Boreolestes gen. nov., a new genus of carnivorous slugs from Western Caucasus, and some considerations on the phylogeny of Trigonochlamydidae (Pulmonata)

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ABSTRACT. Boreolestes gen. nov. with 2 species, B. likharevi sp. nov. (type species) and B. sylvestris sp. nov. from NW Caucasus is described. The new genus is characterized by a very large mantle covering most of animal back and by the presence of a well-developed perivaginal gland. The new genus is similar to cave-dwelling Troglolestes Ljovushkin et Matekin, 1965, but differs from the latter by a well-pigmented mantle, presence of perivaginal gland, and absence of vaginal accessory organ at the base of spermathecal stalk. It is suggested that Trigonochlamydidae derived from a zonitoid ancestor. An attempt has been made to reconstruct the probable phylogenetic relationships in Trigonochlamydidae.

A peculiar family Trigonochlamydidae consists of obligatory carnivorous slugs. Its range is of a relict type, occupying Caucasus and adjacent territories of Iran and Turkey. Up to date, 7 monotypic genera of the family have been known [Ljovuschkin, Matiokin, 1965; Likharev, Wiktor, 1980; Schileyko, 1988]. Here we describe the eighth genus composed of 2 species.

Systematic account

Trigonochlamydidae Hesse, 1882
Hesse, 1882: 32 (as subfam. Trigonochlamydia).

Trigonochlamydinae Hesse, 1882
Boreolestes Schileyko et Kijashko, gen. nov.

Type species — Boreolestes likharevi Schileyko et Kijashko, sp. nov.

Diagnosis. Preserved animals elongated-ovate, rounded at both ends. Mantle very large, covering nearly entire back of slug. Mantle surface covered with vague or quite distinct small papillae. Pneumostome situated *not far from posterior end of mantle. Hood occupying somewhat less than 1/3 of mantle length. Upper surface of mantle strongly pigmented, leaden-colored; indistinct blotches with whitish dots in centre seen at magnification. Horse-shoe-like groove on mantle normally developed or presented by only right branch. Orifice of genital atrium situated slightly behind right tentacle base.

Eyes normally developed.

Shell composed of thickened nucleus and very delicate, fragile spatula.

Throat length about 1/4 of body length. Numerous retentors attached to throat obliquely-laterally, along one irregular line. Radula of normal "carnivorous" type, but teeth relatively small. Jaw rudimentary, transparent, exceptionally thin.

Lung cavity very small. Veneration scarcely visible.

Reproductive apparatus without accessory organs except for perivaginal gland. Penis sheath absent.

The genus is similar to Troglolestes Ljovushkin et Matekin, 1965 in possessing a very large mantle and in the absence of penis sheath and "spermatophores" in penis. Boreolestes differs from Troglolestes in the presence of intensive pigmentation of the mantle and perivaginal gland, the absence of distinct papillae on the mantle surface and additional vaginal sac at the base of spermathecal stalk.

Distribution. NW Caucasus. 2 sp. Mollusks live on open slopes under stones, at wet conditions.

Etymology. Boreo- (L., northern, indicating the area of the genus at northern border of the family range) plus -lestes (a robber, traditional ending of generic names in Trigonochlamydidae). Gender masculine.

[Диагноз. Фиксированные животные удлиненно-овальной формы, закруглённые на обоих концах. Мантия очень большая, закрывает почти всю спину животного. Поверхность мантии покрыта невскими или чёткими папиллами. Пневмостом расположен близ заднего края мантии. Капюшон занимает немного меньше 1/3 длины мантии. Верхняя поверхность мантии сильно пигментирована, имеет свинцово-окраску; при увеличении заметны нечеткие папиллы с белесыми точками в центре. 0 борозда на мантии развита нормально или представлена лишь... ]

Boreolestes likharevi
Schileyko et Kijashko, sp. nov.
(Figs. 1, 2)

Type locality — Oshten-Fisht Mountains, western part of Great Caucasus, about 2000 m above the sea level.

Material. NW Caucasus, Oshten-Fisht Mountains, west-facing slope of Mount Oshten, saddle, under stones, June 24, 1997; coll. P.V. Kijashko (holotype and paratype);
— west-facing slope of Mount Oshten, environs of Psheno-Dakh Lake, July 5, 1997; coll. P.V. Kijashko (3 paratypes);

Distribution. NW Caucasus (Oshten-Fisht Mountains).

Etymology. The species is named in honour of Prof. Ilya M. Likharev, who made a considerable contribution to studying of land mollusks, slugs in particular.
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FIG. 2. Boreolestes likharevi sp. nov. Holotype. A — reproductive tract and interior of penis; B, C — throat (B — lateral view, C — dorsal view). AG — albumen gland; HG — hermaphroditic gland; P — penis; Pil — pillars inside penis; PR — penial retractor; PVG — perivaginal gland; R — retentors; RS — reservoir of spermatheca; SOD — spermoviduct; VD — vas deferens.

FIG. 2. Boreolestes likharevi sp. nov. Голотип. А — репродуктивный тракт и вскрытый пенис; В, С — глотка (В — вид справа, С — вид со спинной стороны). AG — белковая железа; HG — гермафродитная железа; P — пенис; Pil — пилястры внутри пениса; PR — пениальный ретрактор; PVG — перивагинальная железа; R — ретенторы; RS — резервуар семеприемника; SOD — спермовидукут; VD — семепровод.

**Diagnosis.** Длина тела фиксированного голотипа (самый большой экземпляр) 10.6 мм.

Белковая железа большая, неправильной формы. Спермовидукут объёмистый. Камера оплодотворения скрыта в тканях белковой железы. Семепровод плотно прилегает к пенису. Пенис довольно длинный, внутри с двумя широкими пилястрами, покрытыми многочисленными маленькими папиллами. Железистые подушки и "сперматофоры" внутри пениса отсутствуют. Половой ретрактор крепится к пенису терминально. Свободный яйцевод довольно короткий, примерно той же длины, что и вагина. Перивагинальная железа хорошо развита, окутывает вагину и основание протока семеприемника. Проток семеприемника короткий, резервуар овальный.

**Boreolestes sylvestris** Kijashko, sp. nov.
(Figs. 3, 4)

**Type locality** — environs of Ghooseriple, Molchepa riverside (right tributary of Belaya River), NW Caucasus.
**FIG. 3.** Boreolestes sylvestris sp. nov. Holotype. A, B — external appearance; C, D, E — shell. Asterisk — horse-shoe-like groove.

**Material.** NW Caucasus, Molchepa riverside (right tributary of Belaya River), 6 km from Ghoomeriple, mixed coniferous-broad-leaved forest (*Fagus orientalis, Abies nordmanniana*), July 1, 1998, coll. P.V. Kijashko (holotype and 6 paratypes); — near the same place, July 2, 1998, coll. P.V. Kijashko (13 paratypes).

Holotype and 5 paratypes are stored in the Zoological Institute of Russian Academy of Sciences (Saint-Petersburg), 6 paratypes are in the Zoological Museum of Moscow State University, No. Lc-24424; 7 paratypes are in the Museum of scientific collections of Zoological department of Rostov State University.

**Description.** Body length of holotype (the largest specimen) 10.0 mm. Both branches of horse-shoe-like groove on mantle normally developed. Surface of mantle covered with numerous, small, distinct papillae. Albumen gland irregularly triangular. Spermoviduct and talon as in *B. likharevi*. Vas deferens not adhering to penis. Penis moderately long, internally with 2 longitudinal pilasters; inner surface of penis and pilasters covered with minute papillae. Glandular pads, and "spermatophores" inside penis.
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FIG. 4. Boreolestes sylvestris sp. nov. Holotype. A — reproductive tract; B — interior of penis and vagina; C, D — throat (C — lateral view, D — dorsal view). Abbreviations as in Fig. 2. Scale bars — 1 mm.

Distribution. NW Caucasus (upper part of Belaya River basin).

Discussion

Trigonochlamydidae are evidently a very peculiar and ancient family. Its ancient age is indicated, in particular, by the fact that seven of eight genera of the family are monotypic (only Boreolestes consists of 2 species), and the family is composed of two subfamilies, one of which (Selenochlamydinae Likharev et Wiktor, 1980) is also monotypic.

To reconstruct possible phylogenetic relation-
ships among genera, we need to discuss the archetype of pre-trigonochlamydid organization. We think that the family has originated from a zonitoid ancestor for the following reasons:

1. The very unusual structures inside penis in some Trigonochlamydidinae are traditionally designated as "spermatophores", but they are not actually spermatophores, because they are not transferred to a partner during copulation, and there is no mechanism which could provide the transfer of the "spermatophores" content to a partner. Besides, it is unclear how the semen fluid could get in this "spermatophore". At the same time, the penis of Spinophallus (Zonitidae) has conspicuous structures inside [Riedel, 1960], which resemble trigonochlamydid "spermatophores". Muratov [1998, this volume] suggested that "spermatophores" of such kind are filled with carbonate buffer and probably supply the recipient spermatheca with this buffer.

2. One of conspicuous characters of Zonitidae is the presence of perivaginal gland. In species of Boreolestes we have also found a well developed perivaginal gland of quite traditional zonitid structure.

3. Both Zonitidae (at least, Zonitini and Oxy-

chilini) and Trigonochlamydidinae usually have a short spermathecal stalk lacking a diverticule.

4. Penial retractor in representatives of both taxa is attached to penis (or to flagellum) terminally or subterminally.

5. Although there are no obligatory predators among Zonitidae, most of them are omnivorous (not herbivorous), their radulae are of universal type, and the closely related family Daudebardiidae is composed of predators only.

6. Shells of many Zonitidae are thin and sometimes show a tendency to reduction down to vitrinoid stage (Godwini, Vitrinizonites). Likharev and Wiktor [1980: 97], when discussing the origin of Trigonochlamydidinae, wrote: "Judging by their internal shell, in which the nucleus is shifted leftward from longitudinal axis and growth lines on the spatula are shifted to the right, these slugs... originated from snails with succinoid shells". We do not agree with this viewpoint, because, if we imagine the stage of reduction next to that of Vitrinizonites, we get a shell, much resembling those of Daudebardia, and the next step would be the trigonochlamydid shell.

7. In addition, skin of the upper surface of cephalopodium of large Zonitidae often has characteristic bluish-leaden color; back of cephalopo-
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of some Trigonochlamydidae (*Parmacellilla, Trigonochlamys, Hyrcanoles, Dnlolestes*) is similarly colored.

Schileyko [1982, 1986] suggested that Trigonochlamydidae have ancient connections with South African endodontoid genus *Trachycystis* because the penis of *Trachycystis* contains structures that are somewhat similar to those of some Trigonochlamydidae [Sirgel, 1980]. This hypothesis, however, contradicts the above-considered facts and should be rejected.

There are two groups in Trigonochlamydidae (Fig 5) species with (rather) small mantle (*Parmacellilla, Trigonochlamys, Hyrcanoles, Dnloles*, and *Lesticulus*), and species with enormously large mantle, covering most of animal back (*Boreolestes* and *Troglolestes*). In the first group the mantle may be either posterior (*Parmacellilla*) or medial in position (rest genera). As the posterior position of the mantle is probably an initial condition (compare with Daudebardidae which are immediate derivatives of Zomtidae), *Parmacellilla* is seemingly the most archaic member of Trigonochlamydidae. Besides, the shell of *Parmacellilla filipowitschi* Simroth, 1910 retains the distinct traces of spiral coiling (Fig 6).

The next stage of mantle transformation was its shift forward, a state occurring in all other Trigonochlamydidae. Therefore, the median position of the mantle is an advanced feature.

Thus we consider *Parmacellilla* as the most archaic genus of the Recent trigonochlamydid taxa *Selenochlamys*, retaining the primitive position of mantle, early deviated from *Parmacellilla*-like lineage, lost the "spermatophores", and changed the internal structure of penial tube [Likharev, Wiktor, 1980].

*Troglolestes* and *Boreolestes* have an enormous mantle and lack penis sheath. Hence, they are related to each other, although the former is colorless and lives deeply in caves, whereas the latter is normally pigmented and inhabits open slopes (lives under stones). We suggest that the succession of habitats indicates that *Boreolestes* is an ancestor of *Troglolestes*. Moreover, *Boreolestes* is the only representative of the family which retains penvaginal gland, an evidence of origin of Trigonochlamydidae from zomtid ancestor. As far as the strange "additional sac" in *Troglolestes* is concerned, it is unclear whether it is a glandular organ. If it is shown to be glandular, this "sac" is probably a derivative of penvaginal gland.

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**Boreolestes** gen. nov., новый род хищных слизней из Западного Кавказа и соображения по филогении Trigonochlamydidae (Pulmonata)

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Описание *Boreolestes* gen. nov. из северо-западного Кавказа с 2 видами — *B. likharevi* sp. nov. (типовой вид) и *B. sylvestris* sp. nov. Новый род характеризуется очень большой мантией, закрывающей почти всю спину животного, и присутствием хорошо развитой перивагинальной железы. Новый род сильно напоминает пещерного *Troglolestes* Ljovushkin et Matekin, 1965, но отличается, интенсивной пигментацией мантии, наличием перивагинальной железы и отсутствием дополнительного вагинального органа при основании протока семеприемника. Предполагается, что Trigonochlamydidae произошли от зонитоидного предка. Сделана попытка реконструировать возможные филогенетические связи внутри Trigonochlamydidae.