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**The slugs of Bulgaria (*Arionidae*, *Milacidae*,
Limacidae, *Agriolimacidae* — *Gastropoda*, *Stylommatophora*)**

[With 118 text-figures and 31 maps]

Abstract. All previously known Bulgarian slugs from the *Arionidae*, *Milacidae*, *Limacidae* and *Agriolimacidae* families have been discussed in this paper. It is based on many years of individual field research, examination of all accessible private and museum collections as well as on critical analysis of the published data. The taxa from families to species are supplied with synonymy, descriptions of external morphology, anatomy, bionomics, distribution and all records from Bulgaria. It also includes the original key to all species. The illustrative material comprises 118 drawings, including 116 made by the author, and maps of localities on UTM grid.

The occurrence of 37 slug species was ascertained, including 1 species (*Tandonia piriniana*) which is quite new for scientists. The occurrence of other 4 species known from publications could not be established.

Basing on the variety of slug fauna two zoogeographical limits were indicated. One separating the Stara Planina Mountains from south-western massifs (Pirin, Rila, Rodopi, Vitosha Mountains), the other running across the range of Stara Planina in the area of Shipka pass.

INTRODUCTION

Like other Balkan countries, Bulgaria is an area of Palearctic especially interesting in respect to malacofauna. So far little investigation has been carried out on molluscs of that country and very few papers on slugs (mostly contributions) were published. The papers by BABOR (1898) and JURINIĆ (1906) are the oldest ones. Both authors wrongly identified many Bulgarian slugs as Western or Central European species. WOHLBEREDT (1911) only repeated the data given by these authors. Valuable information was brought out by J. WAGNER (1931b, 1934a, 1934b).

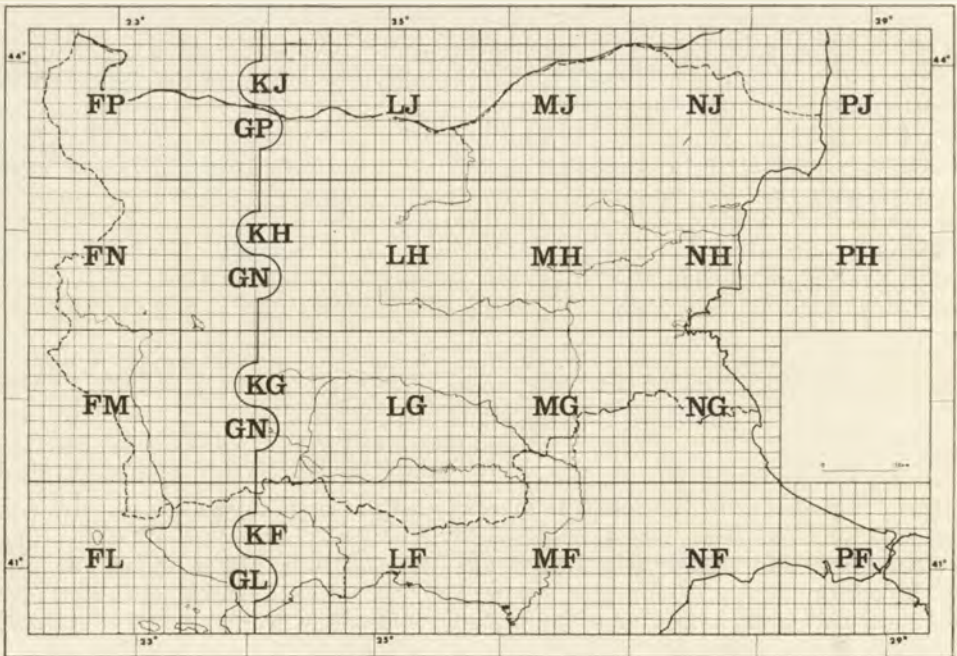
Since the 1960's there has been a certain revival of interest in these slugs and a series of contributory notes has been published. These are papers by GROSSU and LUPU, HUDEC, URBAŃSKI and WIKTOR, and WIKTOR (see bibliography). Some of them include the descriptions of new species. More extensive are papers by URBAŃSKI and WIKTOR (1968), OŠANOVA (1964, 1968, 1970, 1972) and finally, the book by DAMJANOV and LIKHAREV (1975) is the most complete study of the Bulgarian terrestrial snails. The book contains a survey of available information and the authors' own research. In spite of this fact the knowledge of Bulgarian slugs is still rather fragmentary.

The present paper is based on specimens collected by the author in Bulgaria in 1964, 1967, 1969 and 1976, and on specimens received from J. URBAŃSKI, and also the Institute of Zoology, Polish Academy of Sciences in Warsaw and the Hungarian Natural History Museum in Budapest.

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In lists of material examined below, the localities not followed by a collector's name are those in which specimens were collected by me or my wife (who helped me in 1967, 1969 and 1976). Institutions in which the material is deposited are referred to in the text by the following abbreviations:



Map 1. Lettering of squares in UTM grid of Bulgaria

BAN: Zoological Institute of Bulgarian Academy of Sciences in Sofia,
HNHM: Hungarian Natural History Museum in Budapest,
IZW: Institute of Zoology, Polish Academy of Sciences in Warsaw,
MNH: Museum of Natural History, Wrocław University in Wrocław.

Notice

To define the letter symbols of squares on maps with UTM grid, use map 1.
If not otherwise marked, the scale in all figures denotes 1 mm.

SYSTEMATIC RANK OF SLUGS

This group includes pulmonary terrestrial snails in which the shell is reduced in size and hidden inside the mantle. The reduction of shell took place parallelly in various systematic groups, therefore the term "slugs" refers to morphology and ecology but slugs are not a monophyletic taxon.

A shell is a generalized organ in molluscs, so its lack is a derived feature. It protects the body against losing water, mechanical and chemical injuries, insolation and natural enemies. Apart from this, constituting the only hard part within the soft body of these animals, the shell fulfills very important skeleton functions, i.e. supports the muscles. The diminution and reduction of shell gradually devoids the slug of its external protection; but even the smallest shell functions as a kind of skeleton. Due to the naked, elastic body slugs can occupy an ecological niche in biocenosis inaccessible for shell-bearing snails. The reduction of a heavy, stiff shell enables them better movement abilities. The body shape changes, elongates, becomes elastic, making possible quick movements and also squeezing through small holes. However, the danger of losing water increases. The slugs react to it by staying in narrow crevices with high humidity. They are active when the air gets moist. Thus they are night animals but they are also active during rainy and foggy periods. While the shell-bearing snails are rather passive when protecting themselves from dry weather or enemies (withdrawing inside the shell), the slugs escape to safe places. Most often they cover long distances between their feeding ground and hiding-place. In this respect they are different from many shell-bearing snails which stay in the feeding ground for a long time (sometimes even for the whole warm period) closing the shell entrance during the dry weather.

In his excellent book on molluscs SOLEM (1974) comes to the conclusion that two factors were responsible for the emerging of such ecological form as slugs — high humidity and lack of calcium. He also notices that the world's mountain regions, with a lot of rain and volcanic rocks containing little calcium, abound with slugs. The limited availability of calcium reduces the shell but the moist environment keeps these animals alive. The author obviously simplifies the problem. Were it so, damp, rainy and short of calcium tropical forests would also have a lot of slugs and that is not true. The abundance and diversity of high mountain molluscs is probably the result of ecological variety. Finally,

the reduction of shell has a different meaning for carnivorous and phytophagous species. In the carnivorous forms the lack of a shell facilitates the deglutition of prey, while in phytophagous ones it enables them to move to feeding grounds or hiding places. In both cases the reduction of shell is advantageous and obviously the natural selection favoured it in suitable environments.

Mucus is more important for slugs than for the shell-bearers, for both locomotion and protection. It enables to keep the body clean, protects it from certain natural enemies but first of all it constantly keeps the body moist. Slugs living in dry habitats have very dense, thread-forming mucus (*Milacidae*). These animals are not very active but they can survive long dry periods, surrounded with a kind of coat of half coagulated mucus. Slugs have also a striking ability to absorb water from the atmosphere and to survive water losses. Some species can lose up to 60 % of their body weight by evaporation and take the water up absorbing it fast through the integument.

The distinction of slugs as a separate ecological group has also a practical reason. Due to their mobility they often become agricultural and horticultural pests. They can be met where no other snails occur.

Slug control usually involves the same methods for all their species disregarding their systematic position.

Bulgarian slugs belong to four families. Their development from three different ancestral stocks is a striking example of evolutionary parallelism. In all four cases the way of reducing the shell is similar. It results in the emergence of similar morphological forms and ecological adaptations. The three development lines resulted in the superfamilies *Arionoidea*, *Limacoidea* and in *Zonitoidea* (LIKHAREV and WIKTOR 1979, 1980; WIKTOR and LIKHAREV 1980).

SYSTEMATIC CHECK-LIST OF THE SLUGS OF BULGARIA¹

Superfamily: *Arionoidea* GRAY, 1840

Family: <i>Arionidae</i> GRAY, 1840	81
Subfamily: <i>Arioninae</i> GRAY, 1840	82
Genus: <i>Arion</i> FÉRUSAC, 1819	82
Subgenus: <i>Arion</i> s. str.	83
1. <i>Arion</i> (<i>Arion</i>) <i>lusitanicus</i> MABILLE, 1868	83
Subgenus: <i>Mesarion</i> HESSE, 1926	85
2. <i>Arion</i> (<i>Mesarion</i>) <i>subfuscus</i> (DRAPARNAUD, 1805)	86
Subgenus: <i>Carinarion</i> HESSE, 1926	89
3. <i>Arion</i> (<i>Carinarion</i>) <i>silvaticus</i> LOHMANDER, 1937	90
Subgenus: <i>Kobeltia</i> SEIBERT, 1873	92
4. <i>Arion</i> (<i>Kobeltia</i>) <i>hortensis</i> FÉRUSAC, 1819	93

¹ Doubtful species unnumbered.

Superfamily: *Zonitoidea* MÖRCH, 1864

Family: <i>Milacidae</i> ELLIS, 1926	95
Genus: <i>Milax</i> GRAY, 1855	96
5. <i>Milax parvulus</i> WIKTOR, 1968	97
6. <i>Milax verrucosus</i> WIKTOR, 1969	99
Genus: <i>Tandonia</i> LESSONA et POLLONERA, 1882	101
7. <i>Tandonia kusceri</i> (WAGNER, 1931)	102
8. <i>Tandonia serbica</i> (WAGNER, 1931)	105
9. <i>Tandonia budapestensis</i> (HAZAY, 1881)	109
10. <i>Tandonia piriniana</i> n. sp.	111
11. <i>Tandonia cristata</i> (KALENICZENKO, 1851)	115
12. <i>Tandonia pinteri</i> (WIKTOR, 1975)	118
— <i>Tandonia sowerbii</i> (FÉRUSAC, 1823)	120
— <i>Tandonia rustica</i> (MILLET, 1843)	120
13. <i>Tandonia totevi</i> (WIKTOR, 1975)	122

Superfamily: *Limacoidea* RAFINESQUE, 1815

Family: <i>Limacidae</i> RAFINESQUE, 1815	123
Subfamily: <i>Limacinae</i> RAFINESQUE, 1815	123
Genus: <i>Limax</i> LINNAEUS, 1758	125
Subgenus: <i>Limax</i> s. str.	125
14. <i>Limax (Limax) maximus</i> LINNAEUS, 1758	126
15. ? <i>Limax (Limax) subalpinus</i> LESSONA, 1880	129
16. <i>Limax (Limax) cinereoniger</i> WOLF, 1803	131
17. <i>Limax (Limax) punctulatus</i> SORDELLI, 1870	135
18. <i>Limax (Limax) macedonicus</i> HESSE, 1928	139
19. <i>Limax (Limax) conemenosi</i> BOETTGER, 1882	142
Subgenus: <i>Limacus</i> LEHMANN, 1864	144
20. <i>Limax (Limacus) flavus</i> LINNAEUS, 1755	144
21. <i>Limax (Limacus) maculatus</i> (KALENICZENKO, 1851)	147
Genus: <i>Lehmannia</i> HEYNAMANN, 1862	149
22. <i>Lehmannia nyctelia</i> (BOURGUIGNAT, 1861)	150
23. <i>Lehmannia brunneri</i> (WAGNER, 1931)	153
24. <i>Lehmannia horezia</i> GROSSU et LUPU, 1962	157
25. <i>Lehmannia sarmizegetusae</i> GROSSU, 1970	159
— <i>Lehmannia</i> sp.	160
Genus: <i>Malacolimax</i> MALM, 1868	160
— <i>Malacolimax tenellus</i> (MÜLLER, 1774)	160
Family: <i>Agriolimacidae</i> WAGNER, 1935	161
Genus: <i>Deroceras</i> RAFINESQUE, 1820	162
Subgenus: <i>Deroceras</i> s. str.	163

26. <i>Deroceras (Deroceras) laeve</i> (MÜLLER, 1774)	163
27. <i>Deroceras (Deroceras) sturanyi</i> (SIMROTH, 1894)	166
28. <i>Deroceras (Deroceras) panormitanum</i> (LESSONA et POLLONERA, 1882)	169
Subgenus: <i>Agriolimax</i> MÖRCH, 1865	172
29. <i>Deroceras (Agriolimax) turcicum</i> (SIMROTH, 1894)	172
30. <i>Deroceras (Agriolimax) reticulatum</i> (MÜLLER, 1774)	175
31. <i>Deroceras (Agriolimax) thersites</i> (SIMROTH, 1886)	178
32. <i>Deroceras (Agriolimax) agreste</i> (LINNAEUS, 1758)	180
— <i>Deroceras (Agriolimax) agreste transcaucasicum</i> (SIMROTH, 1901) sensu HUDEC et VAŠATKO (1971)	182
33. <i>Deroceras (Agriolimax) cf. pageti</i> GROSSU, 1972	183
Subgenus: <i>Plathystimulus</i> WIKTOR, 1973	184
34. <i>Deroceras (Plathystimulus) cf. zilchi</i> GROSSU, 1969	184
35. <i>Deroceras (Plathystimulus) bulgaricum</i> GROSSU, 1969	185
Subgenus: <i>Liolytopelte</i> SIMROTH, 1901	186
36. <i>Deroceras (Liolytopelte) bureschi</i> (WAGNER, 1934)	187
Genus: <i>Krynickyllus</i> KALENICZENKO, 1851	190
37. <i>Krynickyllus urbanskii</i> (WIKTOR, 1971)	190

KEY TO BULGARIAN SLUGS

(dimensions in brackets refer to preserved individuals)

1. Body broadly rounded apically. Sole without longitudinal grooves. Pneumostome in anterior part of mantle. *Arionidae* 2.
- Body apex acutely angulate. Sole divided into three zones by two longitudinal grooves. Pneumostome in posterior part of mantle 5.
2. Adults \pm 100 (70) mm long, stout. Skin with large, prominent tubercles. Lateral bands only in juveniles. Oviductus with large ligula inside. *Arion lusitanius* (p. 83).
- Adults to 70 (45) mm long, body elongated. Skin with small, rounded tubercles. Lateral bands almost always present. No ligula. 3.
3. Spermatheca oval, elongate, narrow at top. Back with hardly visible keel. Slime always hyaline. *Arion silvaticus* (p. 90).
- Spermatheca spherical. Back slightly rounded with no trace of keel. Slime usually yellow or orange but occasionally hyaline 4.
4. Sole brown-orange. Lateral bands with ill-defined lower margins, dark pigment diffused onto lower parts of sides. Swollen part of oviductus and epiphallus subequal in length. *Arion hortensis* (p. 93).
- Sole cream-coloured. Lateral bands well-defined from beneath (sometimes absent). Swollen part of oviductus shorter than epiphallus. *Arion subfuscus* (p. 86).

5. Keel high, usually attaining mantle hindmargin (except *Tandonia totevi*). Mantle with horseshoe-shaped groove. Sole transverse grooves forming V-like pattern, both on median and lateral zones. Slime dense. Epiphallus present. Female parts of genitalia or atrium with accessory glands.
 *Milacidae* 6.
- Keel low, not attaining mantle hindmargin. Mantle without horseshoe-shaped groove. Sole transverse grooves on lateral zones at right angle to body axis. Slime thin. Epiphallus and accessory glands in female parts of genitalia and on atrium absent 16.
6. Body wormlike, elongated, white or cream-coloured, back sometimes bluish ash-grey. Mantle distinctly papillate. Epiphallus, penis and vas deferens forming one, not differentiated duct.
 *Milax verrucosus* (p. 99).
- Body stouter, not wormlike, uniformly coloured or spotted. Mantle with inconspicuous tubercles. Vas deferens thinner than penis or epiphallus; these organs well delimited from one another and coiled 7.
7. Atrium barrel-shaped, with long stimulator inside. Accessory glands forming a single glomus and opening into atrium at its side.
 *Milax parvulus* (p. 97).
- Atrium narrow, without stimulator *Milax parvulus*. Accessory glands surrounding oviductus and opening into vagina 8.
8. Body length at least (75) mm. Keel not attaining mantle. Penis coil-shaped. Body with blackish pattern on olive-green background.
 *Tandonia totevi* (p. 122).
- Body length less than 75 mm. Keel attaining mantle. Penis different 9.
9. Back black or nearly so 10.
- Back chocolate brown or even lighter, often with small dark spots 11.
10. Back almost uniformly blackish-green. (Skin grooves darker in preserved individuals). Mantle without lateral bands. Vas deferens turning gradually into long epiphallus with small appendix in-between (Fig. 29). Body length up to (20) mm.
 *Tandonia piriniana* (p. 111).
- Back black or nearly so. Mantle with irregularly delimited lateral bands. Epiphallus conical, very short. Vas deferens without appendix. Length (30–35) mm.
 *Tandonia pinteri* (p. 118).
11. Body ash-grey greenish or ash-grey yellow with darker skin grooves, with no spots or lateral bands on mantle. Epiphallus claviform, shorter than to as long as penis.
 *Tandonia cristata* (p. 115).
- Body of varying colour, with chocolate brown or blackish spots, lateral bands on mantle. Epiphallus of different shapes, longer than penis 12.
12. Body white-cream with numerous distinct, almost black spots. Epiphallus 3–4 times length of penis. Spermatheca tapered at its end.
 *Tandonia rustica* (p. 120).

- Body brown, pink-brown or ash-grey pink with blackish pattern composed of spots of various size 13.
13. Dark spots on body and lateral bands of mantle ill-defined, unsharply delimited. Vas deferens opening into penis asymmetrically (Fig. 24). Spermatheca elongated, cylindric or oval 14.
- Dark spots of body and lateral bands of mantle with sharply defined margins. Vas deferens opening into penis symmetrically (Fig. 18). Spermatheca spherical or nearly so 15.
14. Body \pm stout. Back triangular in cross section. Keel distinctly separated, lamellate. Spermatheca with cylindric sac.
. *Tandonia sowerbii* (p. 120).
- Body narrow elongated. Back evenly rounded. Keel poorly arched. Spermatheca sac longitudinally oval.
. *Tandonia budapestensis* (p. 109).
15. Epiphallus thin, coiled 5–6 times, longer than penis. Penis \pm spherical anteriorly. Retractor penis very thin. Posterior part of body without round black spots.
. *Tandonia kusceri* (p. 102).
- Epiphallus thick, short, not coiled. Penis strongly swollen, extended and oval anteriorly. Retractor penis broad. Posterior part of body with irregularly distributed large black spots, similar to drawing ink marks.
. *Tandonia serbica* (p. 105).
16. Intestinum forming 3 loops. Sole with transverse grooves in central longitudinal zone. Mantle usually less than $\frac{1}{3}$ of body length.
. *Limacidae* 17.
- Intestinum forming 2 loops. Central, longitudinal part of sole with V-like grooves bent at an angle. Mantle more than or equal to $\frac{1}{3}$ of body length.
. *Agriolimacidae* 29.
17. Intestinum without coecum 18.
- Third intestinal loop with long coecum 24.
18. Penis short, oval. Body yellow (cream-coloured in preserved specimens). Skin thin. Length up to 50 (35) mm.
. *Malacolimax tenellus* (p. 160).
- Penis long, tubular. Body of different colour. Skin thick. Body length usually more 19.
19. Vas deferens opening into apical part of penis (Figs. 48, 58) 20.
- Vas deferens opening into penis laterally, apical part of penis forming a coecum (Figs. 59, 63) 23.
20. Penis \pm half of body length. Mantle spotted. 21.
- Penis at least twice body length. Mantle usually uniform in colour, sometimes spotted 22.
21. Body olive-green with dark pattern. Mantle with large spots. Sole in adults with dark, longitudinal, lateral bands.
. *Limax subalpinus* (p. 129).

- Body differently coloured, usually with black or dark blue pattern on cream-coloured background. Spots often forming rows of irregular stripes. Sole always unicolour.
 *Limax maximus* (p. 126).
22. Penis at least twice body length. Colouration variable. Mantle without spots. Lateral longitudinal zones of sole usually blackish or black.
 *Limax cinereoniger* (p. 131).
- Penis about 4 times body length. Colouration variable. Mantle sometimes with spots. Sole unicolour.
 *Limax punctulatus* (p. 135).
23. Back and mantle with evenly distributed small, black dots on cream background (but not in rows).
 *Limax conemenosi* (p. 142).
- Back and mantle unicolour or with rows of dots of various size. Colouration variable.
 *Limax macedonicus* (p. 139).
24. Coecum joining intestinum at bend of third loop (Fig. 45). Mantle without lateral bands. Body spotted, green if unicolour. (Subgenus *Limacus*) . 25.
- Coecum joining intestinum beyond third loop bend, with rectum (Fig. 46). Mantle often with lateral bands. Body covered by different pattern, often forming bands (striped), sometimes black if unicolour. (*Lehmannia*) . . . 26.
25. Spermatheca opening into oviductus.
 *Limax flavus* (p. 144).
- Spermatheca opening into penis.
 *Limax maculatus* (p. 147).
26. Penis in form of coiled tube, about $\frac{2}{3}$ of body length, spherically rounded at rear. Penial gland absent or in form of tubercle.
 *Lehmannia nyctelia* (p. 150).
- Penis much shorter, not coiled, conical or clavate. Penial gland well-developed 27.
27. Spermatheca much shorter than penis. Penis short, tube-shaped. Penial gland conical.
 *Lehmannia brunneri* (p. 153).
- Spermatheca equal to or longer than penis. Penis conical or clavate. Penial gland of various shapes 28.
28. Spermatheca and penis equal in length. Penial gland in form of tubercle or a short flagellum.
 *Lehmannia marginata* (p. 160).
- Spermatheca longer than penis. Penial gland in form of long flagellum.
 *Lehmannia horezia* (p. 157).
 and *L. sarmizegetusae* (p. 159).
29. Penis cylindrical or clavate without penial gland and stimulator. Spermatheca \pm twice as long as penis.
 *Krynickillus urbanskii* (p. 190).
- Penis different with penial gland or appendix and stimulator. Spermatheca as long as penis 30.
30. Intestinal coecum twice as long as wide. Stimulator narrow, conical. (Subgenus *Agriolimax*) 31.

- Intestinal coecum absent or in form of small pocket as long as wide (Fig. 114). Stimulator different by shape, not conical 35.
31. Penial gland consisting of long stalk, which ramifies into several branches covered with large glandular papillae. Penis usually constricted. Body brown or brown-cream, unicolour or maculate. *Deroceras thersites* (p. 178).
- Penial gland without long stalk, ramified or not. Body cream-coloured, unicolour or maculate. 32.
32. Penial gland as long as penis. *Deroceras pageti* (p. 183).
- Penial gland shorter than half of penis 33.
33. Penial gland forming small cone or tubercle without glandular papillae. *Deroceras agreste* (p. 180).
- Penial gland differently shaped, with glandular papillae 34.
34. Vas deferens opening into penis admedianly between two small swellings; one swelling with penial gland, gland varying from simple tubercle to branched appendix. *Deroceras turcicum* (p. 172).
- Vas deferens opening into penis on lateral side, without swellings; penial gland in form of simple or branched appendix. *Deroceras reticulatum* (p. 175).
35. Stimulator with hard plate. *Deroceras bureschi* (p. 187).
- Stimulator without hard plate. 36.
36. Stimulator papillate or hemispherical. (*Deroceras* s. str.) 37.
- Stimulator fan-like. (Subgenus *Plathystimulus*) 39.
37. Penis elongate, often evanescent or absent; its apical part (distal of vas deferens) crook-like or helical, with 2 or 3 papillae. Body brown or chocolate in colour. Mantle finely spotted. *Deroceras laeve* (p. 163).
- Penis short, without appendix, with two evaginations subapically . 38.
38. Penis hammer-like, its swellings transverse; one of these (which is penial gland) sometimes with papillae. *Deroceras sturanyi* (p. 166).
- Penis posteriorly with crook-like appendices directed to each other. Branched penial gland present between appendices. *Deroceras panormitanum* (p. 169).
39. Body length about 12 mm. Integument transparent. Penis posteriorly with penial gland and simple appendix directed backwards. Stimulator spoon-like. *Deroceras zilchi* (p. 184).
- Size larger. Integument not transparent. Penis cylindrical — slightly narrowed mesally. Penial gland with two branches. Two stimulators: conical and plate-like. *Deroceras bulgaricum* (p. 185).

Arionoidea GRAY, 1840

Slugs or semi-slugs: in most species shell represented by small detached crystals or a thick lenticular plate, or totally reduced, but visible externally in *Binneyinae* (in which it is ear-shaped, with helically coiled embryonic part, covering only a small part of visceral sac). Foot broad, with sole undivided by grooves into longitudinal zones. Kidney ring-like or in form of a narrow horse-shoe, surrounding aorta. Jaw odontognathic. Broad marginal teeth of radula with short, wide basal plates and one or several cusps.

Philomycidae (South Asia, Central and North America) and *Arionidae* (see below) are included in this superfamily.

After PILSBRY (1948) many authors include the above-mentioned families and *Endodontidae* in one superfamily *Endodontoidea* because of a peculiar shape of marginal teeth of radula. The shell of *Endodontidae* is prominently spiral, flattened, well-developed (so that the whole body can be retracted inside), with a tendency towards complicated shapes and reduction of the body size. This evolutionary tendency is quite different from that characteristic of slugs. Slugs appear only in groups with a general tendency towards reduction in number of shell coils and lack of lip, teeth and lamella in a widened opening of the shell. Thus, it has not been proved that *Endodontidae* and *Arionidae* are closely related and consequently *Endodontidae* cannot have been ancestral of these slugs. The opinion that slugs could have originated from *Endodontidae* must be rejected. Radula of this type can be found in many other gastropods with well-developed shells, e.g. *Helicidae*. Furthermore, the stylophore is present both in *Philomycidae* and *Helicidae*, this organ perhaps indicates their relationship (LIKHAREV and WIKTOR 1979, 1980).

Arionidae GRAY, 1840

Arionidae GRAY in TURTON, 1840: 104.

References: ALTENA 1966: 286; DAMJANOV and LIKHAREV 1975: 235; LIKHAREV and WIKTOR 1980: 386; PILSBRY 1948: 660; RIEDEL and WIKTOR 1974: 85; WIKTOR 1973: 21 and 281.

Rudimentary shell always present. Body elongate, mantle small, not covering the whole back. Kidney circular (surrounding aorta). Cephalic retractors with a tendency towards division into several individual bands. Intestine forming two loops. Epiphallus present, bursa copulatrix with truncus, penis often reduced.

The family has 4 subfamilies: *Ariolimacinae* (Nearctics), *Binneyinae* (Nearctics), *Anadeninae* (Nearctic and Oriental Regions), and *Arioninae* (Pale-
arctics)¹.

Arioninae GRAY, 1840

Mantle small, round, covering about $\frac{1}{3}$ of body, containing calcium crystals which sometimes form a plate-like, rudimentary shell. Respiratory orifice on the right side of the anterior part of the mantle. Back slightly rounded, sometimes with vestigial keel. Body apex obtuse. A pit-like caudal gland present just above foot edge (Fig. 1).

Reproductive system (Fig. 2). Penis absent, large epiphallus present. Oviductus often well-developed, with ligula. Atrium of varying size and shape, sometimes with lateral pockets. Sperma transferred in worm-like spermatophore often accompanied by a longitudinal keel or frill but never by spikes. Genital retractor divided into several small bands, one of which is always fixed to truncus bursae, one to oviductus and one usually to atrium. Left and right side tentacle retractors with separate insertion.

Most *Arioninae* occur in western Palearctic between Sahara and the Ural Mountains, but one endemic species (*Arion sibiricus* SIMR.) — in Siberia (from Altai Mts to the Pacific coast). In the western distribution centre they range north to 68° in Scandinavia, and south to Sahara, Bulgaria and southern Ukraine, but they are unknown from the Black Sea coast and the Caucasus.

This subfamily includes about 35 species. All Bulgarian species are widely distributed, and none is endemic.

Because of a rather uniform external and internal body structure in *Arioninae* it is hard to delimit genera and subgenera, the value of their diagnostic features being difficult to estimate. Nevertheless, two groups may be distinguished: slugs with a plate-like shell and a specific organ atriopenis, including *Geomalacus* ALLMAN (with a nominate subgenus and *Arrudia* POLLONERA), and slugs in which the shell consists of more or less detached crystals and the atriopenis is lacking and with reproductive system different in details but very similar in a general outline. It seems that this group should be treated as a single genus *Arion* FÉRUSSAC and together with nominate subgenus it should include the following taxa: *Ariunculus* LESSONA, *Microarion* HESSE, *Mesarion* HESSE, *Kobeltia* SEIBERT and *Carinarion* HESSE. Phylogenetical relationships between these subgenera are not known. Future investigation (including bionomics) will probably reduce the number of the currently recognized subgenera.

Genus *Arion* FÉRUSSAC, 1819

Arion FÉRUSSAC, 1819: 50. Typus: *Arion empiricorum* FÉRUSSAC, 1819 [= *Arion rufus* (LINNAEUS) or *Arion ater* (LINNAEUS)].

¹ PILSBRY (1948) and ZILCH (1959–1960) consider *Oopeltidae* as a subfamily in *Arionidae*, but ALTENA (1966) treats them as a separate family.

Shell represented by separate crystals. Mantle surface covered by slight granular swellings. Skin thick. Colouration uniform or body sides banded. Epiphallus, oviductus and spermatheca duct opening into atrium separately. Life span of these slugs about one year. Usually in forests; omnivorous. Range as given above for the subfamily. About 25 species known.

Subgenus *Arion* s. str.

Body length up to 250 mm. Sole very broad. Skin with deep grooves, separated by sharp ridges. Slime hyaline, yellow or orange. Back and mantle in mature individuals unicolour but with lateral bands in some juveniles. Sole variously coloured, but never white. Foot edge often differently coloured from the remaining body. Spermatheca large, spherical. Atrium usually large. Ligula always present.

Slugs preferring moist conditions, living mainly in water areas. The original distribution in western Europe from Scandinavia to the Pyrenees, the Alps and Central Europe. Some species introduced also into other countries (e.g. Bulgaria), where they live as synanthropes.

Arion (Arion) lusitanicus MABILLE, 1868

Arion lusitanicus MABILLE, 1868: 134. Terra typica: Portugal (La Serra d'Arriba near Lisbon).

? *Arion empiricorum* FÉR.: OŠANOVA 1964: 209.

? *Arion ater rufus* (LINNAEUS): DAMJANOV and LIKHAREV 1975: 238.

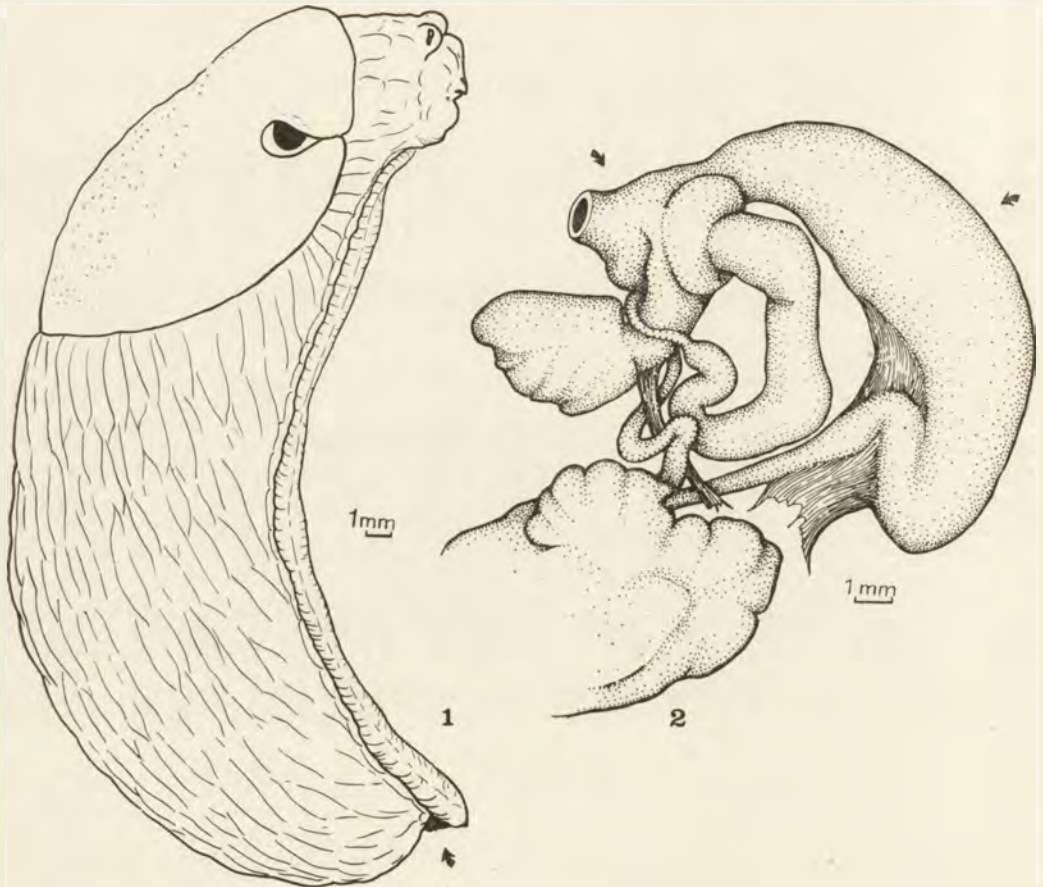
References: ALTENA 1956: 89 (morphology-illustrations, bibliography); 1971: 184 (range); CHEVALIER 1969: 73 (morphology, taxonomy); DAMJANOV and LIKHAREV 1975: 238; GERHARDT 1940: 570 (copulation); LIKHAREV and WIKTOR 1980: 395; QUICK 1960: 135 (survey); RIEDEL and WIKTOR 1974: 102; SCHMID 1970: 95; SIMROTH 1891: 339; WIKTOR 1977: 291.

In Bulgaria this species is the biggest representative of the family. Body length up to about 100 mm. Body stout, sole broad (Fig. 1).

Colouration varying but not within the same population. Body with light or dark lateral bands in some juveniles, but unicolour in adults (except the foot edge), colour usually yellow, orange, different hues of red and brown, black, sometimes dark-blue, or ash-grey-greenish. Only orange or red-brown specimens were collected in Bulgaria by the author.

Genitalia (Fig. 2). The long, anteriorly swollen oviductus, with a large, longitudinal ligula inside, is distinctive of *A. lusitanicus*. Oviductus short, straight posteriorly; vas deferens short, coiled around spermatheca duct. Epiphallus much thicker than vas deferens, distinctly delimited from the latter, anteriorly with a ring-like swelling. Spermatheca egg-shaped, with a relatively short duct. Atrium short, small.

Formula of the radula: according to QUICK (1960) C. 17-19, 45, according to ALTENA (1956) — C. 65/x 167, where central tooth is tricuspid while the remaining bicuspid.

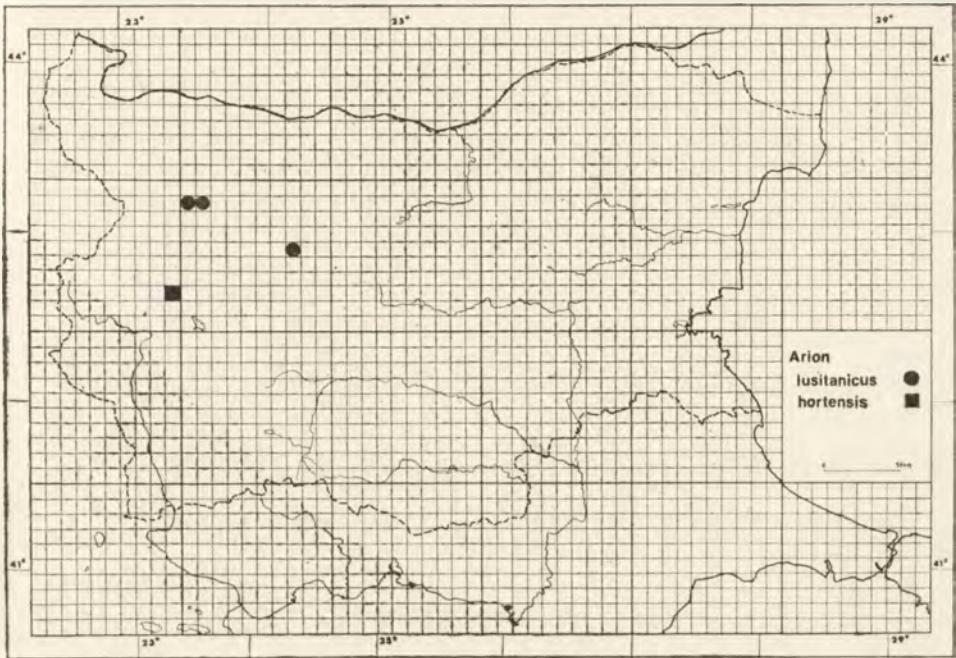


Figs. 1-2. *Arion (A.) lusitanicus* MAB.: 1 — side view, the arrow points to caudal gland excretion (specimen from Teteven), 2 — copulatory organs (specimen from Dabnika)

Bionomics. Only fragmentary and unreliable data are available. The slug is known to occur in mass, often as a synanthrope. Horticultural pest. In Teteven also found in mass populations in glades, forests, at the forest edge near the shelter. After a moist night the author found hundreds of juvenile individuals under the floor of the tent put up the day before. The whole tent, including the roof, was covered by traces of their crawling.

Distribution incompletely known. Introduced by man into large parts of its present-day area. Originally known from south-western Europe. Found also in Portugal, Spain, Andorra, France (especially southern), Algeria, Italy,

Liechtenstein, Switzerland, Great Britain and Ireland. Apparently introduced into West Germany and Bulgaria. In Bulgaria found only in a few localities (synanthropic biotopes) in Stara Planina area, probably occurring also in other localities.



Map 2. *Arion lusitanicus* and *Arion hortensis*

Material examined: 14 specimens.

Records (Map 2):

Stara Planina: Teteven in Beli Vit Valley, south-east of the town Dabnika near Vratsa leg. L. PINTÉR (HNHM); also: ALTENA (1971) — Vratsa.

Comments. OŠANOVA (1964, 1968, 1970) mentioned *Arion rufus* from Vratsa and Dabnika, and *Arion empiricorum* from Vratsa. Since *Arion lusitanicus* has been found in both localities, it is possible that OŠANOVA misidentified her specimens. However, the occurrence of *Arion rufus* in Bulgaria is not excluded. Therefore, all large Bulgarian slugs, supposedly belonging to *Arion lusitanicus*, should be carefully studied anatomically to make the identification sure. DAMJANOV and LIKHAREV (1975) mention this species after OŠANOVA, taking it for *Arion ater rufus*.

Subgenus *Mesarion* HESSE, 1926

Mesarion HESSE, 1926: 65. Typus: *Arion subfuscus* (DRAPARNAUD, 1805) (*Limax*).

?*Prolepis* MOQUIN-TANDON, 1855: 14. Typus: *Arion fuscus* (MÜLLER, 1774).

Tetraspis HAGENMÜLLER, 1885: 303. Typus: *Tetraspis letourneuxi* HAGENMÜLLER, 1885
[= *Arion subfuscus* (DRAPARNAUD, 1805)].

Body length up to about 75 mm. Keel absent. Integument finely sculptured. Back darker, sometimes chocolate or black, sides at least partly rust-coloured. Mantle and sides usually with a dark or light band. Sole cream-coloured. Slime hyaline or rusty, sometimes orange. Atrium small, spermatheca small and spherical. Oviductus always thick as compared with epiphallus. Three species known (one at Far East).

Arion (Mesarion) subfuscus (DRAPARNAUD, 1805)

Limax subfuscus DRAPARNAUD, 1805: 125. Terra typica: France (Sorézois and Montagne in Tarn).

Synonyms: ?*Limax fuscus* MÜLLER, 1774; *Arion subfuscus* JOHNSTON, 1838 (nomen nudum); *Arion cinctus* DUMONT et MORTILLET, 1857; *Arion euthymeanus* FLORENCE, 1886; ?*Arion olivaceus* KOTULA, 1884 — for data concerning these synonyms see HESSE (1926).

References: ANT 1957: 8; DAMJANOV and LIKHAREV 1975: 243; FRÖMMING 1954: 154 (bionomics); GERHARDT 1940: 570 (copulation); KÜNDEL 1908: 86, 1916: 323 (data concerning bionomics); LIKHAREV and WIKTOR 1980: 396; MÜLLER 1913: 181 (food); ØKLAND 1923: 24 (survey); RIEDEL and WIKTOR 1974: 103 (survey); QUICK 1946: 181 (copulation), 1960: 133 (survey and illustrations); SIMROTH 1885: 280 (illustrations), 1901: 47 (illustrations and distribution); WIKTOR 1973: 29 (survey, illustrations), 1977: 291.

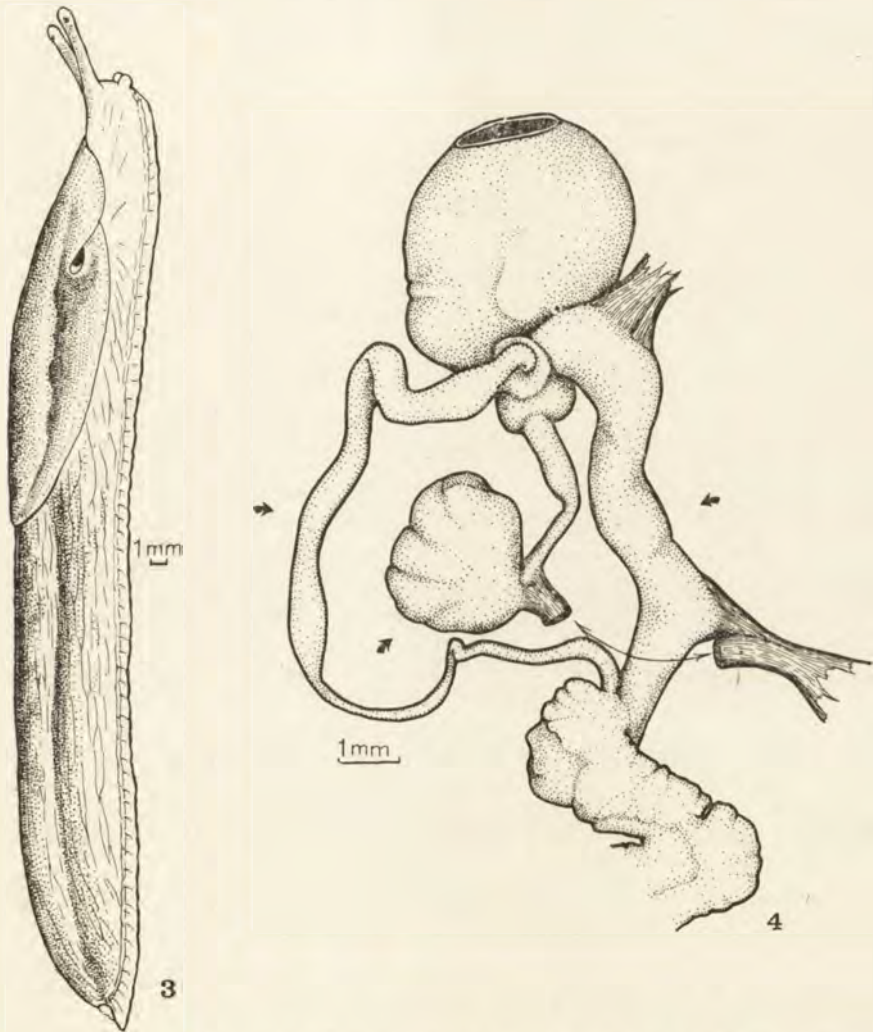
Medium-sized, up to about 70 mm, usually smaller. Slugs 35–45 mm in length are mature. The biggest Bulgarian specimen was 38 mm long after preservation. Body elongate. Length of mantle more than $\frac{1}{3}$ of the crawling body. Back slightly rounded, not very convex. Skin finely grooved.

Colouration variable within the same population. Body usually rust-coloured, yellow-brown, orange-brown, seldom olive-brown. Sides with dark, brown bands, most distinct on mantle in most individuals, especially juveniles. Bands attaining body end, varying from light to dark, often inconspicuous or absent in large individuals. Slugs without bands are usually lighter in colour: ash-grey-yellow or ash-grey-brown. In banded forms beneath pneumostome the dark pigment forming a characteristic triangle. Unlike in most other species pneumostome is surrounded from 3 sides: from above, behind and below (Fig. 3). All the forms described above are not varied anatomically, but it can be said that those with lateral bands are most often juveniles while the bigger ones, devoid of bands, are fully developed (WIKTOR 1973). Many authors call the smaller, banded form *A. subfuscus fuscus* POLL., and *A. subfuscus brunneus* LEHM. the larger unbanded form. A third form (rarely found) are slugs with back and mantle uniformly chocolate or black-chocolate and light, orange or yellow-olive sides. These are most probably melanistic individuals. The author found only juveniles of this form in Bulgaria (Rila — Parangalitsa).

The reason of the colour variation described above is not clear. Apparently none of the three forms can be correlated with fenological or ecological factors, although the large unbanded form is most frequent in open habitats, especially in mountain meadows or on rocks above the timberline.

Slime usually orange or yellow, but hyaline in large, unbanded specimens.

Genitalia (Fig. 4). Glandula hermaphroditica small, entirely hidden among liver lobes. Ductus hermaphroditicus thin, long. Albumen gland located centrally or in anterior part of body. Spermoviductus narrow, with little glan-



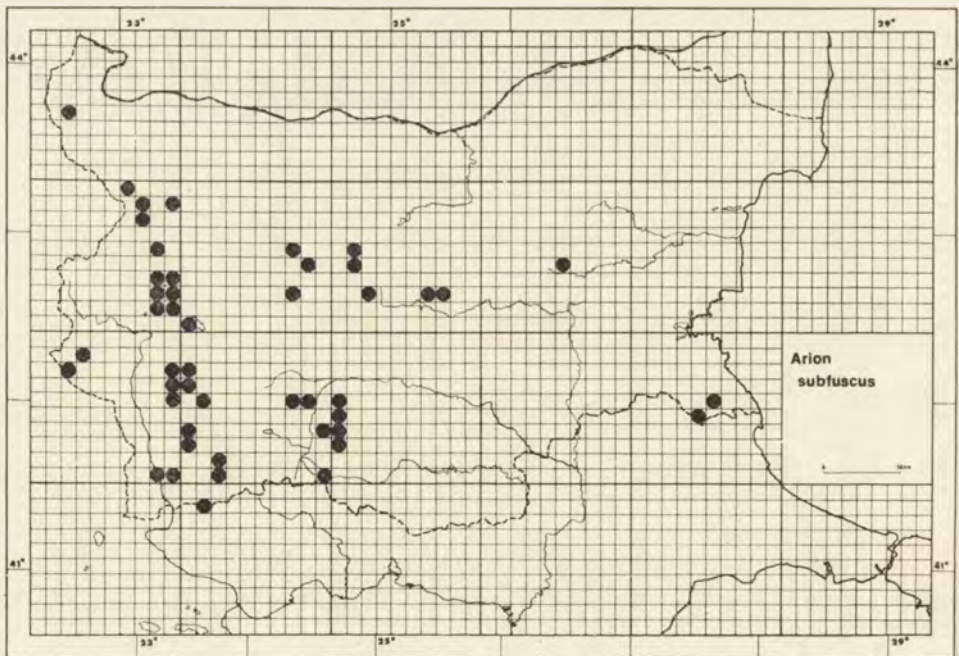
Figs. 3-4. *Arion (M.) subfuscus* (DRAP.): 3 - side view (of a living specimen from Poland), 4 - copulatory organs (specimen from Shipka)

dular swellings. Oviductus abruptly broadened near the insertion of genital retractor, its narrow part very short. Ligula absent, superseded by longitudinal ridges. Vas deferens thin, long, gradually changing into thicker, long epiphallus. Spermatheca spherical, spermatheca duct long, with irregularly-shaped swell-

ling at the junction with atrium. Atrium short, barrel-like, well-differentiated. Vas deferens never looping around spermatheca duct. Genital retractor short, wide, inserted to oviductus at its broadened part.

Formula of radula: C. 42-67/×124-149.

Bionomics. Occuring in widely different biotopes, it is found most often in forest of various kinds, both deciduous and coniferous. Particularly frequent in mountains, also met at clearings and above timberline up to subalpine zone, choosing both areas of rich mountainous vegetation and rocks covered only with lichens. In mountains reaching the altitude of about 2900 meters above sea level, the highest occurrence in Bulgaria known to me being at altitude of 2000 meters above sea level (Vezhen, Damianitsa, Yakoruda). In synanthropic environments not frequent though met there as well. Living from 13 to 17 months, matures sexually at age between 8,5 and 10,5 months. Lays eggs at various year seasons, no distinct season preference observed. Eggs: yellow or creamy of 3-4 mm in diameter. Hatching period not stable, depending on environment temperature, lasts from twenty odd to hundred days. Young slugs after hatching are pale brown with blackish tentacles, darker lateral zones visible after 3-4 days (SZABO and SZABO 1934, KÜNKEL 1916, FRÖMMING 1954). Copulation was observed only fragmentarily and should be investigated in detail. This slug feeds on various food, preferring capped fungi, yet eats alive and dead parts of flower plants, fruit, carrion, especially of invertebrates, and vertebrate excrement.



Map 3. *Arion subfuscus*

Distribution. This species has the widest range of all *Arioninae*, including almost all of Europe from Portugal in west to the Ural (which it maybe passes) and from Iceland and northern Scandinavia to the Balcans and the steppe region in southern Ukraine.

In Bulgaria occuring in all the mountain and submountain areas, not found in the wide valleys of the Danube and the Marica, nor in Bulgarian Dobrudzha.

Material examined: 285 specimens.

Records (Map 3):

Stara Planina: Vratsanska Pl. in the region of Purshevitsa and Milanovo; Berkovitsa leg. TOTEV (MNH); Beli Vit Valley near Teteven, Vezhen, Ribaritsa near Teteven, Cherni Osum Valley near Troyan; Kalofer leg. BOROWIEC and TARNAWSKI; near Shipka Pass, Buzludzha near Kazanlyk, Zheravna near Kotel. Also: OŠANOVA (1968, 1970) — Buchino Pass, Sredkovets, Shabovitsa Valley, Barzya; URBAŃSKI and WIKTOR (1968) — Petrohan Pass, Troyan.

Vitoshka: Zlatni Mostove, Boyana and Boyanskie Oзера, Vladaya, Bistritsa, Cherni Vrukh; near shelter house "Momina skala" leg. BURESCH (BAN). Also: HUDEC (1964) — Boyana; OŠANOVA (1968) and URBAŃSKI and WIKTOR (1968) — Zlatni Mostove.

Sofia — WAGNER (1934a)

Plana: Kokalyane, Kokalyanski Monastir.

Sredna Gora: Kaprivshitsa; near shelter house Bogdan leg. SZIGETHY (HNHM).

Osogovska Planina: region of Hizha Osogovo; also: URBAŃSKI and WIKTOR (1968) — Bogoslav; WAGNER (1943a) — Kyustendil.

Pirin: Bansko, Bunderitsa and slopes of Vikhren, near shelter house Damyanitsa, Biegovitsa in Bistritsa Valley near Sandanski, Gotse Delchev on the river Mesta, Bereznitsa near Gotse Delchev. Also: WAGNER (1934b) — Pirin (?).

Slavianka: Carev Vrukh leg. CONKOV (BAN).

Rila: Borovets, near Rilski Monastir, reserve Parangalitsa near Blagoyevgrad, region of waterfall Skakavitsa, near shelter houses Vada and Lovna, Yakoruda; Malavitsa leg. ♀ (IZW); Tshamkuria leg. BURESCH (BAN), near III-Rilske Ozero leg. CHORBADZHIEV (BAN). Also: WAGNER (1934a, 1934b) — Tsham-Kuria, Rilski Monastir; JAECKEL (1954) — Stinyakovo; OŠANOVA (1968) — Rilski Monastir and Kanarata; URBAŃSKI and WIKTOR (1968) — Rilski Monastir.

Rodopi: Pesthera — reserve Snezhanka, near shelter house Zdrevets not far from Plovdiv, region of Chepelare leg. PAWLOWSKI and BLASZAK (MNH), Khvoyna region of Bela Churkva, Narechinske bani leg. D. PAPASSOFF (BAN), Chudni Mostove (Erkruprya) numerous localities (MNH) and leg. PINTÉR (HNHM), Persenk, numerous localities near Smolyan, Batak. Also: URBAŃSKI and WIKTOR (1968) — Lepenitsa, Golyam Perelik.

Strandzha (Istranca): Gramatikovo, Ajdere Valley near Malko Turnovo.

Subgenus *Carinarion* HESSE, 1926

Carinarion HESSE, 1926: 65. Typus: *Arion circumscriptus* JOHNSTON, 1828.

Carinella MABILLE, 1870: 106 (non *Carinella* JOHNSTON, 1833; nec SOWERBY, 1839).

Body length up to about 50 mm. Dorsal keel well-marked in all juveniles and many adults. Integument finely sculptured. Body ash-grey with darker dorsum, yellowish ash-grey or brownish in some specimens. Sole white or cream-

coloured. Sides with bands. No dark pigment beneath respiratory orifice. Slime hyaline. Atrium large, flattened in most specimens. Bursa copulatrix oval or tapering apically. Oviduct thinner than epiphallus. Distribution: almost all Europe. Three species known.

***Arion (Carinarion) silvaticus* LOHMANDER, 1937**

Arion circumscriptus var. *silvatica* LOHMANDER, 1937: 98. Terra typica: southern Sweden (? and Denmark).

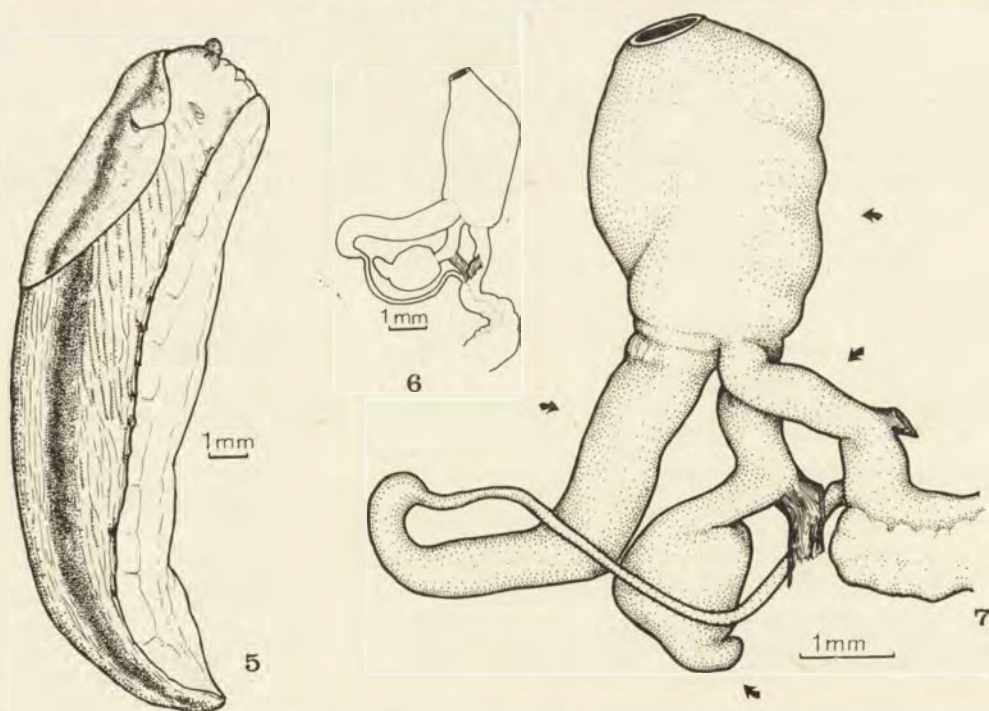
Arion (Arion) circumscriptus JOHNST.: WAGNER 1934a: 59, 1934b: 90; HUDEC 1964: 191.

Arion (Carinarion) circumscriptus JOHNSTON: OŠANOVA 1968: 237, 1970: 73, 1972: 141; URBAŃSKI and WIKTOR 1968: 50.

References: DAMJANOV and LIKHAREV 1975: 242; LIKHAREV and WIKTOR 1980: 405; RIEDEL and WIKTOR 1974: 114; WIKTOR 1973: 38 (survey and illustrations in last two), 1977: 291.

Body length about 25 mm in living specimens, 21 mm and 6 mm width in preserved Bulgarian specimens.

Colour variable (Fig. 5). Dorsum and mantle dark ash-grey to dark grey-brown, almost blackish in some preserved individuals. Sides and mantle with dark bands. Mantle almost uniformly coloured between bands, without black spots. Dorsum darker than sides, lower edge of side bands sharp, upper edge



Figs. 5-7. *Arion (C.) silvaticus* LOHM.: 5 — side view (specimen from Vladaya), 6-7 — copulatory organs (6 — specimen from Zheravna, 7 — from Shipka)

blurred (dark pigment intermingling with dark dorsum). Dark pigment present also in skin grooves on body sides but lighter than in dorsum. Bulgarian specimens have the dorsum paler and the dorsal edge of the lateral band more distinct than individuals from Central Europe. Sole white or cream-coloured.

Slime transparent, hyaline or slightly yellowish.

Genitalia (Figs. 6–7). Broad, flattened atrium is distinctive. Width almost equal to length. Epiphallus large, cone-shaped, sometimes slightly swollen near atrium, without dark band. Oviduct short, thick. Spermatheca duct short, thick, swollen anteriorly (but not spherical). No differences were found in genitalia of Bulgarian and Central European specimens.

Radula with no specific features, its formula C. 30–38/×106–114.

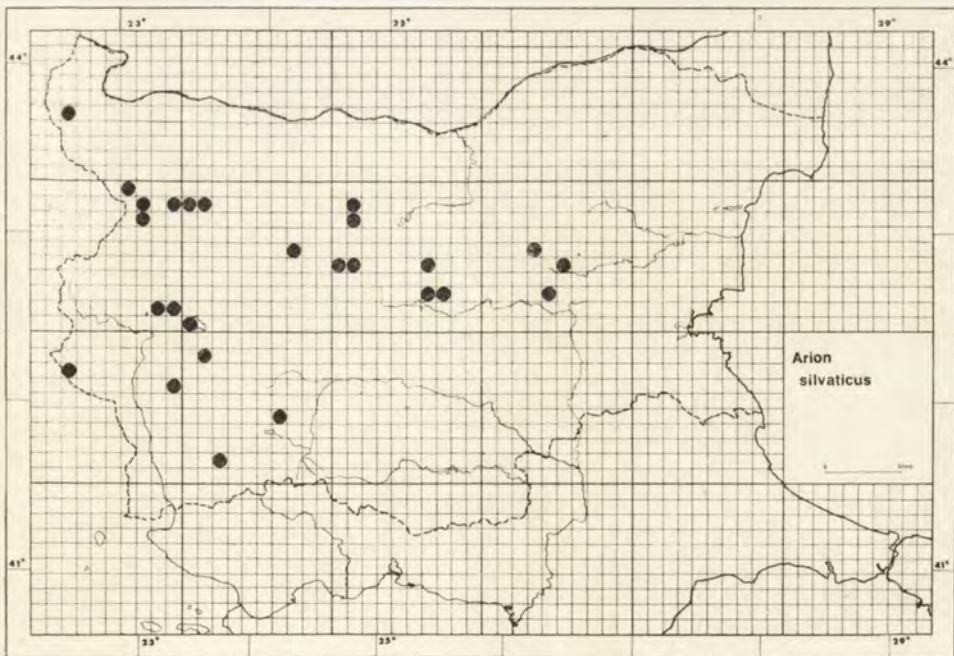
Bionomics poorly known. Woodland species living in deciduous forests, especially in mountains, often at valley bottoms and near brooks, in humid and medium damp biotopes. In Bulgaria up to the altitude of 1400 m.

Distribution incompletely known. Recorded from Scandinavia, W-regions of USSR, Poland, Romania, Bulgaria, Holland, France, West Germany (LIKHAREV and WIKTOR 1980, SCHMID 1972).

In Bulgaria in a high mountain region (Stara Planina, Vitoshka, Pirin, Rila, Rodopi).

Material examined: 158 specimens.

Records (Map 4):



Map 4. *Arion silvaticus*

Stara Planina: Vratsa, near Purshevitsa and Ledenika shelters within Vratsanska Planina, Teteven, Bulgarene near Lovech, Beli Osum in the vicinity of Troyan, Gabrovo, many localities near Shipka, Stoletov leg. L. PINTÉR (HNHM), vicinity of Buzludza near Kazanlyk, Zheravna and the area around Kotel. Also: WAGNER (1934a) — Sliven; URBAŃSKI and WIKTOR (1968) — Ledenika; OŠANOVA (1968, 1970) — Dabnika, Berkovitsa, Lakatnik, Sredkovets, Petrohan, Shabovitsa, Barzya.

Vitosha: Boyana, Boyanski Vodopad leg. OŠANOVA and PINTÉR (HNHM), Boyanske Ozera, Zlatni Mostove, Bistritsa, Dragalevtsi, Vladaya. Also: WAGNER (1934a), HUDEC (1964) and OŠANOVA (1972) — many localities.

Plana: Kokalyane and Kokalyanski Monastir.

Osogovska Planina: Near Hizha Osogova, Kyustendil.

Pirin: Breznitsa near Gotse Delchev.

Rila: Borovets. Also: WAGNER (1934b) — Tsham-Kuria; OŠANOVA (1968) — Rilski Monastir.

Rodopi: Batak and the area around.

Comments.

Some specimens of *A. silvaticus* are externally similar to *A. subfuscus* or *A. hortensis*. Unlike *A. silvaticus* the two latter species belong to other subgenera and can be easily distinguished by spherical spermatheca and the remaining subgenus features.

Other species of the subgenus *Carinarion* differ from *A. silvaticus* as follows:

A. circumscriptus JOHNSTON has a more elongated body with spots on the mantle; blurred lower edges of side bands; flattened atrium twice as long as wide; epiphallus smaller, not swollen in the anterior part and with a dark pigment band on the surface; spermatheca duct and the oviduct of the same thickness, both with no swellings in the anterior part.

A. fasciatus (NILSSON) — the body flattened dorsoventrally, lighter coloration; bounded side bands with yellow or orange stripe beneath; conical (not flattened) atrium; epiphallus larger with larger swelling bulbous in the anterior part; spermatheca duct thicker with bigger swelling, the oviduct distinctly thinner.

Previous literature uses one name, *Arion circumscriptus*, for the three species (*circumscriptus*, *silvaticus*, *fasciatus*). *A. fasciatus* is possible to meet in Bulgaria, especially in synanthropic environment. It is also possible to find *A. circumscriptus* there, since the western part of Stara Planina has biotops characteristic for this species. This possibility is taken into consideration by DAMJANOV and LIKHAREV (1975). Localities of *A. circumscriptus* as known from the previous data should be revised.

Subgenus *Kobeltia* SEIBERT, 1873

Kobeltia SEIBERT, 1873: 81. Typus: *Arion hortensis* FÉRUSAC, 1819.

Body length up to 35 mm. Integument finely sculptured, no keel on the back. Colour variable, usually dark. Body sides with dark bands. Atrium small. Spermatheca spherical. Oviduct thick, thicker than epiphallus. Four or six species known. They all occur in western and southern Europe.

Arion (Kobeltia) hortensis FÉRUSSAC, 1819

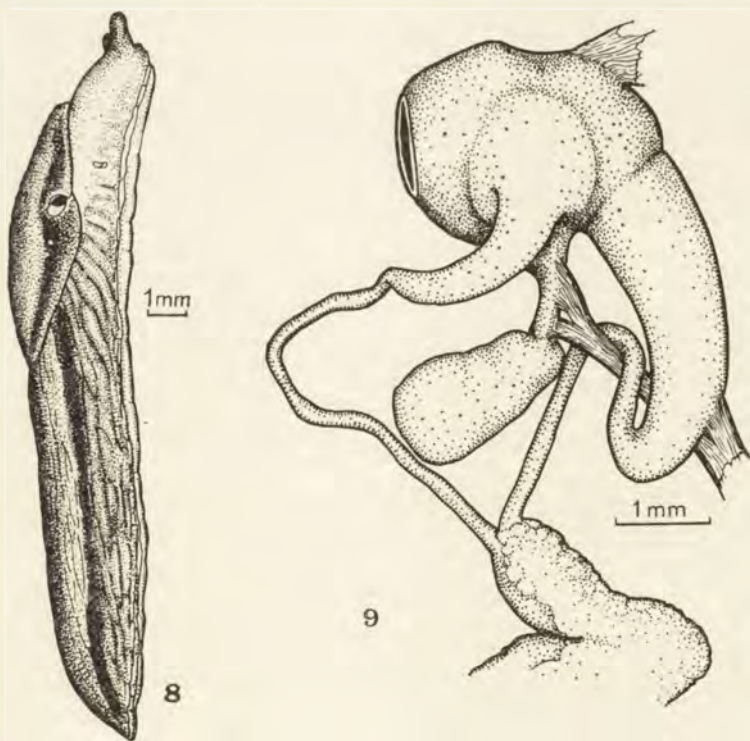
Arion hortensis FÉRUSSAC, 1819: 65. Terra typica: France.

Synonyms: ? *Arion anthracicus* BOURGUIGNAT, 1866; *Arion pelophilus* MABILLE, 1870; *Arion elongatus* COLLINGE, 1894; *Arion hortensis* FÉRUSSAC R: DAVIES (1977).

References: DAMJANOV and LIKHAREV 1975: 242; DAVIES 1977: 174; 1979: 123; FRÖMMING 1954: 153 (bionomics); GERHARDT 1936: 324 (copulation); KÜNKEL 1916: 86 (bionomics); OŠANAVA 1964: 204 (bionomics); ØKLAND 1923: 40 (survey); QUICK 1946: 178 (copulation), 1960: 130 (bibliography, illustrations); RIEDEL and WIKTOR 1974: 119 (bibliography, illustrations); SIMROTH 1885: 238; WIKTOR 1973: 43 (bibliography, illustrations), 1977: 291.

Body length up to about 35 mm in crawling, about 15 mm in preserved specimens. Body slender, mantle rather small, integument finely sculptured.

Living specimens chocolate-black with darker dorsum and lateral bands. Bands gradually paler downwards, with evanescent lower margin (Fig. 8). Head and tentacles black. Sole orange, brown-orange or dark yellow. Juveniles bluish ash-grey with dorsum darker and sole yellow. In specimens preserved in alcohol the yellow pigment is washed away colouring the fluid, the dorsum and sides become blue steel-grey, or even blue, the lateral bands blackish,



Figs. 8-9. *Arion (K.) hortensis* FÉR.: 8 - side view, 9 - copulatory organs (specimens from Poland)

and the sole whitish or cream-coloured. Colouration characteristic of living juveniles and adults enables their recognition.

Slime yellow-orange, hyaline.

Genitalia (Fig. 9). The unusually long oviductus is distinctive; broad, elongately conical anteriorly, narrow, tubular posteriorly. Both parts of almost the same length. Epiphallus distinctly shorter than broadened part of oviductus, slightly swollen in the middle with annular swelling near atrium. Spermatheca spherical. Spermatheca duct thick, tubular, gradually broadening anteriorly. Atrium small, barrel-shaped. Spermoviductus short as compared to copulatory organs.

Radula. Lateral teeth with narrow and long mesocone. Formula: C. 29-35/× 101-121.

Bionomics. This species is especially adapted to biotopes changed by human activities. As a synanthropic species it spread over a large part of Europe (including Bulgaria). In natural biotopes it is mainly a forest species. It is also frequent in gardens, parks, vegetable-cultivated grounds, greenhouses, refuse heaps, cellars, vegetable or fruit warehouses etc. The slugs hide under stones, logs, in the ground or in leaf litter. Individuals of various developmental stages, and probably also eggs, hibernate in cellars, drains, greenhouses, hotbeds, under stones and in the ground. Synanthropic populations have no seasonal life cycles, so that individuals of all ages can be met simultaneously. The species sometimes is a dangerous pest in greenhouses and horticultural grounds. It is omnivorous, feeding first of all on fruit, especially berries (strawberries, wild strawberries), seedlings and new weak plants (cabbage, celery, lettuce, all *Papilionaceae*, and flowers). Its control is especially difficult in areas with natural hiding-places.

According to KÜNKELE (1916) and FRÖMMING (1954) the slug lays about 200 eggs during its lifetime. The eggs are laid in batches of 12-80 each, from 2 to 3.5 mm in length. According to OŠANOVA (1964), hatching takes 20-38 days in Bulgaria. The first eggs are laid by the slugs 17 weeks old (but sometimes 7 months old). There seem to be two main periods of oviposition: from the end of March to the end of April, and from the end of October to the end of December, though occasionally eggs are laid during other cool or cold periods. Laying eggs from July to the beginning of September has not been noticed in Bulgaria. Most individuals live for about 9 months. In Bulgaria most slugs die in January and in May.

Copulation has been observed by several authors (GERHARDT 1936, QUICK 1960, OŠANOVA 1964) but their results are contradictory. So are the descriptions of spermatophores. This may suggest that two similar and not yet recognized species are involved (see RIEDEL and WIKTOR 1974).

Distribution. Originally *A. hortensis* inhabited south-western Europe, Great Britain and probably North Africa. As a synanthrope common in central

Europe (to western Poland). More eastwards known from isolated synanthropic biotopes and greenhouses. Introduced to the USA.

In Bulgaria known only in Sofia.

Material examined: 55 specimens.

Records (Map 2):

Sofia: leg. POPOV, see also OŠANOVA (1964, 1968), URBAŃSKI and WIKTOR (1968).

Comments.

DAVIES (1977, 1979) states that three distinct species i.e. *Arion hortensis* FÉRUSSAC, 1819, *A. distinctus* MABILILE, 1868 and *A. owenii* DAVIES, 1979 are in literature commonly confused under the name *hortensis*. I was able to compare with her results only two specimens from Bulgaria (collection of J. URBAŃSKI). The other specimens were sent to me 10 years ago. After having examined these I sent them back. Probably they no longer exist. The two specimens studied show features which according to DAVIES are characteristic of *hortensis*. Because of the ill preservation of the above specimens, Fig. 9 shows the genitalia of a specimen from Poland.

Zonitoidea MÖRCH, 1864

This group has a tendency to reduce shell. The shell is fully developed only in most *Zonitidae*, being flat, spirally coiled, so large that the whole body can retract inside. In *Vitrinidae* and *Parmacellidae* shell is more or less ear-shaped, protecting only part of the body. Most *Vitrinidae* are semislugs and *Parmacellidae* become sluggish as they grow and get mature. *Milacidae*¹ include only slugs, their vestigial shell is lenticular with refined accretion lines. Shell cavity closed up.

In all families female parts of genitalia and atrium with a tendency to form various accessory organs; male parts usually with papilla inside penis and with epiphallus.

Lateral teeth of radula narrow, cuspid or sword-shaped.

Milacidae ELLIS, 1926

Milacidae ELLIS, 1926: 252; LIKHAREV and WIKTOR 1980: 354; WAGNER 1935: 189 and 1936: 92; WIKTOR 1973: 49; ZILCH 1959: 265. As *Milacinae* in *Parmacellidae*: GERMAIN 1930: 106. As pars *Milacinae* in *Limacidae*: HESSE 1926: 30.

Species placed until recently in *Milax* (which was included in *Parmacellinae*, *Limacidae*) are now excluded from that subfamily and family and placed in *Milacidae*. Similarly, *Parmacella* and *Boettgerilla* (both extralimital) are now placed in families of their own, not in *Limacidae*.

¹ I follow VAN GOETHEM (1972) in considering *Boettgerilla* SIMR. as belonging to a separate family, not to *Parmacellidae* (ZILCH 1959-1960) or *Milacidae* (WIKTOR 1973).

Body length variable, up to 100 mm, elongated, tapered posteriorly. Mantle at least $\frac{1}{3}$ of body length, granular and with small papillae (which are visible only in living specimens), without concentric grooves, with a horseshoe-shaped groove opened posteriorly (the horseshoe sometimes closed). Pneumostome postmedian. Rear of the body with a distinct keel which attains mantle hindmargin, and with two shallow cavities beneath mantle hindmargin. Posterior part of the body with 9–12 longitudinal grooves between median line and pneumostome. Sole divided into three longitudinal zones, with transverse V-shaped grooves.

Unicolour or with dark spots, mantle in many species laterally with irregular, longitudinal bands.

Slime dense, sticky, colourless, milky or yellow.

Shell flat, slightly convex in upper part, with well-defined concentric growth lines. Nucleus placed on shell's longitudinal axis near hindmargin.

Epiphallus large, producing spermatophore, connected with penis. Penis variously shaped, with glans inside (papilla), not crossing tentacle retractor. Spermatheca duct opening into oviductus. Accessory glands opening into vagina or atrium. Atrium often with stimulator inside.

Eggs with calcareous shell.

Jaw oxygnathic. Central and lateral teeth of radula with 2 or 3 cusps; marginal teeth sword-shaped. Intestinum with two loops, the second one protruding more backwards than the first one. Right liver lobe constituting apical part of viscera.

Distributed throughout North Africa, Asia Minor to Caucasus, Europe eastwards to southern Ukraine, north to Ireland, England and south-western Poland. Several species have been introduced into other parts of the world. About 40 known species.

Previous classifications of *Milacidae* (as defined here) are evidently artificial (HESSE 1926; WAGNER 1930). In this paper I recognize 2 genera within *Milacidae*: *Milax* GRAY, 1855 and *Tandonia* LESSONA et POLLONERA, 1882, which are based on structural, behavioural, and distributional characters (WIKTOR 1981). Recognizing *Aspidoporus* as a genus was an error caused by BABOR's (1889) inaccurate description (see WIKTOR 1979).

Genus *Milax* GRAY, 1855

Milax GRAY, 1855: 174. Typus: *Limax gagates* DRAPARNAUD, 1801.

Amalia MOQUIN-TANDON, 1855: 19. Typus: *Milax gagates* (DRAPARNAUD, 1801) (*Limax*).
Lallemantia MABILLE, 1868: 143. Typus: *Limax polyptyleus* BOURGUIGNAT, 1859 (= *M. gagates*).

Pyrainea LESSONA et POLLONERA, 1882: 57. Typus: *Amalia gagates* (DRAPARNAUD, 1801).

Cypria SIMROTH, 1910: 158. Typus: *Amalia cypria* SIMROTH, 1910 (= *Limax barypus* BOURGUIGNAT, 1866).

Micromilax HESSE, 1926: 33; new name for *Cypria* SIMROTH nec ZENKER, 1854.

References: HESSE 1926: 33 (sectio *Lallemantia*); LIKHAREV and WIKTOR 1980: 357; WAGNER 1930: 52 (sect. *Lallemantia*); WIKTOR 1981: 145.

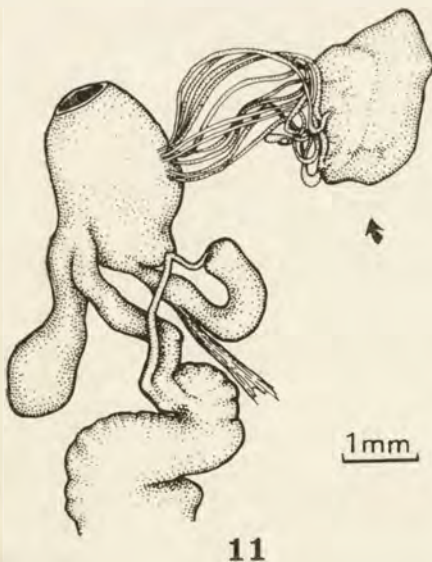
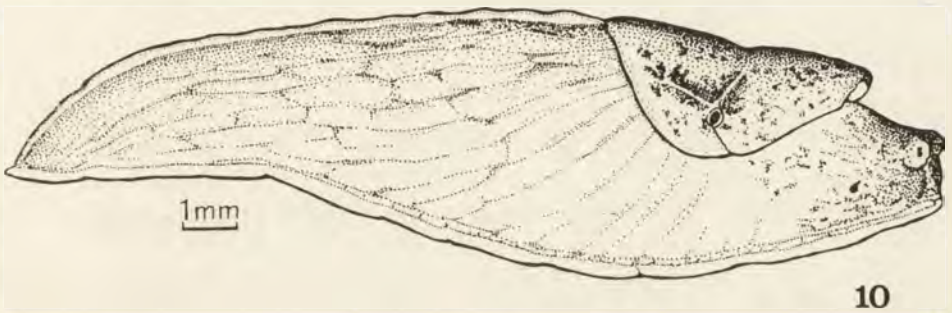
Body length up to 70 mm. Body stout, cuneiform posteriorly. Keel sharp, protruding, attaining mantle hindmargin.

Atrium large, barrel-shaped, with stimulator inside (except *M. verrucosus*). Accessory glands opening asymmetrically directly into atrium near stimulator base. Epiphallus short, broadening posteriorly.

Distribution. British Isles, Mediterranean region, areas behind the Caucasus.

Milax parvulus WIKTOR, 1968

Milax (Milax) parvulus WIKTOR in URBAŃSKI and WIKTOR, 1968: 91. Locus typicus: Iskrets (Iskrec) (Bulgaria, Stara Planina). Lectotypus: MNH No. 457 design. WIKTOR 1968: 419).



Figs. 10–12. *Milax parvulus* WIKTOR: 10 – side view (specimen from Purshevitsa), 11 – copulatory organs, 12 – stimulator seen in the open atrium (11–12 after WIKTOR 1968)

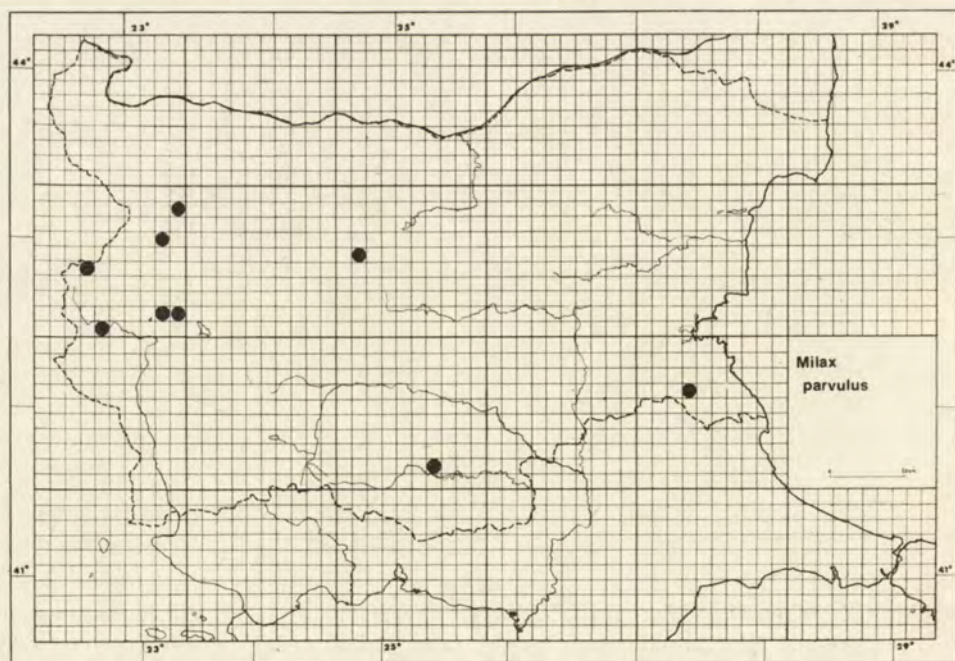
References: DAMJANOV and LIKHAREV 1975: 334; WIKTOR 1968: 419 (description, illustrations), 1977: 292.

Body broadest at mantle level, cuneate posteriorly, 25 mm long in largest preserved specimens. Keel prominent.

Living specimens with dark dorsum; keel and sole brown-black with orange. Preserved specimens without orange colour, with well-defined blackish pattern. Mantle with irregular dark spots which form irregular reticulate pattern (Fig. 10), with black, irregular band on each side; bands indistinctly connected anteriorly with each other in some specimens. Head and tentacles blackish. Posterior part of body (behind mantle) bluish ash-grey with blackish reticulate pattern (dark pigment placed in skin grooves). Sole and keel cream-white in preserved specimens. Preserved specimens resemble *Tandonia budapestensis* and *T. cristata* in habitus and colouration.

Genitalia (Figs. 11–12). Atrium large, barrel-shaped, with rolled, elongate, smooth stimulator inside. Stimulator semicircular or crescent-like (semilunar) in cross section. Accessory (atrial) glands forming dense, white mass, situated between sole muscles and crop or pharynx. Accessory glands joining atrium with 9–13 thin, silky white ducts. Penis and epiphallus ill-defined, forming single subconical organ with vas deferens opening into its end. Spermatheca duct thick, spermatheca oval or spherical. Oviductus in shape of a broad tube, sometimes with small, pocketlike swelling.

Radula. Medial and lateral teeth tricuspid, except the external one, which is bicuspid. Marginal teeth dagger-like. Formula: C. 13. 1. 24/ × 92.



Map 5. *Milax parvulus*
<http://rcin.org.pl>

Bionomics unknown. Slugs of this species collected by me were found on calcareous rocks, under stones or in brushwood and in open grass fields.

Distribution. Known only from Bulgaria (several localities).

Material examined: 33 specimens (holotype and paratypes).

Records (Map 5):

Stara Planina: URBAŃSKI and WIKTOR (1968) — Iskrets, in the vicinity of Purshevitsa (Vratsanska Planina), Troyan, and Trun shelters (western Bulgaria). Gara Zemen — DAMJANOV and LIKHAREV (1975).

Vitosha: DAMJANOV and LIKHAREV (1975).

Rodopi: DAMJANOV and LIKHAREV (1975) — near Kurdzhali.

Strandzha: DAMJANOV and LIKHAREV (1975) — Zviezdec.

The Black Sea coast: DAMJANOV and LIKHAREV (1975) — near the Silistar River.

Milax verrucosus WIKTOR, 1969

Milax verrucosus WIKTOR, 1969: 47. Locus typicus: Gabrovo (Stara Planina, Bulgaria).
Holotypus: MNH No. 460.

?*Milax* sp.: OŠANOVA 1970: 78.

References: DAMJANOV and LIKHAREV 1975: 335; WIKTOR 1977: 292.

Body elongate or worm-like, obtusely angulate at posterior end, both in living and preserved specimens (Fig. 13). Length up to about 35 mm in crawling, up to 28 mm in preserved specimens (which are up to 4 mm wide). Mantle covering only $\frac{1}{6}$ to $\frac{1}{7}$ of the body length in crawling, about $\frac{1}{4}$ in preserved, shrunk individuals. Keel low, but visible till body hindmargin. Integument finely sculptured. Mantle with distinct papillae which do not occur in other *Milax*.

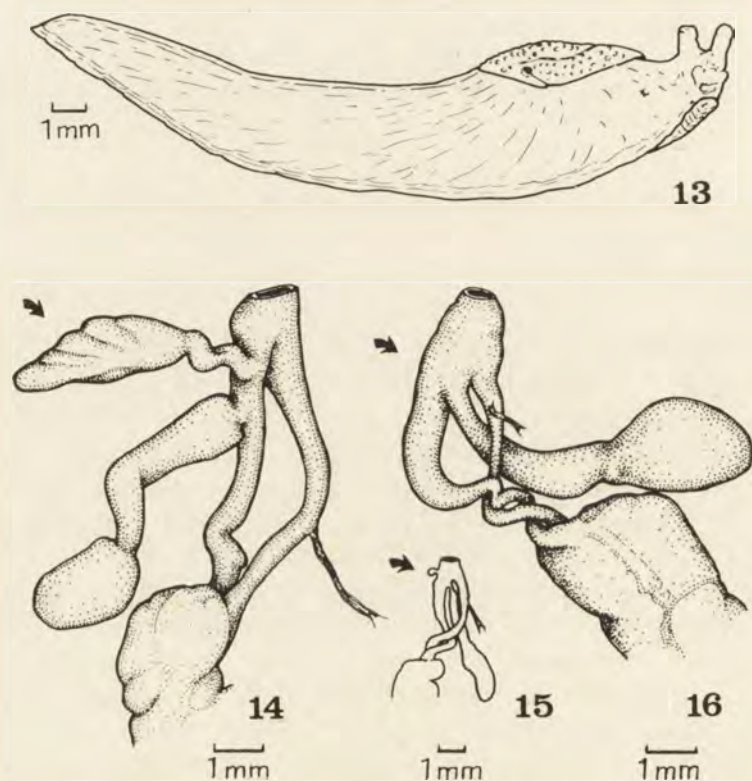
Unicolour, without spots or pattern. Most specimens snow-white or cream-coloured. Largest specimens with slightly ash-grey or bluish, darkened dorsum. Tentacles always blackish. Slime hyaline, very dense.

Genitalia (Figs. 14–16). Many details (e.g. proportions, shape) distinguish *M. verrucosus* from other *Milacidae*. Spermoviductus extremely short, in adults subequal to oviduct in length. Albuminal gland unusually large, as long as the distance from beginning of spermoviductus to anterior part of atrium. Vas deferens, epiphallus and penis poorly differentiated, forming one straight duct, broadening gradually and extremely short, its length equal to oviductus. Retractor penis narrow, long. Oviductus gradually broadening, communicating anteriorly with spermatheca duct (which is long, broad). Spermatheca oval, small as compared to spermatheca duct. Atrium short, as if both male and female copulatory organs fused, without stimulator. Accessory gland lacking in juveniles (Fig. 16), first appearing as small pocket on atrium wall at junction with female duct (Fig. 15). When fully developed it forms a single wing-like organ communicating with atrium by a single duct (Fig. 14). Reproductive organs attaining right tentacle.

Musculus columellaris peculiar, consisting of two separate, ramifying muscles: tentacle retractors and bifurcated pharynx muscle.

Formula of radula: C. 7–8. 19–21/ × 93–104.

Bionomics. Specimens were collected at altitudes less than to slightly more than 1000 m. The slugs can be met mostly in valleys, in undergrowth places. I collected them in deciduous and mixed type forests, mainly in beech-hornbeam with walnut. The specimens hide under stones and underground where they dig canals. Put outside their hiding places they quickly withdraw into other dark places.



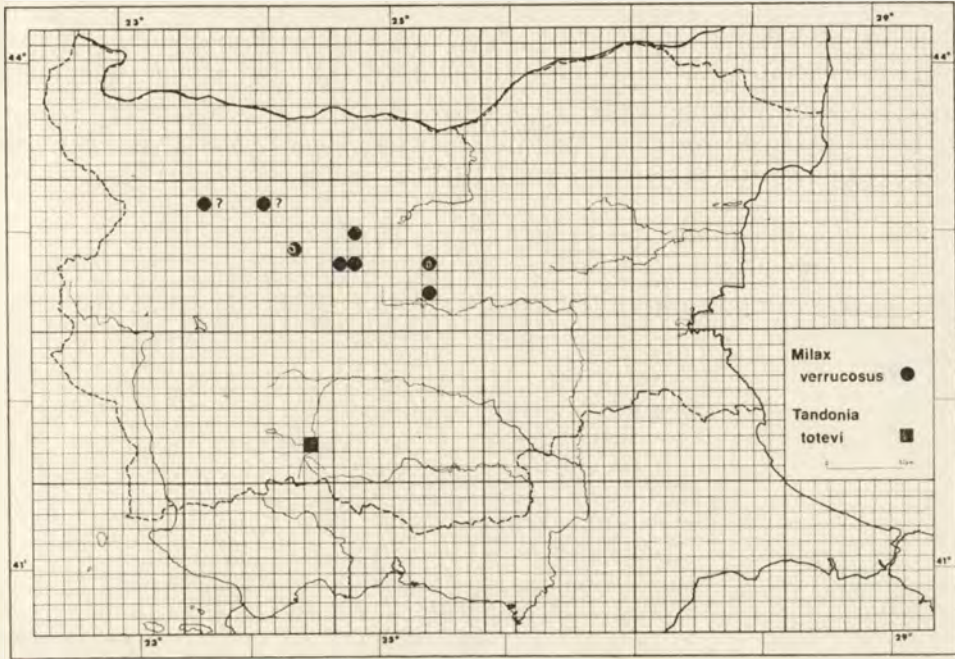
Figs. 13-16. *Milax verrucosus* WIKTOR: 13 - side view (specimen from Shipka), 14 - copulatory organs of the specimen, with a fully developed atrial accessory gland (specimen from Gabrovo), 15 - copulatory organs with the beginning of atrial accessory gland (specimen from Teteven), 16 - copulatory organs without the gland (specimen from Shipka) (14-15 after WIKTOR 1969)

Distribution. Certain records are all from central Stara Planina between Teteven and Shipka pass. Some questionable findings suggest that the range is much wider (see below).

Material examined: 33 specimens.

Records (Map 6):

Stara Planina: near Teteven (several localities), Cherni Osum, Ispolin at Shipka pass, ?Peshtera Bankovitsa near Iskur (improperly preserved) leg. A. POPOV (coll. URBAŃSKI). Also: WIKTOR (1969) - Gabrovo, Teteven; OŠANOVA (1970) - ?Dabnika (as *Milax* sp.).



Map 6. *Milax verrucosus* and *Tandonia totevi*

Comments.

Milax verrucosus lacks an atrial stimulator, which is a generalized organ in *Milax* s. str. The genitalia are simplified (shortened vas deferens—penis section), the columellar muscle is peculiar, and so is the integument. At least some of these characters are probably caused by the subterranean way of life (elongate body, absence of pigment, verrucosus integument). Changes in musculature and reductions in genitalia are probably further consequences. One can assume that *Milax verrucosus* developed from an ancestor similar to other present-day *Milax* and that during its evolution accessory gland ducts were fused or reduced, the stimulator was reduced, the vas deferens shortened, etc.

Genus *Tandonia* LESSONA et POLLONERA, 1882

Tandonia LESSONA et POLLONERA, 1882: 54. Typus: *Limax marginatus* DRAPARNAUD, 1805 (non MÜLLER) (= *Limax rusticus* MILLET, 1843).

Subamalia POLLONERA, 1887: 5. Typus: *Amalia robici* SIMROTH, 1885.

Promilax WAGNER, 1930: 50. Typus: *Amalia baldensis* SIMROTH, 1910.

References: HESSE 1926: 33 (sectio *Tandonia*); WAGNER 1930: 51 (sectio *Tandonia*); WIKTOR 1981: 145.

Body elongate in crawling specimens, almost parallel-sided in most species, with abruptly narrowed, short posterior part. Length up to about 100 mm. Keel usually low, attaining mantle hindmargin in some species, limited to posterior part of dorsum in others.

Atrium small, tubular, without stimulator. Accessory glands opening into vagina (not atrium), glands either as individual tubes around vagina, or fused in two large masses, every mass with one or more ducts. Penis short, epiphallus long, often narrowing posteriorly.

Distribution. Southern Alps (most species), central and partly western Europe, Crimea, North Africa, Asia Minor.

About 30 species.

Tandonia kusceri (WAGNER, 1931)

Milax (Milax) Kusčeri WAGNER, 1931a: 72. Locus typicus: Sveta Petka near Niš (Serbia, Yugoslavia). Holotypus: Naturhist. Mus. Vienna.

Milax (Milax) Kusčeri WAGNER, 1931b: 200.

?*Amalia (Tandonia) hessei* BTTG.: BABOR 1898: 40.

?*Amalia (Tandonia) carinata* LEACH: BABOR 1898: 40.

?*Amalia marginata* DRAP.: JURINIČ 1906: 10.

Amalia marginata DRAP.(?): WOHLBEREDT 1911: 184.

?*Milax (Milax) marginatus* DRAP.: WAGNER 1934a: 57.

Milax (Milax) Kusceri H. WAGN.: WAGNER 1934a: 57, 1934b: 90.

Milax rusticus longipenis GROSSU et LUPU, 1961a: 137. Locus typicus: Babadag (N-Dobru-dzha (Dobruja), Rumania). Holotypus: MNH "Gr. Antipa", Bucharest, No. 13109.

Milax rusticus f. *balkanicus* GROSSU et LUPU, 1961a: 139. Locus typicus: Comorova (SW-Dobru-dzha, Rumania). Holotypus: MNH "Gr. Antipa", Bucharest, No. 13126.

Milax (Milax) bojanensis HUDEC, 1964: 187. Locus typicus: the garden near "Bojanska cerkva" (Boyana near Sofia, Bulgaria). Holotypus: Senckenbergisches Museum, Frankfurt a/M., No. 175690. Also HUDEC 1965: 11, 1967b: 20.

?*Milax rusticus* MILLET: LUPU 1968: 31.

Milax longipenis (GROSSU et LUPU): LUPU 1968: 34.

Milax longipenis bojanensis (HUDEC): LUPU 1968: 35.

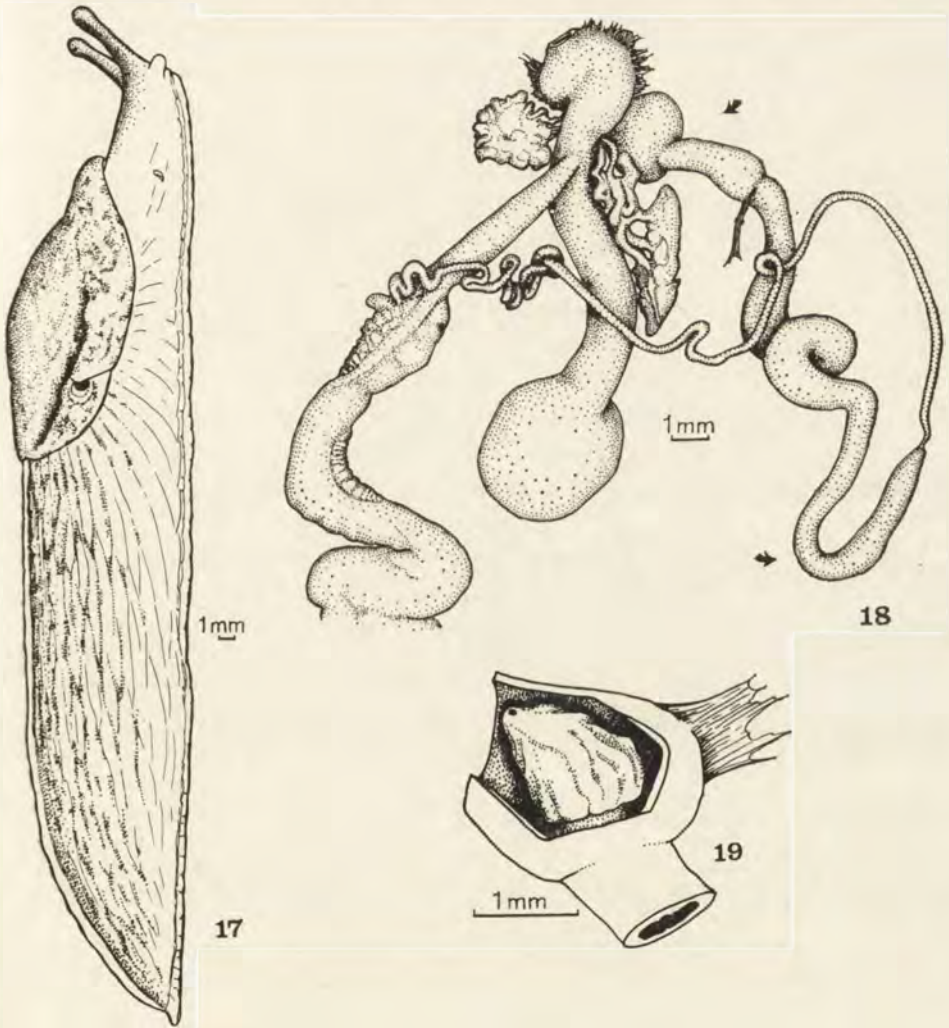
References: DAMJANOV and LIKHAREV 1975: 330; HUDEC 1965: 11, 1967b: 20; HUDEC and VAŠATKO 1971: 19 (illustrations, photographs, synonyms); LIKHAREV and WIKTOR 1980: 374; OŠANOVA 1970: 77, 1972: 147 (bionomics); URBAŃSKI and WIKTOR 1968: 86 (illustrations, description); WIKTOR 1977: 293.

Body length up to about 100 mm in crawling, about 55–65 mm in preserved specimens. Mantle about $\frac{1}{4}$ of body length. Keel often inconspicuous in living specimens, attaining mantle hindmargin, visible only posteriorly in improperly preserved specimens (e.g. macerated).

Colouration. Living specimens pink-brown or ash-grey pink with many irregular blackish spots (Fig. 17), confluent into two lateral bands on mantle. Mantle of some specimens with weakly pigmented band. Head and tentacles blackish, remaining part of dorsum with spots along skin grooves. Preserved specimens devoid of pink colouration, body getting mucky yellow or brown and spots black. Keel without spots, lighter in colour than dorsum. Sole mucky-cream.

Slime dense, hyaline, milky in irritated specimens.

Genitalia (Figs. 18–19). Epiphallus and vas deferens very long. Penis short, anterior part spherically broadened with papilla inside (Fig. 19), posterior part cylindrical, slightly broadening. Slight constriction (with a narrow retractor inserted in it) can be regarded as its posterior limit. Epiphallus tubiform, slightly broadened mesally, coiled helically, communicating with membranous mesenterium by thick blood-vessel. This mesenterium was incorrectly interpreted by URBAŃSKI and WIKTOR (1968) as accessory retractor. Epiphallus



Figs. 17–19. *Tandonia kusceri* (WAGN.): 17 — side view (specimen from Ropotamo), 18 — copulatory organs (specimen from Balchik) 19 — papilla inside the penis (after LIKHAREV and WIKTOR 1980)

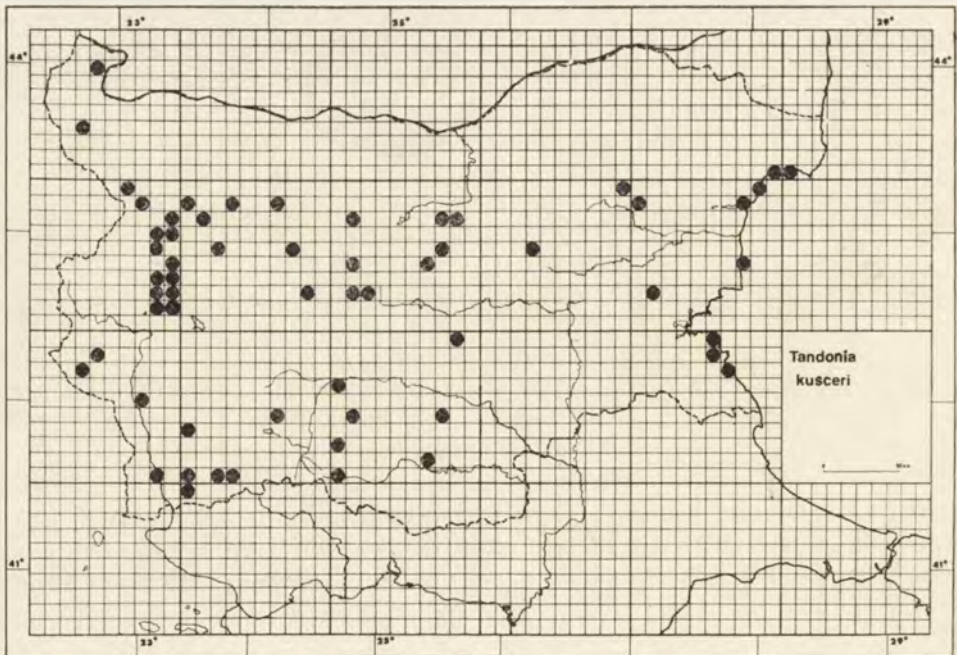
part cylindrical, slightly broadening. Slight constriction (with a narrow retractor inserted in it) can be regarded as its posterior limit. Epiphallus tubiform, slightly broadened mesally, coiled helically, communicating with membranous mesenterium by thick blood-vessel. This mesenterium was incorrectly interpreted by URBAŃSKI and WIKTOR (1968) as accessory retractor. Epiphallus

5–8 times of penis length. Vas deferens thin, as long as 1–1.5 of penis and epiphallus taken together. Oviductus straight, tubular, a little longer than penis. Spermatheca oval or spherical. Spermatheca duct equal to penis in diameter. Vagina very short, with numerous yellowish tubular accessory glands opening into it. Atrium very short, flattened, communicating along whole length with body integuments.

Radula. Its formula: C. 16–18. 37–40/×113.

Bionomics. Largely tolerant to most ecological factors. Met in biotopes of various humidity (including xerothermic ones). Most numerous in sites abundant with stones, bricks or logs. Met in forests, bushes and rock rubble with sparse vegetation. Sometimes found in large numbers on calcareous soils. Hiding under stones and logs. Reaching the altitude of 1250 m at Vitosha (OŠANOVA 1972). All known habitats below this altitude. Life history almost totally unknown. Mating specimens were photographed by OŠANOVA (1972) who also gave some information on the life of the species. She collected eggs in spring (8th April). Hatching takes 16–20 days under laboratory conditions. Eggs iridescent, oval, 4.5×4 mm in diameter. Several generations probably overlap, as suggested by the size differences in simultaneously occurring specimens.

Distribution. Known from Serbia, Bulgaria (numerous records), western Turkey and Rumanian Dobrudzha. Found also in Odessa, USSR, but probably introduced there (LIKHAREV and WIKTOR 1980).



Map 7. *Tandonia kusceri*

Material examined: 188 specimens.

Records (Map 7):

Stara Planina: Botevgrad leg. POPOV (MNH). Vratsa, Lakatnik on the Iskur, Teteven, Bulgarene near Lovech, Sokolski Monastir near Gabrovo leg. PINTÉR (HNHM), Cherni Osum near Troyan, Dryanovski Monastir near Dryanovo, Kalofer leg. WARCHAŁOWSKI (MNH), Kotel, Karlovo, Madara near Shumen (Kolarovgrad) leg. BEŠKOV (MNH), Shumen (Kolarovgrad) leg. BEŠKOV et STARĘGA (IZW), NW of Aitos on the Aitoska reka leg. SZIGETHY (HNHM). Also: WAGNER (1934a) — Shumen, Radomirsko, Rebrovo, Svoje, Iskur-Defilé (the Iskur gorge); WAGNER (1934b) — Lakatnik, Iskrets, Cherepiski Monastir, Turnovo, Preobrazhenski Monastir near Turnovo, Zlatna Panega, Polaten near Teteven, Kotel; OŠANOVA (1970) — Belogradchik, Barzija (Barzja), Klisura, Klisurski Monastir, Vratsa, Moravitsa, Buchino Prohod, Iskrets, Svoje, Lakatnik, Rebrovo.

Sofia: in greenhouses leg. POPOV (MNH); also WAGNER (1934a) — Sofia.

Vitosha: Boyanski Vodopad leg. OŠANOVA et PINTÉR (NHMH), Dragalevchi leg. TOTEV (MNH). Also: HUDEC (1964) — Boyana; OŠANOVA (1972) — Boyana, Zheleznitsa, Popovo, Dragalevchi, Simoenovo, Kladnitsa, Chupetlovo.

Sredna Gora: URBAŃSKI and WIKTOR (1968) — Stara Zagora, Starozagorski Bani.

Kresensko — SW Bulgaria leg. BURESCH (BAN).

Pirin: Rozhentsy near Melnik, Sandanski in the municipal park, Gostun near Bansko, Gotse Delchev.

Konyavska Planina: Konyovo. Also URBAŃSKI and WIKTOR (1968) — Dragamirovo.

Kyustendil — WAGNER (1934a), URBAŃSKI and WIKTOR (1968).

Rila: around Blagoevgrad.

Rodopi: Plovdiv, the mountain Bunardzhik, Ognianovo near Gotse Delchev, Kurdzhali, Smolyan, Bachkovski Monastir. Also: WAGNER (1934a) — ? Chepelare; URBAŃSKI and WIKTOR (1968) — Batak, Durken near Batak.

?Khaskovo — JURINIČ (1906).

The Danube Valley: URBAŃSKI and WIKTOR (1968) — Vidin.

The Black Sea coast: Kavarna leg. URBAŃSKI (coll. URBAŃSKI), Balchik, Monastir near Varna, Bakarlyk Hills near Burgas, Primorsko near Burgas. Also: WAGNER (1940) — Varna; HUDEC (1967b, 1965) — Zlatni Piasatsi, Obzor; URBAŃSKI and WIKTOR (1968) — Varna, Sv. Konstantin near Varna, Zlatni Piasatsi, Suzopol, Arkutino blato near Burgas.

Comments.

T. kusceri is similar to *T. serbica* (see comments under that species) and *T. rustica*. Unlike *kusceri*, *rustica* is characterized by its slightly more elongate body, with more obtuse posterior end; the white or dark creamy skin, with small, black spots; the elongate, apically narrowed spermatheca; the mesally broadened spermatheca duct; and the proportionally much shorter epiphallus (see illustrations in HUDEC 1963, WIKTOR 1973).

Tandonia serbica (WAGNER, 1931)

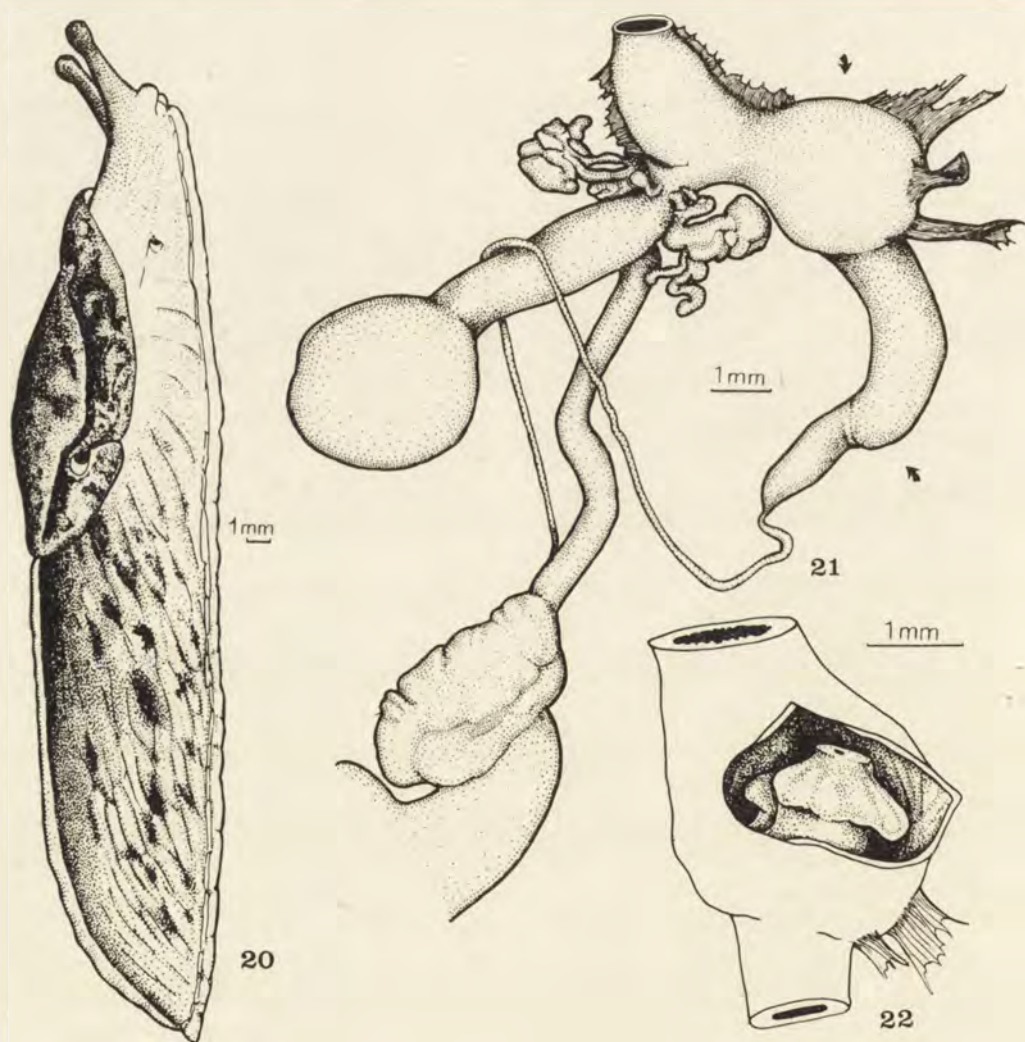
Milax (Milax) serbicus WAGNER, 1931a: 63. Locus typicus: Sveta Petka around Niš (Serbia, Yugoslavia).

Milax (Milax) serbicus WAGN.: URBAŃSKI and WIKTOR 1968: 82; OŠANOVA 1970: 77, 1972: 149.

References: DAMJANOV and LIKHAREV 1975: 329; WAGNER 1931a: 63; URBAŃSKI and WIKTOR 1968: 82 (description, illustrations); WIKTOR 1977: 292.

Body length up to 45 mm in preserved specimens. Individuals 30 mm long are mostly mature. Mantle about $\frac{1}{4}$ of body length. Keel attaining mantle hind-margin in living specimens but invisible posteriorly in some preserved (mostly improperly preserved) specimens; in such specimens it has about $\frac{2}{3}$ of dorsum length.

Colouration. Body brownish, mucky cream-coloured or pink-brown with blackish reticulate pattern, which is formed by pigment in skin-grooves. In most specimens the rear of the body with black spots about 2 mm in diameter, as if splashed with drawing ink (Fig. 20). Occasional spotless specimens resembling



Figs. 20-22. *Tandonia serbica* (WAGN.): 20 — side view, 21 — copulatory organs (specimen from Karlovo), 22 — papilla inside the penis (specimen from Shipka)

juveniles of *Tandonia kusceri*, distinguished only by internal structure (see comments below). Mantle with well-defined, horseshoe-like band, which is usually evanescent anteriorly, occasionally also with median band. Head and tentacles blackish. Sole mucky cream.

Slime hyaline.

Genitalia (Fig. 21). Characteristic of this species are: long penis, epiphallus about twice penis length, both parts separated by shallow constriction (to which penis retractor is attached). Penis oviform or clavate. Anterior part of penis and atrium attached to body wall by a thick membraneous muscle. General structure of genitalia similar as in *T. kusceri* but penis shorter, retractor wider, shorter, thicker as compared with epiphallus, papilla in penis of different type (Fig. 22). Vas deferens thin, long. Spermatheca duct thick. Spermatheca spherical or oval, frequently elongate or narrowed posteriorly. Oviductus tubiform, of varying length, 1–3 times penis length. Accessory glands forming two or more masses which consist of numerous ducts closely pressed together, opening into very short vagina. Atrium short, on the same axis as penis. Spermoviductus orange in most freshly preserved specimens.

Spermatophore with dermoid coppery-yellow cover, consisting of two parts: broad, strongly curled one and capillary, introducing spermatophore. Cover with dichotomously ramified hooks (URBAŃSKI and WIKTOR 1968, fig. 17).

Radula. Formula of teeth: C. 16–19. 38–41/ × 115.

Bionomics. Mainly in rock rubbles, especially limestone. Almost exclusively on dry slopes covered by bushes, up to about 1200 m a.s.l. in mountains. Specimens with spermatophores in spermatheca were collected in June and October. Life cycle almost unknown. It is not sure, if this species has two reproductory cycles or if copulations take place during the whole vegetation period.

Distribution. Known in Serbia and south-western Bulgaria. In Bulgaria: in the north from Prauzhda and Vratsanska Planina and further along Stara Planina to Shipka pass. Also Piryn, Rila and Rodopi at least to the Chaya Valley (Chepelarska reka).

Material examined: 137 specimens.

Records (Map 8):

Stara Planina: Vratsa, Lakatnik, Cherni Osum near Troyan, Rybaritsa near Teteven, Karlovo, (?) at Shipka pass (non-typical specimens). Also: URBAŃSKI and WIKTOR (1968) — Lakatnik, Cherni Osum; OŠANOVA (1970) — Prauzhda.

Vitosha: around Boyana and Boyanskie Ozera. Also: OŠANOVA (1972) — Duhlata.

Trun and the surroundings: leg. BEŠKOV and STAREGA (IZW); also URBAŃSKI and WIKTOR (1968) — Trun and Strazimirovtsi.

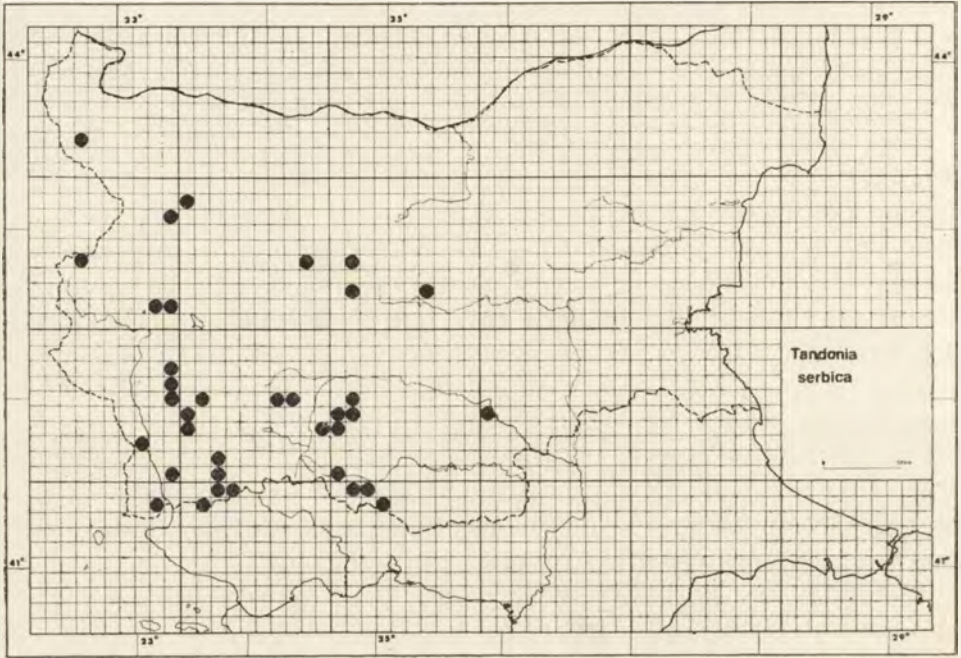
Maleshevska Planina: Berezmitsa near Sandanski leg. BEŠKOV and STAREGA (IZW).

Pirin: Gostun near Bansko leg. BEŠKOV and STAREGA (IZW), Goce Delchev, Koprivlen,

Brezmitsa near Goce Delchev, Liliyanovo near Sandanski.

Slavianka: Carev Vrukh leg. CONKHOV (BAN).

Petrici — URBAŃSKI and WIKTOR (1968).



Map 8. *Tandonia serbica*

Rila: around Yakoruda. Also URBAŃSKI and WIKTOR (1968) — Predel; DAMJANOV and LIKHAREV (1975) — Skakavitsa, Rilski Monastir.

Rodopi: around Peshtera on the Stara Reka river, Asenovgrad, Klubyata near Bachkovski Monastir, Hvoyna, Chudni Mostove (= Erkruprija), between Hvoyna and Chudni Mostove leg. PINTÉR (HNHM). Also: URBAŃSKI and WIKTOR (1968) — Durken near Peshtera, Asenova Krepost near Asenovgrad, Bachkovski Monastir, Narechenski Bani; DAMJANOV and LIKHAREV (1975) — Smolyan, Zlatograd, Madan.

Kharmnali — DAMJANOV and LIKHAREV (1975).

Comments.

T. serbica and *T. kusceri* are very similar and possibly are conspecific. They sometimes occur in the same habitats, although *kusceri* is less eurytopic and less widely distributed.

The most characteristic diagnostic feature of *serbica* is the presence of dark, blot-like spots in the postpallial body part. However, this feature occurs only in some specimens. Spotless individuals are almost identical externally with juvenile *kusceri*, but can be recognized by their inner organs. Penis of *serbica* is larger, oval, epiphallus is markedly shorter and retractor penis is broader than in *kusceri*. All these organs are very significant in size and shape, but intermediates have not been found. Proper identification is difficult without material for comparison and some experiences. Also penial papilla is different in both species, but the range of its variation is unknown.

The spermatophore was found in many *serbica*, but never in *kusceri*. This

fact suggests that the observed differences are actually the result of changes in the sexual cycle. Characters of most *serbica* are proper for the initial (male) phase of the sexual cycle.

***Tandonia budapestensis* (HAZAY, 1881)**

Amalia budapestensis HAZAY, 1881: 37. Locus typicus: Budapest.

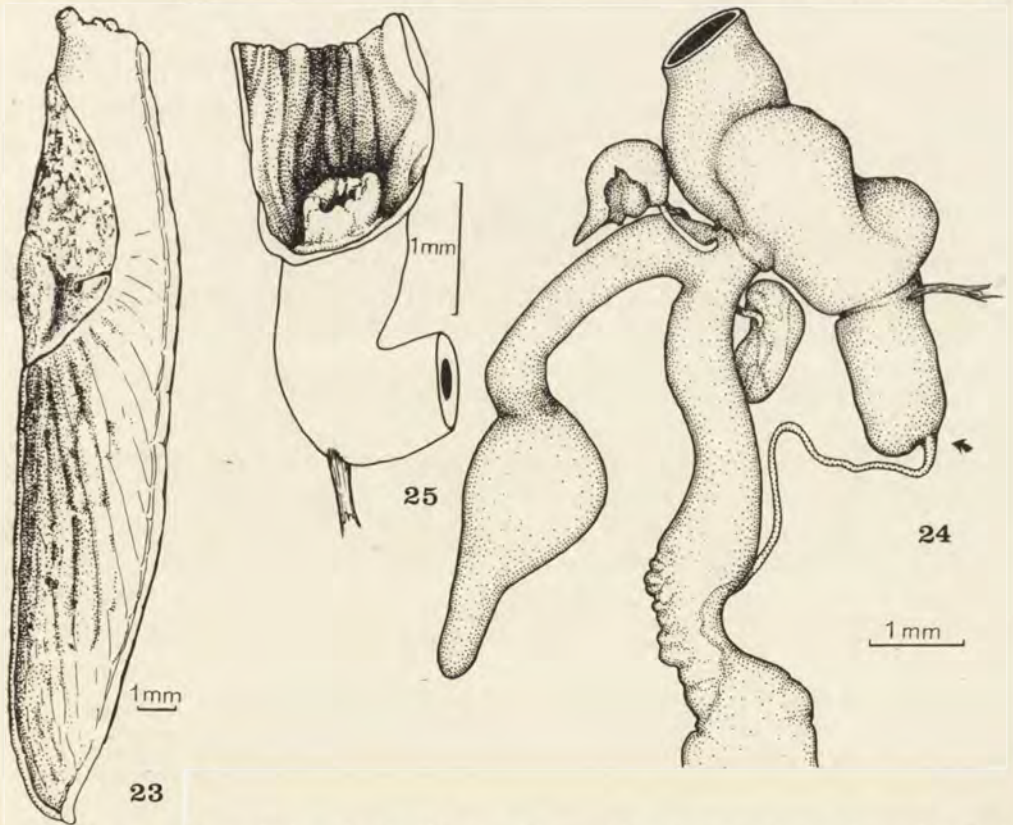
Limax gracilis LEYDIG, 1876: 276 (non *gracilis* RAFINESQUE, 1820).

Amalia Cibiniensis KIMAKOWICZ, 1884: 103. Terra typica: Transylvania.

Amalia gracilis LEYDIG: JURINIČ 1906: 10.

References: DAMJANOV and LIKHAREV 1975: 328; GERHARDT 1936a: 315 (copulation); HUDEC 1963: 149 (bibliography, illustrations); QUICK 1960: 160 (bibliography); LIKHAREV and WIKTOR 1980: 376; WIKTOR 1973: 54 (bibliography, illustrations), 1977: 292.

Body length 60–70 mm in crawling, 30–40 mm in preserved specimens. Mantle covering less than $\frac{1}{3}$ of body length. Body slender, gradually narrowing posteriorly. Keel prominent, attaining mantle hindmargin. Sole narrow.



Figs. 23–25. *Tandonia budapestensis* (HAZ.): 23 — side view (specimen from Vitosha), 24 — copulatory organs (specimen from Vitosha), 25 — papilla inside the penis (specimen from Bucharest)

Colouration. Black-brown, at first sight almost unicolour, yet with numerous small blackish spots on mucky cream or mucky orange background (Fig. 23). Dorsum and mantle slightly darker than sides. Mantle sides with indistinct black bands. Keel and lower parts of sides without black pigment. Head and neck blackish. Sole brown-cream or orange-cream. Body ash-grey-brown or blackish in preserved specimens, without yellowish-orange hue between spots.

Slime very dense, sticky, hyaline, yellowish in irritated specimens.

Genitalia (Fig. 24). Asymmetrical junction of vas deferens and epiphallus is distinctive. Vas deferens opening apically but not medially. Epiphallus cylindrical or claviform, about twice penis length. Penis rounded. Both epiphallus and penis forming one straight line due to lack of any bend at their junction. Penial papilla small (see Fig. 25). Musculus retractor penis attached laterally between epiphallus and penis. Oviductus tubiform. Vagina very short, its accessory glands forming two bundles close to its walls. Spermatheca duct broad, of varying length, as long as spermatheca or much shorter. Spermatheca of varying shape, usually oval, sometimes narrowed posteriorly (Fig. 24), never tapered apically. Atrium short, tubular.

Spermatophore (see QUICK 1960; GROSSU 1961; HUDEC 1963) thin, smooth on about $\frac{1}{4}$ of its length, remainder gradually broadening, covered with bifurcated spines; spines forming two rows (on one side only) near thin part, arranged in four rows on broad part.

Formula of radula: C. 6-13. 2-4. 8-15/ \times 94.

Bionomics. Largely tolerant to most ecological factors, especially as a synanthrope. Met most frequently among shrubs, sometimes in forests, ruins, rock rubble, composts, dumping grounds, parks, and cultivated gardens. Sometimes found in poorly shaded or even insolated biotopes. Hiding under stones and clods of earth. Sometimes a pest on crops. In Bulgaria up to about 1500 m.

Distribution. As a synanthrope it spread over a large part of Europe. Most probably it originally inhabited southern subalpine regions and northern Balkans, eastwards to Austria, Hungary and Rumania (Transylvania) as suggested by its ecological requirements and occurrence in biotopes not changed by man. Introduced into Czechoslovakia, Poland, Belgium, Great Britain and Ireland, Iceland, Turkey and the Hebrides. Isolated habitats in south-west Bulgaria.

Material examined: 26 specimens.

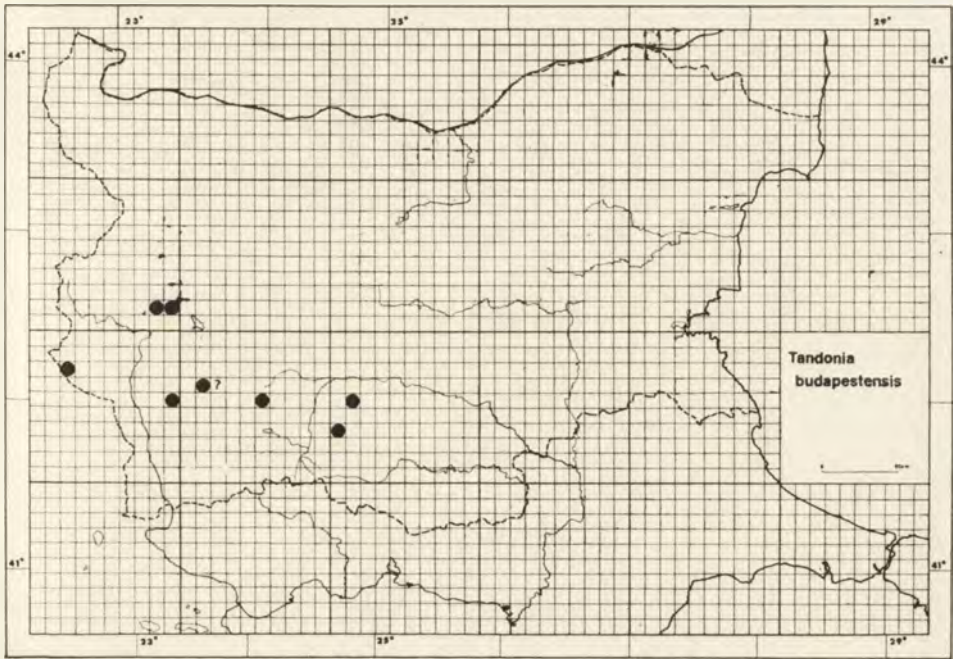
Records (Map 9):

Vitoshka: Zlatni Mostove; also OŠANOVA (1972) — around Boyana and Zheleznitsa.

Osogovska Planina: Osogovo.

Rila: valley of the Bistritsa River near the Parangalitsa nature reserve. Also: JURINIČ (1906) — Carev Vurkh.

Rodopi (URBAŃSKI and WIKTOR 1968): Lepenitsa near Velingrad, Asenovgrad, Hvoyna.

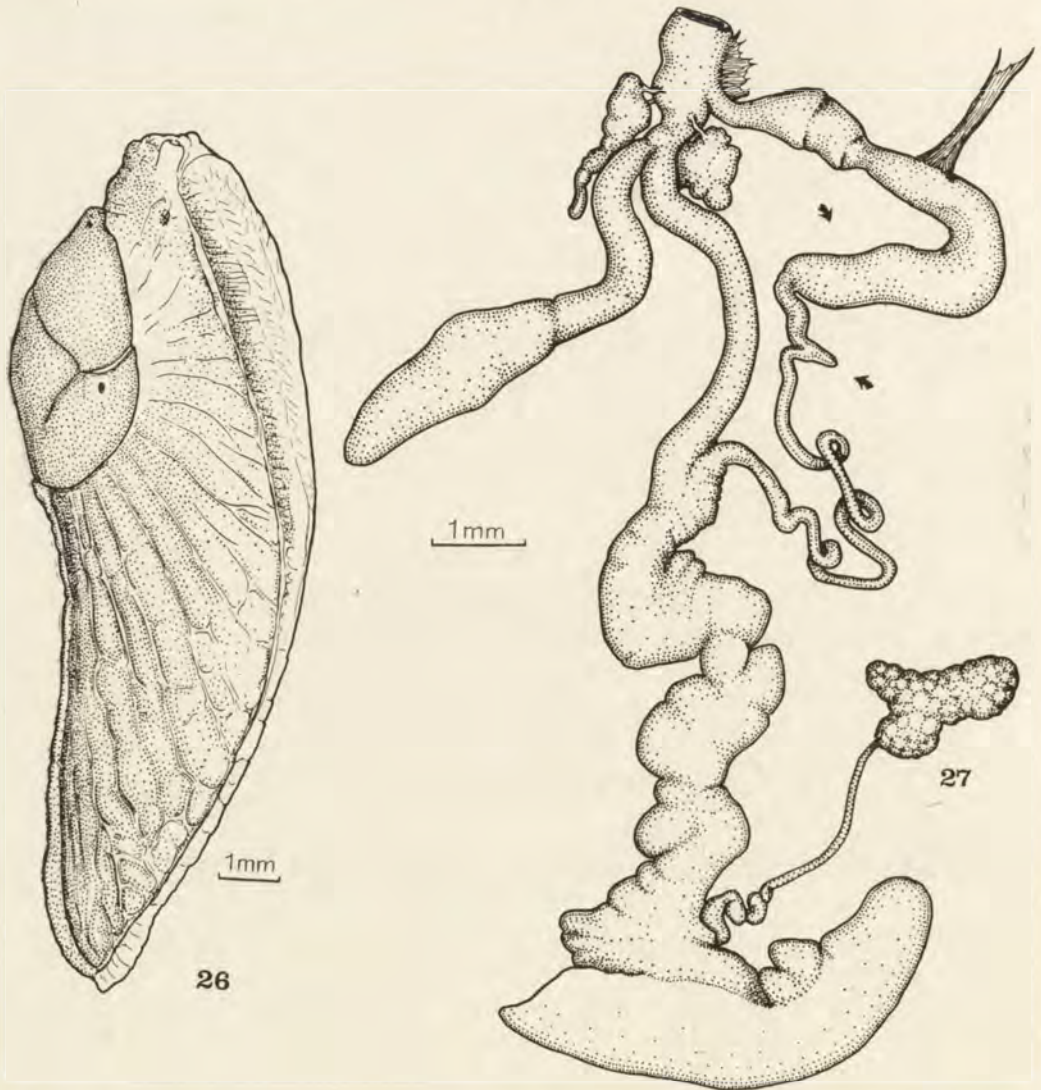
Map 9. *Tandonia budapestensis****Tandonia piriniana* n. sp.**

Diagnosis. The presence of an appendix at the junction of vas deferens and epiphallus distinguishes this species from all other *Tandonia*. Externally, especially when preserved, *T. piriniana* resembles *T. cristata* (KALENICZENKO, 1851), *T. kaleniczenkoi* (CLESSIN, 1883), and *T. schleschi* (WAGNER, 1930) but the elongate penis (Figs. 27–28) and the absence of constriction between penis and epiphallus are distinctive. Contrary to *T. kaleniczenkoi* it lacks a barrel-shaped atrium. *T. strandi* (WAGNER, 1934) has similar genitalia, but it is much larger (body length to 61 mm) and differently coloured.

Body slender. Specimens preserved in alcohol up to 20 mm long, 4 mm wide. Mantle up to 6 mm long. Dimensions of holotype: 15 mm long, 3.5 mm wide, mantle 5 mm long. Keel well-defined, attaining mantle hindmargin (Fig. 26). Integument finely sculptured but grooves shallow, between median line and spiraculum: 13 grooves in holotype and 12 in some of the paratypes.

Living specimens dark green, almost black, preserved more or less uniformly blackish, with darker skin grooves and a semicircular groove on mantle. Keel cream-coloured. Sole blackish laterally, creamy medially.

Genitalia (Figs. 27–29). Glandula hermaphroditica whitish, entirely hidden under liver lobes. Ductus hermaphroditicus short. Vas deferens twisted,

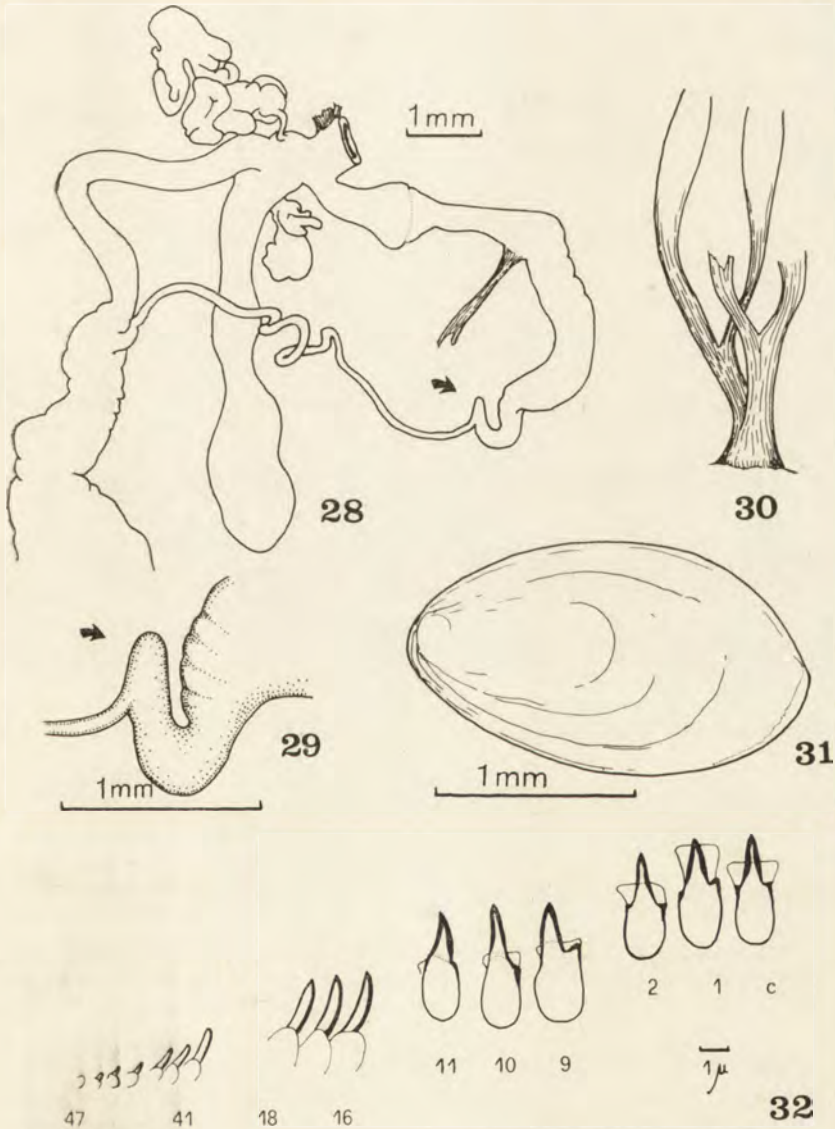


Figs. 26-27. *Tandonia piriniana* n. sp.: 26 — side view (holotype), 27 — genitalia of the holotype

thick. All specimens with a pocket-like appendix between vas deferens and epiphallus (Fig. 29), as if fused loop of vas deferens, probably functioning as a gland. Epiphallus elongatedly conical with apex directed posteriorly, at its junction with appendix as wide as vas deferens. Penis narrowest at junction with atrium, also with narrowing anterior part (where a small papilla is situated) but no tapering on musculus retractor insertion. Oviductus tubiform, without swellings. Spermatheca elongate, tapering apically. Spermatheca duct broad,

tubular. Spermatheca with its duct equal in length to penis with epiphallus. Vagina short, spherically swollen anteriorly. Atrium broad, flattened.

Musculus columellaris bifurcating directly at its base, i.e. at its posterior insertion (Fig. 30).



Figs. 28–32. *Tandonia piriniana* n. sp.: 28 — diagram of the genitalia of one of the paratypes (from Rozhentsy), 29 — appendix on the verge of vas deferens and epiphallus, 30 — musculus columellaris, 31 — shell of the paratype, 32 — teeth of the paratype radula (specimen from Rozhentsy)

Formula of radula almost as in *Tandonia cristata*: C. 10. 37/ × 94 (paratype from Rozhentsy) but cusps narrower (Fig. 32).

Shell (Fig. 31) distinctly flattened, longitudinally oval with poorly differentiated growth lines.

Digestive system: Fig. 33.

Bionomics. The collected specimens were found under stones among thick shrubs.

Distribution. Known only from southern Pirin foothills at the altitude of about 500 m.

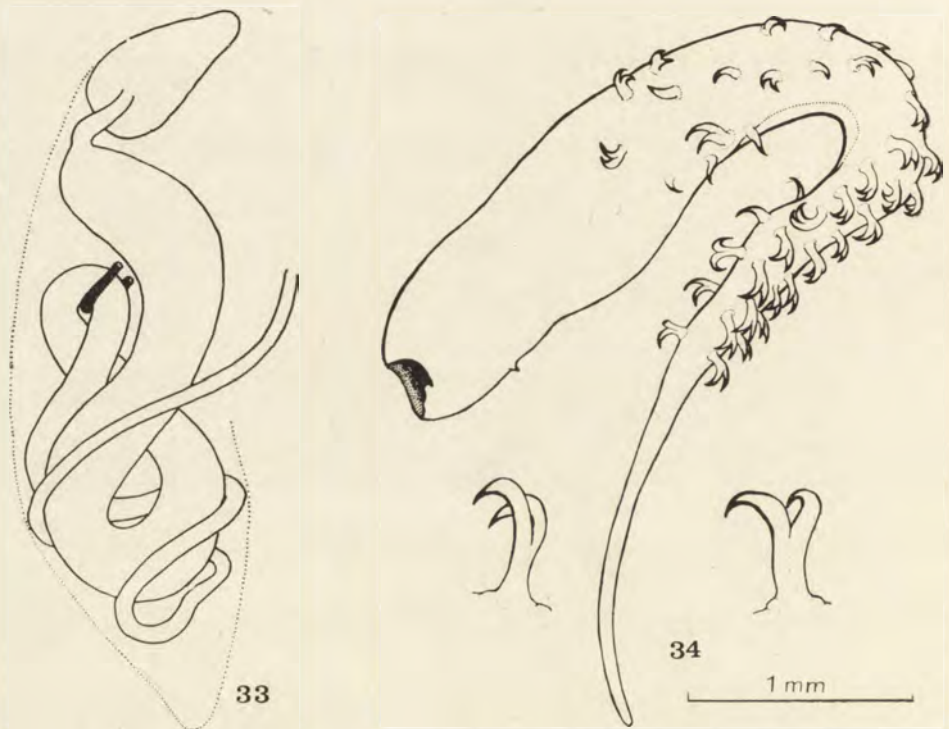


Fig. 33. *Tandonia piriniana* n. sp. — alimentary tract (specimen from Koprivlen).
 Fig. 34. *Tandonia cristata* (KAL.) — spermatophore and one of the hooks on its surface, in a larger scale (specimen from Ropotamo)

Material examined (Map 11):

Holotypus: Koprivlen south of Gotse Delchev (Pirin foothills — south-western Bulgaria). Moderately humid hornbeam-beech brushwood at valley bottom stream. Leg. A. WIKTOR 25 V 1967, MNH No. 468.

Paratypes: the same data as holotypus: MNH; 1 + 2 juv. — Koprivlen near Gotse Delchev, a dry slope with hornbeam bushes, marble, leg. A. WIKTOR 25 V 1967 (MNH); 1 + 2 juv. — Rozhentsy (Rozheny) near Melnik (S-Pirin, Bulgaria), leg. A. WIKTOR 2 VI 1967 (MNH).

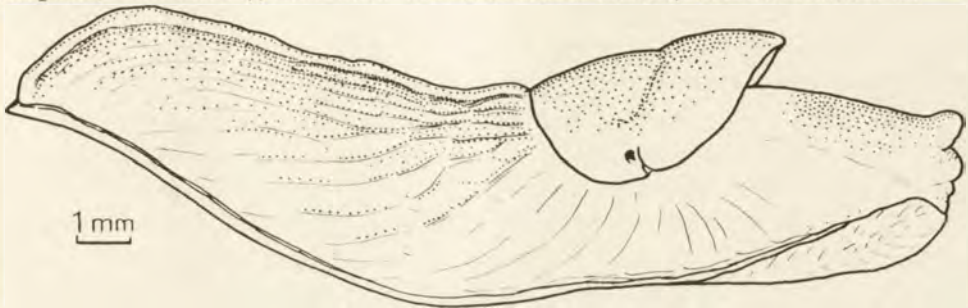
Tandonia cristata (KALENICZENKO, 1851)

Krynickillus cristatus KALENICZENKO, 1851a: 225. Locus typicus: Otuz — Crimea. (non *Limax cristatus* LEIBLEIN, 1829).

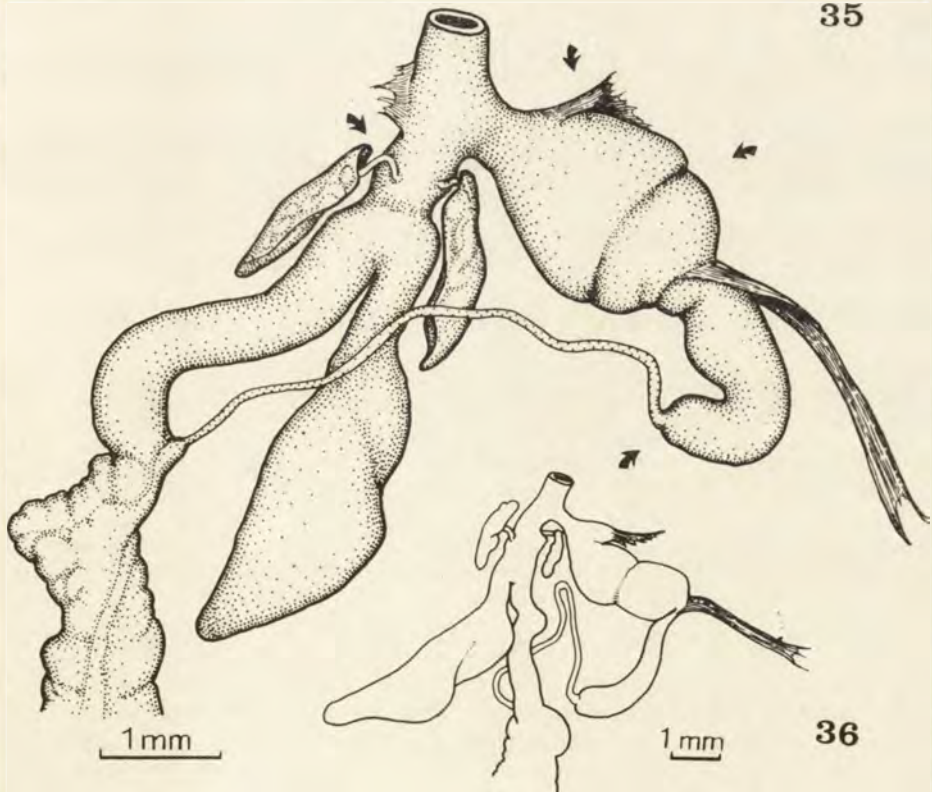
? *Amalia pallidula* COCKERELL, 1890: 286.

Milax (Milax) cristatus nanus GROSSU et LUPU, 1961: 141. Locus typicus: Cocos Monastery (E-Rumania). Holotypus: Mus. Gr. Antipa, Bucharest; URBAŃSKI and WIKTOR 1968: 80.

References: DAMJANOV and LIKHAREV 1975: 333; GROSSU and LUPU 1961: 141 (description, illustrations); LIKHAREV and WIKTOR 1980: 365; WIKTOR 1977: 292.



35



36

Figs. 35-36. *Tandonia cristata* (KAL.): 35 — side view (specimen from Smolyan), 36 — copulatory organs (specimen from Cherni Osum)

Body length up to 30 mm in living specimens. The largest preserved Bulgarian specimen is 25 mm long, 6 mm wide, mantle 6 mm long. Body slender, slightly narrowing posteriorly. Keel well-defined, prominent. Integument finely sculptured, forming a reticulate pattern. Usually 8 or 9 grooves between keel and pneumostome, sometimes 11.

Colouration. Living specimens ash-grey-greenish or ash-grey-yellowish with darker dorsum and mantle. Preserved specimens pale ash-grey or bluish-ash-grey, skin grooves becoming darker than the background (Fig. 35). Head and tentacles blackish. Sole cream-coloured.

Slime hyaline or slightly yellowish, dense.

Genitalia (Fig. 36). Vas deferens and epiphallus well delimited. The whole vas deferens thin, opening into epiphallus apicomediaally. Epiphallus usually shorter than or equal to penis, claviform, broadening posteriorly, conical or barrel-shaped when contracted, sometimes slightly hooked. Junction of epiphallus with penis as a distinct constriction where retractor is inserted. Penis slightly constricted medially and tapering anteriorly, its anterior part longer than the posterior one. A membranous retentor keeping penis close to body walls at junction with atrium. Penis with small, rounded papilla inside (Fig. 37). Oviductus tubiform, broad, broadening at junction with spermatheca

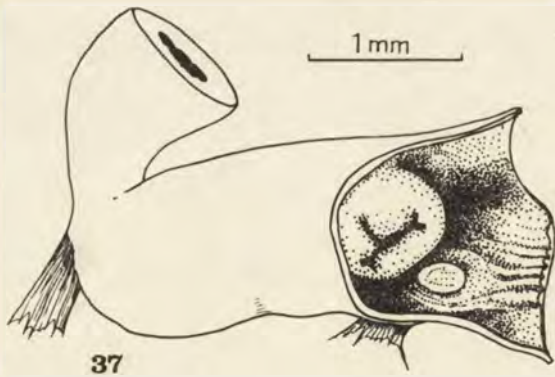


Fig. 37. *Tandonia cristata* (KAL.) — papilla inside the penis (after LIKHAREV and WIKTOR 1980)

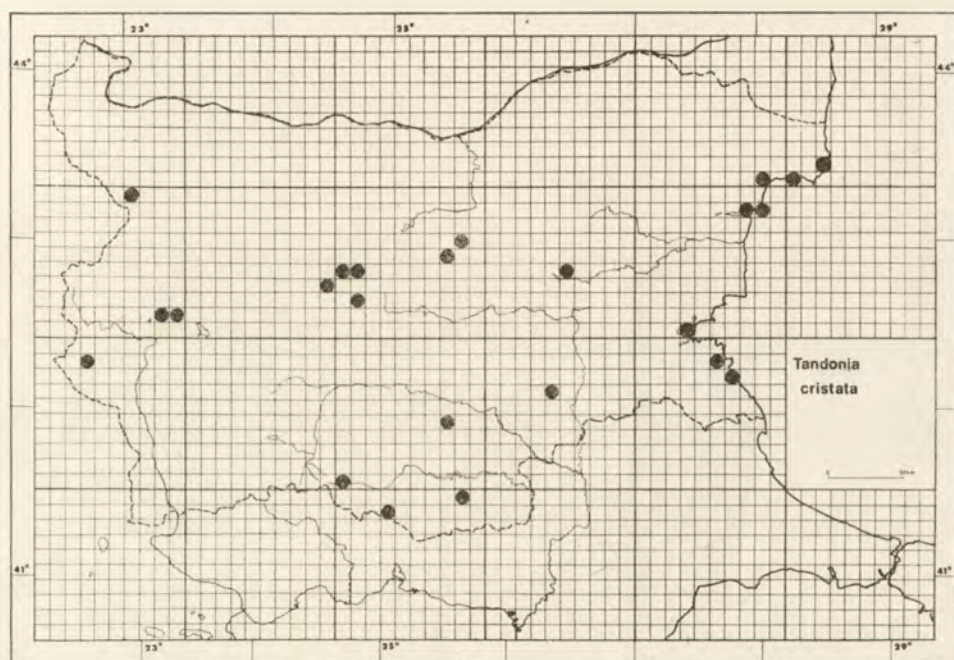
duct. Vagina short, distinct, with two white accessory glands opening into it by two ducts. Spermatheca variously shaped, in juveniles elongate, indistinctly delimited from spermatheca duct (see URBAŃSKI and WIKTOR 1968, Fig. 14), in adults broadening anteriorly when filled, but with posterior end narrow. Spermatheca short, tubular, twice as long as spermatheca duct.

Spermatophore (Fig. 34) not yet described. A well preserved spermatophore was found in a specimen collected on October 29. It was placed in the spermatheca and twice folded (not coiled spirally). Its sheath was light yellowish (golden-hued), irradient. Surface with two strong double hooks.

Formula of radula: C. 9. 38/ × 101 (teeth — see URBAŃSKI and WIKTOR 1968, Fig. 15).

Bionomics. Hiding under big stones deep in soil. Met mostly in mixed and deciduous forests, also among shrubs. Found most frequently in loamy soils, lower parts of valleys and their bottoms. Recorded from non-forest biotopes, e.g. gardens. Up to 1500 m in mountains.

Distribution. Southern Ukraine (Odessa, Uzhorod, Crimea), Rumanian Dobruzha (= Dobruja), Bulgaria, northern Turkey.



Map 10. *Tandonia cristata*

Material examined: 41 specimens.

Records (Map 10):

Stara Planina: valley around Karlovo city, Cherni Osum and Beli Osum near Troyan, around Dryanovo Monastir near Dryanovo, Zheravna near Kotel. Also: URBAŃSKI and WIKTOR (1968) — Berkovitsa and Turnovo.

Kyustendil: — DAMJANOV and LIKHAREV (1975).

Vitoshka: around Boyana and Boyanske Ozera. Also: DAMJANOV and LIKHAREV (1975) — Pancharovo, Simeonovo, Zlatne Mostove.

Rodopi: Smolyan. Also: DAMJANOV and LIKHAREV (1975) — Zlatograd, Krumovgrad.

Khaskovo: URBAŃSKI and WIKTOR (1968) — Khaskovski mineralni bani.

Sakar Planina: URBAŃSKI and WIKTOR (1968) — Topolovgrad.

The Black Sea coast: Kavarna leg. and coll. J. URBAŃSKI, Batova near Balchik, Aladzha

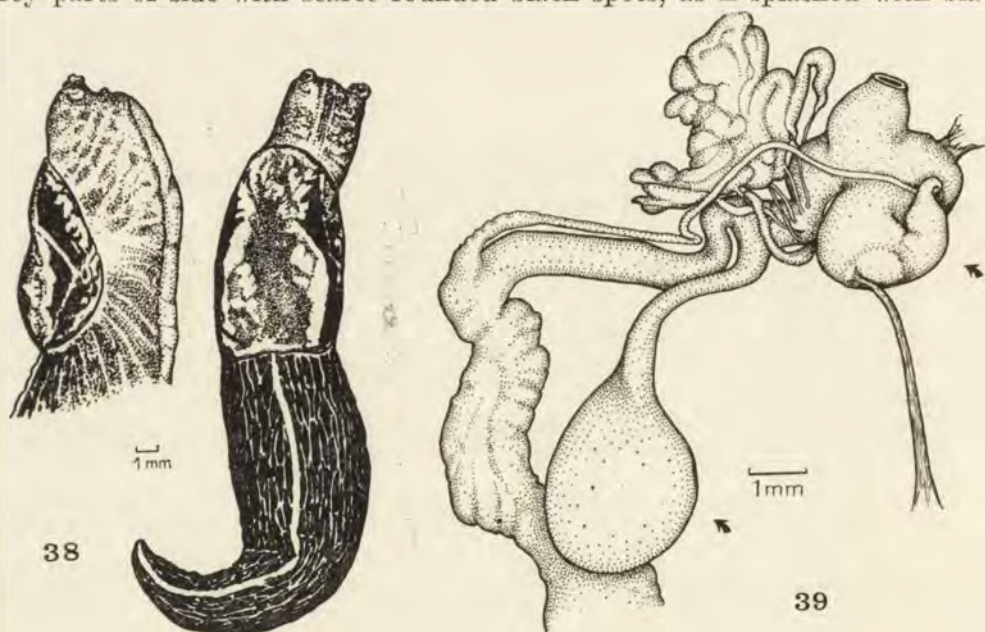
Monastir near Varna, Bakarlyk Heights near Burgas. Arkutino on Ropotamo, Rusal-ka — Tank Liman leg. and coll. J. URBAŃSKI. Also: URBAŃSKI and WIKTOR (1968) — Zlatni Piasatsi and DAMJANOV and LIKHAREV (1975) — Ropotamo and Burgas.

Tandonia pinteri (WIKTOR, 1975)

Milax pinteri WIKTOR, 1975: 77. Locus typicus: Cudni Mostove (= Chudni Mostove), Rodopi (Bulgaria). Holotypus: MNH No. 458.

Body length in preserved adults usually 30–35 mm (observed maximum 52 mm), width 7–8 mm. Mantle 10–12 mm long. Integument finely grooved, shallow.

Colouration (Fig. 38). Dorsum almost black, side getting lighter downwards, grey parts of side with scarce rounded black spots, as if splashed with black



Figs. 38–39. *Tandonia pinteri* (WIKTOR): 38 — side and top view, 39 — copulatory organs (after WIKTOR 1975)

pigment. Mantle with complicated pattern and irregular lateral bands, their lower edges jagged, forming a system of detached spots. Upper bands with edges irregular but continuous, well differentiated from mucky cream semicircular band near mantle groove. Mantle blackish or ash-grey medially, with indistinct dark (but not black) spots. Head and neck blackish, sole mucky cream.

Genitalia (Fig. 39). Vas deferens long, thin. Epiphallus small, conical, hooked anteriorly. Penis big as compared to epiphallus, irregularly spherical, indistinctly delimited from broad atrium. Penis with a big, elongated papilla

inside (Fig. 40). Spermatheca oval, broadening posteriorly. Spermatheca duct usually thin, longer than spermatheca. Combined length of spermatheca and its duct 1–3 times combined length of penis and epiphallus. Free oviductus tubular, equal in length to penis and epiphallus together. Vagina short, a little shorter than oviductus. Accessory glands cream-coloured, consisting of compact tube-like structures, opening into vagina by several thin ducts.



Fig. 40. *Tandonia pinteri* (WIKTOR) — papilla inside the penis (specimen from Deven)

Formula of radula: C. 15.36/×137.

Bionomics unknown. Met in moist and well shaded sites. Collected up to 1500 m in mountains.

Distribution: known only from Bulgaria.

Material examined: 35 specimens: holotype and 34 paratypes.

Records (Map 11):

Rodopi: Chudni Mostove (Erkrupria = Erkruprya), Smolyan, Deven.

Tandonia sowerbii (FÉRUSAC, 1823)

Limax Sowerbii FÉRUSAC, 1823: 96. Locus typicus: London. Usually, but incorrectly spelled "sowerbyi".

Limax carinatus RISSO, 1826: 56.

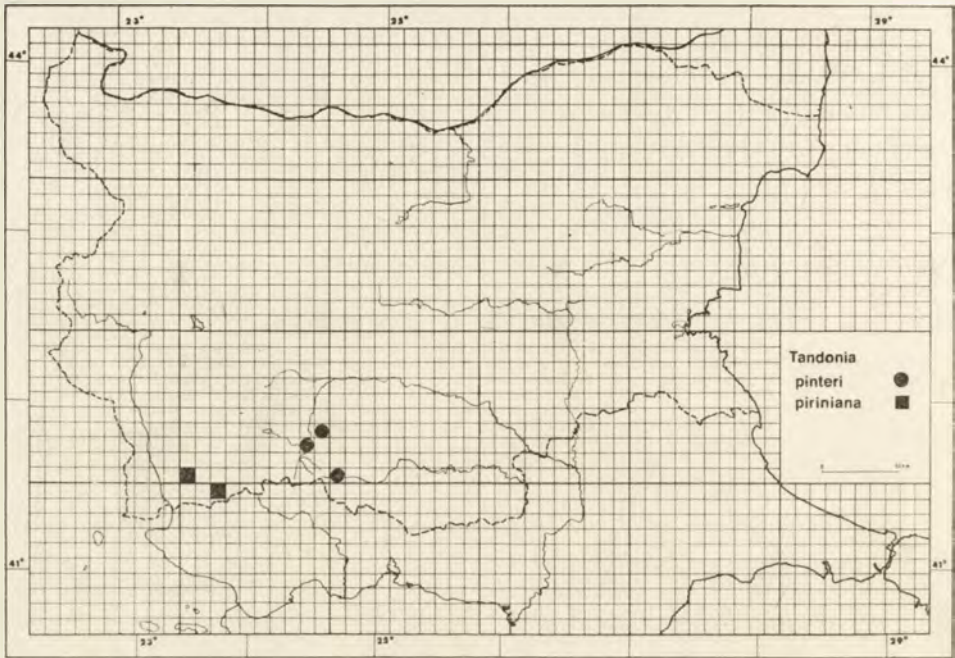
?*Amalia (Tandonia) hessei* BTG.: BABOR 1898: 40.

?*Amalia (Tandonia) carinata* LEACH: BABOR 1898: 40.

Milax collingei HESSE, 1926: 111 (see QUICK 1960: 158).

?*Milax (Milax) Sowerbyi* FÉR. subsp. *Hessei* BTG.: WAGNER 1931a: 60.

References: QUICK 1960: 158 (survey, illustrations).



Map 11. *Tandonia pinteri* and *Tandonia piriniana*

This species probably does not occur in Bulgaria. It was recorded from Sliven by BABOR 1898 (as *Amalia hessei* BTG.), and WAGNER 1931a (as *Milax sowerbyi* ssp. *Hessei* BTG.), but the specimens probably were *T. kusceri* which is common in Sliven area and which externally resembles *T. sowerbii*. Also specimens recorded by BABOR 1898 as *Amalia carinata* LEACH from Sliven probably were *T. kusceri*.

Unlike *T. kusceri*, the dorsum of *T. sowerbii* is compressed laterally roof-like. Keel protruding, forming a sharp ledge. Body densely spotted but not reticulate. Epiphallus short, cylindrical, asymmetrically connected with vas deferens. Spermatheca elongated, cylindrical.

Distribution: Greece, Italy, France, Belgium, Holland, Spain, British Isles.

Tandonia rustica (MILLET, 1843)

Limax rusticus MILLET, 1843: 1. Locus typicus and type unknown.

Amalia marginata DRAP.: JURINIČ 1906: 10

Milax (Milax) marginatus DRAP.: WAGNER 1934a: 57.

References: HUDEC 1963: 149; LIKHAREV and WIKTOR 1980: 372; WIKTOR 1973: 51.

Probably not occurring in Bulgaria. Recorded by JURINIČ (1906) from Chepelare (Rodopi), Charen Vruh (Rila) and "Aku-Bunarskit" near Khaskovo, but these records probably refer to *T. kusceri*. The latter species was unknown to JURINIČ (it was described in 1931) and externally it is very similar

to *T. rustica*. WAGNER (1934a) recorded it from Chepelare (as *Milax marginatus*), but the figure he refers to (his Abbildung 10) clearly indicates the genitalia of *T. kusceri*.

See comments on *Tandonia kusceri* (p. 105).



Fig. 41. *Tandonia totevi* (WIKTOR) — external appearance (after WIKTOR 1975)

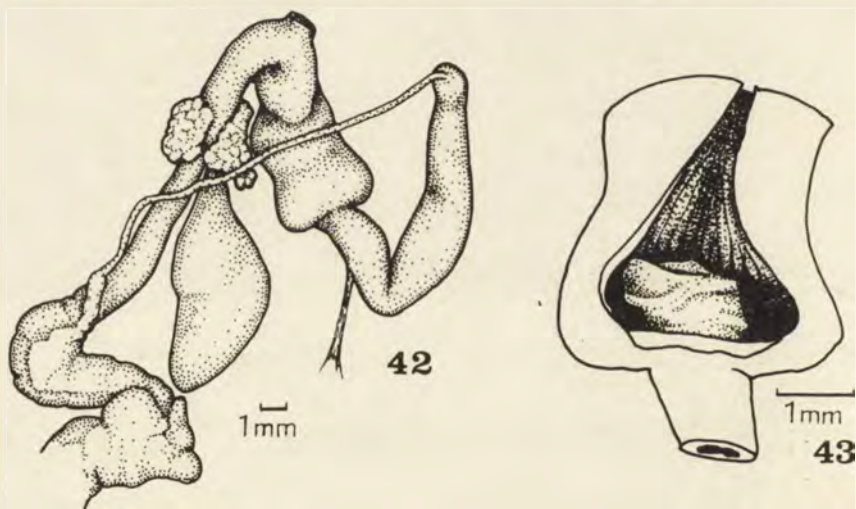
Tandonia totevi (WIKTOR, 1975)

Milax (Subamalia) totevi WIKTOR, 1975: 82. Locus typicus: Deven, Rodopi (Bulgaria).
Holotypus: MNH No. 459.

Body length in preserved adults above 70 mm, mantle length 24 mm, body width approximately 15 mm. Body elongate, as in big *Limax*, especially *L. flavus* (see p. 144). Keel scarcely sculptured, about 1 cm long. Skin grooves small, poorly differentiated; up to 21 grooves between pneumostome and median line of dorsum. Mantle groove also ill-defined.

Colouration (Fig. 41). Dorsum and mantle blackish-olive, with lighter olive-green or mucky-cream spots. Body sides resembling the above mentioned spots in colour, lacking dark pigment (especially anteriorly). Dorsum at middle with light stripe which attains keel.

Genitalia (Fig. 42). Epiphallus tubular, bent and folded over forward. Penis big, reel-like anteriorly, one side with wall-swelling. Retractor penis very thin. Penial papilla — see Fig. 43. Spermatheca elongated, as if directly



Figs. 42–43. *Tandonia totevi* (WIKTOR): 42 — copulatory organs, 43 — papilla inside the penis (holotype)

opening into oviductus because of spermatheca duct being poorly differentiated. Oviductus tubular, slightly thinner than epiphallus. Vagina of the same diameter as oviductus. Accessory glands pressed together, sticking to oviductus. Atrium short, hardly visible.

Formula of radula: C. 17. 49/ × 156.

Bionomics unknown.

Distribution: known only from the type locality where it occurs as a synanthrope in ruderal habitats (Map 6).

Limacoidea RAFINESQUE, 1815

Slugs. Shell entirely hidden in a closed cavity inside the mantle. It has the shape of an asymmetrical plate with lines of increment. The embryonic part of the shell is situated a little to the left of the long axis. Body rear pointed, frequently a keel on the back. The sole divided in three elongated zones. Kidney surrounds falcatedly the heart on its right, partly on its back. Secondary ureter separated from kidney, set apart. Urinary bladder occurs. In female part of genitalia and atrium no accessory organs, no epiphallus. However, on and inside the penis accessory organs of various kinds may occur. Jaw oxygnathic. Marginal teeth of radula dagger-like and sword-like. *Limacidae*, *Agriolimacidae* and *Boettgerillidae* (over 250 species in all) belong here.

Limacidae RAFINESQUE, 1815

References: DAMJANOV and LIKHAREV 1975: 300; HESSE 1926: 8 (*Limacinae*); JUNGELUTH, LIKHAREV, WIKTOR 1981: 15; LIKHAREV and WIKTOR 1980: 219; PILSBRY 1948: 521; QUICK 1960: 163; RAFINESQUE 1815: 141; WAGNER 1934: 7, 1936: 88; WIKTOR 1973: 63; WIKTOR and LIKHAREV 1980: 423.

This taxon was previously considered as a subfamily, but LIKHAREV and WIKTOR (1980), WIKTOR and LIKHAREV (1979, 1980) proved that it should be given the family rank.

Slugs big, 45–200 mm long. Body much elongated, tapering posteriorly. Mantle less than half of body length (usually less than $\frac{1}{3}$), situated in anterior part of body. Mantle surface with concentric grooves (visible only in living specimens) but without grooves or circle around pneumostome. The latter usually postmedian, exceptionally antemedian. Keel varying in length, sometimes reaching mantle hindmargin. 12–27 elongate grooves present between midline and pneumostome. Sole divided into 3 longitudinal zones, with transverse grooves.

Colouration variable; unicoloured, striped or spotted.

Slime hyaline or yellowish, watery.

Shell strongly flattened, thin, asymmetrical. Embryonic part shifted posteriorly and to the left of longitudinal axis.

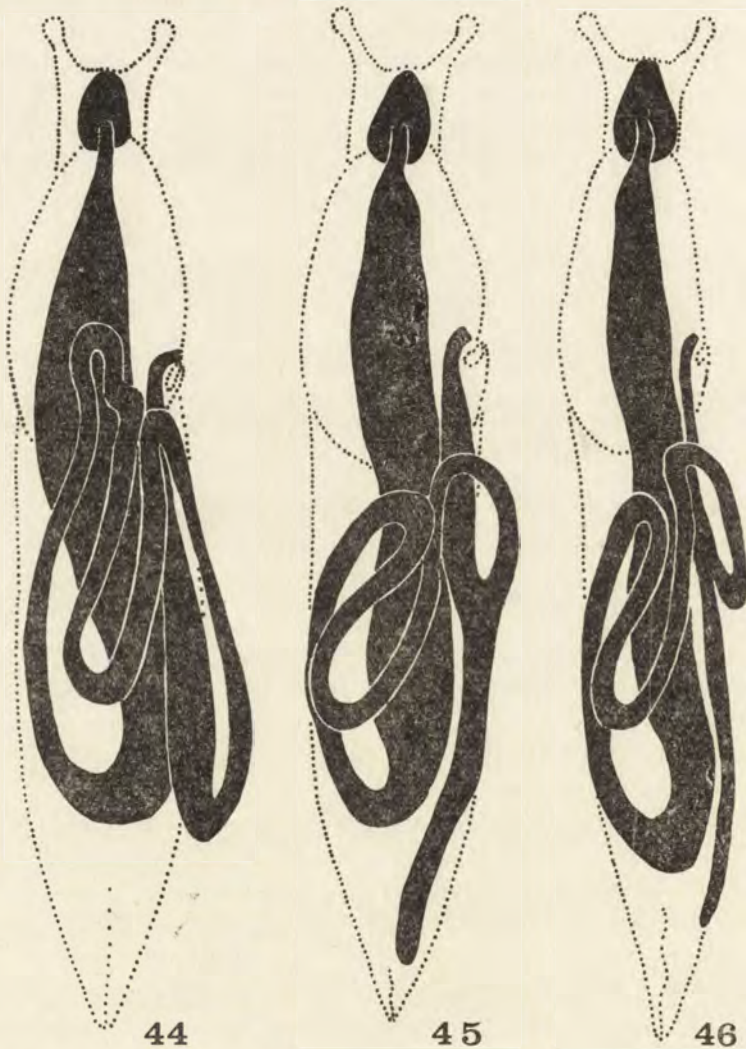
Genitalia. Oviductus and atrium without accessory glands. Stimulator and epiphallus absent. Some species with penial gland or appendix in posterior part of penis. Penis well-developed (except *Bielzia*). Musculus retractor penis almost always crossing right ommatophore or its retractor.

Eggs with soft areola (sheath).

Jaw oxygnathic. Central and lateral teeth of radula tricuspid. Adaxial marginal teeth sometimes dagger-like (i.e. smooth-edged), externally with two or more cusps. Most species with 3 intestinal loops, the first loop being the

longest. Coecum, if present, connected with the third loop (Figs. 44–46), thus lying behind musculus columellaris.

Distribution. North Africa, Europe, the Caucasus, Central Asia and Asia Minor.



Figs. 44–46. Diagrams of alimentary systems: 44 — *Limax* s. str., 45 — *Limacus*, 46 — *Lehmannia*

Included genera: *Limax*, *Lehmannia*, *Bielzia*, *Malacolimax*, *Gigantomilax*, *Caspilimax*, *Caucasolimax*, *Turcomilax*, *Eumilax* and *Metalimax*. 100 species together.

Genus *Limax* LINNAEUS, 1758

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

Synonyms: *Limacella* BRARD, 1815 (non BLAINVILLE); *Eulimax* MOQUIN-TANDON, 1855. — Bibliography in HESSE (1926).

References: HESSE 1926: 8; LIKHAREV and RAMMELMEIER 1952: 308; DAMJANOV and LIKHAREV 1975: 301; QUICK 1960: 180; PILSBRY 1948: 523; WIKTOR 1973: 64; LIKHAREV and WIKTOR 1980: 273.

Length variable. Pneumostome postmedial. Keel always well-developed, but sometimes very short.

Colouration variable. Body often striped and spotted.

Slime thin.

Genitalia. Penis elongate, seldom spherical-clavate, crossing right ommatophore or its retractor. Penis with longitudinal folds inside. Retractor penis inserted apically or laterally. Vas deferens opening into penis apically or subapically and laterally. In the latter case the portion of penis forms a coecum.

Jaw with median projection. Marginal teeth of radula dagger-like or with two or more cusps. Intestine forming 3 loops, the second one usually the shortest. Kidney heart-shaped, rhomboidal or rectangular. Life-span 1 or 2 years. Mainly in forests.

Distribution. Most species are broadly Mediterranean; North Africa to eastern Europe and Asia Minor.

About 90 species in 8 subgenera.

Subgenus *Limax* s. str.

Heynemannia MALM, 1868: 54. Typus: *Limax maximus* LINNAEUS, 1758.

Gastroa PINI, 1876: 21 (sectio). Typus: *Limax maximus* LINNAEUS, 1758 (present designation).

Chromolimax PINI, 1876: 25 (sectio). Typus: *Limax cinereoniger* WOLF, 1803 (present designation).

Opilolimax PINI, 1876: 30 (sectio). Typus: *Limax punctulatus* SORDELLI, 1870 (present designation).

Stabillea PINI, 1876: 35 (sectio). Typus: *Limax psarus* BOURGUIGNAT, 1862 (present designation).

Macroheyemannia SIMROTH, 1891: 303. Typus: *Limax maximus* LINNAEUS, 1758 (present designation).

Body length usually over 100 mm. Keel covering a considerable part of dorsum in some species, while very short in others.

Colouration various and variable within individual species, body often striped, with ill-defined bands, or spotted. Keel usually lighter in colour. Sole unicolour, sometimes whitish in the middle and pigmented laterally.

Penis cylindrical, long. Spermatheca small as compared to other organs. Spermatheca duct shorter than spermatheca. Prostate mostly not fused with female duct. Coecum on rectum always absent.

Most species crawl up trees and copulate hanging on slime thread attached to a branch.

About 20 species included. Mostly in the Mediterranean region and Asia Minor.

Limax (Limax) maximus LINNAEUS, 1758

Limax maximus LINNAEUS, 1758: 652. Terra typica: ? Sweden.

Synonyms: *Limax cinereus* LISTER, 1678; *Limax cinereus* MÜLLER, 1774 (partim); *Limacella parva* BEARD, 1815; *Limax antiquorum* FÉRUSSAC, 1819 (pars); *Limax maculatus* NUNNELEY, 1837; *Limax cellarius* (d'ARGENVILLE) LESSONA et POLLONERA, 1882 — details concerning the synonyms in HESSE (1926, p. 76).

References: ALTENA 1960: 77; ANT 1957: 9; DAMJANOV and LIKHAREV 1975: 304; FISCHER 1917-1919: 101; FRÖMMING 1954: 183 (biology); GERHARDT 1933: 417, 1934: 233, 1937: 522, 1939: 183 (copulation); GITTENBERGER, BACKHUIS, RIPKEN 1970: 80; JUNGBLUTH, LIKHAREV and WIKTOR 1981: 213; LIKHAREV and WIKTOR 1980: 278; QUICK 1960: 191 (survey); WIKTOR 1973: 65 (survey, illustrations), 1977: 291.

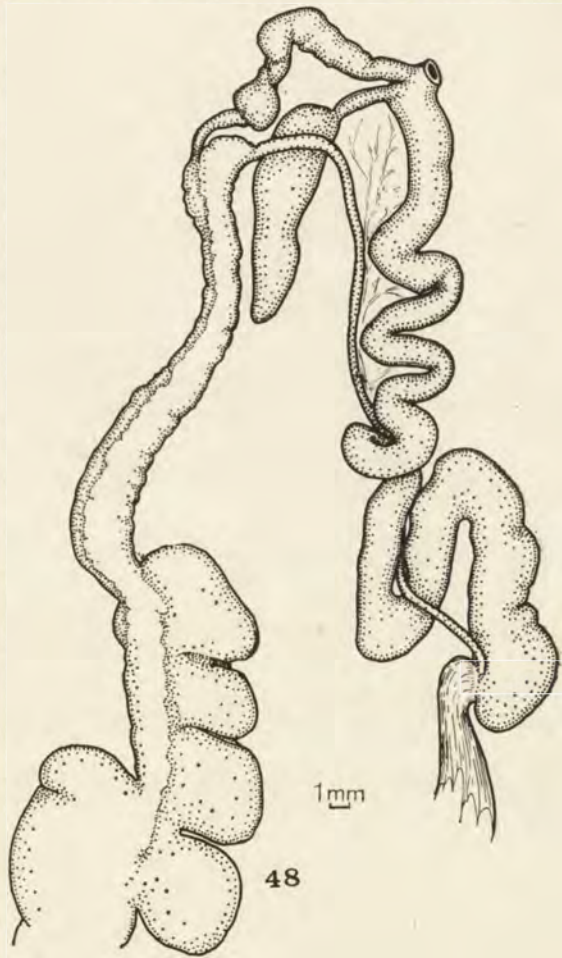
Crawling specimens up to 20 mm long; specimens 100 mm long usually mature. Mantle about $\frac{1}{3}$ of body length. Keel well visible on about $\frac{1}{3}$ of body length. There are 21-36 grooves between dorsum midline and spiraculum, usually 23.

Colour varying. Most specimens spotted (Fig. 47). Body mucky cream-, straw- or coffee-coloured with irregular black, dark-blue-black or brown spots. Spots irregular on mantle but partly posteriorly confluent into rows. Large spots on mantle distinguish *L. maximus* from similar species such as *L. cinereoniger*, *L. macedonicus*. Some specimens are all light in colour, ash-grey-cream or brownish etc., while others are mainly or all dark. Bulgarian specimens are usually lighter, thus less spotted than individuals from Central Europe (where the species is synanthropic). Bulgarian specimens usually have a few well-defined black spots on the mantle. In posterior part of body the spots, arranged in two rows, form irregular bands. In all forms, irrespective of mantle and dorsum colouration, sole is always light-cream or brownish-cream (lateral zones of sole are never dark).

Slime colourless.

Genitalia (Fig. 48). Vas deferens thin, connected with penis by a thin membrane and opening asymmetrically into its apical end. Penial coecum absent. Penis cylindrical, elongate and convoluted, equal to half of body or longer, as long as body in some Bulgarian individuals. Such specimens are intermediate between *L. maximus* and *L. cinereoniger* (see comments p. 133). Penis slightly broadened and rounded posteriorly. Retractor inserted at vas deferens's opening, i.e. at penis apical end. Oviductus short, broadened anteriorly. Spermatheca oval, spermatheca duct and atrium very short.

Formula of radula approximately C. 70/ × 150.

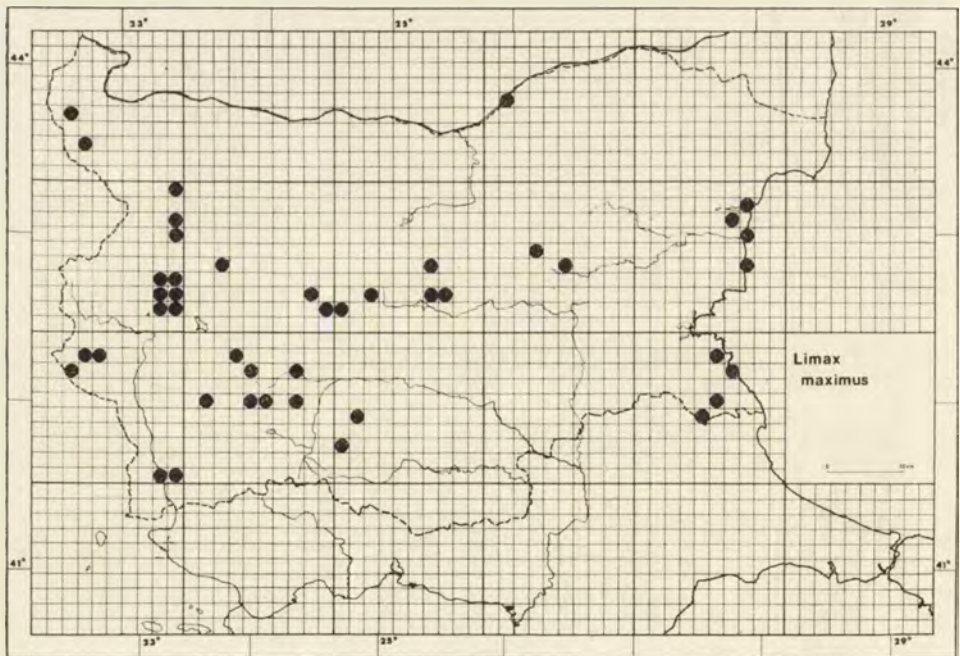


Figs. 47-48. *Limax (L.) maximus* L.: 47 - side view (specimen from Shipka), 48 - copulatory organs (specimen from Ropotamo)

Bionomics. In Bulgaria met in both natural and anthropogenic habitats such as built-up areas, up to 1500 m in mountains. Most frequent in mixed and deciduous forests, especially of damp hornbeam-oak and beech type; usually hiding under logs, stones, in stumps, less frequently under bark. A pest widespread in various parts of the world, often met in greenhouses, cellars, drains, under stones. Frequently damaging vegetable and horticultural crops such as strawberries and wild strawberries. Often found in humid vegetable warehouses. The slugs copulate on the trunks of trees or in places which allow to hang the body downward on a slime thread (never on the ground — see GERHARDT 1933–1939 and FRÖMMING 1954).

Distribution. Native in southern and western Europe and probably in North Africa. Its original distribution is difficult to be established since it spread over a large area as a synanthrope. It is often mistaken for *L. cinereoniger* and probably some other species in southern Europe. As a synanthrope it is common in Scandinavia, White Russia, Ukraine and Caucasus. It has been introduced to South Africa, North America, Australia, Tasmania, New Zealand.

In Bulgaria probably native, but also living as a synanthrope. Distributed throughout the whole country.



Map 12. *Limax maximus*

Material examined: 59 specimens.

Records (Map 12):

Stara Planina: Gabrovo, around Shipka, Buzludzha near Kazanluk, Kotel, Zheravna near

Kotel and Mt. Rozbojna leg. BEŠKOV and STAREGA (IZW); Kalofer leg. BOROWIEC and TARNAWSKI. Also: JURINIČ (1906) — Svoje, Kiselcova Mogila near Gabrovo; URBAŃSKI and WIKTOR (1968) — Vitinya north-east of Sofia, Kotel; OŠANOVA (1970) — Klisurski Monastir, Rakovski Monastir, Stoyanovo, Prauzhda, Lakatnik.

Osogovska Planina: around Hizha Osogova; also JURINIČ (1906) — Bogoslov near Kyustendil.

Konyavska Planina: Konyavo.

Sofia: WAGNER (1934a).

Vitoshka: OŠANOVA (1972) — many records.

Sredna Gora: DAMJANOV and LIKHAREV (1975).

Pirin: Sandanska Bistritsa Valley near Sandanski around Popina Luka.

Rila: around Yakoruda.

Rodopi: Peshtera. Also: JURINIČ (1906) — Chepinsko, Chepelare, Kostenec, Sestrimo; WAGNER (1934a) — Pazardzhik; URBAŃSKI and WIKTOR (1968) — Chepino baya near Velingrad, Lepenitsa, Bachkovski Monastir.

Strandzha: Gramatikovo and north-west of this place, near Malko Turnovo. Also: DAMJANOV and LIKHAREV (1975).

Russe — leg. BOROWIEC and TARNAWSKI.

The Black Sea coast: at the mouth of the Kamchiya River, Obzor, Bakarluk hills near Burgas and Suzopol, Arkutino on the Ropotamo River. Also: JURINIČ (1906) — Varna; URBAŃSKI and WIKTOR (1968) — Dolen Chiflik near Varna and the mouth of the Ropotamo River.

? *Limax (Limax) subalpinus* LESSONA, 1880

Limax subalpinus LESSONA, 1880: 332. Terra typica: Piemonte and Veneto (Italy).

References: LESSONA et POLLONERA 1882: 35; WIKTOR 1977: 292.

Description of two specimens found in Bulgaria: mature preserved specimen 80 mm long, up to 13 mm wide, mantle 27 mm in length. Keel $\frac{1}{3}$ of body length with 21 grooves between body midline and pneumostome. The other specimen (juvenile) 28 mm long.

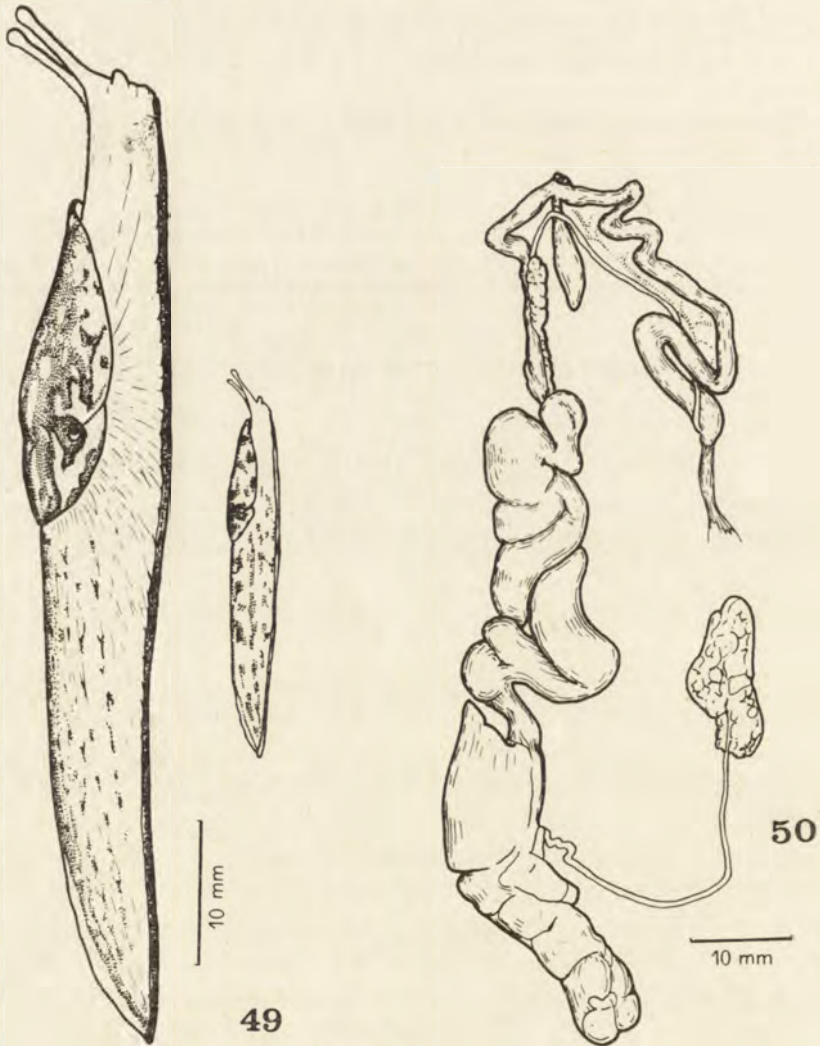
Colouration. When alive body olive-green with dark green, partly blackish, pattern. Mantle with irregular, partly fused, spots (Fig. 49). Pneumostome surrounded with dark areola. Dorsum with spots of the same colour as on mantle, forming longitudinal rows or irregular bands. Around keel black pigment present together with green, forming blackish-green spots. Keel cream-greenish. In alcohol green pigmentation disappeared leaving the body with brown-ash-grey pattern, but spots around keel remained almost black. Sole in the mature specimen with black lateral zones, cream-coloured in the middle (colouration typical also of *L. cinereoniger*).

Genitalia (Figs. 50, 52) very similar to *L. maximus*. Glandula hermaphroditica wide, leaf-like. Glandula albuminalis big, elongate. Spermoviductus thick and convoluted posteriorly, straight and narrow anteriorly. Penis resembling that of *L. maximus*, longer than half of body length. Posterior part of penis straight. Retractor inserted exactly at penis end, vas deferens opening laterally near to retractor's insertion.

Material examined: both specimens examined were found in the north-western Rila Massif, at the altitude of about 1500 m, between the shelters of Vada and Lovna in a spruce-pine forest (Map 14).

Comments.

The taxonomic status of this species is not clear. LESSONA (1880) and LESSONA and POLLONERA (1882) described several different varieties or subspecies. Some of them can be distinguished from *L. maximus* by a peculiar pattern on the mantle.



Figs. 49-50. ? *Limax (L.) subalpinus* LESS.: 49 — side view of two different specimens, 50 — genitalia (specimens from the vicinity of Lovna)

Limax (Limax) cinereoniger WOLF, 1803

Limax cinereo-niger WOLF, 1803: 7. Terra typica: Germany.

Synonyms: *Limax maximus* LINNAEUS, 1758 (partim); *Limax antiquorum* FÉRUSAC, 1819 (pars); *Limax Cyreneus* COMPANYO, 1837; *Arion lineatus* DUMONT, 1849; *Limax bilobatus* ROY et DROUËT, 1851 (non FÉR.); *Limax Claravallensis* DROUËT, 1851; *Limax lineatus* DUMONT et MORTILLET, 1852; *Limax coeruleans* STROBEL, 1857 (non BIELZ); *Limax cinereus* var. *intermedia* BREVIÈRE, 1881 — details concerning the synonyms — in HESSE (1926, p. 80).

Limax cinereoniger schulzei GERHARDT, 1941: 586. Terra typica: Rila.

Limax (Limax) zilchi GROSSU et LUPU, 1960: 161. Locus typicus: Cocos Monastery (Rumania). Holotypus: MNH "Grigori Antipa", Bucharest, No. 9500/118.

References: DAMJANOV and LIKHAREV 1975: 302; FRÖMMING 1954: 194; GERHARDT 1933: 417, 1934: 244, 1937: 518; GITTENBERGER, BACKHUYS, RIPKEN 1970: 80; LIKHAREV and WIKTOR 1980: 274; LUPU 1973: 47; QUICK 1960: 187; WAGNER 1934c: 17; WIKTOR 1973: 68, 1977: 291; WIKTOR and LIKHAREV 1980: 428.

Living specimens up to 200 mm long. Preserved Bulgarian specimens up to 95 mm long, 20 mm wide, mantle length up to 35 mm. Keel covering more or less $\frac{1}{3}$ of body length. Skin with fine grooves, 23 between dorsal line and spiraculum.

Colouration much variable. Mantle characteristically unicoloured or nearly so, unspotted, with lighter, as if underpigmented, spaces on sides. Mantle usually darker medially, sides and anterior part gradually lightening. Body behind mantle often with dark spots (Figs. 51) or bands which vary even within the same



Fig. 51. *Limax (L.) cinereoniger* WOLF — a form especially often met in Bulgaria (specimen from Yakoruda)

population. Most Bulgarian specimens are grey-ash-grey with darker dorsum, blackish, black or brown-grey, often with darker bands. Some Bulgarian specimens are steel-grey or grey-ash-grey with few black spots arranged in one or two rows (such forms are unknown from Central Europe). They are usually larger than remaining individuals. All specimens, irrespective of colouration have the keel light cream-coffee or cream-coloured. Sole uniformly creamy whitish in immature and albinotic individuals, with darker (sometimes black) lateral zones in all Central European and most Bulgarian adults. The laterally dark sole is generally regarded as a recognition feature of *L. cinereoniger* but actually it is all white in some Bulgarian individuals. The author has never found such specimens in Central Europe.

Slime always colourless, hyaline.

Genitalia (Fig. 53) as in *L. maximus* except that penis is 1.0–1.5 times body length. Other parts of genitalia as in *L. maximus*, *L. punctulatus*, *L. subalpinus* and some other poorly known Mediterranean slugs such as *L. dacampi* MENEGAZZI, 1854 (see comments, p. 133).

Bionomics. Met mostly in mixed and deciduous forests of all types, in mountains up to above timberline. Crawling on ground and trees. Hiding in stumps, decaying tree trunks and under bark. Feeding on lichens and algae on bark and rocks, on mushrooms and various parts of plants (leaves, fruit, roots, etc.). Copulating on trees hanging on slime thread like related species. Lifespan: several years. Juvenile forms met mostly on tree trunks. In Bulgaria up to about 2500 m in Pirin (Vihren, Damjanitsa) and about 1800–1900 m in Stara Planina, Rodopi and Rila. In the Alps recorded from 2600 m. Avoiding man-made habitats.

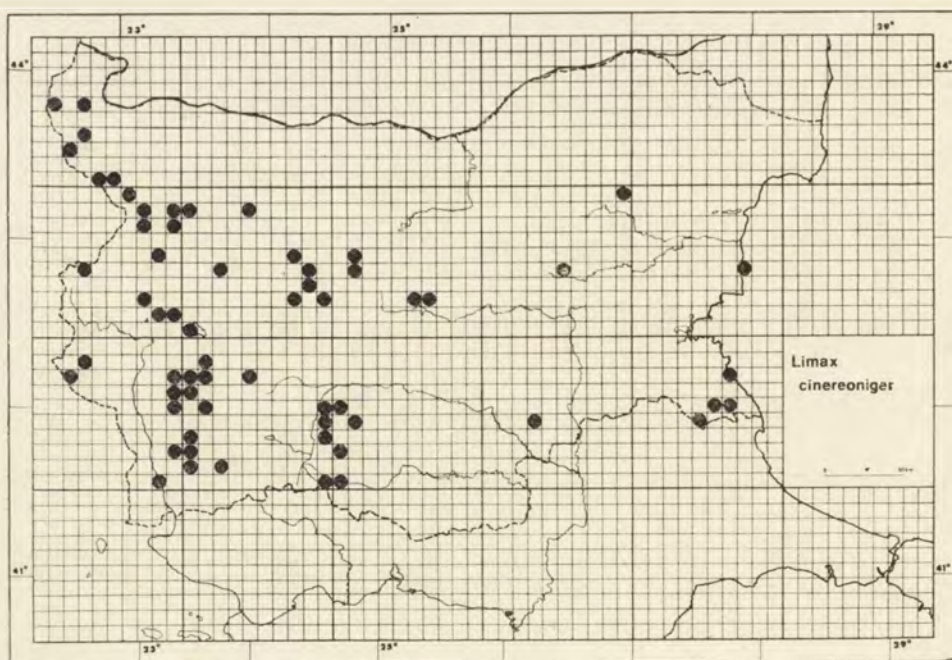
Distribution. Almost whole Europe southwards to Greece, Italy (together with many allied species), Sardinia and the Pyrenean Peninsula. Northwards to 67° in Norway, eastwards to Crimea, Kazan and Kisheniow.

In Bulgaria frequent in whole country, especially in mountains.

Material examined: 248 specimens.

Records (Map 13):

Stara Planina: south of Belogradchik, near the Ledenika Cave (Vratsa), Berkovitsa leg



Map 13. *Limax cinereoniger*

TOTEV (MNH), the Buchino Prohod Valley, around Teteven and Ribaritsa village, Vezhen, Cherni Osum, around Shipka, the Shipka Pass, Ispolin near Shipka, Kazanluk, Zheravna near Kotel. Also: WAGNER (1934a) — Karlukovo, (1934b) — Visek near Kolarovgrad (Shumen); URBAŃSKI and WIKTOR (1968) — Petrohan, Zgorigrad near Vratsa, Ledenika near Vratsa; Vitinya near Botevgrad, Troyan, Ostrec near Troyan; OŠANOVA (1970): Vrasha chuka, Bela voda, Izvoza, Lakatnik, Berkovitsa, Markresh, Vedernik, Petrohan. Hajdushka dupka near Karlukovo — the Iskur Valley leg. PAPA ZOV (BAN)

Vitoshka: around the Ofelia shelter, Boyana, Boyanski vodopad. Also: HUDEC (1964) — Boyana; URBAŃSKI and WIKTOR (1968) — Zlatni Mostove; OŠANOVA (1972) — Kikish, Kominite, near Zheleznitsa, Bistritsa, Zlatni Mostove, Vladayskata reka, Slavia, Ostrec.

Sredna Gora: near the Bogan shelter leg. SZIGETHY (HNHM), Koprivishtitsa leg. BEŠKOV and STAREGA (IZW). Also: DAMJANOV and LIKHAREV (1975).

Plana: around Kokalyane and Kokalyanski Monastir.

Lyulin Planina: WAGNER (1934a).

Trun: URBAŃSKI and WIKTOR (1968).

Kyustendil: WAGNER (1934a).

Osogovska Planina: around Hizha Osogovo.

Pirin: Bansko, Vikhren, around the Damyanitsa shelter, Kamienitsa leg. BOROWIEC and TARNAWSKI; Biegovitsa on the Bistritsa river near Sandanski, Breznitsa near Gotse Delchev. Also: DAMJANOV and LIKHAREV (1975).

Rila: Malovitsa leg. ? (IZW), around Skakavitsa, Parangalitsa near Blagoevgrad, Yakoruda, near the Lovna and Vada shelters, around Rilski Monastir.

Rodopi: Bachkovski Monastir, Byala Cerkva, around Chudni Mostove, Ilvoyna, Persenk, Smolyan, Charnaya reka near Smolyan, Smolyanskie ozera, around the Zdravets shelter, Batak, the slopes of the Rodopi near Yakoruda. Also: JURINIČ (1906) — Chepelare, Chepinsko; WAGNER (1934a) — Sestrino; URBAŃSKI and WIKTOR (1968) — Bachkovski Monastir, Zdravets.

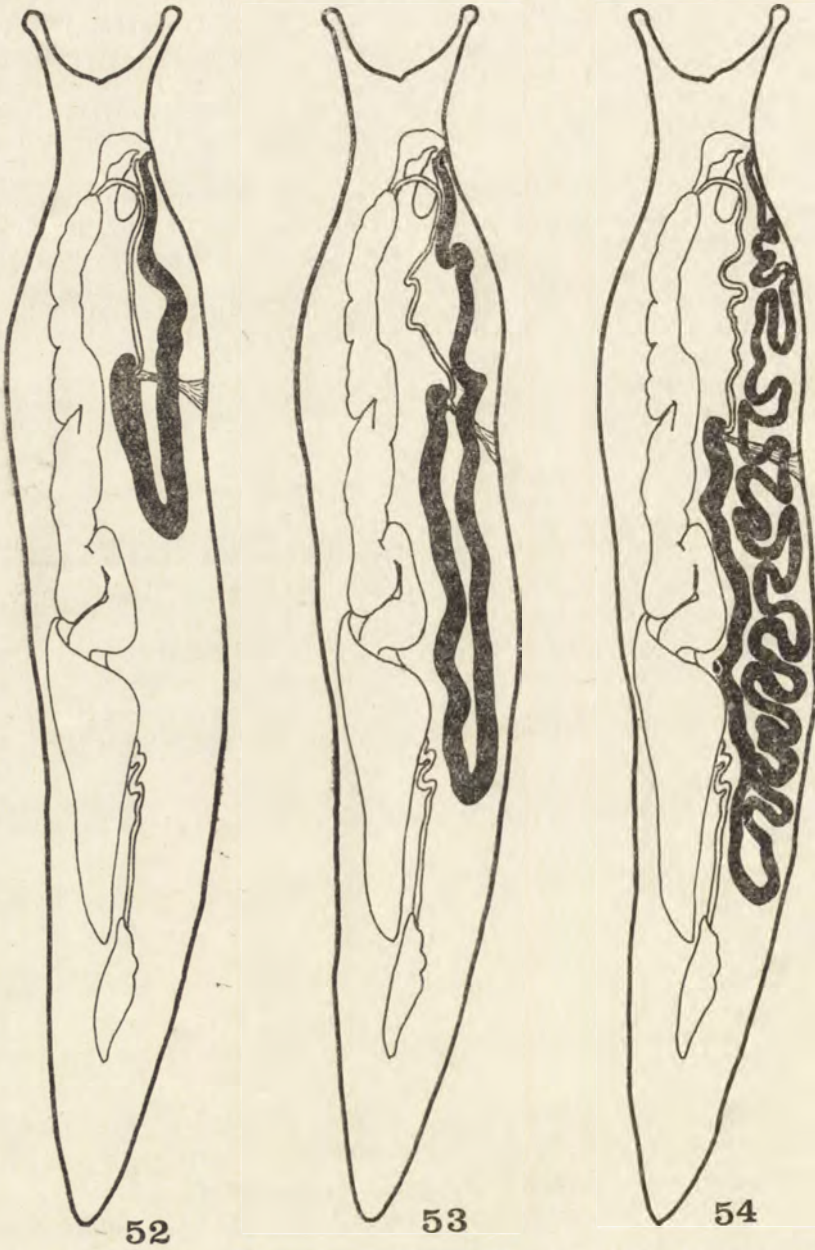
Sakar Planina: DAMJANOV and LIKHAREV (1975)

Strandzha: around Gramatikovo, on the Veleka river, Ajdere near Malko Turnovo, Kachul near Malko Turnovo leg. STAREGA (IZW)

The Black Sea coast: Obzor; also URBAŃSKI and WIKTOR (1968) — Arkutino.

Comments.

Several slugs similar to *L. cinereoniger* have been described: *Limax maximus*, *L. punctulatus*, *L. bielzi* SEIBERT, 1873, *L. dacampi* MENEGAZZI, 1855 (= *dacampoi*). Anatomically they differ only in the penis length. (Figs. 52–54). They can also be distinguished by colouration. The problem is varying colouration. They need a modern revision. The relationship of *L. cinereoniger* and *L. maximus* is not clear. These species are distinct in Central Europe but there are intermediate specimens in Bulgaria; such specimens have a unicolour sole and spotted mantle, but their penis is much longer than in similarly coloured typical *maximus*, e.g. from Poland. Also GROSSU and LUPU (1960) (as *L. zilchi*) and LUPU (1973) observed such intermediate individuals. In Poland the two species are ecologically separated: *cinereoniger* is a native forest species and *maximus* is a synanthrope introduced from south or west. In Bulgaria both species are native.



Figs. 52-54. Diagrams of genitalia, penis marked black: 52 - *Limax (L.) maximus* L. and *Limax (L.) subalpinus* LESS. et POLL., 53 - *Limax (L.) cinereoniger* WOLF, 54 - *Limax (L.) punctulatus* SORD.

Limax (Limax) punctulatus SORDELLI, 1870

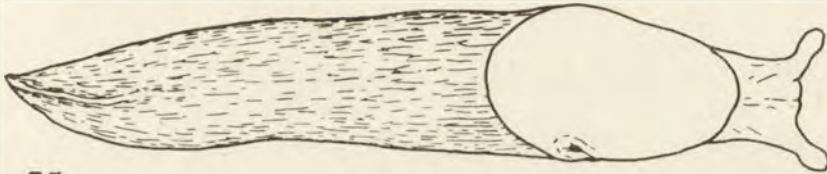
Limax punctulatus SORDELLI, 1870: 250. Locus typicus: Como, Esino around Verona (Italy).

Limax cinereoniger WOLF: LESSONA 1880: Tav. III Fig. 7 and 10; PEYER and KUHN 1928: 485.

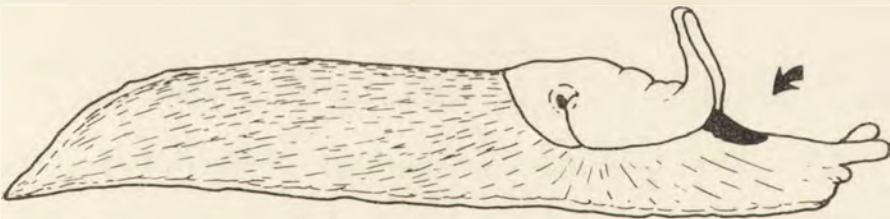
Limax redii GERHARDT, 1933: 425. As a lectotype of the species I choose a photograph denoted as Abb. 4 (GERHARDT 1933) — since the author of the type did not designate it (see comments below). Locus typicus: Serpiano (Tessin, Switzerland).

References: FORCART 1965: 110; GERHARDT 1933: 425 (copulation); PEYER and KUHN 1928: 485 (copulation); PINI 1876: 31; WIKTOR 1977: 292.

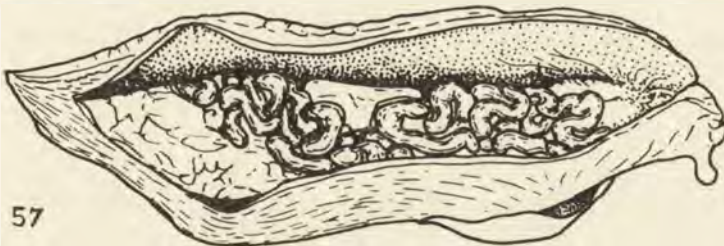
Body length up to 130 mm (PINI 1876). Largest specimen preserved in alcohol known to the author: length 105 mm, width 20 mm, mantle length 29 mm. Body shape similar to *L. cinereoniger* but more wormlike. Keel in preserved specimens covering exactly $\frac{1}{4}$ of body length. There are 18–29 grooves between median line and pneumostome.



55



56



57

Figs. 55–57. *Limax (L.) punctulatus* SORD.: 55 — top view, 56 — side view (the arrow points to the characteristic mark on the neck), 57 — slugs with body coverings cut, and visible coiled penis

Colour varying: grey-brown, chocolate or grey-yellowish; body with black or dark brown spots, or spotless, with darker dorsum and mantle. Spots (when present) usually forming rows on body sides. Mantle mostly unicolour, sometimes with dark spots. Some specimens have ill-defined light bands on darker background on body sides. Keel slightly lighter than the surroundings, sometimes with lighter bands at its extension. All Bulgarian specimens known to the author have a tomato-red blot on the neck under the mantle. The blot becomes visible

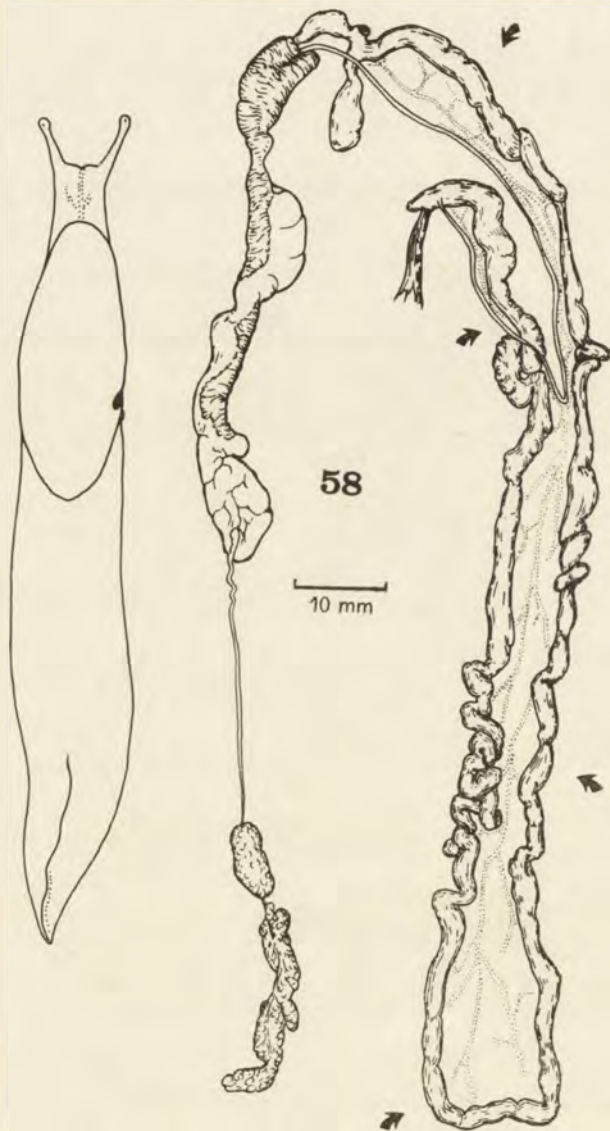
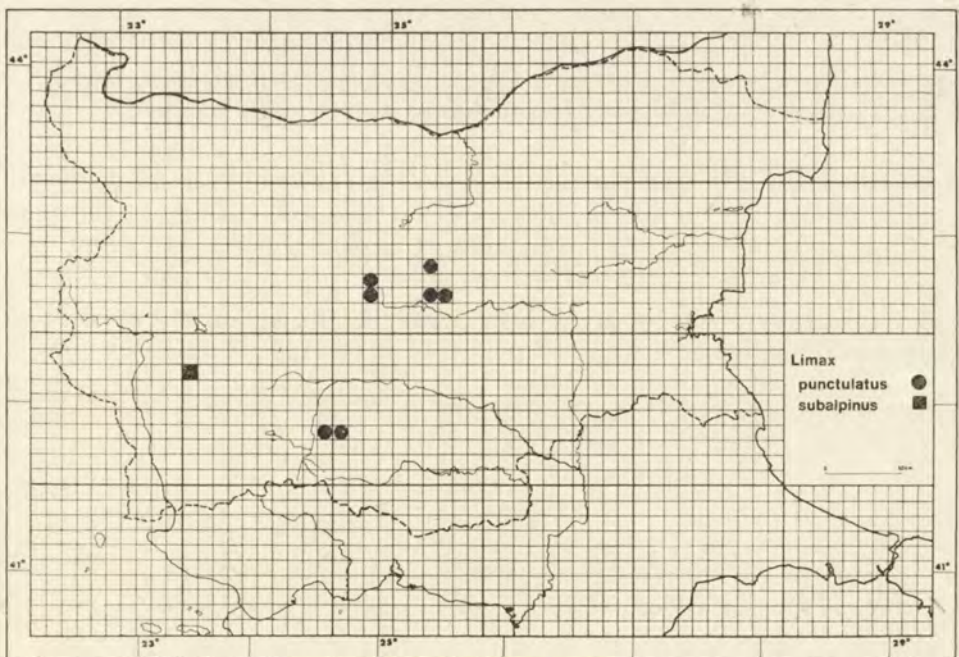


Fig. 58. *Limax (L.) punctulatus* SORD. — genitalia and the body outline drawn in the same scale (the arrows show the penis) (specimen from Buzludza)

after bending aside the free, anterior end of mantle (!) (Figs. 55–56). It disappears in alcohol within a few days. This feature has not been recorded yet. Sole unicolor, creamy.

Genitalia (Figs. 54, 57, 58). Glandula hermaphroditica leaf-like, much elongated. Ductus hermaphroditicus thin, only slightly convoluted. Albumen gland short, broadened, distinctly smaller than in *L. cinereoniger*. Spermoviductus with well-developed glands of male duct, especially anteriorly where a broad, flattened prostate is situated. Prostate fused with female duct to the end, reaching base of spermatheca duct. Vas deferens thin, about 4 times shorter than penis. Penis unusually large, forming more than $\frac{1}{3}$ of visceral mass, convoluted, covering remaining genitalia, intestinum and a part of liver. Its loops reaching $\frac{4}{5}$ of the length of visceral mass (Fig. 57). Penis at least 2.5 times longer than body. During copulation, when fully erected, its length up to 70–85 cm! (GERHARDT 1933). Externally penis as in *L. cinereoniger* but longer and thinner as compared with body length. Penis longest in specimens at male phase with gonad being relatively big at that time and albumen gland slightly smaller. In older specimens penis becomes thicker and shorter but is still much longer than in other species of that genus. Posterior end of penis with very short and narrowed coecum (Fig. 58). Retractor penis is a strong muscle, with penis reversed its length is only about 2.5 cm. Spermatheca elongate, well-delimited from spermatheca duct. Oviductus and atrium short as in *L. cinereoniger*.



Map 14. *Limax punctulatus* and *Limax subalpinus*

Radula. Teeth similar as in *L. cinereoniger*. Formula of *L. punctulatus* from Buzhdza: C. 15+2. 58/×170.

Bionomics. According to GERHARDT (1933) the slug obviously differs from the remaining species of that genus in copulation behaviour. It is a forest slug living in similar biotopes as *L. cinereoniger* but there is little information concerning its ecological requirements. In Bulgaria it reaches the altitude of about 1700 m, i.e. more or less the upper deciduous timberline.

Distribution. Poorly known, probably often mistaken for other species of that genus. Recorded from Italy (Calabria, Apulia, Piedmont and Como) and southern Switzerland (Tessin). Till now no records from Bulgaria. Found in the central part of Stara Planina and Central Rodopi but it should be expected in other mountain massifs as well.

Material examined: 43 specimens from Bulgaria and 8 specimens from Serpiano (Prov. Tessin — Locus typ. *L. redii* GERH., 2 specimens det. GERHARDT), Sila Piccola (Prov. Catanzaro — 3 specimens) and Monte San Georgio at the Lugano Lake (3 specimens).

Records (Map 14):

Stara Planina: around Ispolin in the area of the Shipka Pass (Stoletov), Buzludzha not far from Kazanluk, Kalofer and cirque at Botev (leg. BOROWIEC and TARNAWSKI), the slopes west of Gabrovo.

Rodopi: Hvoyna (the Chepelarska reka valley), the eastern slope of the Persenk Mountain.

Comments.

Closely related to *Limax cinereoniger*. The differences: a longer penis, more developed prostate and a different copulation. Also external differences: a unicolour sole, poorly sculptured and poorly coloured keel, finer skin grooves and a different shape of body. Its posterior end is less cuneate and broader. A red blot on the neck under mantle (visible only in living specimens) is a distinctive feature in Bulgarian specimens. Unfortunately, it is not known if slugs from other areas have that blot, too. The specimens from San Georgio at the Lugano Lake (preserved in formalin) bear traces of that blot.

Bulgarian specimens are mostly spotless, ash-grey-chocolate, sometimes with lighter bands. The author met also specimens which were brown-blackish with rows of small black spots in posterior part of body. Mantle unicolour. The specimens coming from southern Italy (Prov. Catanzaro) lent to the author by Dr. FORCART from the Museum in Basel had, contrary to Bulgarian specimens, spotted mantle. Those from the Lugano Lake (North Italy), although lighter in colour, resembled the Bulgarian ones. In the Humboldt Museum in Berlin there are two specimens designated as paratypes of *L. redii* (No. 77969). Owing to Dr. KILIAS kindness the author could borrow them. Both specimens are dissected. They origin from Tessin and Serpiano (locus typicus of *L. redii*) and, determined by GERHARDT, they cannot be considered to be types as GERHARDT does not mention typical specimens in his work. The word

"Paratypen" could have been put on the label "ex post". Taking all this into account as a lectotype the author designates a photograph presenting a preserved specimen (see above).

POLLONERA (1888, Plate III, Figs. 7-8) described two varieties: *L. punctulatus* var. *canapiciana* and var. *rari-punctata*. His illustrations of genitalia indicate a different species resembling *L. maximus*.

Limax (Limax) macedonicus HESSE, 1928

Limax macedonicus HESSE, 1928: 10. Terra typica: Golešnica Planina (Golesniza), Yugoslavia, Macedonia (Makedonia).

Limax macedonicus leucopus HESSE, 1928: 12. Locus typicus: Peristeri (Greece).

Limax carbonarius leucopus: JAECKEL 1954: 68.

Limax carbonarius graecus: JAECKEL 1954: 68.

Limax carbonarius submaculatus: WAGNER 1940: 143.

Limax carbonarius: WAGNER 1934b: 88, 1940: 142; DAMJANOV and LIKHAREV 1975: 306; WIKTOR 1977: 292.

Limax macedonicus: WAGNER 1934a: 53; URBAŃSKI and WIKTOR 1968: 58; OŠANOVA 1970: 75; DAMJANOV and LIKHAREV 1975: 304; WIKTOR 1977: 292.

References: see synonyms and comments.

The largest preserved specimen is 78 mm long and 18 mm wide, with mantle 22 mm long. Body almost cylindrical, narrowing posteriorly, not cuneate as in other related species. Dorsum rounded, keel very short, only 1 cm in length. Between median line of dorsum and pneumostome from 19 to 25 grooves.

Colouration varied. In mountains (Pirin and Rila) most specimens black. At smaller altitudes also specimens brown, blackish or grey, usually with rows of darker and lighter spots or banded sides. Mantle darkest, unicolour or with few lighter spots.

At the Black Sea coast all specimens unicolour, light, fleshcoloured-cream or pinkish-cream, also whitish. Sole always cream-coloured in all specimens, both lowland and mountain (!). Keel of the same colour as dorsum.

Slime colourless.

Genitalia (Figs. 59-61). Large glandula hermaphroditica constituting posterior tapered end of visceral mass. Ductus hermaphroditicus thick in juveniles, thin and always convoluted in adults. Glandula albuminalis short and broad. Spermoviductus thick and convoluted posteriorly, narrowing anteriorly, prostate slightly broader than female duct. Vas deferens thin, opening into penis laterally at least 5 mm from posterior end, slightly behind retractor insertion. Penis cylindrical, more than half of body in length. Its posterior end with straight or spirally coiled, gradually narrowing coecum. Penis and its coecum with a wide fold inside (Fig. 61). Spermatheca oval, with short, well-delimited,

spermatheca duct. Free oviductus about 3 times shorter than penis, broadened anteriorly. Atrium very short.

Radula of the grey-brown specimen from the Sandanska Bistritsa Valley



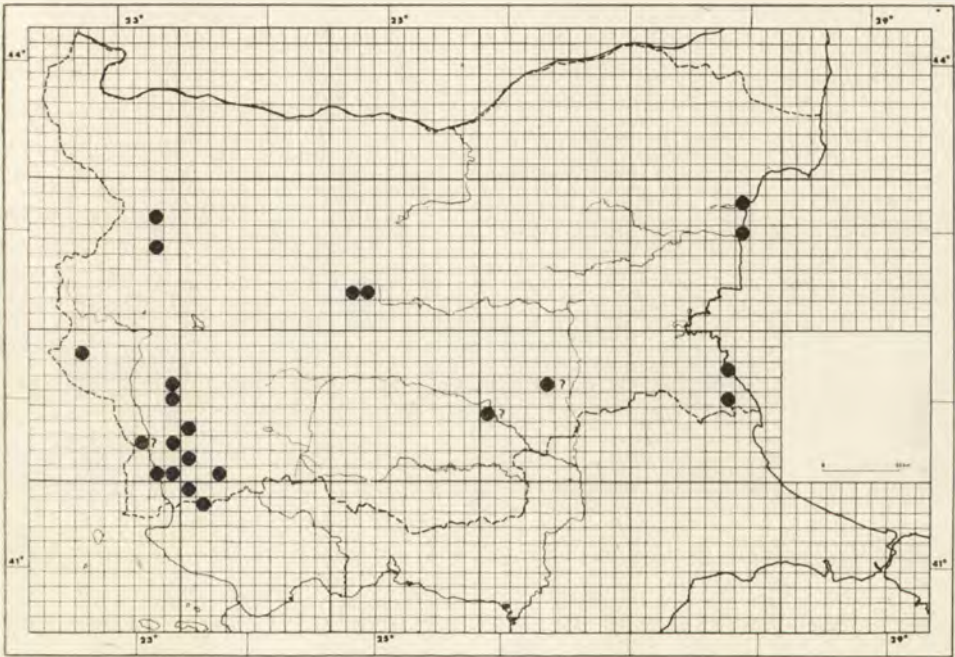
Figs. 59–61. *Limax (L.) macedonicus* HESSE: 59 — genitalia, 60 — posterior penis section hook-like bent, 61 — posterior penis section, a fold inside (59 and 61 — specimen from Popina Luka, 60 — from Arkutino)

(near Sandanski) similar to that of *L. cinereoniger*. Its formula: C. 70/ × 165.

Intestine convoluted in very loose loops. Posterior bends of all loops of the same length.

Bionomics. Living in deciduous forests of all types and in shrubs. Hiding under stones and bark of trees. At the mouth of the Kamehiya River at night the author observed many specimens of this species climbing very high on the tree trunks.

Distribution. Yugoslavian and Greek Macedonia, Thessaly and almost all Bulgaria (see comments). In mountains reaching the altitude of about 2000 m (black form).



Map 15. *Limax macedonicus*

Material examined: 47 specimens.

Records (Map 15):

Stara Planina: the Karlovo valley, Ponor Planina — Cerovo near the Vodnata cave leg. BEŠKOV and STARĘGA (IZW), Kalofer leg. BOROWIEC and TARNAWSKI. Also OŠANOVA (1970) — Dzhagalovci.

The Struma Valley: URBAŃSKI and WIKTOR (1968) — Skakavitsa north of Kyustendil. Maleshevska Planina: Breznitsa leg. BEŠKOV and STARĘGA (IZW) ? — a juvenile specimen.

Pirin: the Vihren slopes and around Bansko leg. BEŠKOV and STARĘGA (IZW), Bansko, at Vihren leg. BOROWIEC and TARNAWSKI, Breznitsa near Sandanski, Popina Luka in the Bistritsa valley and Lilyanovo near Sandanski, the Mesta valley near Gotse Delchev. Also WAGNER (1934b) — the Bunderitsa valley; DAMJANOV and LIKHAREV (1975) — Melnik.

Rila: at the Bistritsa river near Blagoevgrad. Also WAGNER (1934b) — Rilski Monastir. Slavianka (Alibotush): at Carev Vrukh leg. CONKHOV (BAN).

Khaskovo: WAGNER (1934a).

Sakar: URBAŃSKI and WIKTOR (1968) — Topolovgrad.

Strandzha: at the Velaka river near Gramatikovo.

The Black Sea coast: Monastir Aladzha near Varna, at the mouth of the Kamchiya river, Arkutino on the Ropotamo river. Also WAGNER (1940) — Varna and URBAŃSKI and WIKTOR (1968) — on the Ropotamo.

Comments.

From the Balkan region several *Limax* species were described, having at the posterior penis end a blind section, i.e. coecum. A number of species were also described, basing on their outer appearance only, the types most often do not exist. This group needs a detailed revision and settling of the very complicated synonymy. In my latest paper on Yugoslavian slugs (WIKTOR 1982) I believe that the earliest name for the species occurring in Yugoslavia and Bulgaria is *Limax graecus* BOETTGER, 1889. After studying a rich material of slugs from Greece I have to change my mind. It has turned out that there are two very similar species, both varying much in colouration and colour pattern on the body, not to be externally distinguished. They are partly sympatric, yet only one reaches to Bulgaria, it is *L. macedonicus*. The other species is *Limax cephalonicus* SIMROTH, 1886, and a junior synonym of this name is *Limax graecus* SIMROTH, 1889. *L. cephalonicus* (= *graecus*) differs from *L. macedonicus* only in the penis, which is shorter than a half of the body, thicker, nearly straight and clubshaped. At the same time the coecum is longer and is about $\frac{1}{7}$ of the penis length.

At present it is not known to which slug one of the oldest names *Limax maximus* var. *carbonaria* BOETTGER, 1885 refers. The anatomy of the slug is not known, it is distinguished only by darker zones on the sole. We cannot rule out that it is a melanistic form of one of the above mentioned species, which I call either *L. macedonicus* or *L. cephalonicus*.

Limax carbonarius albanicus JAECKEL, 1954 (Fig. 15) from Berisha in Albania has a different penis, this name probably is not a synonym of *L. macedonicus*.

Limax (Limax) conemenosi BOETTGER, 1882

Limax Conemenosi BOETTGER, 1882: 100. Locus typicus: Preveza (Prevesa), NW Greece.

Limax (Heynemannia) Conemenosi var. *multipunctata* BOETTGER, 1885: 158.

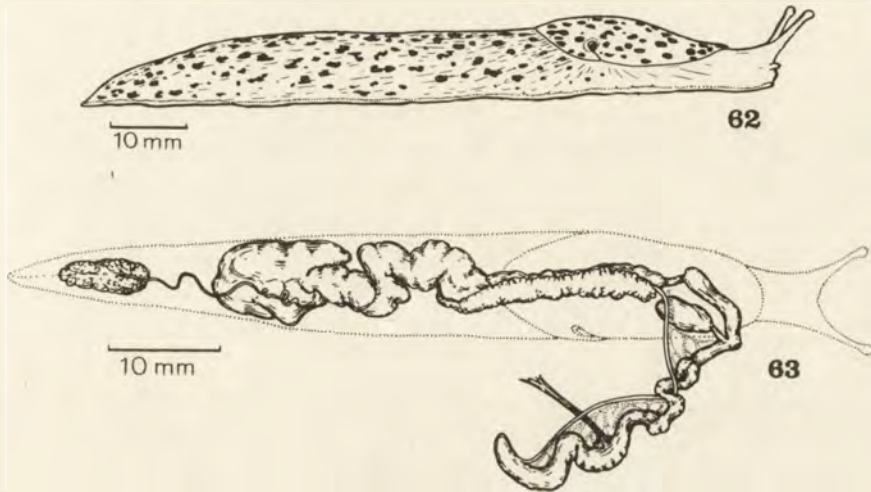
References: BABOR 1898: 41; BOETTGER 1885: 158; DAMJANOV and LIKHAREV 1975: 306; HESSE 1928: 13; OŠANOVA 1972: 145; SIMROTH 1889: 5; URBAŃSKI and WIKTOR 1968: 58; WAGNER 1934a: 52; WIKTOR 1977 : 292.

Largest preserved specimen is 80 mm long, 12 mm wide, mantle 22 mm long. Body much elongate with small mantle covering only $\frac{1}{4}$ of body length. Dorsum slightly convex. Keel very short, poorly sculptured, in largest specimens only 1 cm long. Between median line of dorsum and pneumostome 21–23 grooves.

Colouration. Body mucky-cream, grey-cream, yellowish or reddish-grey. This light background with numerous rounded black spots, about 1 mm in dia-

meter (Fig. 62). Spots covering mantle, dorsum and sides of posterior part of body. Sole unicolour, the same as other parts of body.

Genitalia (Fig. 63) Externally similar to *L. macedonicus*. Glandula hermafroditica oval in shape, situated at the end of visceral mass. Glandula albuminalis short, rounded. Copulatory organs resembling those of *L. macedonicus*. Penis



Figs. 62–63. *Limax (L.) conemenosi* BTTG.: 62 – side view, 63 – genitalia (specimens from Kyustendil)

about half of body length. Its posterior end (coecum) broad and not narrowing (!), shorter than in *L. macedonicus*. Vas deferens connected with penis at an acute angle, its opening far from retractor insertion. As in *L. macedonicus* penis with broad fold in its posterior end. Retractor penis narrower (finer) than in *L. macedonicus*.

Formula of radula: C. 15. 53/ × 150.

Bionomics requires investigations. Found in shrubs and as a synanthrope in parks, gardens etc.

Distribution. North Greece and the Corfu Islands, Cephalonia and the Cyclades. In Bulgaria spread over a considerable area as a synanthrope. Probably introduced there.

Material examined: 19 specimens, mostly juveniles.

Records (Map 16):

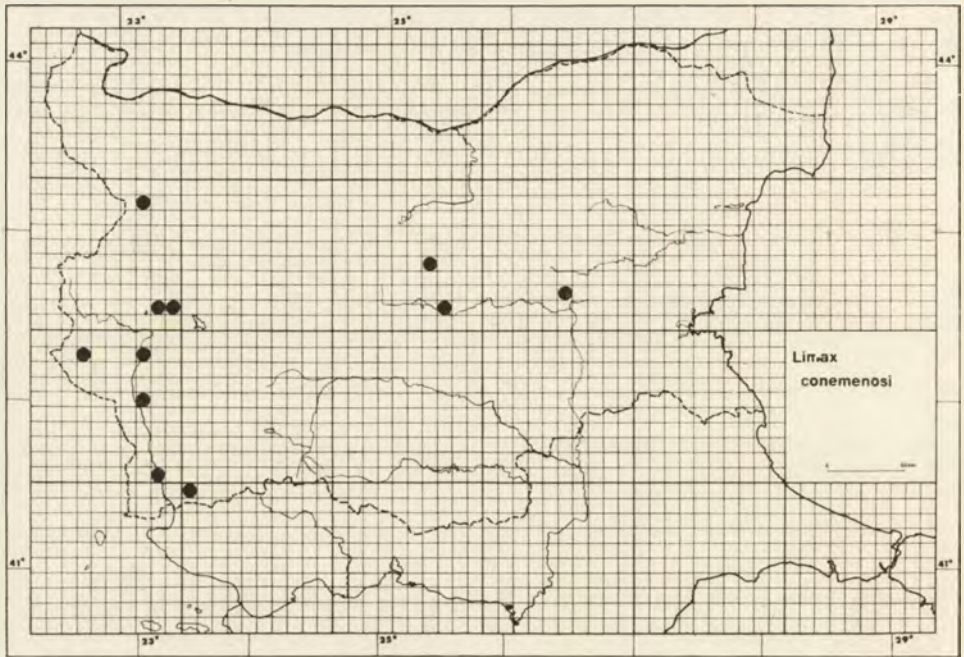
Stara Planina: ? By the road from Berkovitsa to Sofia. Also: BABOR (1898) – Slivno (Sliven); WAGNER (1934a) – Gabrovo; DAMJANOV and LIKHAREV (1975) mention the village of Gabare near Kazanluk.

Kyustendil: WAGNER (1934a) and URBAŃSKI and WIKTOR (1968).

Stanke Dymitrov and Blagoevgrad: DAMJANOV and LIKHAREV (1975).

Vitosha: OŠANOVA (1972).

Pirin: the city park in Sandanski, Melnik leg. A. WARCHAŁOWSKI, BOROWIEC and TARNAWSKI (MNH), Petrich leg. R. BAŃKOWSKA (IZW).

Map 16. *Limax conemenosi*Subgenus *Limacus* LEHMANN, 1864

Limacus LEHMANN, 1864: 145. Typus: *Limax breckworthianus* LEHMANN, 1864 (= *L. flavus* L.).

Plepticolimax MALM, 1868: 62. Typus: *Limax breckworthianus* LEHMANN, 1864.

Simrothia CLESSIN, 1884: 62. Typus: *Limax breckworthianus* LEHMANN, 1864.

Body length about 70 mm. Keel short, ill-defined. Body with intricate pattern of dark and light spots, rarely unicolour. Sole light, unicolour. Penis cylindrical, shorter than half of body. Spermatheca duct short, joined with penis or oviductus. Spermoviductus distinctly short, its female part broadening anteriorly. Prostate longer than vas deferens, slightly shorter than oviductus. Last loop of intestine very short, with coecum which attains posterior part of body (Fig. 45).

Slugs living on trees, rocks and in undergrowth, showing a tendency to synanthropization. Two species included, probably originating from broadly understood Mediterranean area. As synanthropes introduced into various parts of the world.

Limax (Limacus) flavus LINNAEUS, 1758

Limax flavus LINNAEUS, 1758: 652.

Synonyms given in literature (see HESSE 1926, WIKTOR 1973, LIKHAREV and WIKTOR

1980) probably refer to this species as well as to closely related *Limax maculatus* KALENICZENKO, 1851.

References: CHATFIELD 1976: 1; GITTENBERGER, BACKHUYS and RIPKEN 1970: 82 (illustrations); GROSSU and LUPU 1959: 561; LUPU 1970: 66; QUICK 1960: 184; WIKTOR 1973: 75 (illustrations, description).

Body length up to 120 mm in living and up to 80 mm in preserved specimens (biggest preserved specimen from Bulgaria is 72 mm long, 19 mm wide, its mantle 23 mm in length). Dorsum rounded, keel very short, 10–15 mm, covering only about $\frac{1}{7}$ of body length. Skin grooves poorly sculptured, 22–23 between median line and pneumostome.

Dorsum and mantle with a system of irregular, partly joined, dark, grey-olive or grey-greenish spots on lighter, whitish-yellow or orange-olive background (Fig. 64). On sides dark pigment not attaining edge of foot. Head and tentacles grey. Sole cream-olive.

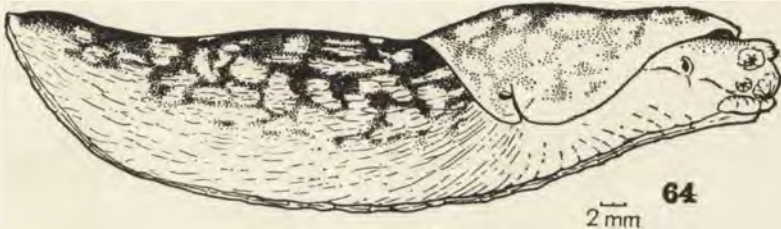


Fig. 64. *Limax (L.) flavus* L. — side view (specimen from Kotel)

Slime yellow or orange, hyaline and watery.

Genitalia (Fig. 65). Glandula hermaphroditica rounded, hidden under liver lobes. Prostate very long, slightly narrowed anteriorly. Vas deferens almost equal to half of penis in length, opening asymmetrically at apical end of penis. Penis barrel-shaped, slightly swollen anteriorly, variously twisted; sometimes forming “C”, inverted “E”, or irregularly hooked. Its length about $\frac{1}{8}$ of body. Retractor penis inserted at vas deferens’ opening. Inside penis two longitudinal folds, joined near atrium. Spermatheca oval. Spermatheca duct muscular, broadened anteriorly, opening into female duct. Oviductus tubular in its posterior part, broadening anteriorly, its walls getting thicker. Spermatheca duct and oviductus connected in common, broad duct distinguish this slug among all *Limacidae*. Atrium very short.

Radula. Ecto- and entoconus in all teeth poorly developed. Marginal teeth dagger-like, poorly bent. No clear distinction between particular groups of teeth. Mean formula: C. 56/×151.

Intestine coecum usually attaining the end of body.

Bionomics. In Bulgaria the slug occurs as a synanthrope in gardens, ruderal environments, suburban waste lands and in parks.

Distribution. The original range of the species is not known. It certainly occurs in Bulgaria, Rumania, Hungary, European parts of the USSR, the Netherlands, GDR, FRG, Poland, Great Britain, Ireland and Italy, but probably in a much wider area.

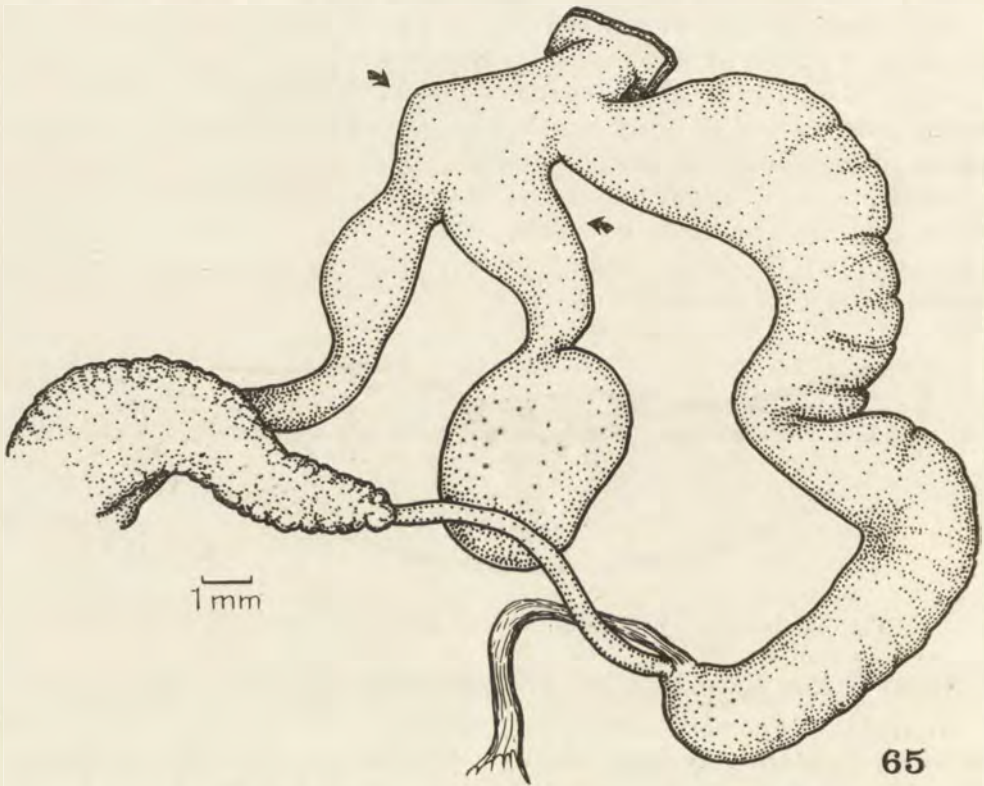


Fig. 65. *Limax (L.) flavus* L. — copulatory organs (specimen from Obzor)

Material examined: 75 specimens from Bulgaria and 30 specimens from other parts of Europe.

Records (Map 17):

Stara Planina: Botevgrad, Kotel.

Sofia: in greenhouses.

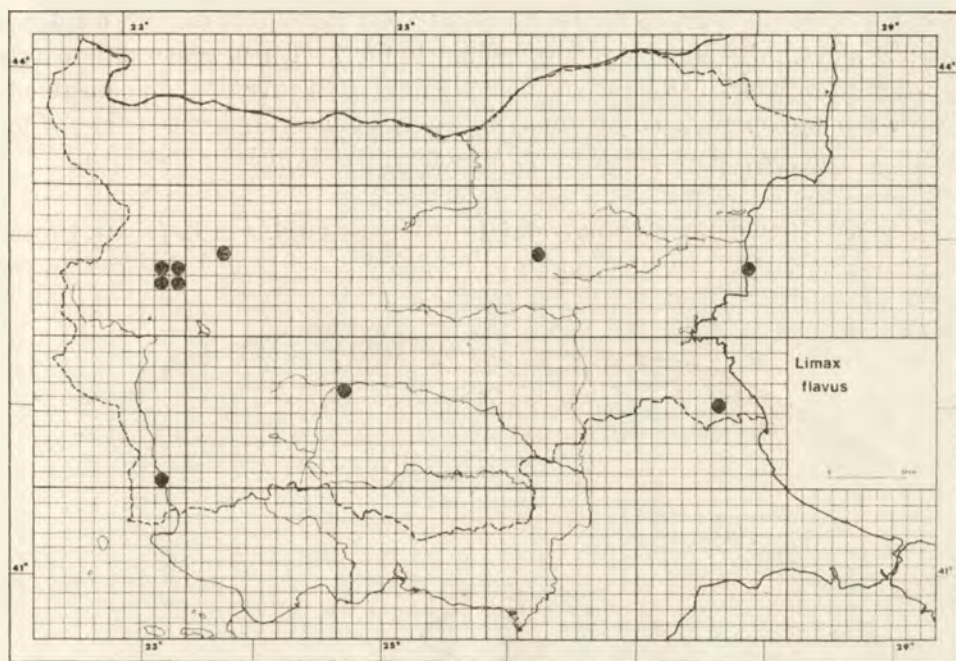
Pirin: Sandanski — in park.

Plovdiv.

The Black Sea coast: Obzor.

Comments.

All literature data require verification. A very similar species, i.e. *L. maculatus*, lives in Europe. Until recently it has not been distinguished from *L. flavus*. It is different in colouration (darker) and dark pigment on body sides attains the edge of foot. Both species differ in genitalia structure. They can be easily identified by spermatheca duct which in *L. flavus* opens into oviductus

Map 17. *Limax flavus*

while in *L. maculatus* it opens into atrium or penis at its junction with atrium. These characteristics were ignored by many authors, e.g. BABOR (1898), WAGNER (1934a) and OŠANOVA (1970). Since the species they described cannot be identified, the records given by these authors will not be included in this publication.

***Limax (Limacus) maculatus* (KALENICZENKO, 1851)**

Krynickyllus maculatus KALENICZENKO, 1851: 226. Locus typicus: Kuchukoy (South Crimea).

Limax grossui LUPU, 1970: 63. Locus typicus: Hageni south-east of Mangalia (Rumania). Holotypus: MNH "Gr. Antipa", Bucarest, No. 13145.

Limax pseudoflavus EVANS, 1978a: 173. Locus typicus: Athlone (Ireland). Holotypus: British Museum (NH) No. 19781 W.

Limax flavus (pars): URBAŃSKI and WIKTOR 1968.

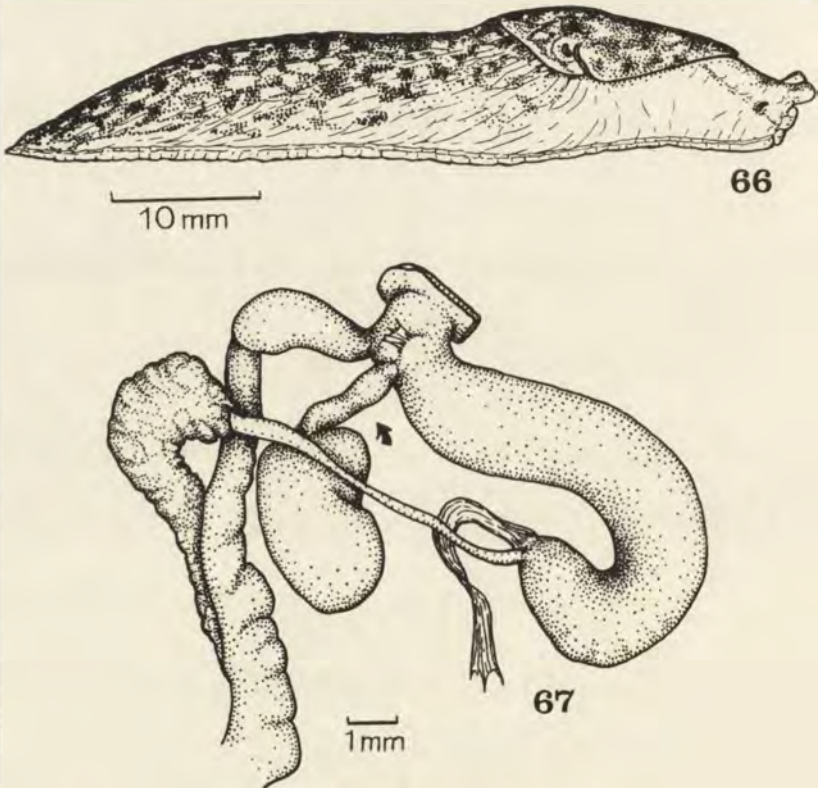
Biggest preserved specimen 72 mm in length, 15 mm in width, mantle 24 mm long. Between median line and pneumostome 23 grooves. Body length in most mature specimens between 40 and 50 mm.

Colouration (Fig. 66). In lighter specimens hard to distinguish from *L. flavus* (at least after preservation). Preserved darker specimens rather grey, living specimens greenish-grey. Dark spots more concentrated than light area.

Sometimes dark pigment spilled so that only few light dots remain on dorsum and body sides. Also unicolour specimens; light, brownish-green when living, grey when preserved. The light specimens are always juvenile. As compared to *L. flavus* the dark pigment on body sides reaches lower, almost to edges of foot. Head and tentacles blackish or grey, sole cream-yellowish or greenish.

Slime yellow.

Genitalia (Fig. 67). Except copulatory organs similar to *L. flavus*. Prostate slightly broader. Penis shorter, more or less $\frac{1}{7}$ of body length, hooked in form



Figs. 66-67. *Limax (L.) maculatus* (KAL.): 66 - side view (specimen from Malko Turnovo)
67 - copulatory organs (specimen from Arkutino-Ropotamo)

of "C" or smooth "S" letters, contrary to *L. flavus* spermatheca duct opening into atrium at its junction with penis or into penis. Oviductus tubular posteriorly. In its anterior part walls slightly thicker and broadening as in *Limax* s. str. Atrium very short.

Radula. C. 16. $35/\times 132$.

Intestine looped as in *L. flavus*. Coecum usually not attaining posterior part of body.

Bionomics. A forest species, most frequently collected by the author in deciduous forests or on old hornbeam trees where it hides in hollows. Some mossed trees are covered by slime so that they shine in the sun.

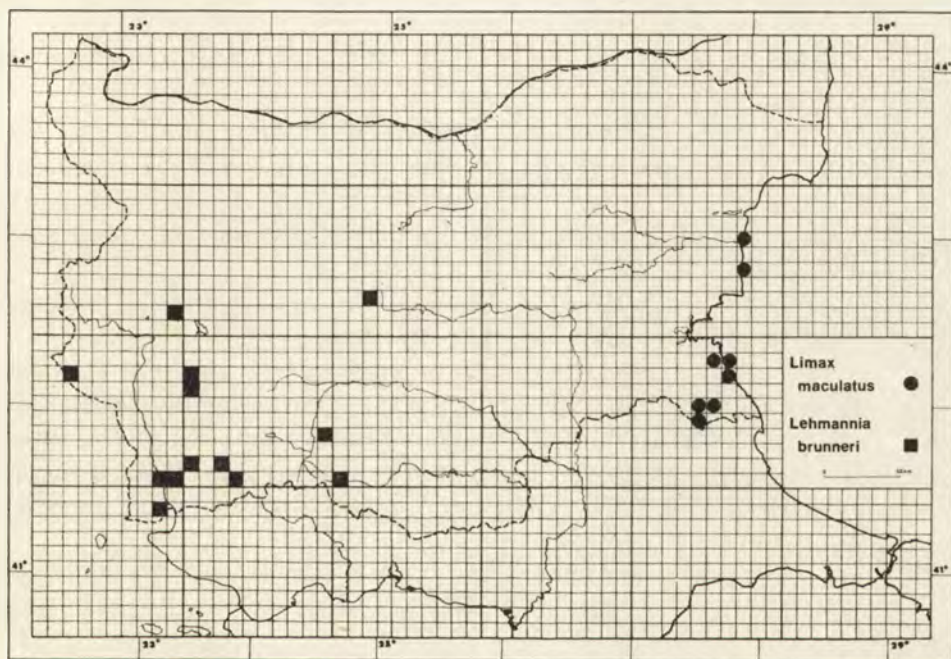
Distribution. Known from Rumania, USSR, Turkey and Ireland. In Bulgaria met only at Black Sea and Strandzha Mts.

Material examined: 50 specimens from Bulgaria and series of specimens from USSR, Turkey and Ireland.

Records (Map 18):

Strandzha: Malko Turnovo, Gramatikovo, Aydere.

The Black Sea coast: the mouth of the Kamechiya river, the Bekarlyk hills near Burgas, Arkutino, Cap Maslen Nos (in URBAŃSKI et WIKTOR 1968 given as *L. flavus*).



Map 18. *Limax maculatus* and *Lehmannia brunneri*

Genus *Lehmannia* HEYNEMANN, 1862

Lehmannia HEYNEMANN, 1862: 211. Typus: *Limax marginatus* MÜLLER, 1774.

Synonyms: *Simrothia* CLESSIN, 1884; *Melitolimax* POLLONERA, 1891; *Ambigolimax* POLLONERA, 1887. Bibliography in HESSE 1926.

References: GROSSU and LUPU 1962: 191; HESSE 1926: 17; HUDEC and BRABENEC 1965: 271; JUNGBLUTH, LIKHAREV and WIKTOR 1981: 20; LIKHAREV and WIKTOR 1980: 261; QUICK 1960: 193; WALDÉN 1961: 85; WIKTOR 1973: 85; WIKTOR and LIKHAREV 1980: 424.

Body length up to about 80 mm. Body narrow, slowly and steadily narrowing posteriorly. Mantle attaining not more than $\frac{1}{3}$ of body length, narrower

anteriorly, in living slugs covered with concentric grooves. Pneumostome post-medial. Keel short, ill-defined. Skin fine, thin and soft, with fine longitudinal grooves, between medial line and pneumostome about 20. Medial zone of sole gradually narrowing posteriorly.

Colouration. Body usually with blackish or chocolate pattern on mucky-cream background. Mantle with at least two lateral bands (a distinctive feature), sometimes more. Bands also on dorsum and sides, sometimes replaced by dark spots arranged in rows. Keel light, its extension with a distinct light band reaching mantle. In some mountain species and melanistic specimens normally covered with bands, colouration is uniformly black with a light median band running through keel and dorsum. Sole in striped slugs uniformly mucky-cream, in black slugs blackish on fringes.

Slime colourless, watery, in irritated slug very abundant, sometimes dripping in drops.

Genitalia. Prostate broad. Vas deferens short and thick. Penis short, up to $\frac{2}{3}$ of mantle, usually smaller, in form of a club broadened posteriorly. Crossed with retractor of right tentacle. Posterior part of penis with a whip-like and always undivided penial gland. Inside penis uvular fold forming a letter V. Bursa copulatrix connected with penis.

Radula. Lateral teeth S-bent. External marginal teeth with numerous cusps (JUNGBLUTH, LIKHAREV and WIKTOR 1981).

Intestine looped 3 times. The first loop longest, the third one very short. Coecum usually attaining posterior part of body, opening into rectum, i.e. the last section of the third loop, its junction situated anteriorly (Fig. 46) contrary to *Limacus* with junction at the bend of the third loop. Kidney in shape of a rounded heart. A slight swelling in place where other slugs have lobus (WIKTOR and LIKHAREV 1980).

Very active slugs, usually living on tree trunks and rocks. Feeding mostly on lichens. Distributed over Europe and North Africa (formerly included Asiatic species belong to another genus). Most specimens met in mountains.

16 species included, many of them poorly known. Some of them can be synonymized.

Lehmannia nyctelia (BOURGUIGNAT, 1861)

Limax nyctelius BOURGUIGNAT, 1861: 305. Terra typica: Algeria.

Agriolimax (Malacolimax) kervillei GERMAIN, 1907: 154.

Mesolimax Brauni: BABOR, 1898: 41.

? *Mesolimax Brauni*: WAGNER 1937: 389.

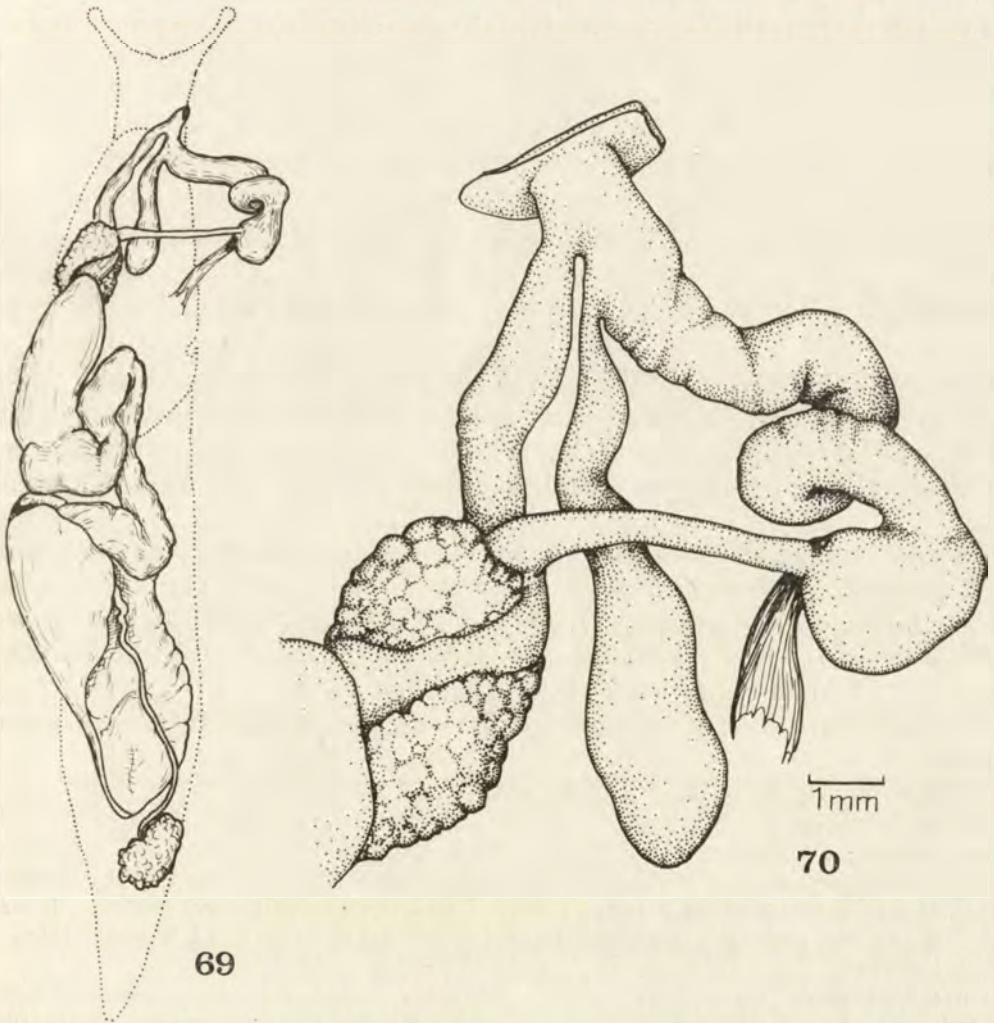
References: DAMJANOV and LIKHAREV 1975: 309 [*Limax (Limacus)*]; GROSSU and LUPU 1963: 141, 1965: 135; HUDEC 1967b: 20; JUNGBLUTH, LIKHAREV and WIKTOR 1981: 20 (radula); LIKHAREV and WIKTOR 1980: 271; PINTÉR 1968a: 180; QUICK 1960: 200; URBAŃSKI and WIKTOR 1968: 51; WIKTOR 1973: 99 [*Limax (Malacolimax)*] (illustrations and survey), 1977: 291.

Biggest preserved specimens from Bulgaria 46 mm long, 8–9 mm wide, mantle 9 mm long. Between median line and pneumostome 22 grooves. Body slim, usually broader behind mantle.

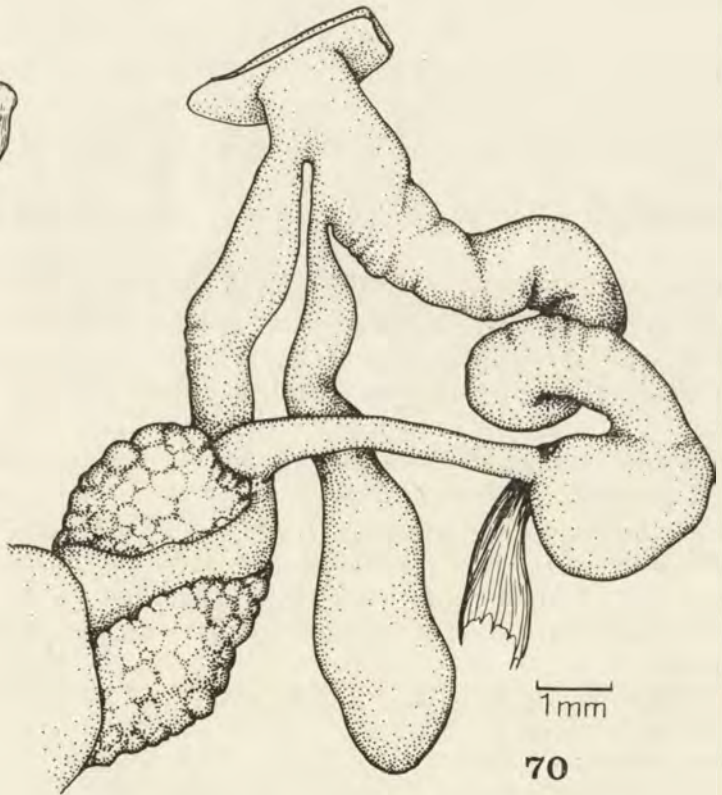


10 mm

68



69



1 mm

70

Figs. 68–70. *Lehmannia nyctelia* (BOURG.): 68 — side view, 69 — genitalia diagram, 70 — copulatory organs (specimens from Kalofer)

Colouration varied. Usually body mucky-cream with darker, grey or grey-chocolate, pattern. Bands on body sides sometimes united posteriorly. Mantle often with dark, blurred band in middle. Central part of dorsum with light strip posteriorly attaining keel, sides with two or two pairs of more or less visible bands, sometimes replaced by rows of almost black, rounded spots (Fig. 68). Also specimens almost without bands on dorsum, high mountain forms black or chocolate-black. Sole mucky-cream or grey.

Genitalia (Figs. 69–70). The species is distinguished by spirally coiled penis ($\frac{2}{3}$ of mantle length or longer), spherically broadened posteriorly. Typical whip-like penial gland absent, sometimes only small swell posteriorly. Spherical broadening of penis with big fold inside. Vas deferens thick, shorter than penis, its opening asymmetrically, rather laterally, on spherical end of penis. Retractor penis inserted at opening of vas deferens. This part of penis dark pigmented. Spermatheca shorter than penis, elongate, gradually broadening posteriorly. Spermatheca and its duct not well-delimited. Oviductus at most half of penis in length. Genitalia usually covered with dark pigmented mesenterium.

Radula: C. 77/ × 112. Particular groups of teeth not well distinguished.

Bionomics. A forest species occurring mainly in deciduous forests, esp. beech woods. Frequent in mountains, also above upper timberline. In the Rila Mts reaching up to about 2700 m a.s.l. Creeping on trees and hiding under bark, hollows in tree stumps, on rocks or rock rubble. After rain slugs creep out in great numbers, especially high in mountains. Feeding mainly on lichens.

Distribution. The range of the species has not been studied thoroughly. In natural environments it occurs in the Balkans and in the mountains of Eastern and Central Europe where it is probably native. Known from Poland, Czechoslovakia, Hungary, Rumania and Bulgaria. Also in North Africa. According to GROSSU and LUPU (1965) the species was originally distributed over a large area including the Mediterranean region while at present its occurrence is rather relict. Ecological requirements of this slug (WIKTOR 1973) indicate that it was introduced into Africa and other parts of the world. As a synanthrope known from the USA, South Africa, Great Britain and Egypt.

In Bulgaria met in all mountain massifs and belongs to most common species.

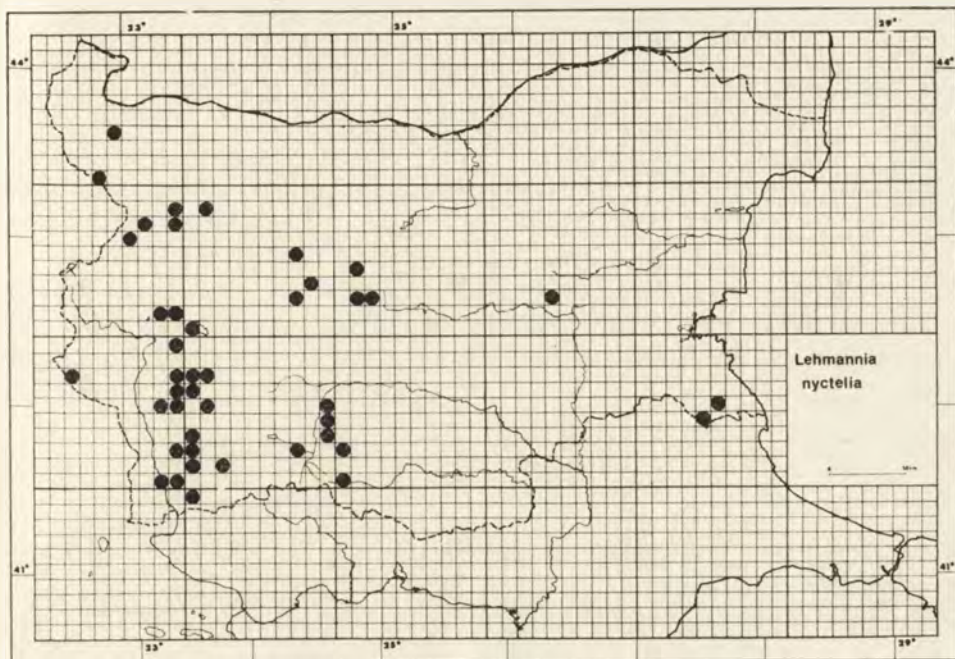
Material examined: above 300 specimens.

Records (Map 19):

Stara Planina: Vratsanska Planina — Ledenika, Purshevitsa, Cherni Osum, around Teteven, Vezhen, Kalofer leg. WARCHALOWSKI, BOROWIEC and TARNAWSKI (MNH), Karlovo. Also BABOR (1898) and WAGNER (1937) — around Sliven; OŠANOVA (1970) — Izvoza, Bela Voda, Stojanovo, Petrohan, Dabnika, Codech; URBAŃSKI and WIKTOR (1968) — Petrohan.

Plana: Kokalyane.

Vitoshka: around the Ofelin shelter and some other regions. From the same place recorded by GROSSU and LUPU (1965), URBAŃSKI and WIKTOR (1968), HUDEC (1967), OŠANOVA (1972, several records).

Map 19. *Lehmannia nyctelia*

Sredna Gora: Koprivshitsa.

Pirin: Bansko and the area around, Gostun leg. BEŠKOV and STAREGA (IZW), around the Damianitsa shelter, at Vikhren, Kamienitsa leg. BOROWIEC and TARNAWSKI (MNH), Breznitsa near Gotse Delchev, Sandanski and the Sandanska Bistritsa valley, Melnik leg. PINTÉR (HNHM).

Osogovska Planina: around the Osogovo shelter. Also URBAŃSKI and WIKTOR (1968) — Strazimirovci (= Strazimirovtsi).

Rila: the Bistritsa valley near and in the Parangalitsa reserve, above the Rilski Monastir, in the area of the Skakavitsa water fall, in the area of Sedmite Ozera, near the Lovna and Vada shelters, slopes of the Musala. Also: OŠANOVA (1968) — Krnarata; URBAŃSKI and WIKTOR (1968) — Rilski Monastir and Partyzanska Polyana.

Rodopi: around the Zdravets shelter, Bela Cherkva, Chudni Mostove, Persenk, Chepelare leg. PAWŁOWSKI and BŁASZAK (MNH), Deven, Smolyan, Smolyanske Ozera between Smolyan and Persenk leg. PINTÉR (HNHM), Dospad leg. ? (BAN), Yakoruda — recorded also by URBAŃSKI and WIKTOR (1968).

Stranzha: in the area of Malko Turnovo, the Velaka valley near Gramatikovo, Harami Bonar near Gramatikovo.

DAMJANOV and LIKHAREV (1975) recorded that species from "Gorna Traka".

Lehmannia brunneri (WAGNER, 1931)

Agriolimax Brunneri H. WAGNER, 1931b: 197. Locus typicus: "Rilo-Vr." (probably Rilets Vukhr), Rila (Bulgaria). Syntypi: Naturhistorisches Museum Vienna.

Agriolimax Brunneri: WAGNER 1937: 386.

Deroceras brunneri: JAECKEL, KLEMM and MEISE 1957: 161.

Deroceras brunneri = *Lehmannia marginata*: URBAŃSKI and WIKTOR 1968: 75.

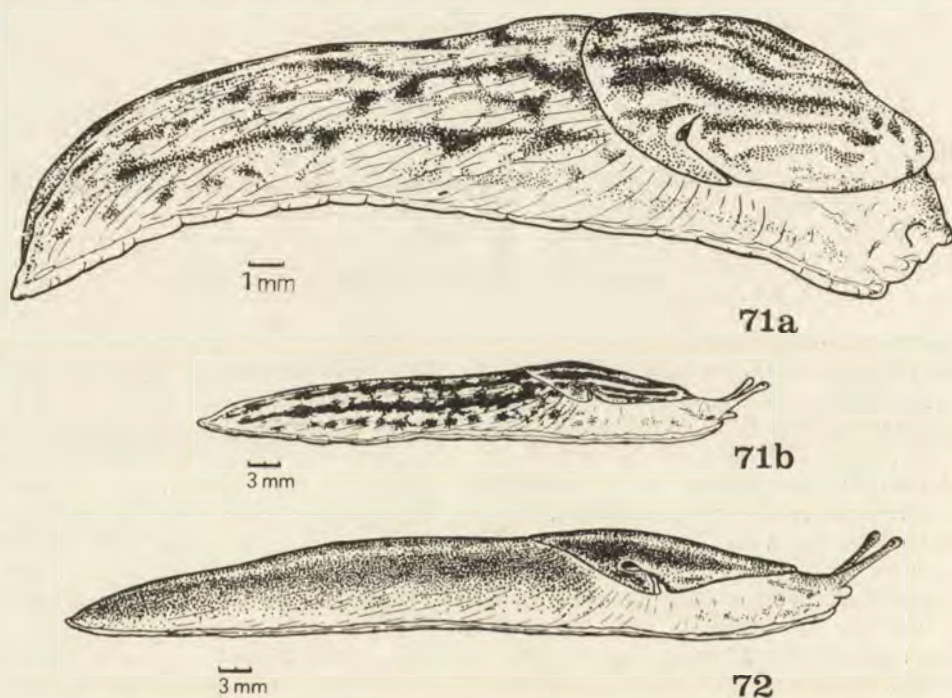
Gigantomilax occidentalis: URBAŃSKI and WIKTOR 1968: 79.

Limax (Lehmannia) macroflagellatus (partim): DAMJANOV and LIKHAREV 1975: 314 and Fig. 244.

References: see above.

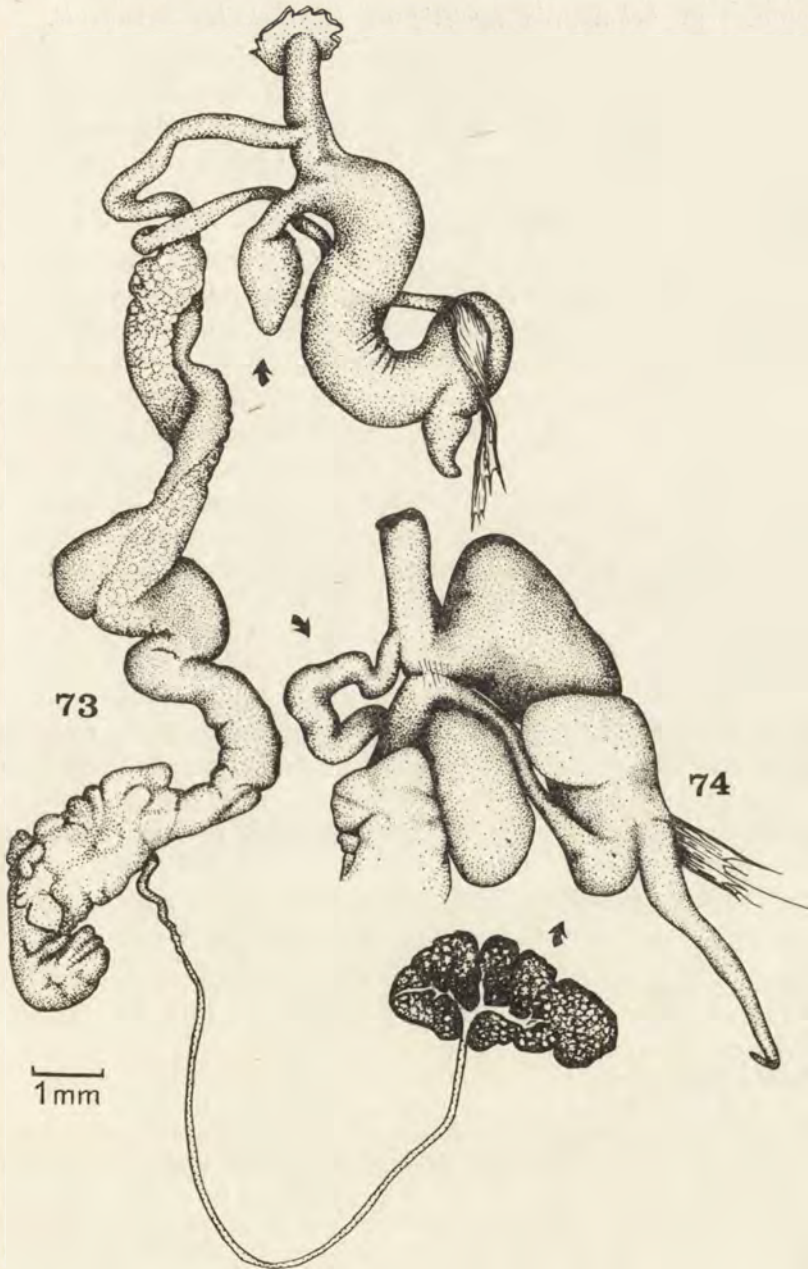
Preserved specimens up to 45 mm long, 6–7 wide, mantle 14 mm long. Between median line of dorsum and pneumostome 19–22 grooves. Body very slim.

Colouration usually uniformly deep black, sometimes dark blue in hue. Only sole light, in the middle grey-cream with blackish sides. Some specimens with sides lightening downwards till they become mucky-cream; keel and its extension with distinct lighter band (Fig. 72). Some specimens (Fig. 71) externally re-



Figs. 71–72. *Lehmannia brunneri* (WAGN.): 71 — side view of specimens from Vitosha, 72 — side view of specimen from Sandanski

semble *Lehmannia macroflagellata* GROSSU et LUPU. Body covered with distinct, contrasting, almost black, black-grey pattern on mucky-cream background. On mantle 5–7 well-delimited bands. Body sides with 4 bands and rows of spots below. Head and sole mucky-cream or brown-cream. Tentacles blackish or black. Specimens with bands are slightly smaller (up to 35 mm when preserved), known from the massifs of Vitosha and Osogova Planina. Black specimens



Figs. 73-74. *Lehmannia brunneri* (WAGN.): 73 — genitalia, 74 — copulatory organs of another specimen, the natural position of oviduct and vas deferens is preserved (specimens from Vitosha)

occur in higher mountains (Pirin, Rila) and can be easily mistaken for melanistic specimens of *Lehmannia nyctelia* or *Krynickyllus urbanskii*.

Genitalia (Figs. 73–74). Prostate without distinct broadening. Vas deferens thin and long as compared to genitalia, at least $\frac{1}{2}$ longer than penis and twice as long as oviductus. Penis much elongate, cylindrical, often S-twisted. Vas deferens opening at its posterior end. Characteristic funnel-like penis pocket changing into vas deferens (Fig. 74). All posterior end of penis, at least its junction with vas deferens, usually with dark pigment. Retractor penis inserted at the base of penis pocket. Penial gland situated laterally, whip-like, half of penis in length. Its free end almost always bent posteriorly. It should be noticed that in *L. brunneri* there is no spherical broadening at the end of penis which is characteristic of most species of this genus. Inside penis a well-developed uvular fold. Penis walls of variable thickness with outside wall thicker. Spermatheca very small, with its duct may be equal to half of penis length. Spermatheca duct opening into penis at some distance from atrium. Oviductus tubular and long as compared to other species. In natural position spermoviductus anteriorly reaching atrium so that long oviductus, finding no place between those organs, protrudes twisted from side of the whole structure (Fig. 74). Atrium tubular, well-delimited.

Radula: C. 12. 33/ × 123

Bionomics. Mountain species preferring upper timberline regions or even above. Most habitats between 1400 and 2650 m a.s.l., exceptionally at lower altitudes, always in mountains. The author always collected the slugs of this species on rocks. Although there were trees near, the slugs did not appear on them. Hiding in crevices and rock rubble. Easy to find at nightfall and in rain when great numbers of slugs creep out of their hiding-places. Most specimens collected were juveniles. Life-span — probably 2 seasons as in May and June besides juveniles also mature specimens can be found. I autumn adults dominate.

Distribution. So far known only from mountain massifs of Bulgaria.

Material examined: 238 specimens.

Records (Map 18):

Stara Planina — ? Kalofer (juv.) leg. A. WARCHAŁOWSKI (MNH).

Vitosha — Zlatnite Mostove.

Pirin — Lilyanovo near Sandanski, east of Sandanski leg. BOROWIEC and TARNAWSKI (MNH), Popina Luka leg. M. ŚWIĘCZYŃSKI (MNH), Biegovitsa in the Sandanska Bistritsa valley leg. B. POKRYSZKO (MNH), Kamienitsa Vrukh leg. BOROWIEC and TARNAWSKI (MNH), Breznitsa near Gotse Delchev, Petrich rocks on the Struma leg. URBAŃSKI (coll. URBAŃSKI).

Osogovska Planina — Osogovo.

Rila — Sedmite Ozera, Zeleni Rid, Malovitsa leg. STAREGA (IZW), the Rilska Reka valley leg. BURAKOWSKI (IZW), Granchar leg. BERON (IZW), Rilo-Vr. (syntype), Rilski Monastir leg. PINTÉR (MNHM).

Rodopi — Ognyanovo near Gotse Delchev, Chudni Mostove (Erkruprya), Smolyanske Ozera.

Lehmannia horezia GROSSU et LUPU, 1962

Lehmannia horezia GROSSU et LUPU, 1962: 196. Locus typicus: Vaideeni (Region Arges. Rumania). Holotypus: MNH "Gr. Antipa", Bucharest, No. 13134.
References: LIKHAREV and WIKTOR 1980: 267.

Preserved specimens up to 44 mm long, 9 mm wide, mantle 17 mm long. According to GROSSU and LUPU (1962) living specimens about 70 mm long. Body stout, mantle big as compared to other species. Externally resembles *Lehmannia marginata* (MÜLL.).

Body cream-grey with ill-defined darker pattern and two blurred bands on mantle (Fig. 75). Between bands mantle slightly brownish. Lateral bands only on mantle. Sides of dorsum sometimes with rows of blurred, dark ash-grey spots. Keel cream with a band of the same colour at its extension. Sole cream-coloured, too.

Genitalia (Figs. 76–78). Prostate in Bulgarian specimens usually less broadened than in the illustrations in GROSSU and LUPU (1962, Fig. 7). Vas deferens very short. Penis more or less equal to $\frac{1}{4}$ of mantle, clavate, always rounded (not flattened). Its posterior part usually dark pigmented. Musculus retractor penis very long, broad, laterally fixed to spherical broadening of penis. Vas deferens opening also laterally, near musculus retractor penis. Long, often spirally coiled, whip-like penial gland situated opposite the part of penis where retractor is inserted. Penial gland slightly longer than half of penis (Fig. 76). Spermatheca longer than penis, sometimes twice that long. Oviductus more or less equal to penis.

Radula. No clear distinction between medial and lateral teeth. Formula: C. 73/ × 129.

Bionomics. A forest species met mainly in deciduous forests in lower prealps. In Rumania at the altitude of 700 m, in Bulgaria between 1000 and 2400 m a.s.l., i.e. above upper timberline. Living on beech-trees and rocks. In the middle of June fully mature specimens were found.

Distribution. So far known only from locus typicus. In Bulgaria the author collected the slugs in central part of Stara Planina.

Material examined: 24 specimens.

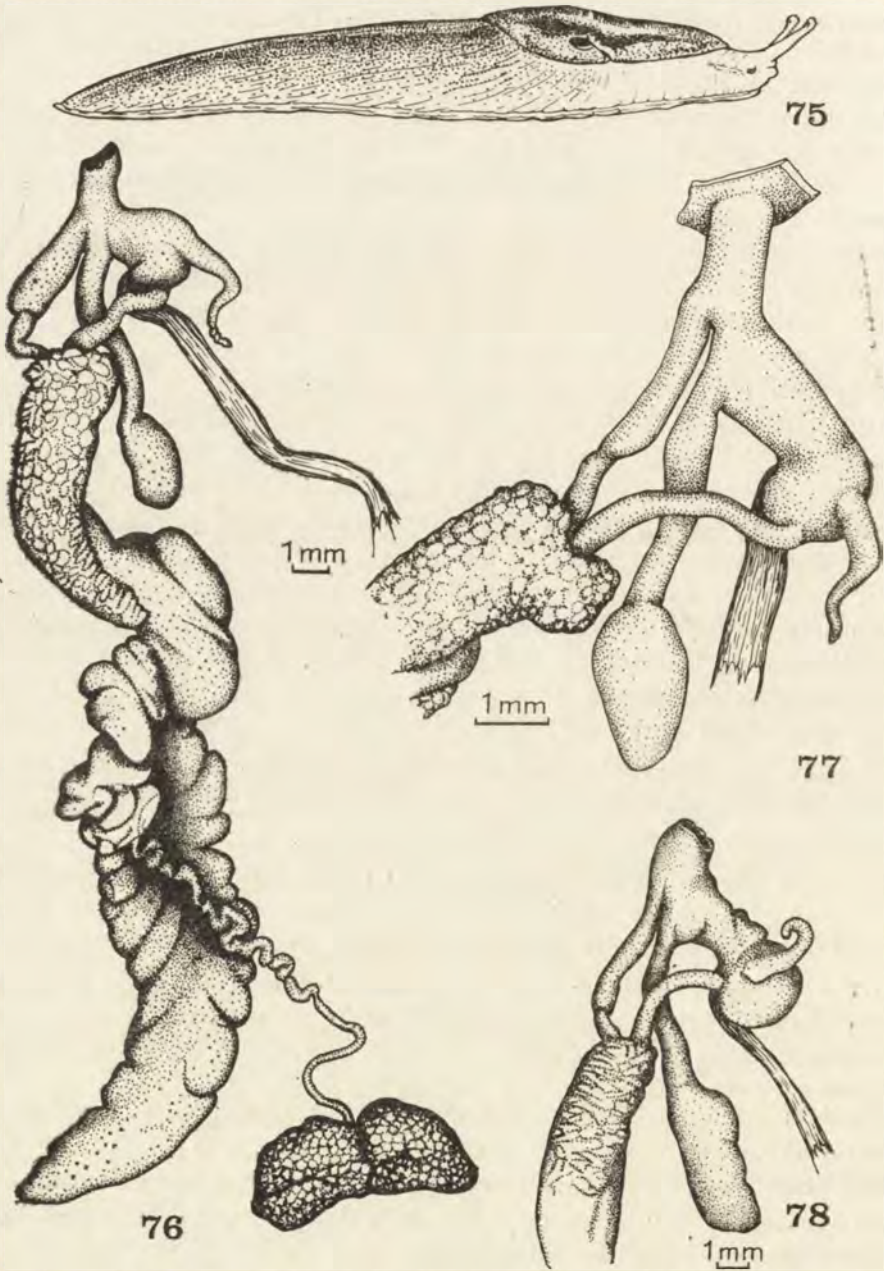
Records (Map 20):

Stara Planina: the area of Vezhen, Teteven, around Buzludzha Shipka and Kazanluk.

Comments.

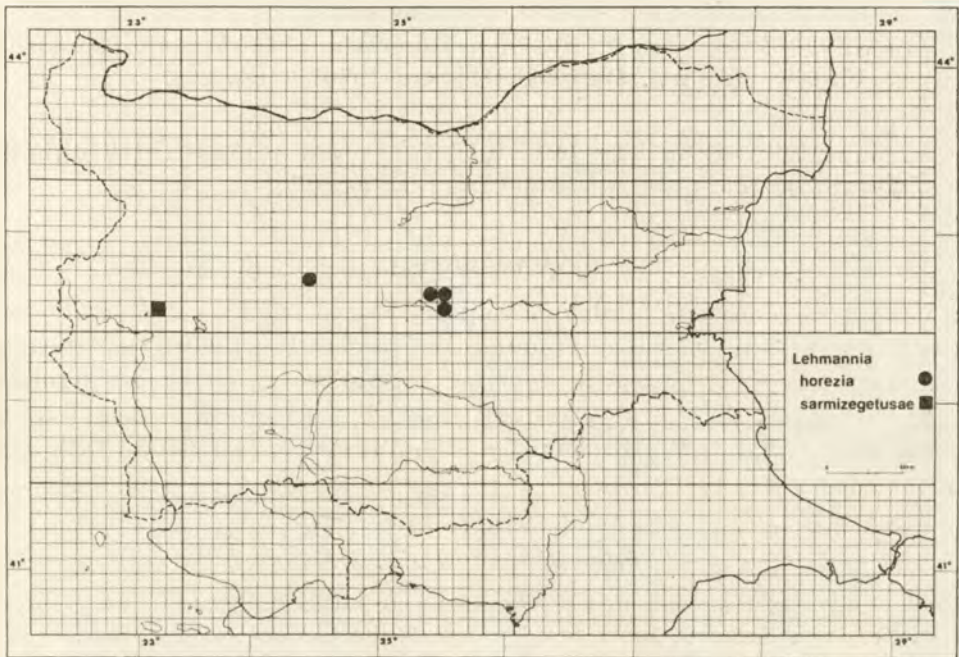
The slug resembles *Lehmannia rupicola* LESSONA et POLLONERA (see: FORCART 1966), the differences being: slightly shorter penis, longer and differently shaped spermatheca and shorter oviductus.

Descriptions in GROSSU and LUPU (1962) suggest that *L. horezia* and *L. macroflagellata* GROSSU et LUPU, 1962 are closely related. It is not so. *L. macroflagellata* is well known to the author. It is frequent in the mountains of Central Europe (see: WIKTOR 1973). *Lehmannia macroflagellata* is smaller, slimmer,



Figs. 75-78. *Lehmannia horezia* GROSSU et LUPU: 75 — side view, 76 — genitalia, 77-78 — copulatory organs of two other specimens (77 — specimen from Vezhen, 78 — specimen from Buzludzha)

with a distinct (not blurred) pattern on body which posteriorly is intensively spotted. They also differ in anatomy: more spherically broadened prostate, smaller, conical, often flattened (triangular) penis. Penial gland thinner as compared to penis and much longer. Spermatheca smaller, spermatheca duct longer.



Map 20. *Lehmannia horezia* and *Lehmannia sarmizegetusae*

As indicated by the description *Lehmannia medioflagellata* LUPU, 1968 is a similar species as can be seen in genitalia structure. Big and broad bursa copulatrix may be swollen with sperm. An essential difference is shorter coecum which the authoress emphasized in her description.

Lehmannia sarmizegetusae GROSSU, 1970

Lehmannia sarmizegetusae GROSSU, 1970: 110. Locus typicus: valley of the Lapusineul Mic river in the Retezat Mts (Rumania). Holotypus: GROSSU's collection.

Taxonomic status of this slug is unclear to the author since the description given by GROSSU does not include any features distinguishing it among other known species.

According to GROSSU (1970) preserved specimens are up to 30 mm long. Body yellow-brown, darker on dorsum, lightening downwards. Mantle with

dark bands. Head with yellow band, sides of head with numerous longitudinal spots.

Penis elongate, cylindrical, with subterminally and laterally situated short and flattened penial gland. Distinctive features given by GROSSU: thin vas deferens, its junction with penis and shape of penial gland. Spermatheca duct thick, in length more or less equal to oviductus.

Known only from a few records from Rumania, one of the paratypes comes from the Vitosha massif in Bulgaria (GROSSU 1970), (Map 20).

Comments.

My impression of the description and illustration in GROSSU (1970) is that *L. sarmizegetusae* does not differ from *L. horezia*.

Lehmannia sp.

Literature concerning Bulgaria contains information on *Lehmannia marginata* (MÜLL.). The author has not found that species. It is known that the name of *L. marginata* was commonly used for several species, now distinguished. As the author has no proofs he cannot state what species were meant by the the following authors: WAGNER (1934a, 1934b), OŠANOVA (1970, 1972), DAMJANOV and LIKHAREV (1975).

Malacolimax MALM, 1868

Malacolimax MALM, 1868: 66. Typus: *Limax tenellus* MÜLLER, 1774.

Microheynemannia SIMROTH, 1891: 302. Typus: *Limax tenellus* NILSSON, 1822.

References: HESSE 1926: 12; LIKHAREV and WIKTOR 1980: 258; WIKTOR 1973: 77.

Medium-sized and small slugs not longer than 60 mm. Keel short, ill-defined. Body usually light, unicolour, or with ill-defined lateral bands on mantle sides. Sole unicolour.

Penis short, bulb-shaped or in form of a barrel. Vas deferens swollen anteriorly, fused or situated close to posterior part of penis. Penis with folds inside, without stimulator. Spermatheca duct short, opening into penis or at its junction with atrium. Prostate fused with female duct. Radula with central and lateral teeth tricuspid, marginal with two or four cusps.

Life-cycle about one year. Eggs transparent.

Seven species included, mostly poorly known.

Distribution. Probably besides West and Central Europe also areas of North Africa.

Malacolimax tenellus (MÜLLER, 1774)

Limax tenellus MÜLLER, 1774: 11. Locus typicus: Frideriksdal near Copenhagen (Denmark).

Synonyms: *Limax serotinus* SCHRENK, 1848; *Limax cereus* HELD, 1849; *Limax collinus* NORMAND, 1852; *Limax sylvaticus* DUMONT et MORTILLET, 1852; *Limax flavus*

NORMAND, 1852; *Limax cinctus* HEYNEMANN, 1862; *Limax xanthius* BOURGUIGNAT, 1866. (Bibliography in HESSE (1926)).

References: DAMJANOV and LIKHAREV 1975: 310; LIKHAREV and WIKTOR 1980: 259; QUICK 1960: 180; WIKTOR 1973: 78, 1977: 291.

Body length up to 50 mm, in preserved specimens about 35 mm. Body stout, mantle relatively big, covering almost $\frac{1}{3}$ of body. Integument thin, soft, finely sculptured.

Colouration uniform, i.e. without pattern of spots, in various hues of intense yellow. Head and tentacles blackish. Sole white-cream. Mantle, less frequently dorsum sides, with blurred grey bands absent in living specimens.

Slime watery, yellow.

Genitalia. Penis short, bulb-shaped. Vas deferens opening into penis archwise, surrounding its apical end in form of a fused crescent roll. The latter usually slightly uneven, with dark pigmentation. Inside part of penis divided into two longitudinal pockets. Spermatheca oval, shorter than penis.

Formula of radula: C. 12-18. 35-42/ × 110-140.

Bionomics. Species living in various types of forests, also in parks and shrubs. Choosing well-shaded, moist sites. Hiding in undergrowth and under wood logs. Mature in autumn or at the end of summer. Feeding on mushrooms. Met both in lowlands and mountains.

Distribution. Almost all Europe, from France to Moscow and Kazan in the USSR, from Scandinavia to Bosnia, Macedonia and Romanian Dobruja.

Habitats in Bulgaria require confirmation. It was recorded by JURNIČ (1906) from Rodopi but we know that the author used the keys for Central European fauna when designating the slugs. DAMJANOV and LIKHAREV (1975) recorded the species from Belogradchik i.e. from north Bulgaria. In this region the author collected juvenile slugs which could have belonged to *L. tenellus* but were too young to be identified.

Comments.

Preserved slugs can be easily mistaken for some species of *Deroceras*, sometimes also *Lehmannia*. But they can be easily identified by intestine.

Agriolimacidae WAGNER, 1935

Agriolimacidae WAGNER, 1935: 174; *Deroceratinae* MAGNE, 1952: 30; *Derocerasinae*: HUDEC 1972: 84.

References: LIKHAREV and WIKTOR 1980: 123; WAGNER 1935: 174; WIKTOR 1973: 103, 105; WIKTOR and LIKHAREV 1980: 418.

Slugs of small length, usually between 20 and 30 mm, rarely up to 60 mm. Body often stout, tapering posteriorly. Mantle big, covering more than $\frac{1}{3}$ of body, with concentric grooves on its surface. Pneumostome post- or antemedially surrounded by well-delimited round plate. Keel short, reduced. Grooves on

body ill-defined. Between median line of dorsum and pneumostome less than 20 grooves. Sole divided into 3 zones, 2 outside zones with transversal grooves arranged at the right angle in relation to body axis. Central zone with V-shaped grooves.

Body unicolour or spotted, never with bands.

Slime watery, colourless, in some irritated specimens also milky, turbid liquid is excreted.

Shell much flattened, asymmetric or symmetric, i.e. the embryonic part may be situated on the longitudinal axis of shell.

Genitalia. Penis short, spherical, cylindrical and almost always narrowed in the middle. Most species with various accessory structures, e.g. penial gland, usually branched pockets and appendices. Penis may be partly surrounded with tubular membrane. Most species with stimulator inside penis. Epiphallus and accessory glands on atrium and oviductus absent. Musculus retractor penis only exceptionally crossing right tentacle.

Eggs soft and transparent.

Jaw oxygnathic. Intestine with only two loops, the second one longer than the first one. Coecum, if present, only slightly longer than its width, connected with rectum.

Distribution. Almost all Holarctic, most genera and species in Palearctic.

The following genera included: *Deroceras*, *Krynickillus*, *Mesolimax*, *Lytolpelte*, *Megalopelte* and *Pseudarion*. Together about 150 species.

Genus *Deroceras* RAFINESQUE, 1820

Deroceras RAFINESQUE, 1820: 10. Typus: *Limax gracilis* RAFINESQUE, 1820 [= *D. laeve* (MÜLLER, 1774)].

Agriolimax MÖRCH, 1865: 378. Typus: *Limax agrestis* L. — Till very recently in European literature the name of *Agriolimax* MÖRCH was used for all representatives of this genus.

References: DAMJANOV and LIKHAREV 1975: 313; FORCART 1965: 111; HESSE 1926: 21; LIKHAREV and WIKTOR 1980: 125; QUICK, 1960: 163; PILSBRY 1948: 532; WIKTOR 1973: 102; WIKTOR and LIKHAREV 1980: 418 (pallial complex).

Preserved specimens up to 45 mm. Mantle relatively big, usually about $\frac{1}{3}$ of body length or longer. Keel very short. Between middle dorsum line and pneumostome up to 14 grooves.

Colouration cream, brown, grey or black. Uniform or light background with detached, as if splashed, pigment. Sometimes irregular network.

Slime watery, colourless, some species when irritated produce dense, milk-white excretion.

Genitalia. Retractor penis does not cross retractor of right ommatophore. Penis short, spherical, cylindrical or divided in two by a narrowing, sometimes with appendices. Retractor penis attached rather laterally than apically. Penial gland of various shapes, often branched, usually big, less frequently in form

of one small or several papillae or hooked appendix. In many species penis with pocket-like swelling or appendices. Penis always with stimulator inside. Stimulator conical, fan-like or shovel-like. Its surface covered by thin and numerous strips externally resembling human dermatoglyphics, sometimes also a hard slate. Often besides stimulator stripped fold in penis. Spermatheca big, oval, spermatheca duct short, together equal in length. Atrium short.

Jaw with central protuberance (oxygnathic). Radula with central and lateral teeth tricuspid, marginal teeth dagger-like.

Intestinal coecum present or absent.

Shell with nucleus (embryonic part) leftwards. Slugs living on ground and green plants, do not climb trees, mesophylic and hygrophylic.

Distribution. Almost all Holarctic but most species in Palearctic, especially in its western parts. In the north reaching the tundra zone.

About 100 species in 4 subgenera.

Subgenus *Deroceras* s. str.

Synonyms (all partim): *Hydrolimax* MALM, 1868 and *Arctolimax* WESTERLUND, 1894, *Malino* GRAY, 1885.

References: DAMJANOV and LIKHAREV 1975: 316; LIKHAREV and WIKTOR 1980: 128; WIKTOR 1973: 106.

Body narrow, sides more or less parallel. Mantle big, almost half of body length, its posterior edge reaching near of body. Skin soft, partly transparent, through which the shape of inner organs can be seen. Colouration uniform or spotted cream, brown or black.

Slime colourless, very watery.

Penis usually elongate. Its posterior part with one or two appendices or pockets. Penial gland in form of small papillae or bifurcated appendices. Stimulator in shape of hemispherical papillae or obtuse cone.

Intestinal coecum absent or in form of small and shallow pocket which in length is at least equal to its width.

Slugs favouring humidity, living near water in both open and forested biotopes.

Distribution. Almost all Holarctic.

Deroceras (Deroceras) laevis (MÜLLER, 1774)

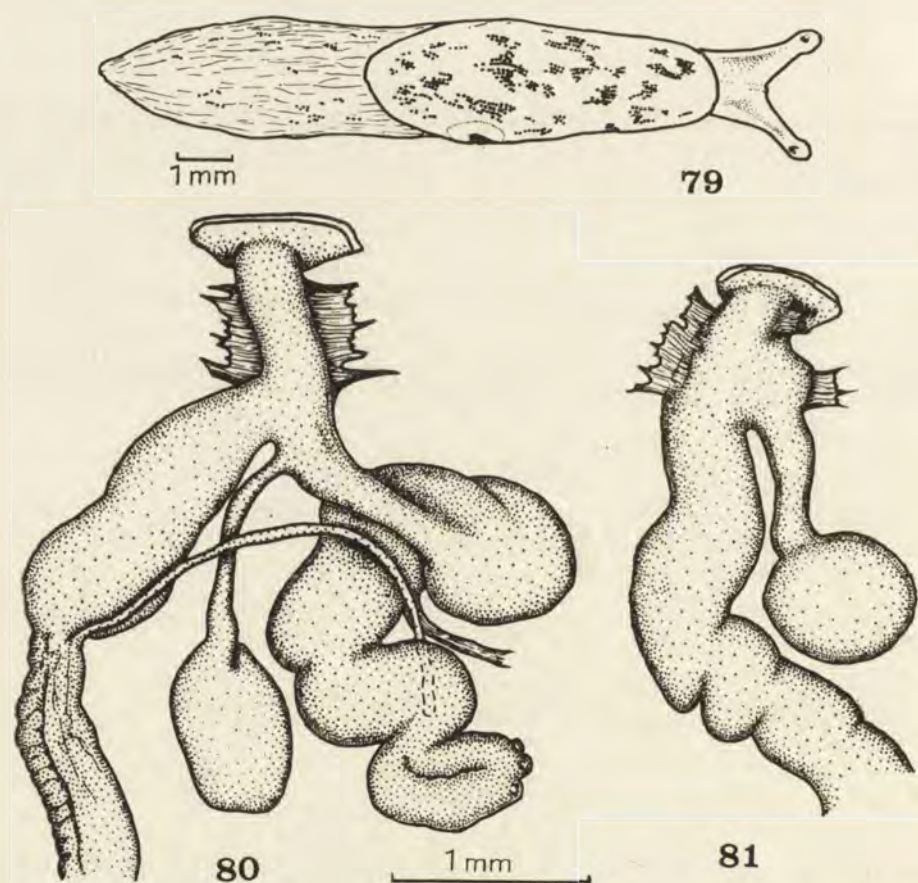
Limax laevis MÜLLER, 1774: 1. Locus typicus: Frideriksdal near Copenhagen (Denmark). *Agriolimax renschi* WAGNER, 1934b: 89 (syn. n.) Aphallic specimen. Locus typicus: Rilski Monastir (Rila Mts, Bulgaria). Holotypus: Zoologisches Museum Berlin No. 78336.

Other synonyms: *Limax brunneus* DRAPARNAUD, 1801; *Limax gracilis* RAFINESQUE, 1820; *Limax campestris* BINNEY, 1842; *Limax parvulus* NORMAND, 1852; *Limax weinlandi*

HEYNEMANN, 1862; *Limax araneus* GESSIS, 1867; *Agriolimax bovenoti* COLLINGE, 1870; *Limax montanus* INGERSOLL, 1875; *Limax castaneus* INGERSOLL, 1875; *Limax ingersolli* BINNEY, 1875; *Limax hyperboreus* WESTERLUND, 1876; *Krynickillus montanus* NEVILL, 1880; *Limax Hemphilli* BINNEY, 1890; *Limax berendti* var. *pictus* COCKERELL, 1897; *Agriolimax psudodioicus* VELICHKOVSKIJ, 1910. (Full quotations — see references).

References: DAMJANOV and LIKHAREV 1975: 316; GITTENBERGER, BACKHUYS, RIPKEN 1970: 83; LIKHAREV and WIKTOR 1980: 129; PILSBRY 1948: 539; QUICK 1960: 172 (survey); WALDÉN 1956: 347; WIKTOR 1973: 106 (survey and illustrations), 1977: 291.

Living slugs up to about 25 mm in length, preserved up to 22 mm, usually 11 mm. Mantle almost half of body length. Body slim (Fig. 79), posteriorly obtusely narrowing. Keel ill-defined, short. Skin thin, as if watery. In living specimens skin pattern well-distinct, consisting of longitudinal grooves, 10–14 between median line of dorsum and pneumostome.



Figs. 79–81. *Deroceras (D.) laeve* (MÜLL.): 79 — top view (specimen from Poland), 80 — copulatory organs of an euphalic specimen from Belogradchik, 81 — copulatory organs of aphalic specimen from Bansko

Colouration usually chocolate-black, brown or less frequently brown-cream. Seen with the naked eye looks unicolour, when examined with a magnifying glass distinct small, blackish spots. Tentacles blackish. Sole slightly lighter than dorsum. Its central zone more transparent than two lateral, more grey, ones.

Genitalia (Figs. 80–81). Male copulatory organs often reduced which may lead to full aphyly (PILSBRY 1948; WIKTOR 1973). Specimens with both female and male organs fully developed are usually smaller and darker. Their glandula albuminalis is small. Vas deferens thin and very long, opening into penis laterally at about $\frac{2}{3}$ of its length. Penis much elongate, irregular in shape, with a broadening in its anterior part. Its posterior part tubular, sometimes with several swellings. The whole organ sometimes hooked or spirally coiled. Posterior penis part behind vas deferens' opening probably functions as a penial gland which is proved by the presence of 2–3 small papillae on its apical end. Musculus retractor penis inserted laterally at about half of penis length. Stimulator small, hemispherical or obtusely conical. Spermatheca duct as long as spermatheca or shorter. Oviductus thick, tubular, usually longer than spermatheca. Atrium tubular, too.

Reduction of male organs most often concerns penis. Penis may be shorter, poorer, survive as a broadening or swell on atrium into which a shortened vas deferens opens. Further reduction may lead to the disappearance of even trace of penis, blind end of vas deferens having no connection with atrium. In extreme cases no free vas deferens (Fig. 81). Female organs never reduced. Forms with reduced penis are bigger with bigger glandula albuminalis and oviduct.

Radula: C. 12–13. 24–29/ × 84–108.

Intestine without coecum, only with groove in its place.

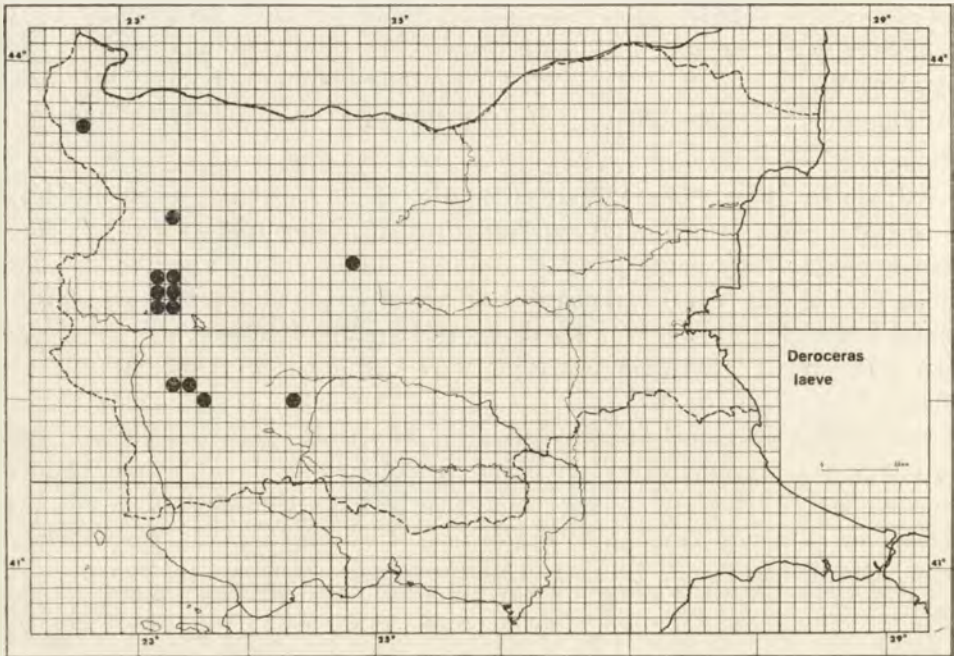
Bionomics. A hygrophyllic slug. Found near water, at rivers, lakes and ponds, wet meadows and forests, especially alder and oak woods. Hiding in decaying detritus, under wood logs, in soil and peat. The slug may spend some time under water without consequences, not losing its ability to crawl. The specimens of various reproductory stages were found throughout the year. Probably there is no special reproductory season. Life-cycle very short, only about 2 months. Met mainly in lowlands and lower mountains but in the Alps even at the altitude of 2300 m. Besides humidity requirements it is a slug of great ecological tolerance, therefore it occurs in the tundra zone as well as in the tropics. Often synanthropic, also in greenhouses.

Distribution. Natural range covers the whole Holarctic. As a synanthrope introduced into many continents and islands.

It can be expected in the whole area of Bulgaria although known from few habitats.

Material examined: 27 specimens.

Records (Map 21):

Map 21. *Deroceras laeve*

Stara Planina: Belogradchik and around, Lakatnik on the Iskur river, Cherni Osum.
 Sofia and the area around: DAMJANOV and LIKHAREV (1975); Sofia — greenhouses; Simeonovo, Dragalevtsi.
 Rila: the area around Yakoruda, also DAMJANOV and LIKHAREV (1975) — Maliovitsa, WAGNER (1934b) — Rilski Monastir.
 Rodopi: the Snezhanka reserve near Peshtera.

Comments.

Till recently mistaken for *Deroceras (D.) sturanyi* (SIMR.) (WIKTOR 1973) therefore previous references to this species (also SIMROTH's) should be revised.

Deroceras (Deroceras) sturanyi (SIMROTH, 1894)

Agriolimax Sturanyi SIMROTH, 1894: 393. Locus typicus: the area of the Ohrida Lake (Yugoslavia). Lectotypus (design. WALDÉN): Naturhist. Mus. Vienna No. 19493b.
Deroceras romanicus GROSSU et LUPU, 1959a: 46. Locus typicus: Sibiu (Rumania).

References: HUDEC, 1970: 109; KOSIŃSKA 1980: 113 (life history); LIKHAREV and WIKTOR 1980: 132; LUPU 1972: 88; PINTÉR 1968b: 111; REISCHÜTZ 1973: 8; URBAŃSKI and WIKTOR 1968: 65; WALDÉN 1966: 63; WIKTOR 1971: 274, 1973: 113 (survey), 1977: 291.

Living specimens up to about 38 mm in length, preserved to 20 mm, mantle 7–8 mm long. When crawling posterior mantle edge situated in posterior body end. Body shape similar to *Deroceras laeve* but bigger and stouter (Fig. 82).

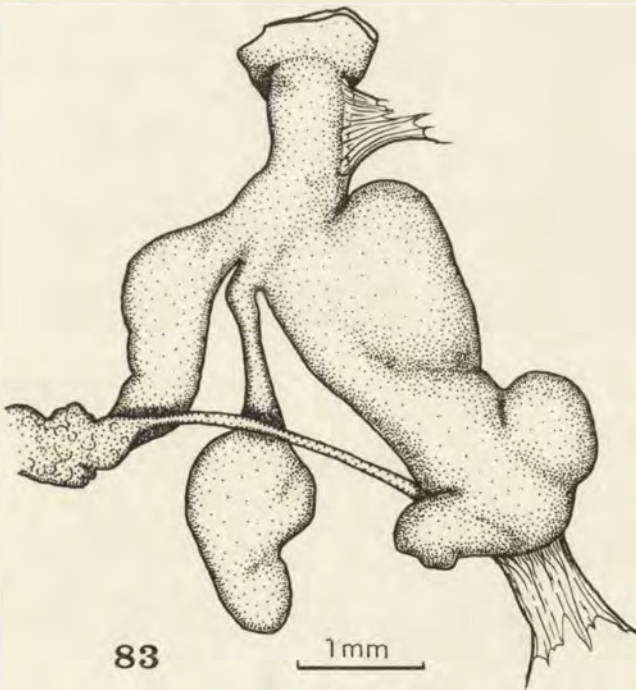
Keel ill-defined. Skin thin, transparent, its sculpture fine, in preserved specimens hardly visible. Preserved slugs with whitish strips on body sides.

Colouration uniform, without spots. Dorsum slightly darker than sides. Most frequently mucky-cream, coffee-coloured, less frequently grey-cream, brown and exceptionally black.

Genitalia (Fig. 83). Vas deferens thin, more or less equal to penis in length. Anterior part of penis cylindrical. Its posterior part with two pocket-like, asymmetrical structures, situated across the long axis of penis, together in



82



83

Figs. 82-83. *Deroceras (D.) sturanyi* (SIMR.): 82 — top view (specimen from Poland), 83 — copulatory organs (specimen from Bulgarene)

form of a hammer. One of the pockets usually longer and narrower, sometimes divided into penial appendices or covered by small papillae. It is a penial gland. The other one smaller and hemispherically rounded. Opening of vas deferens

and musculus retractor inserted laterally between the two pockets. Stimulator obtusely conical. Genitalia, at least in part, covered by dark brown mesenterium.

Formula of radula: C. 12-16. 28-41/× 94-102.

Intestinal coecum absent or near gonad on rectum a slight bent, a broadening or a shallow plate is present.

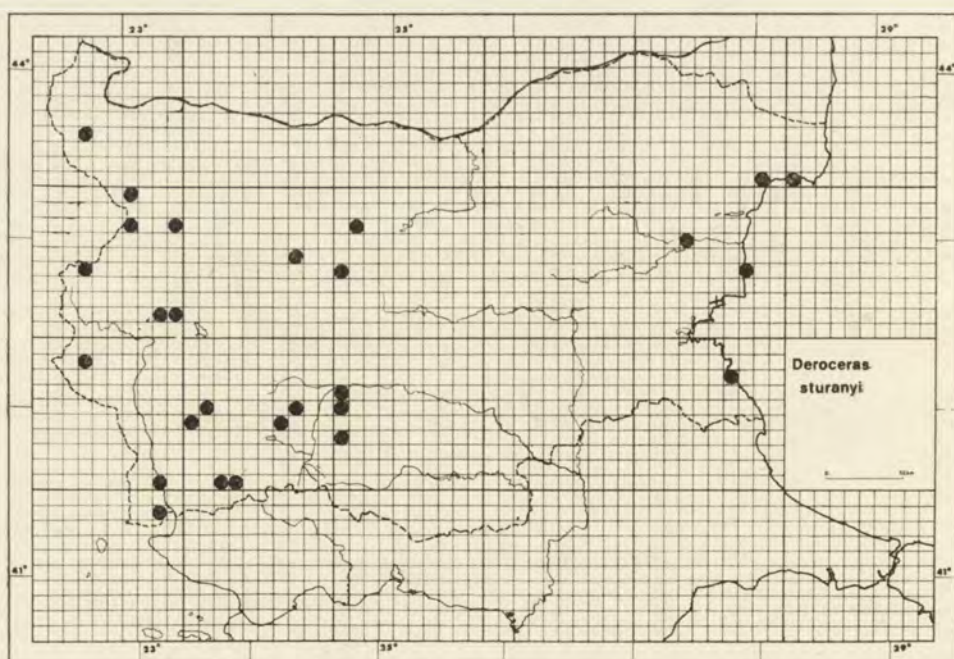
Bionomics. Mesophylic species but met in wet biotopes. Always in open biotopes or only shaded by bushes or under single trees. Very frequent in ruderal biotopes. Found in meadows, at roadsides, in parks and gardens, vegetable lands, cellars, etc. Hibernating as eggs, first generation appearing in spring. Mature forms met since the beginning of summer till first ground frosts, which probably kill them. Numerous but not in great numbers. May behave as pests.

Distribution. Almost the whole Europe but recognized not long ago therefore mentioned only in newest publications. Recorded from Bulgaria, Yugoslavia, Rumania, Hungary, Austria, F.R.G., Poland, the Netherlands, Czechoslovakia and the Gothland Island. Known also from the European part of the USSR. Probably met in Turkey (WIKTOR 1971). Found in greenhouses in Kazakhstan. Original distribution unknown, as it occurs as a synanthrope.

Material examined: above 350 specimens.

Records (Map 22):

Stara Planina: Belogradchik, Lakatnik, Berkovitsa leg. TOTEV (MNH), Teteven on the Beli



Map 22. *Deroceras sturanyi*

Vit, Bulgarene near Lovech, Beli Osum near Troyan. Also: URBAŃSKI and WIKTOR (1968) — Berkovitsa; OŠANOVA (1970) — Hajdushki Vodopad, Moravitsa, Berkovitsa, Shishmanovo.

Vitosha — OŠANOVA (1972)

Pirin: the area of Petrich, Bansko and Sandanski leg. BOROWIEC and TARNAWSKI (MNH). Trun and Kyustendil — URBAŃSKI and WIKTOR (1968)

The Mesta valley at Gotse Delchev and near Yakoruda.

Rodopi: Plovdiv, Bachkovski Monastir leg. PINTÉR (HNHM), Hvoina, Peshtera, Batak, Ognyanovo near Gotse Delchev.

The Black Sea coast: Kavarna leg. URBAŃSKI, Batova near Balchik, Gara Sindel near Provadya, Obzor, the Ropotamo mouth. Also: URBAŃSKI and WIKTOR (1968) — Nesebur.

Comments.

Until recently mistaken for *Deroceras laeve* as SIMROTH (in his work, 1885) include illustrations (T. 9 Fig. 17 VIII C and 18 VIII D) interpreted as presenting *D. laeve*. When the same author described *D. sturanyi* (1894) he did not mention that he had already described the slug mistaking it for *D. laeve* (see WIKTOR 1973).

The two species can be easily differentiated; *D. sturanyi* is never spotted, penis differently shaped, stimulator bigger, more conical. Aphallic form absent in this species. Life-cycle longer, living only in open biotopes. The authors made a mistake considering the species as a dimorphic form of *D. laeve* (WIKTOR 1973).

Deroceras (Deroceras) panormitanum (LESSONA et POLLONERA, 1882)

Agriolimax panormitanum LESSONA et POLLONERA, 1882: 52. Locus typicus: Palermo (Sicilia).

Agriolimax Polloneræ SIMROTH, 1889b: 179. Locus typicus: Palermo.

Agriolimax Caruanae POLLONERA, 1891: 3. Locus typicus: Porta Reale, Malta. Syntypus (?): Senkenbergisches Museum, Frankfurt a/M., No. 165017 (ALTENA 1962).

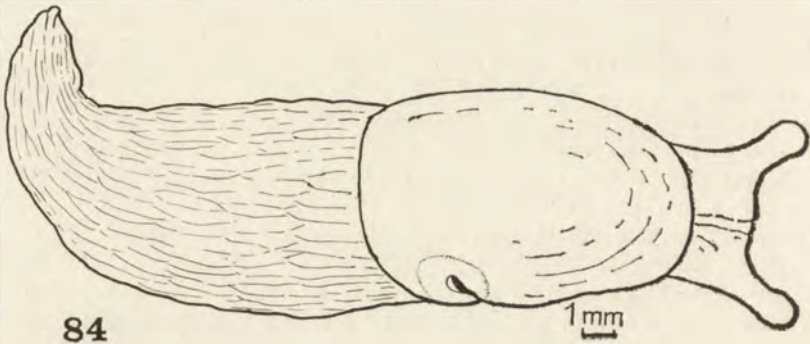
Agriolimax dubius HOFFMANN, 1941: 254. Locus typicus: Palermo, Sicilia. Syntypus: Mus. Basel.

Deroceras meridionale REYGRABELLET, 1963: 339. Terra typica: Bouches-du-Rhone and Low Alps (Basses-Alpes).

References: ALTENA 1962: 48 (*caruanae*); CHEVALLIER 1970: 387 (*caruanae*); DAMANOV and LIKHAREV 1975: 318 (*caruanae*); GIUSTI 1973: 208, 1976: 218 (synonyms); LIKHAREV and WIKTOR 1980: 135 (*polloneræ*); PINTÉR 1974: 133 (*caruanae*), QUICK 1960: 75 (*aruanae*); WALDÉN 1960: 30 (*caruanae*).

Body length in Bulgarian preserved specimens up to 30 mm, width 5.5 mm and mantle length 12 mm. More than half of mantle not accreted, free, easily bent anteriorly. Keel hardly visible. Body stout (Fig. 84). Skin thin and soft, poorly sculptured. Between median line and pneumostome 11 grooves.

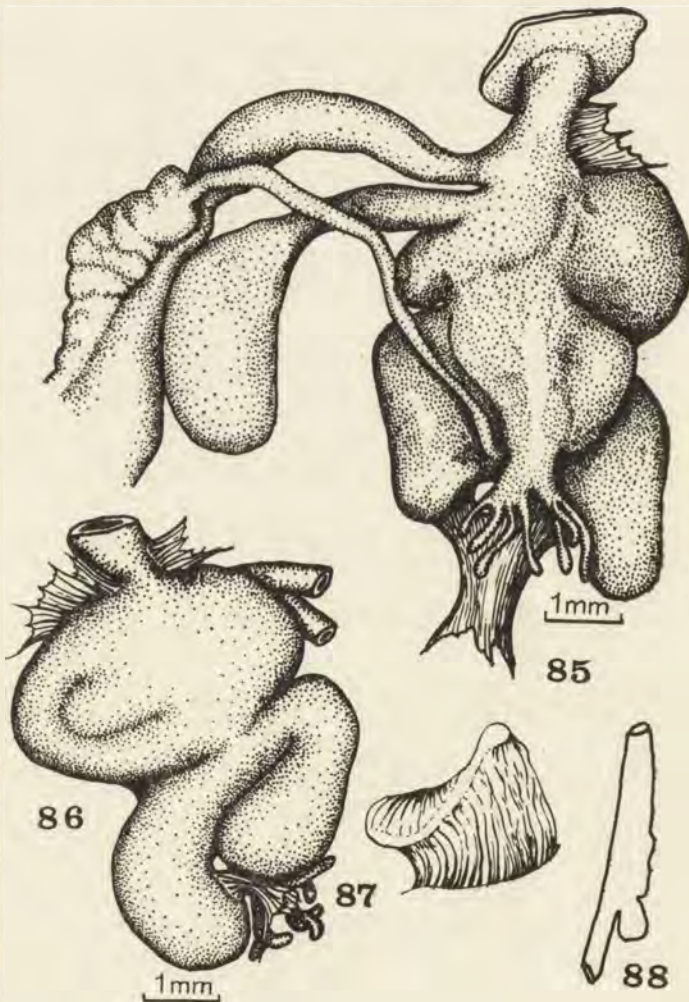
Colouration in all Bulgarian specimens known to the author differs from the described above. All body uniformly black, dark grey or light violet in hue. Sides slightly lighter. Sole cream-grey. In other parts of Europe grey, cream or brown slugs occur. Also specimens with dark spots.



84

1mm

Fig. 84. *Deroceras (D.) panormitanum* (LESS. et POLL.) — top view (specimen from Bistritsa)



1mm

85

86

87

1mm

88

Figs. 85–88. *Deroceras (D.) panormitanum* (LESS. et POLL.): 85 — copulatory organs, 86 — penis seen from the other side, 87 — stimulator, 88 — intestinal coecum (specimens from Bistritsa)

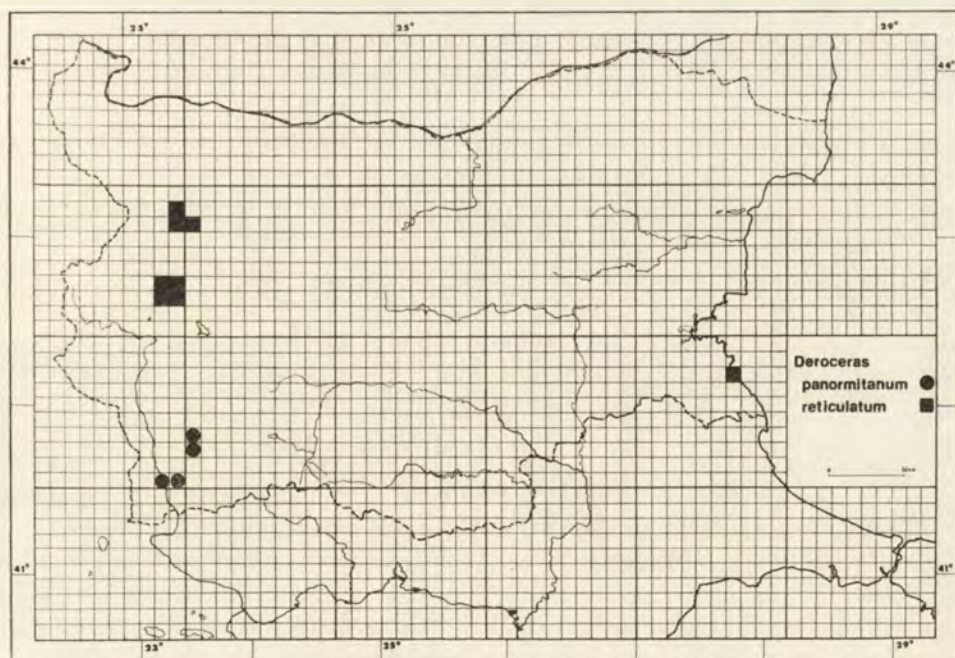
Genitalia (Figs. 85–87). Penis big, distinctly divided with a narrowing into two parts. In posterior parts two hooked, usually equal in length, bent to each other and directed backwards appendices. Between them penial gland is situated. Penial gland in shape of brush, i.e. with a distinct “handle” and only in distal part divided into 5–6 digital (not ramified) appendices (!) forming two groups. Surface of the appendices smooth, without papillary swellings. In juveniles the gland may be undivided. Vas deferens opening into penis between hooked appendices near penial gland. Musculus retractor penis bifurcated and fixed to both appendices. Stimulator flattened, sometimes almost lobate (Fig. 87). Sometimes its end slightly elongate in form of uvula. Atrium long, tubular.

Radula of Bulgarian specimens: C. 18.34/× 98.

Intestinal coecum as a small pocket (Fig. 88). According to some authors (QUICK 1960) coecum is absent in this species, according to others (WALDÉN 1960) it is present.

Bionomics. In Bulgaria met at the altitude of 1250–2500 m a.s.l. in humid biotopes, at streams, in mixed and coniferous forests. In the middle of June most slugs mature.

Distribution. Occurring in Sicily, in the Tuscan Archipelago and Bulgaria. As introduced recorded from Great Britain, Farover Islands, France, Belgium, Denmark, Sweden, Finland, Hungary and California.



Map 23. *Deroceras panormitanum* and *Deroceras reticulatum*

Material examined: 70 specimens.

Records (Map 23):

Pirin: Bańsko, around the Damianitsa shelter, around Biegovitsa near Sandanski and Popina Luka.

Comments.

Taxonomic status of this slug is not clear. Recently, the problem has been dealt with by GIUSTI (1973, 1976). It is worth noticing that in GIUSTI the stimulator of the specimens he examined was conical while in Bulgarian specimens the organ is flattened.

Subgenus *Agriolimax* MÖRCH, 1865

Agriolimax MÖRCH, 1865: 378 (as subgenus *Limacis*). Typus: *Limax agrestis* LINNAEUS, 1758.

References: HESSE 1926: 23; LIKHAREV and WIKTOR 1980: 142; WIKTOR 1973: 120.

Body stout, cuneately narrowing posteriorly. In fully extended slugs mantle $\frac{1}{3}$ body length, posterior edge does not attain half of body. Skin thick, not transparent. Body intensively spotted, rarely unicolour. Slime in crawling slugs colourless, in irritated ones — milk-white, turbid.

Penis short, spherical or with fissure in middle. Penial gland in form of single or branched appendix. Other accessory structures (appendices) absent. Stimulator conical, narrowed apically, less frequently laterally flattened.

Intestinal coecum always present, usually several times longer than wide, exceptionally in form of shallow pocket.

Deroceras (Agriolimax) turcicum (SIMROTH, 1894)

Agriolimax turcicus SIMROTH, 1894: 392. Locus typicus: Ohrid (Yugoslavia). Lectotypus: Naturhist. Mus. Vienna No. 19491.

Deroceras wiktorei GROSSU, 1969: 168. Locus typicus: Orşova — Eşalniţa on the left bank of the Danube (Rumania). Holotypus: coll. GROSSU 1147.

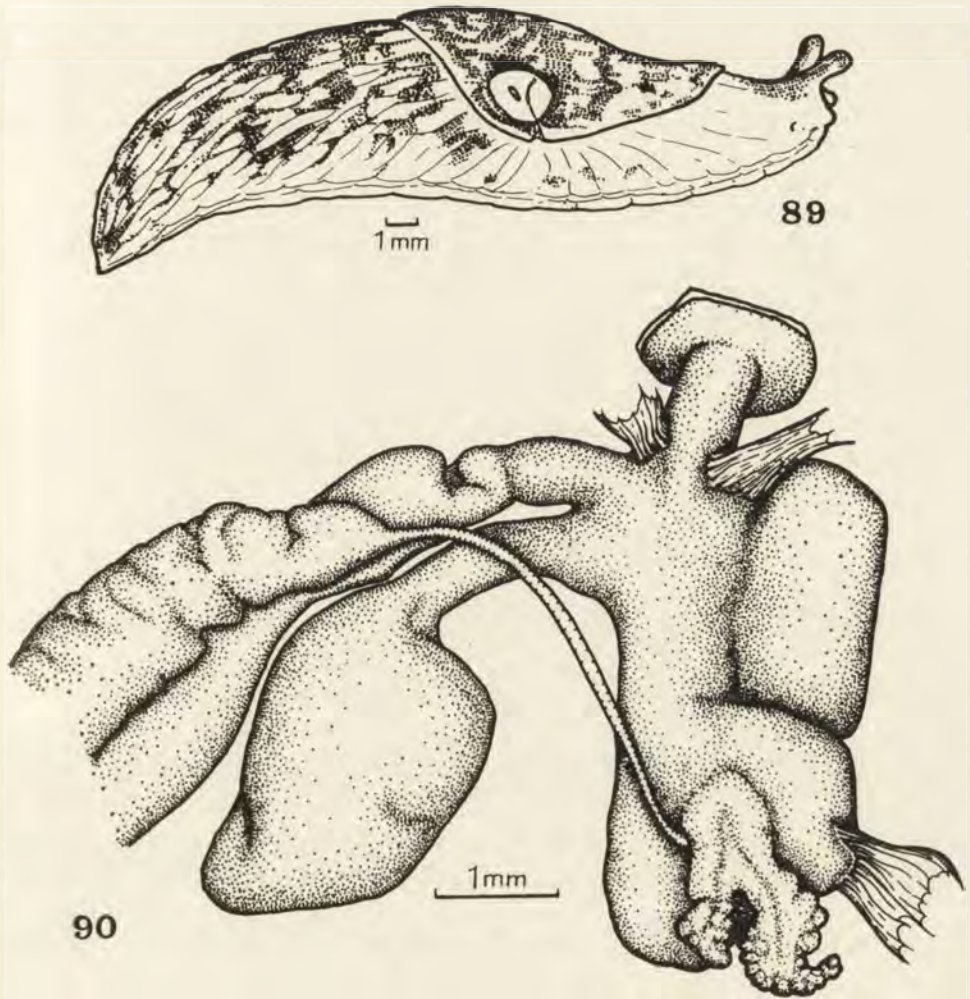
? *Deroceras waldeni* GROSSU, 1969: 169. Locus typicus: Jurilovica, the Dolojman Cape on the Razelem Lake (Dobruja = Dobrudzha, Rumania). Holotypus: coll. GROSSU 1148.

? *Deroceras forearti* GROSSU et LUPU, 1961: 21. Locus typicus: Babadag (Dobruja = Dobrudzha, Rumania). Holotypus: MNH. "Gr. Antipa", Bucharest, No. 13119.

References: DAMJANOV and LIKHAREV 1975: 319; HUDEC and VAŠÁTKO 1971: 35; LIKHAREV and WIKTOR 1980: 152; LUPU 1972: 95; WIKTOR 1971: 271, 1977: 292 (*wiktorei*).

Body usually about 20 mm long. Biggest specimens known to the author are 27 mm long, with mantle 10 mm long and 5 mm wide.

Colouration (Fig. 89) mucky-cream or light grey-cream with chocolate or blackish spots on mantle and dorsum. No relation between dark pigment distribution and skin sculpture. Middle zone of dorsum spotless. Sole mucky-cream, unicolour.



Figs. 89-90. *Deroceras (A.) turcicum* (SIMR.): 89 — side view (specimen from Buzludzha), 90 — copulatory organs (specimen from Shipka)

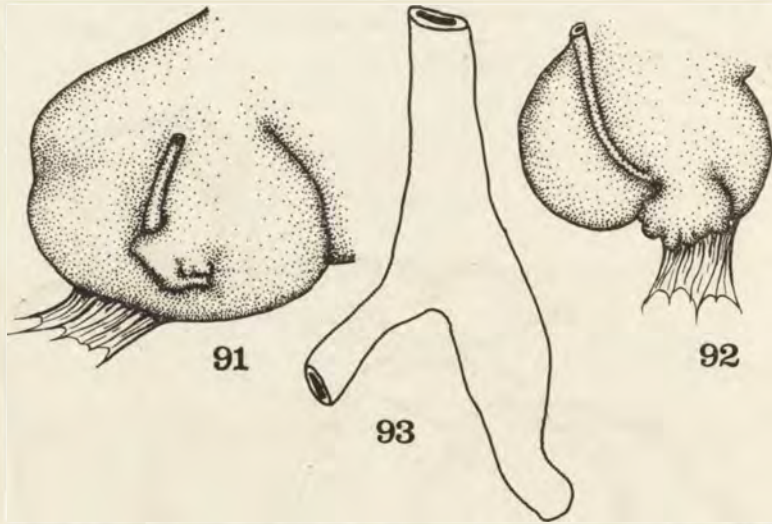
Genitalia (Figs. 90-92). Penis in mature specimens almost always with fissure in middle. Penial gland varied; not big, often in form of swell with small papillae (Fig. 92) (cf. *D. forcarti* GROSSU and LUPU, 1961), may be well-developed (Fig. 91-92). Its varieties include: *D. wiktori* and *D. waldeni*. Posterior penis end from crop side with two swellings (!), one with penial gland. Vas deferens opening between the swellings (cf. *D. reticulatum*, p. 175).

Radula: C. 14. 30/× 99.

Intestinal coecum well-developed, usually shorter than in *D. reticulatum* (Fig. 93).

Bionomics. A forest species living in deciduous, mixed and coniferous

woods, rarely in meadows. In beech and hornbeam woods sometimes in great numbers. In forest biotopes it is the most numerous species so far observed by the author. During rain in the Shipka regions (Stara Planina), there were more than 10 specimens per 1 m². In May and June mainly specimens with



Figs. 91–93. *Deroceras (A.) turcicum* (SIMR.): 91–92 — various types of penial glands (specimens from Beli Osum and Breznitsa), 93 — intestinal coecum (specimen from Shipka)

small penial gland are found. At the end of summer and in autumn penial glands in most specimens are developed in form of several appendices. Some slugs probably hibernate as the author met single mature specimens at the beginning of May. Mesophylic species. In mountains reaching the altitude of about 2000 m a.s.l. Also as a synanthrope, usually in bushes.

Distribution. Not well-known, often mistaken for *Deroceras reticulatum*. Occurs in Bulgaria, Yugoslavia, Rumania and Turkey. It should be expected in Greece but probably the range is wider.

Material examined: above 500 specimens.

Records (Map 24):

Stara Planina: around Belogradchik and the Magurata cave, the Petrohan pass, Buchino Prohod, Vratsa, around the Ledenika cave, Karlukovo leg. DELCHEV (BAN), Lakatnik, Belediehan near Berkovitsa, Teteven and the area around, Troyan and the Beli and Cherni Osum valleys, Shipka, Stoletov, Buzludzha, Karlovo, Kalofer leg. WARCHALOWSKI (MNH), Zheravna near Kotel.

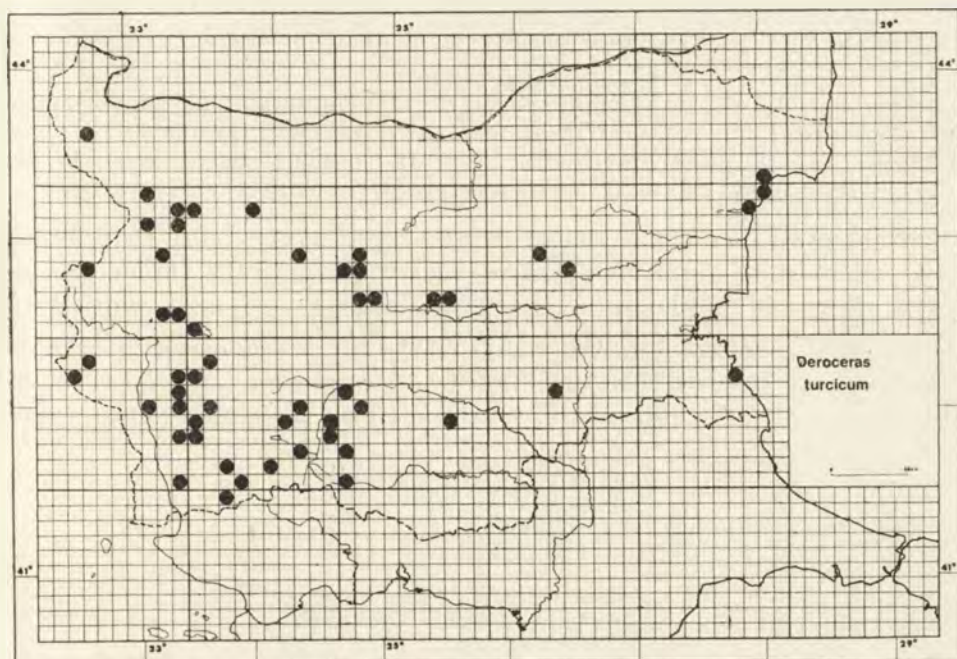
Vitosha: Vladaya, Dragalevchi, Bistritsa, Boyana.

Zhelenitsa near Sofia.

Plana: Kokalyane.

Pirin: Bansko, Bunderitsa (1800 m), Damianitsa (2000 m), Popina Luka near Sandanski, Breznitsa and Koprivlen near Gotse Delchev.

Trun and Kyustendil leg. et coll. URBAŃSKI.

Map 24. *Deroceras turcicum*

Osogovska Planina: near the Osogova shelter.

Rila: Blagoyevgrad, the Parangalitsa reserve, the area of the Vada Lavna shelter and Skakavitsa waterfalls, around Rilski Monastir, Borovets, Yakoruda.

Rodopi: Plovdiv, Asenovgrad, Bela Churkva, Chudni Mostove, Persenk, Smolyan, Deven, Chepelare, Peshtera Durken leg. et coll. J. URBAŃSKI, Batak, around Yakoruda, Ognyanovo near Gotse Delchev, Dospad (BAN).

The area of Khaskovo — leg. et coll. URBAŃSKI.

Topolovgrad and the area around (Golyam Monastir) leg. URBAŃSKI.

The Black Sea coast: Batova near Balchik, Zlatni Piasatsi, Aladzha, on the Ropotamo river.

Comments.

Opposite to DAMJANOV and LIKHAREV the author does not regard the species as a young form of *D. reticulatum*. The opinion is based on morphological differences and ecological requirements (see: *D. reticulatum* — comments, p. 177). Biology of this species should be examined thoroughly as well as its possibilities of hybridization with *D. reticulatum*.

Deroceras (Agriolimax) reticulatum (MÜLLER, 1774)

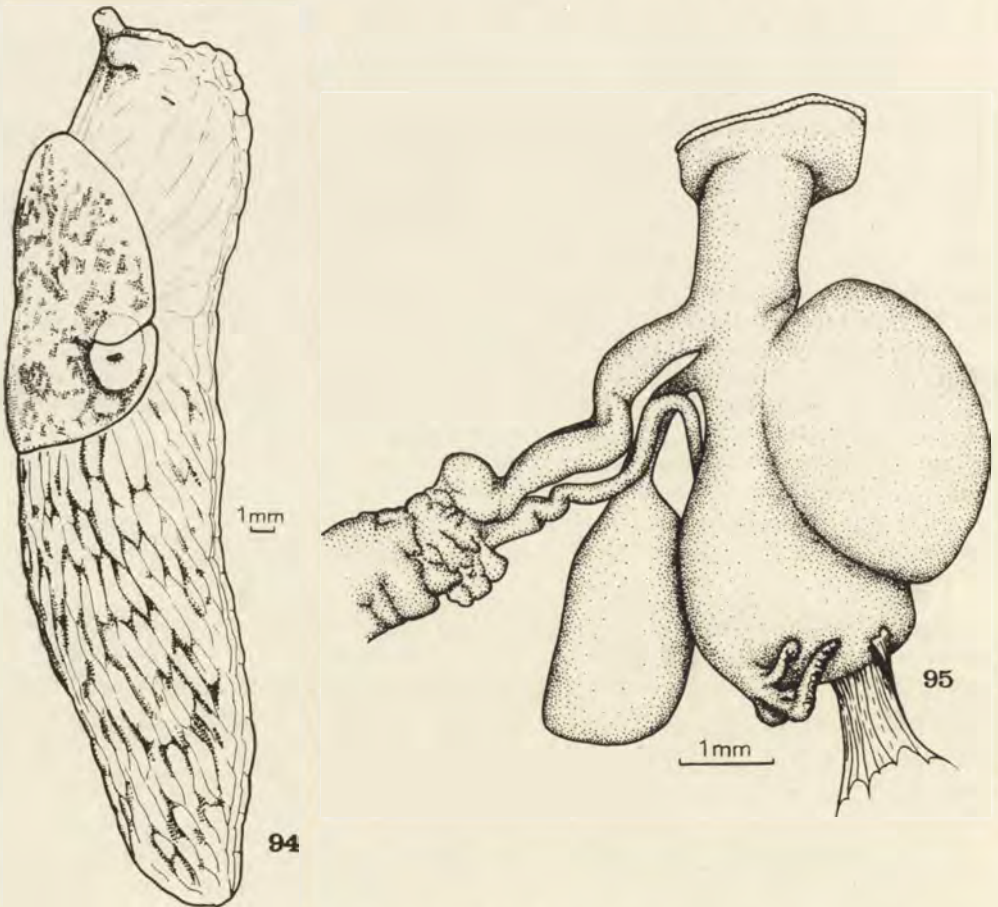
Limax reticulatus MÜLLER, 1774: 10. Locus typicus: Frideriksdal near Copenhagen (Denmark). Holotypus probably does not exist. Description and illustration of specimens from locus typicus see: ALTENA 1969: 102.

Limax agrestis or *Agriolimax agrestis*: many authors, especially in the 19th cent., did not distinguish between *Deroceras reticulatum* and *D. agrestis* taking them for one species. See also *D. turcicum*.

References: DAMJANOV and LIKHAREV 1975: 319; FRÖMMING 1954: 214 (bionomics); JAECKEL 1962: 145; LIKHAREV and WIKTOR 1980: 149 (bionomics); LUTHER 1915: 1; QUICK 1960: 164 (survey); RUNHAM and HUNTER 1970: 31 (bionomics and ecology); WAGNER 1935: 183 (*Agriolimax agrestis reticulatum*); WIKTOR 1973: 125 (survey), 1977: 291.

Body length in wholly extended living specimens not more than 30 mm, in preserved — up to about 25 mm. The biggest known to the author specimen from Poland was 45 mm long, its mantle 13 mm long, maximum width 8 mm.

Colouration (Fig. 94). Generally mucky-cream, light-coffee, less frequently olive-cream with blackish or chocolate-coloured spots. On mantle irregular dark spots. On dorsum and sides spots form a pattern as the pigment



Figs. 94-95. *Deroceras (A.) reticulatum* (MÜLL.): 94 — side view, 95 — copulatory organs (specimens from Purshevitsa)

is distributed mainly in skin grooves. Pigmentation varies within populations from wholly dark to light specimens. Juveniles often without dark spots. Tentacles blackish, dorsum and head with small dark spots. Sole usually cream, in intensively coloured specimens brown.

Genitalia (Fig. 95). Penis big, with thick walls, fissure in middle (the last absent in juveniles). Penial gland well-developed but of varied shape, always covered by nodulous glandular papillae. The whole gland in form of a single, slightly flattened appendix, or consisting of several branched appendices from one, very short, stalk. Vas deferens always opening into outside (directed to body integument) penis wall (!). Near opening penis without swellings. Retractor penis inserted in penis narrowing. Stimulator big, conical, tapered. Outside penis wall, in place where stimulator is inserted, small hollow is present.

Radula: C. 16–22. 21–32/ × 93–110.

Intestinal coecum well-developed, long, several times longer than wide.

Bionomics. A species of great ecological tolerance, always living in open or half-open biotopes but never in forests. Most frequent in ruderal environments, refuse heaps, gardens, ditches, plough-lands (especially loam), parks and meadows. In some regions a dangerous pest. In wet summers after a mild winter may destroy crops in 100%. Life-span, as in other species, about one year. Mature in late summer and in autumn. Many specimens hibernate and can be met in spring. Most of them die in late summer after having laid eggs. Feeding on green parts of plants, fruit, bulbs, roots, occasionally on animal dung and decaying parts of plants. Hiding under tree logs, stones, soil clods and in soil. A mesophylic slug.

Distribution. Native land of this slug is not known. Spread over a large area as a synanthrope, partly native, partly introduced. Most common slug in whole Europe, less frequent in the south, replaced by other species. In the Balkans insular. As an extreme synanthrope does not enter natural biotopes. Introduced into North America, Peru, Australia, Tasmania, New Zealand and South America. All this information should be confirmed as some similar species have been described.

Material examined: about 200 specimens.

Records (Map 23):

Stara Planina: around the Ledenika cave and Purshevitsa shelter near Vratsa, on the Iskur river and in Lakatnik.

Sofia – greenhouses.

The Black Sea coast: the Ropotamo reserve.

Also: WAGNER (1934a), HUDEC (1964), URBAŃSKI and WIKTOR (1968) and OŠANOVA (1970). Their information requires confirmation – see comments.

Comments.

The species is similar to *D. turcicum* and often mistaken for it (also WIKTOR and URBAŃSKI 1968).

Deroceras reticulatum differs from *D. turcicum* in: bigger size, vas deferens opening into penis wall directed towards outside body wall (not to intestine), penis without swellings near vas deferens opening, the species does not live in forests.

***Deroceras (Agriolimax) thersites* (SIMROTH, 1886)**

Agriolimax Thersites SIMROTH (as *Agriolimax Thersites* HEYNEMANN et KOCH), 1886: 317.

Locus typicus: Pireus near Athens (Greece). Lectotypus: Natur-Museum Senckenberg, Frankfurt a/Main, No. 155226, designation anonymous.

References: URBAŃSKI and WIKTOR 1968: 70; WAGNER 1934a: 54; WIKTOR 1977: 292.

Preserved specimens about 35 mm long, 7–11.5 mm wide, mantle 12 mm long. Body stout.

Colouration (Fig. 96) brown or brown-cream. Some specimens unicolour,

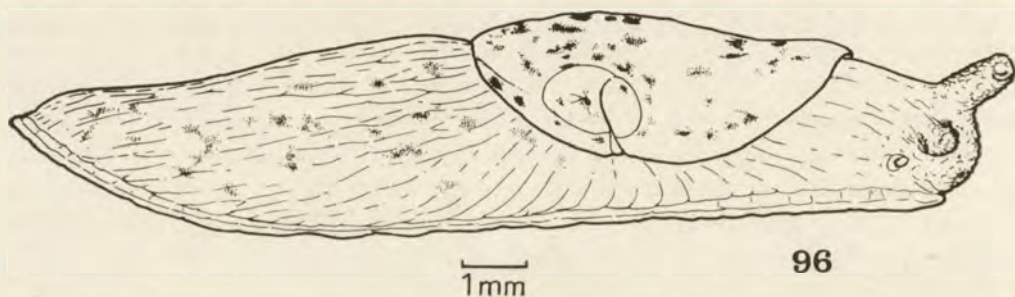


Fig. 96. *Deroceras (A.) thersites* (SIMR.) — side view (specimen from Rezevo)

some with fine, blackish spots on mantle and other parts of dorsum. Extension of short keel in dorsum middle with light spotless band. Skin thick.

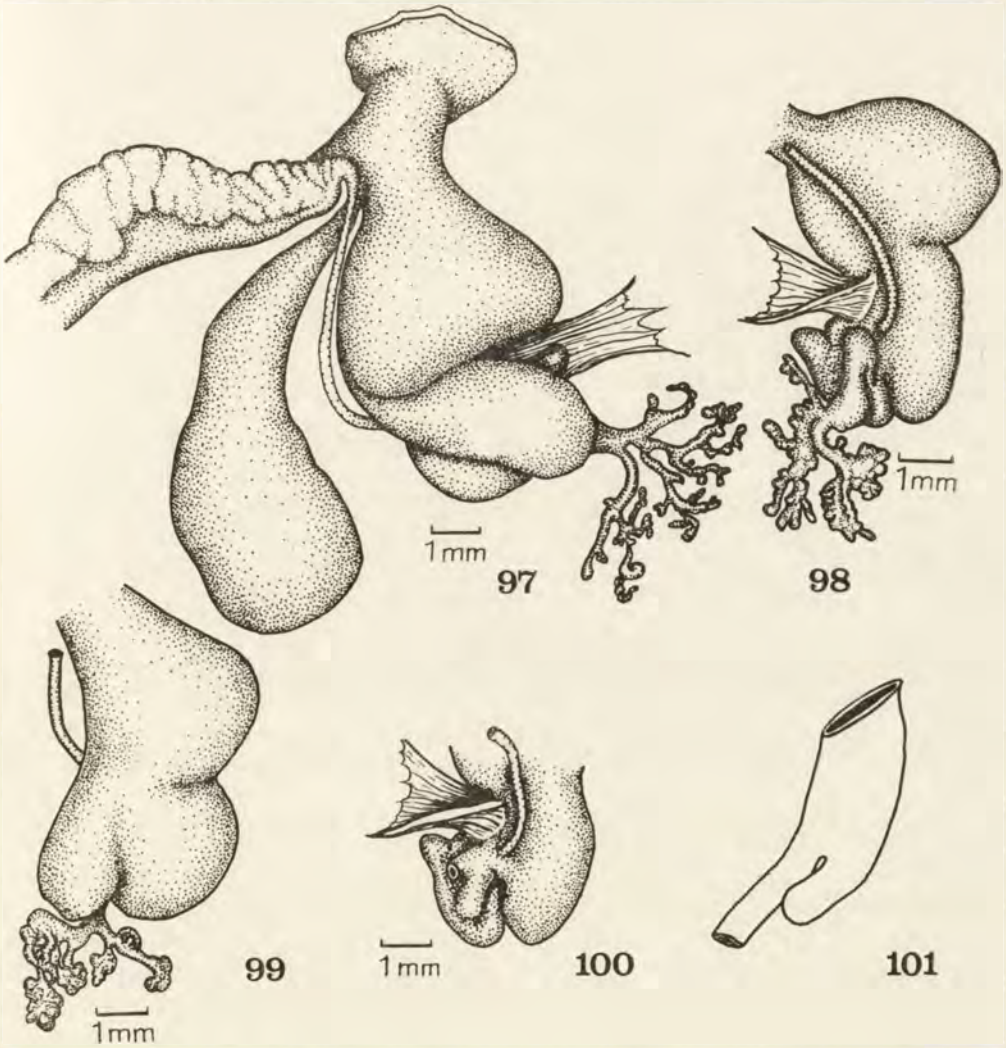
No information on slime.

Genitalia (Figs. 97–100). Penis most often divided by a deep narrowing into two. If the narrowing absent penis oval. Its posterior part sometimes with lateral pocket or small appendix. Penial gland half of penis in length, often in form of a “tree” with one, long “trunk” and “top” divided into numerous, bent twigs. Sometimes penial gland consists of 2 or 3 “trees” but it is always big, with “trunk” and “twigs”. Retractor and opening of vas deferens situated laterally in posterior penis part. Stimulator big, flattened, with almost parallel sides. Spermatheca characteristic in shape, much elongate, indistinctly changing into spermatheca duct.

Formula of radula: C. 19+1. 31/ × 99.

Intestinal coecum as a distinct pocket (Fig. 101).

Distribution. Known from Greece, south-eastern Bulgaria, can be expected in Turkey.



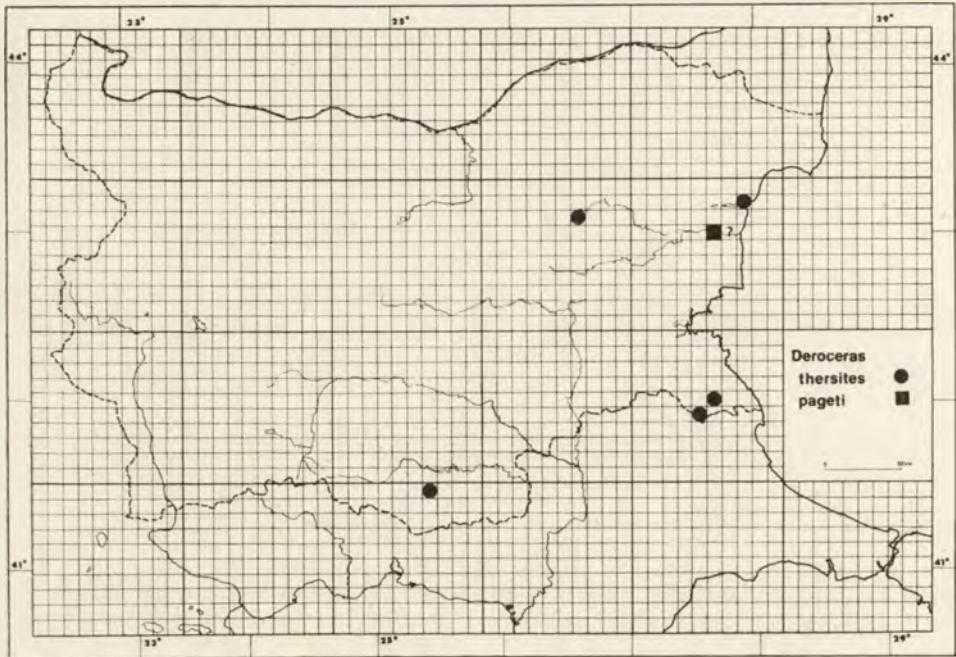
Figs. 97-101. *Deroceras (A.) thersites* (SIMR.): 97 — copulatory organs, 98-99 — penis view from different sides, 100 — anterior penis section, penial gland cut off, 101 — intestinal coecum (specimens from Rezevo)

Material examined: 22 specimens.

Records (Map 25):

Strandzha: Malko Turnovo leg. P. PETKOV (BAN), Rezevo leg. D. TOTEV (MNH); also WAGNER (1934a) — Malko Turnovo and Urgari, URBAŃSKI and WIKTOR (1968) — Gramatikovo.

Preslavskva Planina: Turnovitsa leg. A. VARGA (MNH).



Map 25. *Deroceras thersites* and *Deroceras pageti*

Deroceras (Agriolimax) agreste (LINNEAUS, 1758)

Limax agrestis LINNEAUS, 1758: 652. Terra typica: Sweden.

Synonyms: *Limacella obliqua* BRARD, 1815; *Limax bilobatus* FÉRUSSAC, 1819; *Limax pallidus* SCHRENK, 1848; *Krynickillus minutus* KALENICZENKO, 1851; *Limax varnayanus* BOURGUIGNAT, 1861; *Agriolimax Fedtschenkoni* KOCH et HEYNEMANN, 1874 (nom. err.); *Agriolimax agrestis* var. *Fedtschenkoi* KOCH et HEYNEMANN, 1874; *Agriolimax transcaucasicus* SIMROTH, 1901; *Agriolimax transcaucasicus coeciger* SIMROTH, 1901. (Bibliography, see references).

References: DAMJANOV and LIKHAREV 1975: 320; HESSE 1926: 97; JUNGBLUTH, LIKHAREV and WIKTOR 1981: 21; LIKHAREV and WIKTOR 1980: 142; LUPU 1976: 11; LUTHER 1915: 1; QUICK 1960: 170; WAGNER 1935: 180; WALDÉN 1956: 360; WIKTOR 1973: 121, 1977: 291.

Living specimens about 40 mm long. Biggest preserved Bulgarian specimen was 30 mm long, mantle 7 mm long, 6 mm wide. Body relatively stout, posterior end gradually narrowing cuneately. Skin thick but soft.

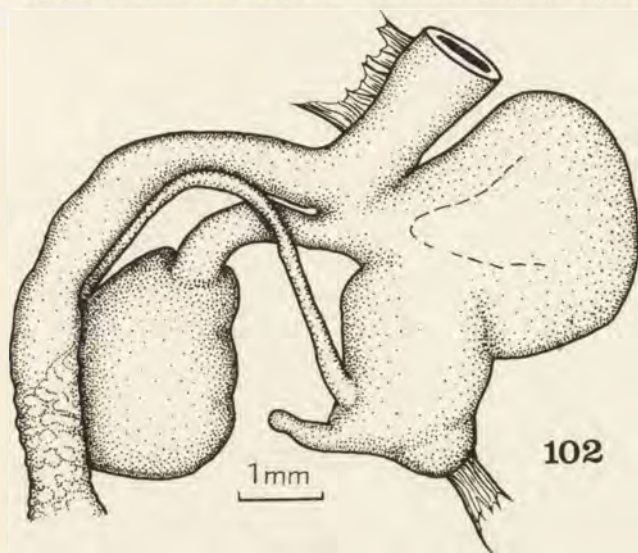
Body cream or light coffee-coloured, spotless. Mantle, dorsum and sole fringes slightly lighter.

Externally resembling unicolor *Deroceras reticulatum* but differing in penial gland which is never branched and without glandular papillae (Figs. 102–103). It is a single, nodulous or hooked process. Penis less narrowed than in *D. reticulatum*. Stimulator big, narrow, conical.

Radula: C. 14–17. 18–21/× 82–93.

Intestinal coecum always well-developed (Fig. 104).

Bionomics. The slug is mature in the second half of summer or in autumn. Hibernating in eggs. Found mainly in open biotopes, especially meadows,



Figs. 102–104. *Deroceras (A.) agreste (L.)* 102 – copulatory organs, 103 – posterior penis section, 104 – intestinal coecum (specimens from Rilski Monastir)

ditches, gardens, parks, plough-lands, sometimes in bushes or near them. Often synanthropic. In Bulgaria and Central Europe never occurs in forests. Usually living in small populations, most often along with *D. reticulatum*. In mountains reaching up to 2500 m (Alps).

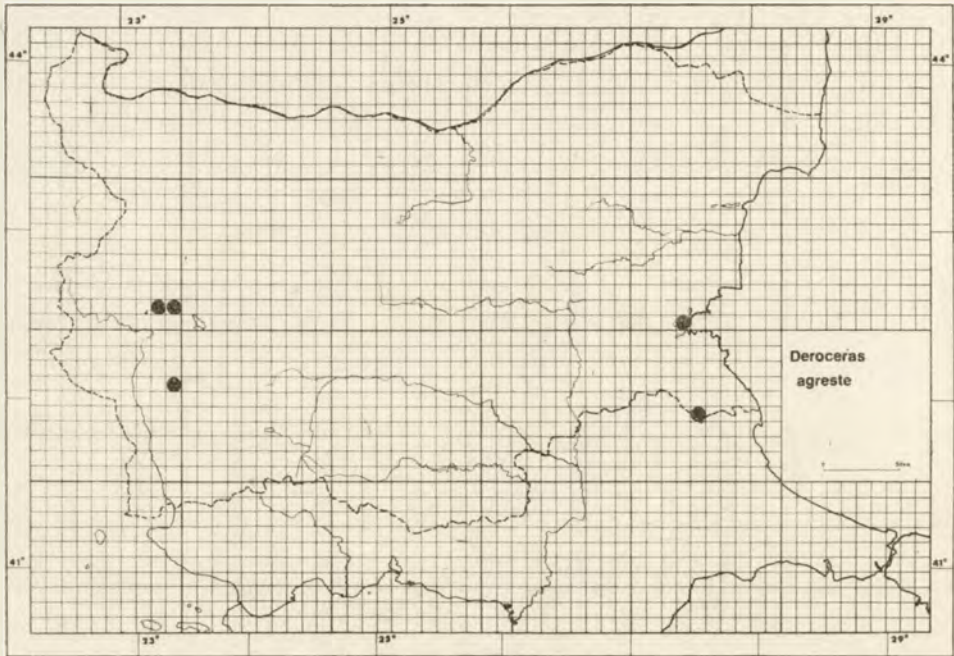
Distribution. Not well known, often mistaken for other species. Probably living in all Europe (among others in Scandinavia, British Isles, Iceland, Central Europe), certainly reaching the Kola Peninsula and the tundra zone, in the south – the Crimea and Central Asia.

Probably a Palearctic species but in many places insular.

Material examined: 2 specimens.

Records (Map 26):

Rila: Rilski Monastir, collected in 1937 leg. JAWŁOWSKI (IZW) and in 1953 leg. et coll. URBAŃSKI.

Map 26. *Deroceras agreste*

Also: WAGNER (1934a, 1934b) — information requires confirmation. Data in URBAŃSKI and WIKTOR (1968), except the area of Rilski Monastir, turned untrue (some *D. turcicum*).

DAMJANOV and LIKHAREV (1975) record the slug from Vitosha, Malko Turnovo in the Stranzha Mts. and Burgas at the Black Sea.

Comments.

Often mistaken for other species, especially *D. reticulatum*, from which it differs mainly in shape of penis, penial gland and absence of spots. It may also be mistaken for unicolour forms of *D. turcicum* from which it differs in bigger size, absence of swellings on posterior end of penis, opening of vas deferens on the outside penis wall.

? *Deroceras (Agriolimax) agreste transcausicum* sensu HUDEC et VAŠATKO (1971)

HUDEC and VAŠATKO (1971: 19) described the slug collected in Pirin at Vihkren (2500–2600 m a.s.l.) as follows: fine, dark spots, penis similar as in *Deroceras agreste* (op. cit. Fig. 7) and intestine with 3 loops (!) which would indicate another genus (if it is not a mistake). The authors considered the slug to be subspecies *transcausicum* SIMROTH, 1901. Coecum was as long as in *coeciger* SIMROTH, 1901 which turned out to be a synonym of *D. agreste* (see LIKHAREV and WIKTOR 1980). Taxonomic status of the slug from Pirin described by HUDEC and VAŠATKO requires explanation.

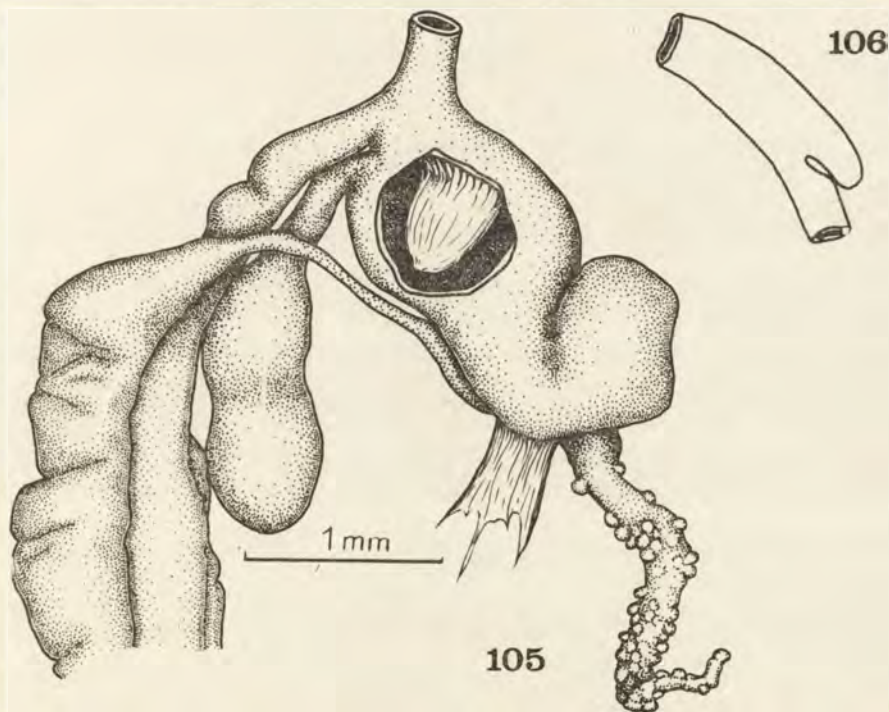
Deroceras (Agriolimax) cf. pageti GROSSU, 1972

Deroceras pageti GROSSU, 1972: 640. Locus typicus: Taygetos, Peloponnese (Greece).
Holotypus: Naturhist. Mus. Vienna, No. 36025.

Contracted specimens 11 mm long, 3.5 mm wide, mantle 4 mm long. Body blackish, spotless. Sole cream coloured in middle, dark-grey on sides.

Genitalia (Fig. 105). Penis narrowed. Posterior part bent, in form of a deep pocket with a long, more or less equal to penis, penial gland inserted. Penial gland undivided, with big papillae. Retractor penis broad. Stimulator in form of a thick, obtuse cone.

Intestinal coecum small but well-visible. (Fig. 106).



Figs. 105-106. *Deroceras cf. pageti* GROSSU: 105 — copulatory organs, 106 — intestinal coecum (specimen from Dolen Chiflik)

The only specimen probably belonging to this species was collected by KARNOZHYSKI on September 12, 1953 in Dolen Tschiflik (Chiflik), in Querceto-fagetum (MNH). Map 25.

Comments.

The slug which the author had was much contracted, it was probably put directly into alcohol. It is different from the specimen described by GROSSU (1972) with almost spherical penis and therefore the author is not quite certain about its identification. It should be noticed however, that the variety scale of this slug is unknown.

Subgenus *Plathystimulus* WIKTOR, 1973

Plathystimulus WIKTOR, 1973: 130. Typus: *Deroceras subagreste* (SIMROTH, 1893).

References: LIKHAREV and WIKTOR 1980: 153.

Externally, body similar to *Agriolimax* (see p. 172). Mantle covers about $\frac{1}{3}$ of the body length. Skin thick. Body unicolour or spotted. Slime in crawling slugs colourless, in irritated ones milk-white.

Penis of various shapes but always short. Penial gland big and branched. At the posterior end there usually occurs an appendix. Stimulator completely flat, flabelliform or spadeshaped.

Intestine coecum shaped like a shallow pocket.

Slugs of the forest or open environment. Southern areas from France and Greece to the Caucasus, in the North up to Sudetes and Carpathian Mountains.

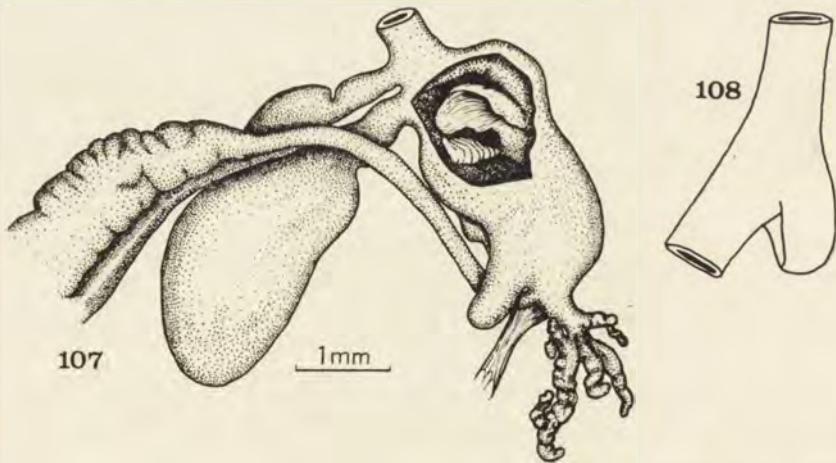
Deroceras (Plathystimulus) cf. zilchi GROSSU, 1969

Deroceras zilchi GROSSU, 1969: 164. Locus typicus: Cozla, south of Banat in the area of the Danube gorge (Portile de Fier, Rumania). Holotypus: coll. GROSSU 1144.

The slugs the author had resembled *D. zilchi* but he is not quite certain about the identification.

Biggest specimens 21 mm long, 3.5 wide, mantle 6 mm long. Body uniformly cream-white. Skin thin.

Genitalia (Fig. 107). Only specimens from Lakatnik were fully mature (the specimen from Magura was partly damaged, without gonad, probably young). — Penis with lateral short appendix in posterior part and small, nodulous



Figs. 107–108. *Deroceras cf. zilchi* GROSSU: 107 — copulatory organs, 108 — intestinal coecum (specimen from Belogradchik)

swelling near vas deferens' opening and retractor penis. Penial gland with short stem and a bunch of 4 long appendices. Retractor penis not bifurcated. Stimulator flat and short, spoon-like. Coecum (Fig. 108) longer than in GROSSU's description.

Distribution. So far known only from *Locus typicus*.

Material examined: 5 specimens.

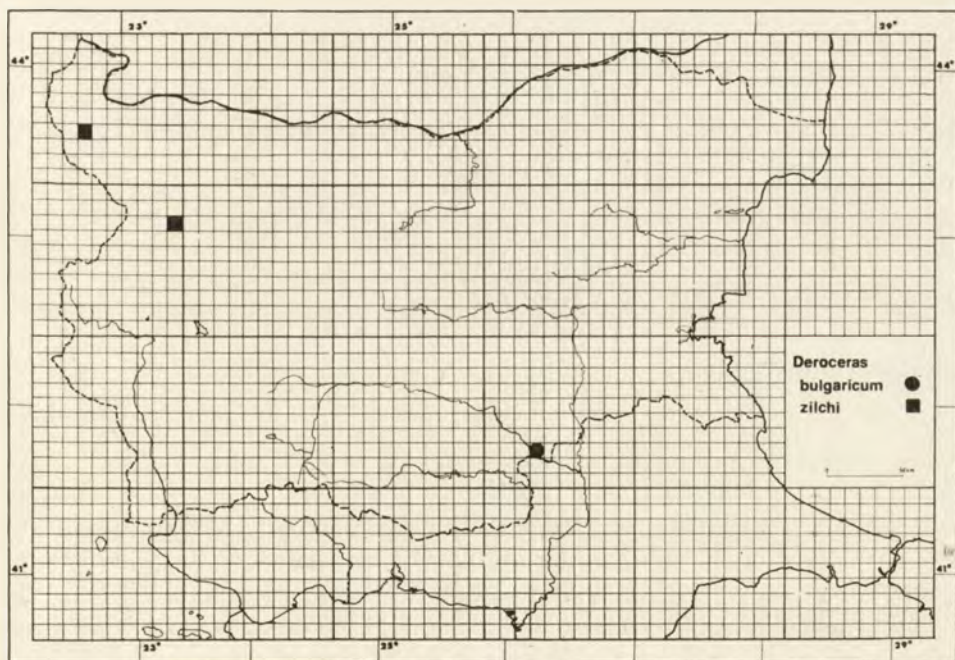
Records (Map 27).

W-Stara Planina: Lakatnik at the Iskur gorge; near the Magura cave west of Belogradchik.

Comments.

A species with similar genitalia lives on the Cyclades. It is *D. seriphium* WIKTOR et MYLONAS, 1981. The latter differs in: spotted body, differently shaped penis, nodule near vas deferens' opening absent, retractor bifurcated, stimulator big (see: WIKTOR and MYLONAS 1981).

Bulgarian localities are within the range of the biogeographical influence of the Banat Mts.



Map 27. *Deroceras bulgaricum* and *Deroceras zilchi*

***Deroceras (Plathystimulus) bulgaricum* GROSSU, 1969**

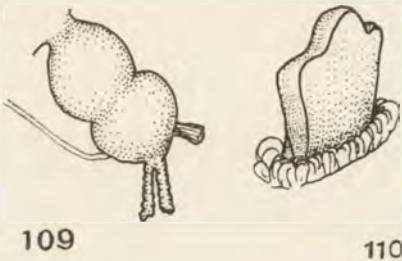
Deroceras bulgaricum GROSSU, 1969: 163. *Locus typicus*: Svilengrad (Bulgaria). Holotypus: Senckenbergisches Museum, Frankfurt a/M., No. 19444.

Species unknown to the author. So far only one specimen (holotype) has been found. The description is a summary of that given by GROSSU.

Body length of preserved specimen 16 mm. Skin thick with clearly visible grooves. Keel short. Mantle free anteriorly, bent aside.

Colouration uniformly grey. Dorsum and mantle darker.

Genitalia (Fig. 109). Penis elongate ("balgförmig"), slightly narrowed in middle. Penial gland irregular, in form of two digital structures with small papillae of different size. Vas deferens' opening and retractor insertion near



Figs. 109–110. *Deroceras* (?) *bulgaricum* GROSSU:
109 — penis, 110 — stimulator (after GROSSU
1969)

posterior penis end. Two stimulators inside penis; one bigger, flattened with a slightly elongate lobe in its middle (Fig. 110), the other smaller, conical.

Intestinal coecum absent. (Map 27).

Subgenus *Liolytopelte* SIMROTH, 1901

Liolytopelte SIMROTH, 1901: 174 (as subgenus of *Lytopelte* BOETTGER, 1886). Typus: *Lytopelte caucasica* SIMROTH, 1901.

References: DAMJANOV and LIKHAREV 1975: 322; HESSE 1926: 24; LIKHAREV and WIKTOR 1980: 169; WIKTOR 1973: 117.

Preserved specimens to 40 mm long. Posterior mantle fringe attaining middle of body or even reaching posterior body part. Anterior mantle edge free, i.e. not accreted. Skin very soft, partly transparent. Body unicolour or spotted, cream, brown, grey or violet. Slime watery, hyaline.

Penis pear-like, spherical or cylindrical. Its posterior part with various swellings or appendices. Typical penial gland absent. Inside penis a longitudinal fold anteriorly changing into stimulator of various shape with calcareous plate on top or sides.

Intestinal coecum absent or in its place a slight broadening on rectum.

Forest slugs, favouring humidity. Found in undergrowth, in mountain and submontane regions. Distributed over eastern Balkans, eastern and southern Carpathians and Caucasus. Seven species.

Deroceras (Liolytopelte) bureschi (WAGNER, 1934)

Agriolimax (Hydrolimax) bureschi WAGNER, 1934a: 55. Locus typicus: the Mednik cave at the Iskur gorge west of Elisena, Vratsanska Planina (Bulgaria). Lectotypus: Mus. BAN, Sofia.

Deroceras ilius: GROSSU and LUPU 1959a: 46.

Lytopelte herculana GROSSU, 1964: 84, 1970: 105. Locus typicus: Băile Herculane (Romania). Holotypus: Coll. GROSSU No. 1055.

Lytopelte herculana: HUDEC 1967a: 349; LUPU 1972: 94.

References: HUDEC 1967a: 349; LIKHAREV and WIKTOR 1980: 174; URBAŃSKI and WIKTOR 1968: 62; WIKTOR 1977: 292.

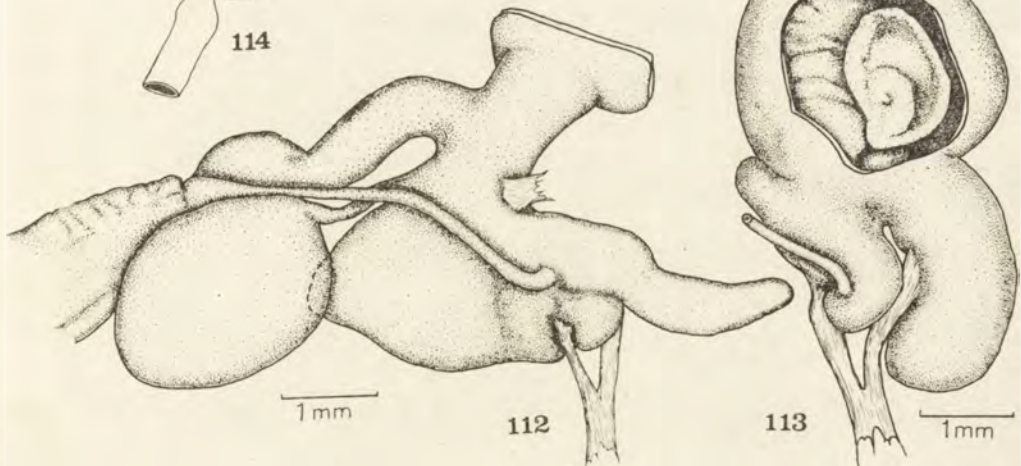
Biggest preserved specimen 30 mm long, 6 mm wide, mantle 9 mm long. Body shape resembles *Deroceras laeve* but the part behind mantle is broader and shorter as compared to other parts of body (Fig. 111).



111



114



112

113

Figs. 111-114. *Deroceras (L.) bureschi* (WAGN.): 111 - side view (specimen from Ribaritsa), 112-113 - copulatory organs (specimens from Ribaritsa and Yakoruda), 114 - intestinal coecum

Colouration chocolate or dark-coffee, unicolour, with numerous big, blackish or blurred, darker spots of spread pigment.

Genitalia (Figs. 112–113). Penis irregular in shape, anteriorly much broadened. Its posterior part with a pocket into which vas deferens opens. Near pocket long digital appendix reversible into penis is located. Retractor penis bifurcated, its one part attached to appendix, the other to the pocket. Inside penis well-developed fold with yellowish oval plate on its top. Broader part of the plate sometimes with visible concentric accretion lines, narrower part with papillary nodules (Fig. 113).

Formula of radula: C. 12. 32/ × 15.

Intestinal coecum absent or rectum with a small broadening as in Fig. 114.

Bionomics poorly known. The slug occurs in undergrowth, especially in beech and hornbeam woods, most often near water and in wet places. Frequent in mountains, up to 2000 m a.s.l. Hiding under stones and in undergrowth.

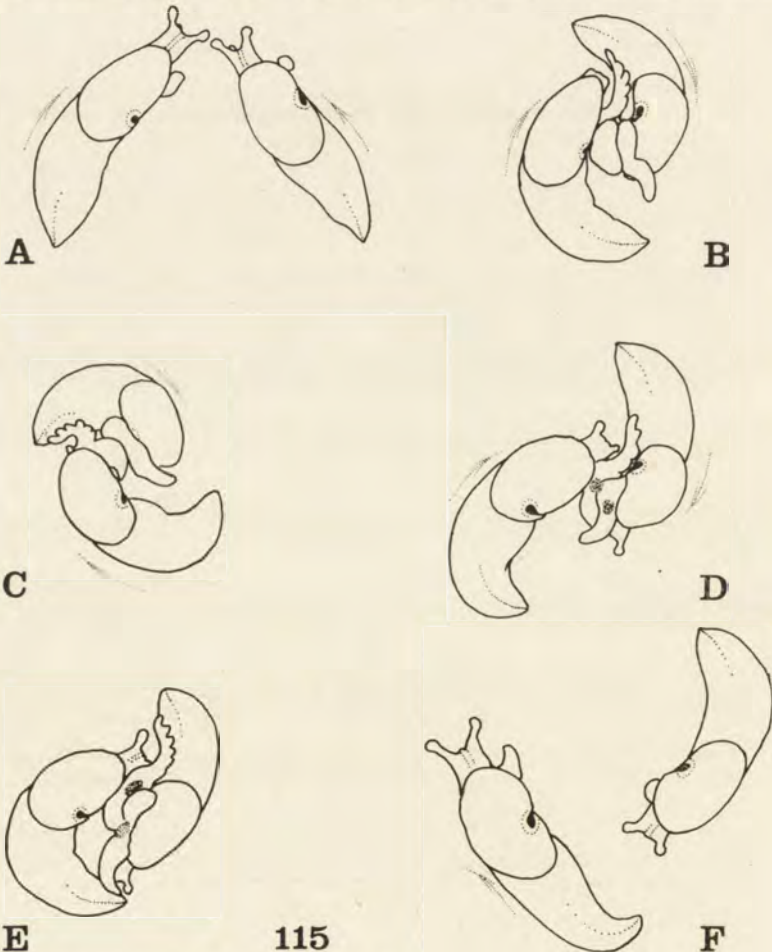
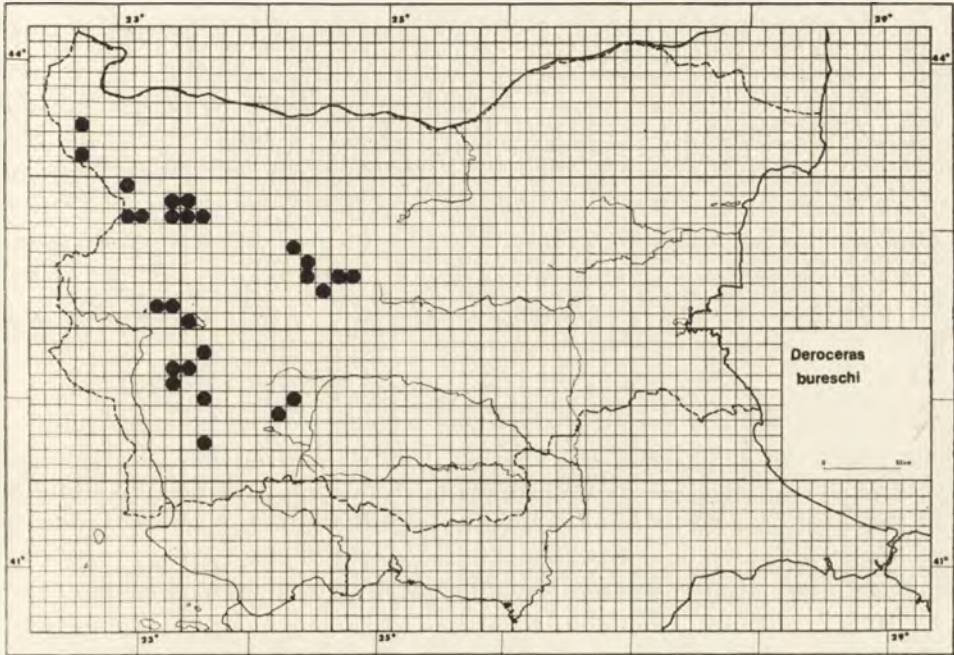


Fig. 115. Various stages in the courtship *Deroceras (L.) bureschi (WAGN.) (Ribaritsa)*

In May and June mature specimens can be met. In October most slugs are in male phase of gonad development. The author only once watched courtship and copulation. It happened during rain at noon on warm day of July 9. The copulation took place on a piece of bark on the ground. Subsequent phases are shown in Fig. 115. Copulation is similar as in *Deroceras* s. str.; everted penis and appendix which looks as penial gland.

Distribution. Southern areas of Rumania and Bulgaria. Probably also in Yugoslavia.



Map 28. *Deroceras bureschi*

Material examined: 224 specimens.

Records (Map 28).

Stara Planina: around Belogradchik, Vratsa, Vratsanska Planina in the area of Ledenika and Purshevitsa, the Iskur gorge, Teteven, Ribaritsa and the Vezhen slopes near Teteven, the valleys of Cherni Osum and Beli Osum. Also: WAGNER (1934a) — Mednik near Plakatnitsa; URBAŃSKI and WIKTOR (1968) — Petrohan, the area of Ginchi, Berkovitsa, Lakatnik, Vratsa, Zgorigrad; OŠANOVA (1970) — Cherna near Lyutadzhik, the Dalga valley, Lakija on the Zhrelo river, Petrohan, Lakatnik.

Vitosha: around Boyana and Boyanske Ozera, Zlatni Mostove, near the Ofelin shelter, Dragalevchi, Bistritsa leg. OŠANOVA et PINTÉR (HNHM). Also HUDEC (1967), OŠANOVA (1972), URBAŃSKI and WIKTOR (1968).

Plana: Kokalyane.

Sredna Gora: the Bogan shelter leg. SZIGETHY (HNHM).

Pirin: Breznitsa near Gotse Delchev.

Rila: around Yakoruda, Rilski Monastir, the Lovna shelter, near the Skakavitsa waterfalls, Borovets.

Rodopi: in the area of Yakoruda and Batak. Also: WAGNER (1934a) — Mednik near Plakantsa.

Genus *Krynickillus* KALENICZENKO, 1851

Krynickillus KALENICZENKO, 1851: 220. Typus: *Krynickillus melanocephalus* KALENICZENKO, 1851¹.

References: JUNGBLUTH, LIKHAREV and WIKTOR 1980: 21 (radula); LIKHAREV and WIKTOR 1980: 190.

Following SIMROTH (1901) the genus was often included in *Agriolimax* (= *Deroceras*). It seems not right (LIKHAREV and WIKTOR 1980).

Preserved specimens 40–45 mm long. Body narrow, gradually narrowing backwards. Mantle less than $\frac{1}{3}$ of body length, in living specimens with distinct crescent-like groove directed towards mantle centre. Keel very short, ill-defined, only at body end. Integument finely sculptured, between pneumostome and median line 16–18 grooves, lateral zones of sole with almost transverse grooves which in middle zone are V-shaped.

Colouration uniform, spotless. Dorsum and mantle darker than sides. Body mucky-cream to brown and black in colour.

Slime hyaline, thin.

Genitalia simple in structure. Penis parallel to right ommatophore or crossing it (an individual feature), short, cylindrical, without accessory organs. Inside with small folds. Stimulator absent. Spermatheca with very long and thin spermatheca duct. Free parts of vas deferens and oviductus very long. Atrium short.

Central and lateral radular teeth tricuspid, marginal dagger-like.

Intestinal cecum absent, only a small pocket.

Shell asymmetrical with embryonic part shifted leftwards.

Slugs living in deciduous and mixed forests. Hiding in undergrowth, under stones, less frequently under bark and in stumps. Distributed over the Black Sea region, in Rumanian Dobruja, Bulgaria, Turkey, Crimea and Caucasus. 2 species known.

Krynickillus urbanskii (WIKTOR, 1971)

Deroceras (*Krynickillus*) *urbanskii* WIKTOR, 1971: 264. Locus typicus: Karlovo, Stara Planina (Bulgaria). Holotypus: MNH No. 455.

Deroceras melanocephalus: GROSSU and LUPU 1957: 171; LUPU 1971: 126.

Deroceras melanocephalum: URBAŃSKI and WIKTOR 1968: 72.

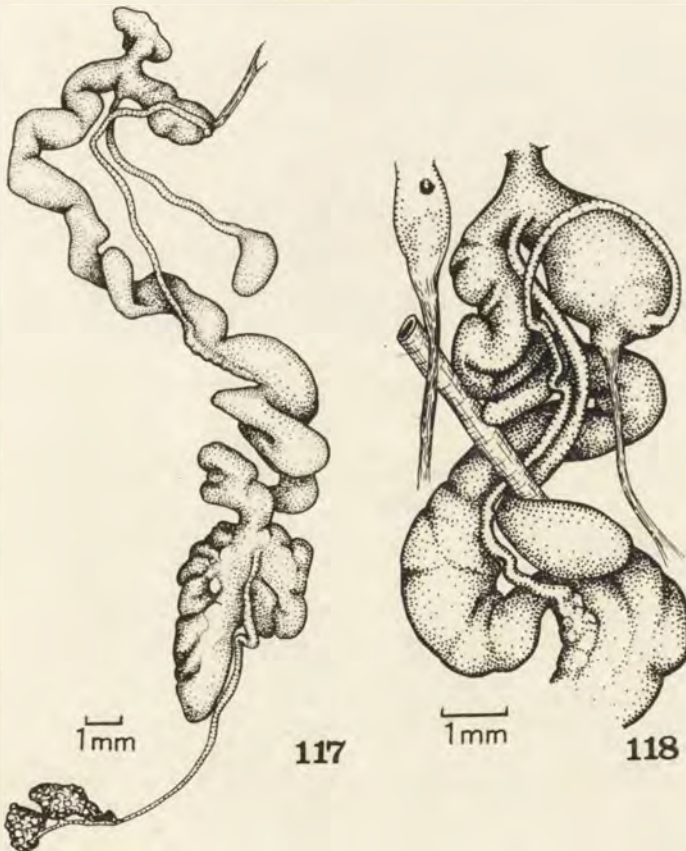
Deroceras (*Krynickillus*) *urbanskii*: DAMJANOV and LIKHAREV 1975: 324.

¹ KALENICZENKO (1851) gives among synonyms the name "*Krynickia melanocephala*" referring to his work from 1839 (Bull. Soc. Imp. Nat. Moscou, 1:30). As there is no description in this work the name should be treated as nomen nudum.

Preserved specimens about 45 mm long, mantle up to 15 mm in length. Body very narrow (shape similar as in *Lehmannia*). Keel attaining about $\frac{1}{3}$ of dorsum length. Mantle groove well-visible (Fig. 116). Round, flattened area around pneumostome ill-defined. Integument finely sculptured, skin thin. Between median line and pneumostome 18 grooves.



Fig. 116. *Krynickillus urbanskii* (WIKTOR) — side view (after WIKTOR 1971)



Figs. 117–118. *Krynickillus urbanskii* (WIKTOR): 117 — genitalia, 118 — copulatory organs in their natural position (after WIKTOR 1971)

Colouration black-ash-grey or black. Dorsum darker, sides lightening downwards. Middle of dorsum with lighter, blue, band. Head and neck blackish. Sole cream.

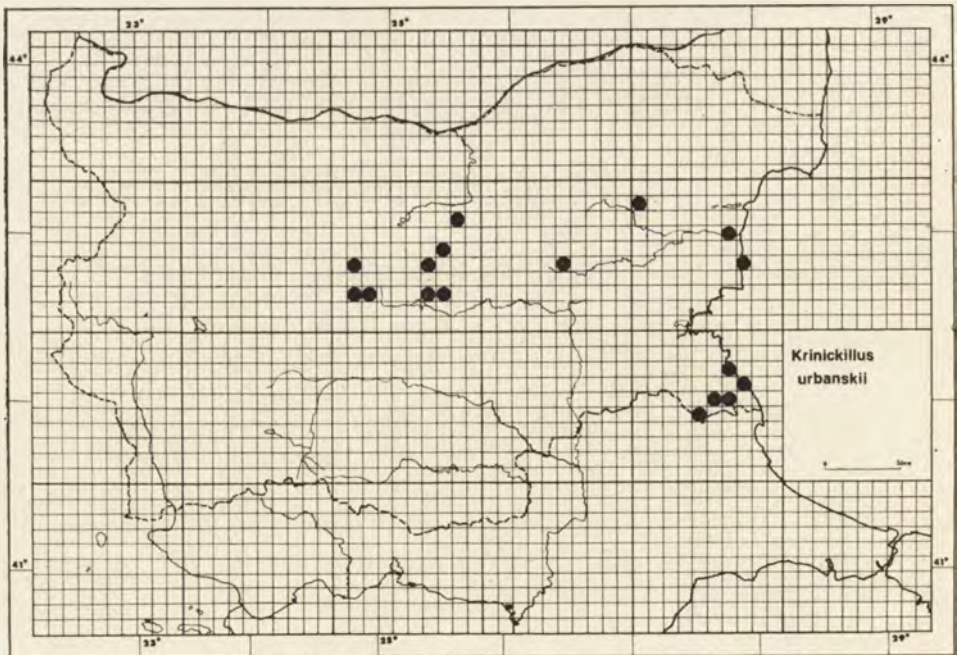
Genitalia (Figs. 117–118). Gonad and glandula albuminalis elongate. Spermoyiductus very short, vas deferens and oviductus as long as spermoviductus or longer. Vas deferens very thin, apically opening into penis. Penis bulb-like, cylindrical, slightly narrowed anteriorly. Retractor penis fine and narrow, inserted laterally on posterior end of penis. Spermatheca small, oval. Spermatheca duct very long, almost as thin as vas deferens. Both spermatheca and spermatheca duct about twice penis length. Oviductus in shape of bent tube, thick. Atrium short, tubular,

Formula of radula: C. 12–13. 39–45/ × 125–132.

Intestinal coecum absent.

Bionomics almost unknown. Very mobile slug, crawling fast. Sometimes crawls out on tree trunks. Occurs in beech, hornbeam and oak woods, also in bushes. In mountains up to about 1500 m. Mature specimens were collected mainly in October.

Distribution. Known from Rumanian Dobruja, eastern part of Stara Planina, the Black Sea coast, Strandzha and Trabzunt in Turkey.



Map 29. *Krynickillus urbanskii*

Material examined: 68 specimens.

Records (Map 29):

Stara Planina: the Shipka pass, Buzludzha near Kazanluk, Kalofer leg. BOROWIEC and TARNAWSKI (MNH), Madara leg. BEŠKOV and STAREGA (IZW). Also: WIKTOR (1971) — Karlovo, Shipka, Preobrazhenski Monastir and Sveta Trojca Monastir near Turnovo, Dryanovski Monastir near Dryanovo, Cherni Osum near Troyan, Gabrovo, Zheravna near Kotel.

Strandzha: the area of Gramatikovo, at the Veleka river, Kochul near Malko Turnovo leg. STAREGA (IZW), the valley of Aydere near Malko Turnovo. Also: WIKTOR (1971) — Gramatikovo and Malko Turnovo.

The Black Sea coast: at the mouth of the Kamehya river, Primorsko, Kiten. Also: WIKTOR (1971) — Obzor and in the area of the mouth of the Ropotamo river.

ZOOGEOGRAPHICAL CHARACTERISTICS

I have already devoted to this problem a separate paper (WIKTOR 1977). In the last few years, the views on specific names of some slugs changed, so the names used previously are partly synonymous now. Owing mainly to the discovery of new slugs or describing of new species the list has grown considerably. However, this fact has no impact on the general picture of the ranges and zoogeographical characteristics.

At present, 13 out of 37 species known in Bulgaria have vast ranges reaching at least the Central and Western Europe. These are:

<i>Arion lusitanicus</i>	<i>Limax cinereoniger</i>
<i>Arion subfuscus</i>	<i>Limax flavus</i>
<i>Arion silvaticus</i>	<i>Lehmannia nyctelia</i>
<i>Arion hortensis</i>	<i>Deroceras leae</i>
<i>Tandonia budapestensis</i>	<i>Deroceras sturanyi</i>
<i>Limax maximus</i>	<i>Deroceras agreste</i>
	<i>Deroceras reticulatum</i>

Arion lusitanicus, *A. hortensis* and *Deroceras reticulatum* are alien introduced elements in the examined area. The remaining ones are autochthonic in Bulgaria but the country constitutes only a fragment of their vast zoogeographical range. The following ones inhabit smaller area:

<i>Tandonia kusceri</i>
<i>Tandonia cristata</i>
<i>Limax maculatus</i>

In the Black Sea region they reach further to the East, to the USSR and *T. kusceri* inhabits also a large area of Yugoslavia.

The following species extend over the Bulgarian border:

<i>Tandonia serbica</i>	<i>Lehmannia sarmizegetusae</i>
<i>Limax macedonicus</i>	<i>Deroceras turcicum</i>

<i>Limax conemenosi</i>	<i>Deroceras zilchi</i>
<i>Lehmannia horezia</i>	<i>Deroceras bureschi</i>

The majority of them inhabit also the neighboring areas of Rumania and, sometimes, Yugoslavia, e.g. *D. turcicum* and probably *D. bureschi*.

Krynickyillus urbanskii comprises within its range the Black Sea, occurring both in eastern Bulgaria and Rumania as well as in northern Turkey. *Deroceras panormitanum* occurs in the Mediterranean region and ranges to Bulgaria from the South. Finally, *Deroceras thersites* and *Deroceras pageti*, the species hardly examined occur in eastern Bulgaria and in Greece.

The distribution of *Limax subalpinus* is still unclear. Probably, *Limax punctulatus* is a mountainous element inhabiting the Alpine area and extending toward the Balkans.

The list of species recorded only from Bulgaria is long. However, it should be noticed that most of them have been described very recently so their occurrence on the adjacent area cannot be excluded. These are:

<i>Milax verrucosus</i>	<i>Tandonia pinteri</i>
<i>Milax parvulus</i>	<i>Lehmannia brunneri</i>
<i>Tandonia totevi</i>	<i>Deroceras bulgaricum</i>
<i>Tandonia piriniana</i>	

It is worth mentioning here that in that group only *Milax parvulus* range reach the coast of the Black Sea.

Bulgaria is the area crossed by several distinct zoogeographical limits dividing this country into several zoogeographically different areas. It is reflected by the slug fauna.

Basically, 14 species listed below can be excluded from the further discussion, as they inhabit the whole area of Bulgaria. These are:

<i>Arion subfuscus</i>	<i>Limax macedonicus</i>
<i>Arion silvaticus</i>	<i>Limax conemenosi</i>
<i>Milax parvulus</i>	<i>Limax flavus</i>
<i>Tandonia kusceri</i>	<i>Lehmannia nyctelia</i>
<i>Tandonia cristata</i>	<i>Deroceras turcicum</i>
<i>Limax maximus</i>	<i>Deroceras sturanyi</i>
<i>Limax cinereoniger</i>	<i>Deroceras macedonicus</i>

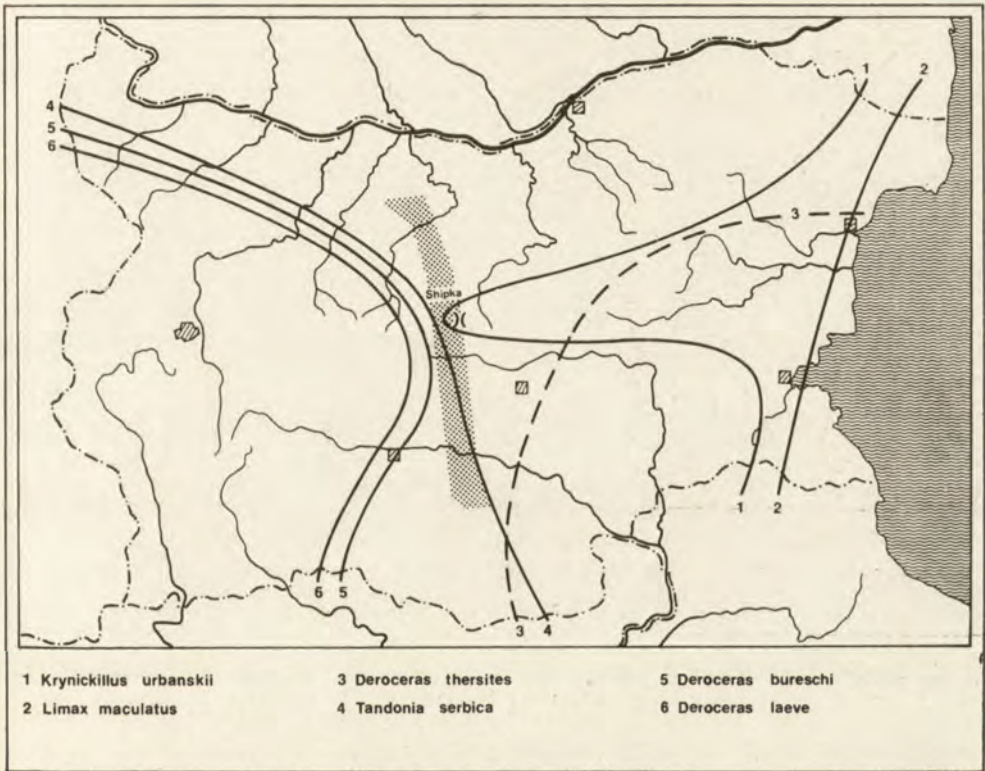
I also include in this group *D. agreste*, despite its insular occurrence. However, it has a very large range and it is probably autochthonic in Bulgaria.

Also, the introduced species should be excluded from our considerations, i.e. *Arion lusitanicus*, *A. hortensis*, *Deroceras reticulatum*. The remaining species exhibit a marked regionalization and they are confined to small areas of Bulgaria.

The range of the following species is limited to western Bulgaria:

Tandonia serbica
Deroceras laeve
Deroceras bureschi

with their limit of range from western Stara Planina Mts to Shipka pass as well as to southern massifs of Rila and Pirin and western Rodopi (Map 30). In that area exclusively the following species were found:



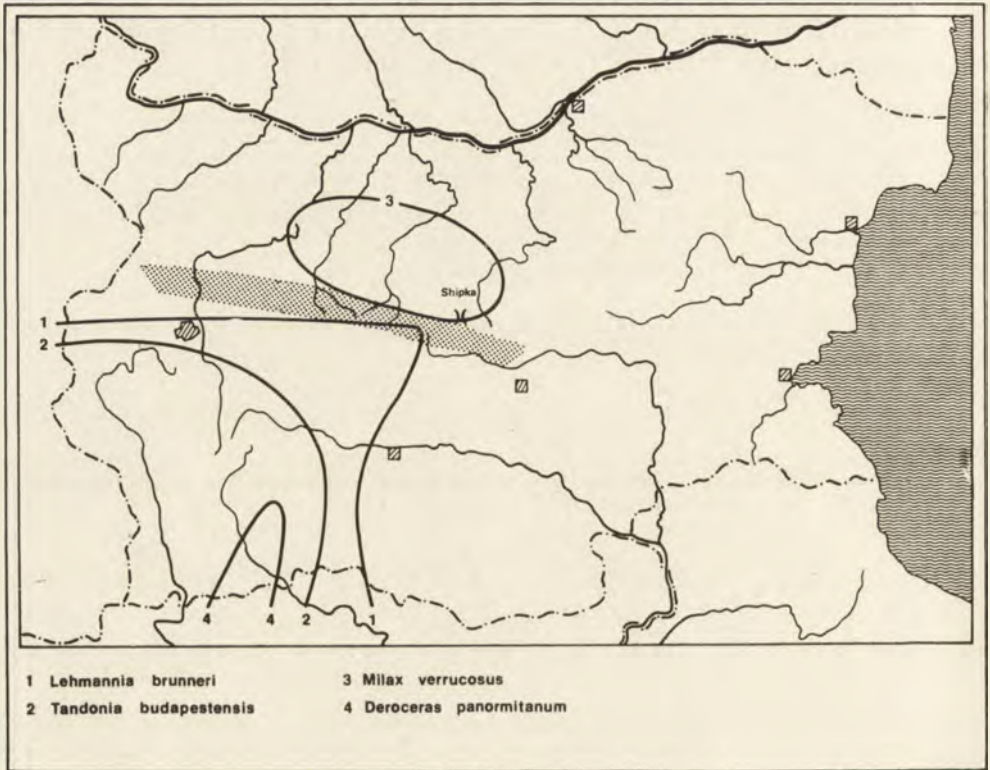
Map 30. Zoogeographical limit (dotted band) between two groups of slugs: eastern and western, passing through Shipka pass and along the eastern border of Rodopi Mts.

Limax punctulatus
Limax subalpinus
Lehmannia sarmizegetusae

The species occurring exclusively in south-western Bulgaria constitute the next group. These are:

Tandonia budapestensis
Lehmannia brunneri
Deroceras panormitanum

Two of them reach in the North the Vitosha massif and *L. brunneri* stretches slightly into the area of Stara Planina Mts (Map 31). The following species should be included here:



Map 31. Zoogeographical limit between slugs of the massifs of south-west Bulgaria (Rila Pirin, Rodopi, Vitosha) and the massif of Stara Planina.

Tandonia totevi
Tandonia piriniana
Tandonia pinteri

The following species are limited to western part of Stara Planina Mts:

Milax verrucosus
Deroceras zilchi
Lehmannia horezia

None of them extends toward the east part of Shipka pass.

The species occurring exclusively in the East, in the area adjacent to the Black Sea (Map 30):

Limax maculatus *Deroceras bulgaricum*

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STRESZCZENIE

[Tytuł: Ślimaki nagie Bułgarii (*Arionidae*, *Milacidae*, *Limacidae*, *Agriolimacidae* — *Gastropoda Stylommatophora*)]

Praca została oparta głównie na własnych badaniach terenowych przeprowadzonych w latach 1964, 1967, 1969 oraz 1976. Objęły one praktycznie cały obszar kraju. Niezależnie od tego zbadano wszystkie materiały muzealne i znajdujące się w prywatnych kolekcjach, do których udało się autorowi dotrzeć. Praca ma charakter monografii systematycznej, gdzie omówiono wszystkie gatunki stwierdzone przez autora i znane z literatury. W tym drugim przypadku dane poddano krytycznej analizie, uwzględniając materiały dowodowe oraz obecne poglądy na systematykę. Po przeprowadzeniu licznych synonimizacji, wykazaniu niewątpliwych omyłek niektórych autorów, w tym również swoich własnych (URBAŃSKI i WIKTOR 1968), ustalono występowanie w Bułgarii 37 gatunków ślimaków nagich. Z tego jeden (*Tandonia piriniana*) jest nowy dla nauki. Występowanie trzech gatunków podano w wątpliwość (*Tandonia rustica*, *T. sowerbii*, *Lehmannia marginata*). Dwóch niedawno opisanych z Bułgarii gatunków (*Deroceras bulgaricum*, *Lehmannia sarmizegtusae*) nie udało się autorowi znaleźć.

Praca zawiera oryginalny klucz do wszystkich gatunków oraz szczegółowe opisy morfologii, dane o bionomii i rozmieszczeniu oraz wykazy wszystkich znanych stanowisk. Uzupełniają to oryginalne rysunki oraz mapy rozmieszczenia ze stanowiskami ujętymi w siatce UTM. Przy każdym gatunku podano informacje o typach, synonimie oraz ważniejszą literaturę.

Analiza zoogeograficzna fauny ślimaków nagich dokonana uprzednio przez autora (WIKTOR 1977) została zaktualizowana, choć nie zmieniło to w sposób istotny poglądów na temat podziału kraju na obszary o różnej faunie ślimaków nagich. Na podstawie tej fauny można wyznaczyć dwie wyraźne granice (Mapa 30 i 31). Jedna przebiega mniej więcej przez przełęcz Szipka w paśmie Starej Planiny i wzdłuż wschodniej granicy Rodopów, druga zaś rozgranicza masywy górskie południowo-zachodniej Bułgarii (Piryn, Riła, Rodopy, Witosza) od pasma Starej Planiny.

Całość pracy dopełnia pełne piśmiennictwo dotyczące ślimaków nagich badanego obszaru.

[Заглавие: Слизни Болгарии (*Arionidae*, *Milacidae*, *Limacidae*, *Agriolimacidae* — *Gastropoda*, *Stylommatophora*)]

Работа основана главным образом на полевых исследованиях, проведенных автором в 1964, 1967, 1969 и 1976 гг. Исследования эти охватили фактически территорию всей страны. Независимо от них автор исследовал все материалы, хранящиеся в музеях и в частных коллекциях, к которым имел возможность доступа. Работа носит характер тематической монографии, где обсуждены все виды, констатированные самым автором и известные из литературы. Во втором случае имеющиеся данные были критически проанализированы с учетом фактических материалов и современного подхода к систематике этой группы. По установлении многочисленных синонимов и исправлении невызывающих сомнений ошибок некоторых авторов, в том числе также и собственных (URBAŃSKI и WIKTOR 1968) установлено, что в Болгарии встречается 37 видов голых слизней. Один из них (*Tandonia piriniana*) является новым в науке. Встречаемость трех видов подвергнута сомнению (*Tandonia rustica*, *T. sowerbii*, *Lehmannia marginata*). Двух недавно описанных из Болгарии видов (*Deroceras bulgaricum*, *Lehmannia sarmizegtusae*) автору не удалось найти.

Работа содержит оригинальный определитель всех видов, а также подробные морфологические описания, данные по биологии и распространению, перечень всех известных местонахождений. Дополняют это оригинальные рисунки и карты местонахождений, нанесенных на карты UTM. При каждом из видов приведены информации о типах, синонимах и основных литературных источниках.

Зоогеографический анализ слизней, произведенный автором ранее (WIKTOR 1977), актуализирован, хоть это не изменило существенно образом взглядов относительно разделения страны на районы различающиеся по фауне слизней. На основании этой фауны можно провести две четкие границы (Карты 30 и 31). Одна из них проходит через перевал Шипка в горной цепи Стара Планина и вдоль восточной границы Родопов; вторая разграничивает горные массивы юго-западной Болгарии (Пирин, Рила, Родопы, Витоша) от цепи Стара Планина.

Работу дополняет полная библиография, касающаяся слизней исследуемой территории.