

A new micropterous winter species of *Leuctra* (Plecoptera: Leuctridae) and little known endemic stoneflies from the Greater Caucasus

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Abstract

A new micropterous winter emerging stonefly species, *Leuctra abkhaziae* sp. n. from Abkhazia and western Georgia in the Greater Caucasus is described and illustrated. Descriptions and illustrations are also provided for larvae of the little-known Caucasian endemic species *Leuctra simplex* and perlodid *Bulgaroperla mirabilis caucasica*.

Key words: Plecoptera, *Leuctra abkhaziae* sp. n., Leuctridae, micropterous, Abkhazia, western Georgia, the Greater Caucasus, *Bulgaroperla*, Perlodidae

Introduction

Apterous and micropterous stonefly species of *Leuctra* Stephens, 1836 are distributed along major mountain systems of Central, West, and southeastern Europe surrounding the Mediterranean and Black seas but are absent from northern Europe (Vinçon 2012): *Leuctra clerguae* Vinçon & Pardo, 1994 is recorded from the western Pyrenees in France and Spain (Vinçon & Pardo 1994); *L. ligurica* Aubert, 1962 from the Ligurian Apennines and Ligurian Alps in northern Italy; *L. gardinii* Ravizza, 2005 from the Cottian Alps at the border of Italy and France (Ravizza 2005); *L. aptera* Kačanski & Zwick, 1970 is a species of streams of the upper Drina Mountains of the western Balkans in Bosnia and Herzegovina; *L. istenicae* Sivec, 1982 from the Pohorje Mountains, Julian Alps, Slovenia; *L. helenae* Braasch, 1972, *L. kumanskii* Braasch & Joost, 1977 known from Balkan Mountains in Bulgaria; and *L. boluensis* Kazanci, 1999 recorded from Bolu in the Pontic Mountains, Turkey. Recently two new species *L. adjariae* Teslenko, 2019 and *L. georgiae* Teslenko, 2019 were described from the Meskheta Range of Lesser Caucasus (Teslenko *et al.* 2019) and thus a missing geographical connection of the Caucasus to the Pyrenees-Apennines-Alps-Balkans and Pontus was added to the distribution of these species of apterous or micropterous *Leuctra*.

This paper includes a description of another new micropterous winter species of *Leuctra*, *L. abkhaziae* sp. n. inhabiting streams at the southern edge of the Greater Caucasus Range in Abkhazia and western Georgia. Descriptions of larvae of the endemic Caucasus species *L. simplex* Zhiltzova, 1960 and the perlodid *Bulgaroperla mirabilis caucasica* Zhiltzova, 1973 are also provided.

Material and methods

Adults were collected by sweeping or handpicking from the snow surface. All specimens were preserved in 75% ethanol. The abdomens of adults were removed and soaked in 10% NaOH overnight and rinsed with distilled water. Specimens were examined with the aid of a compound microscope in transmitted light. Illustrations were produced using digital cameras (Nikon Coolpix 995 and Toupe View 3.7) and with the stereomicroscope Olympus SZX16 and the digital camera Olympus DP74, and stacked using Helicon Focus software. The final illustrations were post-processed for contrast and brightness using Adobe® Photoshop® software. Photographs were taken in the Federal

Scientific Center of the East Asia Terrestrial Biodiversity, Far Eastern Branch, Russian Academy of Sciences, Vladivostok, Russia (FSC EATB FEB RAS). The holotype and all paratypes are deposited in the collection of the FSC EATB FEB RAS. Terminology of species description follows Vinçon & Ravizza (2001) and Zwick (2004).

Results and discussion

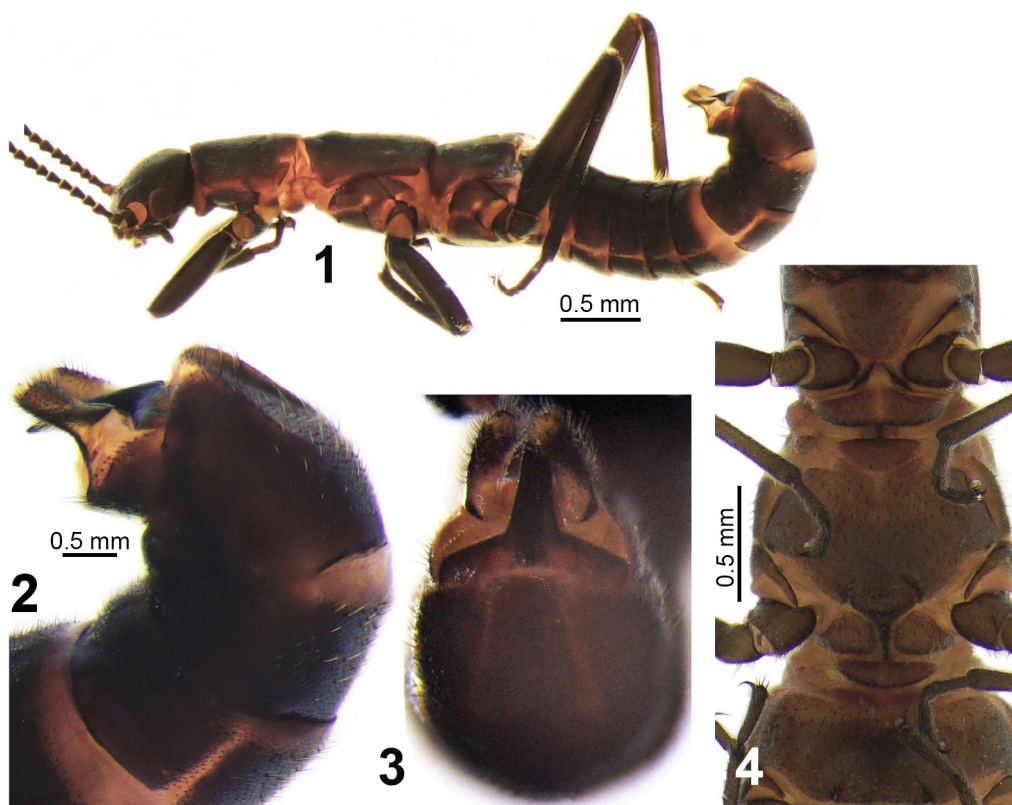
Leuctra abkhaziae Teslenko sp. n.

(Figs 1–11)

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Material examined. Holotype male. Western Georgia. Samegrelo, Zemo-Svaneti, Chkhorotsku municipality, Egris Ridge, Khobi River, upstream, near the Shurubumi cave, 42°38.587 N 42°12.193 E, 04.02.2017, coll. D. Palatov (FSC EATB FEB RAS). Paratypes: 1 male, 6 females (1 mounted). Abkhazia. Gagra Ridge, Lashipse River, 250 m upstream from the entry into Ritsa Lake, 43°28.529 N 40°33.469 E, 08.02.2018, coll. D. Palatov.

Description. Body length of males 5.6 mm, females 5.0–7.2 mm. Micropterous, with minute immobile vestigial wings, in the form of dark plates on meso and metathorax (Fig. 9). General color brown, sclerotization heavy, body covered with dense pilosity (Figs. 1–3, 5–8). Palpi, head, pronotum, meso- and metanotum and legs uniformly brown (Fig. 1). Ocelli vestigial. Prothoracic sternum of the male with sclerites typical of *Leuctra*; postfurcasternum reduced to a small round sclerite surrounded by pleurae, spinasternum a transverse triangular, semi-oval sclerite, separated from basisternite II (Fig. 4).

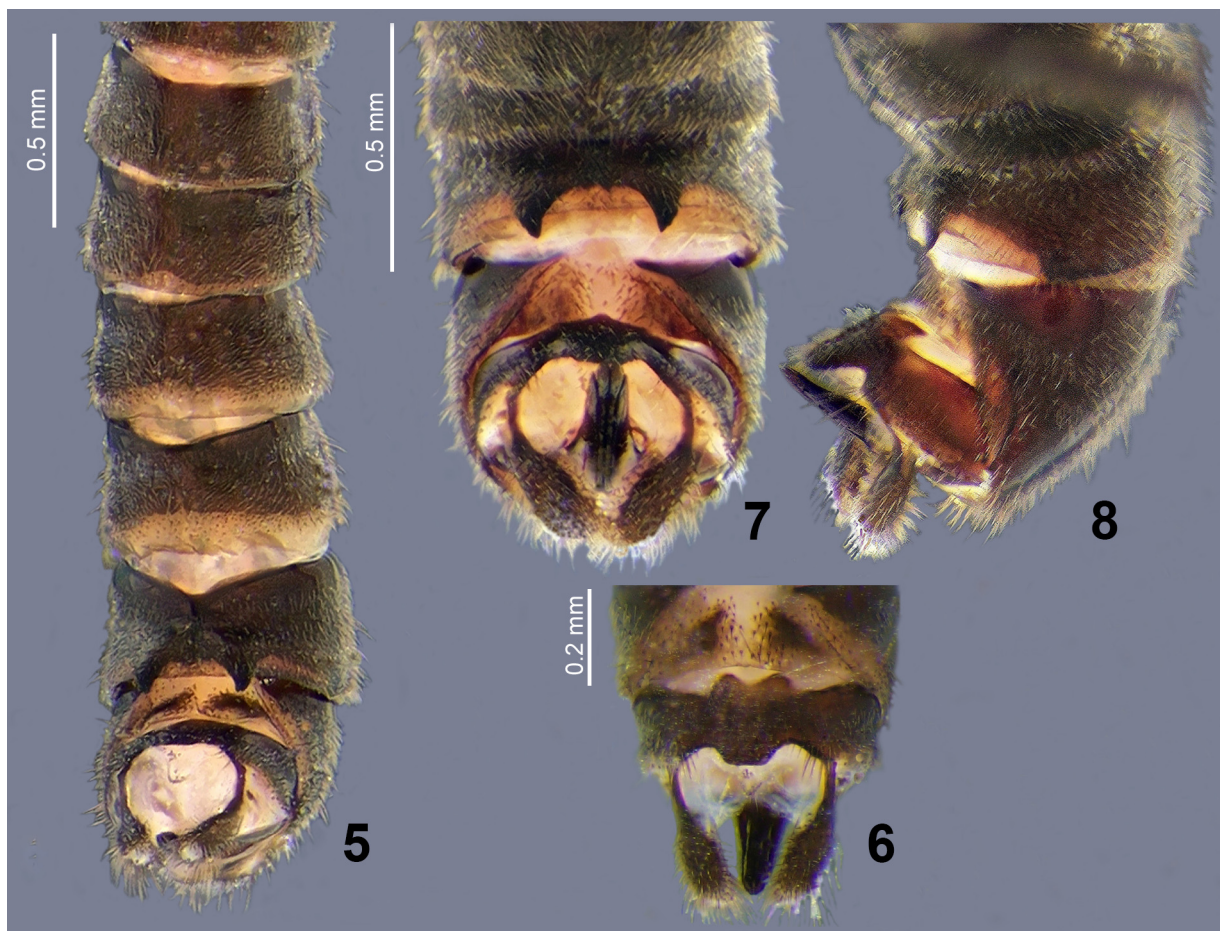


FIGURES 1–4. Male of *Leuctra abkhaziae* sp. n. 1. Habitus, lateral. 2. Abdominal tip, lateral. 3. Abdominal tip, ventral. 4. Pro-, meso- and metathorax.

Male. Terga I–VII simple, darkly sclerotized, except posterior margin on terga V–VII (Fig. 5).

Tergum VIII anteriorly concave, with a pair of posteromedial darkly sclerotized and widely spaced horn-shaped processes, directed inward and extending to the posterior margin of tergum VIII, posterior margin membranous (Figs. 5, 7, 8). Tergum IX membranous, with distinct antecosta, divided medially for $\frac{1}{3}$ of segment width, postero-medial sclerites are paired but separate triangular pigmented spots covered with black setae (Figs. 5, 7). Tergum

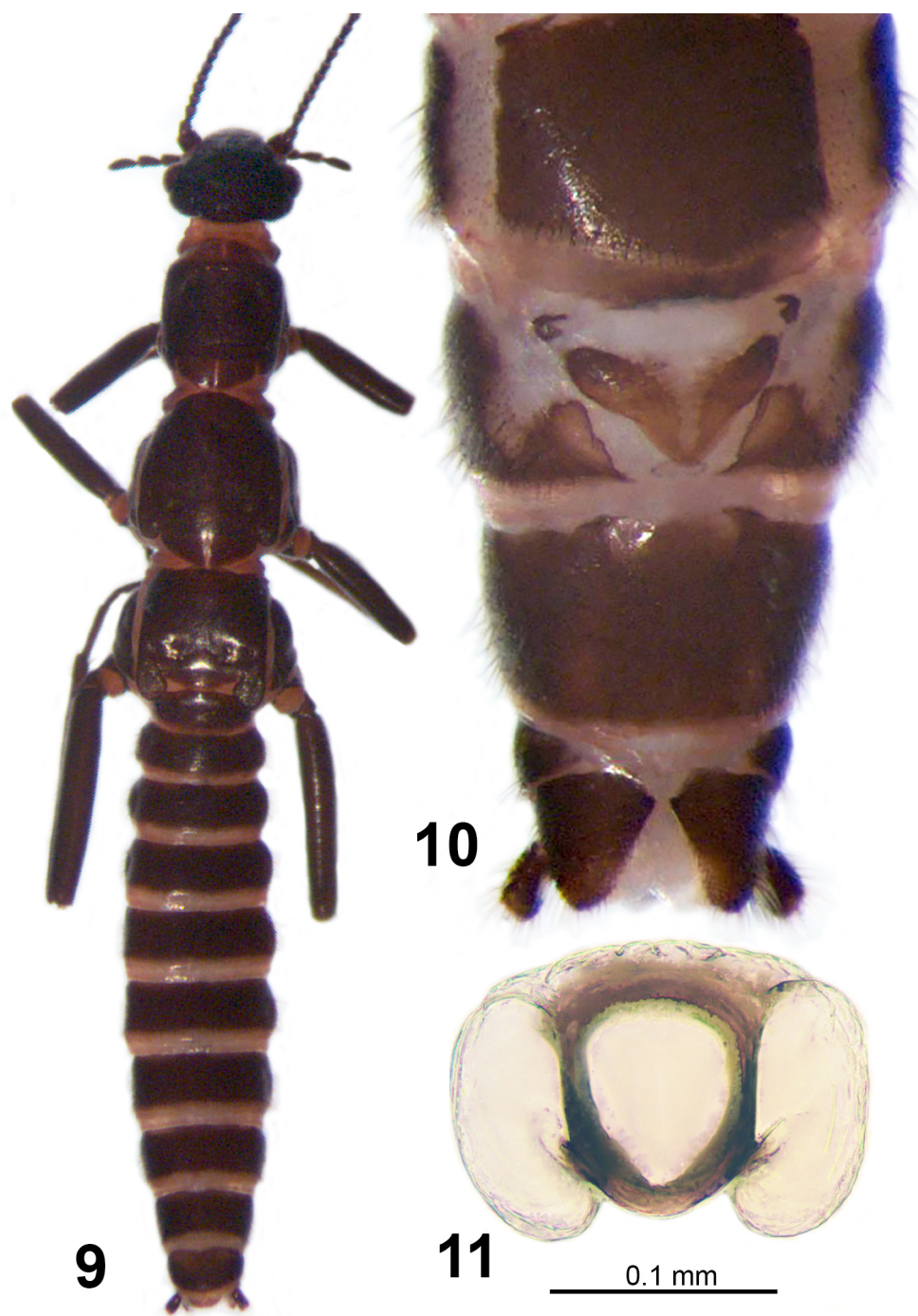
X with wavy, anteromedian margin, posteromedian margin bears a trapezoid process with bluntly rounded corners (Figs 6, 8). Epiproct small, simple and membranous (Figs. 5, 6). Cerci tear-shaped in dorsal view, each cercus gently bent inward, slightly sclerotized on outer edge and covered with setae; the inner part membranous, apices truncated in lateral view, with vestigial terminal segment (Figs. 2, 3 5–8). Paraprocts strong, heavily sclerotized (Fig. 3); styles slightly shorter than specilla (Fig. 7). Specilla gently narrowed to the apex and ending in a round point in dorsal view (Figs. 6–8). Sternum IX with U-shaped unsclerotized area, vesicle absent (Figs. 2, 3, 8).



FIGURES 5–8. Male of *Leuctra abkhaziae* sp. n. 5. Abdominal tip, III–X terga, dorsal. 6. Abdominal tip, IX–X terga, epiproct, styles, cerci, dorsal. 7. Abdominal tip, tergum VIII with horn-shaped processes; tergum IX with posteromedial sclerite; tergum X, cerci, dorsal, styles and specilla, ventral. 8. Abdominal tip, VIII–X terga, lateral.

Female. Terga II–X completely sclerotized (Fig. 9). Sternum VII convex, large, ventral sclerite almost rectangular with weakly rounded posteromedial margin, sometimes overlapping the anterior margin of sternum VIII covering the base of subgenital plate (Fig. 10). Sternum VIII with a triangular subgenital plate, ending slightly before the posterior margin of sternite. Anterolaterally from the wide unpigmented base of the subgenital plate stands a pair of small sclerotized spots. The convergent sides of the plate bear a pair of elongate-oval sclerites together forming a V-shape. Caudally from the plate the pleurites reach far to the ventral side, the extension anteriorly with an elongate swelling, caudally it is drawn out into a sharp point (Fig. 10). Sternum IX with concave anterior margin (Fig. 10). Seminal receptacle spheroid with a ring-shaped spermathecal sclerite which ends in a pair of lateral arms joined to each other by a sclerotized arch (Fig. 11).

Diagnosis. Micropterous in both sexes. Terga I–VII of male simple; tergum VIII with a pair of posteromedial heavily sclerotized widely spaced horn-shaped processes, directed inward; tergum X wavy along anteromedian margin, posteromedian margin trapezoid with bluntly rounded corners. Epiproct membranous, small and oval; cerci tear-shaped; styles slightly shorter than specilla. Ventral vesicle absent. Female subgenital plate triangular with unpigmented base delimited anterolaterally by a pair of small sclerotized spots and laterally by paired of elongate-oval sclerites; a pair of sclerites extending anteriorly with an elongate swelling armed the subgenital plate laterally. Seminal receptacle spheroid enclosing a ring-shaped spermathecal sclerite with a pair of lateral arms.



FIGURES 9–11. Female of *Leuctra abkhaziae* sp. n. 9. Habitus, dorsal. 10. Subgenital plate, ventral. 11. Spermatheca, cleared, mounted ventral.

Affinities. The extent of sclerotization of the male abdominal terga, the shape of tergal processes, and structure of epiproct, *L. abkhaziae* may be assigned to the *prima* species subgroup within the *hippopus* species group according to Ravizza & Vinçon (1998) and Ravizza (2002). Males of the Balkanian species, *L. olympia* Aubert, 1956 and *L. istenicae* have similar horn-shaped and widely spaced processes on tergum VIII. In *L. olympia*, the processes are short, curved laterally, directed perpendicular to the body axis, and between the tergal processes is a rounded bulbous protrusion. In *L. istenicae* the tergal processes are long, extended to the middle of tergum IX, whereas in *L. abkhaziae*, the tergal processes reach the posterior margin of tergum VIII and both species lack a protrusion between the tergal processes. The posteromedial sclerite on tergum IX is semi-oval with diffuse apex in *L. olympia*, the same sclerite of *L. abkhaziae* and *L. istenicae* appears as a pair of pigmented triangular spots, which are disconnected at

their base and covered with black setae. *Leuctra abkhazica* differs from both above mentioned and other species in the specific shape of tergum X, which is trapezoid posteromedially with bluntly rounded corners. The females of the three species are only a generally similar in having triangular subgenital plates with a bilobed posterior margin but the internal genitalia differ in the details. The spermatheca of *L. abkhaziae* has a strongly sclerotized central arch and caudally connected arms, similar to some members of the *prima* sub-group. The seminal receptacle of *L. istenicae* has not yet been described.

Adults of *L. olympia* are active in early to mid-spring, whereas *L. istenicae* and *L. abkhaziae* adults emerge in autumn and winter. The three species are geographically distributed within a relatively small area in different mountain ranges. *Leuctra olympia* is endemic to the western and southern regions of the Balkans (Muranyi *et al.* 2014); *L. istenica* is relatively common in springs in the Pohorje Mountains of the Alps of Slovenia (Sivec 1982); and *L. abkhaziae* is associated with the Egris and Gagra Ridges of the Greater Caucasus Mountain Range in Abkhazia and western Georgia.

Distribution. One male of *L. abkhaziae* was collected with adults of *Brachyptera transcaucasica* Zhiltzova, 1956 and a female of *L. fusca* (Linnaeus, 1758) in the Khobi River near the Shurubumi Cave, Samegrelo, Zemo-Svaneti, Chkhorotsku, western Georgia, in February 2017 (Figs. 12, 13). The Khobi River drains the southern portion of the Egris Ridge (Greater Caucasus), the Colchis Lowland into the Black Sea. At the type locality, the Khobi River flows into a low mountain valley at an altitude 330 m.a.s.l., in a sharp, but low canyon (Fig. 13), width of river is 30 m, water current 0.3–1.0 m/s. On February 2018, one male and six females of *L. abkhaziae* were collected 250 m upstream from the mouth of the Lashipse River, Gagra Ridge (Greater Caucasus), Abkhazia (Fig. 12). The Lashipse River is about 10 m wide, speed of flow 0.6–0.7 m/s. The river flows into a lake, Ritsa Lake of glacial-tectonic origin, where the average water temperature is + 3.8 °C in February (Figs. 14, 15). Ritsa Lake is located at an altitude of 950 m above sea level in a deep mountain fir valley of the Lashipse River. Adults of *L. abkhaziae* were walking on the snow with adults of *Capnia nigra* (Pictet, 1833). A larva of *Capnopsis shilleri archaica* Zwick, 1984 was also collected from the Lashipse River.



FIGURES 12–15. 12. Map of the collecting sites of *Leuctra abkhaziae* sp. n. in Abkhazia and Western Georgia (black dot). 13. Collecting site of *Leuctra abkhaziae* sp. n., in the Khobi River (the West Georgia). 14, 15. Collecting sites of *Leuctra abkhaziae* sp. n., in the Lashipse River (Abkhazia, Ritsa Lake Basin). Photo by D. Palatov.

Leuctra abkhaziae appears to be a rare, rheophilic species that inhabits cold water streams at an altitude not exceeding 1,000 m.a.s.l. on the southern edge of the Greater Caucasus Mountain Range in Abkhazia and western Georgia.

Etymology. This species is named after the Autonomous Republic of Abkhazia. The specific name is considered feminine.

Two other rare stonefly species on different stages of larval development were found in streams of Abkhazia and on the Black Sea coast during winter and spring 2018. The description of larvae of two Caucasian endemics species is given below.

Taeniopterygidae Klapálek, 1905

Brachyptera transcaucasica Zhiltzova, 1956

Material examined: 2♂, 2♀ 1 exv. Abkhazia. Sukhumi District. Gumista River, 500 m above the bridge on Sukhumi town, 10.02.2018, coll. D. Palatov.

Distribution. Caucasus, Armenia, and Turkey (Darilmaz *et al.* 2016). In Anatolia it extends throughout the Pontus. In Caucasus, the emerging period extends from the second half of April to July. This is a montane and rheophilic species occurring in streams at 500–1900 above sea level (Zhiltzova 2003). Adults were first collected in February.

Leuctridae Klapálek, 1905

Leuctra svanetica Zhiltzova 1960

Material examined: 2♂, 1♀ Abkhazia. Ochamchyr District. Cave Head of Otap, sweeping above stream in cave, around lamps of the artificial lighting, 42°55.193 N 41°32.196 E, 05.02.2018, coll. D. Palatov.

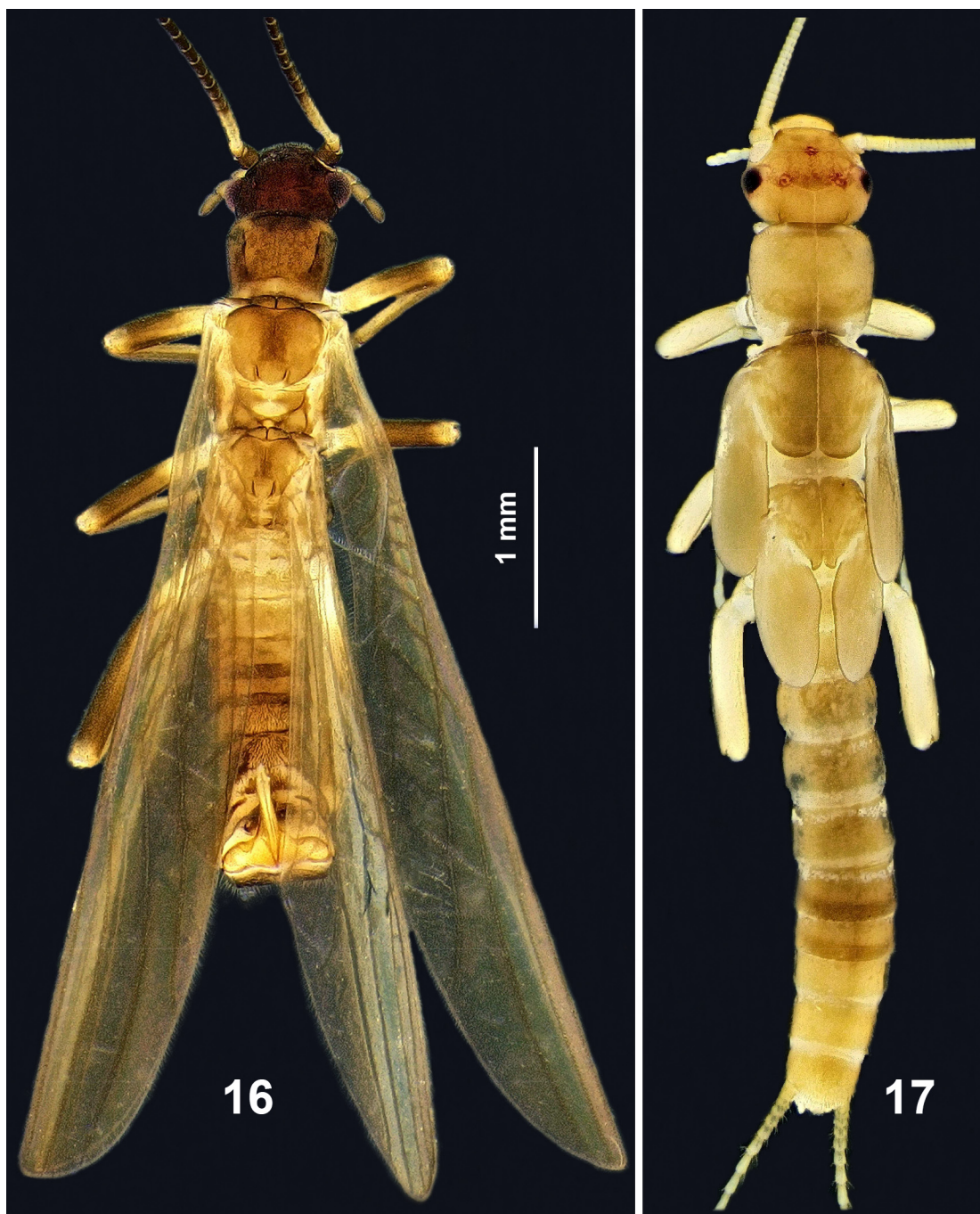
Distribution. Karachay-Cherkessia, Georgia, Turkey. An endemic of the Caucasus, a high mountain and crenophilic species, inhabiting streams higher than 1,800 m.a.s.l. Adult emergence occurs at the end of July into beginning of August (Zhiltzova, 2003). Adults were collected for the first time also in February.

Leuctra simplex Zhiltzova, 1960

Material examined: 4♂, 7 larvae. Russia. Krasnodarky Region, Novorossiysk District, Abrau-Dyurso District, Abrau River, 2 km above the Abrau Settlement, 155 m.a.s.l., 44°43.546 N 37°35.498 E, 18.04.2018, coll. D. Palatov.

Structure of the male genitalia of *L. simplex* agrees well with original description (Zhiltzova 1960), except for a color details. The general color is brown with contrasting yellow patches. Head tinted chocolate brown with dark tentorial callosities at the base of the antenna and small dark spot in the area of the anterior ocellus; occiput covered with dark brown callosities posteriorly. Antenna dark brown, except flagellular segments 1–4 pale-yellow; scape and pedicel dark brown (Fig. 16). Pronotum light brown with dark brown callosities. Scutum of meso- and metanotum light brown with a diffuse dark brown patch above scutellum. Legs are striped, femur yellow with mesal diffuse dark brown patch (Fig. 16).

Mature larvae. The association of the mature larvae with adults was established from preemergent male larvae, collected together with adults. Body length: 4.7–5.4 mm in males, 5.9–6.0 mm in females. General color brownish with greenish tint (Fig. 17). On the head each ocellus contoured with a thin bright brown stripe of chocolate brown tint; a narrow brown band between lateral ocelli above epicranial suture (Fig. 17). Clypeus typical with a pair of small dark patches on corners. Antenna, legs and cerci pale. Pronotum oval, approximately 1.6X wider than long, without pattern, anterior and posterior margins slightly darker than disk (Fig. 17). Rear edge of thorax between front wing-pads rounded; between hind wing-pads the thorax margin forms two little pointed extensions (Fig. 17). Fore femur 2.2X longer than wide (Fig. 22). Abdominal terga I–VI greenish brown, integument pale, matte in appearance, terga VII–X pale (Fig. 17).



FIGURES 16–17. *Leuctra simplex*, habitus, male, dorsal. 16. Adult. 17. Larva.

Setation. Macroscopic pilosity sparse. Head bears a few short club-shaped bristles behind the eyes. Antennal segments with pointed setae much shorter than length of segments. Setal fringe of short club-shaped bristles with rounded apices and a few occasional long, fine hairs on pronotum only on anterior corners (Figs 18, 19); one or two short bristles are on posterior pronotal margin closer to the posterior corner. Occasional long hairs and tiny clothing hairs cover pronotal disk (Fig. 19). Setation of legs is mixed: setal fringe on the outer femur margin of fore leg includes a few scattered, short acute bristles and a few long, fine hairs in second half of outer margin (Fig. 22). The longest acute bristles not exceed 10% of femur width on the fore leg. Tibia with spine-shaped bristles in distal half; outer margin with a few fine hairs (Fig. 22). Outer margin of femur of hind leg with sparse, cylindrical bristles and long fine hairs; setae on the tibia are similar with those on fore leg (Figs. 22, 23). Wing pad margins without pilosity. All terga covered with tiny clothing hairs and with a posterior fringe of short, thin setae (Fig. 20). Tergum IX of male additionally covered with stiff acute bristles posterolaterally (Fig. 21). Tergum X with numerous similar stiff bristles distributed evenly over tergum, and longer than that on tergum IX, especially along posterior margin (Fig.

21); the longest bristles not exceed 10% of tergum X width. Cerci with 10–12 slender acute bristles in the apical whorl on basal cercal segments, length of bristles does not exceed the segment length (Fig. 21). Paraprocts of male covered with stiff acute bristles near posterior edge ventrally.

Diagnosis. Mature larvae have a contrast thin, bright brown stripe around each ocellus and narrow, brown band between lateral ocelli on the head. Rear edge of mesonota between wing-pads rounded; in metanota forming two small pointed extensions. Pilosity sparse. Pronotal fringe at anterior corners as unnumerous, short, club-shaped bristles, rounded at the apex, with a few occasional long, fine hairs.

Remark. The specific identifications of larvae stages in *Leuctra*, a large and difficult genus remains problematic with exception for a few European species (Zwick 2004). Using the concept of Operational Taxonomic Units as presented by P. Zwick (2004), the larvae of *L. simplex* are most similar to those of the *prima–hippopus–inermis* group and cannot be currently distinguished from the other taxa.

Distribution. The Abrau River, a small foothill river, originates on the western slope of Zhen-Gora Mountain (Abrau Mountains) and flows into Abrau Lake. A rare species, endemic to the western Caucasus and the Krasnodarsky Region occurs at 600 m.a.s.l., adults emerge in May.

Nemouridae Billberg, 1820

Nemoura cinerea (Retzius, 1783)

Material examined. 1♂, 3♀, 3 larvae. Russia. Krasnodarsky Region, Novorossiysk District, Abrau-Dyurso Distric, Abrau River, 2 km above the Abrau settlement, 155 m above sea level, 44°43.5457 N 37°35.4979 E, 18.04.2018, coll. D. Palatov.

Distribution. Widespread transpalearctic species, flies in April–August.

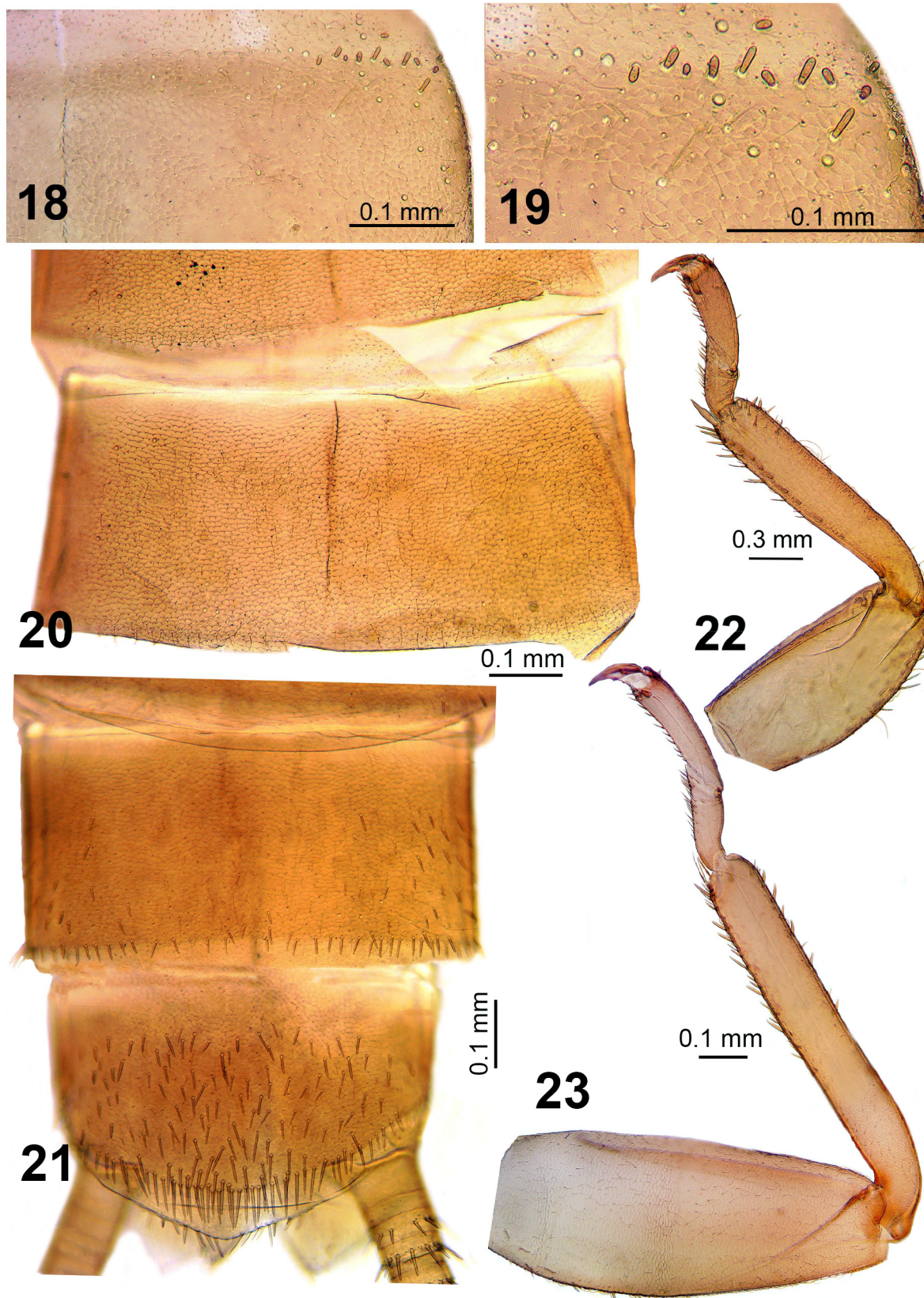
Perlodidae Klapálek, 1909

Bulgaroperla mirabilis caucasica Zhiltzova 1973

Material examined. 3♂, 1♀, 1 larva. Russia. Krasnodarky Region, Novorossiysk urban District, Abrau-Dyurso Distric, Abrau River, 2 km above the Abrau settlement, 155 m above sea level, 44°43.546 N 37°35.498 E, 18.04.2018, coll. D. Palatov.

Mature larva. The association of the mature larva with the adult was established from preemergent male larva collected with adults. Body length of the male mature larva 14 mm. Preserved specimen brown-yellowish with pale markings and pale legs (Fig. 24). Dorsum of head brown with pale pattern (Figs. 24, 25); a pale diffuse patch anterior to median ocellus; lateral frontoclypeal corners brown (Fig. 25); thin lateral branches of M-line and tentorial callosities are pale. A pale trident-shaped spot arranged in interocellar and epicranial areas, with short neck in the part of transverse setal row across occiput widely interrupted medially. Occiput brown, a thin pale band around each eye (Figs. 24, 25). Antennae pale, scape medium brown. Mandible with 6 pointed teeth and a deep cleft between apical and subapical teeth (Fig. 28). The upper edge of lower mandibular tooth weakly serrate (Fig. 29). Lacinia bidentate, triangular (Fig. 27), row of setae along inner edge sparse, discontinuous medially, begins with four thin hairs arranged near apical and subapical teeth, two hairs very long, reach the apex of subapical tooth; two strong marginal setae below subapical tooth; the marginal scattered setae at lacinial base thinner and shorter than beneath the subapical tooth (Fig. 27). The length of galea does not exceed the length of the three basal palpus segments (Fig. 27), with thin short setae along outer edge. Setal fringe along inner edge of galea consists of 7 thin hairs in basal half, and longer than on inner margin of lacinia (Fig. 27).

Pronotum oval with rounded corners, 1.8X as long, brown with dark brown posterior and anterior pronotal margins mesally, lateral margins with pale band; median pronotal line and spots forming a X-shaped pale pattern diffused medially (Figs 24, 25). Meso- and metanota with pale median line and complex color pattern (Fig. 24). Abdominal terga pale, each tergum with one median and two lateral pale spots surrounded with dark brown patches, forming longitudinal rows (Fig. 26). Paraprocts and cerci pale; paraprocts blunt (Fig. 30). Ventral surface of abdomen pale. On mesosternum, branches of Y—ridge meet posterior corners of furcal pits. Only first 2 abdominal segments divided into terga and sterna, others ring-shaped.



FIGURES 18–23. Larva of *Leuctra simplex*. 18. Short club-shaped bristles on anterior corner of pronotum. 19. Setae on disk and setal fringe of right anterior corner of pronotum. 20. Terga V–VI with posterior fringe of short, thin setae. 21. Terga IX–X with stiff acute bristles. 22. Right fore leg. 23. Right hind leg.



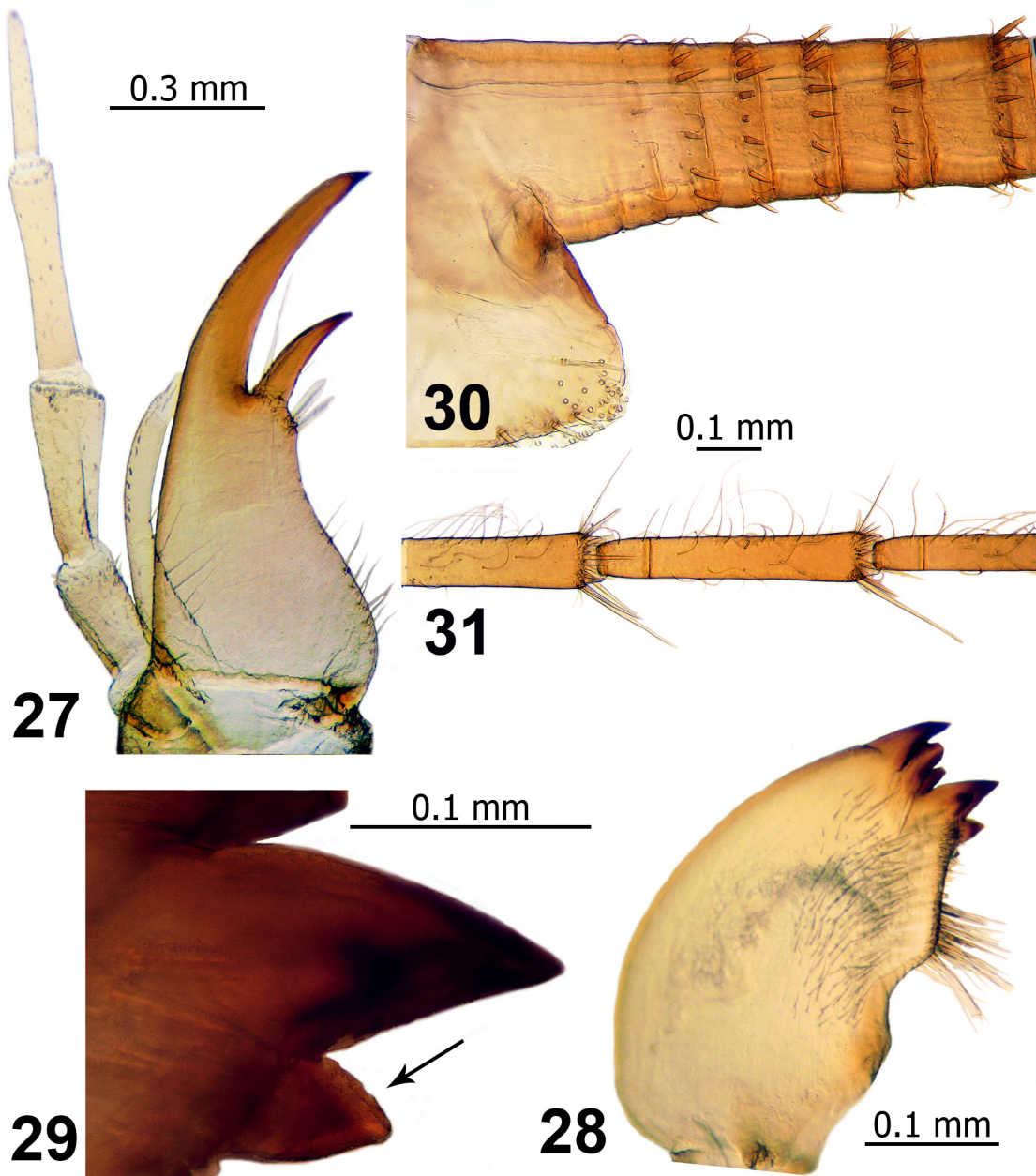
FIGURES 24–26. Larva of *Bulgaroperla mirabilis caucasica*. 24. Habitus, dorsolateral. 25. Head and pronotum, dorsal. 26. Terga V–VIII, pigmented spots with short setae.

Setation. Fine black pilosity (or clothing hairs) appressed to body surface closely and cover mainly pronotum and legs (Fig. 24). Transverse setal row across occiput medially widely interrupted, plurilinear setation presents only behind eyes, medially turning into an irregular single row ending far from middle (Fig. 25). Marginal setae on pronotum and abdominal terga relatively short, inconspicuous. Setal fringe around pronotum relatively regular and sparse, a few bristles on posterior pronotal corners much longer than on anterior ones, length of the longest bristles at the posterior pronotal corners attains 3.2% of pronotal width (Fig. 25). Dark pigmented spots with short setae seen on all abdominal terga (Fig. 26). Swimming hairs on the legs present (Fig. 24). Apical whorl of cercal segments

basally and in the middle part contains short bristles; dorsal fringe of fine hairs lacking (Figs. 30, 31). Apical whorl of cerci in apical half packed with tenuous dorsal fringe of scattered silky hairs, length of hairs not exceeding length of the corresponding segment (Fig. 31). Additionally, the apical whorl in apical half of cerci bears one long dorsal and ventral setae (Fig. 31).

Remark. The West Palaearctic genus *Bulgaroperla* Raušer 1966 includes a single species *B. mirabilis* Raušer, 1966 with three subspecies *B. mirabilis mirabilis* Raušer, 1966, *B. mirabilis nigrita* Zwick, 1978, and *B. mirabilis caucasica*. The adults and larvae of these subspecies differ in body size and color patterns (Braash & Joost 1971, Zhiltzova 1973, Zwick 1978). *Bulgaroperla mirabilis caucasica* can be distinguished by the smaller body size and lighter color pattern from the other two recognized subspecies.

Distribution. Endemic of the Western Caucasus, occurs in lowland streams (900–1000 m), adults emerge in May—beginning of June.



FIGURES 27–31. Larva of *Bulgaroperla mirabilis caucasica*. 27. Right lacinia, ventral. Galea with long setae along inner edge. 28. Right mandible, ventral. 29. Arrow shows a weak serration on outer cusp of lower mandibular tooth, ventral. 30. Left cercus, basal segments, ventral. 31. Left cercus, apical segments, ventral.

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