



A new species of *Megaperlodes* Yokoyama *et al.* 1990 (Plecoptera, Perlodidae) from the South of the Russian Far East

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Abstract

A new species of Plecoptera *Megaperlodes tiunovi* **sp. n.**, from the South of the Russian Far East is described and illustrated. The relationships with its close relatives are discussed. Newly discovered features are added to the diagnosis of the genus *Megaperlodes*, especially previously overlooked eversible lobes within the paraprocts, egg structure, and wing venation.

Key words: Plecoptera, Perlodini, *Megaperlodes*, eversible paraproct lobes, eggs, South Russian Far East, Japan

Introduction

The original Japanese description of the new genus *Megaperlodes* Yokoyama, Isobe & Yamamoto, 1990 and its type species, *M. niger* Yokoyama, Isobe, & Yamamoto, 1990 was relatively brief. This species was found in Yamagata Prefecture (central Japan, Honshu) and recorded from 11 streams flowing through the foothills of the Sekiryo, Gassan, Agatsuma and Iide Mountains. *Megaperlodes* was included in the tribe Perlodini and distinguished from other genera by tergum 10 of male entire, male paraprocts divided into two apices, abdominal segments 1–6 clearly divided into terga and sterna, triangular egg, and lacinia unidentate in the larva (Yokoyama *et al.* 1990). The original description was incomplete, types were not designated, but the name *M. niger* is nevertheless available (ICZN 2014). The male, female, and larvae are however, well-illustrated (Yokoyama *et al.* 1990, Inada *et al.* 1998, Shimizu *et al.* 2005). Additional localities for *M. niger* were found in the streams and rivers in Okayama (Inada *et al.* 1998) and Ibaraki (Yoshinari 2001) Japanese Prefectures.

This paper provides descriptions and illustrations of all life stages of a second species of the *Megaperlodes*, *M. tiunovi* **sp. n.** discovered in a small salmonid foothill stream flowing out of the East Manchurian Mountains (south of the Russian Far East) into the Sea of Japan. Notes and illustrations of the related *M. niger*, especially of the previously overlooked eversible paraproct lobes (EPL) of the male, the structure of the egg, and wing venation are also provided.

Methods and material

Nymphs were associated with adults by common occurrence. Two mature nymphs were collected from the Brus'ya River in April 2013. Adult and larval exuviae were collected from supports of a bridge crossing the Brus'ya River on 12 May 2014. Additional live males, females, and larval exuviae were collected on 18 May at the same site. Adults were kept in the laboratory in plastic containers covered by cotton. The paraproctal lobes of male were everted on a freshly preserved specimen following the procedure outlined by Zwick (1982). A few egg masses were produced 2–3 days later. The last female survived until 1 of June. Some egg masses were incubated in vial with river water kept in a refrigerator. The other egg masses were fixed in 75% ethanol, transferred stepwise to 95% ETOH, and then fixed on specimen stubs with double-sided tape and air dried for detailed study. Specimens

were gold coated before examination with a LEO-40 scanning electron microscope in the Centers of Collective Use in the Institute of Biology and Soil Science and Institute of Biology of the Sea, Far Eastern Branch Russian Academy of Sciences, Vladivostok.

The Holotype and paratypes are deposited in the Institute of Biology and Soil Science, Far Eastern Branch, Russian Academy of Sciences, Vladivostok. Specimens of *M. niger* from the type locality in Yamagata Prefecture, Japan were kindly provided by Dr. T. Shimizu allowing comparison of the life stages with *M. tiunovi* **sp. n.** This material included 1 male, Mogami-machi, Usugi, upstream of Obyoko-gawa Stream, 25.05.1994, coll. T. Kishimoto; 1 male (dissected), 1 female, at light, Nishikawa-machi, Oh-gawa, 23.06.1998, coll. A. Ishizuka; 1 nymph, the same locality, May to June, coll. N. Yokoyama.

Taxonomic position

Tergum 10 entire in the male, paraprocts with an EPL, and the trilateral egg, places *Megaperlodes* in the tribe Perlodini and in the *Perlodes* group (Zwick 1997). Larval characters including the short or indistinct submental gills, arms of the mesosternal ridge meeting the posterior corners of the furcal pits, and an indistinct suture between basisternum and furcasternum also supports the above inclusion.

Megaperlodes is distinguished from members of *Perlodes* group with EPLs, i.e. *Perlodes* Banks 1903 and *Filchneria* Klapálek 1907 by distinct lateral divided abdominal segments 1–5 and segment 6 partially divided. It also differs from these genera by the membranous or slightly sclerotized transversal band on the posterior margin of male tergum 10; the band has rounded posterolateral edges and is medially supported by a small conical internal peg between the paraproct lobes. The EPLs of *Megaperlodes* are bifid, consists of a wide base and a long fingerlike projection covered by setae. The EPLs of *Perlodes* are inconspicuous; *Filchneria* has large, bulbous EPLs (Zwick 1997, Teslenko et al. 2010). Larvae of *Megaperlodes* differ from all genera of the *Perlodes* group by the bare and unidentate lacinia, which is somewhat similar to *Kogotus* Ricker 1952 of the Diploperlini (Stark & Szczytko 1984).

Results and discussion

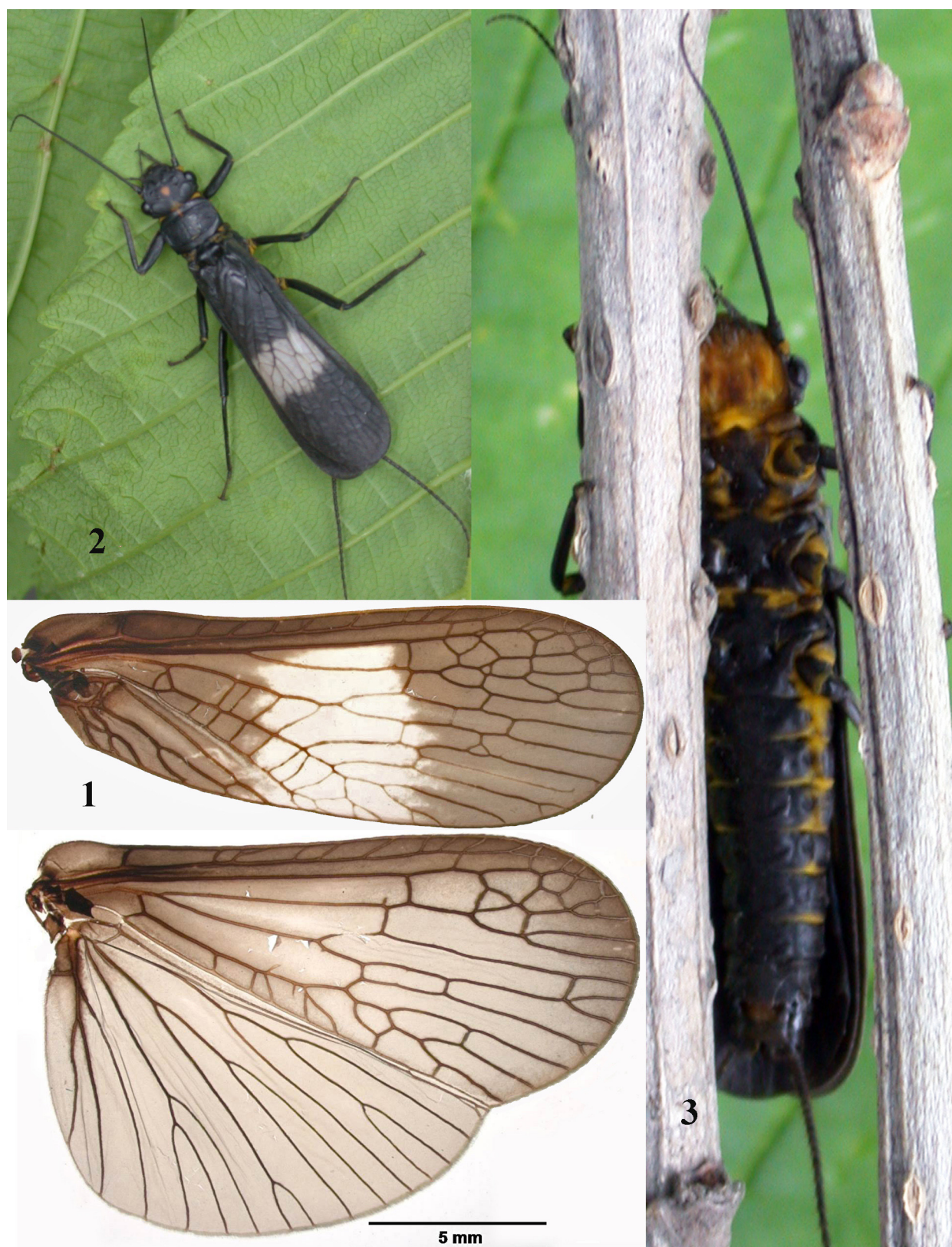
Megaperlodes tiunovi Teslenko **sp. n.**

(Figs. 1–19)

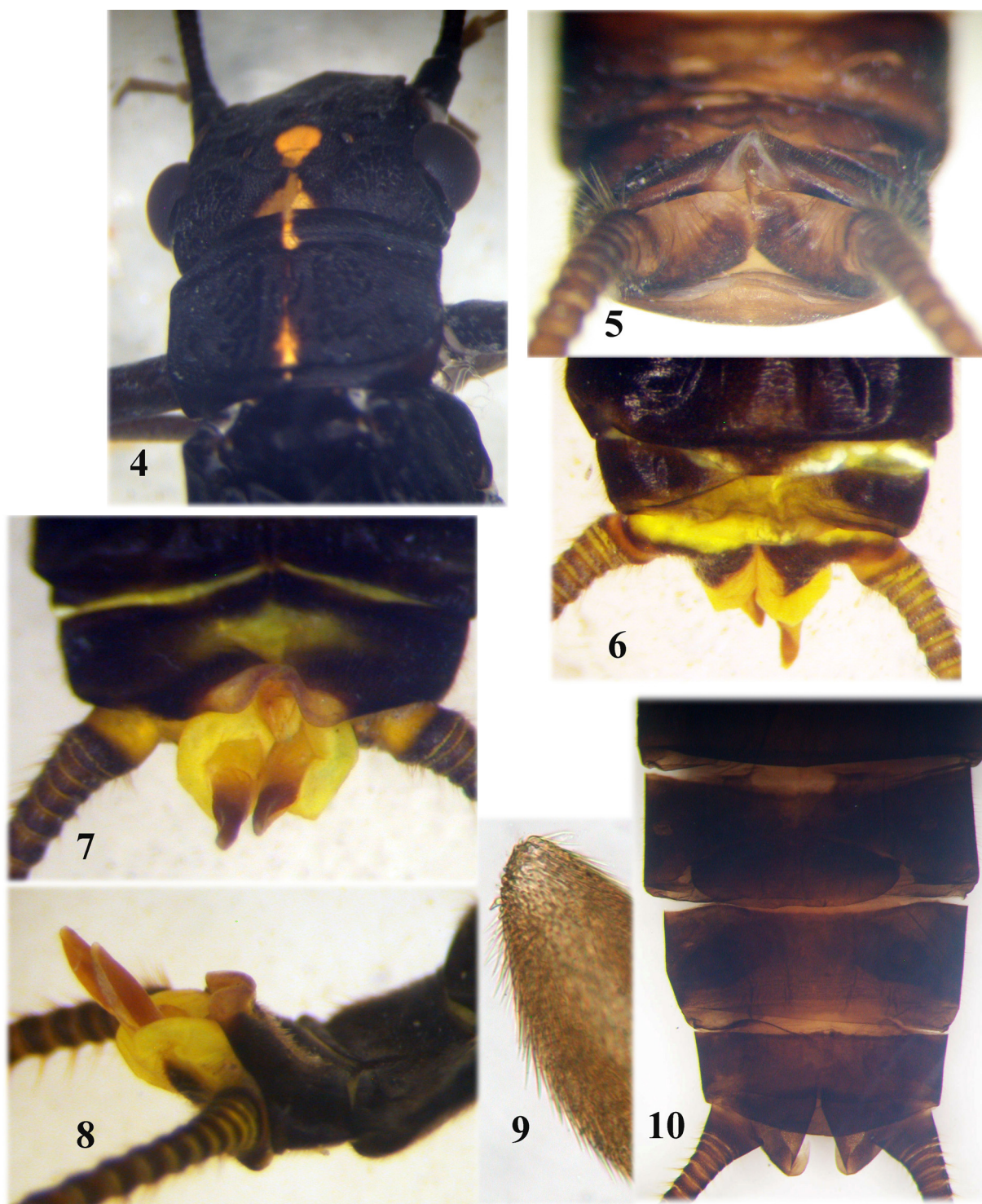
Description. Adult habitus. Sexually dimorphic, female larger than male. Mean body length from tip of the head to the apex of abdomen, males, 17.0–17.3 mm; females 22.0–26.2 mm. Wings slightly shortened. Forewing length, males, 15.2–16.0 mm; females, 19.8–21.8 mm; wingspan, males, 32.3–34.1 mm; females 42.8–46.8 mm. The front wing of male and female (Fig. 1) black, fumose, veins dark, in the middle with a contrastive white frosted spot, occupying about $\frac{1}{3}$ of the wing length. The spot extends from R1 to the posterior wing edge, lateral margins of the spot are indistinct, and veins in the spot paler. Wing venation includes an irregular net near the apex sometimes consisting of four rows of cells. Seven to ten cross veins between C and Sc; five apical veins between Sc and R1 (Fig. 1). Rs with five apical branches. Nine to thirteen veins between M and Cu2; four anal veins branching into six. Hindwing black fumose, slightly paler in the cord area, in males especially. Anal area enlarged and pleated, A2–A5 forked; A5 with dark small spot at base.

General body colour black with yellow spots; membranous ventral portions also yellow (Figs. 2, 3). Head and pronotum matt black, with sharply delimited bright yellow marks. Head with compound eyes wider than the pronotum; M-line smooth and distinct (Fig. 4). Interocellar area with a small tear-shaped bright-yellow spot, widest anteriorly. A small yellow triangle extends along the epicranial stem on the occiput (Fig. 4). A posterolateral reticulate callosity behind each compound eye. Antennae shorter than cerci, black; palpi dark brown. Head ventrally yellow brown (Fig. 3). Submentum almost square, with slightly rounded lateral margins, the submental gills very small to almost absent in both sexes. The pronotum rectangular, same width as the head width under the compound eyes, with narrow longitudinal thread-like median yellow band widened triangularly at the anterior pronotal margin as well as before the posterior pronotal furrow (Fig. 4). Pronotal rugosities smooth, the lateral fields matt. The arms of the mesosternal ridge meet the posterior corners of the furcal pits; suture between basisternum and furcasternum indistinct (Fig. 3).

Abdominal tergites black, strongly sclerotized and covered by short colourless clothing hairs, only tergum 1 with X-shaped white spot medially, with a rounded inside black spot. Abdominal segments 1–5 divided laterally by yellow pleural folds, more distinct in females; posterior segments ring-shaped, entire, fully sclerotized (Fig. 3). Legs black except bright yellow joints (Fig. 2).



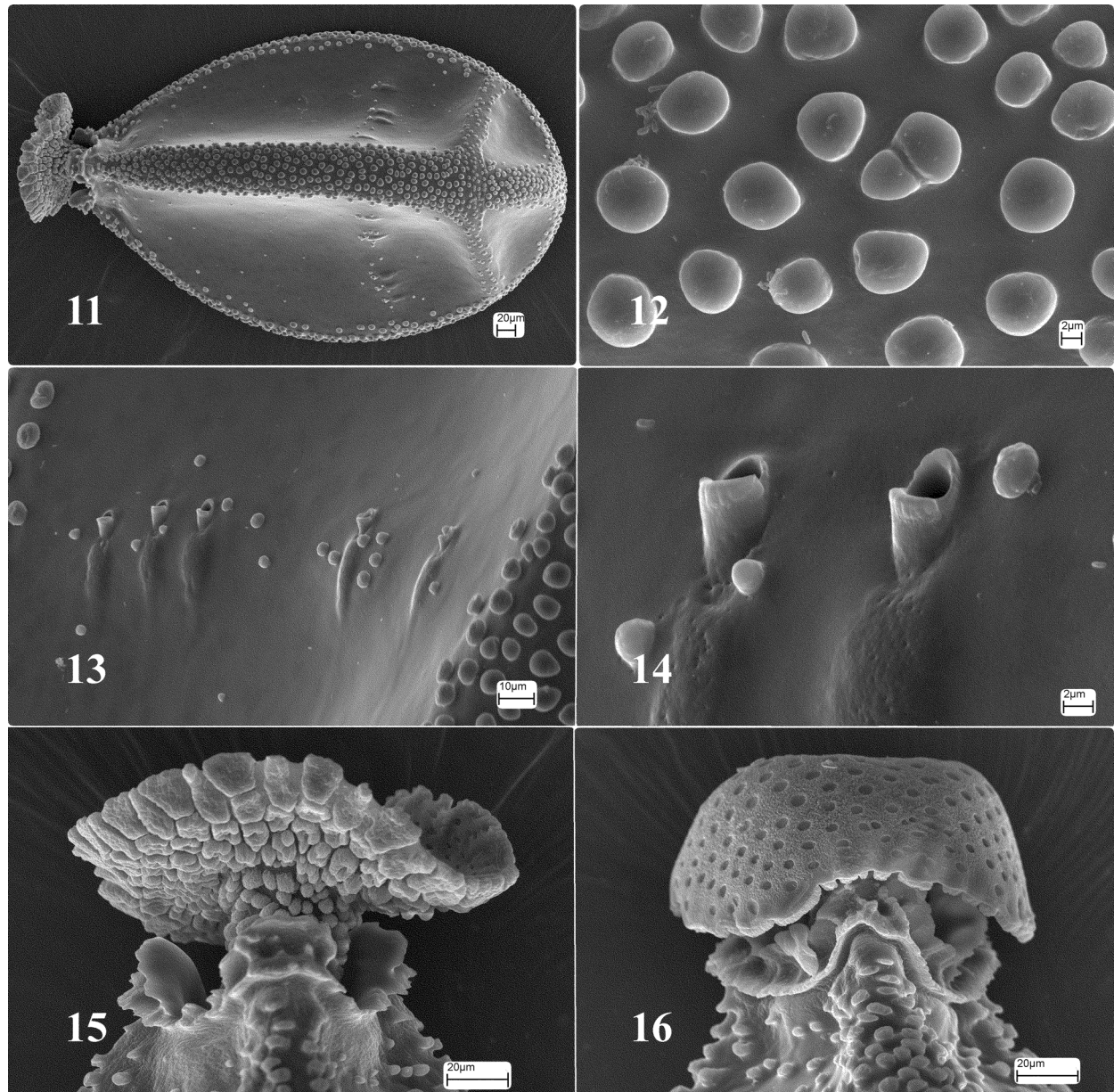
FIGURES 1–3. *Megaperlodes tiunovi* sp. n.: 1. Wings of female. 2. Habitus, female, dorsal. 3. Habitus, female, ventral. Scale (mm): 1 = 5.0.



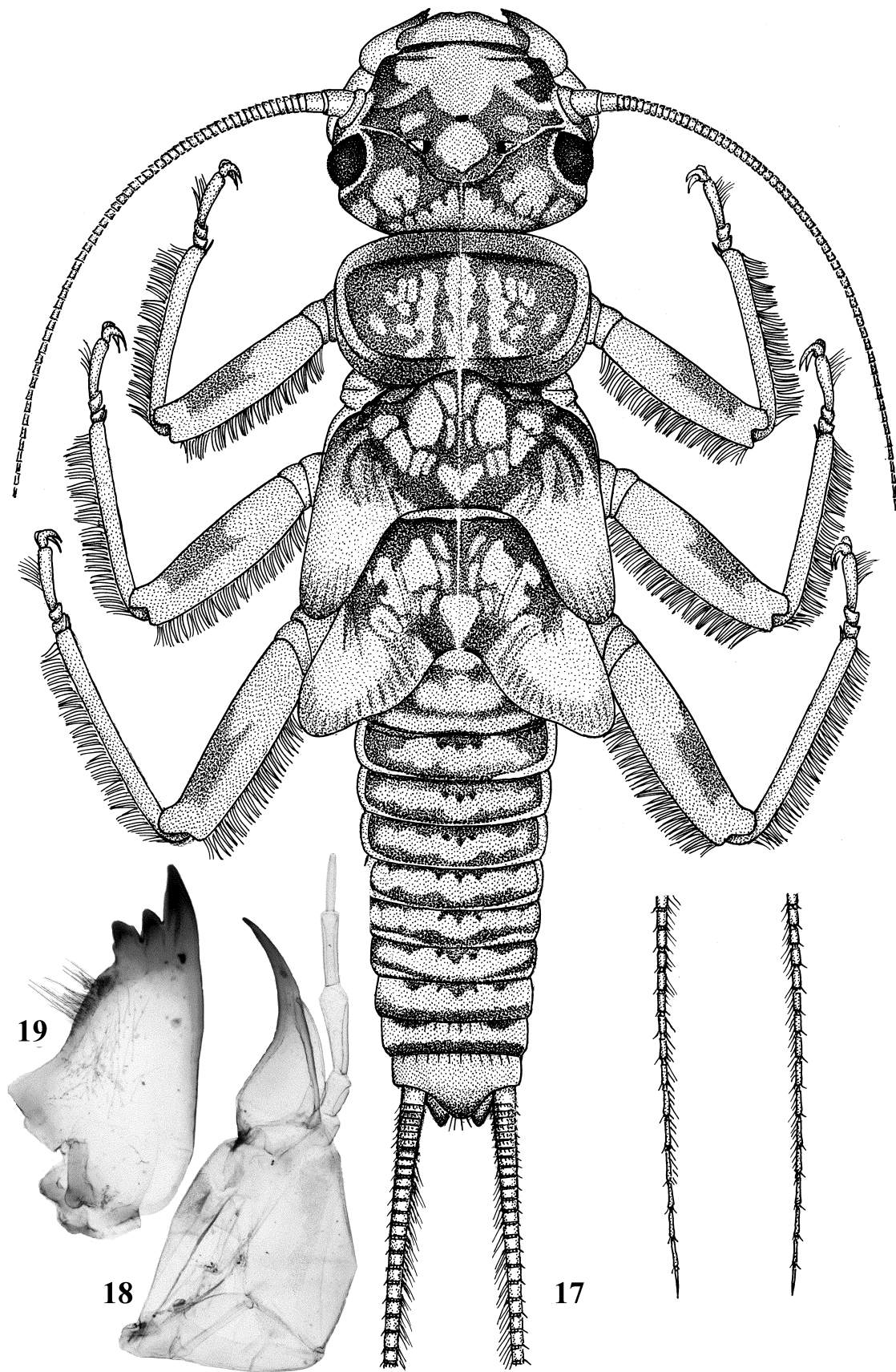
FIGURES 4–10. *Megaperlodes tiunovi* sp. n.: 4. Head and pronotum, dorsal. 5. Male abdominal tip in repose, posterior. 6. Same, everted, ventral. 7. Same, everted, dorsal. 8. Same, everted lateral. 9. Tip of the fingerlike projection, of the everted paraproctal lobe, lateral. 10. Female, subgenital plate, cleared, ventral.

Male. Abdominal tergum 8 black, slightly impressed dorsomedially; two submedial rounded swellings covered by short colourless hairs close to the posterior margin, especially apparent in lateral view (Figs. 5, 8). Posterior margin of tergum 9 with a medial triangular notch, which extends $\frac{1}{2}$ of the length of tergum 9, two posterolateral rounded swellings covered by short fine colourless hairs (Fig. 7); in repose tergum 9 hidden by tergum 8 and noticeable as narrow band with a triangular posteromedial notch (Fig. 5). Sternum 9 bears a scoop-shaped subgenital plate extending backward and curved upward (Figs. 5, 6). Sternum 10 narrow, pale medially with

two black lateral bands hidden by the subgenital plate in ventral view (Fig. 6). Tergum 10 entire, black, with median diamond-shaped yellow spot, covered by short fine colourless hairs (Fig. 7). In repose, tergum 10 tapers backward and caudally triangular, the paraprocts touch in contact dorsomedially, pressed against the lower face of tergum 10. In everted condition, a yellow membranous strip with rounded posterolateral edges protrudes from under the edge of tergum 10 and supported by a small medial conical peg located between the paraproct lobes and concealed by them in repose (Figs. 7, 8). The paraproct sclerite wide, heavily sclerotized basally, narrowed and bluntly rounded distally (Figs. 5, 6, 8). Eversible paraproct with lobe (EPL) arises from the base of the paraproct sclerite (Fig. 8). EPL large, inflated, ball-shaped basally, yellow and bears a long fingerlike projection, extended at the base and pointed towards the top (Figs. 6–8); ventral face of the projection membranous, the dorsal face covered by long thin brown-red sclerotized setae, more densely in the distal $\frac{1}{3}$ of the projection (Figs. 8, 9). Both projections closely appressed, directed obliquely backward and upward (Figs. 6–8).



FIGURES 11–16. *Megaperlodes tiunovi* sp. n., egg: 11. Habitus: anchor, longitudinal ridges, anterior pole, row of micropyles, dorsal. 12. Globular bodies on longitudinal ridge. 13. Row of micropyles, dorso-lateral. 14. Chorion structure and micropyles lateral. 15. Internal surface of anchor, pedicel, collar, dorsal. 16. External surface of anchor, collar, dorsal.



FIGURES 17–19. *Megaperlodes tiunovi* sp. n., larvae: 17. Habitus, female. 18. Right lacinia, ventral. 19. Right mandibular, ventral.

Female. Sternum 8 black with a small pale spot anteromedially, a short transversal subgenital plate extending slightly beyond the edge of sternum 8 (Fig. 10), posterior margin of the plate with a weak medial notch separating two lateral lobes, slightly rounded posteriorly, covered by small setae (Fig. 10). Lateral margins of subgenital plate rounded. Abdominal sternum 9 black with pale spot medially, a pair of dark posterolateral sclerites looks like oblique bands directed to anterior margin. Abdominal sternum 10 and the blunt paraprocts unmodified and back.

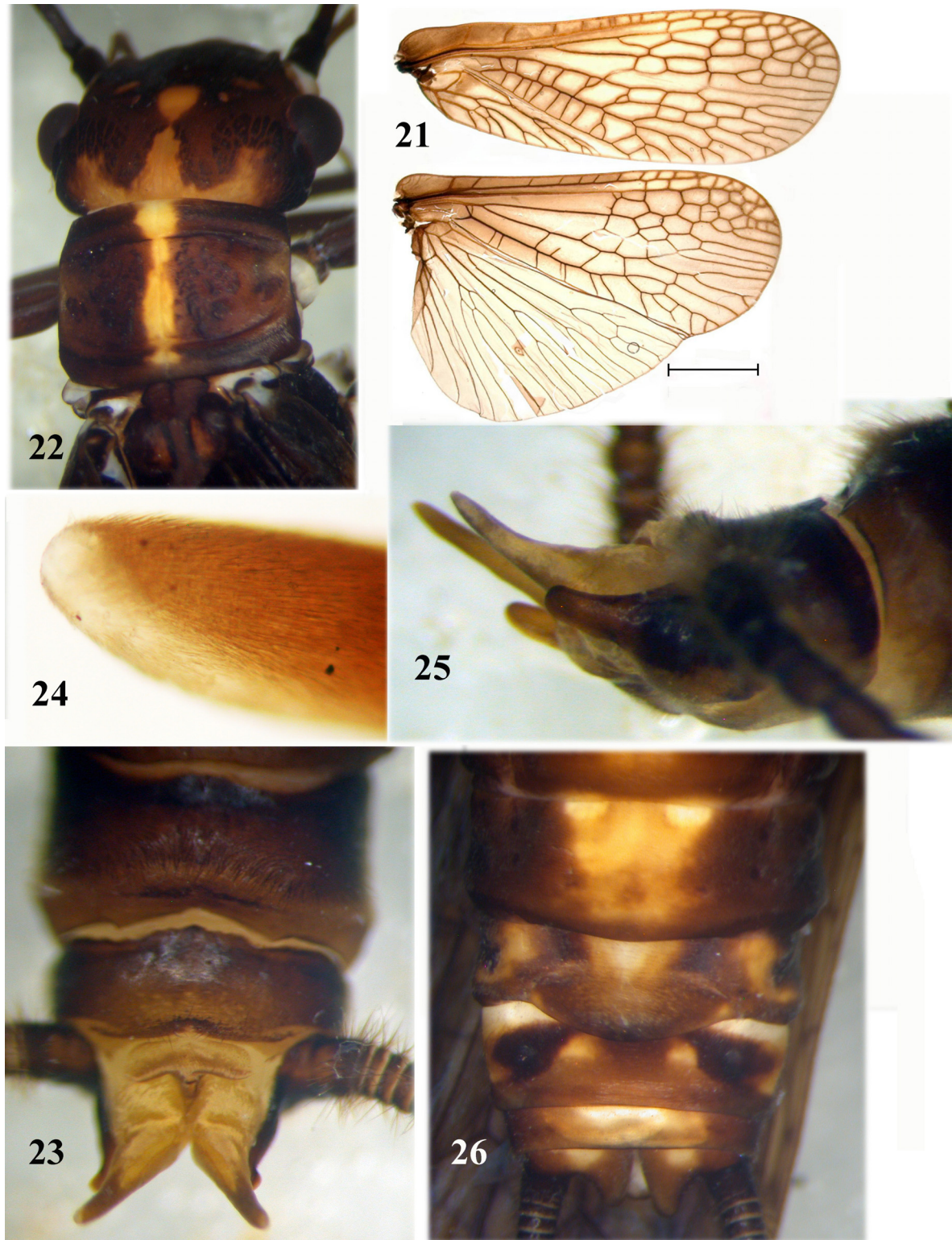
Egg. Trilateral (Fig. 11), 614 X 345 μm with narrow anterior pole. The longitudinal ridges (maximal width 65 μm) delimiting the three faces of the egg, densely covered by globular bodies (Figs. 11, 12). Each face additionally with a transverse ridge close to the posterior pole, also covered by globular bodies smaller and less dense, than on the longitudinal ridges (Fig. 11). A row of 3–7 micropyles near transverse ridge (Figs. 11, 13) on each of the three faces. Micropyle openings elevated above the chorion surface, rostral with rounded margins (Figs. 13, 14). Collar short, formed by medially projecting extensions of the three longitudinal ridges, each top of extension flaky, and petal-shaped, smooth on inner surface (Fig. 15). Collar delimited by rim on outer side basally (Figs. 15, 16). Anchor mushroom-shaped with short pedicel (Fig. 16); external surface pleated with globular bodies (Fig. 16). Internal surface of anchor as Fig. 15. The margin of the anchor covers the pedicel, not reaching the collar's rim (Fig. 16). The chorion surface smooth (Fig. 14).



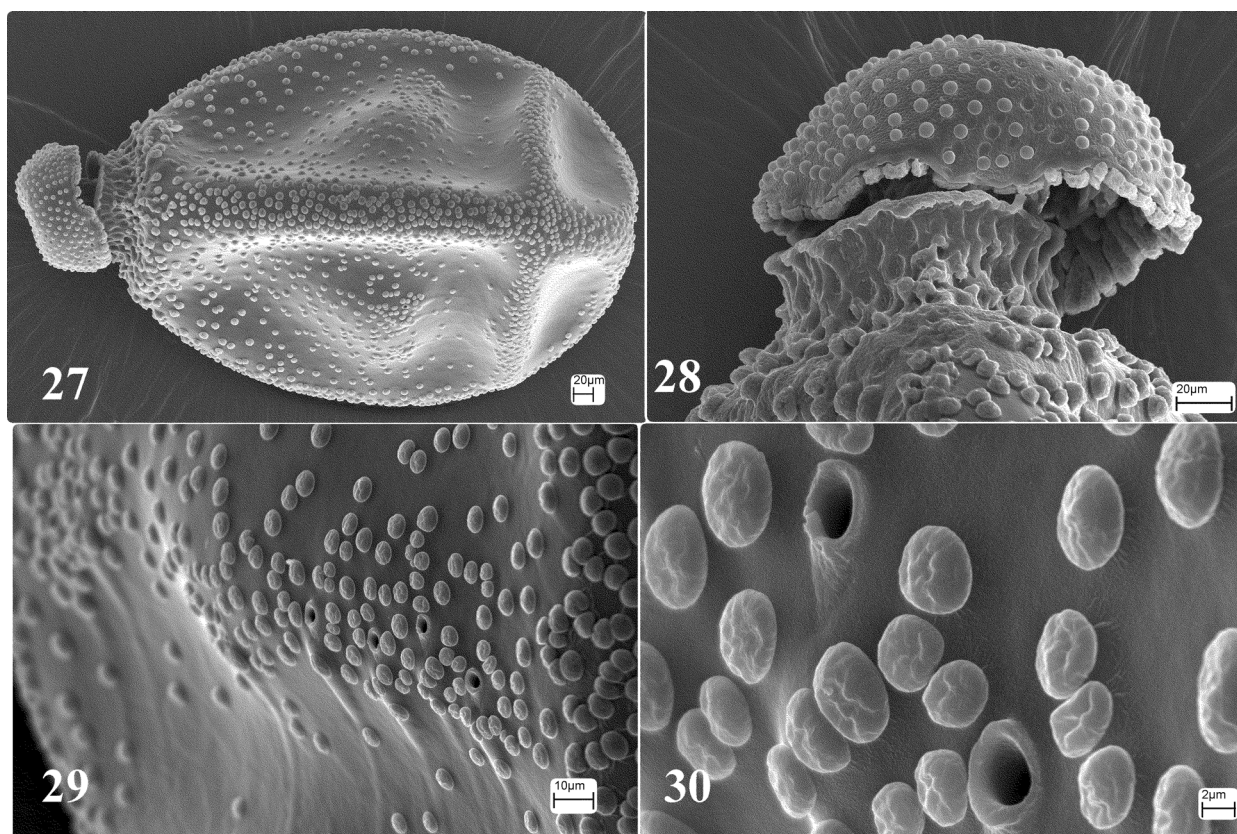
FIGURE 20. Type locality on the Brus'ya River (Photo by I. Tiunov).

Larvae. Mature female larvae 20.5–21.5 mm long ($n=2$). General colour grey-brown with a pale pattern. Body covered by short brown clothing hairs. Antennae, cerci and ventral body side pale grey. Head wider than the pronotum with a large, triangular, pale spot in front of the anterior ocellus extending onto the clypeus, labrum pale (Fig. 17). M-line pale, distinct; interocellar area brown with tear-shaped central pale spot (Fig. 17). A small triangular pale spot laterally from each posterior ocellus and the tentorial callosities pale. Occiput with a large triangular pale spot around the epicranial stem, two pairs of pale spots bordered by sinuate brownish rims behind each eye. No postocular spinule row. Lacinia unidentate (Fig. 18), narrow apically, pointed and well sclerotized, basal $\frac{1}{2}$ expanded. Submarginal setae absent. Galea reaches more than $\frac{1}{2}$ of the lacinia length. Mandible (Fig. 19) simple, not deeply cleft, with medial setae; mandibular teeth without serrations; a small patch of acanthae basally

from the last tooth. Submentum square with almost straight lateral margins; submental gills very short or almost absent. Pronotum trapeziform, transverse with rounded angles; anterior margin wider than posterior one; median, dorsal stripe pale, narrow, slightly wider posteriorly, a pale reticulate stripe presents on each lateral field of pronotum; pronotal margins without fringe of bristles (Fig. 17). Legs pale-grey, femur ventrally in distal ½ with elongate brownish mark. Outer margins of femur, tibia and tarsus with a fringe of colourless silky hairs.



FIGURES 21–26. *Megaperlodes niger*: 21. Wings of female. 22. Head and pronotum of male. 23. Male abdominal tip with everted paraproctal lobes, dorsal. 24. Tip of the fingerlike projection of the everted paraproctal lobe, lateral. 25. Male abdominal tip with everted paraproctal lobes, lateral. 26. Female abdominal tip, ventral. Scale (mm): 21 = 5.0.



FIGURES 27–30. *Megaperlodes niger*, egg: 27. Habitus: anchor, longitudinal ridges, median semispherical swellings, row of micropyles, dorsal. 28. Anchor and collar, dorsal. 29. Row of micropyles, dorso-lateral. 30. Chorion structure and micropyles lateral.

Abdominal segments 1–5 divided by hairless pleural membranes. Terga with a few colourless long hairs posteriomediaally, more pronounced on the last terga; the bristles at posterior tergal margins not detected. Terga brown with irregular yellow median band, the brown edge in front of it with three prominent dark spots; the distinct caudal setae present on terga 8 and 9; the pattern on terga 9 and 10 diffuse (Fig. 17). All abdominal terga covered by brown clothing hairs. Paraprocts normal length, apex rounded. Cerci pale greyish with dorsal fringe of fine, silky, colourless hairs (Fig. 17) increasing in length towards apical cercal segments, each cercal segment with an apical whorl of short brown setae.

Material examined. Holotype, male. Russian Far East, Primorsky Region, the Brus'ya River under road bridge, near Bamburovo Settlement, 42.56.480'N 131.19.120'E, 12.05.2014, coll. Teslenko V. Paratypes: 1 male, 6 females, 7 exuviae, the same locality and data as holotype, coll. Teslenko V.; 2 males (dissected in vial), 10 females (one dissected in vial).

Other material. 5 egg masses, 7 exuviae, the same locality, 18.05.2014, coll. V. Teslenko; 2 nymphs, the same locality, 28.04.2013, coll. I. Tiunov.

Etymology. The species is named in honor of the ornithologist Ivan M. Tiunov, who also made significant contributions to the knowledge of the stonefly and mayfly fauna of the Russian Far East.

Distribution. The new species is known from the small foothill salmonid stream, the Brus'ya River. This stream is located in the South Russian Far East in the Primorsky Region near the border with China and Korea. The Brus'ya River flows out from the East Manchurian Mountains to the Peter the Great Bay of the Sea of Japan. The type locality is situated about 5 km from the mouth (Fig. 20). Water temperature at the time of collection (12 of May 2014 at 12 am) was 3.8°C.

Remarks. *Megaperlodes tiunovi* is smaller in size than *M. niger* and differs in number of the abdominal segments divided laterally by yellow pleural folds, segments 1–5 are divided in *M. tiunovi*, whereas segments 1–6 are divided laterally by pleural folds in *M. niger*. The front wing *M. tiunovi* is black with a contrasting white frosted spot medially (Fig. 1), the front wing *M. niger* (Fig. 21) lacks a spot. The male of *M. niger* lacks a median yellow

spot on tergum 10. In everted condition, the posterior margin of tergum 10 of *M. niger* appears like a long transversal slightly sclerotized sclerite with rounded lateral margins (Fig. 23). The paraproct sclerite of *M. niger* is larger than in *M. tiunovi* and completely heavily sclerotized, with the base hemispherical, the sclerite long, medially narrowed, and then widened and distally bluntly rounded (Figs. 23, 25). The rectangular base of the EPL of *M. niger* has a long fingerlike projection, narrowed from base to the pointed tip (Figs. 23, 25), and densely covered by short setae (Fig. 24). The female subgenital plate of *M. niger* is caudally rounded and covered by short setae (Fig. 26). The egg of *M. niger* has a wider anterior pole with an entire collar (Figs. 27, 28). Each egg face has medially an additional hemispherical swelling (Fig. 27); the micropyles are shorter than in *M. tiunovi*, slightly elevated above the chorion surface, openings with rounded margins (Figs. 29, 30). The larvae differ in color, shape of submentum and pronotum (Fig. 3E in Inada et al. 1998).

Acknowledgments

The author thanks Dr. I. Tiunov for collecting larvae and for images of the type locality. The help of Prof. T. Tiunova, Drs. N. Naryshkina, and V. Loctionov, Vladivostok, Russia during slide preparation is very much appreciated. T. Eroshenko, Vladivostok, Russia, is sincerely thanked for the illustrations. Dr. T. Shimizu (Gifu, Japan) is thanked for the translating the Japanese references and for sending material of *M. niger* from the type locality. The author is very grateful to Prof. P. Zwick (Schlitz, Germany) and Dr. D. Murányi (Budapest, Hungary) for valuable comments, suggestions, linguistic revision that greatly improved the original manuscript, and also to Prof. Boris Kondratieff (Fort Collins Colorado, USA) for linguistic suggestions. The present work was supported in part by FEB RAS, Grant No 12-1-P30-01.

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