



## Balkanian species of the genus *Isoperla* Banks, 1906 (Plecoptera: Perlodidae)

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### Abstract

Ten taxa of Balkan *Isoperla* Banks, 1906 are described or redescribed on the basis of SEM studies of the penis, traditional morphological features, and egg structure: *I. oxylepis oxylepis* (Despax, 1936), *I. oxylepis balcanica* Raušer, 1962, *I. bosnica* Aubert, 1964 stat. rev., *I. citrina* sp. n., *I. albanica* Aubert, 1964, *I. vevcianensis* Ikononov, 1980, *I. tripartita tripartita* Illies, 1954, *I. obliqua* Zwick, 1978 stat. n., *I. pesici* sp. n. and *I. autumnalis* sp. n. The types and arrangement of scales and sensilla on penial lobes are summarized for West Palaearctic species groups with some preliminary changes in species grouping proposed. An annotated checklist of the Balkanian species is given and the known distribution of endemic taxa are depicted on maps. *Isoperla oxylepis balcanica* and *I. vevcianensis* are new for the fauna of Albania, while *I. bosnica* and *I. grammatica* (Poda, 1761) are new for Montenegro and Greece, respectively. Additional significant new country records are provided for *Amphinemura triangularis* (Ris, 1902), *A. quadrangularis* Zwick, 1978, *Nemoura caligula* Zwick, 1978 and *Leuctra jahorinensis* Kačanski, 1972.

**Key words:** Plecoptera, *Isoperla*, species groups, new species, redescription, penial structures, SEM, Balkans

### Introduction

The genus *Isoperla* Banks, 1906 is Holarctic and Oriental, the most species rich genus among the Perlodidae with about 150 species worldwide (DeWalt et al. 2011, Baumann & Lee 2009, Szczytko & Stewart 1979, Zwick & Surenkhorloo 2005). The western Nearctic and eastern Palaearctic species are relatively well known, even in the

larval stage (Stewart & Stark 2002, Teslenko & Zhiltzova 2006), but most western Palaearctic species are not well diagnosed (Zwick 2004) and are in need of complete revision.

Though the importance of the study of the armature of aedeagus for species identification has long been recognized (Despax 1936), a comprehensive analysis of distribution of spinules, spinule patches, and sclerites of everted aedeagi has only been conducted for western Nearctic species (Szczytko & Stewart 1979). Very rarely has this level of morphological analysis been conducted for western Palaearctic species (but see Rupprecht 1984, Zhiltzova 1961, Zwick 1971). Despite the efforts of many scientists using morphological, behavioural, and molecular methods (Fochetti 1993, Lillehammer & Økland 1987, Rupprecht 1968), no synthesis of the western Palaearctic *Isoperla* has occurred.

The discovery of a unusual new species from Albania has resulted in a scanning electron microscope (SEM) study of this enigmatic genus of European Plecoptera. Most western Palaearctic species groups share an aedeagus with a similar arrangement of four lobes. In this paper, I summarize the overall natural shape of the everted aedeagus and the distribution and types of spinulae and sensilla on the lobes. Based on my findings, I propose changes in species group assignments and describe or redescribe selected species from the Balkans using morphology of the aedeagus, other morphological features, and the egg chorion. Additionally, I summarize the known distribution of *Isoperla* species in the Balkans with comments on their taxonomy and habitat.

## Material and methods

Newly collected specimens were caught by hand, sweep net or beating sheet. The aedeagus of males was everted in the field or from live specimens in the laboratory. All specimens were stored in 70% ethanol and deposited in the Collection of Smaller Insect Orders, Department of Zoology, Hungarian Natural History Museum (HNHM), the collection of the former Limnologische Fluss-Station des Max-Planck-Instituts für Limnologie, presently held by Prof. Peter Zwick, Schlitz, Germany (CPZ), or the Dr. Gilles Vinçon Collection, Grenoble, France (CGV). Additional studied material are held in the HNHM, the Wien Natural History Museum (WNHM) and the collection of Dr. Wolfram Graf (CWG). Institutions where specimens reside are indicated by these codens within the Materials Examined sections of the paper.

Penial structures have been studied by SEM in the following further species: *Isoperla ambigua* (Despax, 1936) (France), *I. belai* Illies, 1963 (Romania), *I. buresi* Raušer, 1962 (Romania), *I. carbonaria* Aubert, 1953 (Italy), *I. curtata* Navás, 1924 (Spain), *I. grammatica* (Poda, 1761) (Slovenia, Greece), *I. insularis* (Morton, 1930) (France), *I. lugens* (Klapálek, 1923) (Austria), *I. pusilla* (Klapálek, 1923) (Romania), *I. rivulorum* (Pictet, 1841) (Austria), *I. orobica* Ravizza, 1975 (Italy), *I. sudetica* (Kolenati, 1860) (Slovakia, Romania) and *I. zwicki* Tierno de Figueroa & Fochetti, 2001a (Austria).

Specimens whose penis was mounted on slides, portions used for the drawings, or that were the subject of SEM study are indicated in the material examined sections. Glycerine gelatin was used for slide preparations. SEM images were made using a Hitachi S-2600N scanning electron microscope. Penises for SEM study were critical point dried and sputter coated with gold-palladium.

Species ranges, local distributions in the Balkans, and habitat preferences were compiled from the following works: Braasch & Joost (1971), Fochetti (2004), Ikonomov (1986), Illies (1978), Murányi (2008), Raušer (1965b), Sivec (1980a, 1980b), Tierno de Figueroa & Fochetti (2001b), or from references cited within these works. Terminology of adult morphology mainly follows that of Tierno de Figueroa & Vinçon (2005), while in the case of eggs, terminology follows Isobe (1997) and Sivec & Stark (2002).

## Penial structure of the West Palaearctic *Isoperla* species

In the species examined, the penis consists of four lobes and a basal section (Figs. 6, 30, 72, 114, 124), with the exception of the *albanica* group where the paired lateral lobes are further divided into an upper and a lower lobe (Fig. 48). The penis bears one to five areas of heavy, stout armatures that consist of coloured scales whose shape and size are unique to a species (Figs. 10–12, 25, 34–37, 52–54, 66, 76–81, 104, 118–120). The medial penial armatures (numbering one to three) are located either on the medial lobe adjacent to the ventral lobe (Figs. 6, 30), mesally on the ventral lobe (Fig. 48), or basally on the medial lobe adjacent to ventral lobe with a disjunct patch on

the basal part on the ventral lobe (Figs. 72, 114). Additionally, lateral penial armatures (two or lacking) appear ventrolaterally of the lateral lobes (Figs. 30, 72, 114).

The size of the lobes is directly related to the degree of extrusion, but the relative size and shape of lobes remains constant (see Figs. 76–78). The ventral lobe is hemispherical or elongated, the medial lobe is usually longer than wide, similar in shape to the lateral lobes which are bent above the lateral penial armatures if they are present (Figs. 6, 30, 48, 72, 114).

The distribution of uncoloured scales and sensilla on the lobes are also distinctive. The basal section often bears triangular scales of varying size and density (Figs. 16, 39) or simple hair-like scales, and sparse hydra-like scales (Figs. 48, 72). The ventral lobe frequently bears simple or branched hair-like scales or both types (Figs. 40, 82), triangular scales (Fig. 83), or sausage-like scales (Figs. 54). The lateral sides of the ventral lobes always lack scales (Fig. 6). The medial lobe can bear branched spike-like scales (Figs. 13, 15), triangular scales (Fig. 57), hairy scales and sparse hydra-like scales (Fig. 58), or small ciliated scales (Fig. 84). Lateral, basal, and ventral surfaces of the medial lobe or the entire lobe may be devoid of these structures (Fig. 30). The lateral lobes may bear hydra-like scales (Figs. 14, 38), simple, rarely branched hair-like scales (Fig. 6), or some parts may be devoid of scales entirely (Fig. 30). Sensilla occur only on lateral lobes, and when they do they are mixed with scales (Figs. 14, 38). If the lateral lobes are divided, the upper lateral lobes bear elongate, triangular, hairy scales mixed with sensilla (Fig. 56), branched and simple hair-like scales and bald surfaces. The lower lateral lobes are bald beside a medial area of hydra-like scales mixed with sensilla (Fig. 55).

### **Species groups of the West Palearctic *Isoperla***

Consiglio (1967) based his species groupings of European *Isoperla* on the earlier efforts of Despax (1936), Aubert (1946), Illies (1952b) and Consiglio (1961); his grouping is still considered valid. This system is almost exclusively based on the shape and the distribution of scales of the heavy stout penial armatures. Unfortunately, we are far from establishing phylogenetic relationships within the western Palearctic *Isoperla*. A synthesis of morphological, molecular, and possibly behavioural data will be required to test relationships in this difficult genus. Nevertheless, the present SEM studies and new species descriptions support some preliminary changes in species groupings.

#### ***goertzi* group**

Consiglio (1967) diagnosed this group by the presence of ridges in the medial penial armature (Fig. 34), but given recent developments it appears that this group is paraphyletic. Both *I. bosnica* Aubert, 1964, currently treated as a member of the *oxylepis* group, and *I. citrina* sp. n., have these ridges. They also exhibit character states that align them clearly with the *rivulorum* group. I propose the dissolution of the *goertzi* group and transfer of *I. goertzi* Illies, 1952a and *I. citrina* to the *rivulorum* group, whereas *I. bosnica* is assigned to the *oxylepis* group.

#### ***oxylepis* group**

Consiglio (1967) diagnosed this group by the presence of folded sides of the wide medial penial armature that is composed of triangular scales and by the absence of lateral penial armatures. The presence of dense uncoloured scales all over the lobes is also characteristic of this group. The following are included in this group: *I. oxylepis oxylepis* (Despax, 1936), *I. oxylepis balcanica* Raušer, 1962, *I. bosnica*, *I. orobica* and *I. submontana* Raušer, 1965a.

#### ***rivulorum* group**

Consiglio (1967) diagnosed the group by the presence of an unfolded, short, wide medial penial armature that consists of triangular scales. As discussed before ridges may also be present, but are no longer considered a distinguishing characteristics of a group. My examination has determined that most of the species included in the group have lateral penial armatures. Additionally, baldness of the medial lobe and scarcity of uncoloured scales on the lateral lobes may also be diagnostic for the group. I have included the following in this species group: *I. rivulorum*, *I. ambigua*, *I. andreinii* (Festa, 1938), *I. carpathica* Kis, 1971, *I. citrina* sp. n., *I. flava* Kis, 1963b, *I. goertzi*, *I. hyb-*

*laea* Consiglio, 1961, *I. ilvana* Consiglio, 1958, *I. insularis*, *I. kir* Fochetti & Vinçon, 1993 and *I. oenotriae* Consiglio, 1967. Placement of *I. moselyi* (Despax, 1936) in this group is questionable, considering the shape of the medial penial armature and its scales (G. Vinçon pers. com.).

### ***sudetica* group**

Consiglio (1967) diagnosed this group based on the presence of scales of the medial and lateral armatures being spike-like instead of triangular, including both *I. sudetica* and *I. silesica* Illies, 1952a in the group. My examination suggests that other characters of *I. sudetica* agree with those of the *rivulorum* group. Additionally, *I. silesica* has a divided medial penial armature, a characteristic unique among western Palearctic *Isoperla* and one warranting placement of the species in the new *silesica* group. Thus, *I. sudetica* remains the only member of the group.

### ***silesica* group**

This new group can be diagnosed by the medial penial armature being divided into an upper and a lower portion, both consisting of spike-like scales. Additionally, this group lacks lateral penial armature and has bald areas between the upper and lower portion of the medial penial armature. Wolfram Graf (pers. comm.), has also detected a lower medial penial armature in *I. zwicki*, a character not mentioned in the original description (Tierno de Figueroa & Fochetti 2001a). The following species, *I. silesica*, *I. breviptera* Ikonomov, 1980, *I. vevcianensis* Ikonomov, 1980 and *I. zwicki*, are included in this group.

### ***saccai* group**

This group is characterized by triangular, elongate medial penial armature with an unfolded lateral edge that consists of long scales (Consiglio 1967). The four species formerly included in the group: *I. saccai* (Festa, 1939), *I. lugens*, *I. albanica* Aubert, 1964 and *I. russevi* Sowa, 1970 are apparently not closely related and this group is probably polyphyletic. *Isoperla albanica* is transferred to a new group, the *albanica* group. Despite very different coloured armatures, the uncoloured structures of *I. lugens* are very similar to those of *I. carbonaria* (assigned to the *acicularis* group). SEM studies of additional species are needed to resolve the validity of these two groupings.

### ***albanica* group**

This new group is diagnosed by the elongate, undivided medial penial armature being composed of long scales that are located on the ventral lobe of the penis. It is also characterized by the dense triangular scales of the medial lobe, and the divided lateral lobes. *Isoperla albanica* and *I. belai* are included in this group.

### ***tripartita* group**

Consiglio (1967) diagnosed this group by the presence of a divided medial penial armature located on the ventral lobe of the penis. Divisions of the armature may be into an upper and lower portion and usually is at least partly divided into a left and a right half with the scales being dart-shaped. Lateral penial armatures are usually present. Uncoloured scales are scarce, but present on lateral lobes in a characteristic transverse, narrow stripe of hydra-like scales. *Isoperla tripartita tripartita* Illies, 1954, *I. tripartita recta* Zwick, 1978, *I. autumnalis* sp. n., *I. illyrica* Tabacaru, 1971, *I. obliqua* Zwick, 1978 and *I. pesici* sp. n. are assigned to this group.

## **Taxonomy**

### ***Isoperla oxylepis oxylepis* (Despax, 1936)**

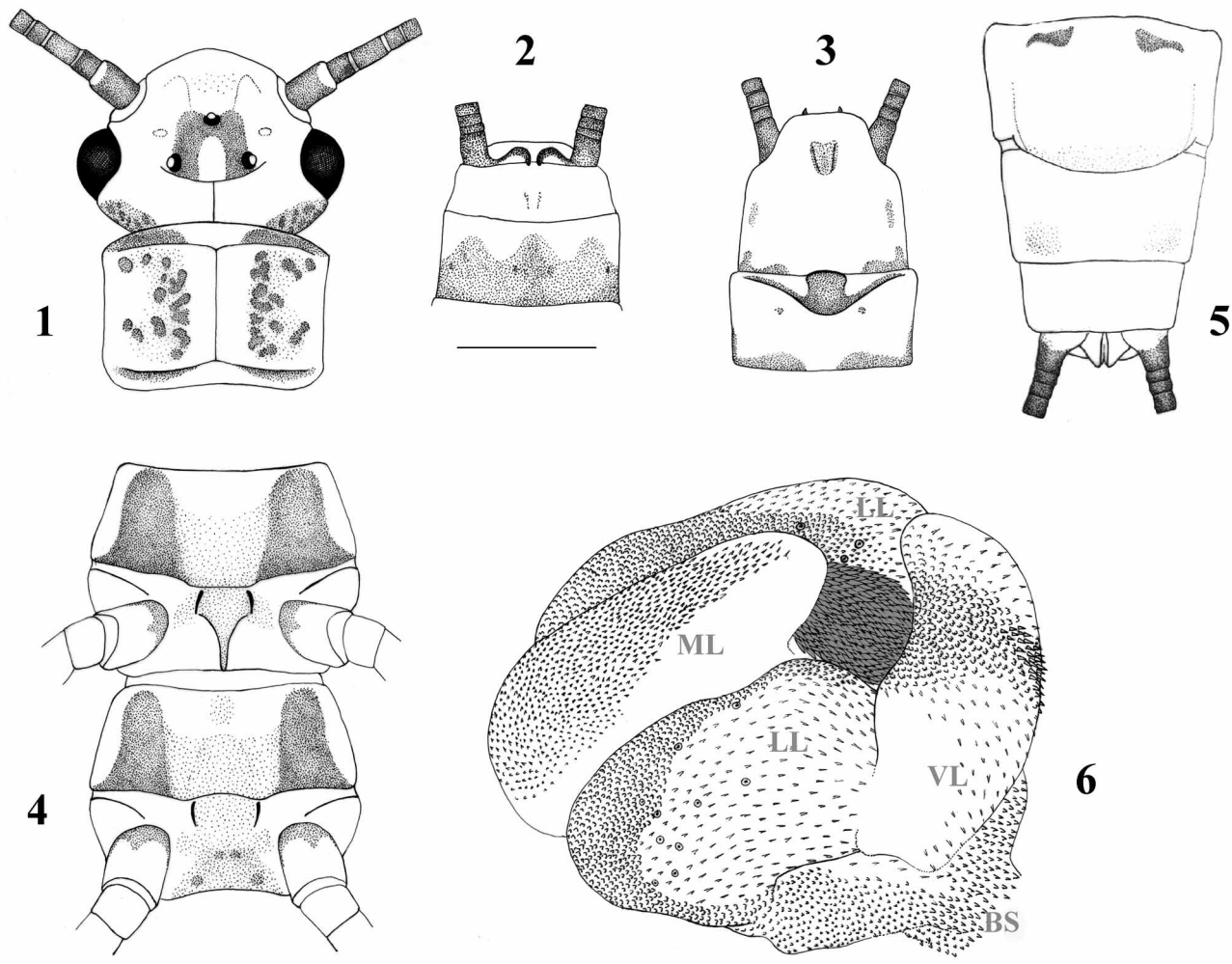
(Figs. 7, 11, 17)

*Chloroperla grammatica* ssp. *oxylepis* Despax, 1936 — Despax 1936: 357 (original description of male)

*Isoperla grammatica* var. *oxylepis* (Despax, 1936) — Claassen 1940: 204 (comb. n., catalog)

*Isoperla grammatica* forma *oxylepis* (Despax, 1936) — Despax 1951: 101 (repr. of Despax 1936)

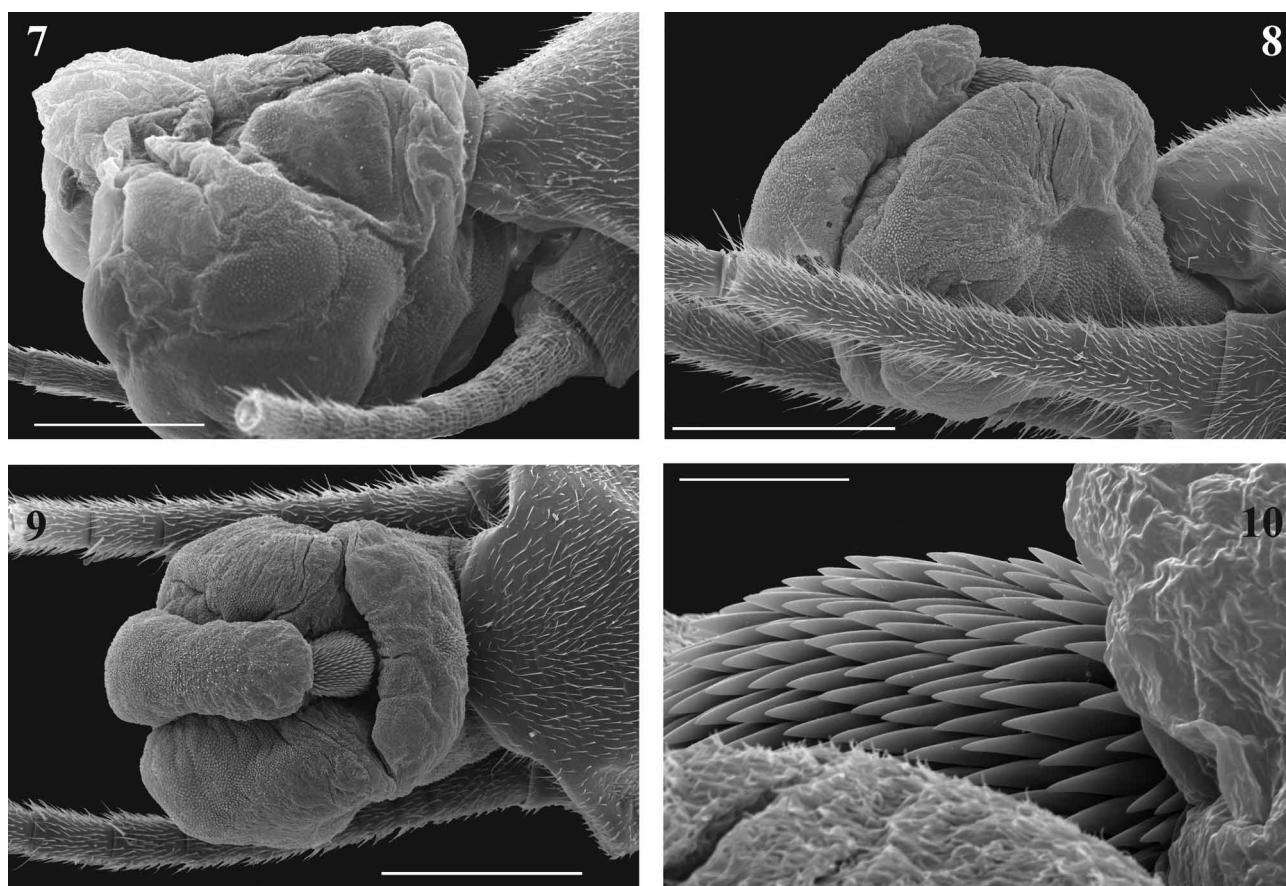
*Isoperla oxylepis* (Despax, 1936) — Illies 1952b: 388 (stat. n., supplementary description of male), 401 (description of larva); Illies 1955: 100, 142 (repr. of Illies 1952); Winkler 1956: 335 (supplementary description of male); Winkler 1957: 62 (supplementary description of male and larva); Raušer 1962: 79 (comparative drawings of male); Illies 1966: 414 (catalog); Rupprecht 1969: 30 (drumming); Kimmins 1970: 347 (protolog); Zwick 1973: 249 (catalog); Kis 1974: 237 (supplementary description of male and female); Raušer 1980: 102 (supplementary description of larva).



**FIGURES 1–6.** *Isoperla oxylepis balcanica* Raušer, 1962 — 1: head and pronotum; 2: male terminalia, dorsal view; 3: male terminalia, ventral view; 4: meso- and metathorax, ventral view; 5: female terminalia, ventral view; 6: extruded penis, dorsolateral view (ML: medial lobe; LL: lateral lobe; VL: ventral lobe; BS: basal section) — scale 1 mm: 1–5; 0.5 mm: 6.

**Material examined:** FRANCE: Auvergne region: Falgoux, Mts Cantal, Mars, 1200 m, 02.08.2004, leg., det. G. Vinçon: 1m 2f (HNHM); AUSTRIA: Niederösterreich: Kaiserbrunn, Mts Raxalpe, Höllental, Schwarza River at Abbrenn bridge, 03.06.2006, leg. L. Dányi, Á. Vári: 5m 3f (HNHM; one penial armature prepared on slide); SLOVAKIA: Žilinský region: Mts Malá Fatra, Vrátna Stream, 06.07.1967, leg. H. Steinmann: 6m 12f (HNHM; *I. rivulorum*, det. H. Steinmann); Zázrivá, Mts Malá Fatra, Zázrivka Stream, 06.07.1967, leg. H. Steinmann: 2m 5f (HNHM; *I. rivulorum*, det. H. Steinmann); Zuberec, Mts Západné Tatry, Brestová, Studeny Stream, 860 m, 22.07.2003, leg. K. Balogh, I. Béres, D. Murányi, Zs. Szegedi: 2m 3f (HNHM); Važec, Mts Vysoké Tatry, 08.07.1967, leg., det. H. Steinmann: 14m 10f (HNHM); Liptovský Mikulas, Mts Nízke Tatry, 07.07.1967, leg. H. Steinmann: 1m (HNHM); Demänovská Dolina, Mts Nízke Tatry, 07.07.1967, leg. H. Steinmann: 1m (HNHM; *I. rivulorum*, det. H. Steinmann); Prešovský region: Vysoké Tatry, Mts Vysoké Tatry, Podbanské, 08.07.1967, leg. H. Steinmann: 1m (HNHM; *I. rivulorum*, det. H. Steinmann); Podspády, Mts Belianske Tatry, Javorinka Stream, 11.07.1967, leg. H. Steinmann: 1m (HNHM); Lendak, Mts Belianske Tatry, Tatranská Kotlina, 11.07.1967, leg. H.

Steinmann: 7m 2f (HNHM; *I. rivulorum*, det. H. Steinmann); Spišská Belá, Beliansky Stream, 11.07.1967, leg. H. Steinmann: 18m 16f (HNHM; *I. rivulorum*, det. H. Steinmann); Banskobystrický region: Donovaly, Mts Nízke Tatry, 09.07.1967, leg. H. Steinmann: 2m 3f (HNHM; *I. rivulorum*, det. H. Steinmann); Stará Huta, Mts Javorie, Blýskavica, Tisovník Stream, 660 m, 10.07.2004, leg. K. Balogh, K. Harnos, D. Murányi: 1m (HNHM); Povojné, Mts Javorie, Tisovník Stream, 480 m, 11.07.2004, leg. K. Balogh, K. Harnos, D. Murányi: 6m 7f (HNHM; eggs prepared for SEM); 20.06.2006, leg. Á. Garai, J. Kotschán, D. Murányi: 2m (HNHM; one male terminalia prepared for SEM); Příboj, Mts Krupinská Planina, Tisovník Stream, 260 m, 11.07.2004, leg. K. Balogh, K. Harnos, D. Murányi: 1f (HNHM); Košický region: Hrabušice, Mts Slovenský Raj, Kláštorisko, 10.07.1967, leg. H. Steinmann: 1m (HNHM); Stratená, Mts Slovenský Raj, 10.07.1967, leg. H. Steinmann: 1m 1f (HNHM; *I. rivulorum*, det. H. Steinmann); HUNGARY: Borsod-Abaúj-Zemplén county: Kishuta, Mts Zemplén, Kőkapu, 19.05.1966, leg. H. Steinmann: 3m (HNHM); Kemence Stream, 230 m, 08.06.2006, leg. Cs. Csuzdi, E. Horváth, D. Murányi: 1m 2f (HNHM); ROMANIA: Cluj county: Cluj-Napoca, Someșul Mic River, 19.05.1971, leg., det. B. Kis: 12m 9f (HNHM); Bacău county: Cașin, Salutaris, 800m, leg Fodor, Z. Kaszab: 1m 1f (HNHM); Poiana Sărată, Mts Nemira, 18.06.1971, leg. B. Kis: 1m 2f (HNHM).



**FIGURES 7–10.** *Isoperla oxylepis oxylepis* (Despax, 1936) (7) and *I. oxylepis balcanica* Raušer, 1962 (8–10) — 7–8: extruded penis, lateral view; 9: extruded penis, dorsal view; 10: medial penial armature, lateral view — scale 0.5 mm: 7–9; 0.05 mm: 10.

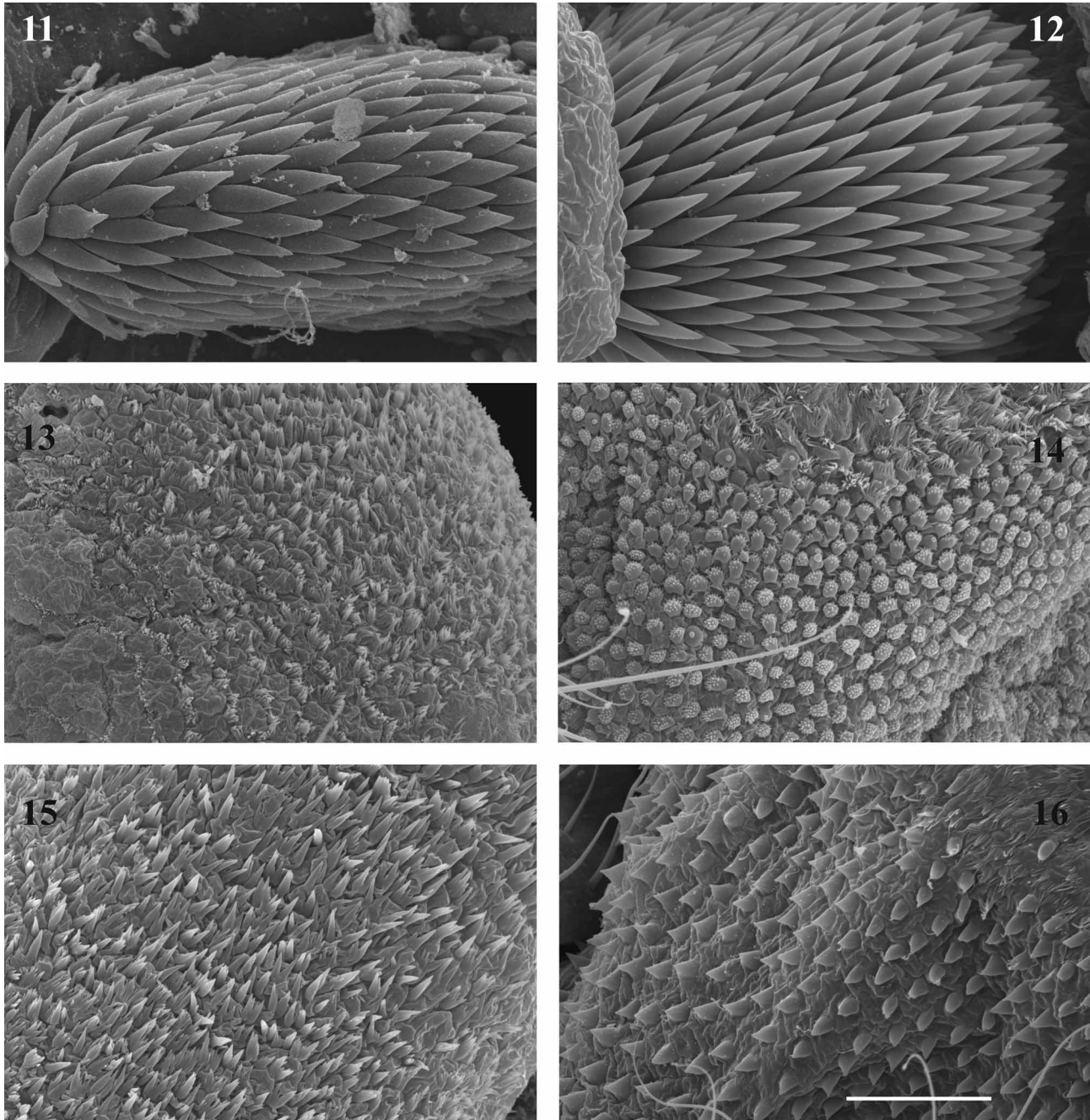
**Diagnosis.** This species is characterized by an oblong medial penial armature of, the sides of which are folded but lack lateral expansions. The scales of this armature are triangular, their length being 2.5x their width. Lateral penial armatures lacking.

**Complementary description:** General appearance, dimensions, male and female abdomen: Similar to *I. oxylepis balcanica* redescribed below, and see also the literature cited above (Despax 1936, Illies 1952b, Winkler 1957, Kis 1974).

**Penis:** Divided into four lobes, plus a basal section in everted position (Fig. 7). The medial penial armature is located on the medial lobe adjacent to the ventral lobe, lateral penial armatures lacking. The medial penial armature is oval, lateral sides folded; length 160–210  $\mu\text{m}$ , width 90–120  $\mu\text{m}$  (Fig. 11). The scales are triangular and erect,

cross section cylindrical; their length is 30–45  $\mu\text{m}$ , width 12–18  $\mu\text{m}$ . Lobes and the distribution of colorless scales similar to *I. oxylepis balcanica*, but the ventral lobe bears no strong triangular scales and the stripe of spike-like scales on the medial lobe is less extended.

Egg: Similar to *I. oxylepis balcanica*, but the chorion with more pronounced follicular cell impressions (FCIs) in the studied eggs (Fig. 17).



**FIGURES 11–16.** *Isoperla oxylepis oxylepis* (Despax, 1936) (11) and *I. oxylepis balcanica* Raušer, 1962 (12–16) — 11–12: scales of the medial penial armature, dorsal view; 13: spike-like scales on the apical part of the medial lobe; 14: hydra-like scales and sensilla of the lateral lobes; 15: spike-like scales of the medial lobe on its end at the ventral lobe; 16: triangular scales of the basal section — scale 0.05 mm (for all figures).

Larva not studied herein (see Illies 1952b, Raušer 1980).

**Affinities:** See *I. oxylepis balcanica* below.

**Ecology and distribution:** The species was originally described from the French Massif Central (Kimmins 1970). Later it was reported from most of Central Europe (Fochetti 2004), and from Slovenia, Croatia, Bosnia-Her-

zegovina, Serbia and Montenegro in the Northern parts of the Balkans (Sivec 1980a). In the Central Balkans it is replaced by *I. oxylepis balcanica*. The studied material was collected from May to July from various, but usually larger streams occurring in hilly or submontane regions, together with a diverse community of stoneflies.

### ***Isoperla oxylepis balcanica* Raušer, 1962**

(Figs. 1–6, 8–10, 12–16, 18–20, 126)

*Isoperla oxylepis balcanica* Raušer, 1962 — Raušer 1962: 80 (original description of male); Illies 1966: 414 (catalog); Zwick 1973: 249 (catalog).

**Material examined:** ALBANIA: Gjalica Ljums (Kukës district, Mts Gjalica e Lumës), 1000–1600 m, 16.07.1918, leg. E. Csiki: 1m (HNHM; *I. oxylepis*, det. W. Joost 1975); Dibër district: Radomirë, Mts Korab, spring and stream E of the village, N 41°49.032' E 20°30.016', 1440 m, 26.06.2007, leg. L. Dányi, Z. Eröss, Z. Fehér, A. Hunyadi, D. Murányi: 4m 13f (HNHM; used for drawings, one male terminalia and eggs prepared for SEM), 2m 2f (CGV); Radomirë Stream E of the village, N 41°49.022' E 20°30.022', 1445 m, 28.06.2007, leg. L. Dányi, Z. Fehér, D. Murányi: 1f (HNHM; eggs prepared for SEM); Mat district: Gurri i Bardhë, Mts Shkanderbeu, open stream S of the village, N 41°25.839' E 20°05.518', 1025 m, 30.06.2007, leg. L. Dányi, D. Murányi: 2m 1f (HNHM).

**Diagnosis:** This subspecies is characterized by medial penial armature that is nearly circular with its sides being folded but lacking lateral expansions. The scales of the armature are triangular and relatively slender, their length being 3x their width. Lateral penial armatures lacking.

**Description:** Medium-sized species, macropterous. Body length: males 10.0–11.5 mm (n=9), females 10.5–14.0 mm (n=17); forewing length: males 11.0–12.0 mm (n=9), females 11.5–13.5 mm (n=17). General colour yellowish but the meso- and metanotum and the abdomen mostly brown; pilosity of the body and legs short and dense. Head yellow, with a broad U-shaped dark brown patch connecting the three ocelli; tentorial callosities and M-line hardly visible, occiput with brown rugosities laterally (Fig. 1). Eyes as large as the area delimited by the three ocelli. Scape dark brown, pedicel and the following three or four antennomeres are brown, distally darker brown; palpi brown. Pronotum yellow, rectangular, edges angled; rugosities are large and brown, anterior and posterior margins outlined in brown. Mesonotum dark brown but yellow anteriorly and medially, metanotum dark brown. Wings yellowish, veins pale in the anterior fourth of the wings, further veins brown. Ventral surface of thorax mostly pale, meso- and metabasisternum bear two broad, dark brown stripes laterally, medial parts light brown; furcasternites light brown, furcal pits black (Fig. 4). Femora pale but the dorsal surface and the ventral edges brown. Tibiae pale ventrally, brown dorsally; tarsi dark brown.

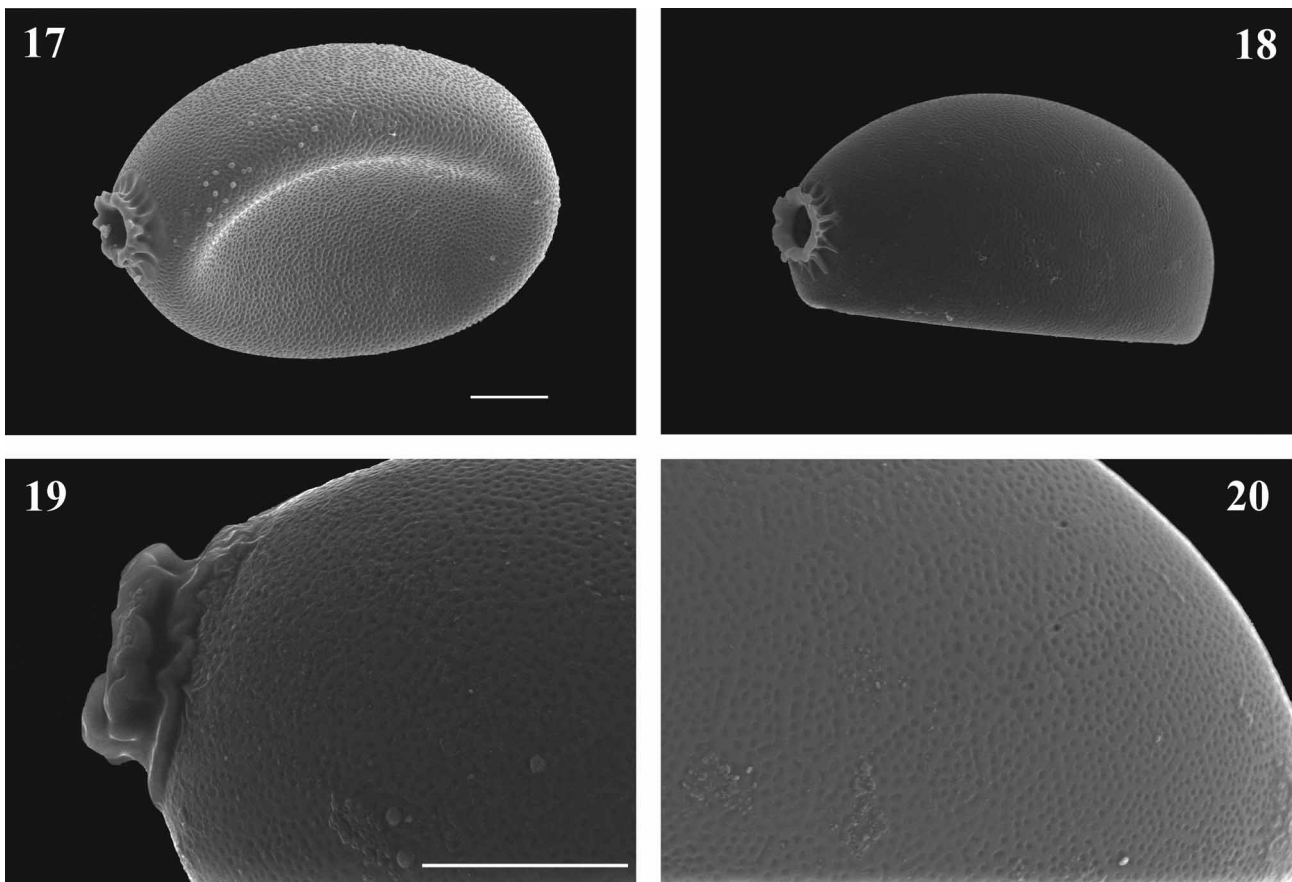
Male abdomen: First tergite dark brown but yellowish anteriorly and medially. Tergites II–VII entirely dark brown, tergite VIII dark brown or dark brown with yellowish brown marks posteriorly. Tergite IX dark brown or brown, posteriorly it bears an undulating yellowish transverse stripe; tergite X yellowish (Fig. 2). Transverse row of four pigmented spots seen on all but tergite X. Ventral surface of abdomen mostly yellow, sternites II–VIII have a brown transverse anterior line, interrupted in the middle at least on segments VII–VIII; sternites II–VII have a medial transverse row of four, sternite VIII of two spots. Vesicle of sternite VIII brown, as wide as long, its posterior margin slightly truncate; shorter than half of the segment's length (Fig. 3). Sternite IX yellow but with brown patches anterolaterally, the medial penial armature visible through the integument in the posterior half of the segment. Paraprocts brown, sharp, thin and slightly recurved; cerci dark brown, base of the first cercal segment sometimes paler.

Penis: Divided into four lobes and a basal section in extruded position (Figs. 6, 8–9). The medial penial armature located on the medial lobe adjacent to the ventral lobe, lateral penial armatures lacking. The medial penial armature oval, lateral sides folded; length 150–170 µm, width 130–150 µm (Figs. 10, 12). The scales are triangular and erect, cross section cylindrical (Figs. 10, 12). Their length is 30–45 µm, width 10–15 µm. The ventral lobe is hemispherical, most of the surface covered with small, simple hair-like scales. Lateral sides bald; medial section bears branched hair-like scales and a central patch of strong triangular scales that are resembling to the scales of the



medial penial armature but are smaller and not coloured. The medial lobe is long and narrow; sides are smooth but the medial section bears a stripe of branched spike-like scales. This stripe is apically wider and consists of smaller but more numerous scales which are grading into stronger ones towards the tapering end over the medial penial armature (Figs. 13, 15). The lateral lobes are long and slightly bent above the basal section. They bear a lengthwise stripe of small, hydra-like scales (Fig. 14); the stripe rises from the dorsolateral ends of the basal section and continues along the medial lobe. Apical part of the lobe bald, rest of the lobe ventrobasally from the stripe of hydra-like scales covered with simple and a few branched hair-like scales. A few sensilla settled in an elongated, diagonal field, both between the hydra-like scales and the hair-like scales. The basal section covered mostly with triangular scales (Fig. 16), but these are grading into hydra-like scales towards the dorsal origin of the lateral lobes, and the section beneath the ventral lobe bears simple hair-like scales. Triangular scales are stronger but sparser ventrally.

Female abdomen: First tergite dark brown but yellowish anteriorly and medially. Tergites II–IV dark brown, tergites V–VII paler, tergites VIII–IX pale brown, tergite X yellowish with some brown marks. Transverse row of four pigmented spots seen on all segments. Sternites II–VIII yellow with an interrupted transversal anterior line; sternites II–VII have a medial transverse row of four spots, hardly visible on the apical ones. Subgenital plate covers most of sternite VIII and the anterior part of sternite IX, most of the plate yellowish but posterior edge usually somewhat darker; posterior margin rounded (Fig. 5). Sternite IX yellow, bearing two pale brown lateral patches on the posterior half. Sternite X and the paraprocts yellow; cerci dark brown, base of the first cercal segment usually paler.



**FIGURES 17–20.** *Isoperla oxylepis oxylepis* (Despax, 1936) (17) and *I. oxylepis balcanica* Raušer, 1962 (18–20) — 17–18: egg, lateral view; 19: collar with anchor, lateral view; 20: micropyles, lateral view — scale 0.05 mm.

Egg: Chorion brown, 0.32–0.35 mm long and 0.20–0.25 mm wide (n=30). Shape oval, cross section half moon shaped as one side of all the examined eggs are depressed (Fig. 18), though this shape is possibly an artifact (see Tierno de Figueroa et al. 2000). Hatching line inconspicuous. Micropyles placed in a transverse row on the opercular third, not raised (Fig. 20). Chorion with hardly visible ornamentation of penta- or hexagonal FCIs, but dense, well visible punctation present within each impression. Collar round, rim flanged, bears extended ribs. Anchor flat,

anchor surface structure in development stage 1 (unmodified, according to Isobe 1997), and with few globular bodies (Fig. 19).

Larva: unknown.

**Affinities:** This subspecies differs from *I. oxylepis oxylepis* in that it has a more nearly circular medial penial armature that consists of relatively longer and narrower scales. Furthermore, the ventral lobe bears strong triangular scales, and the stripe of spike-like scales on the medial lobe is more extended in *I. oxylepis balcanica*. Both subspecies differ from the closely related *I. submontana* and *I. orobica* by the oval medial penial armature, furthermore, the vesicle of sternite VIII is weakly separated in *I. submontana*. They also can be separated from *I. bosnica* by the lack of lateral expansions on the medial penial armature.

**Ecology and distribution:** The subspecies was originally described from the Rila Mountains of Western Bulgaria (Raušer 1962). Later it was reported from Montenegro and Kosovo (Sivec 1980b) and Macedonia (Ikonov 1986; see also the distribution notes on *I. bosnica* below) (Fig. 126). In Central Europe and in the northern Balkans it is replaced by the nominal subspecies. *Isoperla oxylepis balcanica* is newly reported for Albania where it was collected from two streams at the end of June. The locality in the Korab Mountains is above 1400 m, where the stream is flowing across stony substrates and the riparian vegetation is ruderal Mediterranean bush with some willow. The species was quite numerous and found on bushes, sedges and *Petasites* leaves, in common with *Leuctra inermis* Kempny, 1899, *Amphinemura triangularis* (Ris, 1902), *Protonemura intricata intricata* (Ris, 1902), *Nemoura cinerea cinerea* (Retzius, 1783), *I. albanica* and *Perla pallida* Guérin, 1838. The locality in the Shkanderbeu Mountains is above 1000 m, the stream is flowing across stony substrates in an open grassland, the riparian vegetation consists of ruderal plants and a few small eastern hornbeams. Only a few specimens were found on the hornbeams in common with numerous *Perla marginata* Panzer, 1799.

### ***Isoperla bosnica* Aubert, 1964 stat. rev.**

(Figs. 21–25, 127)

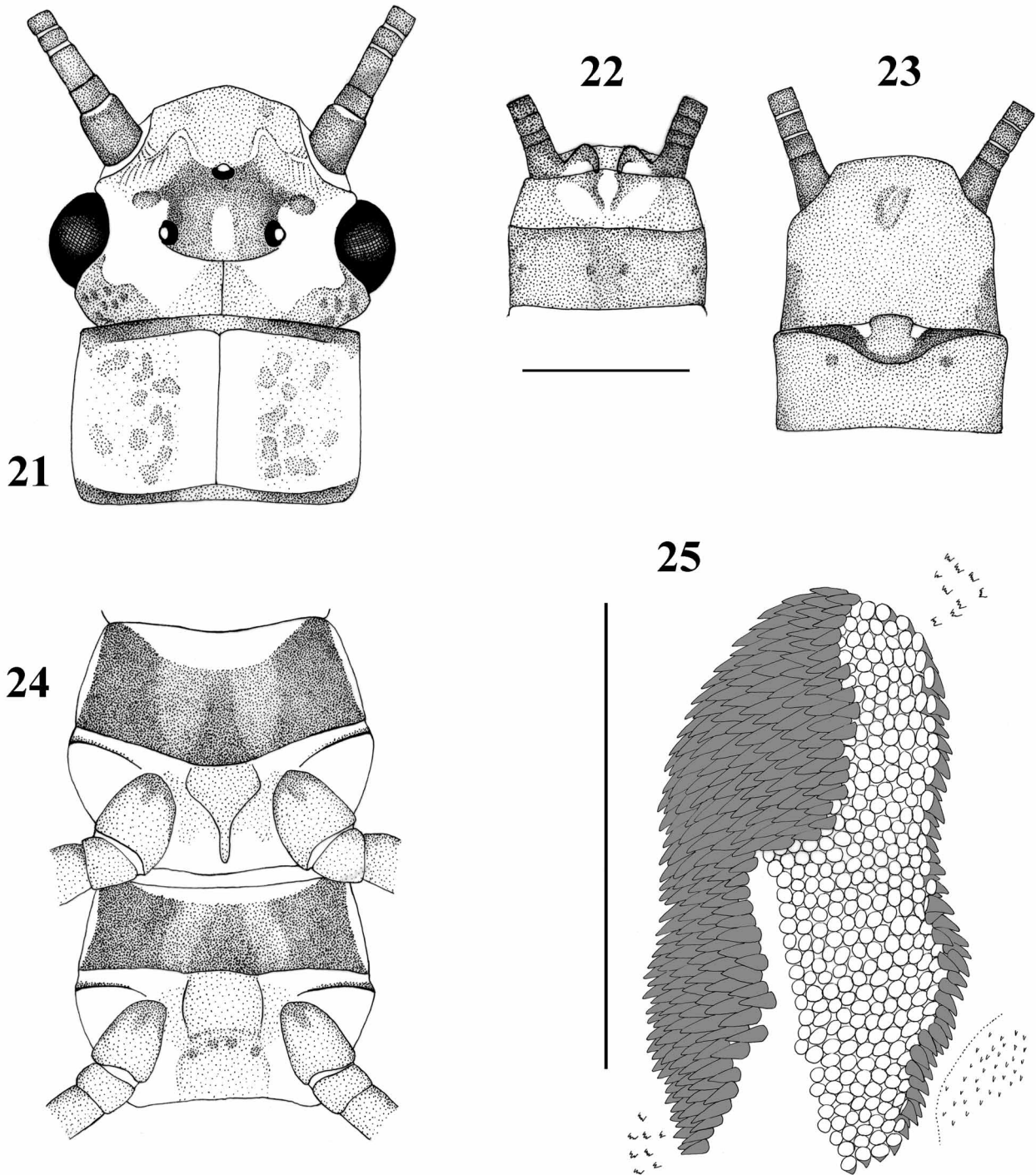
*Isoperla bosnica* Aubert, 1964 — Aubert 1964: 297 (original description of male); Illies 1966: 396 (catalog)

*Isoperla oxylepis balcanica* Raušer, 1962 — Sivec 1980b: 9, Ikonov 1986: 108 (synonymy not stated formally).

**Material examined:** Holotype male: BOSNIA-HERZEGOVINA: Trnovo, 13-15.07.1929, leg. H. Zerny (WNHM; penial armature prepared on slide No. 6, terminalia prepared on plastic sheet and pinned under the dry specimen, labels of the pinned specimen: *I. bosnica* / Aub / J. Aubert / dét. 1963; Typus; 55; Coll. Nat-Mus. Wien; Bosnien / Trnovo, 13.-15. / VII. '29. Zerny); MONTENEGRO: Pljevlja municipality: Kozička Stream at its confluence with Čeotina River, 26.06.2008, leg. V. Pešić: 1m (HNHM; used for drawings, penial armature prepared on slide).

**Diagnosis:** This generally dark species is characterized by medial penial armature that is wide and distinctly folded, bearing long lateral expansions. Its scales are triangular and lateral penial armatures are lacking.

**Description:** Medium-sized species, macropterous. Body length: male 10.5 mm (n=1); forewing length: male 11.5 mm (n=2). General colour brown but the head and pronotum mostly yellow with dark brown markings; pilosity of the body and legs short and dense. Head yellow posteriorly and brown anteriorly, with a wide horseshoe-shaped dark brown patch connecting the three ocelli, small light interocellar area closed posteriorly; tentorial callosities and M-line distinct, many wrinkles present both between the M-line, the antennal bases, and the tentorial callosities; occiput with dark brown rugosities, brown markings extend both laterally and medially (Fig. 21). Eyes as large as the area delimited by the three ocelli. Scape dark brown, pedicel and the following three or four antennomeres brown, distal flagellomeres darker; palpi brown. Pronotum yellow, rectangular, edges angled; rugosities are large and brown, indistinct, anterior and posterior margins dark brown, but lighter medially. Mesonotum dark brown but yellow anteriorly, metanotum dark brown. Wings yellowish brown, subcosta and the venation of the basal fourth pale, other veins dark brown. Ventral surface of thorax mostly pale, meso- and metabasisternum mostly dark brown; furcasternites light brown, furcal pits brown (Fig. 24). Femora brown, the dorsal surface and the ventral edges dark brown. Tibiae dark brown dorsally, paler ventrally; tarsi dark brown.



**FIGURES 21–25.** *Isoperla bosnica* Aubert, 1964 — 21: head and pronotum; 22: male terminalia, dorsal view; 23: male terminalia, ventral view; 24: meso- and metathorax, ventral view; 25: medial penial armature — scale 1 mm: 21–24; 0.5 mm: 25.

Male abdomen: First tergite dark brown but yellowish medially, tergites II–VIII entirely dark brown. Tergite IX somewhat lighter, tergite X pale brown with tripartite yellowish markings medially (Fig. 22). Transverse row of four pigmented spots seen on all but tergite X. Sternites II and VIII–IX pale brown, sternites III–VII dark brown; sternites II–VII with a medial transverse row of four spots, sternite VIII with two spots. Vesicle of sternite VIII brown, as wide as long, its posterior margin is weakly rounded; as long as the one third of the segment's length (Fig. 23). Sternite IX bears dark brown patches anterolaterally, the medial penial armature visible through the posterior half of the segment. Paraprocts pale brown, sharp, thin and recurved; cerci dark brown.

Penis: Lobes and the distribution of colourless scales, hairs and sensilla cannot be studied because the specimens were collected without evertion of the penis. The medial penial armature is wide and distinctly folded with long lateral expansions, probably located on the ventral lobe (Fig. 25); lateral penial armatures lacking. The central part of the medial penial armature is hemispherical but open both at the upper and the lower ends; lateral expansions abruptly tapering. Length 280 µm, width with the backfolded lateral expansions 1350 µm; width of the unfolded central part about 150 µm. Outstretched view of the medial penial armature shown in the original description (Aubert 1964: Fig. 30). The scales are triangular and erect, cross section cylindrical; their length 30–50 µm, width 15–18 µm. The penis bears hydra-like scales around the lateral expansions of the medial penial armature, and small triangular scales more lateral to these.

Female, egg, larva: unknown.

**Affinities:** *Isoperla bosnica* was originally assigned to the *rivulorum* group sensu Consiglio 1961 (Aubert 1964). Later Consiglio (1967) transferred it to the *goertzi* group; herein it is transferred to the *oxylepis* group. It was treated as a synonym of *I. oxylepis balcanica* by Sivec (1980b) and Ikonomov (1986), herein it is recognised as a valid species. It differs from the other species of the group by the presence of long lateral expansions on the medial penial armature and general dark colour.

**Ecology and distribution:** The species was originally described on the basis of a single male collected at Trnovo, SE Bosnia-Herzegovina in 1929 (Aubert 1964). Despite intensive collecting, no additional specimens have been found in Bosnia-Herzegovina (Kačanski 1979) and the species was reported only from NW Macedonia (Ikonomov 1979) in addition to the type locality (Fig. 127). Later Ikonomov (1986) treated *I. bosnica* as a synonym of *I. oxylepis balcanica*. It is not clear if the Macedonian specimens refer to *I. bosnica* or to *I. oxylepis balcanica*. The species is new for the fauna of Montenegro, the single male being collected at the end of June from a submontane stream near its confluence with the Ćeotina River. It was collected with a male of *I. tripartita tripartita* and a pair of *P. pallida*.

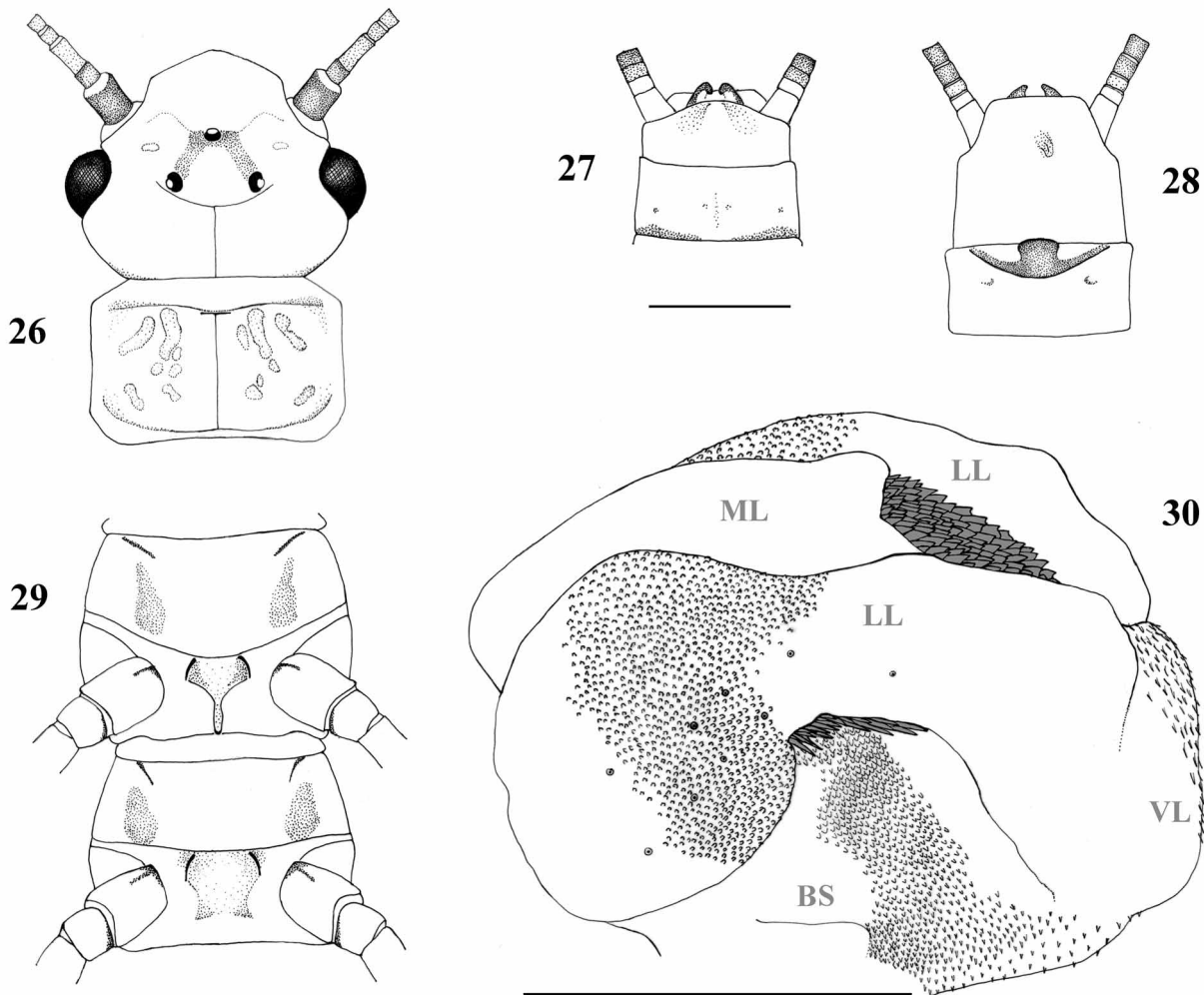
**Remarks:** As already noted in the original description (Aubert 1964), the holotype is in poor condition and the coloration is hardly visible. The redescription is based on the newly collected Montenegrin specimen that agrees well with the holotype both in measurements and morphological features. The medial penial armature of the holotype is slide mounted, distorting the lateral edges, resulting in a similar appearance of this structure to that found in *I. oxylepis*. This may have resulted in the incorrect synonymy with *I. oxylepis balcanica* (Ikonomov 1986).

### ***Isoperla citrina* sp. n.**

(Figs. 26–42, 127)

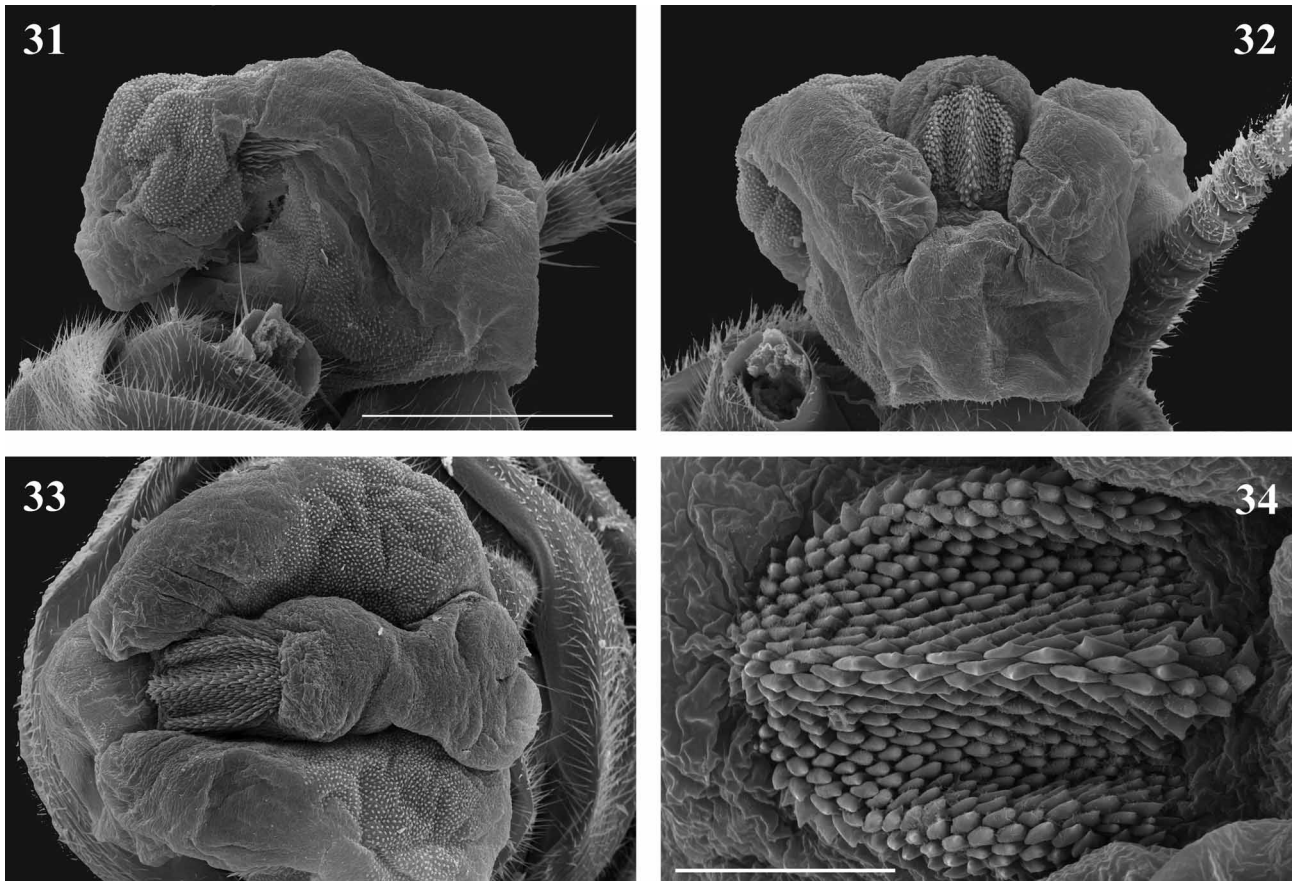
**Type material:** Holotype male: ALBANIA: Dibër district: Radomirë, Mts Korab, torrent E of the village, N 41°49.131' E20°30.160', 1460 m a.s.l., 26.06.2007, leg. D. Murányi (HNHM: PLP2589; used for drawings Figs. 26–29). Paratypes: same locality and date: 1m (HNHM: PLP3038; used for drawing Fig. 30, terminalia prepared for SEM), 1m (CGV, penial armatures prepared on slide).

**Diagnosis:** This small-eyed, pale species is characterized by a medial penial armature that is oval with two lateral and one medial longitudinal ridge. The scales of the medial armature are drop-shaped in dorsal view, triangular in lateral view, while the scales of the lateral armatures are spike-like.



**FIGURES 26–30.** *Isoperla citrina* sp. n. — 26: head and pronotum; 27: male terminalia, dorsal view; 28: male terminalia, ventral view; 29: meso- and metathorax, ventral view; 30: extruded penis, dorsolateral view (ML: medial lobe; LL: lateral lobe; VL: ventral lobe; BS: basal section) — scale 1 mm: 26–29; 0.5 mm: 30.

**Description:** Medium-sized species, macropterous. Body length: holotype 10.0 mm, paratypes 10.0–10.5 mm (n=2); forewing length: holotype 11.0 mm, paratypes 10.5–11.0 mm (n=2). General colour bright yellow (especially in life), with few dark brown markings; pilosity of the body and legs short and dense. Head yellow with a dark brown V-shaped line connecting the ocelli; tentorial callosities and M-line barely visible, occiput lacking rugosities (Fig. 26). Eyes smaller than the area delimited by the three ocelli. Scape dark brown, pedicel basally yellowish, the following three or four antennomeres are yellowish but the remainder is dark brown; palpi dark brown. Pronotum yellow, rectangular, edges angled; rugosities are large but few and not prominent, light brown coloured. Meso- and metanotum yellow with some dark patches on the posterior half. Wings yellowish, venation pale in the anterior half, costa and the distal few millimetres of the longitudinal veins brown; posterior half of the wing membrane indistinct brownish markings. Ventral surface of thorax yellow, meso- and metabasisternum bear two elongated brown patches in the line with the base of coxae; furcasternites light brown, furcal pits black (Fig. 29). Femora yellow with longitudinal dark brown stripe on the dorsal and on ventral edges. Tibiae yellowish, tarsi brown.



**FIGURES 31–34.** *Isoperla citrina* sp. n. — 31: extruded penis, lateral view; 32: extruded penis, caudal view; 33: extruded penis, dorsal view; 34: medial penial armature, dorsal view — scale 0.5 mm: 31–33; 0.1 mm: 34.

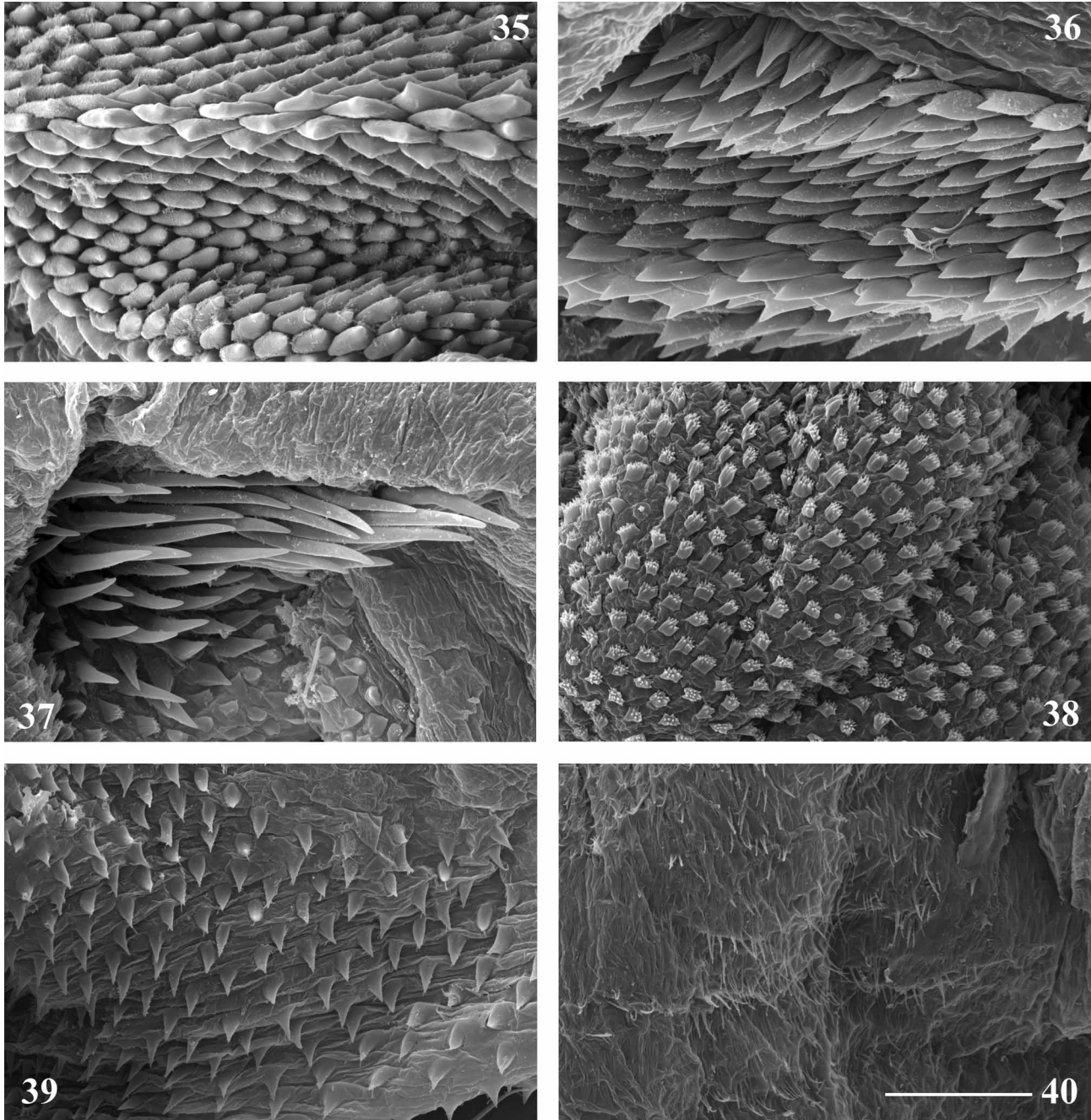
Male abdomen: First five tergites dark brown; the next three are yellow but having a dark brown longitudinal medial and an anterior transverse line. Tergite IX has only a transversal anterior line interrupted in the middle, tergite X yellow with very pale posterior triangular patches (Fig. 27). Transverse row of four pigmented spots seen on all but tergite X. Ventral surface of abdomen yellow, sternites II–VIII have a brown transverse anterior line interrupted in the middle; sternites II–V have a medial transverse row of four spots, while sternites VI–VIII have two. Vesicle of sternite VIII brown, as wide as long, its posterior margin is nearly truncate with only the edges rounded; as long as one third of the segment's length (Fig. 28). Sternite IX uniformly yellow, the medial penial armature can be seen through its posterior half. Paraprocts brown, blunt, thin and slightly recurved; the first two cercal segments yellow but distal part of the cerci are dark brown.

Penis: Divided into four lobes and a basal section in extruded position (Figs. 30–33). The medial penial armature located on the medial lobe on its end at the ventral lobe. Lateral penial armatures located on the basal section just beneath the lateral lobes. The medial penial armature is oval with two lateral and one medial longitudinal ridge; length 230–240  $\mu\text{m}$ , width 190–200  $\mu\text{m}$  (Fig. 34). The scales are drop-shaped in dorsal view (Fig. 35), triangular in lateral view; some of them, especially in the medial groove, are shark-teeth shaped (Fig. 36). Their length is 10–25  $\mu\text{m}$ , width 5–10  $\mu\text{m}$ , height in lateral view about 25  $\mu\text{m}$ . Lateral penial armatures are triangular, length 160–170  $\mu\text{m}$ , width 90  $\mu\text{m}$  (Fig. 37). The scales are spike-like, their length is 15–60  $\mu\text{m}$ , width less than 10  $\mu\text{m}$ ; the apical ones are much longer than the basal ones. The ventral lobe is hemispherical, covered with small, mostly simple hair-like scales only in a median stripe (Fig. 40). The medial lobe is long and narrow, smooth besides the medial penial armature. The lateral lobes are long and curved above the lateral penial armatures. They bear a transverse stripe of small, hydra-like scales (Fig. 38); the stripe rises dorsally to the lateral penial armatures and broadens toward the medial lobe. A few sensilla are settled in an elongate field on the sides, both between the hydra-like scales and on the bald surface. The basal section bears triangular scales in addition to the lateral penial armatures, which are settled in a stripe spread between the lateral penial armatures, beneath the ventral lobe (Fig. 39); scales are thinner and sparse midways.



Female, egg, larva: unknown.

**Affinities:** *Isoperla citrina* is a member of the *rivulorum* group. The three ridges of the medial penial armature distinguishes it from all the other members of this group. A similar structure is known in *I. goertzi*, but it has only two ridges, the shape of the armature is different and the scales are longer and narrower. Among the *Isoperla* species with similarly pale habitus, the new species is similar to *I. flava* also with small compound eyes, but the shape of the penial armatures and their scales are quite different.

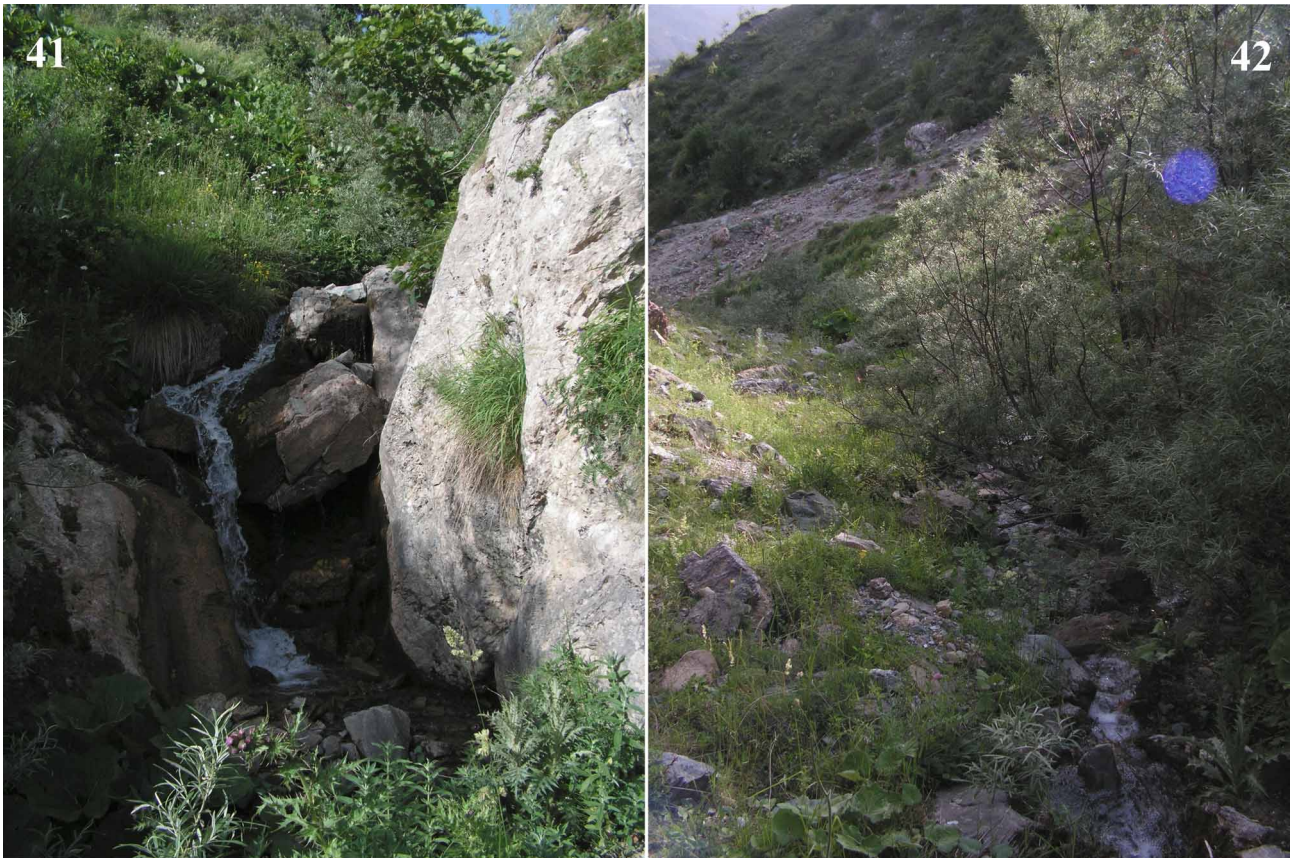


**FIGURES 35–40.** *Isoperla citrina* sp. n. — 35: scales of the medial penial armature, dorsal view; 36: scales of the medial penial armature, lateral view; 37: lateral penial armature; 38: hydra-like scales and sensilla of the lateral lobes; 39: triangular scales of the basal section; 40: hair-like scales of the ventral lobe — scale 0.05 mm (for all figures).

**Ecology and distribution:** The species was collected at the end of June from a high gradient stream above 1400 m in the Korab Mountains (Figs. 40–41, 127). This stream flows through a small limestone gorge with extensive riffles over coarse substrates. Slower sections flow over gravel and sand substrates. Riparian vegetation varies from tall sedge to Mediterranean bush and low willows. The species was found on sedges and on *Petasites* leaves

in common with *Leuctra inermis*, *Amphinemura quadrangularis* Zwick, 1978, *Protonemura intricata intricata*, *I. albanica* and *Perla pallida*. This species is apparently rare since *I. albanica* was more numerous than it and the accompanying species were found also at additional localities in the area.

**Etymology:** The name *citrina* (from the Latin word *citrus*, means lemon tree) refers to the bright yellow colour of the living insect, and is considered an adjective, gender feminine.



**FIGURE 41–42.** Type locality of *Isoperla citrina* sp. n.: Albania, Korab Mountains, stream E of Radomirë — 41: fast section; 42: slow section.

### ***Isoperla albanica* Aubert, 1964**

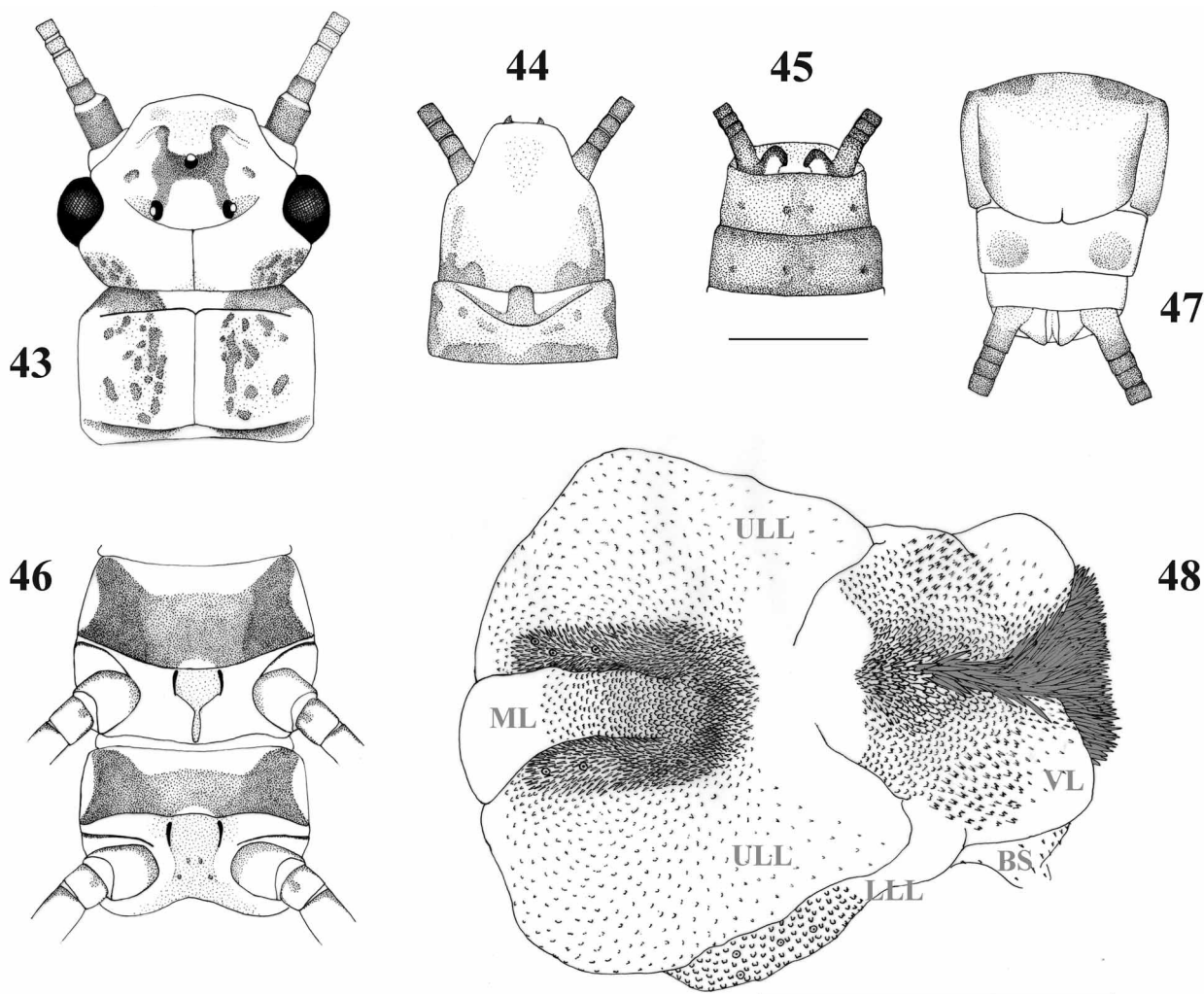
(Figs. 43–61)

*Isoperla albanica* Aubert, 1964 — Aubert 1964: 296 (original description of male and female); Illies 1966: 393 (catalog); Zwick 1973: 241 (catalog).

**Material examined:** Holotype male: ALBANIA: Skala Bicajt (Kukës district, Shkallë Bicaj, gorge of the Tershanë Stream at Bicaj), 17.06.1918 (WNHM; penial armature prepared on slide Nr. 5, terminalia prepared on plastic sheet and pinned under the dry specimen, labels of the pinned specimen: Coll. Nat-Mus. Wien; *I. albanica* / Aub / J. Aubert / dét. 1963; Typus; 2; Alban. Exped. / Skala Bicajt / 17. VI. 1918); Paratype female: same locality and date (WNHM; labels of the pinned specimen: *I. albanica* / Aub / J. Aubert / dét. 1963; Paraypus; Alban. Exped. / Skala Bicajt / 17. VI. 1918); Paratype male: Gjalica Ljums (Kukës district, Mts Gjalica e Lumës), 17–26.06.1918 (WNHM; terminalia with penis prepared on plastic sheet and pinned under the dry specimen, labels of the pinned specimen: *I. albanica* / Aub / J. Aubert / dét. 1963; Paratypus; Alban. Exp. 1918 / Gjalica Ljums / 17–26. VI.); Shkodër district: Okol, Mts Prokletije, stream along the path towards Pejë Pass, N 42°24.496' E 19°45.271', 1010m, 30.05.2005, leg. K. Balogh, Z. Barina, D. Murányi, D. Pifkó: 1f (HNHM); brook along the path towards Pejë Pass, N 42°24.510' E 19°45.300', 1000m, 30.05.2005, leg. K. Balogh, Z. Barina, D. Murányi, D. Pifkó: 1m 1f (HNHM; penial armature prepared on slide); Dibër district: Radomirë, Mts Korab, spring and stream E of the vilage, N 41°49.032' E 20°30.016', 1440 m, 26.06.2007, leg. L. Dányi, Z. Eröss, Z. Fehér, A. Hunyadi, D. Murányi:



3m 17f (HNHM; used for drawings, one male terminalia and eggs prepared for SEM), 2m 2f (CGV); torrent E of the village, N 41°49.131' E 20°30.160', 1460 m, 26.06.2007, leg. D. Murányi; 3m 11f (HNHM); AUSTRIA: Burgenland: Kobersdorf, 18.05.1996, leg., det. W. Graf; 3m (CWG).

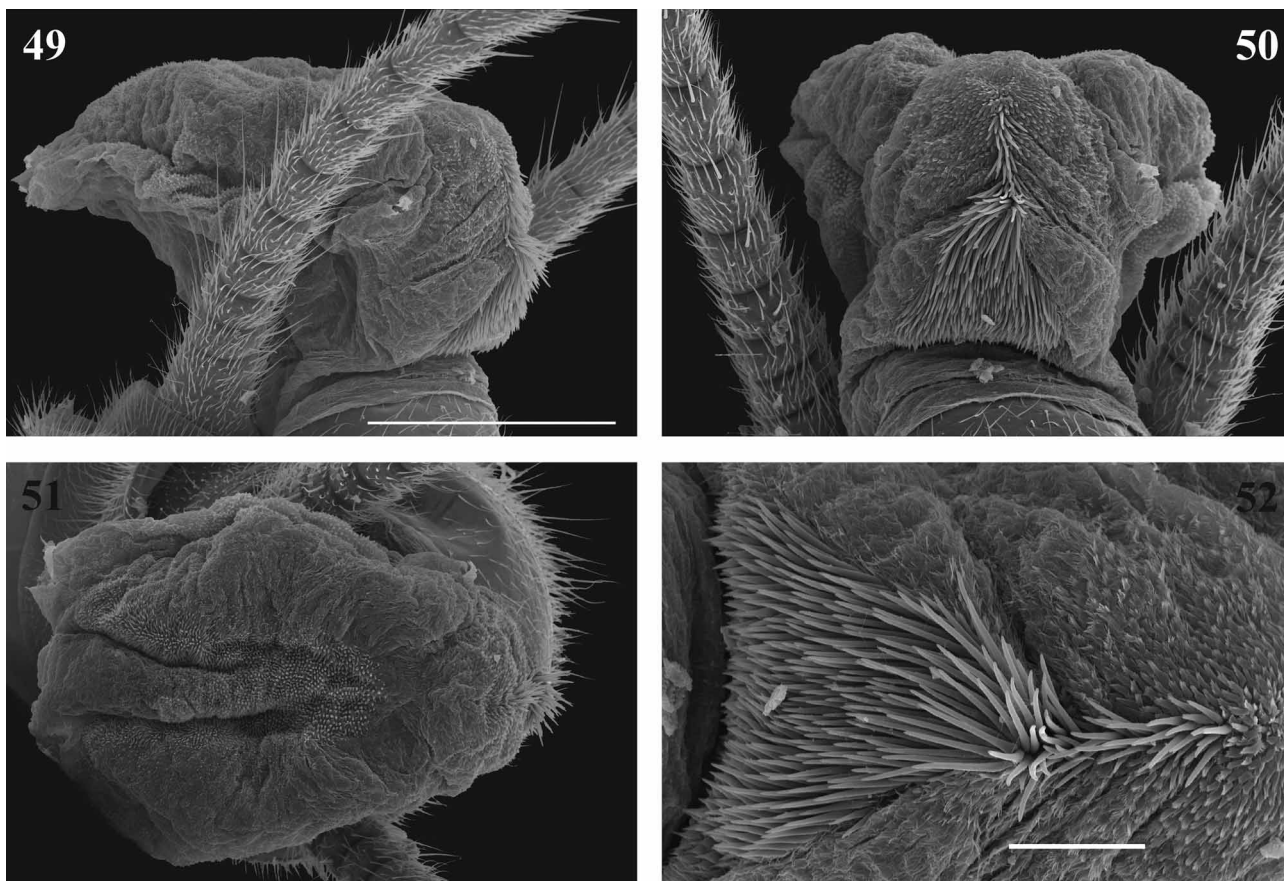


**FIGURES 43–48.** *Isoperla albanica* Aubert, 1964 — 43: head and pronotum; 44: male terminalia, ventral view; 45: male terminalia, dorsal view; 46: meso- and metathorax, ventral view; 47: female terminalia, ventral view; 48: extruded penis, dorsal view (ML: medial lobe; ULL: upper lateral lobe; LLL: lower lateral lobe; VL: ventral lobe; BS: basal section) — scale 1 mm: 43–47; 0.5 mm: 48.

**Diagnosis:** This small, generally dark species is characterized by a triangular penial armature on the median lobe, its scales being dart-shaped and thin. Lateral penial armatures lacking. In females the subgenital plate has shallow, narrow medial notch that continues anteriorly to form a short sulcus on the posterior margin.

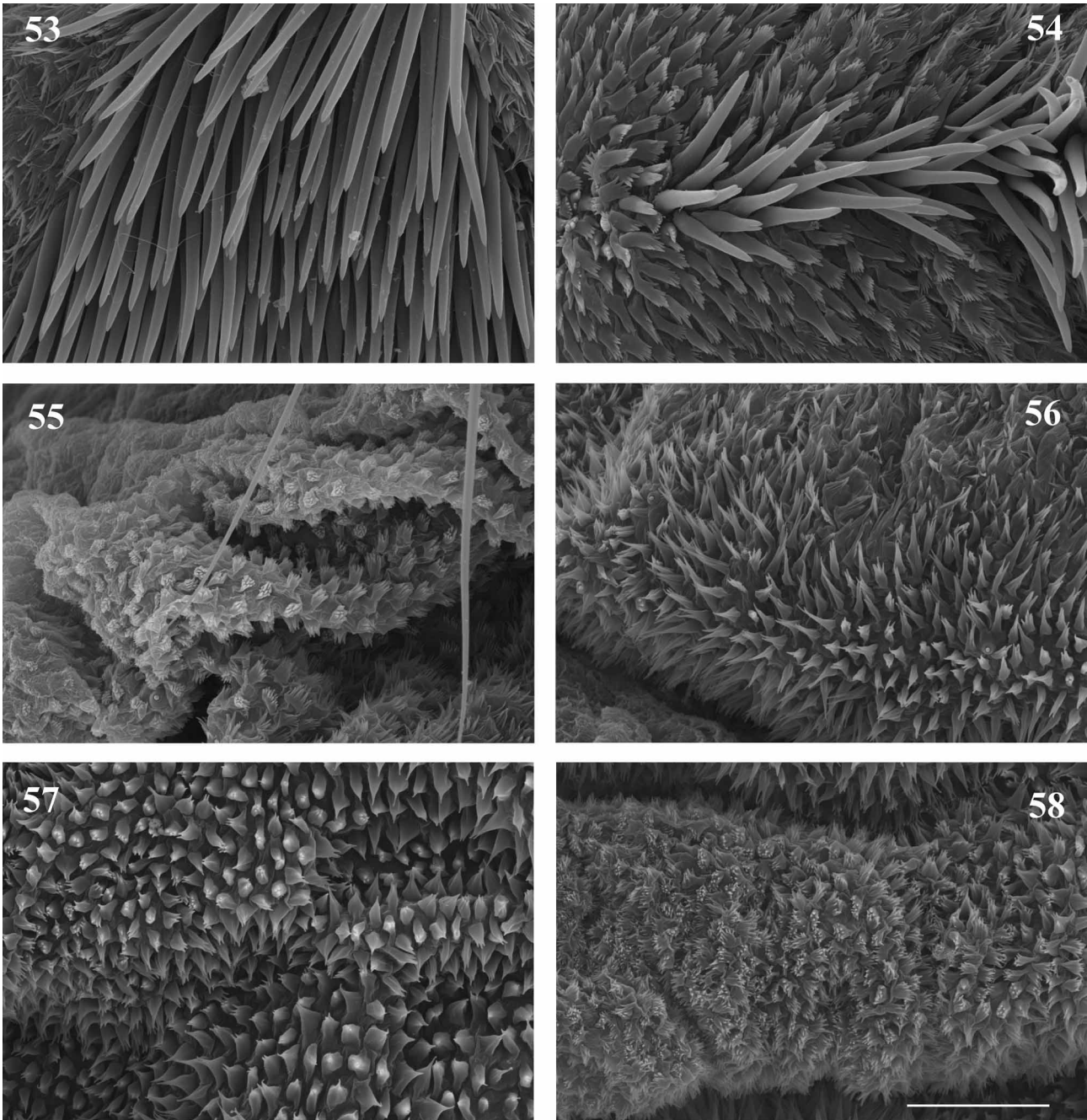
**Description:** Small-sized species, macropterous. Body length: males 8.0–9.5 mm (n=12), females 10.5–12.0 mm (n=32); forewing length: males 9.5–11.0 mm (n=14), females 10.0–11.5 mm (n=33). General colour brown but the head and pronotum mostly yellow with dark brown markings; pilosity of the body and legs short and dense. Head yellow, with an H-shaped dark brown patch connecting the three ocelli and the apical parts of the M-line; tentorial callosities and M-line distinct, occiput with brown rugosities laterally (Fig. 43). Eyes as large as the area delimited by the three ocelli. Scape dark brown, pedicel partly yellowish brown, the following three or four antennomeres are yellowish brown but distal part of the antenna is dark brown; palpi brown to dark brown. Pronotum yellow, rectangular, edges angled; rugosities are small but numerous and brown coloured, anterior and posterior lines brown under and above the rugosities. Mesonotum dark brown but yellow anteriorly and medially, metanotum dark brown. Wings yellowish, venation pale in the anterior fourth, costa and the other parts brown. Ventral surface of thorax mostly pale, meso- and metabasisternum mostly dark brown; furcasternites light brown, furcal pits black (Fig. 46). Femora pale but the dorsal surface and the ventral edges brown. Tibiae brown, tarsi dark brown.

Male abdomen: First tergite dark brown but yellowish brown medially. Tergites II–VII dark brown, tergites VIII–IX paler, tergite X yellowish brown (Fig. 45). Transverse row of four pigmented spots seen on all segments. Sternites II–VII brown with a medial transverse row of four spots. Sternite VIII paler and with a dark pattern, but only two spots. Vesicle of sternite VIII brown, usually much longer than wide, its posterior margin is rounded; as long as half the segment's length (Fig. 44). Sternite IX yellow but with dark brown patches anteriorly and laterally, the medial penial armature hardly transparent in the posterior half. Paraprocts dark brown, sharp, thin and recurved; cerci dark brown, base of the first cercal segment usually paler.



**FIGURES 49–52.** *Isoperla albatica* Aubert, 1964 — 49: extruded penis, lateral view; 50: extruded penis, caudal view; 51: extruded penis, dorsal view; 52: medial penial armature, caudal view — scale 0.5 mm: 49–51; 0.1 mm: 52.

Penis: Divided into six lobes and a basal section in extruded position (Figs. 48–51). The medial penial armature located on the ventral lobe, lateral penial armatures lacking. The medial penial armature a narrow triangle, broadest toward basal section; length 450  $\mu\text{m}$ , width 300  $\mu\text{m}$  (Fig. 52). The scales are dart-shaped, most of them are slightly bent (Figs. 53–54). The length of the longer ones in the basal part is 80–100  $\mu\text{m}$ , width 10  $\mu\text{m}$ ; shorter scales of the apical part are about 30  $\mu\text{m}$ . The ventral lobe is elongated, covered with sausage-like scales with hairy tip around the apical part of the medial penial armature (Fig. 54). These scales are grading into smaller triangular ones towards the medio-apical part of the lobe which is bald; into branched hair-like scales towards the lateral and the basal parts. Along the basal part of the medial penial armature only simple hair-like scales occur, basolateral areas of the ventral lobe bald. The medial lobe is long and narrow, bearing triangular scales on its end at the ventral lobe (Fig. 57). These scales are grading into a few hydra-like scales, then stout triangular hairy scales towards the central part (Fig. 58); apical part bald and smooth. The upper lateral lobes are long and their ventral part curved downwards. They bear a strip of elongated triangular hairy scales mixed with a few sensilla along the medial lobe (Fig. 56), from its ventral origin to the dorsal fifth. Besides this strip, most of the lobes covered with branched and simple hair-like scales but the ventral and dorsal tips are bald. The lower lateral lobes are smaller than the upper ones, and their medial areas bear small, hydra-like scales mixed with sensilla (Fig. 55); ventral and dorsal parts bald. The basal section bears sparse simple hair-like scales.

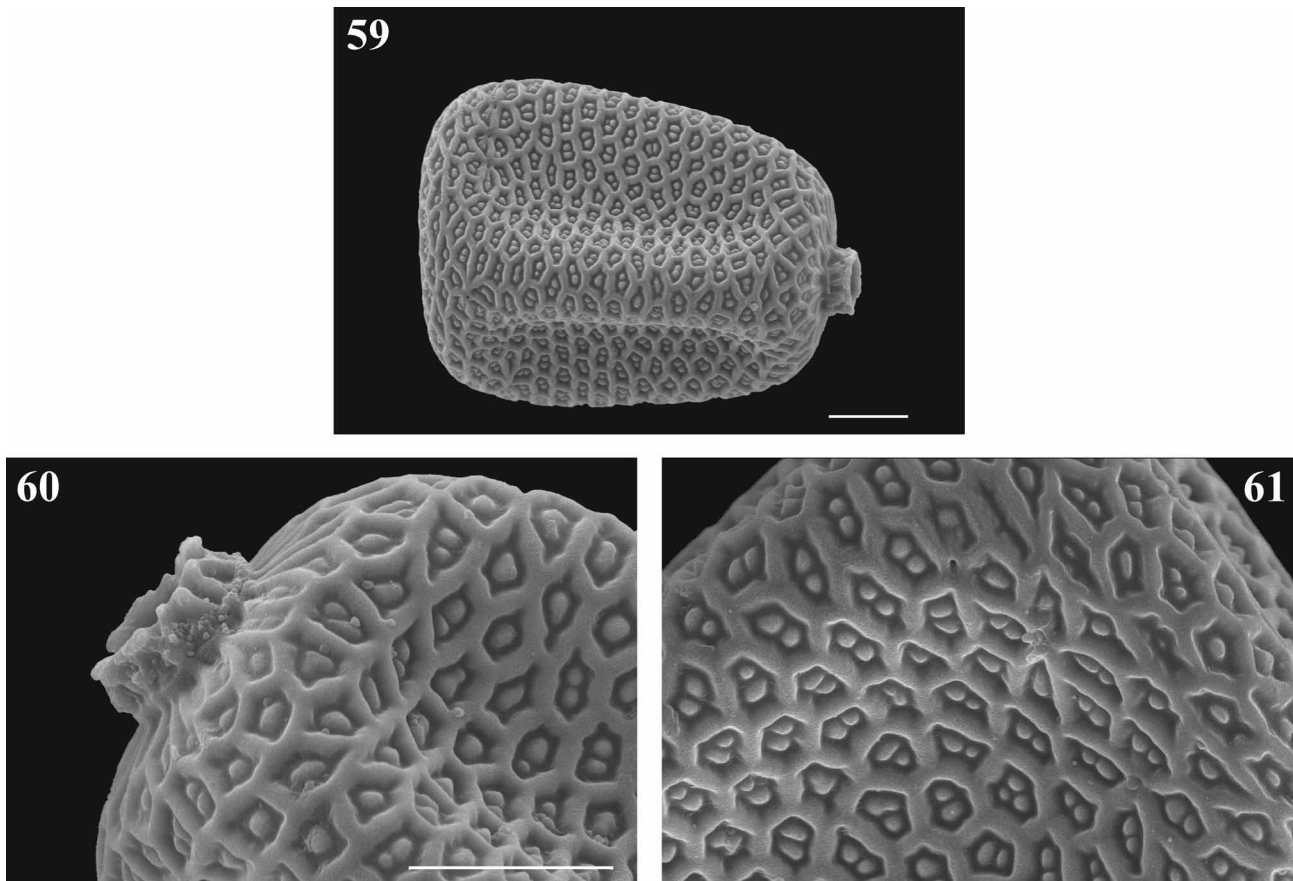


**FIGURES 53–58.** *Isoperla albanica* Aubert, 1964 — 53: scales of the basal part of medial penial armature, caudal view; 54: scales of the apical part of medial penial armature, caudal view; 55: hydra-like scales and sensilla of the lower lateral lobes; 56: triangular hairy scales and sensilla of the upper lateral lobes; 57: triangular scales of the medial lobe on its end at the ventral lobe; 58: hydra-like and triangular hairy scales of the medial lobe on its central part — scale 0.05 mm (for all figures).

Female abdomen: First tergite yellow anteriorly and medially, posterior margin dark brown. Tergites II–VII dark brown, tergites VIII–IX paler, tergite X brown only anteriorly and medially, other parts yellowish brown. Transverse row of four pigmented spots seen on all segments. Sternites II–VII brown with a dark brown transversal anterior line interrupted in the middle, and a medial transverse row of four spots. Subgenital plate covers most of the sternite VIII and the anterior part of sternite IX; anterior part of sternite VIII brown, darker anteriolaterally. Most of the plate yellowish, lateral margins dark at least in the medial section; posterior margin rounded with a characteristic, shallow and usually narrow medial notch that continues in a short sulcus on most of the specimens (Fig. 47). Sternite IX yellow, but bears two brown lateral patches on the posterior half. Sternite X and the parap-  
rocts yellow; cerci dark brown, base of the first cercal segment usually paler.

Egg: Chorion dark brown, 0.30–0.32 mm long and 0.18–0.22 mm wide (n=30). Shape rectangular, cross section quadrangular; narrowing towards the collar end, sides slightly depressed (Fig. 59). Hatching line inconspicuous. Micropyles placed in a transverse row close to the opercular end, not raised, each located on the meeting point of carinae between the follicular cell impressions (FCIs) (Fig. 61). Chorion with marked ornamentation of penta- or hexagonal FCIs with usually two excrescences in their centres. Collar round, rim slightly flanged; bears one row of FCIs (Fig. 60). Anchor not studied.

Larva: unknown.



**FIGURES 59–61.** *Isoperla albana* Aubert, 1964 — 59: egg, lateral view; 60: collar, lateral view; 61: micropyles, lateral view — scale 0.05 mm.

**Affinities:** The species was originally assigned to the *rivulorum* group sensu Consiglio 1961 (Aubert 1964); later Consiglio (1967) transferred it to the *saccaii* group sensu Consiglio 1967. Herein, it is transferred to the *albana* group. It differs from the closely related *I. belai* by lacking lateral and having triangular medial penial armatures. The female is unique in the genus with a shallow medial notch that continues as a short sulcus on the posterior margin of the subgenital plate (not apparent in a minority of specimens).

**Ecology and distribution:** The species was originally described from the Gjalica e Lumes Mountains (Aubert 1964). This is in close proximity to the Korab Mountains from where the new material was collected. It has also been reported from Montenegro, Bosnia-Herzegovina and Serbia (Sivec 1980a), Macedonia (Ikonov 1986), SE Germany (Weinzierl 1999), Austria (Graf 1999, Konar 1999, Ruzicka 2001) and Western Slovakia (Krnó 2003) which suggests an Eastern Alpine–Illyrian distribution. The present data mark its current southern limit. This species was collected in June from the Korab Mountains in high gradient streams above 1400 m. The first location also produced *I. oxylepis balcanica*, while the second yielded *I. citrina* as well. The species was quite numerous at both localities and found on bushes, sedges, and *Petasites* leaves.

**Remarks:** Though the vesicle of sternite VIII of the types and the Austrian specimens are much wider than shown in Fig. 44, these are not as wide as in the original description (Aubert 1964: Fig. 25). The female paratype has a wide, but more rounded medial notch on the subgenital plate than described by Aubert (1964: Fig. 24).

## *Isoperla vevcianensis* Ikonomov, 1980

(Figs. 62–66, 127)

*Isoperla vevcianensis* Ikonomov, 1980 — Ikonomov 1980: 26 (original description of male, female and larva).

**Material examined:** ALBANIA: Librazhd district: Qarishtë, Mts Jablanica, brook E of the village, N 41.24569° E 20.51238°, 1900 m, 04.07.2008, leg. Z. Barina, D. Pifkó, A. Vojtkó: 1m (HNHM; used for drawings, penial armatures prepared on slide); Steblevë, Mts Jablanica, brook SE of the village, N 41.27905° E 20.50103°, 1865 m, 03.07.2008, leg. Z. Barina, D. Pifkó, A. Vojtkó: 1m (HNHM; penial armatures prepared on slide), 1m (CGV; penial armatures prepared on slide).

**Diagnosis:** This broadheaded species is characterized by the presence of a medial penial armature that is covered in spike-like scale and divided into a trapezoidal upper and a rounded lower part, by the absences of lateral penial armatures, and by the presence of an enlarged vesicle of sternite VIII.

**Description:** Large-sized species, macropterous. Body length: males 12–13 mm (n=3); forewing length: males 13–13.5 mm (n=3). General colour yellowish but the meso- and metanotum and the abdomen mostly brown; pilosity of the body and legs short and dense. Head broad and rounded, yellow with a brown patch between the three ocelli; tentorial callosities and M-line more or less distinct, a few wrinkles present between the M-line and the lateral margins; the occiput lacks rugosities but is brown laterally (Fig. 62). Eyes smaller than the area delimited by the three ocelli. Scape dark brown, pedicel and the following three or four antennomeres are brown but distal part of the antenna is dark brown; palpi brown. Pronotum yellow, rectangular, edges angled; rugosities are numerous and brown coloured, anterior and posterior lines brown under and above the rugosities. Mesonotum dark brown but yellow anteriorly, sometimes medially also; metanotum dark brown but yellow anteriorly. Wings yellowish, venation pale in the anterior two thirds, brownish in the posterior third. Ventral surface of thorax mostly pale, meso- and metabasisternum mostly dark brown; furcasternites light brown, furcal pits black (Fig. 65). Femora pale but the dorsal surface and the ventral edges brown. Tibiae brown, tarsi dark brown.

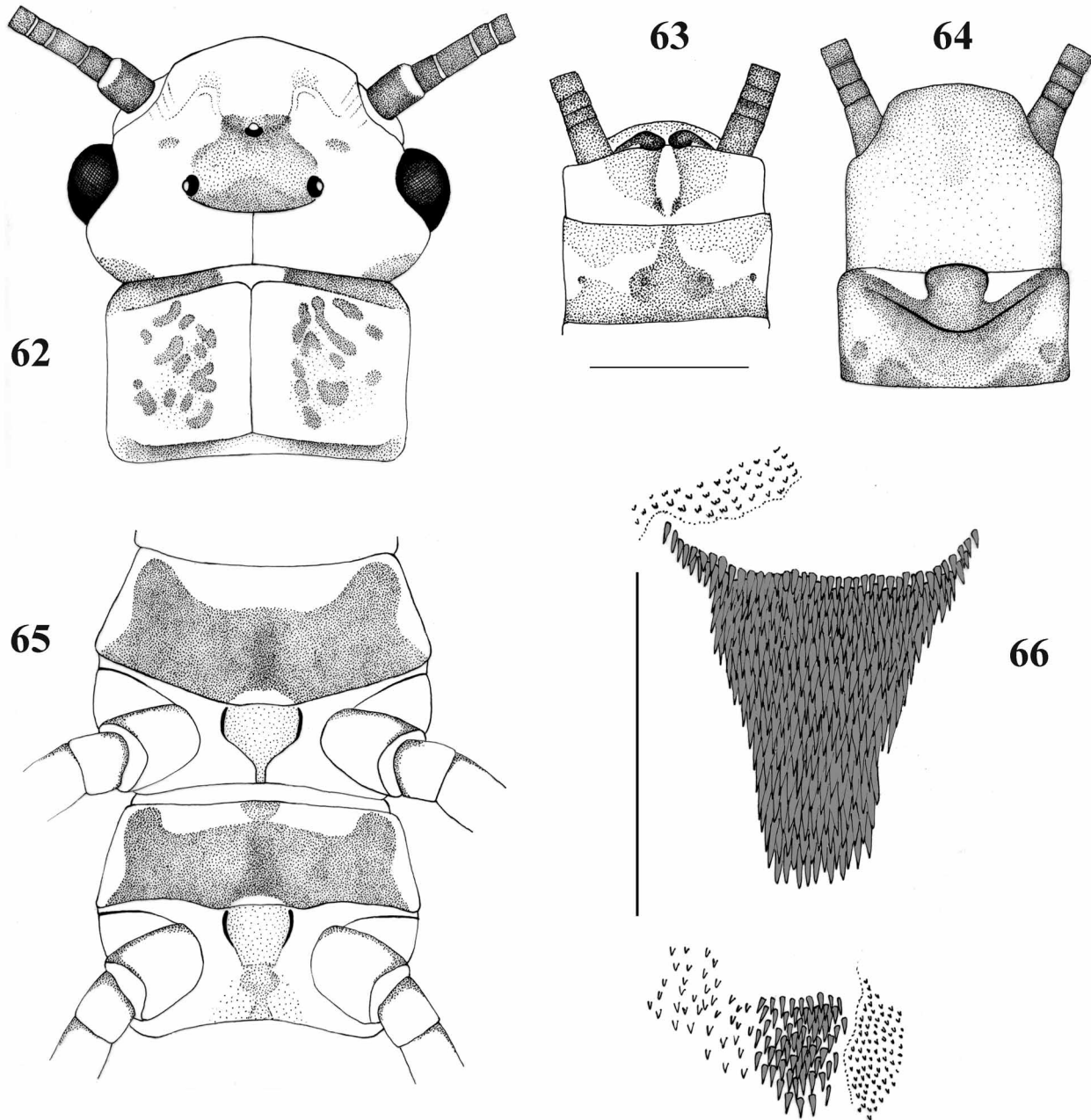
Male abdomen: First tergite dark brown but yellowish medially. Tergites II–VI entirely dark brown, tergite VII entirely dark brown or dark brown with two pale patches posteriorly. Pale markings become more extensive on tergites VIII–IX, but a transverse anterior dark brown stripe and a medial dark brown arrow-like mark always present; tergite X yellowish with two brown patches medially (Fig. 63). Transverse row of four pigmented spots seen on all but tergite X. Sternites II–VI brown with a medial transverse row of four spots; posterior part of sternite VII with a more or less extensive pale pattern. Sternite VIII paler and with a dark pattern, but only two big spots. Vesicle of sternite VIII brown, as wide as long, its posterior margin is weakly rounded; as long as half the segment's length (Fig. 64). Sternite IX yellowish brown but darker posteriorly, the medial penial armatures barely visible in the posterior half. Paraprocts dark brown, blunt, strong and slightly recurved; cerci dark brown in the basal segments, distal part of the cerci are usually paler.

Penis: Lobes and the distribution of non coloured scales, hairs and sensilla cannot be studied because the specimens were collected without evertion of the penis. The medial penial armature is divided into an upper and a lower part and probably located on the ventral lobe (Fig. 66), lateral penial armatures lacking. The upper medial penial armature is trapezoidal, tapered towards the basal section; length 500 µm, width 450 µm. The lower medial penial armature is rounded, slightly elongated; length 200 µm, width 120 µm. The scales are spike-like, those on the upper part are longer but of the same width. The length of the longer ones of the upper part is 150 µm, of the shortest ones in the lower part is 30 µm; width 15 µm. The penis is bald between the upper and lower parts, but bears quite large triangular scales laterally to the lower part; these are grading into smaller ones, shown on Fig. 66, to the right side of the lower medial penial armature. Hydra-like scales occur above a bald line apically to the upper medial penial armature.

Female and larva not studied herein, egg unknown.

**Affinities:** The species was originally not assigned to a species group sensu Consiglio 1967 (Ikonomov 1980); herein it is assigned to the *silesica* group. It differs from *I. breviptera*, *I. silesica* and *I. zwicki* by the shape of the upper medial penial armature which is trapezoidal contrary to the triangular armature of *I. breviptera* and the rounded armature of *I. silesica* and *I. zwicki*; furthermore, *I. breviptera* is micropterous. The broad head and the large vesicle of sternite VIII is diagnostic of *I. vevcianensis*.

**Ecology and distribution:** The species was originally described from the Macedonian side of the Jablanica Mountains (Ikonov 1980), only a few kilometers from the present Albanian localities (Fig. 127). Hitherto, it was known only from the type locality (Ikonov 1986); consequently, the species is new for Albania. It seems to be an endemic of the Jablanica Mountains as it was not found in adjacent Macedonian or Albanian mountain systems. In Albania, it was collected from alpine grassland brooks above 1850 m during early July. Associates include *I. tripartita tripartita* at the Qarishtë brook and *I. tripartita tripartita*, *Leuctra cf. metsovonica* Aubert, 1956, *Nemoura caligula* Zwick, 1978 and a deformed *Protonemura* female at the Steblevë brook. *Isoperla tripartita tripartita* was more numerous than *I. vevcianensis* at either site. At the type locality it occurred between 1100 and 1450 m in June and July.



**FIGURES 62–66.** *Isoperla vevcianensis* Ikonov, 1980 — 62: head and pronotum; 63: male terminalia, dorsal view; 64: male terminalia, ventral view; 65: meso- and metathorax, ventral view; 66: medial penial armatures — scale 1 mm: 62–65; 0.5 mm: 66.



## *Isoperla tripartita tripartita* Illies, 1954

(Figs. 67–98)

*Isoperla tripartita* Illies, 1954 — Illies 1954: 118 (original description of male and female); Illies 1955: 99 (repr. of Illies 1954); Gulička 1955: 628 (supplementary description of male); Winkler 1956: 337 (supplementary description of male); Winkler 1957: 62 (supplementary description of male); Illies 1966: 422 (catalog); Berthélemy 1971: 46 (description of larva); Zwick 1973: 252 (catalog); Kis 1974: 237 (supplementary description of male and female); Raušer 1980: 102 (supplementary description of larva); Tierno de Figueroa et al. 2001: 69 (description of egg).

*Isoperla tripartita tripartita* Illies, 1954 — Raušer 1963: 807 (supplementary description of male); Zwick 1978: 230 (supplementary description of male).

*Isoperla graeca* Aubert, 1956 — Aubert 1956: 206 (original description of male and female); Aubert 1964: 295 (supplementary description of male, refers to *Isoperla illyrica* Tabacaru, 1971); Illies 1966: 404 (catalog); Zwick 1978: 230 (syn. fide).

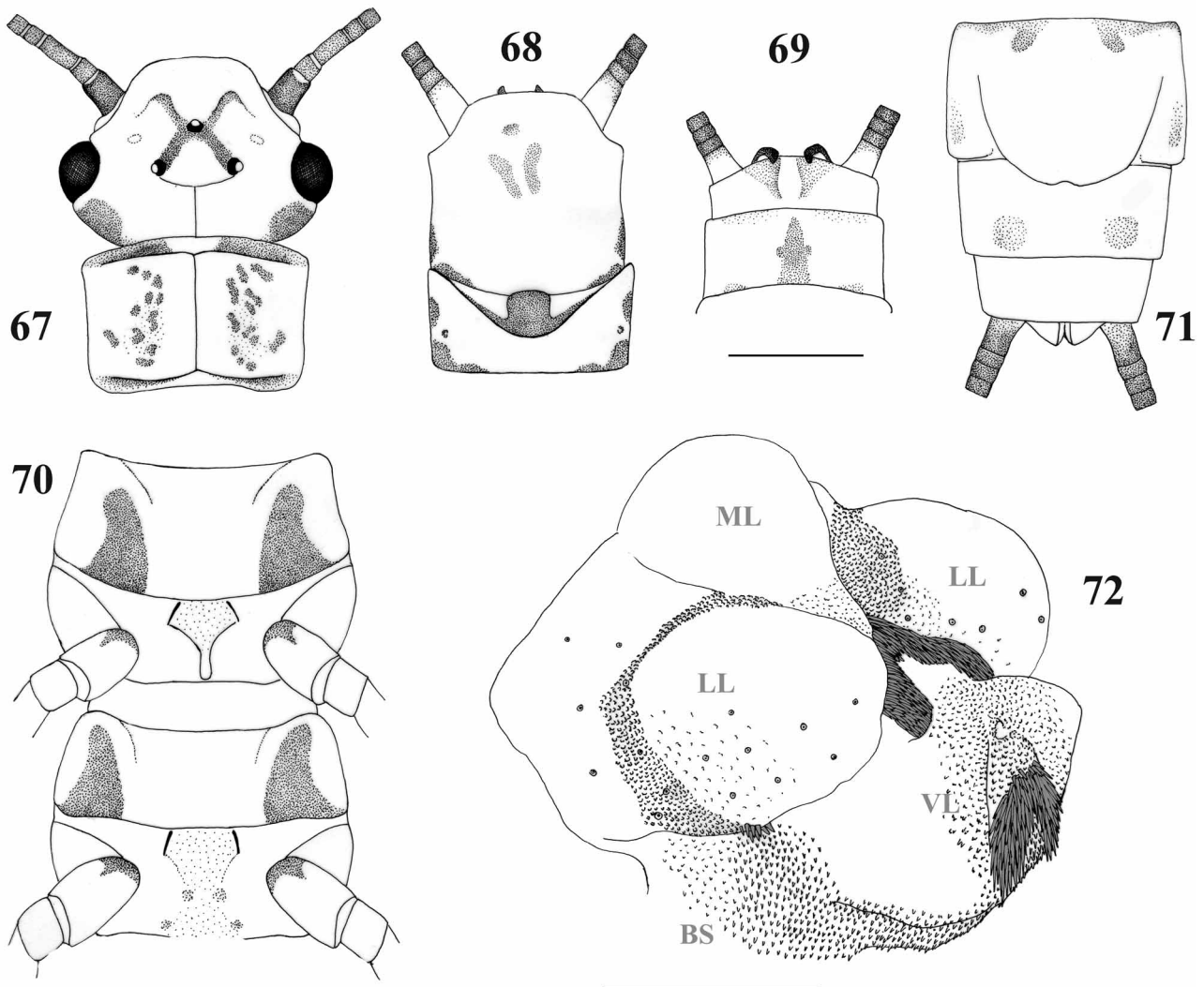
*Isoperla tripartita graeca* Aubert, 1956 — Raušer 1963: 805 (stat. n., supplementary description of male).

**Material examined:** AUSTRIA: Niederösterreich: Wienerwald, Eckbach, 13.05.1999, leg., det. W. Graf: 1m 1f (HNHM; used for drawings Figs. 67–71); HUNGARY: Veszprém county: Eplény, Mts Bakony, Malomvölgyi Stream, 05.05.1972, leg. S. Újhelyi: 1m 2f (HNHM; *I. grammatica*, det. S. Újhelyi); Bakonybél, Mts Bakony, Tisztavíz, 24.06.1972, leg., det. S. Újhelyi: 1m 4f (HNHM); Baranya county: Mánfa, Mts Mecsek, 14.06.1957, leg. L. Móczár, det. W. Joost 1974: 5m 8f (HNHM; eggs prepared for SEM); Komló, Mts Mecsek, Takanyó valley, 21.05.1991, leg. L. Ábrahám: 2m 2f (HNHM; one penial armature prepared on slide); Magyaregregy, Mts Mecsek, Vár-völgyi Stream, 300 m, 26.06.2006, leg. J. Kontschán, D. Murányi: 1m 1f (HNHM); Tolna county: Váralja, Mts Mecsek, Váraljai Stream, 26.05.2005, leg. Gy. Sziráki: 1m (HNHM); Bábaapáti, Mts Mecsek, Hutai Stream, 13.05.2006, leg. Z. Fehér, L. Tamás: 1m (HNHM); Komárom-Esztergom county: Dömös, Mts Visegrádi, Szőkeforrás valley, 16.06.1988, leg. L. Tóth: 1m 2f (HNHM); Pest county: Visegrád, Mts Visegrádi, Apátkuti valley, 19.05.1965, leg. ?: 3m (HNHM); 10.05.1986, leg. L. Tóth: 1m (HNHM; *I. belai*, det. L. Tóth); 21.06.1992, leg. L. Tóth: 2m (HNHM); Szentendre, Mts Pilis, Bükkös Stream, 20.05.1974, leg. S. Újhelyi: 1f (HNHM); 25.05.1977, leg. S. Újhelyi: 1m (HNHM); 30.05.1977, leg. S. Újhelyi: 8m 2f (HNHM); Szokolya, Mts Börzsöny, Hártókút, 14.04.1966, leg. H. Steinmann: 1m 1f (HNHM; *I. belai*, det. H. Steinmann); Les-völgyi Stream, 11.06.1987, leg. L. Tóth: 2m 5f (HNHM); Királyrét, Nagyvasfazék Stream, 20.05.1992, leg. L. Tóth: 4m 5f (HNHM); Kemence, Mts Börzsöny, Királyháza, Kemence Stream, 380 m, 14.06.2005, leg. M. Földvári, D. Murányi, L. Papp: 1m 2f (HNHM; used for drawing Fig. 72, male terminalia prepared for SEM); Nógrád county: Diósjenő, Mts Börzsöny, Kemence Stream, 25.07.1986, leg. L. Tóth: 1f (HNHM); 12.06.1991, leg. L. Tóth: 1m 1f (HNHM); Kemence Stream, 430 m, 03.05.2006, leg. M. Földvári, D. Murányi, L. Papp: 1 larva (HNHM); Málna Stream, 450 m, 03.05.2006, leg. M. Földvári, D. Murányi, L. Papp: 2 larvae (HNHM; used for drawings Figs. 91–93, one maxilla prepared on slide); Szécsény, Mts Cserhát, Pösténypusztá, Ipoly River, 21.05.2005, leg. K. Balogh, K. Harnos, D. Murányi: 1m (HNHM; penial armature prepared on slide); Pásztó, Mts Mátra, Hasznos Stream, 27.07.1967, leg. H. Steinmann: 1m 3f (HNHM); ROMANIA: Mureş county: Brâncoveneşti, 12.05.1971, leg., det. B. Kis: 6m 6f (HNHM; one penial armature prepared on slide); Caraş-Severin county: Băile Herculane, 07.1907, leg. Schmidt, det. W. Joost 1975: 3m (HNHM; one penial armature prepared on slide); Mehedinţi county: Staricea (Vaskapu), 20.05.1969, leg., det. B. Kis: 3m 1f (HNHM; pigmy population, one penial armature prepared on slide); BOSNIA-HERZEGOVINA: Foča region: Dobro Polje, Toplica spring and Dobropoljka Stream at the bridge, N 43°35.658' E 18°29.697', 995 m, 03.06.2009, leg. W. Graf: 3m 4f (CWG); Sutjeska National Park, Jabušnica sastavski, N 43°17.413' E 18°37.040', 765 m, 02.06.2009, leg. W. Graf: 1m (CWG); Sutjeska National Park, Cestu Spring beside the road, N 43°15.902' E 18°35.567', 1110 m, 02.06.2009, leg. W. Graf: 3m 2f 1 larva (CWG); MONTENEGRO: Pljevlja municipality: Pljevlja, Breznica Stream, 01.05.2008, leg. V. Pešić: 1m (HNHM; penial armature prepared on slide); Kozička Stream at its influence to Ćetina River, 26.06.2008, leg. V. Pešić: 1m (HNHM; penial armature prepared on slide); Berane municipality: Berane, Monastiri George Spring, N 42°51'9.2" E 19°51'41.3", 30.05.2009, leg. W. Graf: 6m 6f (CWG); Monastiri Chocho, N 42°51'9.2" E 19°51'41.3", 30.05.2009, leg. W. Graf: 7m 15f (CWG); Kolašin municipality: Biogradska Gora National Park, Biogradska Stream, affluence of Biogradsko Lake, N 42°53'33.0" E 19°36'09.7", 1115 m, 02.06.2009, leg. W. Graf: 3m, 1 larva (CWG); Andrijevica municipality: Gnjili potok,

N 42°45'02.0" E 19°41'51.0", 1125 m, 30.05.2009, leg. W. Graf: 1m (CWG); Visitor Mts, Murino, Murinska River, small streams and spring, N 42°39'17.6" E 19°52'47.6", 880 m, 30.05.2009, leg. W. Graf: 4m, 1 larva (CWG); Plav municipality: Gushinje, Alipašini Springs, N 42°33'0.5" E 19°49'33.1", 930 m, 31.05.2009, leg. W. Graf: 18m 6f (CWG); 09.06.2009, leg. W. Graf: 1m (CWG); Brezjojevica, Lim River at Plavsko Lake, N 42°36'28.9" E 19°55'39.0", 920 m, 30.05.2009, leg. W. Graf: 1m 1f (CWG); KOSOVO: Pejë municipality: Peć (Ipek), 02.07.1917, leg. E. Csiki, det. W. Joost 1975: 1m (HNHM); MACEDONIA: Čaška municipality: Nežilovo, Mts Jakupica, Babuna Spring, 08.07.2008, leg. T. Deli, B. Pál-Gergely, P. Subai: 2m 12f (HNHM; used for drawing Fig. 95, one penial armature prepared on slide, one male terminalia and eggs prepared for SEM); ALBANIA: Shkodër district: Okol, Mts Prokletije, karst spring N of the village, towards Pejë Pass, N 42°25.664' E 19°45.704', 990 m, 30.05.2005, leg. K. Balogh, Z. Barina, D. Murányi, D. Pifkó: 4m (HNHM; used for drawing Fig. 96, two penial armatures prepared on slides); karst spring system N of the village, N 42°25.347' E 19°45.680', 885 m, 01.06.2005, leg. K. Balogh, Z. Barina, D. Murányi, D. Pifkó: 1m (HNHM); stream along the path towards Pejë Pass, N 42°24.496' E 19°45.271', 1010 m, 30.05.2005, leg. K. Balogh, Z. Barina, D. Murányi, D. Pifkó: 1m 2f (HNHM; used for drawing Fig. 94, penial armature prepared on slide, eggs prepared for SEM); Theth, Mts Prokletije, Shalë River, N 42°23.695' E 19°46.265', 750 m, 03.06.2005, leg. K. Balogh, Z. Barina, D. Murányi, D. Pifkó: 1f, 1 larva (HNHM); Tropojë district: Dragobi, Mts Prokletije, Valbonë valley above the village, N 42.460700° E 19.905750°, 890 m, 04.06.2009, leg. Z. Barina, G. Lunk, D. Schmidt: 1m (HNHM; penial armature prepared on slide); Tropojë, Mts Prokletije, open stream on Mt. Callumit, N 42.498620° E 20.124430°, 1970 m, 07.06.2009, leg. Z. Barina, G. Lunk, D. Pifkó, D. Schmidt: 1m (HNHM); Has district: Kruma (Krumë), 06.06.1918, leg. Alb. Exp.: 2m (WNHM; *I. graeca*, det. J. Aubert 1963; penial armatures prepared on slides Nr. 9–10); Kukës district: open brook along the Novoselë–Kolesjan road, N 41°56.594' E 20°29.879', 1800 m, 24.06.2007, leg. L. Dányi, Z. Eröss, Z. Fehér, A. Hunyadi, D. Murányi: 18m 12f (HNHM; one penial armature prepared on slide, eggs prepared for SEM); Bicaj, Mts Gjalica e Lumës, Shkallë Bicaj, Tershanë Stream, N 41°59.518' E 20°25.333', 500 m, 25.06.2003, leg. Z. Eröss, Z. Fehér, J. Kontschán, D. Murányi: 3m 5f (HNHM; used for drawing Fig. 97, one penial armature prepared on slide, eggs prepared for SEM); Ploshtan, 22.07.1918, leg. Alb. Exp.: 1m (WNHM; *I. graeca*, det. J. Aubert 1963; penial armature prepared on slide Nr. 7); Dibër district: Radomirë, Mts Korab, Radomirë Stream E of the village, N 41°49.022' E 20°30.022', 1445 m, 28.06.2007, leg. L. Dányi, Z. Fehér, D. Murányi: 3m 2f (HNHM; one penial armature prepared on slide); spring and torrent beneath Fushë Korabit, N 41°49.207' E 20°30.727', 1770 m, 28.06.2007, leg. L. Dányi, Z. Fehér, D. Murányi: 1m 1f (HNHM); open brook beneath Fushë Korabit, N 41°49.149' E 20°31.304', 1875 m, 28.06.2007, leg. L. Dányi, Z. Fehér, D. Murányi: 1m 1f (HNHM); Fushë Korabit, spring and wet meadow, N 41°49.210' E 20°31.563', 1880 m, 26.06.2007, leg. L. Dányi, Z. Eröss, Z. Fehér, A. Hunyadi, D. Murányi: 1f (HNHM); open brook above Fushë Korabit, N 41°49.121' E 20°32.240', 1905 m, 27.06.2007, leg. L. Dányi, Z. Eröss, Z. Fehér, A. Hunyadi, D. Murányi: 6m 8f, 2 larvae (HNHM; one penial armature prepared on slide, one male terminalia and eggs prepared for SEM); spring and open brook above Fushë Korabit, N 41°49.251' E 20°31.543', 1940 m, 28.06.2007, leg. L. Dányi, Z. Fehér, D. Murányi: 1m 1f, 1 larva (HNHM); Mts Dejë, Varoshit Stream at Shkanderbeu Cliff, N of Murrë Pass, N 41°38.792' E 20°11.390', 975 m, 26.06.2003, leg. Z. Eröss, Z. Fehér, J. Kontschán, D. Murányi: 1m 3f (HNHM); Librazhd district: Qarishtë, Mts Jablanica, brook E of the village, N 41.24569° E 20.51238°, 1900 m, 04.07.2008, leg. Z. Barina, D. Pifkó, A. Vojtkó: 1m 2f (HNHM; one penial armature prepared on slide); Steblevë, Mts Jablanica, Zall i Barik Stream S of the village, N 41.28893°E 20.47496°, 1730 m, 03.07.2008, leg. Z. Barina, D. Pifkó, A. Vojtkó: 2f (HNHM; eggs prepared for SEM); brook SE of the village, N 41.27905° E 20.50103°, 1865 m, 03.07.2008, leg. Z. Barina, D. Pifkó, A. Vojtkó: 3m 5f (HNHM; two penial armatures prepared on slides); Skrapar district: Çeramica, Mts Ostrovicë, stream W of the village, N 40°32.780' E 20°27.527', 1535 m, 06.07.2005, leg. Z. Barina, D. Pifkó, D. Schmidt: 3m 2f (HNHM; one penial armature prepared on slide); brook W of the village, N 40°32.649' E 20°26.573', 1820 m, 05.07.2005, leg. Z. Barina, D. Pifkó, D. Schmidt: 7m 1f (HNHM); Backë, Mts Ostrovicë, spring section of Mrbret River beneath Faqekuq Peak, N 40°31.752' E 20°21.153', 1970 m, 05.07.2005, leg. Z. Barina, D. Pifkó, D. Schmidt: 1f (HNHM); stream beneath the pass between Frengu and Faqekuq peaks, N 40°31.614' E 20°25.021', 1915 m, 04.07.2005, leg. Z. Barina, D. Pifkó, D. Schmidt: 6m

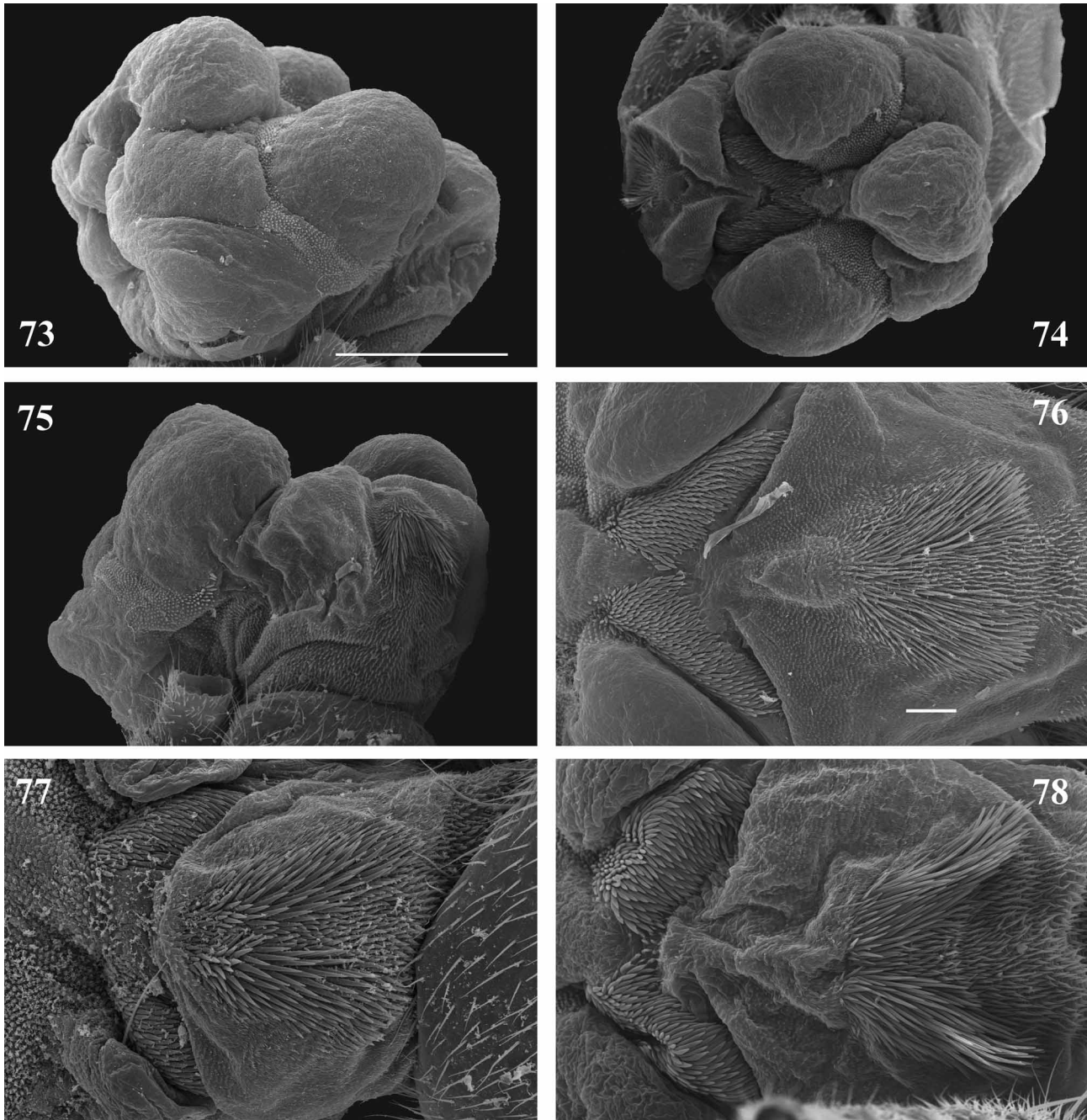


11f (HNHM; used for drawing Fig. 98, two penial armatures prepared on slide, eggs prepared for SEM); E slope of Frengu Peak, N 40°31.561' E 20°24.917', 1900 m, 04.07.2005, leg. Z. Barina, D. Pifkó, D. Schmidt: 1m (HNHM); Mts Ostrovicë, brook beneath the Ostrovicë Peak, N 40°34.051' E 20°26.846', 1960 m, 06.07.2005, leg. Z. Barina, D. Pifkó, D. Schmidt: 6m 5f (HNHM); spring between Ostrovicë and Faqekuq peaks, N 40°33.485' E 20°25.074', 1715 m, 07.07.2005, leg. Z. Barina, D. Pifkó, D. Schmidt: 6m 1f (HNHM); GREECE: Florina prefecture: Pisoderi, Mts Verno, forest stream 3km W of the village, N 40°47'16.5" E 21°13'26.7", 1315 m, 15.05.2006, leg. L. Dányi, J. Kontschán, D. Murányi: 1m, 1 exuviae (HNHM; male terminalia prepared for SEM); Ioannina prefecture: Milea, 5km SW of the village, 1300 m, 09.06.1992, leg. M. Gerecke, det. G. Vinçon: 3m 3f (HNHM; one penial armature prepared on slide, eggs prepared for SEM).



**FIGURES 67–72.** *Isoperla tripartita tripartita* Illies, 1954 — 67: head and pronotum; 68: male terminalia, ventral view; 69: male terminalia, dorsal view; 70: meso- and metathorax, ventral view; 71: female terminalia, ventral view; 72: extruded penis, dorsolateral view (ML: medial lobe; LL: lateral lobe; VL: ventral lobe; BS: basal section) — 67–71: Austria, Wienerwald; 72: Hungary, Mts Börzsöny — scale 1 mm: 67–71; 0.5 mm: 72.

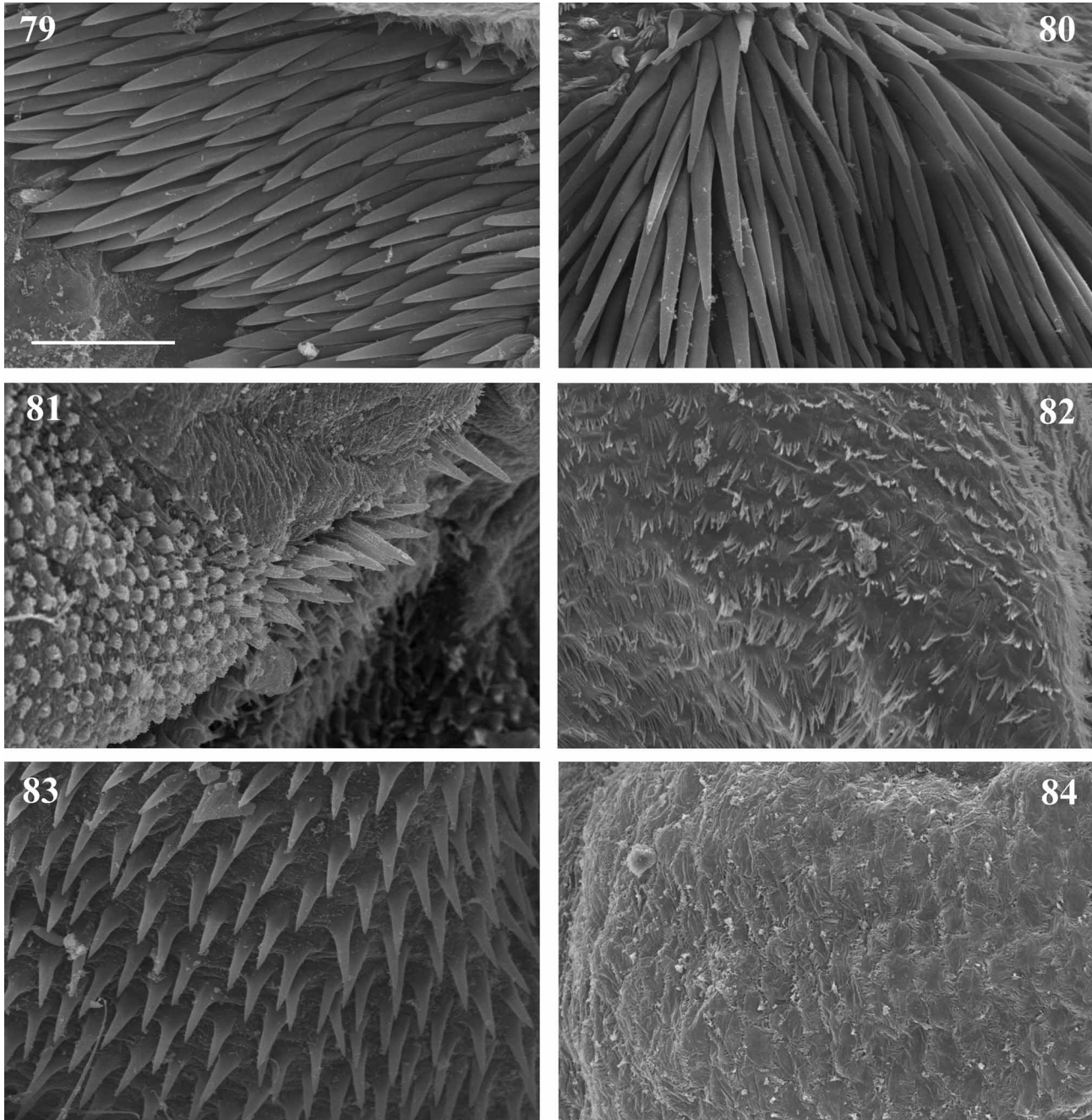
**Diagnosis:** The medial penial armature of this species is divided into upper and lower coloured portions. The upper medial armature is further divided or subdivided into diverging, elongate left and right parts, lower medial armature subdivided; scales spike-like. Its lateral penial armatures are small to vestigial.



**FIGURES 73–78.** *Isoperla tripartita tripartita* Illies, 1954 — 73: extruded penis, lateral view; 74: extruded penis, dorsal view; 75: extruded penis, anteroventral view; 76–78: medial penial armatures, dorsal view — 73–75: Hungary, Mts Börzsöny; 76: Greece, Mts Verno; 77: Macedonia, Mts Jakupica; 78: Albania, Mts Korab — scale 0.5 mm: 73–75; 0.1 mm: 76–78.

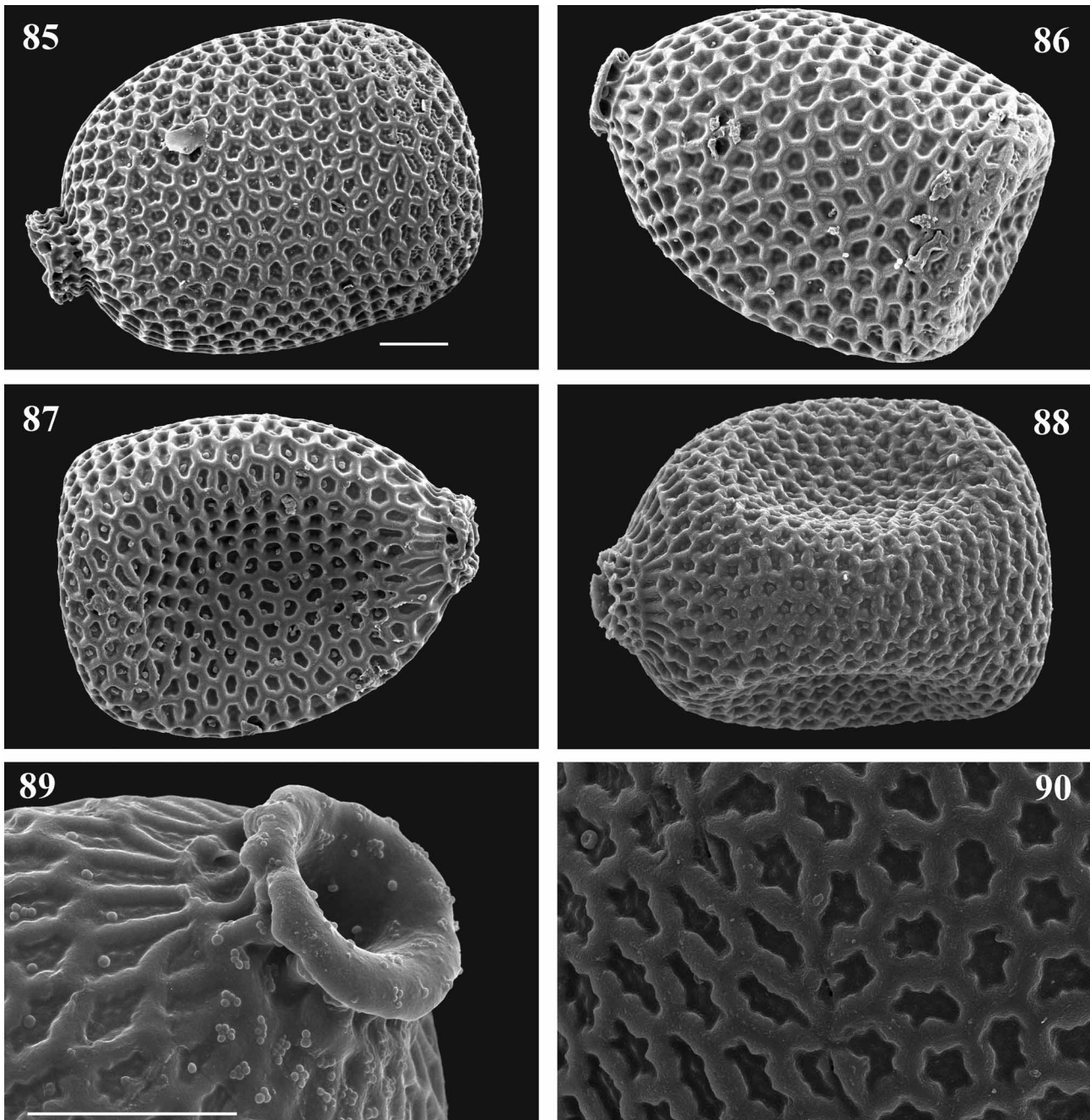
**Description:** Large-sized species, but a pigmy population was also found (Staricea, Romania, see also Remarks); macropterous. Body length: males 12.5–14.5 mm (n=30), females 13.0–16.0 mm (n=30); forewing length: males 12.5–15.0 mm (n=30), females 13.5–16.5 mm (n=30). Pigmy males are 9.0–10.0 mm (n=3), female 10.0 mm; forewing length: males 9.5–10.5 mm (n=3), female 10.5 mm. General colour yellowish but the meso- and metanotum and the abdomen mostly brown; pilosity of the body and legs short and dense. Head rounded, yellow with an X-shaped dark brown patch connecting the three ocelli and the apical parts of the M-line (Fig. 67); on Balkanian specimens it is sometimes modified to a upturned U (Fig. 98), or can be rather extensive (Figs. 94–97). Tentorial callosities and M-line more or less distinct, occiput brown laterally and usually lacks rugosities (Figs. 67, 96), but the rugosities sometimes can be rather numerous (Fig. 95). Eyes as large as the area delimited by the three ocelli (Figs. 67, 94–97), or slightly smaller (Fig. 98). Scape dark brown, pedicel and the following three or four

antennomeres are brown but distal part of the antenna is dark brown; palpi brown. Pronotum yellow to brown, rectangular, edges angled; rugosities are small and usually not so numerous, brown coloured, anterior and posterior lines brown under and above the rugosities. Mesonotum dark brown but yellow anteriorly and medially, metanotum dark brown. Wings yellowish, venation pale in the anterior third, costa and the other veins brown. Ventral surface of thorax mostly pale, meso- and metabasisternum bear two dark brown stripes laterally, furcasternites pale, furcal pits black (Fig. 70); some extremely dark coloured Balkanian populations have entirely dark meso- and basisternum with dark furcasternites. Femora pale but the dorsal surface and the ventral edges brown. Tibiae pale ventrally, brown dorsally; tarsi brown.

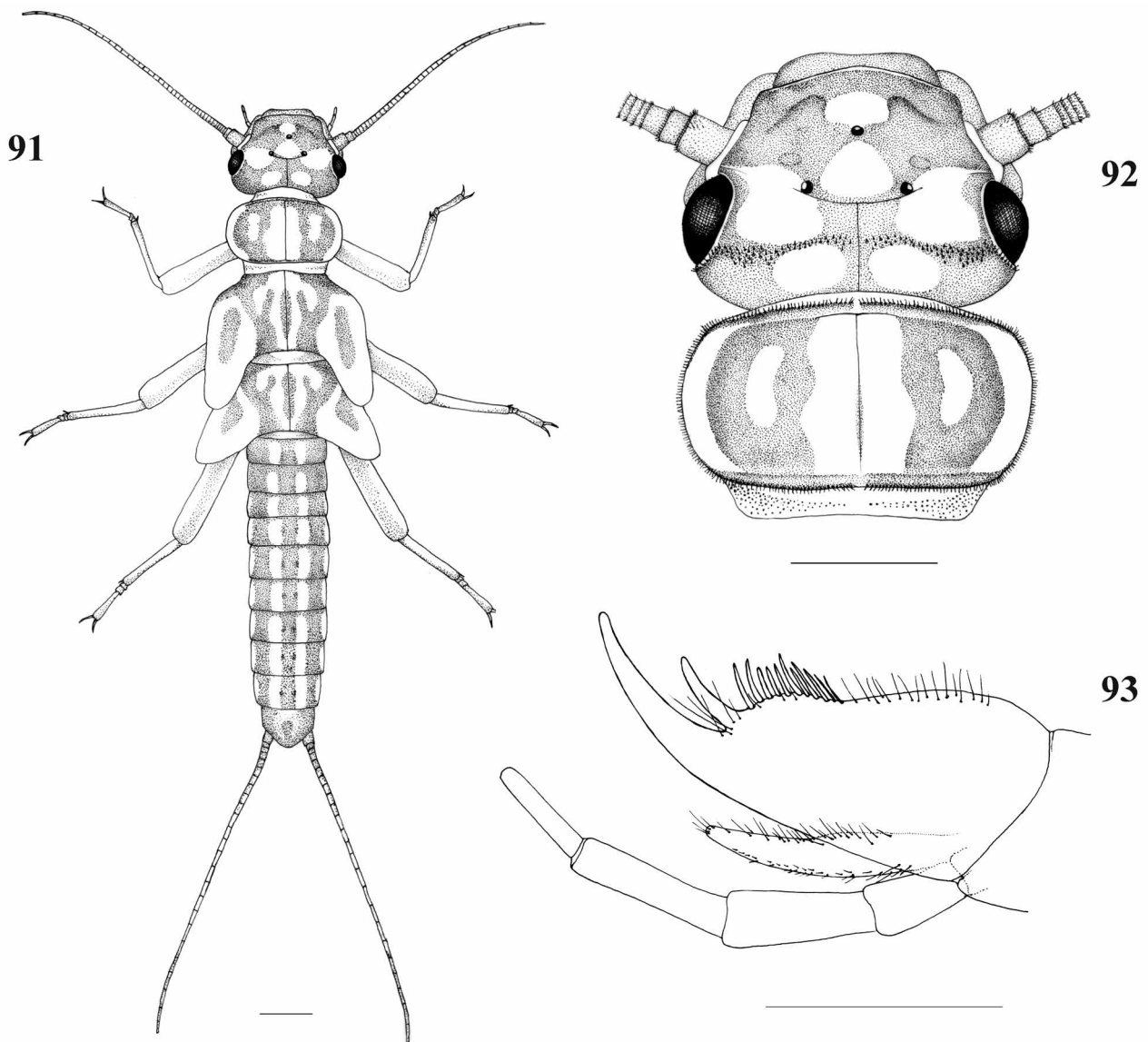


**FIGURES 79–84.** *Isoperla tripartita tripartita* Illies, 1954 — 79: scales of the upper medial penial armature, dorsal view; 80: scales of the lower medial penial armature, dorsal view; 81: lateral penial armature; 82: small branched hair-like scales of the ventral lobe; 83: triangular scales of the ventral lobe; 84: small ciliated scales above the upper medial penial armature of the medial lobe — Hungary, Mts Börzsöny — scale 0.05 mm (for all figures).

Male abdomen: First tergite dark brown but yellowish anteriorly and medially. Tergites II–VI entirely dark brown, tergite VII entirely dark brown or dark brown with pale marks posteriorly. Pale markings become more extensive on tergites VIII–IX, but a medial dark brown mark always present; tergite X yellowish with two brownish, triangular patches medially (Fig. 69). Transverse row of four pigmented spots seen on tergites I–VIII, tergite IX usually have two spots, tergite X lacks spots. Ventral surface of abdomen mostly yellow, sternites II–VIII have a brown transversal anterior line, usually interrupted in the middle; sternites II–VII have a medial transverse row of four spots, sternite VIII with two spots. Vesicle of sternite VIII brown, as wide as long, its posterior margin is weakly rounded; as long as half the segment's length (Fig. 68). Sternite IX yellow but with brown patches anterolaterally and sometimes with a dark medial area, the medial penial armature visible in the posterior half. Paraprocts brown, sharp, thin and recurved; cerci dark brown, base of the first cercal segment usually paler.



**FIGURES 85–90.** *Isoperla tripartita tripartita* Illies, 1954 — 85–88: egg, lateral view; 89: collar, lateral view; 90: micropyles, lateral view — 85: Hungary, Mts Mecsek; 86: Albania, Mts Gjalica e Lumës; 87: Albania, Mts Ostrovicë; 88: Albania, Mts Korab; 89–90: Albania, Mts Jablanica — scale 0.05 mm (for all figures).



**FIGURES 91–93.** *Isoperla tripartita tripartita* Illies, 1954 — 91: larval habitus, dorsal view (pilosity omitted); 92: larval head and pronotum, dorsal view; 93: larval maxilla, ventral view — Hungary, Mts Börzsöny — scale 1 mm: 91–92; 0.5 mm: 93.

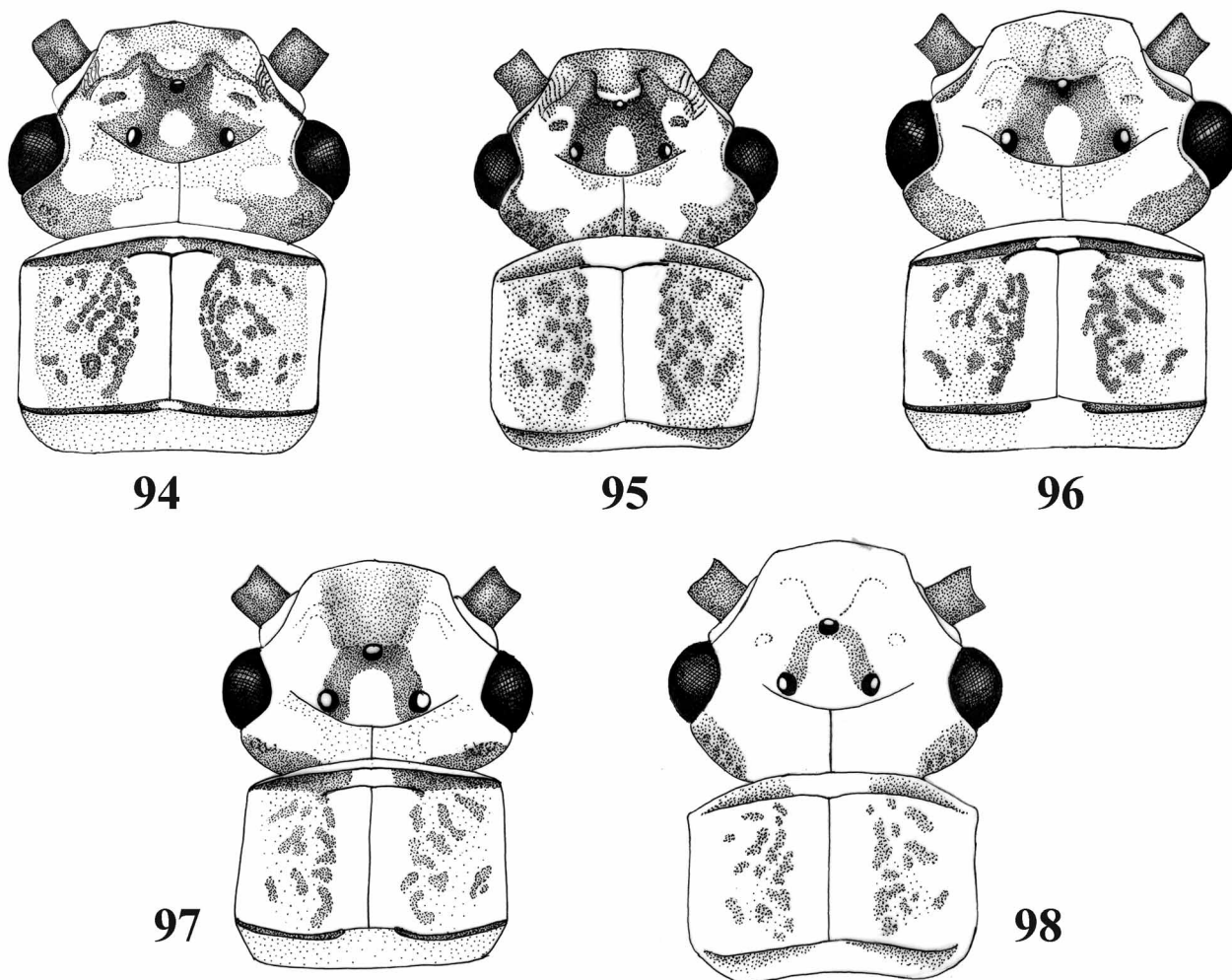
Penis: Divided into four lobes and a basal section in extruded position (Figs. 72–75). The medial penial armature is divided into an upper and a lower part, both are coloured, though the lower part sometimes rather pale; upper armature located on the medial lobe adjacent to the ventral lobe, lower armature located on the central part of the ventral lobe. Lateral penial armatures located on the lateral lobes just above the basal section, but sometimes vestigial and uncoloured. The upper medial penial armature is further divided or subdivided into left and right arms which are diverging towards the ventral lobe, elongated and usually stripe-like but never drop-shaped, sometimes slightly folded. Length of the parts are 300–450  $\mu\text{m}$ , width 120–200  $\mu\text{m}$  (Figs. 76–78). The lower medial penial armature is subdivided into left and right arms which are diverging towards the basal section, usually forming an upturned V. Length 250–370  $\mu\text{m}$ , width 100–250  $\mu\text{m}$  (Figs. 76–78). The scales are spike-like, those on the lower part are usually longer and thinner, short ones of the upper armature sometimes bent. Their length is 40–110  $\mu\text{m}$ , width 5–10  $\mu\text{m}$  (Figs. 79–80). Lateral penial armatures are usually small, consisting of only a few scales arranged in an elongated patch. The scales are spike-like, their length is 15–40  $\mu\text{m}$ , width 5–10  $\mu\text{m}$  (Fig. 81). The ventral lobe is hemispherical, lateral sides bald. Its upper medial section bears small branched hair-like scales (Fig. 82), these are grading into bigger ones towards the lower medial penial armature; the lobe bears a medial stripe of strong triangular scales beneath the armature (Fig. 83), triangular scales also occur basolaterally. The medial lobe is elongate, apical half slightly widening; most of the surface is bald, but bears very small ciliated scales above the



upper medial penial armature (Fig. 84). The lateral lobes are elongated, central part constricted along a transverse stripe of hydra-like scales. This stripe is narrow arises from the lateral penial armatures and continues to the upper medial penial armature. Other surfaces of the lobes are bald to sparsely covered with small ciliated scales ventrolaterally grading into to the hydra-like scales. Sensilla are settled along the lateral part of the lobes, but not apically. The basal section is covered with mostly triangular scales, but these grade into hydra-like scales towards the dorsal origin of the lateral lobes.

Female abdomen: First tergite dark brown but yellowish anteriorly and medially. Tergites II–VI entirely dark brown, pale markings become more extensive on tergites VII–IX, but a medial dark brown mark always present; tergite X yellow or with some brownish patches medially. Transverse row of four pigmented spots seen on all but tergites IX–X. Sternites II–VII yellow with an interrupted transverse anterior line, and a medial transverse row of four spots. Subgenital plate covers most of sternite VIII and the anterior part of sternite IX; anterior part of sternite VIII with two dark patches. Plate usually uniformly yellow; posterior margin rounded, tip sometimes slightly notched (Fig. 71). Sternite IX yellow, bearing two pale brown lateral patches on the posterior half. Sternite X and the paraprocts yellowish; cerci dark brown, base of the first cercal segment usually paler.

Egg: Chorion dark brown, 0.31–0.35 mm long and 0.22–0.26 mm wide (n=30). Shape oval, opercular end usually depressed (Figs. 85–88). Hatching line inconspicuous. Micropyles placed in a transverse row on the opercular third, not raised, each take place close to the meeting of carinae between the FCIs (Fig. 90). Chorion with marked ornamentation of penta- or hexagonal FCIs, sometimes with undulated edges. Collar round, rim flanged or slightly flanged, sometimes with depressed ditch at the base; bears one or two rows of FCIs (Fig. 89). Anchor flat, anchor surface structure in development stage 1 (unmodified), according to Isobe (1997), globular bodies distributed in the whole area (Fig. 89).



**FIGURES 94–98.** *Isoperla tripartita tripartita* Illies, 1954, variations of head and pronotal pattern — 94: Albania, Mts Prokletije; 95: Macedonia, Mts Jakupica; 96: Albania, Mts Prokletije; 97: Albania, Mts Gjalica e Lumës; 98: Albania, Mts Ostrovicë — scale 1 mm (for all figures).

Mature larva: Body length of the matured larva: 14.5–17.5 mm (n=10). General colour brown but with yellowish markings and pale legs (Fig. 91). Pilosity usual for the genus, pronotal, posterior tergal and cercal fringes relatively short and blunt; swimming hairs present on the femora, tibiae and metatarsi, distal half of the cerci with scarce and inconspicuous dorsal hair fringe of erect hairs as long as distal whorl of setae. Head brown or dark brown with a yellow spot anterior to the M-line, interocellar spot large, closed off posteriorly by pigment, a large spot between the posterior ocellus and the compound eye on each side, and a pair of spots posterior to the complete occipital row of setae (Fig. 92). M-line distinct, tentorial callosities barely visible; eyes normal sized. Scape, pedicel and the following five or six antennomeres are light brown, distal part of the antenna yellowish; palpi yellowish, mouthparts light brown. Lacinia bidentate, triangular, with 7–9 strong setae situated on a shallow mound beneath subapical tooth, thin hairs present all along the inner margin to near base; galea with long setae on the inner, and short setae on the outer margin (Fig. 93). Pronotum rounded, dark brown but with a wide medial yellow stripe along the medial suture, a pair of elongate dark brown areas and light inclusions present, lateral margins yellow. Mesonotum and metanotum mostly dark brown but with pale, marbled pattern; wingpads whitish, with an elongated central brown stripe. Ventral surface of thorax pale, furcasternites and furcal pits slightly darker. Legs pale, dorsal surface of femora and tibiae slightly darker. Abdominal tergites brown to dark brown with two more or less continuous, light coloured, longitudinal stripes along the abdomen. Tergites also bear lateral yellow markings, but these are sometimes lacking on the first and last one or two tergites. Transverse row of pigmented spots present, but sometimes hardly seen on all but the last segment. Ventral surface of abdomen pale brown, the distal segments usually darker. Paraprocts brown; cerci light brown in the basal segments, distal part yellowish.

**Affinities:** It differs from *I. tripartita recta* by having divergent left and right arms of the upper medial penial armature instead of parallel arms. Both subspecies differ from the closely related *I. obliqua* and *I. pesici* by their elongate, but never tear drop-shaped (as in *I. obliqua*) or rounded (*I. pesici*), appearance of the upper medial penial armature. The West Balkanian *I. illyrica* differs by having an undivided upper medial penial armature that consists of short scales; and *I. autumnalis* differs by having an uncoloured and undivided lower medial penial armature. Furthermore, *I. autumnalis*, *I. illyrica* and *I. pesici* lack the dark brown lateral stripes on the ventral surface of the thorax that are characteristic for most of the *I. tripartita tripartita* specimens, and the head pattern is rather different from the typical pattern of *I. tripartita tripartita*. In addition, *I. autumnalis* is the only autumnal *Isoperla* species known from the Balkans. The notched subgenital plate that does not continue as a short sulcus was regarded (e.g. Kis 1974) as a distinguishing feature of *I. belai* (formerly assigned to the *tripartita* group). A slightly notched subgenital plate also occurs in *I. tripartita tripartita*. The larva can be distinguished from that of *I. autumnalis* by the more extended pale markings, especially on the wingpads and the stripes on the abdomen.

**Ecology and distribution:** The species was originally described from the Wienerwald of Austria (Illies 1954). Later it was reported from Slovakia, the Czech Republic, Hungary, and Romania in Central Europe, and all of the Balkan countries (Fochetti 2004, Sivec 1980a, 1980b). In the Alps *I. tripartita tripartita* is known only from the Eastern foothills (Graf 1999). It was collected in the western and the southern Carpathians but there are only a few data from the northern and the eastern Carpathians (Fiałkowski & Kittel 2002, Kis 1974, Krno 2003, Zhiltzova 1977). In the Carpathian Basin it is the most frequent *Isoperla* of streams and brooks of the submontane and hilly regions, but it is missing from the Transylvanian Mountains where it seems to be replaced by *I. belai* (Kis 1974). It is widely distributed in the Balkans, where inhabits not only the hilly and submontane waters but is also found in mountain streams, being a typical inhabitant of high montane open brooks. The specimens were collected from April to July, but mostly in the second half of May and the first half of June in the Carpathian Basin. In the Balkanian high montane populations, adults were present in June and July. The accompanying fauna consists of widely distributed European species common to the Carpathian Basin (e.g. *Brachyptera risi* (Morton, 1896), *Capnia bifrons* (Newman, 1839), *Leuctra hippopus* Kempny, 1899, *Protonemura intricata intricata*, *Nemoura cinerea cinerea*). It was collected with a much richer stonefly fauna within the Balkans.

**Remarks:** *Isoperla tripartita tripartita* shows rather high variability that suggests that further splitting of the taxon may be warranted. Unfortunately, SEM studies of the penis did not provide additional characters useful to this purpose, since the variability in the specimens involved both the coloured penial armatures and the body colour pattern, but not the distribution of the uncoloured penial armatures. Investigation using molecular methods, drumming signals, and closer examination of morphological features will be required to tease out meaningful differences in this variable taxon.

*Isoperla graeca* was distinguished from *I. tripartita* by the presence of lateral penial armatures (Aubert 1956); however, Zwick (1978) showed that the types of *I. tripartita* also possess small lateral armatures and synonymized the two species. Raušer (1963) reported that specimens from the Bulgarian Stara Planina and Strandcha Mountains

have no lateral penial armatures, at character state in agreement with the original description. Zwick (1978) himself reported such specimens from the Greek Euboea Island. Some of the specimens studied herein seemingly lack the armatures, but at least a few uncoloured spike-like scales have been observed in these specimens when slide mounted. Vestigial and well developed lateral armatures sometimes occur in the same population, suggesting that this character state is of minor taxonomical value.

The morphology of the medial penial armatures is highly variable, including the shape and length of the arms of the upper medial armature, the degree of folding of the medial armatures, and the degree of subdivision, shape and length of the lower medial armature (see Figs. 76–78, Raušer 1963: Figs. 4–5, 7A and Zwick 1978: Figs. 72b–e). These different forms occur in the same population; hence, they not correspond to geographical areas. Conversely, most of the body colour pattern variations are geographically delimited and more or less constant in a given population. Hungarian populations agree well with the specimens from Wienerwald (Figs. 67–71); this typical colour pattern occurring sporadically in the Balkans, at low altitudes or in high mountains (e.g. foothills of the Verno Mountains, Greece or the higher parts of the Korab Mountains, Albania). Specimens from the Romanian Carpathians have a conspicuous head pattern with dense rugosities on the occiput (Kis 1974: Fig. 146A); single specimens from Kosovo and the Kozička Stream, Montenegro have the same colouration. A similar, but pigmy, population was found at Staricea, Mehedinți county of Romania. Some specimens from Montenegro and most of the North Albanians have a head pattern as illustrated on Fig. 97. Other Montenegrin and Bosnian specimens have a head pattern reminiscent of *I. albanica* (Fig. 43). Specimens from the Ostrovicë Mountains of Albania, and from Berane, Montenegro have the palest head pattern showed on Fig. 98, but typical populations were also found in the Ostrovicë Mountains. Specimens from Babuna Spring, Macedonia (Fig. 95), some specimens from the Prokletije Mountains, Albania (Fig. 94) and some specimens from Montenegro (Biogradska Gora, and some specimens from the Visitor Mountains) are strikingly dark coloured. Here, the ventral surface of the thorax lacks the dark brown lateral stripes that are characteristic for all the other forms, and reminds to those of *I. bosnica* (Fig. 24). Some specimens from the Jablanica Mountains, Albania have a similarly dark head pattern, but these occur in common with forms from the lower parts of the Korab and Prokletije Mountains (Fig. 96), and also with more typical specimens. The colour pattern of the studied larvae seem to be less variable than those of the imagos, but the larvae of the particularly dark forms are notably darker than the typical specimens.

It is worth mentioning that all the studied eggs distinctly differ from the *I. tripartita* eggs described from the Peloponnes, Greece (Tierno de Figueroa et al. 2001), as they have polygonal ornamentation on the chorion instead of punctation on the Greek eggs. This type of ornamentation reminds to those described below for *I. pesici*, but the Greek eggs differ with having a long collar. Given to its locality of origin, the description of Tierno de Figueroa et al. (2001) possibly refers to the unknown egg of *I. obliqua*.

### ***Isoperla obliqua* Zwick, 1978 stat. n.**

*Isoperla tripartita obliqua* Zwick, 1978 — Zwick 1978: 230 (original description of male).

**Material examined:** GREECE: Achaia prefecture: Ano Vlassia, Mts Erimanthos, Selinous Stream, 1000 m, 25.05.1992, leg. H. Malicky, det. G. Vinçon: 2m 2f (HNHM; one penial armature prepared on slide).

**Diagnosis:** This species is characterized by a coloured medial penial armature that is divided into an upper and a lower part. Its upper medial armature is further divided into diverging, tear drop-shaped left and right arms with a lower medial armature that is weakly subdivided. All scales on armatures are spike-like and the lateral penial armatures vestigial.

**Complementary description:** General appearance, dimensions, male and female abdomen: Similar to *I. tripartita tripartita* as redescribed above. Head and pronotal pattern of the examined specimens remind one of that depicted in Fig. 96, but with rugosities on the occiput.

Penis: Lobes and the distribution of non coloured scales, hairs and sensilla cannot be studied in detail because the specimens were collected without an everted penis. However, the narrow stripe of hydra-like scales, characteristic for the species group, can be detected. The medial penial armature is in agreement with the original description (Zwick 1978: Figs. 72j, k). Lateral penial armatures are vestigial, consisting of only a few uncoloured spike-like scales.

Larva, egg: unknown.

**Affinities:** See *I. tripartita tripartita* above.



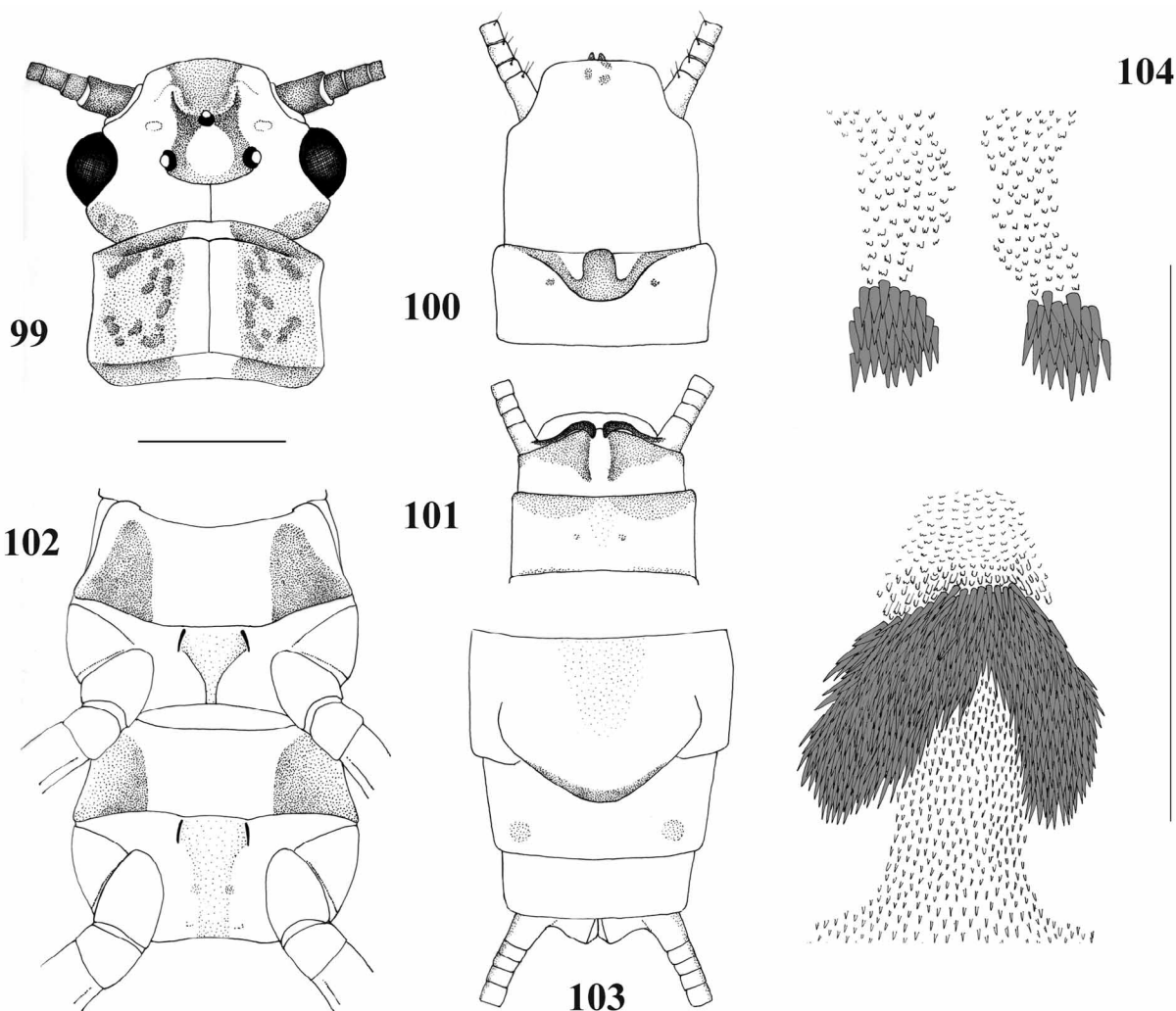
**Ecology and distribution:** The species was originally described from the Greek Euboea Island, Andros Island, the Peloponnes and the Greek mainland (Zwick 1978). The species has not been referenced since its description. The known localities are submontane streams and spring outlets, the adults being caught in May, usually in common with a diverse community of stoneflies.

**Remarks:** The area of the species completely overlaps with *I. tripartita tripartita*, so I propose full species status herein. Nevertheless, as it was already stated in the original description (Zwick 1978), transitional forms towards *I. tripartita tripartita* occur and the validity of the taxon requires further investigation.

***Isoperla pesici* sp. n.**

(Figs. 99–108, 126)

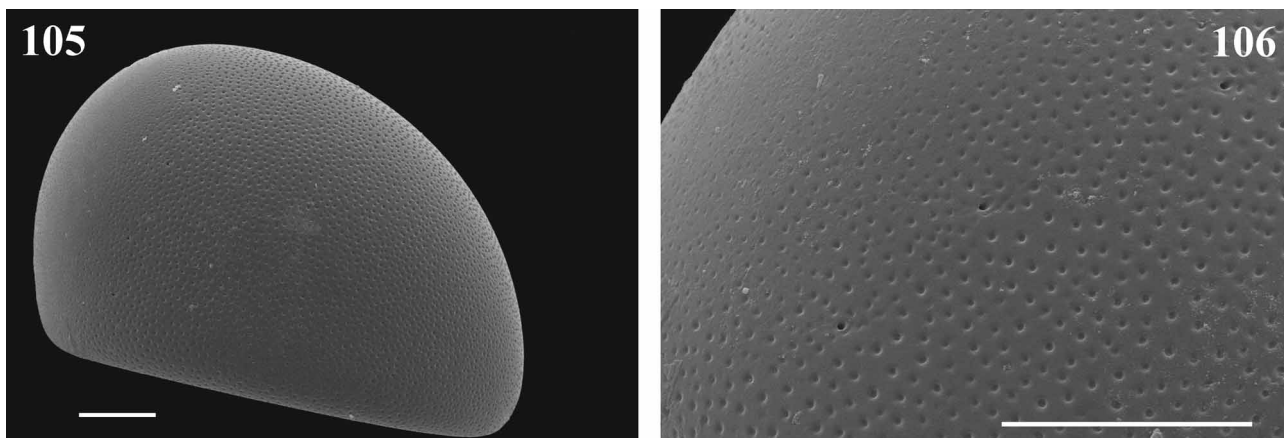
**Type material:** Holotype male: MONTENEGRO: Nikšić municipality: Vidrovan, outlet of the Vukovo Vrelo Spring, N 42°51.47' E 18°56.59', 675 m a.s.l., 21.06.2008, leg. V. Pešić (HNHM: PLP2868; used for drawings Figs. 99–102). Paratypes: same locality and date: 1f (HNHM: PLP3350; used for drawing Fig. 103), 8m 7f (HNHM: PLP3351; used for drawing Fig. 104, three penial armatures prepared on slides, eggs prepared for SEM), 2m 1f (CGV), 2m 1f (CPZ); Vidrovan Stream (upper reach of the Zeta River) in the village, N 42°51'06.9" E 18°56'26.3", 03.06.2009, leg. W. Graf: 6m 3f (CWG; eggs prepared for SEM); Danilovgrad municipality: Spuž, tributary of the Zeta River, N 42°32'03.1" E 19°11'23.6", 28.05.2009, leg. W. Graf: 1m (CWG); Kolašin municipality: Redice, small spring and its outlet above the village, N 42°54'02.3" E 19°16'11.4", 1270 m, 01.06.2009, leg. W. Graf: 1m 1f (CWG).



**FIGURES 99–104.** *Isoperla pesici* sp. n. — 99: head and pronotum; 100: male terminalia, ventral view; 101: male terminalia, dorsal view; 102: meso- and metathorax, ventral view; 103: female terminalia, ventral view; 104: medial penial armature — scale 1 mm: 99–103; 0.5 mm: 104.

**Diagnosis:** This large, macropterous species is characterized by a combination of coloured and divided upper and lower medial penial armatures, by the upper armature being further divided into small, round left and right parts, and by the lower armature also being subdivided. Scales of these armatures are all spike-like. Lateral penial armatures are lacking in this species.

**Description:** Large-sized species, macropterous (Fig. 107). Body length: holotype 12.0 mm, male paratypes 11.5–13.0 mm (n=20), female paratypes 11.5–14.0 mm (n=14); forewing length: holotype 12.0 mm, male paratypes 11.5–12.5 mm (n=20), female paratypes 12.5–14.5 mm (n=14). General colour yellowish but the meso- and metanotum brown, and the abdomen mostly brownish; pilosity of the body and legs short and dense. Head yellow with a longitudinal brown stripe medially, connecting posterior ocelli and the labrum, but with a yellow spot between the ocelli (Figs. 99, 107). Tentorial callosities more or less distinct, M-line distinct, occiput brown laterally and with a few rugosities. Eyes as large as the area delimited by the three ocelli. Scape dark brown, pedicel and the following three or four antennomeres are brown but distal parts darker; palpi light brown. Pronotum brown with a yellow medial line and yellow sides, rectangular, edges angled; rugosities set in brown background, large and brown coloured but indistinct. Mesonotum dark brown but yellow anteriorly and medially, metanotum dark brown. Wings yellowish, venation pale in the anterior fourth, remainder veins brown. Ventral surface of thorax mostly pale, meso- and metabasisternum bear two brown (not dark brown) stripes laterally, furcasternites pale, furcal pits black (Fig. 102). Femora pale but the dorsal surface and the ventral edges brown. Tibiae pale ventrally, brown dorsally; tarsi dark.



**FIGURES 105–106.** *Isoperla pesici* sp. n. — 105: egg, lateral view; 106: micropyles, lateral view — scale 0.05 mm.

Male abdomen: First tergite light brown but yellowish anteriorly and medially. Tergites II–VIII light brown to brown, with some darker marks anteriorly and medially. Tergite IX similar but paler, and with paired posterior dark marks; tergite X yellowish with two brown, triangular patches medially, and with weak posterolateral brown edges (Fig. 101). Transverse row of four pigmented spots seen on tergites I–VIII, tergite IX have two spots, tergite X lacks spots. Ventral surface of abdomen yellow, sternites II–VII have a weak, interrupted light brown transversal anterior line; sternites II–VII have a medial transverse row of four spots, sternite VIII with two spots. Vesicle of sternite VIII brown, 1.5X longer than wide, its posterior margin rounded; as long as half the segment (Fig. 100). Sternite IX uniformly yellow, the medial penial armature visible through the integument in the posterior fourth. Paraprocts brown, sharp, thin and recurved; cerci yellow, distal segments light brown to brown.

Penis: Lobes and the distribution of non coloured scales, hairs and sensilla cannot be studied in details because the specimens were collected without complete eversion of the penis. The medial penial armature is divided into an upper and a lower part, both are coloured; in all probability, upper armature located on the medial lobe adjacent to the ventral lobe, lower armature located on the central part of the ventral lobe (Fig. 104). Lateral penial armatures lacking. The upper medial penial armature is further divided into a left and a right part which are small and round. Length of the parts are 75–100  $\mu\text{m}$ , width 70–80  $\mu\text{m}$ . The lower medial penial armature is subdivided into a left and a right part which are diverging towards the basal section, usually forming an upturned V. Length 220–260  $\mu\text{m}$ , width 100–125  $\mu\text{m}$ . The scales are spike-like and straight, those on the lower part are usually longer and thinner. Their length is 30–60  $\mu\text{m}$ , width 5–10  $\mu\text{m}$ . Origin of the narrow stripe of hydra-like scales, characteristic for the species group, can be seen above the upper medial armatures. Small branched hair-like scales occur above the

lower medial armature, these are grading into bigger ones towards the armature; triangular scales forming a wide stripe beneath the armature.

Female abdomen: First tergite brown but yellowish anteriorly and medially. Tergites II–VII entirely brown, pale markings become more extensive on tergites VII–IX, but a medial dark brown mark always present; tergite X yellow or with some brownish patches medially. Transverse row of four pigmented spots seen on all but tergite X. Sternites II–VII yellow with a weak transversal posterior line, medial transverse row of four spots poorly developed. Subgenital plate covers most of sternite VIII and the anterior part of sternite IX. Plate mostly yellow, but the posterior margin usually brown, and the anteromedial part is light brown; posterior margin roundly triangular (Fig. 103). Sternite IX yellow, bearing two pale brown lateral patches on the posterior half. Sternite X and the paraprocts yellowish; cerci yellow, distal segments light brown to brown.



**FIGURE 107–108.** *Isoperla pesici* sp. n. — 107: habitus of a paratype at the type locality (photo V. Pešić); 108: type locality: Montenegro, Vidrovan, Vukovo Vrelo Spring.

Egg: Chorion light brown, 0.33–0.36 mm long and 0.26–0.28 mm wide (n=30). Shape oval, one side of all the examined eggs are depressed (Fig. 105), though this shape is possibly an artifact (see Tierno de Figueroa et al. 2000). Hatching line inconspicuous. Micropyles placed in a transverse row on the opercular fourth, not raised (Fig. 106). Chorion with shallow punctation, FCIs not visible. Collar and anchor missing.

Larva: unknown.

**Affinities:** See *I. tripartita tripartita* above.

**Ecology and distribution:** The species was collected at spring outlets in June, between 200 and 1270 m in the Zeta and the upper Morača valleys (Fig. 126). The Vukovo Vrelo spring system consists of many springs of variable size that have stony substrate and permanently cold water (Fig. 108). Their water is entrapped in a small artificial lake, then flows in a big stream. The shore vegetation of the springs is ruderal, with *Juncus* stocks and some low bush. The species was found in common with *Leuctra quadrimaculata* Kis, 1963a, *Amphinemura triangularis*, *Protonemura intricata intricata*, *Nemoura cinerea cinerea*, *Nemurella pictetii* (Klapálek, 1900) and *Dinocras megacephala* (Klapálek, 1907). When visited in October, the following species were collected: *L. hirsuta* Bogoescu & Tabacaru, 1960, *L. major* Brinck, 1949, *P. autumnalis* Raušer, 1956, *P. montana* Kimmins, 1941 and *N. pictetii*. The species was found in further two tributaries of the Zeta River with similar cold water. The small spring at Redice is in the source area of the Morača River, and its outlet flows on a steep slope. Here the species was found in common with *P. intricata intricata*, *N. pictetii*, *Perlodes intricatus* (Pictet, 1841) and *Siphonoperla graeca* (Aubert, 1956) (pers. com. W. Graf).

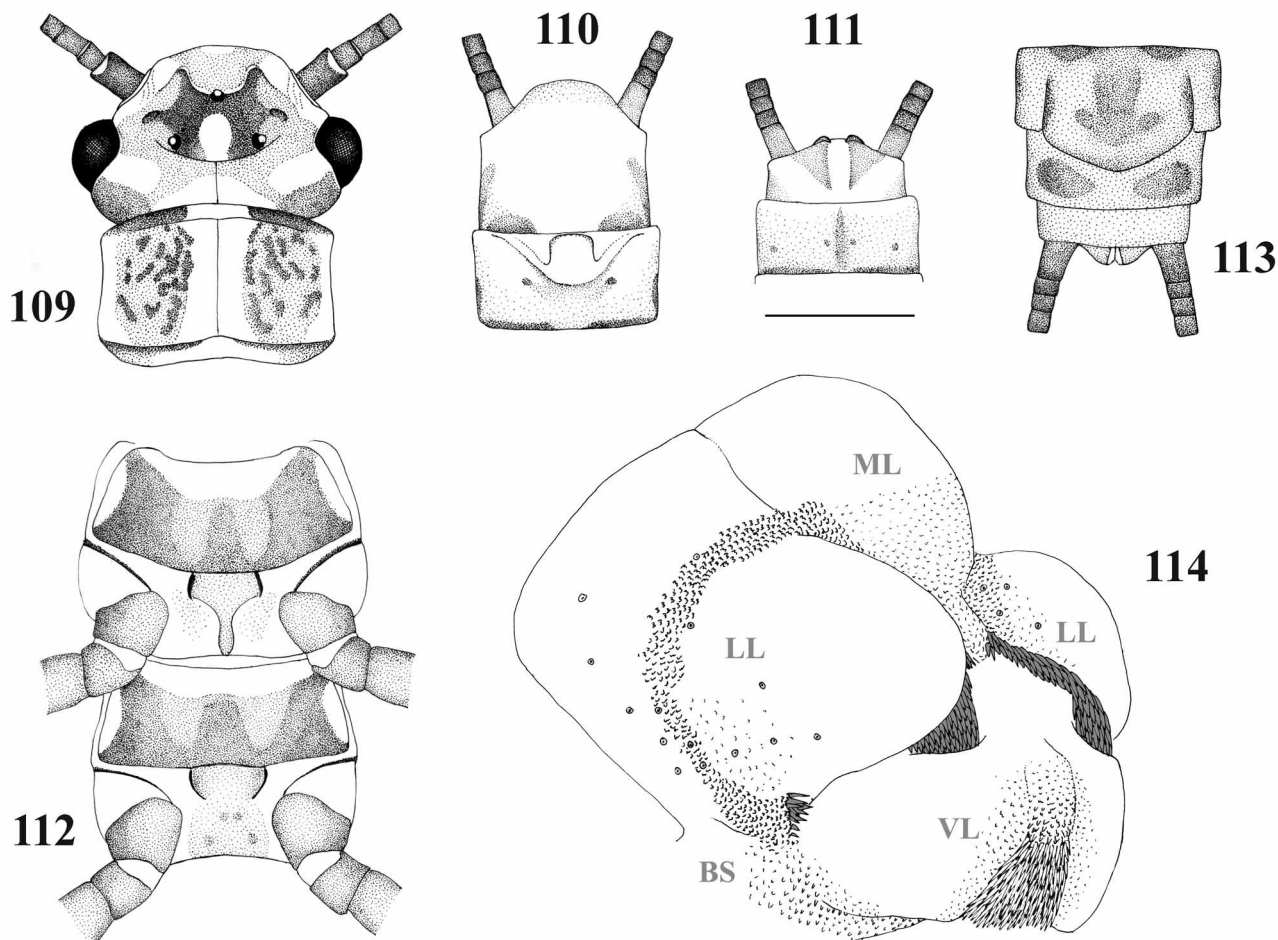
**Etymology:** The species is dedicated to Dr. Vladimir Pešić, Podgorica, Montenegro, noted Acarologist and the collector of the type series. The name is used as the genitive of a noun of male gender.

*Isoperla autumnalis* sp. n.

(Figs. 109–125, 127)

**Type material:** Holotype male: MONTENEGRO: Kolašin municipality: Redice, big side stream of the Morača River beneath the village, N 42°50.921' E 19°20.069', 560 m a.s.l., 10.10.2008, leg. L. Dányi, D. Murányi (HNHM: PLP2961; used for drawings Figs. 109–112, 114, terminalia prepared for SEM). Paratypes: same locality and date: 1f (HNHM: PLP3348; used for drawing Fig. 113), same locality and date: 3 larvae, 1 exuviae (HNHM: PLP3349; used for drawings Figs. 121–123, one maxilla of the exuviae prepared on slide).

**Diagnosis:** This species is characterized by a medial penial armature that is divided into an upper and a lower part, where only the upper armature is coloured. Additionally, the upper armature is further subdivided into diverging, elongated left and right parts; the lower medial armature remaining undivided. Scales of the armature are spike-like. Lateral penial armatures small.

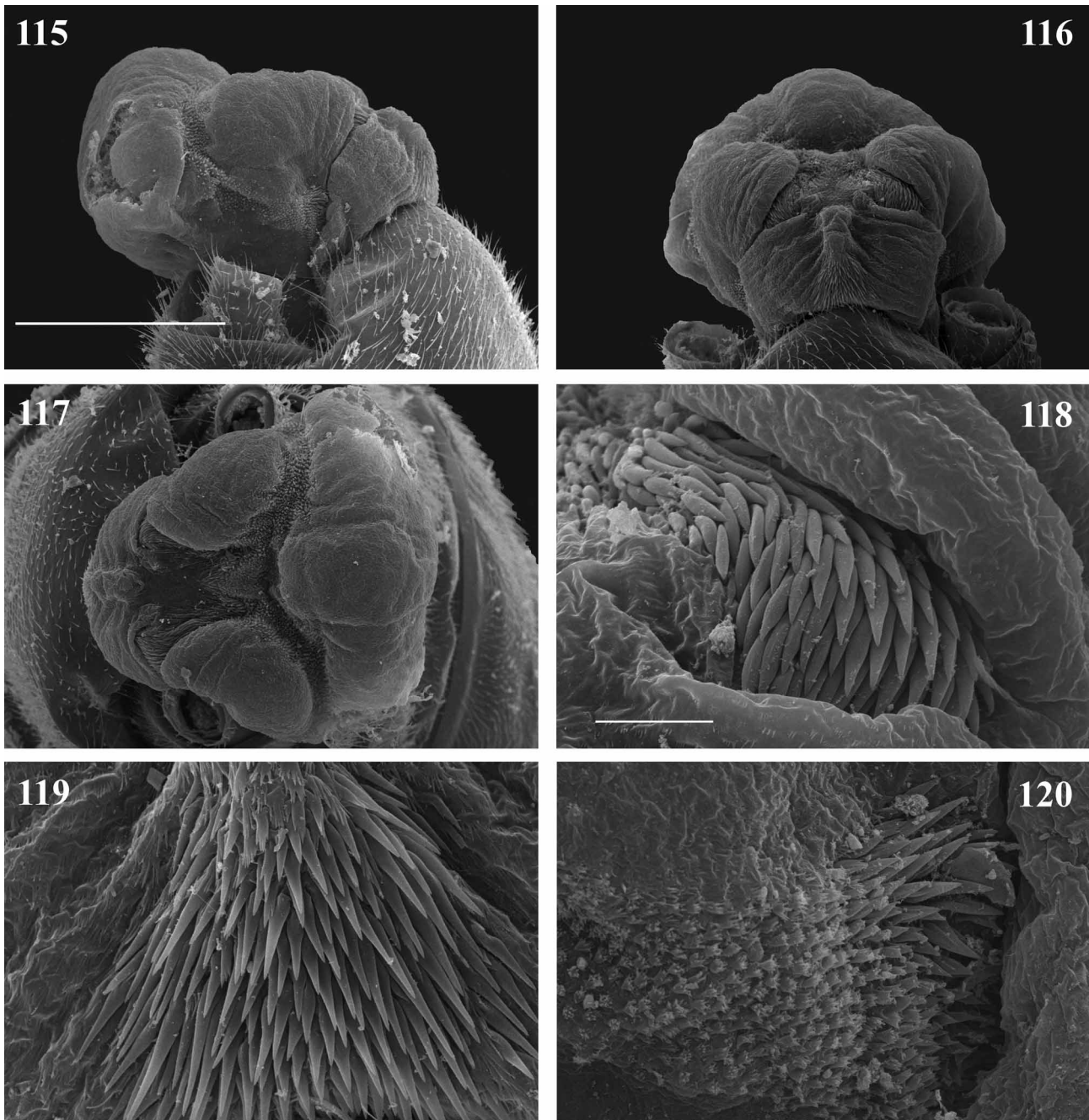


**FIGURES 109–114.** *Isoperla autumnalis* sp. n. — 109: head and pronotum; 110: male terminalia, ventral view; 111: male terminalia, dorsal view; 112: meso- and metathorax, ventral view; 113: female terminalia, ventral view; 114: extruded penis, dorso-lateral view (ML: medial lobe; LL: lateral lobe; VL: ventral lobe; BS: basal section) — scale 1 mm: 109–113; 0.5 mm: 114.

**Description:** Medium-sized species, macropterous. Body length: holotype male 10.5 mm, paratype female 11.0 mm; forewing length: holotype male 11.0 mm, paratype female 12.0 mm. General colour brown but the head and pronotum mostly yellow with dark brown markings; pilosity of the body and legs short and dense. Ground colour of the head yellow, but with large dark brown patch connecting the three ocelli, the tentorial callosities and the M-line, and with a more expanded brown area around the central dark brown patch (Fig. 109). Tentorial callosities and M-line distinct, a few wrinkles present between the M-line and the lateral margins; occiput lacks rugosities but dark brown laterally. Eyes as large as the area delimited by the three ocelli. Scape dark brown, pedicel and the following ten antennomeres are brown but distal part of the antenna is dark brown; palpi brown. Pronotum yellow, rectangular, edges angled; rugosities are large and dark brown, the surrounding area brown, anterior and posterior lines dark brown under and above the rugosities. Mesonotum dark brown but yellow anteriorly and medially,



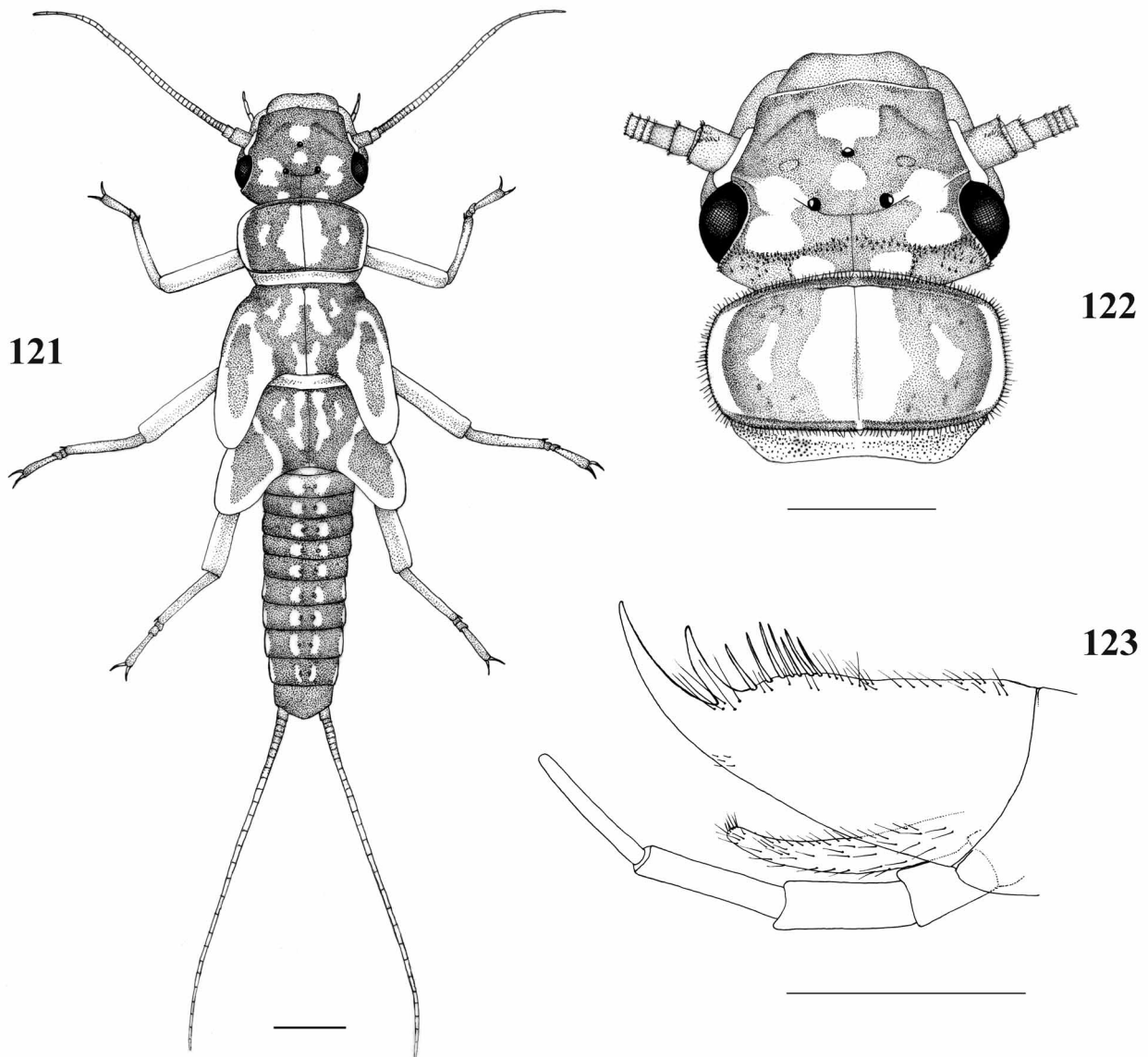
metanotum dark brown. Wings brownish, especially on the outer posterior half; venation dark brown but the anterior fifth of costa whitish. Ventral surface of thorax mostly pale, meso- and metabasisternum mostly dark brown, furcasternites pale, furcal pits dark brown (Fig. 112). Femora brown dorsally and pale ventrally, edges dark brown. Tibiae brown ventrally, dark brown dorsally; tarsi dark brown.



**FIGURES 115–120.** *Isoperla autumnalis* sp. n. — 115: extruded penis, lateral view; 116: extruded penis, caudal view; 117: extruded penis, dorsal view; 118: scales of the upper medial penial armature, caudal view; 119: scales of the lower medial penial armature, caudal view; 120: lateral penial armature — scale 0.5 mm: 115–117; 0.05 mm: 118–120.

Male abdomen: First tergite brown but yellowish anteriorly and medially. Tergites II–VII entirely brown with an interrupted anterior dark brown line. Tergites VIII–IX mostly light brown, but with a medial dark brown mark and an interrupted anterior dark brown line; tergite X yellowish with two brown, triangular patches medially and with posterolateral light brown edges (Fig. 111). Transverse row of four pigmented spots seen on all but tergite X. Ventral surface of abdomen mostly light brown, sternites II–VIII have a brown transverse anterior line interrupted in the middle, and brown lateral margins; sternites II–VII have a medial transverse row of four spots, sternite VIII with two spots. Vesicle of sternite VIII yellow, as wide as long, its posterior margin is rectilinear and only the edges

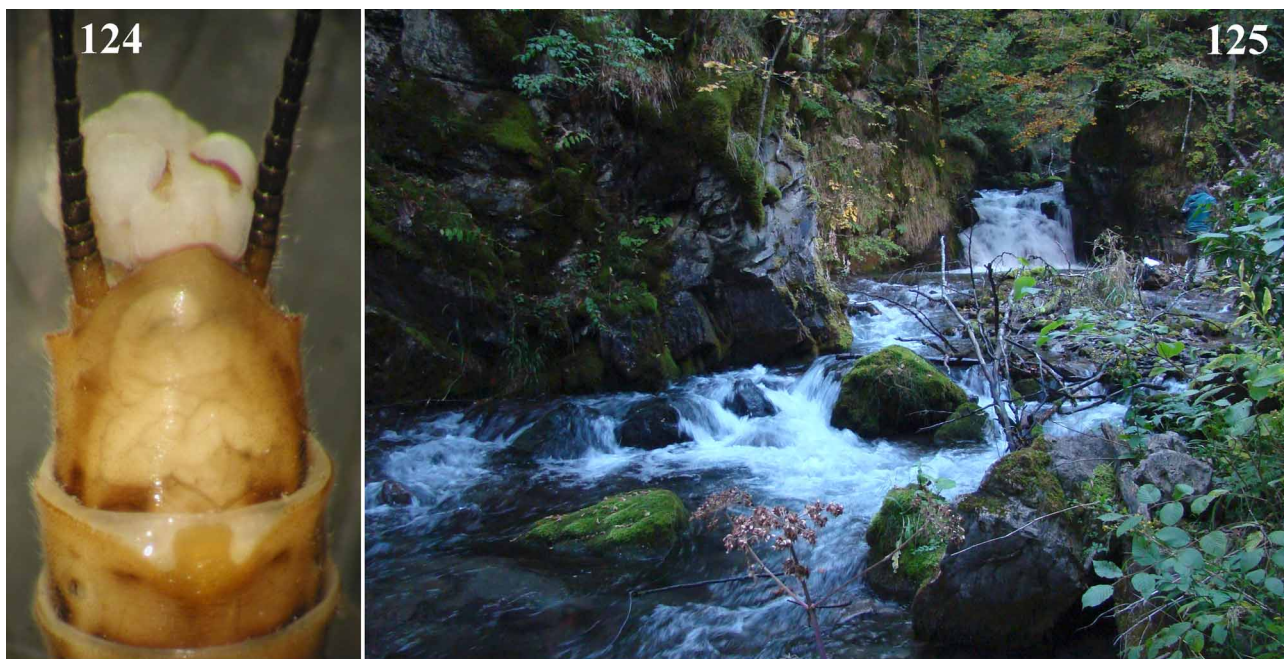
rounded; nearly as long as half the segment's length (Figs. 110, 124). Sternite IX yellowish but with brown patches anteriorly and anterolaterally, the medial penial armature was slightly transparent before extrusion of the penis in the field. Paraprocts brown; cerci dark brown, the first cercal segment brown.



**FIGURES 121–123.** *Isoperla autumnalis* sp. n. — 121: larval habitus, dorsal view (pilosity omitted); 122: larval head and pronotum, dorsal view; 123: larval maxilla, ventral view — scale 1 mm: 121–122; 0.5 mm: 123.

Penis: Divided into four lobes and a basal section in extruded position (Figs. 114–117, 124). The medial penial armature is divided into an upper and a lower part, only the upper part coloured; upper armature located on the medial lobe on its end at the ventral lobe, lower armature located on the central part of the ventral lobe. Lateral penial armatures located on the lateral lobes just above the basal section. The upper medial penial armature is further divided into a left and a right part which are diverging towards the ventral lobe, elongated and slightly folded. Length of the parts are 260  $\mu\text{m}$ , width 80  $\mu\text{m}$  (Fig. 118). The lower medial penial armature is undivided, subtriangular. Length 210  $\mu\text{m}$ , width 190  $\mu\text{m}$  (Fig. 119). The scales are spike-like, those on the lower part are longer and thinner, short ones of the upper armature slightly bent. Their length is 25–60  $\mu\text{m}$ , width 5–10  $\mu\text{m}$  (Figs. 118–119). Lateral penial armatures are small, consisting of only a few scales arranged in a wide patch. The scales are spike-like, their length is 15–30  $\mu\text{m}$ , width 5–10  $\mu\text{m}$  (Fig. 120). The ventral lobe is hemispherical, lateral sides bald. Its upper medial section bears small branched hair-like scales, these are grading into bigger ones towards the lower medial penial armature; the lobe bears a medial stripe of triangular scales beneath the armature, small triangular scales occur also basolaterally. The medial lobe is elongated, apical half slightly widening; most of the surface is bald, but bears very small ciliated scales on the ventral third. The lateral lobes are elongated, central part con-

stricted along a transverse stripe of hydra-like scales. This stripe is narrow, rises from the lateral penial armatures and continues to the upper medial penial armature. Further surface of the lobes is bald besides sparse, small ciliated scales ventrolaterally to the hydra-like scales. Sensilla settled along the lateral part of the lobes, but not in the apical end. The basal section covered mostly with triangular scales, but these are grading into hydra-like scales towards the dorsal origin of the lateral lobes.



**FIGURE 124–125.** *Isoperla autumnalis* sp. n. — 124: terminalia and extruded penis of the holotype; 125: type locality: Montenegro, Redice, side stream of the Morača River (photo L. Dányi).

Female abdomen: First tergite dark brown but yellowish anteriorly and medially. Tergites II–VIII entirely brown with an interrupted anterior dark brown line, tergites IX–X paler. Transverse row of four pigmented spots seen on all but tergite X. Sternites II–VIII light brown with a brown transversal anterior line interrupted in the middle, brown lateral margins and a medial transverse row of four spots. Subgenital plate covers most of sternite VIII and the anterior third of sternite IX; anterior part of sternite VIII with two dark patches. Plate light brown with dark brown margins, and an arrow-like dark brown patch medially; posterior margin rounded with a weak tip (Fig. 113). Sternite IX light brown, bearing two large dark brown lateral patches. Sternite X and the paraprocts light brown; cerci dark brown.

Mature larva: Body length of: 10.5 mm (n=1). General colour dark brown but with yellowish markings and pale legs (Fig. 121). Pilosity usual for the genus, pronotal, posterior tergal and cercal fringes relatively long and acute; swimming hairs present on the femora, tibiae and metatarsi, distal half of the cerci with scarce dorsal hair fringe of erect hairs five times longer than distal whorl of setae. Head dark brown with a yellow spot in front of anterior ocellus, interocellar spot small, a figure 8-shaped yellow spot between the posterior ocellus and the compound eye on each side, and a pair of spots posterior to the complete occipital row of setae (Fig. 122). M-line distinct, tentorial callosities barely visible; eyes normal sized. Scape, pedicel and the following five or six antennomeres are light brown, distal part of the antenna yellowish; palpi yellowish, mouthparts light brown. Lacinia bidentate, triangular, inner lacinial margin with seven stout setae and a row of short tin setae below subapical tooth; galea with long setae on the whole surface (Fig. 123). Pronotum rounded, dark brown with a wide yellow stripe medially, lateral fields with pair of small yellow elongate spots, lateral margins yellow. Mesonotum and metanotum mostly dark brown with pale, marbled pattern medially; wingpads whitish, with a large central dark brown stripe. Meso- and metasternum pale, furcasternites and furcal pits slightly darker. Legs pale, dorsal surface of femora and tibiae slightly darker. Abdominal tergites dark brown with a pair of elongated yellow spots medially. The spots decreasing in size towards the last tergite which is entirely dark brown; tergites VI–IX bear narrow lateral yellow markings. Transverse row of paired pigmented spots seen on all but the last segment. Ventral surface of abdomen pale brown, the distal segments darker. Paraprocts brown; cerci light brown in the basal segments, distal part yellowish.

Egg: unknown.

**Affinities:** See *I. tripartita tripartita* above.

**Ecology and distribution:** The species was collected at a big stream at 560 m in the upper Morača valley in October (Fig. 125, 127). Besides the imagos, one mature and two earlier instar larvae were collected, indicating a true autumnal flight period. The stream has rapid flow with cascades, and stony substrate, with sandy patches at slow or marginal sections. The stream flows through a rocky, forested gorge; the riparian vegetation consisting of *Rubus*, *Petasites* and some tall plants. The species was found in common with *Leuctra mortoni feheri* Murányi, 2007, *L. major*, *L. hirsuta*, *L. jahorinensis* Kačanski, 1972, *Protonemura hrabei* Raušer, 1956, *P. nitida* (Pictet, 1836), *Perla pallida* and *Besdolus illyricus* Kovács & Zwick, 2008. The new species is apparently rare since all the accompanying species were also collected from several similar habitats in the area.

**Etymology:** The name autumnalis (from the Latin word autumnalis, means autumnal) refers to the autumnal flight period of the species. Used as an attributive adjective, gender neutral.

### Annotated checklist of the Balkanian *Isoperla* species

Eighteen species of *Isoperla* are recorded from the Balkans. Twelve species and one subspecies are endemic to the Balkan peninsula (Figs. 126–127). The global and regional distribution, known habitat preference, and taxonomic status are discussed briefly. Abbreviations: F—female; L—larva; E—egg; D—drumming calls; S—SEM structures of the penis. DNA studies were not carried out for any species. Species known from the Aegean Isles of the Anatolian shore (Lesbos, Chios, Ikaria) not included.

#### *acicularis* group:

*Isoperla auberti* Raušer, 1965a — East Balkans (Fig. 126); Bulgaria; submontane streams; poorly known; L, E, D, S unknown.

#### *difformis* group:

*Isoperla inermis* Kačanski & Zwick, 1970 — Dinaric Mts (Fig. 127); Bosnia-Herzegovina, Croatia; karst springs; further studies needed (Popijač & Sivec 2009); E, D, S unknown.

#### *grammatica* group:

*Isoperla grammatica* (Poda, 1761) — Europe; Albania, Bosnia-Herzegovina, Bulgaria, Greece (present paper), Kosovo, Macedonia, Montenegro, Serbia, Slovenia; rivers and large streams; further studies needed (Tierno de Figueroa & Vinçon 2005). New for the fauna of Greece, data: GREECE: Grevena prefecture: Eleftherohori, Venetikos River, N 40°03'06.6" E 21°28'50.2", 475 m, 13.05.2006, leg. L. Dányi, J. Kontschán, D. Murányi: 1m (HNHM; terminalia prepared for SEM); Zakas, Venetikos River, N 40°02'19.3" E 21°17'19.2", 700 m, 14.05.2006, leg. L. Dányi, J. Kontschán, D. Murányi: 1m, 4 larvae (HNHM).

*Isoperla buresi* Raušer, 1962 — Carpathians and Balkans; Bosnia-Herzegovina, Bulgaria, Macedonia; montane streams; moderately known; E, D unknown, S studied for the present paper but not detailed.

#### *oxylepis* group:

*Isoperla oxylepis oxylepis* (Despax, 1936) — Central Europe; Bosnia-Herzegovina, Croatia, Montenegro, Serbia, Slovenia; submontane and montane streams; sufficiently known.

*Isoperla oxylepis balcanica* Raušer, 1962 — Central Balkans (Fig. 126); Albania (present paper), Bulgaria, Kosovo, Macedonia?, Montenegro; montane and submontane streams; moderately known; L, D unknown.

*Isoperla bosnica* Aubert, 1964 stat. rev. — Dinaric Mts (Fig. 127); Bosnia-Herzegovina, Macedonia?, Montenegro (present paper); rivers or large streams?; poorly known; F, L, E, D, S unknown.



*Isoperla submontana* Raušer, 1965a — Central Balkans (Fig. 127); Bulgaria, Macedonia; submontane and montane streams; poorly known; F, L, E, D, S unknown.

*pawlowskii* group:

*Isoperla pawlowskii* Wojtas, 1961 — Central and East Europe; Serbia; rivers; moderately known; E, D, S unknown.

*rivulorum* group:

*Isoperla rivulorum* (Pictet, 1841) — Central and South Europe; Albania? (Pongrácz 1923), Croatia, Greece? (Navás 1923), Kosovo? (Pongrácz 1923), Macedonia? (Navás 1923), Slovenia; submontane and montane streams; moderately known; E unknown, S studied for the present paper but not detailed.

*Isoperla citrina* sp. n. — Korab Mts (Fig. 127); Albania (present paper); montane torrents; poorly known; F, L, E, D unknown.

*saccai* group:

*Isoperla russevi* Sowa, 1970 — East Balkans (Fig. 126); Bulgaria, Macedonia; montane torrents; poorly known; L, E, D, S unknown.

*albanica* group:

*Isoperla albanica* Aubert, 1964 — East Alps and West Balkans; Albania, Bosnia-Herzegovina, Macedonia, Montenegro, Serbia; montane streams; moderately known; L, D unknown.

*Isoperla belai* Illies, 1963 — Carpathians and Balkans; Bulgaria, Serbia, Macedonia; submontane and montane streams; poorly known; L, E, D unknown, S studied for the present paper but not detailed.

*silesica* group:

*Isoperla breviptera* Ikonov, 1980 — Šar Planina (Fig. 126); Macedonia; montane torrents; poorly known; L, E, D, S unknown.

*Isoperla vecianensis* Ikonov, 1980 — Jablanica Mts (Fig. 127); Albania (present paper), Macedonia; montane brooks; poorly known; L, E, D, S unknown.

*tripartita* group:

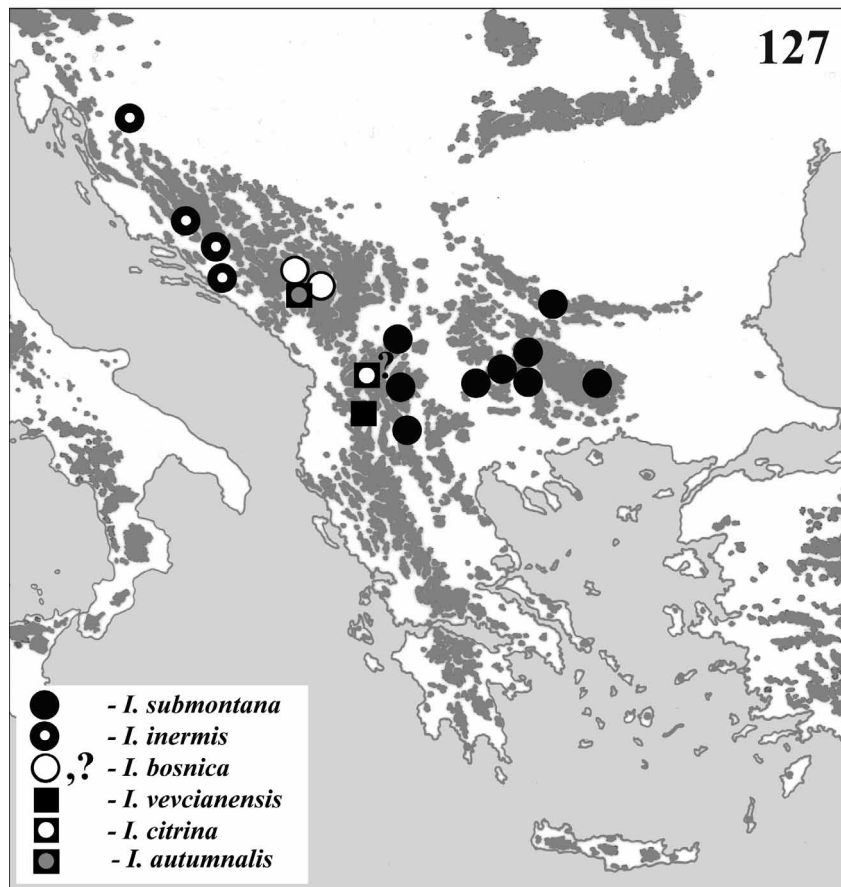
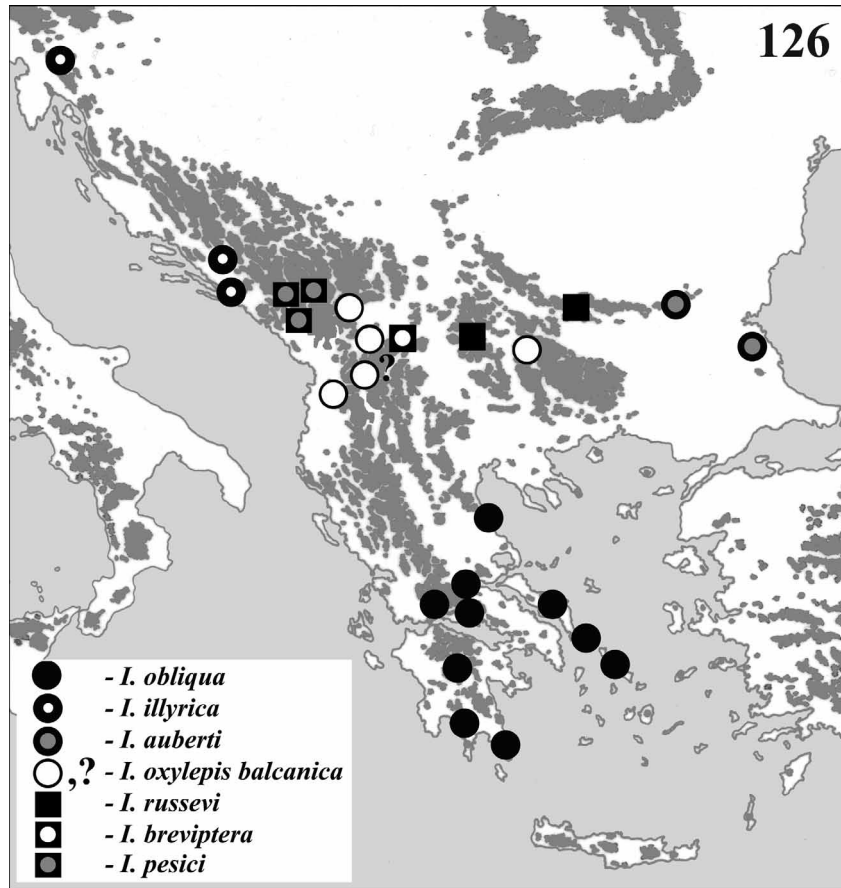
*Isoperla tripartita tripartita* Illies, 1954 — Central and Southeast Europe; Albania, Bosnia-Herzegovina, Bulgaria, Croatia, Greece, Kosovo, Macedonia, Montenegro, Serbia; submontane and montane streams and brooks; further studies needed (present paper); D unknown.

*Isoperla illyrica* Tabacaru, 1971 — Dinaric Mts (Fig. 126); Bosnia-Herzegovina, Croatia, Slovenia; karst springs and brooks; poorly known; L, E, D, S unknown.

*Isoperla obliqua* Zwick, 1978 stat. n. — South Balkans (Fig. 126); Greece; montane and submontane streams; further studies needed (present paper); L, E, D, S unknown.

*Isoperla pesici* sp. n. — Central Montenegro (Fig. 126); Montenegro (present paper); karst springs and streams; poorly known; L, D, S unknown.

*Isoperla autumnalis* sp. n. — Morača valley (Fig. 127); Montenegro (present paper); montane streams; moderately known; E, D unknown.



FIGURES 126–127. Distribution of the Balkanian endemic *Isoperla* Banks, 1906 — grey areas are above 1000 meters.

## Significant records of additional Plecoptera (Nemouridae & Leuctridae) associated with this work

Some of the accompanying species mentioned above are representing new country records for the fauna of Albania and Montenegro. Their data and global distribution are discussed briefly.

*Amphinemura triangularis* (Ris, 1902)

ALBANIA: Dibër district: Radomirë, Mts Korab, spring and stream E of the village, N 41°49.032' E 20°30.016', 1440 m, 26.06.2007, leg. L. Dányi, Z. Eröss, Z. Fehér, A. Hunyadi, D. Murányi: 7m 11f (HNHM).

European species, it was known from all the Balkan countries (Bosnia-Herzegovina, Bulgaria, Croatia, Greece, Kosovo, Macedonia, Montenegro, Serbia and Slovenia) with the exception of Albania.

*A. quadrangularis* Zwick, 1978

ALBANIA: Dibër district: Radomirë, Mts Korab, torrent E of the village, N 41°49.131' E 20°30.160', 1460 m, 26.06.2007, leg. D. Murányi: 6m 2f (HNHM).

South Balkanian species, it was known from Greece, Kosovo, Macedonia and Montenegro.

*Nemoura caligula* Zwick, 1978

ALBANIA: Librazhd district: Steblevë, Mts Jablanica, brook SE of the village, N 41.27905° E 20.50103°, 1865 m, 03.07.2008, leg. Z. Barina, D. Pifkó, A. Vojtkó: 1m 1f (HNHM).

It was known only from the Pindos Mountains of Greece.

*Leuctra jahorinensis* Kačanski, 1972

MONTENEGRO: Kolašin municipality: Redice, big side stream of the Morača River beneath the village, N 42°50.921' E 19°20.069', 560 m, 10.10.2008, leg. L. Dányi, D. Murányi: 1f (HNHM).

It was known only from the Jahorina Mountains of Bosnia-Herzegovina.

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