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# THE MONGOLIAN SPECIES OF ISOPERLINAE (PLECOPTERA: PERLODIDAE)

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A key to the adults of the 10 Mongolian species of *Isoperla* and *Kaszabia* is provided. It is accompanied by first descriptions and illustrations of species-specific details of male and female genitalia, and eggs. *I. eximia* ZAPEKINA-DULKEIT is a new record for the country. *I. potanini* (KLAPÁLEK) is redescribed and removed from *Mesoperlina,* a genus unknown in Mongolia.

Key words: stoneflies; Isoperla; Kaszabia; Mesoperlina; redescription; taxonomy; key; new record; Mongolia

## INTRODUCTION

The stoneflies of Mongolia were repeatedly studied, recently mainly by RAUŠER (1968), ZHILTZOVA (1972, 1974, 1975, 1977, 1979, 1982), and ZHILTZOVA and VARYKHANOVA (1984, 1988). However, new species are still being found, and not all named Mongolian species are as yet adequately described. This is also true for the very large Holarctic genus *Isoperla*. Although most Mongolian species are included in the key to the Russian fauna (ZHILTZOVA & ZAPEKINA-DULKEIT 1986) more structural details should be known and compared to identify all the species without doubt, and to recognize their phylogenetic relationships. For example, *Kaszabia spinulosa* RAUŠER is shown to have very close relatives among *Isoperla*, and probably belongs to the latter genus.

We therefore describe and illustrate previously incompletely known details of genitalia and eggs permitting reliable identifications of all Mongolian Isoperlinae and provide a key to the adults. A species originally described in *Mesoperlina* is transferred to *Isoperla* and *I. eximia* ZAPEKINA-DULKEIT is recorded from Mongolia for the first time, raising the number of known Mongolian *Isoperla* species to nine.

## MATERIAL AND METHODS

Our study material consists of alcohol-preserved specimens from recent collections by P. SURENKHORLOO around the Hydrobiological Field Station Khonin Nuga in the Selenge province of Mongolia, and of previously unstudied collections of the late Prof. Z. KASZAB made during his 4th to 6th expeditions to Mongolia. These old collections were lent to the late J. RAUŠER who had studied earlier Mongolian collections by Z. KASZAB (RAUŠER 1968). However, health problems prevented him to study the present material which was eventually forwarded to P. ZWICK.

The KASZAB collections are deposited in the Hungarian Natural History Museum, Budapest, except some duplicates donated to the authors. In the lists of material, we quote Z. KASZAB's published (KASZAB 1966, 1968a, b) collection protocol numbers in brackets. Most of the fresh material remains in the collection of P. SURENKHORLOO in Ulaanbataar, excepting some duplicates given to P. ZWICK, Schlitz.

We were fortunate to receive some comparative material from Kazakhstan collected by V. DEVYATKOV. We also borrowed type material of two Mongolian species of *Isoperla* from the following institutions: HNHM – Hungarian Natural History Museum, Budapest, ZIAS – Zoological Institute, Russian Academy of Sciences, St. Petersburg.

All the specimens were studied with Wild dissecting microscopes at magnifications up to 100, slide mounted parts (in Euparal) were examined in transmitted light with a Leica DMLS compound microscope, at magnifications up to 630. Male genitalia were artificially everted following the procedure outlined by ZWICK (1982). Eggs were dissected out of females, cleaned of membranes with fine needles, punctured, and mounted on slides.

## TAXONOMY

### Key to adult Mongolian Isoperlinae

1 Femora short, bristly. Each cercus segment with an apical whirl of long setae. No ventral lobe on male sternite 8. Female subgenital plate short, shallowly bilobed. Egg with 6 longitudinal ribs (Fig. 8) *Isoperla potanini*

1' Femora slender, not bristly. Cercus segments caudally with a single ventral seta very much longer than the others. Genital characters variable. Egg not ribbed 2

2 Head pale with a compact isolated central dark mark 3

2' The dark mark in the middle of head includes some variably extended pale area; the dark pattern reaching the eyes, the occiput, or the front edge of head 4

3 Dark mark on head posteriorly excised. Male: vesicle dark, narrow, a little widened caudally, distally truncate. Distal edge of male subgenital plate truncate, wider than front of segment 9, penis with single large symmetrical

sclerite. Female subgenital plate distinctly brace-like, strongly pigmented (Figs 1, 2) *I. lunigera*

3' Mark on head squarish. Male: vesicle on sternite 9 parallel-sided. Subgenital plate caudally rounded, of normal width; penis without major sclerites. Female subgenital plate little extended and pigmented *I. maculata*

4 Males 5

4' Females 11

5 Abdominal segments 3 and 4 with a pointed lateral process *Kaszabia spinulosa*

5' Abdominal segments simple, without lateral process 6

6 Sternite 8 with a distinct racket-shaped ventral lobe 7

6' Rear edge of sternite 8 nearly simple, only a little swollen (Fig. 7) *I. asiatica*

7 Ventral lobe large, broad, with a hair fringe around periphery 8

7' Ventral lobe slender, narrow, without striking hair fringe 10

8 Paraprocts simple, penis with a single large asymmetrical sclerite 9

8' Tips of paraprocts spinulose; penis only with minute sclerotized teeth (Figs 10b, c) *I. mongolica*

9 With small pale occipital mark, middle of mesoscutum darker than sides (Fig. 3a). Penis sclerite basally very wide, crested (Figs 3d, e, 6a) *I. altaica*

9' Without pale occipital mark, middle of mesoscutum paler than sides (Fig. 6c). Penis sclerite basally less wide, not distinctly crested (Fig. 6b) *I. eximia*

10 Penis with a pair of large curved sclerites usually visible by transparency (Fig. 11b) *I. kozlovi*

10' Penis without large sclerites, only a V-shaped row of sharp teeth (Figs 9b-c) *I. obscura*

11 Subgenital plate triangular, long, tip extending to end of sternite 9 12

11' Subgenital plate shorter 13

12 Head largely pale, with horseshoe-shaped dark central mark *K. spinulosa*

12' Head largely infuscate, narrow pale marks only between ocelli and on occiput (Fig. 9a) *I. obscura*

13 Subgenital plate covers half of sternite 9 *I. kozlovi*

13' Subgenital plate barely produced 14

14 Center of head, between ocelli uniformly infuscate (Fig. 3a). A prominent ring surrounds base of egg collar (Fig. 4), chorion not punctate 15

14' A pale mark in center of head, between ocelli. Eggs simple, without ring around collar, chorion distinctly punctate 16

15 Small pale occipital mark present, middle of mesoscutum darker than sides (Fig. 3a) *I. altaica*

15' Without pale occipital mark, middle of mesoscutum paler than sides (Fig. 6c) *I. eximia*

16 Head pale in front of anterior ocellus (Fig. 7a). Egg ca 350 μm long (Fig. 7g) *I. asiatica*

16' Head infuscate in front of anterior ocellus (Fig. 10a). Egg ca 270 μm long (Fig. 10d) *I. mongolica*

## DESCRIPTIONS

### *Isoperla lunigera* (KLAPÁLEK, 1923b)
(Figs 1, 2, 5a)

*Chloroperla lunigera* KLAPÁLEK, 1923, Ann. Soc. Ent. Belg. 63: 26.
*Isoperla lunigera* – ZWICK *et al*. 1971, Ent. Obozr. 50: 862.
*Isoperla flavescens* ZHILTZOVA et POTIKHA – PUREVDORJ *et al.*, 2003, misidentification.

Material studied. MONGOLIA, Selenge aimak, Mandal sum: Khonin Nuga, Eroo River [49°05'N, 107°17'E], 2 ♂♂, 14.VI.2002; 3 ♂♂, 8 ♀♀, 17./18.VI.2002; 2 ♂♂, 6 ♀♀, 16.VI.2003; 2 ♂♂, 4 ♀♀, 19.VI.2003; 4 ♀♀, 21.VI.2003; 5 ♀♀, 26.VI.2003; 1 ♀, 4.VII.2003; 40 ♀♀, 2 ♂♂, 6.VII.2003; 2 ♀♀, 1.VIII.2003; 3 ♂♂, 1 ♀ 4.VIII.2003; Khonin Nuga, Khongi River, 1 ♀, 19.VI.2003; Eroo Hot Spring [49°05'N, 107°17'E], Ar-Ilchlekh River, tributary of Sharlan River, 1 ♀, 28.VI.2003; upper reaches of Bar-Chuluut River [48°58'638N, 106°57'013E], tributary of Eroo River, 2 larvae, 21.VIII.2001 (in coll ZWICK) (all leg. P. SURENKHORLOO). We also studied additional specimens from the Russian Far East, in our collections.

*I. lunigera* has a characteristic contrastive head pattern (Fig. 1a). The species was redescribed by ZWICK *et al.* (1971), after comparing some fresh material from

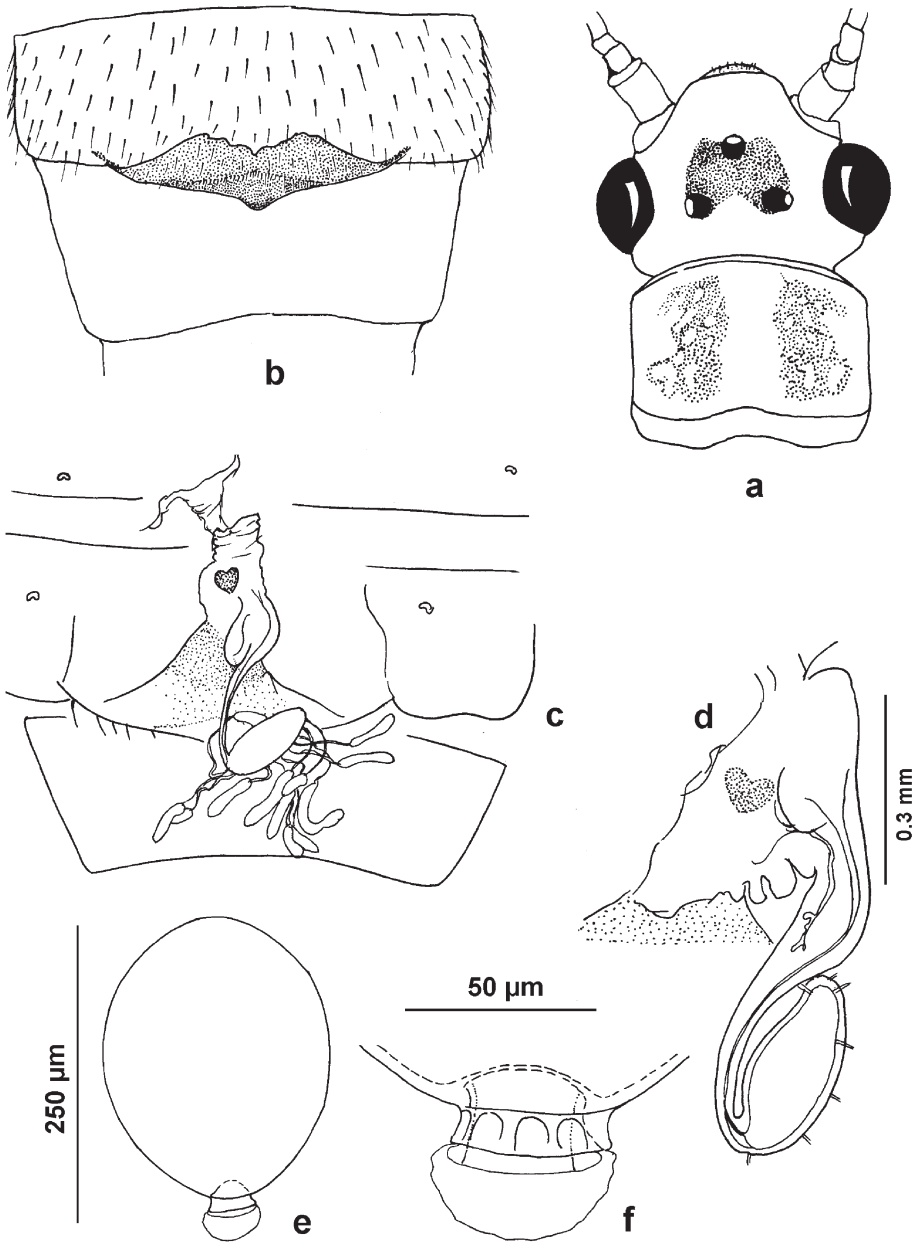


**Fig. 1.** *Isoperla lunigera* (KLAPÁLEK). a = head and pronotum, b = female sternite 8, c = dissected sternites 8 and 9 in dorsal view, showing genital pouch, receptacle, and accessory glands; d = detail of genital pouch and receptacle, e = egg, f = detail of collar indicating chorion thickness and inner parts of anchor in broken lines

the Amur region and Primorje in the Russian Far East with the female holotype (from Irkutsk, in Mus. St. Petersburg).

Size. Front wing length, ♂♂ 10.3–11.0 mm, ♀♀ 11.2–11.7 mm.

Male. We reprint the figure of the distinctive, large, symmetrical penial sclerite (Fig. 2) for comparison with *I. altaica* and *I. eximia*.

Female. The strongly pigmented brace-like subgenital plate (Fig. 1b) is characteristic. There are earlier descriptions and figures, respectively (ZWICK *et al*. 1971, ZHILTZOVA & ZAPEKINA-DULKEIT 1986). Dissections revealed a wide funnel-shaped entry into the female copulatory pouch which houses a small dark heart-shaped sclerite. The oviducts attach anteriorly. Dorsally, the pouch carries a bag-like extension apparently receiving the large male sclerites during copulation. The long duct of the oval seminal receptacle is attached at the front of this extension and carries more than 10 accessory glands.

Egg (Fig. 1e, f). Smaller than the eggs of other Mongolian *Isoperla* species, only 250×170 µm, collar included. Chorion very thin, about 4 µm thick, seemingly structureless. However, at magnification 650, very fine shallow punctuation appears. Collar simple and short; its base is forming a rounded projection into the egg. On the outside, the collar has several horseshoe-shaped impressions separated by minute longitudinal crests. Anchor fungi-form with massive stalk. Micropyles not observed.

Larva (Fig. 5a). One of the larvae from Bar-Chuluut River contained some of the characteristic eggs; its pattern is quite similar to the larva ascribed to *I. altaica* by ZAPEKINA-DULKEIT (1955).

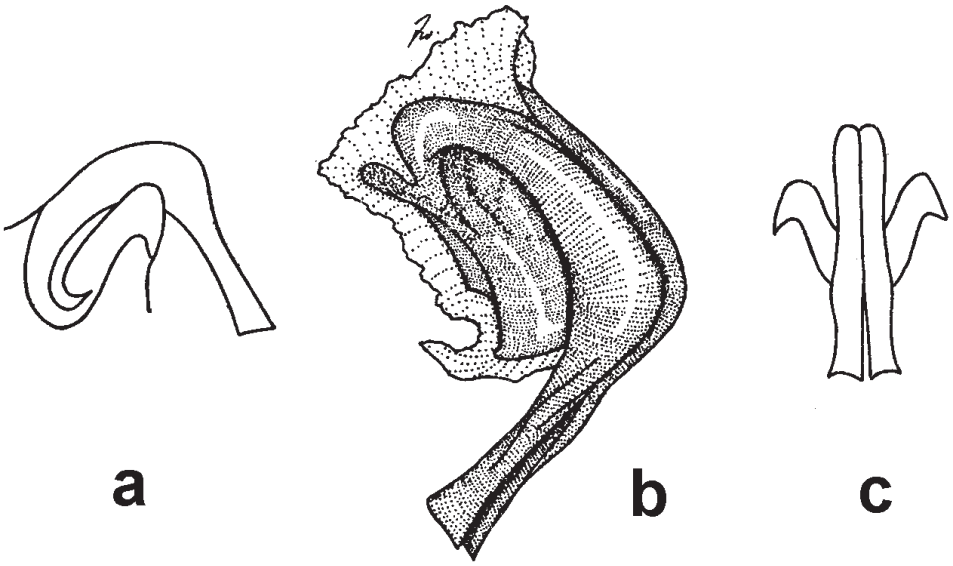


**Fig. 2.** *Isoperla lunigera* (KLAPÁLEK). a–c = penis sclerite in lateral, oblique lateral, and caudal views, respectively (from ZWICK *et al*. 1971)

Diagnostic characters and affinities. Head pattern, penial sclerite and the brace-like pigmented female subgenital plate are distinctive. The female subgenital plate has some resemblance with *Kaszabia spinulosa* whose plate is, however, much longer (RAUŠER 1968, ZHILTZOVA & ZAPEKINA-DULKEIT 1986). Glands on the seminal receptacle and its duct are a synapomorphy of *Systellognatha* (ZWICK 2000) but the heart-shaped sclerite in the genital pouch of the present species is unusual.

Notes. The present species was recorded from Mongolia as *Isoperla flavescens* ZHILTZOVA et POTIKHA (PUREVDORJ *et al*. 2003), in error; *I. flavescens* is not known from Mongolia. For affinities of *I. lunigera*, see under *I. eximia*.

## *Isoperla altaica* ŠÁMAL, 1939
(Figs 3, 4, 5b-d, 6a)

*Isoperla altaica* Šámal: 421, figs 4, 5.
*Isoperla altaica*- ZAPEKINA DULKEIT, 1955. 169, figs 5–9.

Material studied. MONGOLIA: Chovd aimak, ca 35 km N Somon Uenč, Mongol Altaj Gebirge, 1750m, kl. Nebenbach des Uenč gol, 8.VII.1966, 1 ♂♂ [KASZAB 646]. Selenge aimak, Mandal sum, Khonin nuga: Bar-Chuluut River [48°58'638N, 106°57'013E], tributary of Eroo River, 1 ♀, 07.IX.1999; 3 ♀♀, 21.VIII.2001; 2 ♂♂, 4 ♀♀, 04.VIII.2003 (all leg. P. SURENKHORLOO). KAZACHSTAN, surroundings of Ust Kamenogorsk [49°58'N, 82°36'E], basin of River Gornaya Ulbinka, 11.6.2000, leg. & det. V. DEVYATKOV, 8 ♂♂, 9 ♀♀ (in coll. ZWICK). RUSSIA, Kurile Islands, Iturup Island, 1 ♂, 1 ♀, 1.8.1998, Lake Iturup, River Blagodatnaya, leg. & det. V. TESLENKO.

The male type specimen was collected on the River Karas, outflow of Lake Kara-Koli, by the staff of the Hydrobiological State Institute in Leningrad and was given to J. ŠÁMAL for study. The type is not in the collection of the Zoological Institute St. Petersburg today (ZHILTZOVA 1995) and may be lost. ŠÁMAL emphasized its slight brachyptery. His illustration shows a large ventral lobe on sternite 8. Tergite 10 was described and illustrated as "partly open" medially. However, this condition was probably an artifact, perhaps through drying because there is really only a weakly sclerotized median strip.

The original description of body pattern is not detailed. We accept the interpretation of the first revising author (ZAPEKINA-DULKEIT, 1955; 1975) who distinguished *I. altaica* from a new species, *I. eximia*; see also there. The central dark mark on the head is entire and extends to the front edge of the pronotum. In front of it, the head is pale to its front border. A less dark band-like transverse mark extends from the centre of head to the compound eyes. The median part of the meso- and methathoracic scuta is darker than the lateral portion (Fig. 3a).

Size. Fore wing length, ♂♂ 8.2–8.8 mm, ♀♀ 10.5 mm (specimens from Khonin nuga); ♂♂ 8.0–8.2 mm, ♀♀ 10.3–11.2 mm (specimens from Kazakhstan).

Male. Specimens from Kazakhstan are slightly brachypterous, i.e., the wings extend barely beyond the abdominal tip while those from Khonin Nuga (Mongolia, upper reaches of Eroo River) have normal wings. Abdomen dark brown both dorsally and ventrally, except the large ventral lobe on sternite 8 which is strikingly pale yellow, especially the rounded distal edge. Tergite 10,

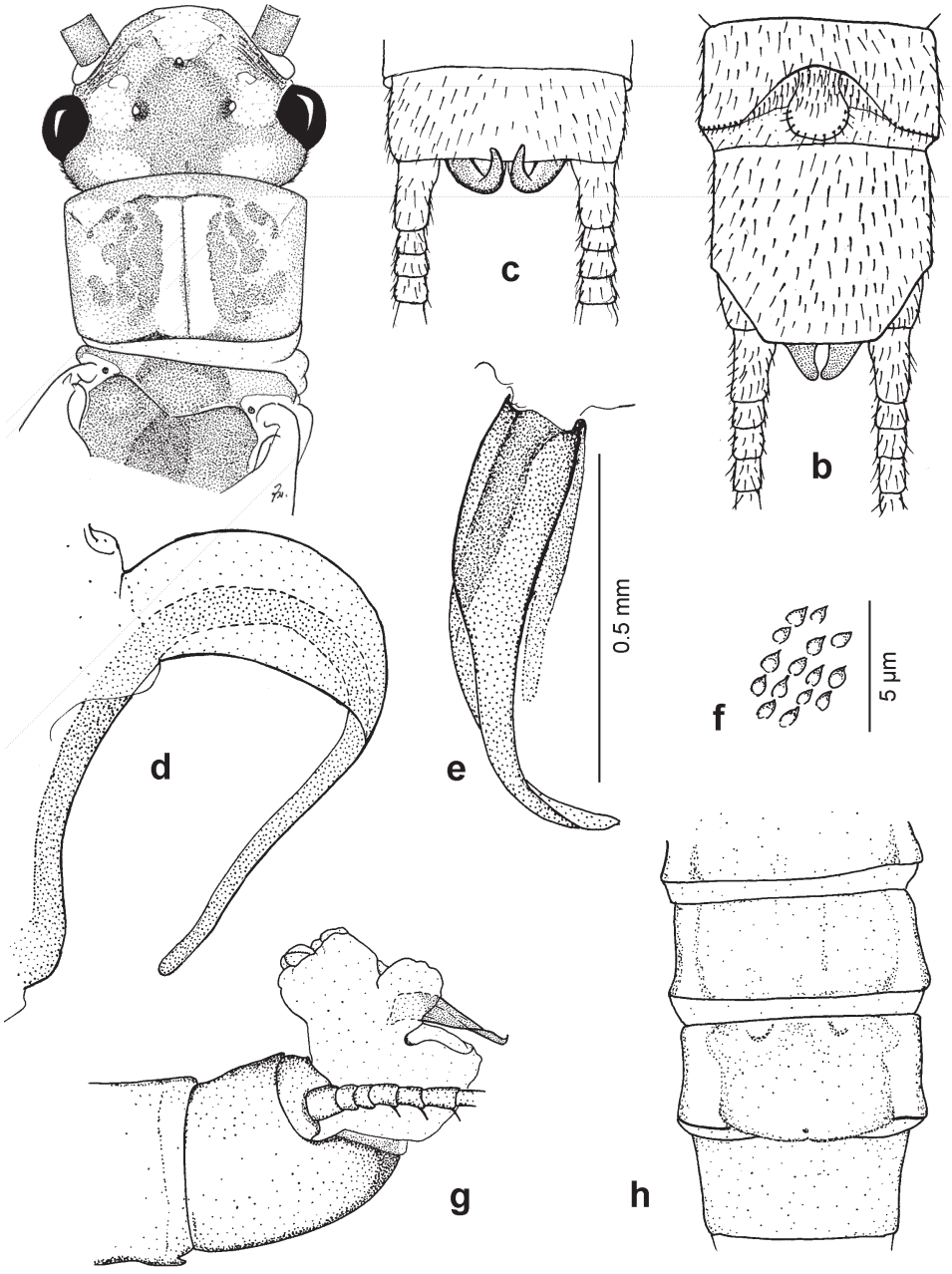


**Fig. 3.** *Isoperla altaica* Šámal. a = head and prothorax, b, c = male abdominal tip in ventral and dorsal views, respectively; d, e = penis sclerite in lateral and caudal views, respectively, f = spicules on penial membrane next to large sclerite, g = male with everted penis, lateral view, h = female abdominal segments 6–9, ventral view

paraprocts and general shape of subgenital plate normal (Figs 3b, c). Pilosity of dark brown cerci resembling those of *I. asiatica*; see there. Penis membraneous, armed with a large asymmetrical sclerite (Figs 3e, f) which stands on the rear face of the everted organ, its slender, slightly twisted apical section points downward (Fig. 3g). Minute scales (Fig. 3f) cover most of the surrounding membrane.

The appearance of the asymmetrical penis sclerite differs depending on slight differences in the positioning of specimens. In side view, the basal part of the sclerite is broad, more than 3 times wider than the apical part. However, when viewed from the apex of the sclerite one notices that only that side of the sclerite is enlarged which lies on top when the curved apex points to the right hand side. The upper edge of this side forms a blunt crest, the opposite side is low and rounded (Figs 3d, e, 6a).

Female (Fig. 3h). Subgenital plate short, projecting only a little, distal margin shallowly indented in the middle, shiny, dark, finely pilose, like the rest of the segment.

Egg. Plump, regular oval with blunt poles. There is a prominent egg shoulder because a raised ring surrounds the plateau from which the collar rises (Fig. 4). The collar lacks distinct meshes but has a finely crenulate margin. The base of the fungiform anchor in the deeply embedded center of the collar is straight and flat. Micropyles not observed.

Eggs from Khonin Nuga measure 360×250 µm and have a thin, structureless chorion of uniform width (7–8 µm). In contrast, eggs from near Ust Kamenogorsk are smaller (295×235 µm), their chorion is finely punctured, in optical section a fine radial striation extends across the chorion which is almost 13 µm thick near the equator of the egg, but only about 9 µm near the opercular pole or next to the ring around the collar.

Larva (Fig. 5b). We illustrate a pharate male in its larval skin which had the penis sclerite already developed. It differs from the larva previously assigned to *I. altaica* (ZAPEKINA-DULKEIT, 1955); see under *I. lunigera*.

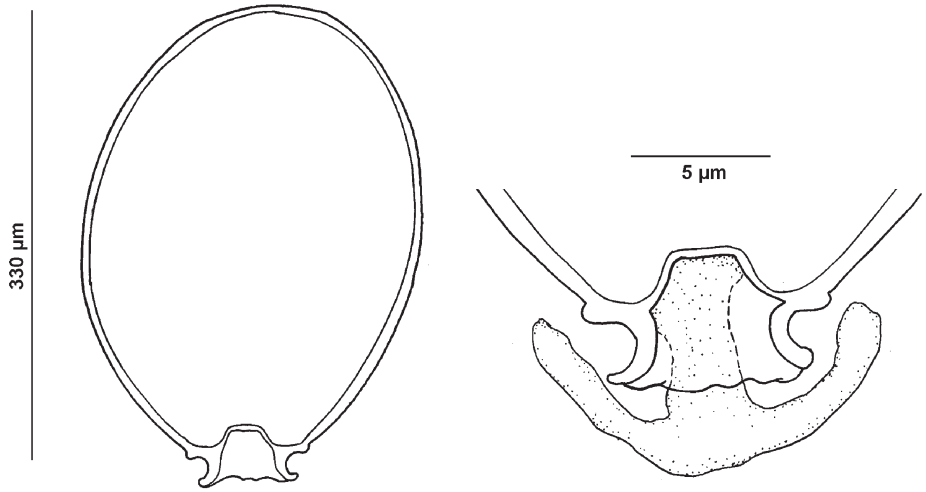


**Fig. 4.** *Isoperla altaica* ŠÁMAL, egg and details of collar; specimen from Khonin Nuga

*Notes and affinities.* The penial sclerites of all specimens are similar. However, there are differences in wing length, egg size and egg chorion thickness between populations. Future studies based on more material are desirable.

*I. lunigera, I. altaica* and *I. eximia* belong to the *I. sordida* species-group distinguished by a large unpaired penis sclerite freely projecting from the membrane. At this time, the present three are the only known Palaearctic members of the group which includes a number of species in western North America (SZCZYTKO & STEWART 1979). The asymmetry of the sclerite suggests that *I. altaica* and *I. eximia* are close allies.

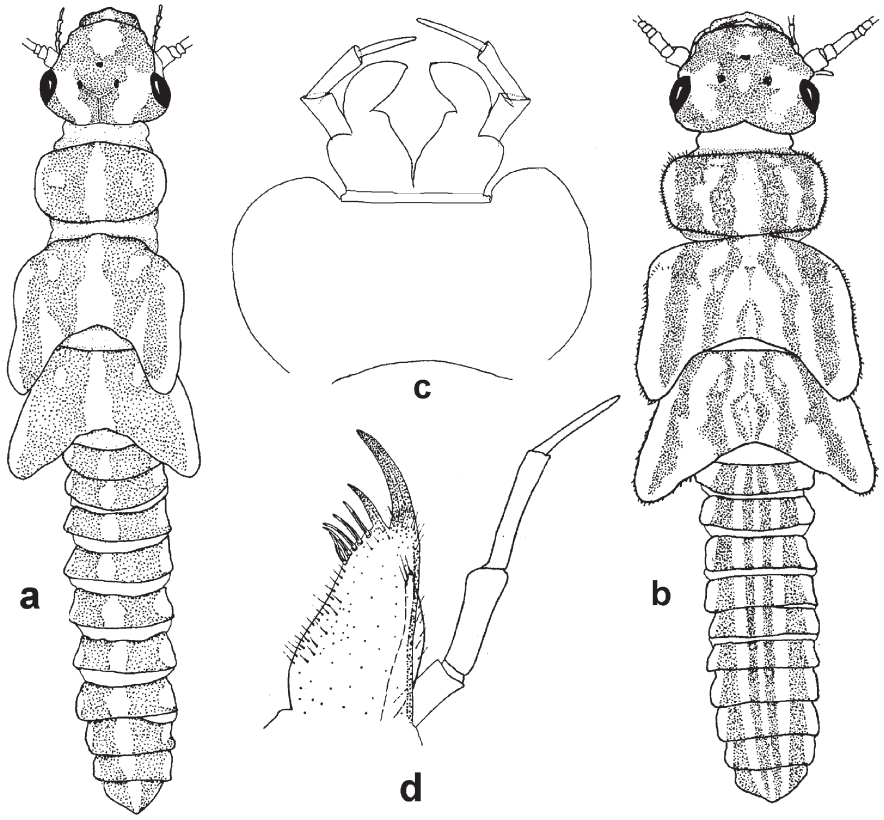


**Fig. 5.** Larvae of *Isoperla* spp. a = *I. lunigera* (KLAPÁLEK), b–d = *I. altaica* ŠÁMAL, with details of labium and labial segment

## *Isoperla eximia* ZAPEKINA-DULKEIT, 1975
(Figs 6b, c)

*Isoperla eximia* ZAPEKINA-DULKEIT, 1975: 211, figs 14–19.

Material studied. MONGOLIA, Selenge aimak, Mandal sum, Khonin nuga: Bar-Chuluut River (48°58'N, 106°59'E), tributary of Eroo River, 1 ♀, 21.VIII.2001; 13 ♂♂, 1 ♀, 04.VIII.2003; [49°02'N, 106°58'E] 2 ♂♂, 05/06.VIII.2003; Uram River, tributary of Khongi River, 1 ♂, 22.VII.2001; Ataa River, tributary of Sharlan River, 9 ♂♂, 1 ♀, 30.VII.2003 (all leg. P. SURENKHORLOO).

A sibling of *I. altaica* with which it occurs sympatrically. Our specimens were identified by comparison with an illustration of the genitalia of the male holotype (from Bargusinskyi Reserve, Birikan River, 4.08.1972, leg. V. A. BELYAEVA; in ZIAS) kindly provided by Dr V. TESLENKO.

*I. eximia* is macropterous. It differs from *I. altaica* by the central field of the pterothoracic scuta distinctly paler than the lateral parts. The head has a small pale mark on the occiput and a dark shade in front of the pale frontoclypeal mark, but lacks tranverse marks connecting the eyes.

Size. Fore wing length, ♂♂ 10.0–10.2 mm, ♀♀ slightly larger.

The penial sclerite is of the same general form as in *I. altaica*, but the base is not strikingly wider than the apex and not distinctly crested.

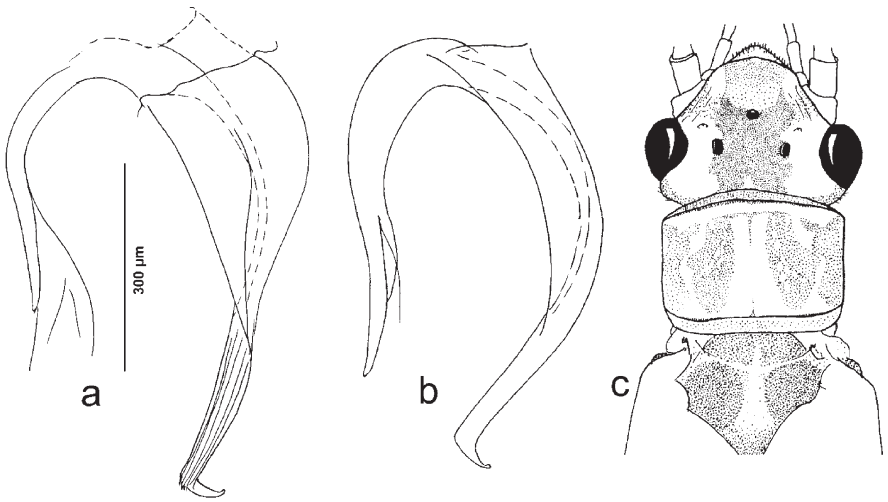


**Fig. 6.** *Isoperla altaica* ŠÁMAL (a) and *I. eximia* ZAPEKINA-DULKEIT (b, c). Penis sclerites (a, b; to same scale) and fore body (c; not to scale)

Egg. Similar to eggs of Mongolian *I. altaica.*

## *Isoperla asiatica* RAUŠER, 1968
(Fig. 7)

*Isoperla asiatica* Raušer, 1968: 364.

Material studied. Male holotype and female allotype, in alcohol, labelled "No. 113, Mongolia, KASZAB/ *Isoperla asiatica* nov. sp. det Raušer 1966" (HNHM) [Comments. According to the publication, the locality data are as follows: Mongolia, CA: Songino (3), Tula, stream, 13 July 1963. J. Raušer detached and cleared the penis membrane and returned it into the cavity of the 10th sternite after study; so did we. The allotype contains no mature eggs.].

Additional material. MONGOLIA, Selenge aimak, Mandal sum: Khonin Nuga, Eroo River [49°05'N, 107°17'E], 2 ♀♀, 24.VI.1998; 4 ♀♀, 23.VI.2001; 4 ♀♀, 14.VI.2002; 1 ♀, 17.VI.2002; 3 ♀♀, 18.VI.2002; 11 ♀, 24.VI.2002; 20 ♂♂, 19 ♀♀, 16.VI.2003; 1 ♀, 17.VI.2003; 13 ♂♂, 12 ♀♀, 18.VI.2003; 3 ♂♂, 3 ♀♀, 19.VI.2003; 6 ♂♂, 1 ♀, 21.VI.2003; 1 ♂, 1 ♀, 26.VI.2003; 4 ♀♀, 29.VI.2003; 1 ♀, 1.VII.2003; 1 ♂, 3.VII.2003; 3 ♀♀, 4.VIII.2003; Khonin Nuga, Khongi River, 2 ♀♀, 18.VI.2003; 2 ♂♂, 5 ♀♀, 24.VI.2001; 1 ♀, 20.VI.2002; Eroo Hot Spring [49°05'N, 107°17'E], Ar-Ilchlekh River, tributary of Sharlan River, 1 ♂, 20.VI.2001; 2 ♀♀, 28.VI.2003; Uram River, tributary of Khongi River, 7 ♂♂, 4 ♀♀, 25.VI.2003; 2 ♀♀, 15.VII.2003. KAZACHSTAN, surroundings of Ust Kamenogorsk [49°58'N, 82°36'E], River Malaya Ulbinka, 22.5.2003, leg. & det. V. DEVYATKOV, 16 ♂♂, 32 ♀♀ (in coll. ZWICK).

The original description by RAUŠER (1968) illustrates details of penial armature, the mesosternal ridge, and ventral views of male and female abdominal tips. We describe and illustrate head and pronotum with their previously undesribed pigment pattern and various structural details, especially those of the penis and egg (Fig. 7).

Colour pattern. General colour light ochre except brown pattern on head and pronotum; terga dorsally brown. Head pale yellowish with a brown mark over the ocelli extending towards the antennae and the occiput. There is a pale spot between the ocelli. Pronotum with the usual brownish muscle attachment marks between the pale centre and the pale lateral edges. Extent of pale pigmentation in centre apparently varies with age; in well-pigmented specimens, only a narrow pale band remains. Legs dorsally brownish, abdominal terga brown, Segments 9 and 10 yellowish.

Size. Fore wing length, ♂♂ 10.2–10.5 mm, ♀♀ 11.2–12.7 mm.

Structure. Typical of genus *Isoperla*. Legs long, femur about 5 times as long as wide, without setae, tibia with several sparse setae ventrally (Fig. 7b). The very dark cerci with fine ground pilosity and a fine crown of setae, a single ventral seta is very long and erect (Figs 7d, e).

Male. 8th sternum without the normal lobe-like appendage, middle of posterior margin only slightly thickened, in side view extending a little backwards towards sternite 9 (Fig. 7c). Sternite 9 forms the subgenital plate which is not distinctive. Everted penis upcurved, turned towards dorsum. Membraneous apical section inflated, with a back-curved little dorsal finger (Fig. 7c). The knee-shaped bend of the everted penis appears as an elongate swelling on the dissected penis membrane and is covered with fine transparent interconnected spicules which RAUŠER regarded as distinctive. The rest of the membrane is covered with many minute oval and slightly pointed teeth (Fig. 7f).

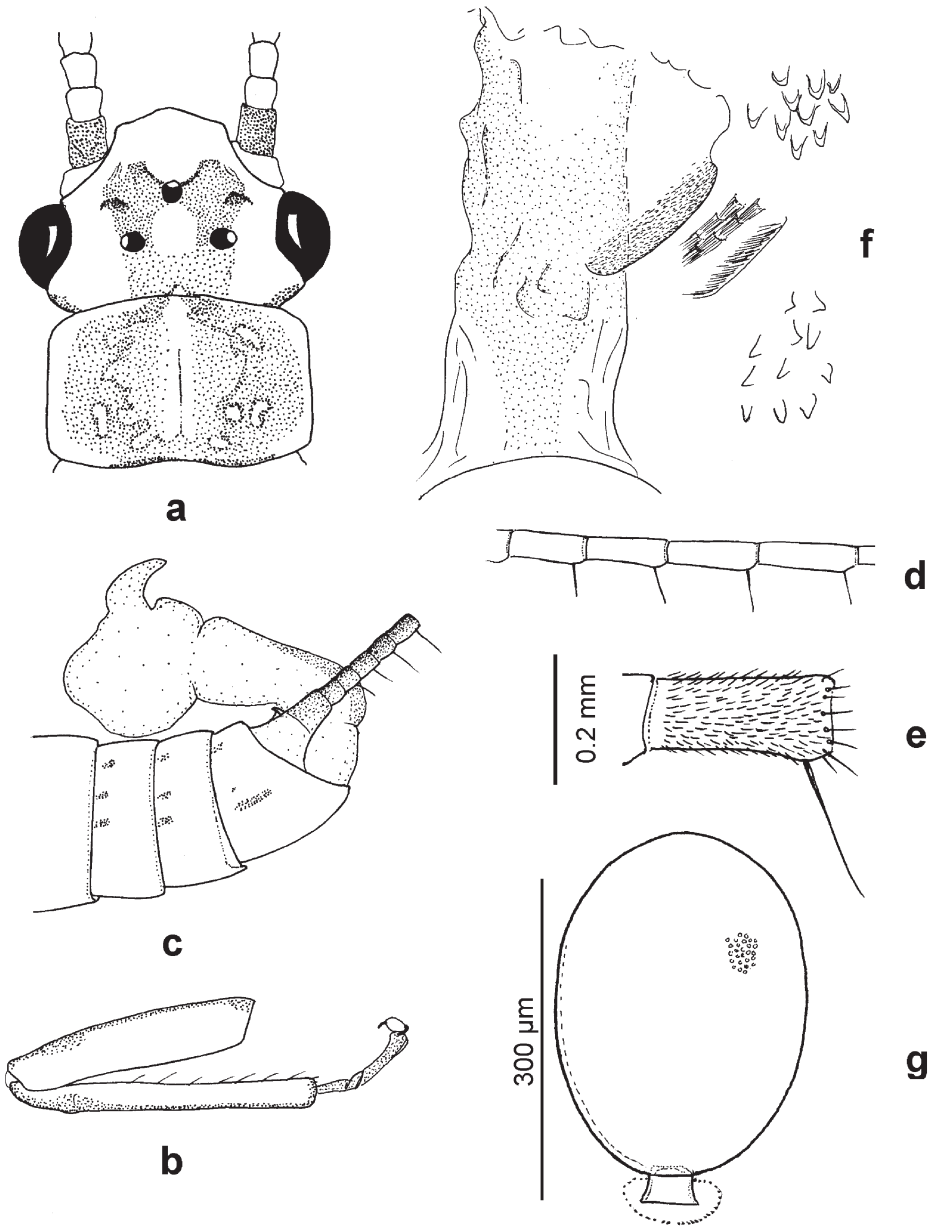


**Fig. 7.** *Isoperla asiatica* RAUŠER. a = adult head and prothorax, b = hind leg, c = lateral view of male abdominal tip with everted penis; d, e, distal cercus segments with single large ventro-apical seta; f, cleared dissected penis with enlarged details of spicules, the frazzled spicules on the swelling being shown in full view and in profile, g = egg

Female. Subgenital plate broad and rounded, projecting little (RAUŠER 1968, his fig. 81).

Egg (Fig. 7g). Regularly oval, 351 µm long, collar included. Collar almost straight, rim barely curved outward, surface without impressions. Base of collar barely projecting into egg. Anchor fungiform, with massive stalk. Chorion about 5.5–6.0 µm thick, uniformly covered with deep groove-like punctures.

Diagnostic characters and affinities. RAUŠER (1968) emphasized the comb-like interconnected spicules of *I. asiatica* which are, however, seen only in transmitted light, at magnifications >200. Moreover, they are not unique, similar microtrichia occurring, for example, on the penis of *I. difformis* (KLAPÁLEK) (BRINCK 1952). Lack of a proper vesicle on male sternite 8, and the penis membrane without major spines or modifications remind one of *I. potanini*. However, *I. potanini* has an even less developed vesicle on sternite 8; for additional differences, see under that species. The female subgenital plate is not distinctive, but the regularly oval, strongly punctate egg with straight collar is characteristic. It is not clear which species may be the closest relative of *I. asiatica*.

Distribution. The type locality is in the Central aimak of Mongolia, not far from Ulaanbataar; our fresh material is from Selenge, to the northwest. However, the species was also found in Kazakhstan, its actual range remains to be explored.

## *Isoperla potanini* (KLAPÁLEK, 1923), **comb. n.**
(Fig. 8)

*Mesoperlina potanini* KLAPÁLEK, 1923a: 114, figs 78, 79; RAUŠER 1968: 367, figs 82–98.

Material studied. MONGOLIA: Bajanchongor aimak, Somon Zag, Changaj Gebirge, 2100m, Zag gol, 18.VII.1966, 87 ♂♂, 9 ♀♀ [KASZAB 708, 709]; Chovd aimak, 3 km N Somon Uenč, 1450m, Uenč gol, 2.–4.VII.1966, 3 ♀♀ [KASZAB 618]; Chovd aimak, ca 35 km N Somon Uenč: Mongol Altaj Gebirge, 1750m, kl. Nebenbach des Uenč gol, 8.VII.1966, 2 ♂♂ [KASZAB 646]; Chovd aimak, Somon Altaj, 1350m, Bodončijn gol, 2.VII.1966, 1 ♂ [KASZAB 613]; Chövsgöl aimak, 8 km N von Somon Burenchaan, 1450m, Delger mörön, 20.VI.1968, 4 ♂♂, 2 ♀♀ [KASZAB 989]; Chövsgöl aimak, 8 km W Somon Burenchaan, 1450m, Delger mörön, 16.VII.1968, 1 ♀ [KASZAB 1117]; Chövsgöl aimak, Alag Mort, 42 km NO vom Pass Chaldzan Sogotyn davaa, 1900m, Tesijn gol, 14.VII.1968, 110 ♂♂, 30 ♀♀ [KASZAB 1110]; Gobi Altaj aimak, von SO Ecke des Až Bogd ul bis ca 20 km O vom "neuen" Somon Altaj, 1500–1900m, , 29.VI.1966, 3 ♀♀ [KASZAB 600]; Uvs aimak, Somon Baruunturuu, 1280m, Baruunturuun gol, 25.VI.1968, 2 ♂♂, 1 ♀, 3 La (putative) [KASZAB 1012].

Size. Fore wing length, ♂♂ 4.7–5.9 mm; ♀♀ 6.7–7.7 mm.

Colour pattern. Ochre or light brown, except a brown pattern on head and pronotum (Fig. 8a) and the dark brown meso- and metanota. Head with a small rhomboid yellow mark between the ocelli and a yellow mark on frontoclypeus in front of the anterior ocellus. There are large light ochre areas between the compound eyes and the posterior ocelli which extend to the rear of head and are medially

separated by a wide brown stripe. Scapus a little darker than rest of antenna. Thorax with a well-defined median pale band; laterally with the usual brownish muscle attachment marks; the lateral edges are light. The cercus segments are distally dark brown, the cerci therefore appear annulate.

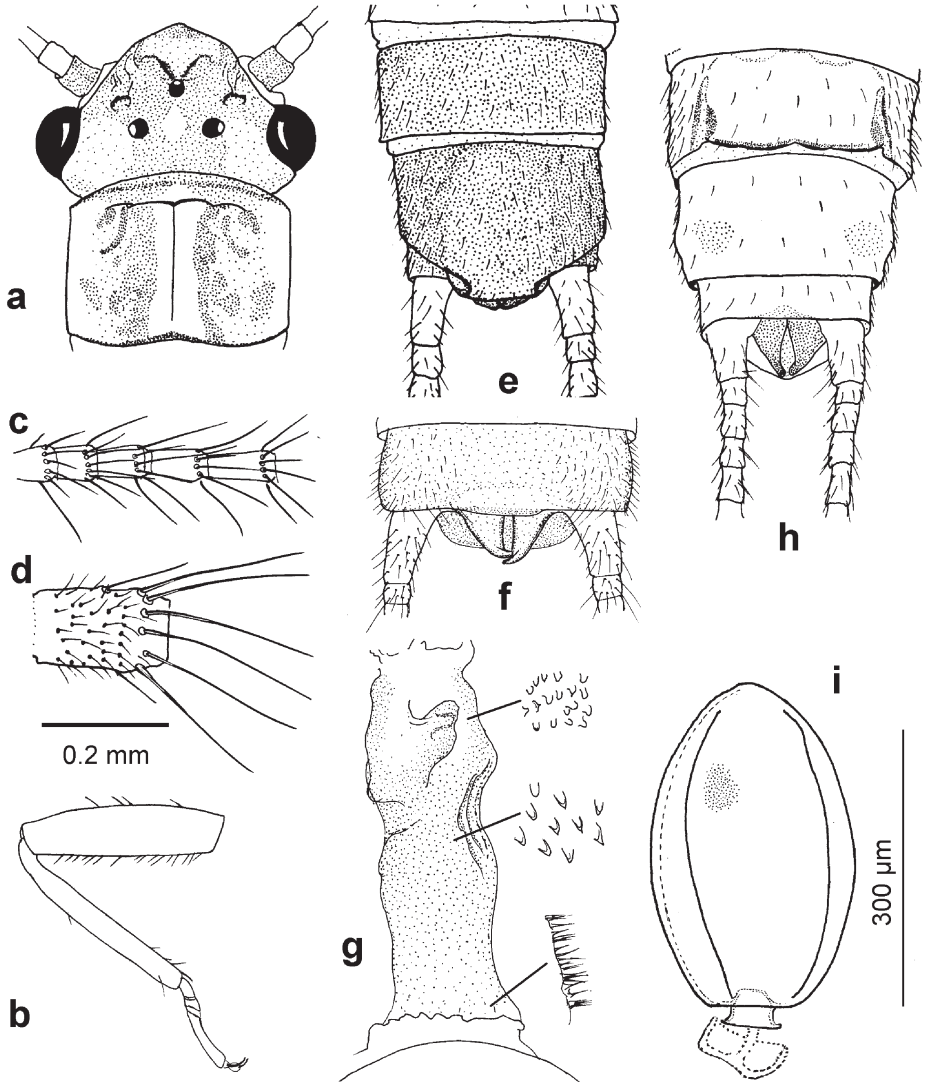


**Fig. 8.** *Isoperla potanini* (KLAPÁLEK): a = head and prothorax, b = hind leg, c, d = middle portion of cercus, e = male abdominal tip, ventral view, f = the same, dorsal view; g = cleared penis membrane, details of armatures all at the same magnification but not to scale, h = female abdominal tip, ventral view, i = egg

The apical brown bands increase in width on distal segments, terminal segments may be completely dark brown.

Structure. Typical of the genus; there are no appendages or flanges on thoracic nota. Legs (Fig. 8b) short, femora about 4 times as long as wide, with several setae along ventral edge and also a few dorsally. Tibiae with very sparse apical setae. Cerci with fine ground pilosity and apical crowns of several long setae approximately of equal size (Figs 8c, d).

Male. Sternite 8 without ventral lobe (Fig. 8e), the intersegmental membrane towards sternite 9 appears a little swollen in side view. Sternite 9 forms a subgenital plate which is almost parallel-sided and apically truncate in ventral view; it covers the elongate paraprocts from below. Paraprocts long, slender, distally little upcurved (Fig. 8f). Penis entirely membraneous, no sclerites or large spines. The everted penis resembles the one of *I. asiatica* in having an unpaired outgrowth on its dorsal side. The membrane is covered with many minute oval and pointed little teeth; near the base are very fine and slender transparent spicules (Fig. 8g).

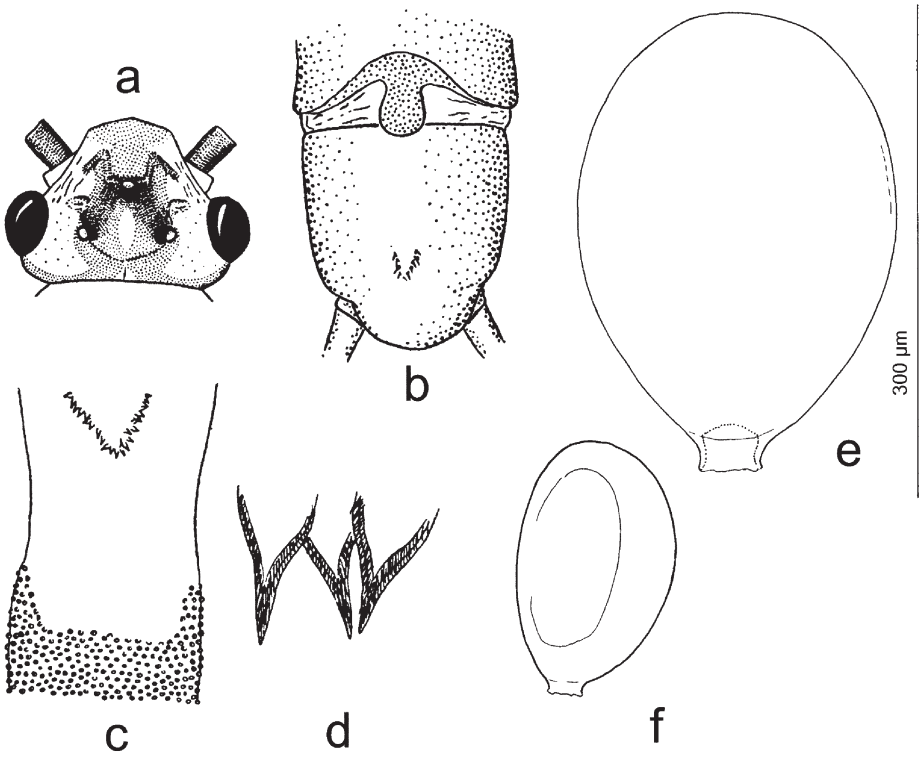


**Fig. 9.** *Isoperla obscura* (ZETTERSTEDT): a = head (after AUBERT, 1959); b = male abdominal tip, ventral view (after DESPAX 1936), c = penis membrane with blunt warts and V-shaped row of pointed teeth, d = detail of pointed teeth, e = egg of specimen from Varanger Peninsula in full view, f = the same in oblique view to show concavity. Figures c and d after ILLIES, 1952. Figs a-d and f not to scale

Female. Subgenital plate barely extended backward, slightly and shallowly bilobed, the shallow medial notch angular (Fig. 8h). Sternite 9 with a round more strongly sclerotized darker area on each side.

Egg (Fig. 8i). About 350 μm long, oval, with 6 blunt longitudinal ribs which reach neither the oval posterior pole nor the flattened anchor pole. Collar simple, stalked, with outwardly bent rim, its base slightly projecting into the egg space. Chorion about 5 μm thick, with distinct coarse irregular punctation. Shape and appearance of eggs varies with degree of hydration. Eggs from dried females appear almost parallel sided and narrow and are about 365 μm long.

Larva (putative). Pale (faded ?), the head pattern resembles *I. difformis* (see ILLIES 1955). Femora and tibiae with fringes of long silky hairs, cerci without any. Dorsal integument with small intercalary setae but without the fine procumbent tomentum-like pilosity that most *Isoperla* larvae have.

*Diagnostic characters and affinities.* Originally the present species was included in *Mesoperlina* and redescribed as such (RAUŠER 1968). It was ZHILTZOVA (1970) who recognized the characters being typical for *Mesoperlina*: male tergite 9 raised and with a spinule patch posteriorly on both sides, tergite 10 posteriorly with a pair of erect, horn-like processes, sternite 8 and paraprocts simple. Distinctive female characters of *Mesoperlina* are not known. ZHILTZOVA recognized that *M. potanini* does not belong in the genus, but left it unplaced.

Several salient diagnostic features of the present species are not mentioned in the redescription by RAUŠER (1968). We therefore confirmed our identification by examining some of KASZAB's material studied by RAUŠER who had compared syntypes in coll. KLAPÁLEK, in the museum in Prague.

*I. potanini* has some superficial resemblance with *I. asiatica* through the very narrow transverse sternal lobe on male sternite 8. However, *I. potanini* differs clearly from all other presently known Mongolian species in that each cercus segment carries a complete apical whirl of several setae, and by the presence of strong erect setae on the ventral edge of the short femur. The short bilobed female subgenital plate, the round spots on sternite 9, and the ribbed egg are also distinctive. However, these differences do not justify the exclusion from genus *Isoperla*. There are Nearctic species with ribbed eggs (SZCZYTKO 2005), and pilosity was not described for many species, the distinctness of *I. potanini* in this respect may only be seeming. The putative larva conforms with other *Isoperla* species.

*I. potanini* is presently known from northern and western Mongolia.

## *Isoperla obscura* (Zetterstedt, 1840) (Fig. 9)

*Perla obscura* Zetterstedt, Insecta Lapponica: 1058.

Material. MONGOLIA; Chövsgöl aimak, Alag Mort, 42 km NO vom Pass Chaldzan Sogotyn davaa, 1900m, Tesijn gol, 14.VII.1968 [KASZAB 1110], 1 ♀; Bajan-Ölgij aimak; ca 20 km NNW Ölgij, 2100m, 2.VII.1968 [KASZAB 1053], 1 ♀; Bajan-Ölgij aimak, Ölgij, 1750m, Chovd gol, re[chtes] Ufer; 30.VI.1968 [KASZAB 1046] numerous adults. Selenge aimak, Mandal sum (leg. P. SURENKHORLOO): Khonin Nuga, Eroo sum, Minj River (49°00'N, 108°02'E), 1 ♂ (?), 02.VII.2001.

*Isoperla obscura* is widespread in the northern part of the Palaearctic Region (LEVANIDOVA & ZHILTZOVA 1979) and was previously recorded from Mongolia (ZHILTZOVA & ZAPEKINA-DULKEIT 1986).

Size. Fore wing length, ♂♂ 7.7–9.6 mm, ♀♀ 9.0–12.8 mm (LILLEHAMMER 1988).

Detailed descriptions of all life stages are available (BRINCK 1949, 1952, ILLIES 1952, LILLEHAMMER 1988), the species can be recognized by the combination of the following characters: – a narrow lanceolate pale mark between the ocelli is separate from a pale mark at the rear of the occiput (Fig. 9a); – the appendage to male sternite 8 is slender, narrower than long (Fig. 9b); – the penis membrane carries a V-shaped row of sharp broadly triangular teeth and surface is rough on its other side (Figs 9c, d); – female subgenital plate long, approximately triangular, pointed, similar to *Kaszabia nigricauda* which, however, has a distinctly horseshoe-shaped mark on the head.

The egg (Figs 9e, f) is regularly oval; when dissected from females, eggs are concave on one side, like most European *Isoperla* species. Collar with straight, slightly irregular rim, base of anchor shallowly arched, chorion about 4 µm thick, at maginification 400 almost imperceptibly punctate. Size of eggs ranges 252–268×169–177 µm in a Mongolian specimen, but 276–289×194–202 µm in a specimen from Norway (Varanger Peninsula, Kongsfjordelv, 9.8.1973, leg. TOBIAS, from Senckenberg Museum, Frankfurt).

## *Isoperla mongolica* ZHILTZOVA, 1972
## (Fig. 10)

*Isoperla mongolica* ZHILTZOVA, 1972, Nacekomye Mongol. 1: 132, figs 9–12.

Material studied. Cleared tip of paratype male abdomen, in glycerol: "1692. Mongolia, 15 km from Ulan Bator, Tuul River, near Gatsurt, 16.VII.[19]67, leg. Kherzner". 1 ♂ with partly everted penis, 3 ♀♀ ♀♀: "7. ; Mongolia, Ovorkhangai aimak, Sumiin and Chuluut River near bridge, 29.VI.[19]57, M. Kozlov" (labels in Cyrillic script; all from coll. ZHILTZOVA. Zool. Mus. St. Petersburg).

Additional material. MONGOLIA: Chovd aimak: 3 km N Somon Uenč, 1450m, Uenč gol, 2.–3.VII.1966, 8 ♂♂, 18 ♀♀ [KASZAB 614, 618, 622]; ca 35 km N Somon Uenč, Mongol Altaj Gebirge, 1750m, kl. Nebenbach des Uenč gol, 8.VII.1966, 1 ♂♂, 6 ♀♀ [KASZAB 646]; ca 44 km N Somon Uenč, Mongol Altaj Gebirge, 1780m, Uenč gol, 8.VII.1966, 21 ♂♂, 4 ♀♀ [KASZAB 647]; Somon Uenč, ca 2 km N vom Dorf, 1450m, Uenč gol, 7.VII.1966, 2 ♀♀ [KASZAB 643]. Chövsgöl aimak: 8 km N Somon Alag-erdene, 1600m, Egijn gol, 17.VII.1968, 1 ♂ [KASZAB 1121]; 8 km N von Somon Burenchaan, 1450m, Delger mörön, 20.VI.1968, 2 ♂♂, 15 ♀♀ [KASZAB 990]; zw. Somon Cecerleg und Somon Bajan-ul, 65 km W Cecerleg, 1700m, 22.VI.1968, 1 ♂ [KASZAB 1002]. KAZACHSTAN, Ust Kamenogorsk [49°58'N, 82°36'E], leg. & det. V. DEVYATKOV, 19 ♂♂,14 ♀♀ (in coll. ZWICK)

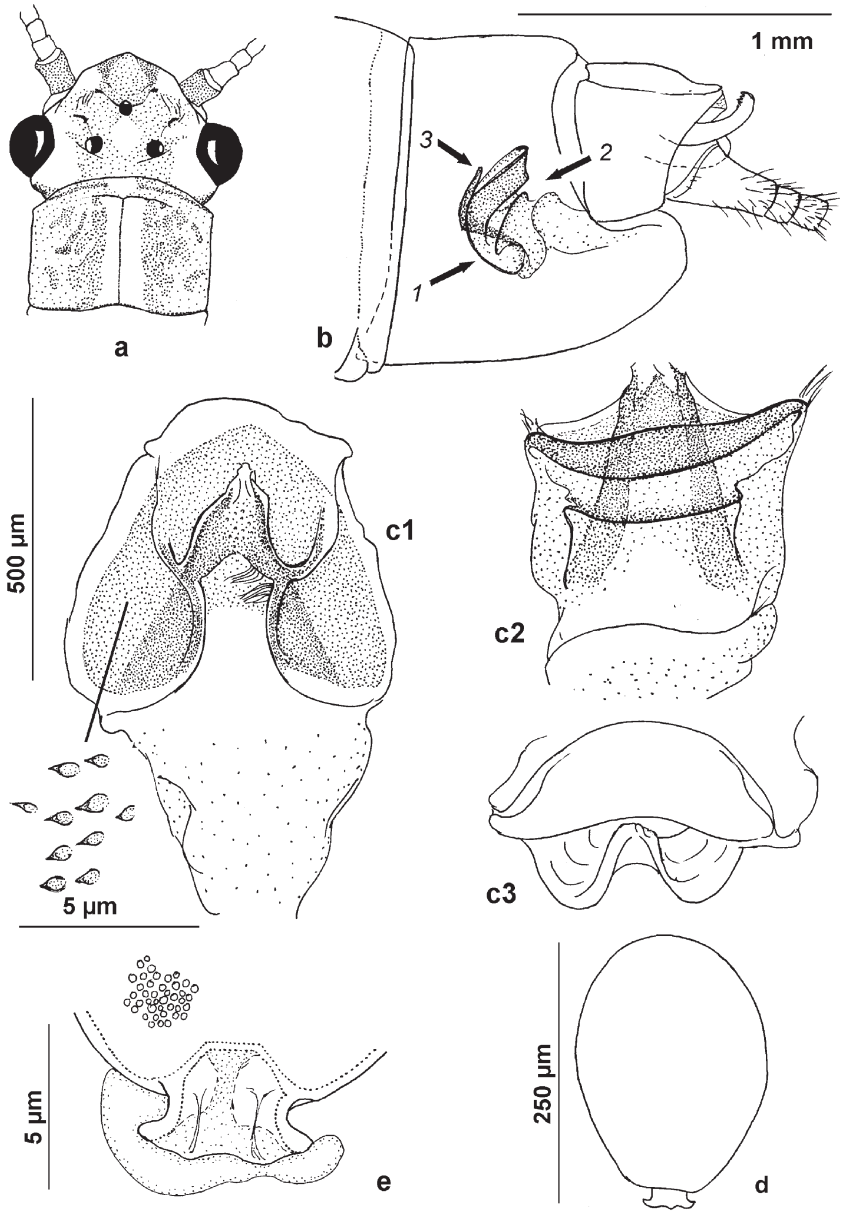


**Fig. 10.** *Isoperla mongolica* ZHILTZOVA. a = adult head and prothorax, b = lateral view of male abdominal tip with folded penis in natural position; arrows and letters identify directions of views shown in Figs c1–3. c1-c3 = folded penis in three different views (inset C1 enlarged); compare Fig. 10b for directions, d = egg, lateral view. e = combined lateral views and optical sections through anterior egg pole with collar and anchor

The present material was recognized by the large ventral lobe on male sternite 8th and the apically slightly spinulose paraprocts. The identification was confirmed by comparison with a male paratype and additional material identified by L. A. ZHILTZOVA. We provide a brief general description and add details of the previuously undescribed penis, vagina, and egg.

Size. Fore wing length, ♂♂ 8.9–9.5 mm, ♀♀ 10.8–12.8 mm.

Colour pattern. General colour dull ochre to light brown, with pale marks. Head infuscated from front of clypeus to behind ocelli; a rhomboid pale spot remains between ocelli and there is often a small pale mark just in front of the anterior ocellus (Fig. 10a). Posterior corners of head and scape also slightly infuscate. Pronotum infuscated, with wide pale middle band and narrow pale lateral edges; muscle attachment scars darker than rest. Mesonotum pale to light yellow in front of and between wings, remainder brown. Metanotum brown, except paler part laterally, in front of wings. Ventral thoracic sclerites light brown. Abdomen dorsally ochre, ventrally lighter, yellowish. Antennae light brown, a little darker than ochre palpi, legs, and cerci.

Structure. A typical *Isoperla* species. *R* without fork, single long fork of *Rs*, branches of *M* usually forked, with long stem. Legs without large setae. Cerci with elongate segments, each ventrodistally with a single erect seta, rarely 2 setae.

Male. Base of abdomen dorsally with pale paramedian bands diminishing from I-III, sometimes IV, and eventually vanishing; posterior segments unicolorous, a little darker than in female. Tergites IX and X medially a little extended, darker than rest, with enhanced pilosity. Sternite VIII: a dark semicircular line demilits a deep notch from which rises the broad, medially constricted peduncle of the wide, rounded and slightly pilose brown ventral lobe. Sternite IX large, bulging over bases of paraprocts. Tips of paraprocts curving forward over distal edge of tergite X, rounded, anteriorly rough owing to presence of several sensilla basiconica.

Penis observed only in contracted (Fig. 10b) and partly everted condition (see ZHILTZOVA 1972, her fig. 11). Penis consisting of several arched folds of rather stiff integument (Figs 10c1-c3) covered uniformly with minute teeth, each with large guttiform base (Fig. 10c1, inset). It appears that the wide funnel-shaped part with the conical median piece stands at the tip of the everted organ.

Female. Subgenital plate only insignificantly projecting, no characteristic form or pigmentation. Vagina is not distinctive, membraneous, without sclerotized elements.

Egg (Figs 10d, e). 185 µm wide, 272 µm long, including 8.5 µm for collar. Oval, posterior (= opercular) pole regularly rounded, wide, sides of egg near collor less arched, narrowing a little towards anterior pole with collar. Chorion about 4 µm thick, uniformly covered with deep, large punctures, their arrangement in polygonal fields indistinct. No opercular suture. Collar 34 µm wide at recurved wavy distal flange, with a few longitudinal crests, base deeply embedded. Anchor fungiform.

*Diagnostic characters and affinities.* The large ventral lobe on male sternite VIII in combination with the apically spinulose paraprocts permits immediate recognition of males. For female identification, see the key. The relations with other species are doubtful.

## *Isoperla maculata* ZHILTZOVA, 1977

*Isoperla maculata* ZHILTZOVA, 1977: 7, figs 10–13.

The species was described from Primorje and is common in the Russian Far East from where we have seen specimens. The pattern is similar to *I. lunigera* (LEVANIDOVA & ZHILTZOVA 1979). A single female was also recorded from Eastern Mongolia (ZHILTZOVA 1982). We have seen no Mongolian material of *I. maculata* and wonder about the identity of the single female in question.

## *Isoperla kozlovi* ZHILTZOVA, 1972
(Fig. 11)

*Isoperla kozlovi* ZHILTZOVA, 1972, Nacekomye Mongol.: 134, figs 13–15.
*Isoperla kozlovi* – ZHILTZOVA & ZAPEKINA-DULKEIT, 1986, Keys to the insects of the Soviet Far East 1: 187–188.

Material studied. MONGOLIA: Selenge aimak, Eroo sum, Minj River [49°00'N, 108°02'E] 1 ♀, 02.VII.2001; Mandal sum, Khonin Nuga, Eroo River [49°05'N, 107°17'E], 1 ♂, 4 ♀♀ 14.–18.VI.2002; 1 ♀, 02.VII.2002; 1 ♂, 16.VI.2003; 1 ♂, 1 ♀, 04.VII.2003 (leg. P. SURENKHORLOO).

Size. Fore wing length 10–10.5 mm (ZHILTZOVA 1972).

We supplement the original description by an illustration of the patterns of head and pronotum (Fig. 11a), details of the penial armature, and of the egg.

Male. ZHILTZOVA (1972) had shown the penis sclerites inside sternite 9, as seen by transparency. When the penis is artificially everted (Fig. 11b), details become visible. Each of the large paired sclerites consists of a longitudinal bar resting in the membrane with an erect, hollow spine-covered process near the distal end. The rest of the penial membrane is covered with a variety of spicules (some of them frazzled) and teeth.

Female. Subgenital plate broad, distinctly projecting, distal margin sinuous, with a shallow median notch, as shown in the available descriptions.

Egg (Figs 11c-e). Oval, about 330 µm long, collar included. Collar with a few subdued meshes, edge simple, base smoothly bulging into interior of egg. Chorion smooth, about 3 µm thick. No micropyle seen.

*Diagnostic characters and affinities*. ZHILTZOVA commented on the resemblance of male genitalia with *Kaszabia spinulosa* Raušer. Indeed, both have longitudinal penial sclerites carrying an erect barbed hollowed finger at the end; see below.

## *Kaszabia spinulosa* RAUŠER, 1968

*Kaszabia spinulosa* Raušer, 1968: 373.

Material studied. MONGOLIA: Archangaj aimak: 20 km W Somon Ögijnuur, 1500 m, 18.VI.1966 [KASZAB 535], 1 ♂; 8 km W Somon Urdtamir, Changaj Gebirge, 1620 m, 19.VI.1966 [KASZAB 540], 1 ♂. Chövsgöl aimak, 22 km W von Somon Cecerleg, 1820m, Tesijn gol, 22.VI.1968 [KASZAB 1001], 1 ♂. Tuv aimak, Gorkhi-Terelj, Tuul River [48°21'N, 107°90'E], 1 ♂, 1 ♀, 09.VII.2003 (coll. S. Enkhtaivan); Selenge aimak, Eroo sum, Minj River [49°00' N, 108°02'E], 1 ♂,

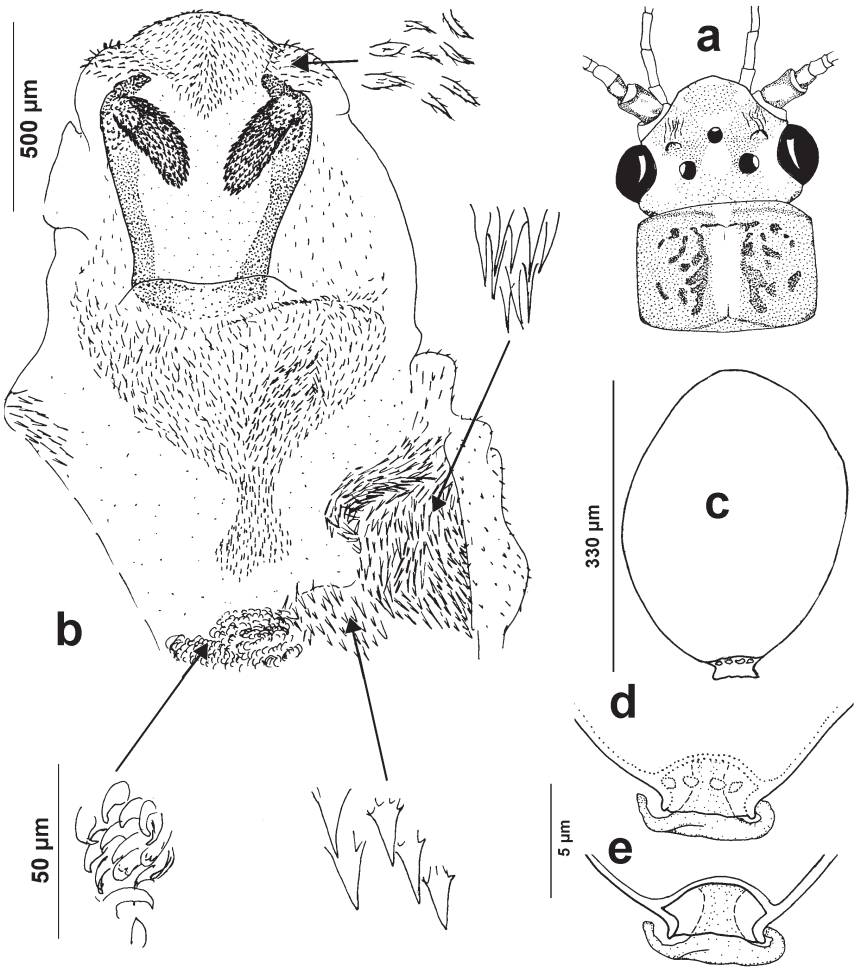


**Fig. 11.** *Isoperla kozlovi* ZHILTZOVA. a = head and prothorax, b = artificially everted penis membrane with major sclerites, details of marginal spinules enlarged, c = egg; d, e = collar enlarged

28.VI.2001; Ar-Ilchlekh River, 2 ♀♀, 28.VI.2003; Mandal sum, Khonin Nuga, Eroo River [49°05'N, 107°17'E], 1 ♂, 20.VI.2002; 1 ♀, 17.VI.2003 (leg. P. SURENKHORLOO).

Genus *Kaszabia* includes the present species and the Japanese *K. digitata* (Kawai) and differs strikingly from *Isoperla* by lateral pointed processes on the anterior abdominal segments of males. However, this is the only marked difference between the two nominal genera. The agreement with *I. kozlovi* in the complex penial sclerites suggests close phylogenetic relationships between these species. Generally, the phylogenetic relations between the many structurally diverse species of *Isoperla* are not well known, and we have not seen the Japanese species; therefore, we refrain from making a conclusion.

Very few eggs of *K. spinulosa* were dissected from a female (Mongolia, Tuv aimak, Ghorki Terelj, coll. S. ENKHTAIVAN). They are elongate oval, 335×175 µm. The collar is simple, its shallowly embedded base is rounded. Details of chorion structure could not be recognized.

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