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Identification Keys to the Clausiliidae J. E. Gray, 1855 (Mollusca: Stylommatophora) from Bulgaria

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Abstract: The paper presents the currently known diversity of the family Clausiliidae J. E. Gray, 1855 on the territory of Bulgaria. All new systematic changes are noted and all new taxa described during the last years are listed. The main key characters for species identification are presented, with additional descriptions of some characters.

Keywords: identification, genera, species, subspecies, Clausiliidae, Bulgaria

Introduction

The terrestrial malacofauna of Bulgaria is characterised by high taxonomic diversity of the family Clausiliidae Gray, 1855. The Europaen representatives of this family are distributed mostly on the Balkan Peninsula. On the territory of Bulgaria, there is an extremely high diversity of species and subspecies of clausiliids. Most of these taxa are summarised in the monograph of Damjanov, Likharev (1975). Following the latter publication, many nomenclatural changes were made, new distributional data were published and some additional species and subspecies were described. At present, the identification characters of the taxa of the family Clausiliidae suggested by Damjanov, Likharev (1975) are not functional and need to be updated. The shell structure and the genital system were the features considered with the highest taxonomic value for identifying clausiliids. As a result of numerous studies of this snail group, concerning their morphology and anatomy, some new criteria for determination of the genus, species and subspecies were introduced (Nordsieck 2002). Leading taxonomical value now has the closing apparatus of the shell (clausilium). Nordsieck, Neubert (2002) point out that the key characters for the determination of the species from the different groups of Clausiliidae require expertise. According to the same authors, the genital system structure also has an important taxonomical value in identifying some of the species.

Specific for the species and subspecies of this family is that most of them have local distributions on isolated rock complexes in Bulgaria of the so-called 'island-type'. Some of them occur on very small territories as *Macedonica pirinensis* Jaeckel, 1954, *Macedonica zilchi* Urbański, 1972, *Macedonica hartmuti* Irikov, 2003, *Macedonica teodorae* Irikov, 2006, *Bulgarica varnensis trimontsiana* Irikov, 2006, *Alinda biplicata karlukovoensis* Dedov, 2009 and other (Jaeckel 1954, Urbański 1972, Irikov 2003, 2006, Dedov 2009). Since many sites of 'limestone islands' of Bulgaria are still insufficiently explored it can be highlighted that the clausiliid fauna of the country needs more studies and many taxa remain unknown. In this paper, we summarise all data concerning the identification characters of the clausiliids from Bulgaria. To support future studies on this group of snails we suggest identification keys to the genera, species and subspecies based on all the current knowledge regarding this group from Bulgaria.

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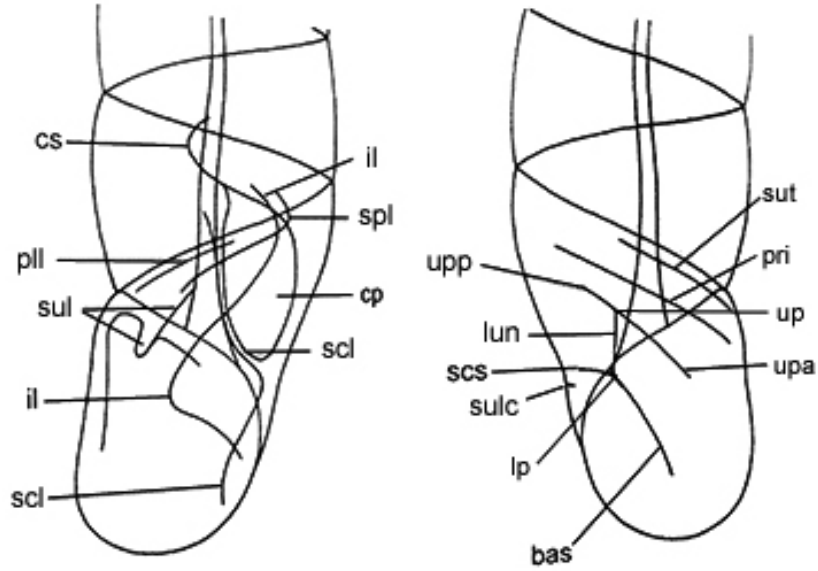

Fig. 1. Schematic illustration of the clausilial apparatus in accordance with Nordsieck, Neubert (2002) considered in this paper: 1 – frontal view, 2 – dorsal view (for the abbreviations see 'Material and Methods')

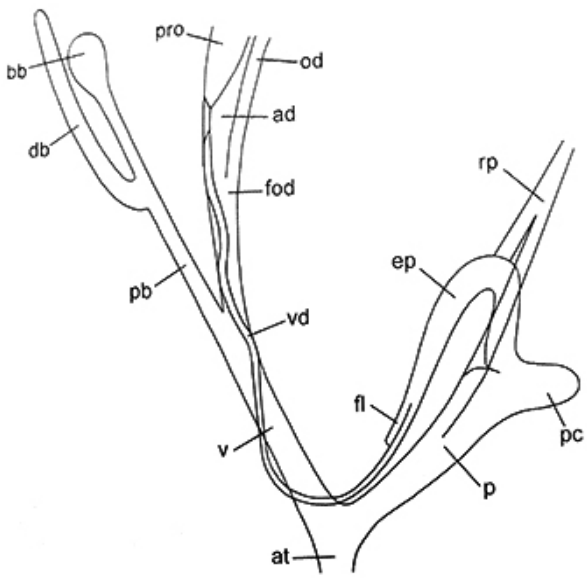

Fig. 2. Schematic illustration of the genitalia of Clausiliidae (according Nordsieck 1985). **Abbreviations**: ad = allosspermiduct (of spermiduct); at = genital atrium; bb = bursa (of bursa copulatrix); db = diverticulum (of bursa copulatrix); ep = epiphallus; fl = flagellum; fod = free oviduct; od = oviduct (of spermoviduct); p = penis; pb = pedunculus (of bursa copulatrix); pc = penial caecum; pro = prostate (of spermoviduct); rp = penial retractor; v = vagina; vd = vas deferens

Material and Methods

The schematic drawings of the clausilial apparatus with main key characters are in accordance with Nordsieck (1982) and Nordsieck, Neubert (2002) (Fig. 1), and the one of the genital system is in accordance with Nordsieck (1985) (Fig. 2). For the construction of the keys, the comparative shell collection of A. Irikov was used as well as all the descriptions of taxa by Rossmässler (1835, 1839), Westerlund (1884, 1892), Wagner A. (1927), Jaeckel S. (1954), Damjanov, Likharev (1975), Nordsieck (1963, 1969, 1972, 1973, 1974, 1977, 1982, 1985, 2002, 2008), Nordsieck, Neubert (2002), Urbański (1960, 1964, 1969, 1972, 1977), Dedov (2009, 2011, 2012), and Welter-Schultes F. W. (2012).

Abbreviations

Plicae of the pariet-columellar side = lamella

superior lamella (parietalis, **sul**) and spiral lamella (spiralis, **spl**):

inferior lamella (columellaris, **il**),

subcolumellar lamella (subcolumellaris, **scl**),

clausilium, consisting of stalk (**cs**) and plate (**cp**),

The space between superior lamella and inferior lamella is named interlamellar.

A parallel lamella (parallelis, **pll**) is often present near to the suture.

Plicae of the palatal side = plicae (in the strict sense):

principal plica (principalis, **pri**),

palatal plicae **(lunellar)**:

upper palatal plica (**up**), if lunella present, with anterior part (**upa**) and posterior part (**upp**),

middle palatal plicae resp. lunella (**lun**),

lower palatal plica (**lp**), if lunella present, with anterior part (basalis, **bas**) and posterior part (subclaustralis, **scs**),

lowest palatal plica (sulcalis, **sulc**),

If subclaustralis and sulcalis are fused or indistinguishable, only the term posterior lower palatal plica should be used.

A sutural plica (suturalis, **sut**) is often present near to the suture.

The callous thickening of the palatal wall behind the peristome is named palatal callus.

Results

Key to the genera of the family Clausiliidae from Bulgaria

1. (26) Spiral lamella present (with the exception of *Laciniaria bajula mursalicae* Urbański, 1969 and *L. b. ditrichi* Nordsieck, 1977).

2. (9) Spiral lamella in contact with superior lamella or both are fragmented and situated in one line, at equal distances from collumela.

3. (6) Periphery of the aperture with many small lamellae.

4. (5) Whole aperture edge with many lamellae and nodules, subcolumellar lamella interrupted and composed of variously developed lamellae; distal part of clausilium plate inclined inwards; diverticulum of bursa copulatrix longer than bursa and its stalk .....***Serrulina***

5. (4) Only columellar end of aperture with lamellae and nodules; subcolumellar lamella not interrupted; distal part of clausilium plate not twisted; diverticulum of bursa copulatrix shorter than bursa and its stalk .....***Dobattia***

6. (3) Aperture edge different.

7. (8) Aperture narrow and high; last whorl with clear basal keel and groove; end of clausilium plate rounded and twisted with a clear angle ....***Clausillia***

8. (7) Aperture more rounded; last whorl with weak basal keel; aperture rounded at its lower part, with weak basal keel; clausilium plate with notched, hooked .....***Vestia***

9. (2) Spiral lamella does not touch superior lamella and both are not situated in one line but located at different distances from the columella.

10. (13) Last whorl without keels.

11. (12) Palatal plicae begins from back side of last whorl; callus above lower palatal plica present; clausilium plate with two cuttings, one big and one small connection, with large outgrowth and concavity in wider section of clausilium plate . .....***Cochlodina***

12. (11) Palatal plicae begins dorso-laterally, laterally or deeper on last whorl; callus above lower palatal plica lacking; clausilium plate with one big cutting in connection, with outhgrowth and regularly-rounded wide side of clausilium .....***Macedonica***

13. (10) Last whorl with one or two keels (with an exception of *Carinigera schuetti* Brandt, 1962, with rounded back side of last whorl).

14. (25) Lunella present.

15. (22) Last whorl with one basal keel; lower palatal plica lacking.

16. (19) Lunella situated laterally.

17. (18) Palatal end of aperture usually with short lamellae or nodules; wider side of clausilium plate strongly twisted; penis without head ..***Laciniaria***

18. (17) Shell without lamellae on aperture edge; wider side of clausilium plate only slightly twisted; head of penis is more or less distinctly separated .....***Alinda***

19. (16) L lunella situated on back side.

20. (21) Inferior lamella positioned vertically and hardly visible in aperture; lower palatal plica insufficiently developed; palatal callus lacking; basal keel more or less clearly visible .....***Euxina***

21. (20) Inferior lamella situated partly spirally and better visible from aperture; lower palatal plica well developed and terminates frontally with palatal callus; basal keel distinct .....***Galeata***

22. (15) Last whorl with double keel: always well developed basal and distinct or insufficiently developed dorsal keel; lower palatal plica present.

23. (24) Lunella strongly developed and below transformed into lower palatal plica, well visible in aperture .....***Carinigera***

24. (23) Lunella less distinctly developed, not well visible in aperture .....***Bulgarica***

25. (14) Lunella lacking .....***Mentisella***

26. (1) Spiral lamella missing or distinctly reduced.

27. (26) Clausilial apparatus strongly reduced, only underdeveloped superior lamella present ....***Balea***

28. (27) Clausilial apparatus not reduced, with developed lamellae.

29. (32) Shell spindle-shaped, with sculpture of more or less developed ribs; subcolumellar lamella hardly visible in aperture; additional lamellae lacking.

30. (31) Shell protruded, small (with height of up to 70 mm), with fine striae and sharply pointed end with rounded apex; inferior lamella not well visible in aperture; callus present, situated at basal sector of aperture and insufficiently developed dorsal and basal keels; lunella situated sideward on last whorl; short and deeply situated principal plica present; distal part of vas deferens thickened; vagina and penis very short .....***Micridylla***

31. (30) Shell spindle-shaped, large (height > 70 mm), with sculpture of densely situated ribs and pointed apex; inferior lamella relatively well visible in aperture; well-developed callus in palatal part of aperture and slight basal groove; lunella situated backside on last whorl; principal plica lacking; distal

part of vas deferens normal, vagina and penis relatively long .....***Idyla***

32. (29) Shell tower-shaped, not densely but distinctly ribbed; subclaustralis relatively well-visible in aperture; additional plica under lower palatal plica present .....***Ruthenica***

Keys to the species and subspecies of the family Clausiliidae from Bulgaria

Subfamily Serrulininae Ehrmann, 1927

Genus *Serrulina* Mousson, 1873

There is only one known species of this genus from Bulgaria.

Serrulina serrulata (L. Pfeiffer, 1847)

Shell ribbed, pale yellow; end of aperture with many lamellae and nodules.

Genus *Dobatia* Nordsieck, 1973

There is only one known species of this genus from Bulgaria.

Dobatia goettingi (Brandt, 1961)

Shell surface smooth, pale yellow; only columellar end of aperture with lamellae and nodules.

Subfamily Alopiinae A.J. Wagner, 1913

Genus *Carinigera* Moellendorff, 1873

Three subspecies and one species of this genus are known from Bulgaria.

Last whorl with two slightly twisted keels: more developed basal keel and less developed dorsal keel. Lunella situated dorsally or dorso-laterally on last whorl, massive.

Carinigera buresi buresi (A. J. Wagner, 1928)

Surface of upper whorls with small white papillae close to suture. Aperture with small lip. Lunella with well-developed basalis.

Carinigera buresi damjanovi (Likharev, 1972)

Surface of upper whorls with big, white papillae and nodules close to suture. Aperture widely-open and big. Lunella with well-developed basalis.

Carinigera buresi dramaensis (Nordsieck, 1977)

Shell without white suture, with rare small white papillae close to suture of upper whorls. Aperture widely-open and big. Lunella with extremely long and thick basalis.

Carinigera schuetti Brandt, 1962

Shell often decollated, with small fine white ribs. Aperture is widely-open and thickened. Parallel lamella present. Lunella situated dorso-laterally, with long and massive basalis.

Genus *Cochlodina* Férussac, 1821

One species is known from Bulgaria, represented with two subspecies. Shell smooth, without ribs. Last whorl without keel.

C. laminata laminata (Montagu, 1803)

Shell distinctly convex, sharply pointed at apex with 10-11$^{1/2}$ whorls.

C. laminata partita (Westerlund, 1892)

Shell slightly convex, slender, gradually and finely pointing along apex with 12-13 whorls.

Genus *Macedonica* O. Boettger, 1877

There are 17 species and subspecies of this genus known from Bulgaria.

1. (7) Lunella rudiment of lower palatal plica present.

2. (3) Aperture without thickened inner lip; subcolumellar lamella slightly to clearly visible inside aperture (excl. *M. martae*, in which lamella and clausilial apparatus significantly reduced); retractor of vagina inserted into pedunculus at distance from its transition into vagina; base of penis-papillae convex, ± long.

3. (6) Shell with well-developed sculpture of stripes and ribs.

4. (5) Clausilial apparatus significantly reduced; palatal plicae short; clausilium plate not closing well opening to aperture .....***M. martae***

5. (4) Clausilial apparatus well-developed: palatal plicae are long, clausilium plate completely closes opening to aperture .....***M. pinteri***

6. (3) Shell surface with slight sculpture or almost smooth .....***M. frauenfeldi***

7. (1) Lunella rudiment missing.

8. (17) Shell without white outer surface stratum; aperture with relatively thickened inner lip; retractor of vagina inserted into pedunculus near to its transition into vagina; penis of small size, base of penis papillae reduced (excl. *M. teodorae* with large penis papilla).

9. (12) Sculpture of shell distinctly developed.

10. (11) Shell with large, rounded ribs ....***M. hartmuti***

11. (10) Shell with white, fine and sharp ribs ....***M. teodorae***

12. (9) Sculpture of shell insufficiently developed.

13. (14) Shell slender, thin, with simple aperture .....***M. brabeneci***

14 (13) Shell spindle-shaped, thick, with thick aperture.

15. (16) Shell of large size and rather spindle-shaped .....***M. marginata***

16. (15) Shell of smaller size and rather tower-shaped .....***M. dobrostanica***

17. (8) Shell with white outer surface stratum; aperture without separate inner lip (simple aperture margin); retractor of vagina inserted into pedunculus at distance from its transition into vagina but closer to vagina in comparison with *frauenfeldi* species; base of penis papillae clear.

18. (19) Shell with significantly developed sculpture of ribs and lamellae .....***M. zilchi***

19. (18) Shell with slightly developed sculpture .....***M. pirinensis***

The taxa of the genus *Macedonica* are subdivided into three groups (Nordsieck 1974, 1977).

***Marginata* species group**

Macedonica marginata marginata (Rossmässler, 1835) – (Syn. *Clausilia auriformis* Mousson, 1859)

Shell surface smooth, with regular, small, fine stripes on upper and lower whorls.

Macedonica marginata major (Rossmässler, 1839)

Shell of large size and with well-developed clausilial apparatus. Palatal plicae usually four.

Macedonica marginata frivaldskyana (Rossmässler, 1839)

Shell convex, of relatively small size, with big ribs at distance from each other, and patches of white touches at suture.

Macedonica marginata balcanica (A. Wagner, 1927)

Shell of relatively small size. Clausilial apparatus rather reduced.

Macedonica brabeneci brabeneci Nordsieck, 1977

Shell slender, gradually shaped, thinner at top. Aperture of elongate-oval shape. Principal plica relatively short.

Macedonica brabeneci prismatica Dedov, 2012

Shell rounded at its middle part, sharply shaped, thin at top. Aperture of oval-auricular shape. Principal plica long.

Macedonica hartmuti Irikov, 2003

Shell small, tower-shaped, with massive, rounded ribs, at distance from each other.*Macedonica teodorae* Irikov, 2006

Shell large, with sparse regular thin ribs, with white touches at suture. Only species of *marginata* group with distinctly developed and long penis papilla.

Macedonica dobrostanica Irikov, 2012

Shell small, smooth. Genital system of small size, in distal part of vagina with longitudinal, segmented fold, so far unknown in other species of this genus.

***Frauenfeldi* species group**

Macedonica frauenfeldi sigma (Westerlund, 1884)

Shell almost smooth, with fine ribs at top, on middle and lower whorls clearly visible at suture. aperture with thickened periphery. Principal plica very long, ending inside. Basalis with lunella rudiment, not well visible in aperture.

Macedonica frauenfeldi regia Nordsieck ,1974

Sculpture of shell of fine stripes. Aperture with thin periphery. Principal plica long. Additional palatal plicae present between principal plica and lower palatal plica, ending with palatal callus in front part of aperture. Basalis large with one lunella rudiment.

Subspecies with relatively large penial papilla exception in *frauenfeldi* group, usually not very long but convex.

Macedonica frauenfeldi riedeli Urbański, 1977

Shell with white suture between all whorls. Sculpture well visible, with fine lines and small ribs. Aperture periphery slightly thickened, indistinctly separated in aperture. Principal plica long, well visible in aperture, going deep inside last whorl. Lower palatal plica visible in inclined view into aperture, with slightly developed lunella rudiment. Male part of genital organs short and convex.

Macedonica frauenfeldi tau Nordsieck, 1977

Aperture periphery well separated in aperture. Lunella deep inside last whorl. Principal plica well developed frontally in aperture.

Macedonica pinteri Sajó, 1968

Shell slender, with weak stripes and large rounded ribs. Aperture periphery with thin and partly separated lip in aperture. Subcolumellar lamella large and well visible in aperture. Palatal plicae well developed. One lunella rudiment.

Macedonica martae Sajó, 1968

Shell with whitish surface, convex, with regular and widely spaced ribs. Aperture periphery with thin and partly separated lip in aperture. Subcolumellar lamella missing. Clausilial apparatus significantly reduced. All palatal plicae short, sometimes with shape of callus.

***Macedonica* species group**

Macedonica pirinensis Jaeckel, 1954

Shell with white surface stratum, slight sculpture excluding neck part, insufficiently developed lamella and closing apparatus. Clausilium plate with clearly visible cutting.

Macedonica zilchi Urbański, 1972

Differs from other forms of the genus *Macedonica* mostly by its large size, convex shell, well-developed bluish-white shell surface stratum and clear sculpture of ribs and clausilial apparatus. Subcolumellar lamella hardly visible inside aperture. Lower palatal plica strongly developed and visible inside aperture. Clausilium plate with double cutting, similar to *cochlodina* species (with one larger and one smaller, widely rounded cutting).

Male section of genital system of large size compared to *marginata* species. Penis papilla large, long, and situated along whole length of penis reaching almost to genital atrium.

Subfamily Mentissoideinae Lindholm, 1924

Genus *Idyla* H. & A. Adams, 1855

One subspecies of this genus is known from

Bulgaria. *Idyla castalia boschi* Nordsieck, 1973.

Shell with fine, dense ribs. innferior lamella hardly visible in aperture. Neck part of last whorl with two keels: basal keel and weak dorsal keel. With one massive lunella and palatal callus near apertural edge. Palatal plicae missing: basalis poorly developed.

Genus *Euxina* Boettger, 1877

Euxina circumdata (L. Pfeiffer, 1848)

Shell slender, gradually growing thiner to apex, densely covered with fine ribs and with white touches at suture. Aperture ovally-elipsoid. Inferior lamella hardly visible in aperture. Last whorl with clear basal keel and slight dorsal bulge. Principal plica long, situated high, near suture. Lunella massive, with lower end twisted inwards. Any other palatal plicae missing. Upper side of clausilium plate regularly rounded, without any cuttings. Diverticulum of bursa copulatrix significantly shorter than bursa of bursa copulatrix. Penis long, convex at its back part.

Euxina persica paulhessei (Lindholm, 1925)

Shell strongly convex in its middle part, sharply growing thinner at apex, with fine stripes and no white touches. Aperture large, rounded. Inferior lamella not well visible in aperture. Last whorl with clear basal keel and slight dorsal bulge. Principal plica very long, longer than lunella inside. With palatal callus near aperture edge and massive lunella. Clausilium plate with parallel sides and not widening at its upper side which rounded. Bursa and diverticulum of bursa copulatrix equal in length. Penis long, with ligament and with penial retractors, folding it and dividing it in two sections.

Euxina pontica borisi (P. Hesse, 1912)

Shell slender, gradually growing thinner at its apex, with fine ribs with tufts of white touches at suture. Aperture brown and large with round-elliptical shape, and thin pale lip. Last whorl with clear basal keel and slight dorsal bulge. Principal plica long, situated high, near suture. Lunella distinctly developed. Clausilium plate widened at front side and with few small cuttings. Biggest cutting forming growth with thickened sharp top.

Genus *Galeata* O. Boettger, 1877

One known species of this genus from Bulgaria.

Galeata schwerzenbachii (L. Pfeiffer, 1848)

Shell of small size, with slender to tower-like shape, whole surface covered with dense and fine ribs with white touches. Aperture small with well-separated apertural edge. Inferior lamella hardly visible in aperture, transformed into thin lamella at front part, ending at apertural edge. Clear basal keel and wide rounded dorsal keel. Principal plica long, penetrating inside from behind lunella. Upper palatal plica long, inclined, such that on inside almost divergating with principal plica, and in its front part ending with callus. Lunella short, massive.

Subfamily Clausiliinae J.E. Gray, 1855

Genus *Ruthenica* Lindholm, 1924

Monotypic genus.

Ruthenica filograna (Rossmässler, 1836)

Shell of very small size, slender with tower-like shape, entirely covered with regular, sharp ribs. Aperture small, with slightly open apertural end. Keels missing, neck side of last whorl with big dorsal bulge. Inferior lamella slightly visible in aperture, front part ending with thin lamella at periphery of aperture edge. One short and thin lamella under inferior lamella, at end of aperture. Subcolumellar lamella partly visible in aperture. Principal plica short, situated deep in last whorl on inside, penetrating behind lunella, cannot be seen in aperture from frontal view. Lunella well developed. Any other palatal plicae lacking.

Diverticulum of bursa copulatrix twice as long as bursa of bursa copulatrix. Penis short. Penial retractor big and connected with proximal end of penis.

Genus *Micridyla* Nordsieck, 1973

There is one known species of this genus from Bulgaria.

Micridyla pinteri (Nordsieck, 1973).

Shell small (smallest species of the family Clausiliidae in Bulgaria), slightly convex, fast tapering upwards, with obtuse apex. Sculpture consists of very fine, regular and dense small ribs. End of aperture separated. Last whorl with neck bulge, slight basal keel and unclear basal groove. Inferior lamella situated vertically and almost invisible in aperture. Subcolumellar lamella partly visible in front part of aperture. Principal plica and lower palatal plica insufficiently developed, short, not visible in front part of aperture, situated behind lunella on inside. Lunella well developed, with small subclaustralis. Palatal callus in lower part, in front part of aperture, penetrating inside. Any other palatal plicae missing. Clausilium plate narrow with tongue-like shape.

Vagina and penis very short.

Genus *Clausilia* Draparnaud, 1805

There is one known species of this genus from Bulgaria.

Clausilia (*Clausilia*) *pumila pumila* C. Pfeiffer, 1828

Shell at lower whorls strongly convex, fast tapering upwards to apex. Shell surface intensely and regularly ribbed with bundles of white touches on ribs. End of aperture open, thickened, clearly separated, and white in color. Superior lamella merges with spiral lamella. Inferior lamella almost

vertical, slightly visible in aperture. Lunella with curved inner ends. Principal plica long, penetrating behind lunella. Palatal callus from which lower palatal plica separated. Wide part of clausilium curved with clear angle.

Subfamily Baleinae A.J. Wagner, 1913

Genus *Mentissella* Nordsieck, 1973

There is one known species of this genus from Bulgaria.

Mentissella rebeli (Sturany, 1897).

Shell slender, with tower-like shape and sharp apex, and fine, dense ribs with bundles of white touches. Aperture with elliptical-oval shape, apertural end slightly open. Inferior lamella almost vertical and hardly visible in aperture. Last whorl with well-developed basal keel and deep basal groove at front. Three palatal plicae: long principal plica, short upper palatal plica and very massive lower palatal plica. Ends of principal plica and of lower palatal plica visible at front part of aperture. One palatal callus in aperture, as part of upper palatal plica. Lunella missing. Clausilium plate with a wide front end.

Genus *Laciniaria* Hartmann, 1842

According to Nordsieck (2008) there are eight valid species and subspecies of this genus in Bulgaria. *Laciniaria potochensis* Dedov, Neubert (2006) a synonym of *Alinda* (*Alinda*) *atanasovi atanasovi* (Urbański, 1964; Nordsieck 2008).

Lower palatal plica missing. Palatal end of aperture usually with lamella and nodules. Sometimes such lamellae present also at parietal end of aperture.

Laciniaria plicata plicata (Draparnaud, 1801)

Shell spindle-shaped, with thin, dense, regular ribs with patches of bundles of white touches. Aperture end in palatal and more rarely in columellar part, with plicae and nodules, situated further inside apertural edge (sometimes with a missing lamella at columellar part). Last whorl on neck with a well-developed basal keel, in front part there a deep basal groove. Principal plica and upper palatal plicae long and almost parallel to each other. Posterior part of upper palatal plica divergates with principal plica close to lunella. Lunella well developed.

Laciniaria plicata kueprijae Nordsieck, 1973

Shell spindle-shaped. sculpture consists of clear, widely spaced, whitish ribs. Lamellae missing at aperture end. Anterior part of upper palatal plicae partly reduced.

Laciniaria plicata rhodopensis Nordsieck, 2008

Shell with widely spaced, regular and sharp ribs, with patches of white touches on them. Between superior lamella and inferior lamella some intermediate nodules (interlamellar and mostly subinterlamellar). Basal groove not reaching aperture end. Neck part of last whorl with a slight basal keel. Principal plica well visible in front part of aperture, penetrating deep inside from behind lunella. Anterior part of upper palatal plica ditinctly inclined to principal plica and ends before lunella.

Laciniaria macilenta (Rossmässler, 1842)

Shell tower-like shaped with a sharp apex, of small size (smallest *Laciniaria* species, 10-11 cm shell height), with fine, dense, regular ribs. Aperture with a few small lamellae, ending inside near principal plica and upper palatal plica. Last whorl at neck with one basal keel, with a deep basal groove at front. Principal plica and upper palatal plica long, well visible in front of aperture, prolonged inside behind lunella. Lunella well developed.

Laciniaria bajula bajula A. Schmidt, 1968

Shell spindle-shaped, with regular ribs on its whole surface. Columellar part of aperture with few lamellae and nodules, situated rather inside than at end of aperture. Inferior lamella vertical and hardly visible in aperture. One interlamellar lamella situated at front of inferior lamella. Basal groove shallow, not reaching apertural end. Neck part of last whorl convex, with a slight basal keel. Palatal plicae, with exception of principal plica, reduced. Principal plica not visible in front part of aperture. Lunella well developed.

Laciniaria bajula mursalicae (Urbański, 1969)

Shell with thin ribs, mostly on middle and upper whorls. Spiral lamella missing. Basal groove insufficiently developed. Last whorl convex at its neck part, without keel. Principal plica short, almost completely reduced and not visible in aperture. Lunella and clausilium missing.

Laciniaria bajula lunella Nordsieck, 1973

Shell surface of middle and upper whorls with dense, thin ribs. Aperture end with few lamellae and nodules on its palatal part, situated rather inside aperture edge. Basal groove inscufficiently developed. Last whorl at its neck part convex without a keel. Principal plica long, hardly visible in front part of aperture, penetrating deep inside from behind lunella. Lunella massive, rainbow-curved with partly formed subclaustralis.

Laciniaria bajula ditrichi Nordsieck, 1977

Shell surface of middle and upper whorls with fine ribs, enlarged at aperture end. Clausilial apparatus distinctly reduced.

Genus *Alinda* H. & A. Adams, 1855

There are 13 species and subspecies known from this genus from Bulgaria.

Shell ribbed, with white touches on suture. clausilial apparatus developed to a different extent.

Alinda (*Alinda*) *biplicata bilicata* (Montagu, 1803)

Shell spindle-shaped, thin and densely ribed,

with white touches. apeture end thickened, separated by open aperture edge. Inferior lamella well visible in aperture. At its parietal part aperture ends with one or two not very large lamellae or nodules. Sometimes between superior lamella and inferior lamella there are one or two interlamellar lamellae. Neck part of last whorl with an unclear basal keel. Principal plica begining rather inside lunella. Upper palatal plica situated at an angle to principal plica, begining from upper end of lunella and ending near end of aperture. Lunella well developed and situated at right side of last whorl. Clausilium with distinctly curved upper part.

Alinda (*A.*) *biplicata michaudiana* (L. Pfeiffer, 1848)

Shell elongated, spindle-shaped, with dense ribs, and patches of white touches near suture. Inferior lamella relatively big, well visible in aperture. Basal groove reaches almost to end of aperture. Neck part of last whorl with clear basal keel and dorsal bulge. Palatal plicae and clausilim partly reduced. Principal plica and upper palatal plicae penetrate inside behind lunella, very thin almost rudimental, in front part of aperture slightly visible. Anterior part of upper palatal plicae short. Often upper palatal plicae completely missing. Lunella rudimental or completely missing.

Alinda (*A.*) *biplicata euptychia* (Ehrmann (in Urbański 1960))

Shell elongate and spindle-shaped, with white touches on ribs near suture. Shell surface with fine and dense small ribs. Inferior lamella big, well visible in aperture. Neck part of whorl with clear basal keel. Principal plica long and penetrating inside behind lunella. Anterior part of upper palatal plica situated at wide angle to pricipaland separated from it, on inside ending in front of lunella, well visible in aperture. Sometimes with short pseudo-palatal plica situated under upper palatal plica. Lunella massive, with distinctly curved upper end parallel to principal plica.

Alinda (*A.*) *biplicata orientalis* Nordsieck, 2008

Shell convex, sharply tapering at its apex, widely ribbed, with white touches near suture. Inferior lamella with well visible aperture. Neck part of last whorl with short basal keel and dorsal bulge. Principal plica long, on inside it prolongs behind lunella. Anterior part of upper palatal plica short, situated at wide angle to pricipalis. Sometimes with short pseudo-palatal plica situated under upper palatal plica. Lunella short with upper end strongly curved inwards, parallel to principal plica.

Alinda (*A.*) *biplicata irikovi* Nordsieck, 2008

Shell convex, widely ribbed, with patches of white touches. Inferior lamella hardly visible in aperture. Without interlamellar plicae. Basal groove reaches end of aperture. Neck part of last whorl with insufficiently developed basal keel. Lunellae dorsolateralis, principal plica not well visible in front part of aperture, and penetrating inside to upper end of lunella. Anterior part of upper palatal plica small, short or missing, most often separated from upper palatal plica. Lunella insufficiently developed.

Alinda (*A.*) *biplicata karlukovoensis* Dedov, 2009

Shell spindle-shaped, with thin and dense ribs, and patches of white touches. On upper whorls with groups of small nodules at suture. Aperture with an open lip. Rarely with interlamellar plicae. Basal groove shallow, reaching almost to end of aperture at front. Neck part of last whorl with a well-developed basal keel and dorsal bulge. Principal plica and upper palatal plica long, well visible in front part of aperture. Principal plica penetrates deeply behind lunella. Anterior part of upper palatal plica situated at a wide angle to principal plica and ending before lunella. Often with additional anterior upper palatal plica. Lunella long with distinctly developed upper end.

Alinda (*A.*) *biplicata alibotushensis* Dedov, 2009

Shell widely ribbed, with white touches. Superior lamella situated near spiral lamella. Anterior part of upper palatal plica separated, owing to higher altitude where this subspecies lives.

Alinda (*Alinda*) *atanasovi atanasovi* (Urbański, 1964)

Shell tower-like shaped, with widely situated whitish ribs and white touches at suture. Inferior lamella vertical, hardly visible in aperture. Between superior lamella and inferior lamella most often with two interlamellar lamellae. Neck part of last whorl with slight basal keel. Principal plica long, penetrating inside from behind lunella, in front paret hardly visible in aperture. Upper palatal plica situated at a clear angle to principal plica and reaching lunella. Lunella long with slightly curved upper end.

Alinda (*Alinda*) *atanasovi kremenensis* (Dedov, 2009)

Shell widely ribbed with white touches.

Alinda (*Alinda*) *wagneri wagneri* (A. Wagner, 1911)

Shell distinctly convex, massive. Sculpture consists of very fine, dense stripes. Inferior lamella and basal groove hardly visible in aperture. Neck part of last whorl with small basal keel and big dorsal bulge. Spiral lamella, palatal plicae and clausilium partly reduced.

Alinda (*A.*) *wagneri petrohanica* (Urbański, 1969)

Clausilial apparatus distinctly reduced. Shell

rather slender in comparison with nominate subspecies. End of aperture not so separated and open. Inferior lamella hardly visible in aperture. Principal plica signifcantly reduced. Without lunella.

Alinda (*Alinda*) *vratzatica* (Likharev, 1972)

Shell tower-like shaped, small, densely ribbed, with thin and dense stripes, some of them white in color. Aperture edge white with well separated open lip. Neck part of last whorl with a distinctly protruded basal keel. Lunellae laterally situated. Principal plica long and penetrating behind lunella; its front part not visible in aperture. Anterior upper palatal plica short, separated, situated at a wide angle to principal plica, inside part ending before lunella, front part hardly visible in aperture. Lunella long, massive, distinctly curved to inside upper end parallel to principal plica.

Genus *Balea* Gray, 1824

There are two known species of this genus from Bulgaria.

Balea kaeufeli (Brandt, 1961)

Shell densely ribbed with fine stripes, white in colour at suture. Basal keel only implicit. Lunellae and plicae missing except for superior lamella and insufficiently developed inferior lamella.

Balea eninskoensis (Irikov, 2006)

Shell surface almost smooth; no white coloration at suture. Last whorl at its neck part convex and protruded, without a keel. With exception of superior lamella, no other lunellae and plicae.

Genus *Pseudalinda* O. Boettger, 1877

There are two known species of this genus from Bulgaria.

Pseudalinda fallax (Rossmässler, 1836)

Shell brown, solid, finely ribbed. Superior lamella long and not connected to spiral lamella, no folds between superior and inferior lamella, inferior lamella deep inside, slightly concave at lower side and forked inside. No lower palatal plicae, lunella dorsal and incomplete, subcolumellar lamella visible from a perpendicular view, next to it with basal furrow.

Pseudalinda golesnicensis A. J. Wagner, 1914

Very similar to *Pseudalinda falax*, but with rather slender shell, yellowish or greenish-brown, with shorter superior lamella.

Genus *Vestia* Hesse, 1916

There are two species and four subspecies of this genus from Bulgaria.

Vestia (*Brabenecia*) *ranojevici ranojevici* (Pavlovic, 1912)

Shell convex with a blunt apex and fine dense small ribs with white touches near suture. Superior lamella merging with spiral lamella. Lip clearly separated and thickened. Interlamellar space covered with few small lamellae. Aperture rounded; inferior lamella deeply situated, hardly visible, at end of aperture ending with two separate lamellae. Subcolumellar lamella not well visible in aperture. Insignificant basal keel and groove. Long principal plica (not well visible in aperture from front and prolonged behind lunella) and short lunella (upper end distinctly curved inwards), situated dorsally on whorl. Clausilium plate toungue-shaped and slightly pointed and hooked at its end. Vagina located distally and not widened proximally.

Vestia (*Vestiella*) *roschitzi trigonostoma* (Pavlovic, 1912)

Shell with well visible sculpture, widely ribbed, convex at its lower side, aperture of triangular shape. With insignificant palatal and well visible basal callus inside base of aperture. Two small lamellae in front of inferior lamella, at end of aperture. Subcolumellar lamella not well visible. Basal keel and basal groove poorly developed.

Vestia (*Vestiella*) *roschitzi nordsieckiana* (Urbański, 1979)

Shell of small size (average shell height of 11.2 mm, and width of 2.7 mm), with dense fine sculpture and no callus at aperture end. Interlamellar space covered with few small lamellae. Last whorl at neck part rounded. Clausilium plate tounge-shaped, its end pointed and hooked.

Vestia (*Vestiella*) *roschitzi neubertiana* Dedov, 2010

Shell with clear sculpture of widely situated ribs. End of aperture with thick callus. Without interlamellar lamellae. Basal keel and groove well developed. With well visible basal callus further inside base of aperture.

Genus *Bulgarica* Boettger, 1877

There are 14 known species and subspecies of this genus from Bulgaria.

1. (16) Aperture end without lamellae or with single lamellae, only on parietal and columellar end of aperture; lausilium without exterior angle, respectively cant, near ± such.

2. (11) Last whorl with two keels: basalis and dorsalis.

3. (6) False upper palatal plica transformed into callus or missing, falsely connected to lunella.

4. (5) Shell with dense ribs, pale to horn-brown .....***B. bulgariensis***

5. (4) Shell except for uppermost and last whorls almost smooth, horn to violet-brown ....***B. hiltrudae***

6. (3) False upper palatal plica well developed, always connected with lunella and well visible in aperture.

7. (10) Basal and dorsal keel well developed.

8. (9) False upper palatal plica long ....***B. fraudigera***

9. (8) False upper palatal plica partly developed .....***B. pseudofraudigera***

10. (7) Dorsal keel less developed ....***B. urbanskii***

11. (2) Last whorl with one basal and only rudiments of second dorsal keel.

12. (13) Subcolumellar lamella extended to edge of aperture, lower palatal plica insufficiantly developed and transformed into a callus, clausilium without external angle, respectively external cant, penis with long ligaments .....***B. vetusta***

13. (12) Subcolumellar lamella not extending to edge of aperture, no palatal callus, lower palatal plica well developed, clausilium with ± well visible external angle, respectively external cant, penis shortens by ± well-formed ligament.

14. (15) Shell convex, with blunt apex and insufficiently-developed double keel, false upper palatal plica insufficiently developed, short, sometimes completely missing .....***B. fritillaria***

15. (14) Shell less convex, with sharper apex and well-developed double keel, false upper palatal plica well developed and rarely missing ....***B varnensis***

16. (1) Aperture end with many lamellae, clausilium with external angle, respectively external cant .....***B. denticulata thessalonica***

Bulgarica (*Strigilecula*) *vetusta* (Rossmässler, 1836)

Shell with thin, dense ribs with white touches. Aperture end thickened, separated. Principal plica long. Upper palatal plica insufficiently developed, lower palatal plica missing. With undeveloped palatal callus.

Bulgarica (*Bulgarica*) *hiltrudae* Nordsieck, 1974

Basal and dorsal keel well developed. With one- five clear interlamellar lamellae.

Bulgarica (*B.*) *fraudigera* (Rossmässler, 1839)

Shell massive, distinctly ribbed with widely situated whitish ribs. Aperture end thick, clearly separated. Inferior lamella horizontally situated, well visible in aperture. Well-developed double keel and long false upper palatal plica.

Bulgarica (*B.*) *pseudofraudigera* Nordsieck ,1973

Shell big with fine dense stripes. Well-developed double keel and short false upper and lower palatal plicae.

Bulgarica (*B.*) *fritillaria* (Frivaldsky, 1835)

Shell convex, with thin and dense small stripes. Dorsal and basal keel partly formed. Basal keel situated laterally at base of aperture and forming a narrow, small groove. Upper palatal plica short.

Bulgarica (*B.*) *varnensis varnensis* (L. Pfeiffer, 1848)

Shell with well-developed principal plica, upper and lower palatal plicae.

Bulgarica (*B.*) *varnensis gabrovnitcana* Irikov, 2006

Shell clearly ribbed with white, rare ribs. last whorl with rather distinctly formed double keel.

Bulgarica (*B.*) *varnensis trimontsiana* Irikov, 2006

Shell insufficiently ribbed with dense small stripes. Dorsal keel less developed than in previous subspecies. Upper palatal plica short, lower palatal plica well developed.

Bulgarica (*B.*) *urbanskii urbanskii* Nordsieck, 1973

Shell with rarely situated ± rounded ribs. Without neck bulge. Principal plica long, upper palatal plica small and interrupted, in front part with remnant of plica similar to palatal callus. In some shells with interlamellar plicae.

Bulgarica (*B.*) *urbanskii paganella* Nordsieck, 1974

Shell with ± thin and sharp ribs. Neck bulge partly formed. Basalis partly separated from lunella. Upper palatal plica almost always missing.

Bulgarica (*B.*) *bulgariensis bulgariensis* (L. Pfeiffer, 1848)

Shell small, distinctly ribbed with dense whitish ribs. Two keels well visible. Number of ribs on 2 mm from penultimate whorl most often 10-18.

Bulgarica (*B.*) *bulgariensis intricata* (Mousson, 1859)

Shell of medium size. Average number of ribs on 2 mm on penultimate whorl on average 19.

Bulgarica (*B.*) *bulgariensis osmanica* (Westerlund, 1884)

Shell of a relatively large size. Average rib number on 2 mm from penultimate whorl most often 29.

Bulgarica (*B.*) *denticulata thessalonica* (Rossmässler, 1839)

Shell convex with dense, fine ribs, with white touches. Dorsal keel insufficiently developed, basal keel narrow and deep, laterally situated. Three palatal plicae well developed.

Discussion

Bulgaria is rich in species of the family Clausiliidae. In Damjanov, Likharev (1975) there are 15 genera, 24 species and 20 subspecies listed. Some of these taxa become invalid systematically or only in the fauna of Bulgaria, while others are with changed nomenclature. After Damjanov, Likharev (1975), many new species and subspecies have been found, repoted and described and many distributional data has been obtained. As a result of the recently acquired knowledge on the family Clausiliidae in

Bulgaria, obtained during the last decades, it can be summarised that 76 species and subspecies (40 species and 36 subspecies) have been recorded from the country till now. Most of the taxa belong to the genera *Macedonica* (17) and *Bulgarica* (14), which characterises the Bulgarian territory as a centre of species radiation of these genera. We reckon that the family diversity is still poorly known. Many species have local distributions from the 'island-type' and have been discovered in different regions over the last few years. We thus suppose that in future research many more new taxa will be found in Bulgaria.

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