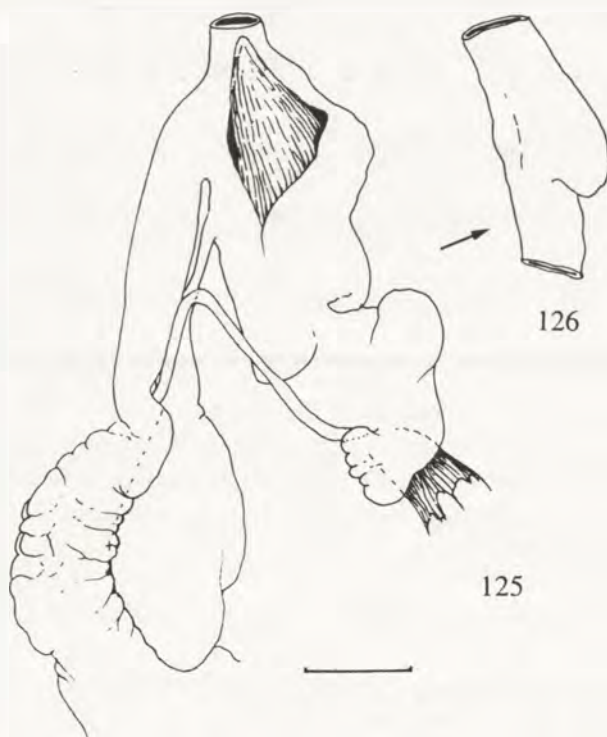
For the synonyms, more detailed data and drawings see Likharev and Wiktor 1980: 154 Figs 111–115.

The occurrence of this slug in this region seems highly improbable. The species is known to be recorded from Central and South Europe by many authors but all these data are at least doubtful and have never been authoritatively confirmed. The species occurs in the area of southern Russia and the northern Caucasus, penetrating southward beyond the main ridge of these mountains (Likharev, Wiktor 1980).

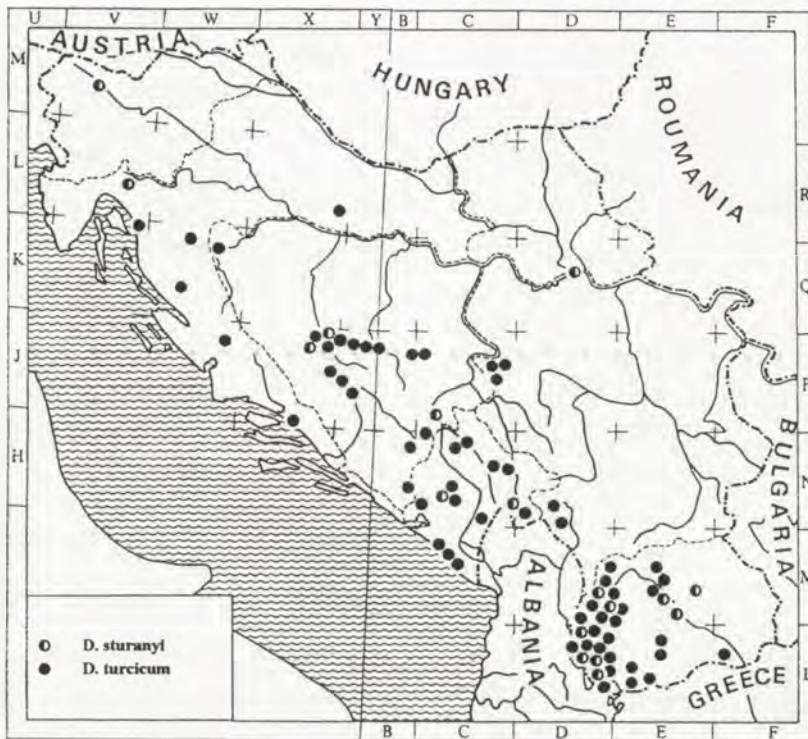
My present survey has not confirmed the occurrence of *D. subagreste* in the region of the former Yugoslavia, the below quotations from literature being most probably referable to some other species, perhaps *D. rodnae*.

Croatia: after Wagner 1935: Curzola (= Korčula Isl.). Wagner 1937a: Curzola (= Korčula Isl.). Jaekel et al. 1958: Dalmatia.

Bosnia and Herzegovina: after Wagner 1937a: Radovac near Konjic (= Konjica).



Figs 125–126. *Deroceras sturanyi* (Simroth, 1894) – copulatory organs and fragments of rectum, specimen from Ohrid (Macedonia).



Map 11. Distribution of *Deroceras sturanyi* and *D. turcicum*.

48. *Deroceras turcicum* (Simroth, 1894)

Agriolimax turcicus Simroth, 1894: 392, Pl. 19, Figs 2–5. Locus typicus: Ochrida Sea (= Lake Ohrid), Macedonia. Lectotypus: Naturhist. Mus., Wien, no. 19491.

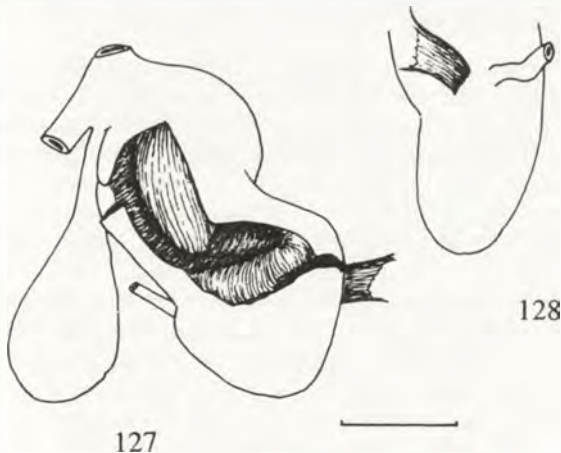
?*Deroceras forcarti* Grossu et Lupu, 1961a: 21, Figs 1–2. Locus typicus: Babadag (Dobruja, Roumania). Holotypus: coll. Grossu, Bucharest, 13119.

Deroceras wiktori Grossu, 1969: 168, Figs 10a–i. Locus typicus: Orșova-Esalnita (Roumania). Holotypus: coll. Grossu 1147.

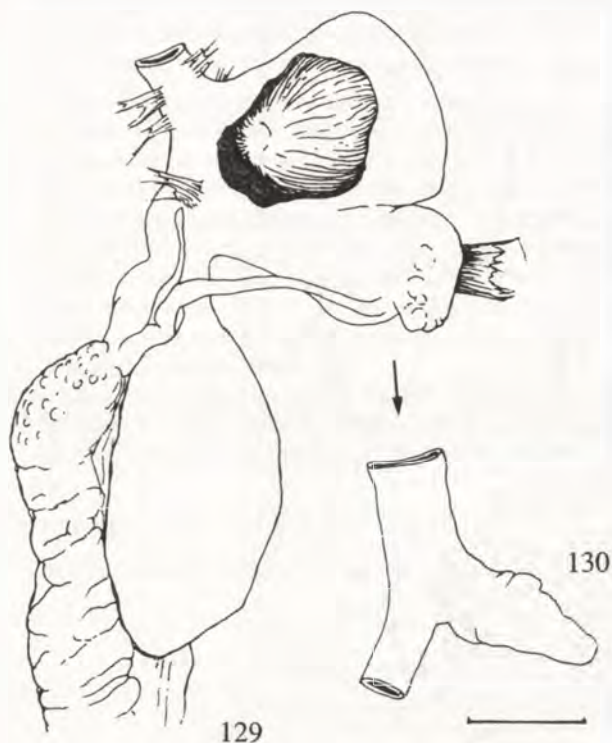
?*Deroceras waldeni* Grossu, 1969: 169, Figs 11a–i. Locus typicus: Jurilovica (Dobruja, Roumania). Holotypus: coll. Grossu, Bucharest, no. 1148.

Deroceras bosnensis Grossu, 1972: 643, Figs 3a–d. Terra typica: Bjelašnica pl. (Bosnia). Lectotypus: Naturhist. Mus., Wien, no. 32333 (Lectotypus – for present designation see Comments). **Syn. n.**

Deroceras hercegovinae Grossu, 1972: 645, Figs 4a–f. Terra typica: Bjelasica pl. (it should be spelled "Bjelašnica"), near Gacko (Herzegovina). Holotypus: Naturhist. Mus., Wien, no. 77502. **Syn. n.**



Figs 127–128. *Agriolimax murinus* Simroth, 1894 – holotypus (= *D. sturanyi*). 127 – penis with stimulator inside. 128 – the other side of penis (the same specimen) with retractor insertion and the connection vas deferens-penis (my drawings!).



Figs 129–130. *Deroceras turcicum* (Simroth, 1894) – copulatory organs and fragments of rectum, specimen from the Sutjeska Nat. Park (Bosnia and Herzegovina).

Both in respect of external appearance and anatomical structure the slug is similar to *D. reticulatum*, although slightly smaller. Its body is up to c. 20 mm long, c. 5 mm wide, mantle length c. 10 mm. General coloration dirty cream or brownish, with black or blackish spots that are different in intensity in different individuals. Keel and mid-back always without spots. Mucus colourless, on irritation a milky white secretion appearing.

Genitalia (Fig. 129). Penis in mature specimens laterally constricted, posteriorly mildly rounded but usually with two protuberances. Between them, on the side of viscera, a thin vas deferens opens in penis, that being an important character distinguishing *D. turcicum* from *D. reticulatum*. Penial gland widely varied in shape, often vestigial – in the form of small nodules or very short twigs with glandular papillae. The organ usually makes the impression of being

reduced when compared with that of *D. reticulatum*. Stimulator in the shape of a narrow cone.

Caecum on rectum well-developed (Fig. 130).

Ecology

An eurytopic species occurring in open habitats and deciduous forests, on fallow land, rubble heaps, often as a synanthrope. Most frequently it is found in large populations.

Distribution

Apart from the former Yugoslavia, the slug is known from Bulgaria, Hungary, Austria, Turkey. It is probably more widely spread but has not been distinguished from *D. reticulatum*.

Examined material from the former Yugoslavia: over 500 spec. (Map 11).

Slovenia: Rozdrto, SW of Postojna, in the village, under a board, 500 m a.s.l.

After Wiktor 1982: Lož, Porožna.

Croatia: Bihać, ruins of a mediaeval castle out of the town, 700 m a.s.l., Bihać, garden; Senj, bank of the Reka, Senjsko Bilo Mts, *Pinus-Ulmus* forest, limestone, below 650 m a.s.l.; Psunj Massif, Strumac, N of Nova Gradiška, slate, *Petasitas* and *Urtica* near a stream; Makarska (Dalmatia), Bobokovo Massif above the village, 600 m a.s.l., limestone; between town Knin and village Krčić in the valley of the Krka (Dalmatia); Nat. Park Plitvice Lakes in the Plješevica Mts, *Fagus* forest, 600 m a.s.l., limestone; Trnovac, S of Gospić, Velebit Mts, leg. W.J.M. Maassen.

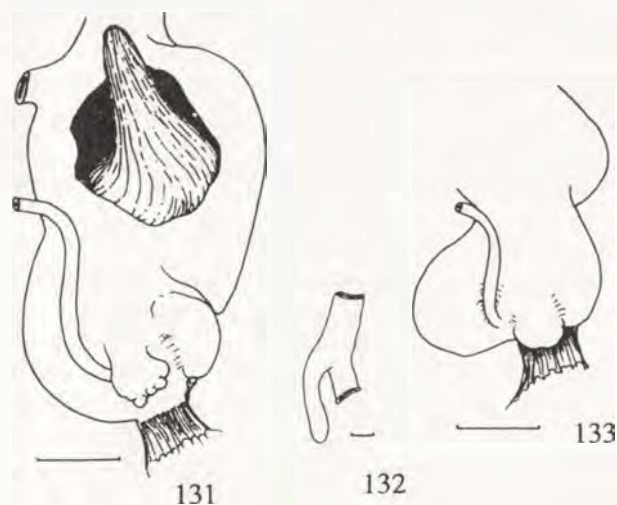
Bosnia and Herzegovina: near Jajce, meadows, 500–700 m a.s.l.; Jajce, in the town, leg. W.J.M. Maassen; Travnik, limestone rocks with *Carpinus-Quercus* bushes, 700–800 m a.s.l.; Travnik, Babanovac Mt. in the Vlašić Massif, *Fagus* forest, limestone, 1800–1940 m a.s.l.; N of Travnik, Babanovac Mt. in the Vlašić Massif, *Pinus-Abies* forest, 1700–1800 m a.s.l.; Travnik, ruins of a 15th-century Turkish fortress, 500 m a.s.l.; Zenica, near a river in the town; Šipovo, SW of Jajce in the valley of the Pilva river, Vitorog Mts, 700–750 m a.s.l., limestone, *Acer-Ulmus* forest; Vran Mts, above Jablanica in the Doljanka valley, *Fagus* forest, 1000–1700 m a.s.l.; Prozor, Raduša Mts, meadows above the town, limestone; Prozor, rocks partly shaded by *Fagus* forest, limestone, 700 m a.s.l., in the Raduša Mts; Raduša Mts at 1200–1900 m a.s.l., *Fagus* forest, limestone; in the Konjuch Mts, near Kladanj (N of Sarajevo), humid *Fagus* forest, limestone, 650 m a.s.l.; Trebović Mt. in the Jahorina Mts, near Sarajevo, 1300–1500 m a.s.l., limestone, shrubs of *Fagus* and *Corylus*; Sutjeska Nat. Park, Voljak Massif (N of Gacko), above the timberline, 1200 m a.s.l., limestone; Sutjeska Nat. Park, Voljak Massif (N of Gacko), *Fagus* forest, 1200 m a.s.l., limestone; Gacko, limestone; Trebinje, by the stream.

Serbia: Titovo Užice (= Užice), environs of the city, 800 m a.s.l., limestone, *Fraxinus-Corylus* shrubs; Kremna (W of Titovo Užice), Tara planina Mts, 1300–1400 m a.s.l., *Pinus* forest; Partizanske Vode (SW of Titovo Užice), Zlatibor Mts, 950 m a.s.l., near the road.

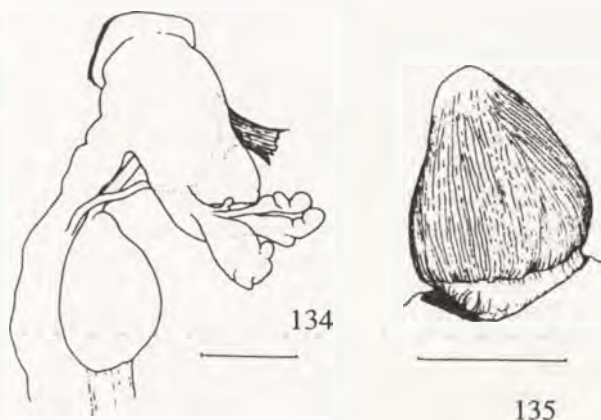
Montenegro: Mojkovac, Biogradski Nat. Park, Bjelasica Mts, 750–1800 m a.s.l., glades; Mojkovac, Biogradski Nat. Park, Bjelasica Mts, 1800–2000 m a.s.l., limestone; Mojkovac, Sinjajevina Mts, 700–900 m a.s.l., slate, meadows and shrubs; valley above Stari Bar near Bar, 700–800 m a.s.l., limestone, olive grove; sea coast in Sv. Stefan (village), near the waterfall; near Nikšić, humid meadows near the river; Rostovac (NW of Nikšić), in the village; Njegoš Mts, Vojnik Mt. (NW of Nikšić), limestone, rocks with *Juniperus* sp. and *Pinus montana*, above the timberline, 1250 m a.s.l.; Žabljak, Durmitor Mts, 1450–1550 m a.s.l., forest and glades; ? Durmitor Mts, on the path from Žabljak to Bobotov Kuk Mt., 1600–1700 m a.s.l., limestone, *Abies-Picea-Pinus* forest; Durmitor Mts, Savin Kuk Massif, above the timberline, 1800–2300 m a.s.l., limestone, grassy slope; Durmitor Mts, on the path from Žabljak to Bobotov Kuk Mt., limestone, *Pinus montana* and *Juniperus* sp., above the timberline, 1700–2100 m a.s.l.; Visitor Mts, by the lake near Plav, 700–1000 m a.s.l.; Visitor Mts, above village Plav, slate and limestone, *Juniperus-Fagus-Pinus* forest.

After Wiktor 1982: Nehaj near Sutomore, Titograd (= Podgorica).

Kosovo: Prizren, Šar planina Mts, the Bistrica river valley, 500–700 m a.s.l., limestone; Prozren, Šar planina Mts, slate



Figs 131–133. *Deroceras bosnensis* Grossu, 1972 (= *D. turcicum*). 131 – penis with stimulator inside (lectotype). 132 – fragment of the lectotype's rectum. 133 – posterior fragment of penis (paralectotype) (my drawings!).



Figs 134–135. *Deroceras hercegovinae* Grossu, 1972 (holotype) (= *D. turcicum*). 134 – copulatory organs. 135 – penis with stimulator inside (both drawings made by me!).

rocks above the town; Peć, in the town, 600 m a.s.l., synanthropic.

Macedonia: Skopje, park forest Vidno above the town, *Castanea-Quercus-Mirtus* forest, 700–900 m a.s.l., slate; Skopje, fort ruins in the town; Jakupica Mts (S of Skopje), slope of Solunska Glava near vill. Bogumila, *Fagus* forest; Kožuf Mts, valley of the stream Stara Reka, 6 km S of Konopište, 750 m a.s.l., volcanic rocks, leg. A. Riedel; Štip, on the hill with ruins and in other anthropogenic habitats in the town; Padalište, S of Gostivar, near the railroad to Kičevo, in a deep valley, 750 m a.s.l., limestone; Gostivar, W of the town, barren lots, 450–500 m a.s.l.; Tajmište, between Gostivar and Kičevo, 700–1000 m a.s.l., *Fagus* forest with *Corylus*, metamorphic rocks; Tajmište, between Gostivar and Kičevo, *Fagus* forest, limestone, 1000 m a.s.l.; Mavrovo Nat. Park, lake shore; Mavrovo Nat. Park, *Abies* forest, green slate, 1700–1900 m a.s.l.; Bistra Planina Mts, Carevec, 1400–1500 m a.s.l., mountain meadows, limestone, leg. A. Riedel; Tearce, 15 km NE of Tetevo, Šar Planina, *Castanea* forest, by the river, crystalline rocks, leg. A. Riedel; Sv. Jovan Bigorski monastery in the Radika valley (S of Mavrovo), slate and limestone, deciduous forest, 700–1000 m a.s.l.; Jablanica Mts, Lukovo, in the Crni Drim valley, c. 1000 m a.s.l., 1 km from Debar, limestone, leg. A. Riedel; above Lukovo vill. (between Debar and Struga), limestone, under stones in the Crni Drim valley, 700–1000 m a.s.l.; Debar, Dešat Massif, limestone and green slate, 1200–1500 m a.s.l.; Banište, near Debar, near a stream, gypsum, 600 m a.s.l., synanthropic; Struga, on Lake Ohrid shore, 700 m a.s.l., synanthropic; Sv. Bogarodica Monastery near Struga, limestone; village Slatyni, c. 35 km N of Ohrid, in the Stogovo Massif, limestone,

700–900 m a.s.l.; Ohrid (town), hill with a fort, on rocks, refuse heaps and under stones; W of Ohrid, a valley in the Galičica Massif, limestone, 700–900 m a.s.l., anthropogenic habitat; shoulder and slope of the Galičica Massif above Lake Ohrid, limestone, on dry rocks, 900–1560 m a.s.l.; Galičica Massif, Gola Buka Mt. (SE of Ohrid), *Fagus* forest, 800–1700 m a.s.l., limestone; Pesočani, N of Ohrid (c. 30 km), by the Sateska river, *Alnus* forest, 700 m a.s.l.; Baba Mts, near village Magarevo (W of Bitola), in a valley, under stones, granite, 700–1000 m a.s.l.; Bitola, slope of the Baba Massif above the town, gneiss, *Fagus* forest, 700–1500 m a.s.l.; Babuna Mts, near Prilep, herbs near a stream; Prilep, hills with ruins above the town, granite, dry habitat with a plant cover, 700–800 m a.s.l.

After Wagner 1937a: Ohrid – cf. *D. turcicum*, Bilek (= Bileća).

Wiktor 1982: environs of Lake Ohrid, ? Tresanie (no exact information on the geographical location).

Comments

In the *Naturhist. Mus.*, Vienna, there is a sample with two (!) specimens of *D. bosnensis*, labelled "Holotypus". Grossu's drawings enclosed with his description of this species (1972) are offhand (he did not use any optical apparatus for drawing). It is difficult to establish which of the specimens the author accepted as the holotype and represented in the figure so inscribed (Grossu 1972, Fig. 3) as his drawings are very much simplified and disregard the most important characters. Therefore, I designate the lectotype, which is shown in my own drawing (Figs 131–133). In my opinion, the specimens classified as *D. bosnensis* have all characters of *D. turcicum* and that is why I synonymize these two names.

The Viennese museum houses also types of *Dero-ceras hercegovinae* Grossu, 1972. However, the number of the holotype is not given in Grossu's paper, although those of paratypes are provided. In the collection the holotype is labelled with No. 77502. Moreover, there is also an error in the name of locus typicus in Grossu's description (1972), where it is spelled "Bjelasica" while the correct spelling on the label is "Bjelašnica". The holotype has its stimulator everted, which actually changes the proportions of penis and penial gland (Figs 134–135). Having examined both the holotype and the paratype from Crnopac (a juvenile specimen) I have come to the conclusion that in both cases this is *D. turcicum* concerned. Thus, I have synonymized with *D. turcicum* also the name *D. hercegovinae*.

D. turcicum is a species widely varying with re-

spect to its external appearance and structure of copulatory organs, the variability range being not smaller than in the case of an allied species, i.e. *D. reticulatum*. *D. turcicum* differs from *D. reticulatum* in smaller size, strong reduction of penial gland, which usually assumes the shape of nodules set directly on penis wall or on an inconspicuous protuberance. This organ may also be more or less branched but the branches are clearly shorter in relation to penis than it is the case in *D. reticulatum*. Besides, most often there is also a well-perceivable difference in the connection between vas deferens and penis. In *D. turcicum* vas deferens opens either apically or in penial wall on the side of viscera, usually between two distensions. In *D. reticulatum* vas deferens joins penis laterally, on the penis wall adherent to body integuments. The slugs discussed differ with regard to natural habitats they choose. *D. turcicum* is mainly a forest species whereas *D. reticulatum* avoids that type of habitats. Both, however, are found as synanthropes in habitats under strong anthropopressure, although in the Balkans *D. reticulatum* occurs only as a synanthrope while *D. turcicum* lives in more or less natural habitats and belongs to the commonest species of the former Yugoslavia. As a synanthrope, the latter slug has a much more restricted range and – e.g. – it is not recorded in Central Europe. Distinguishing between these two species is difficult, hence the best way to identify them is to have representatives of both at one's disposal. Having some practice, one can notice that, in spite of great variability of the two species, there are no transitional forms between them, even when they live in the same habitat as synanthropes.

CHARACTERISTICS OF THE FORMER YUGOSLAVIAN SLUG FAUNA

The former Yugoslavia's territory belongs to the most abundant in slug species regions of Europe. In this relatively small area, above all doubt, the occurrence of at least 48 species has been established (disregarding doubtful records). Among comparable territories only Greece abounds with more slug species, the number of which, according to my recent ascertainment, is 56 (Wiktor in print). This great variety of slugs is, in general, a characteristic of the whole Balkan region.

Within the northern hemisphere three areas of a special diversity of slugs and their abundance can be distinguished. These are the Balkans (*sensu lato*), Caucasus (*sensu lato*) and Iberian Peninsula. It is obvious that these different regions are inhabited by different species, but also different families dominate in each one. The Caucasus is characterized by a great diversity of species representing different families, the occurrence of the family Trigonochlamydidae (endemic in this area) and by plenty of Limacidae species. The abundance in Arionidae is typical of the Iberian Peninsula whereas the Balkans abound with Agriolimacidae and Milacidae. Additionally, the former Yugoslavian territory within the Balkan Peninsula is distinguishable by an exceptional richness of Milacidae, including the greatest number of *Tandonia* species. In this small area as many as 18 species of *Tandonia* are found, which constitutes over a half of all known representatives of this genus (30 species).

Through the former Yugoslavia the south-eastern distribution border of Arionidae runs and only one species (*Arion subfuscus*) extends beyond this area, reaching northern Greece and Bulgaria. The ranges of the remaining species, in the number of merely 6, including the introduced ones, end here.

The diversity of Agriolimacidae in the former Yugoslavia is strikingly low when compared with that found in the neighbouring Greece.

A more detailed analysis shows that for some species the former Yugoslavia constitutes merely a fragment of their extensive range. These are: *Arion subfuscus*, that inhabits vast areas of the western Palearctic and in the territory concerned has its south-eastern border, and the Holarctic *Deroceras laeve*. Among such species *Limax cinereoniger* and *Lehmannia marginata* can also be mentioned, although they inhabit smaller areas of Europe.

Endemism, clearly marked in the former Yugoslavia's territory, concerns mainly the genus *Tandonia* and the region of Dalmatia, particularly the mountain range Velebit and its environs. *Tandonia cavicola* (Map 4), *T. fejervaryi* (Map 4), *T. jablanacensis* (Map 4), *T. rara* (Map 5) and *T. reuleauxi* (Map 5) are recorded only from this area. The endemics of Montenegro and a small adjacent area are *Limax wohlberedti* (Map 9) and *Deroceras maasseni* n. sp. (Map 10), a species described in this paper but still

hardly known. Also *Malacolimax mrazeki* (Map 7), an inhabitant of nearly the whole former Yugoslavia and, probably, vicariant of an allied species, *Malacolimax tenellus*, seems to be endemic. The recently described *Tandonia bosnesis* should also be reckoned among endemics, although this species is known exclusively from locus typicus.

A separate group is made of species that have small ranges, only a part of which belongs to the former Yugoslavia. They can be further divided into two smaller but distinct groups: species of the Alpine origin and those of the Balkan origin.

The Alpine origin slugs are represented, in the first place, by *Arion alpinus* (Map 3), that also occurs in the neighbouring Alpine areas of Italy and Austria, in the north reaching Bavaria. *Tandonia robici* (Map 6) and *T. simrothi* (Map 6) have similar ranges. *Deroceras lothari* (Map 9) should probably be included in this group too. This species is presently known from Italy, Austria, Hungary, Slovenia and Croatia. Its distribution range, however, may prove to be a little larger. Finally, *Tandonia rustica* can also be associated with this group. It is quite widely distributed in Europe, mainly north of the former Yugoslavia, only slightly penetrating into Slovenia (its localities in Croatia, as uncertain, should be confirmed for they may concern another slug).

The Balkan species are probably not entirely of the same geographical origin. *Tandonia albanica* (Map 3), *T. macedonica* (Map 5) and *Lehmannia szihethyae* (Map 8) have narrow ranges limited to Macedonia and areas bordering on Greece, probably on Bulgaria as well, which is probably their original distribution. *Limax cephalonicus* (Map 9), *L. graecus* (Map 9) and *L. conemenosi* (Map 10) are Greek species (their original distribution range was probably here), spread mainly in the south and reaching only Macedonia in the north, perhaps as far as Serbia (if it is not the case of introduction). Species of a more eastern origin, coming probably from mountainous regions of Bulgaria, viz. *Lehmannia brunneri* (Map 7), *T. serbica* and *T. kusceri* (Map 4), constitute the third subgroup. As an introduced synanthrope, the latter species has probably considerably expanded its range in the former Yugoslavia. The origin of *Deroceras turcicum* (Map 11), a species known also from northern Greece, Bulgaria, Hungary, Austria and Tur-

key, and – seemingly – of *Deroceras sturanyi* (Map 11), a slug that has spread far northwards up to Central and East Europe and in the east reached Bulgaria and Turkey, is similar. Both species, i.e. *D. turcicum* and *D. sturanyi*, however, are easily introduced and often occur as synanthropes hence it is difficult to establish their original ranges. The group discussed includes also *Lehmanna nyctelia* (Map 8), mostly a mountain, probably Balkan, species. The slug, densely distributed in Bulgaria, has scattered, apparently insular but indigenous, localities in Serbia and Montenegro, also in Roumania, Hungary and Poland. Besides, it has been introduced to North and South Africa, and Great Britain.

Deroceras rodnae (Map 10) cannot be comprised within any of the groups mentioned above. Its range is poorly known but the slug has been recorded from the East Carpathian Mountains (in Roumania) along their whole arc and farther, through Austria and France, reaching Spain. In Croatia, within the former Yugoslavia, it has a single locality. I think that it is indigenous to this isolated locality or has its southern distribution border here.

Evidently introduced, i.e. foreign, species are the following: *Arion lusitanicus*, *A. distinctus* (Map 3), *Milax nigricans*, *M. gagates* (?), *Tandonia budapestensis*, *T. sowerbyi* (Map 6), *Limax flavus* and *Deroceras reticulatum*.

There still remains a group of slugs noted within the former Yugoslavian boundaries but of unclear zoogeographic affiliation, both in respect of origin and current range. These are *Arion silvaticus* and *A. circumscriptus*.

Summing up, the former Yugoslavia can be divided in three clearly different parts: the north-western area that comprises Slovenia and stretches of western Croatia, Dalmatia, and the region of Macedonia and Montenegro.

As far as ecology is concerned, the slugs of the area discussed are represented by a great number of epilithic, even xerophilous, species linked with the Mediterranean climate. These are, first of all, the numerous Dalmatian endemics mentioned above. The mountains in Dalmatia, particularly the Velebit, extend nearly to the sea-coast and reach considerable altitudes. They are most often built of limestone, their SW, i.e. seaward slopes, are poorly forested and

dry, but condensation of water vapour directly from the sea is possible here. It creates specific circumstances, which must have been conducive to origination of endemics, especially the drought-resistant slugs such as Milacidae. They have a thick mucus, spermatophores and other adaptations to such living conditions. The opposite, i.e. NE, mountain slopes are densely forested and usually constitute quite an ecologically distinct zone. The climate here is considerably more severe than that in Bosnia, Serbia or Macedonia, where, for a change, both deciduous and coniferous forests are comparatively well-preserved.

Almost the whole former Yugoslavia, its southern part in particular, is covered by mountains of considerable altitude. This creates specific climatic conditions, diverse vegetation zones etc. Moreover, the mountainous character of the region have favoured a relatively good preservation of habitat fragments, which are hardly destroyed. It also decides about the immense habitat potentialities. Nearly each mountain range has its own distinct, unique character. The zoogeographic barriers, built by the mountains, even in this small area, played a significant species-creating role. The northern glacier did not reach that part of Europe, although also here it marked the fauna with its stamp and contributed to the process of speciation. The South-Alpine fauna has preserved its distinct character, remaining in isolation from both the West- and Central-European, and also Balkan fauna. Likewise, the Balkan fauna is isolated in an area including Macedonia, Albania and Greece. The regions north of Macedonia, Montenegro and Dalmatia, separated from the Mediterranean Sea by mountains were propitious for migrations in different directions. Here, probably, both north-western (from an area including Central Europe) and eastern (from the present Bulgaria or Roumania) species migrated.

In spite of destruction, dating back even to the Roman times, in the landscape of nearly whole the former Yugoslavia, the anthropopressure here is not so strongly marked as in the majority of other European countries. The mountainous character of the region and inaccessibility of some areas have saved the native fauna. The share of introduced species is considerably smaller and the process of synanthropization, though strong, highly less manifest than

in the neighbouring countries, including Greece. The mountains are less pastured upon and in the mountain agrocenoses agriculturally useless fragments have been preserved less unaffected.

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