



Larvae of two East-Asian species of *Nemoura* (Plecoptera: Nemouridae)

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Abstract

Associated larvae of the two East-Asian *Nemoura* species, *N. papilla* Okamoto and *N. ussuriensis* Zhiltzova are described and illustrated in detail for the first time. The main diagnostic features of late instar larvae of both species are color and pigment patterns, the chaetotaxy of the pronotum, legs, abdomen, and cercal segments.

Key words: Plecoptera, *Nemoura*, larvae, Eastern Asia

Introduction

Stonefly fauna of the East-Asian region is characterized by high species diversity of *Nemoura* Latreille 1796 (DeWalt *et al.* 2016) which are relatively well identifiable as adults (Bae *et al.* 2011, Shimizu 1997, Yang *et al.* 2014, Zhiltzova 2003, Zwick 2010, Zwick & Baumann 2011). Larvae remain poorly known, only few (*N. geei* (Wu 1929), *N. jejudoensis* Zwick & Baumann 2011, *N. jilinensis* Zhu & Yang 2003, and *N. tripotini* Zwick 2010) have been described previously (Murányi & Park 2011, Teslenko 2016) using diagnostic features based on differences in the chaetotaxy of the pronotum, legs, abdominal, and cercal segments, as originally proposed by Raušer (1980) and Zwick (2004). This paper deals with the description and illustration of larvae of the common *N. papilla* Okamoto 1922 and *N. ussuriensis* Zhiltzova 1997 which inhabit transboundary streams and rivers of northern China, south of the Russian Far East, and Korea.

Material and methods

The association of the mature larvae with adults was established from preemergent male larvae or by rearing individuals in plastic bags with moss covered by cotton and kept in a dark, cool outdoor area. Specimens were examined with the aid of a compound microscope in transmitted light. Illustrations were produced using digital cameras Nikon Coolpix 995 and Toup View 3.7. Abdomens were removed and soaked in 10% NaOH overnight and rinsed with distilled water. The morphological terminology follows Zwick (2004).

Results and discussion

Nemoura papilla Okamoto, 1922

(Figs. 1–12).

Okamoto 1922. Bull. Agric. Exp. Stn. Chosen, Suigen 1(1):1–46 + Tafel I I–VI (original description of male and female); Shimizu, 1994, Aquatic Insects, 16(4): 221–223 (*Nemoura papilla* Okamoto, 1922 = *Nemoura denticulata* Kawai, 1954, syn. nov. and *N. levanidovae* Zwick, 1974, syn. nov.) (supplementary description of the epiproct, male and female).

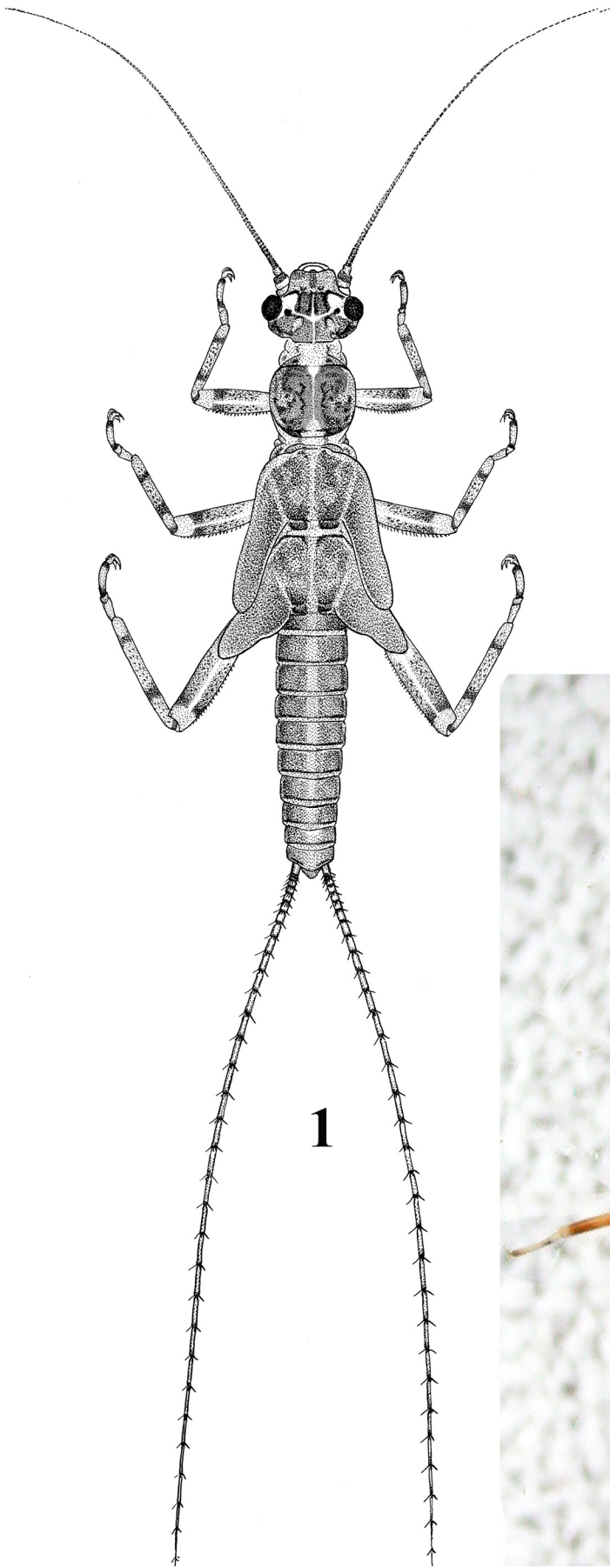
Material examined. Russian Far East, Primorsky Region: 6 males, 26 females, 35 larvae, Anan'evka River,

Razdol'naya River Basin, upper Venevitinovo Settlement, N 43°24.476' E 131°44.302', 27.04–4.05.2015, rearing, coll. V. Teslenko; 15 larvae, Vladivostok, Rybachiy Sett., Meortvaya Pad Stream, N 42°080.417' E 132°021.346', 28.07.–16.08.2015, coll. V. Teslenko.

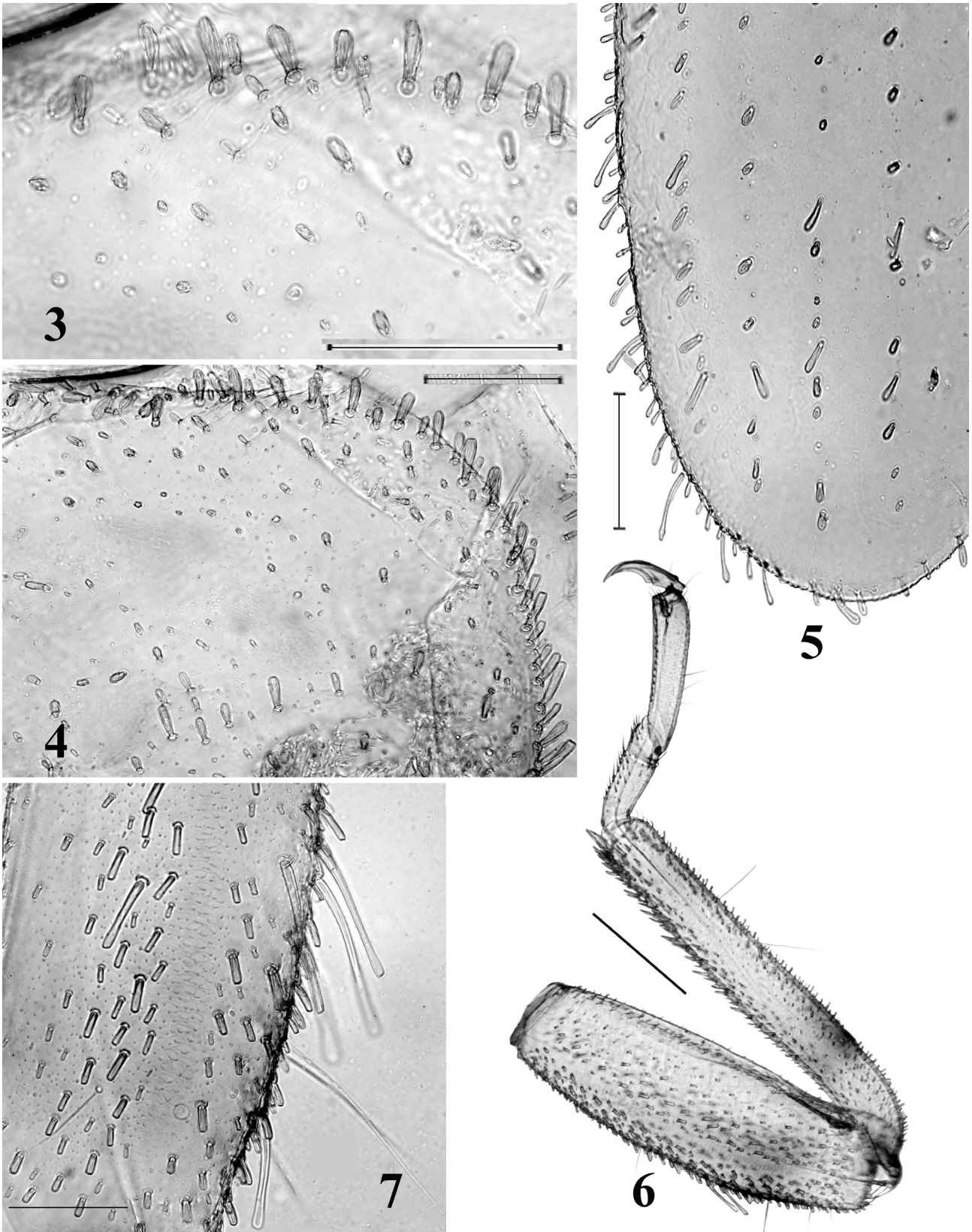
Mature larva (Figs. 1–12). Body relatively slender, length in males, 5.5–6.4 mm; in females 6.8–7.8 mm. General color a mottled brown with specific pattern consisting of pale and dark brown patches on head, legs, and cerci, and a pale mesal stripe on thorax (Figs. 1, 2). Head with pale, tentorial callosities outlined by contrasting unconnected dark brown lines towards posterior ocelli, a rectangular brown interocellar patch with thin longitudinal pale line medially, a diffuse brownish patch in front of the anterior ocellus extending to clypeus (Fig. 2). Epicranial suture appear as pale Y mark between the lateral ocelli; an oval, oblique pale patch to the inside of each compound eye. Occiput with pair of oval oblique pale patches surrounded by thread-like brown loops, posterior margin darkened (Fig. 2). Antenna brown, long, length reaches 85–100% of body length; scape and pedicel dark brown. Pronotum oval, approximately 1.2 X wider than long, pattern diffuse, with small dark brown spots and pale patches of different size and form; narrow pale mesal stripe on pronotum continues over meso-, metanotum and abdominal segments (Figs. 1, 2). Meso- and metanotum with U-shaped brown pattern and diffuse pale patches anteromedially. Legs slender, long with contrasting brown and dark brown bands and pale patches. Femora brown with diffuse dark brown band in the distal $\frac{1}{3}$ and one pale patch apically, sometimes with a bald median pale line (Figs. 1, 2). Fore femur 3.3 X longer than wide (Fig. 6) and hind femur about 4.1–5.0 X longer than wide. Tibia brown with two diffuse dark brown bands in the basal and distal $\frac{1}{3}$ (Figs. 1, 2) and two pale patches basally and distally. Third tarsal segment darkened basally and distally, pale medially. Abdomen relatively slender, integument light, matte in appearance, terga brownish with a mesal row of pale small patches forming a medial longitudinal band (Figs. 1, 2). Cerci pale, very long, length reaches 100–133% of body length, with 31–33 segments, each segment darkened basally and distally, pale medially; the segment sides are nearly parallel in basal part of cercus, club-shaped in middle and apical parts, apical segments very long, 25X longer than wide (Figs. 1, 2, 9).

Setation weakly visible. Setal fringe around the pronotum relatively spaced, consisting of club-shaped bristles of different length (Figs. 3, 4). Few longest club-shaped bristles present at the posterior corners, the longest bristles approximately equal 4.9–5.5% of pronotum width. Pronotum disc bears tiny oval setae with widened apex, short club-shaped setae, and occasional long hairs (Figs. 3, 4). Outer wing pad margin covered with club-shaped bristles; tiny club-shaped setae in the lines on wing-pads (Fig. 5). Legs with markedly heterogeneous chaetotaxy (Figs. 6, 7). All femora covered with spatulate bristles of different length, occasionally fine procumbent setae and seldom thin long hairs (Figs. 6, 7). Setal fringe on outer femur margin in the apical half consisting of three long, club-shaped bristles in an irregular arrangement on fore leg, and with five long, club-shaped bristles on hind leg (Figs. 6, 7). The longest club-shaped bristles reach 37% of the width of femur on fore leg, and 26% of the hind leg. Tibia with sporadic fine procumbent setae, dense and strong spine-like bristles along the inner edge, the bristles not longer than width of tibia; the outer edge bears tiny club-shaped setae (Fig. 6). Terga covered with sparse short club-shaped bristles. The posterior tergal margins feature mostly short club-shaped bristles and one pair of conspicuous relatively long slightly curved club-shaped bristles (Fig. 8). Length of the longest bristles on terga 5–6 reaches 34% of segment length (Fig. 8). Cercal chaetotaxy heterogeneous, bristles of different form and size in the apical whorl; intercalary setation very sparse and almost invisible (Figs. 10–12). Apical whorl comprises a set of club-shaped bristles on basal cercal segments; the longest club-shaped bristles reach 67% of segment length on cercal segments 8–10 (Fig. 10). In the middle part of cerci the apical whorl bears tiny setae with rounded apex mixed with long, acute bristles, which do not exceed 59% of the segment's length on cercal segments 16–17 (Fig. 11). On apical cercal segments the apical whorls include tiny setae with rounded apex and one or two thin acute bristles (like hairs), bristle length is only about 16% of segment length at cercal segment 31 (Fig. 12).

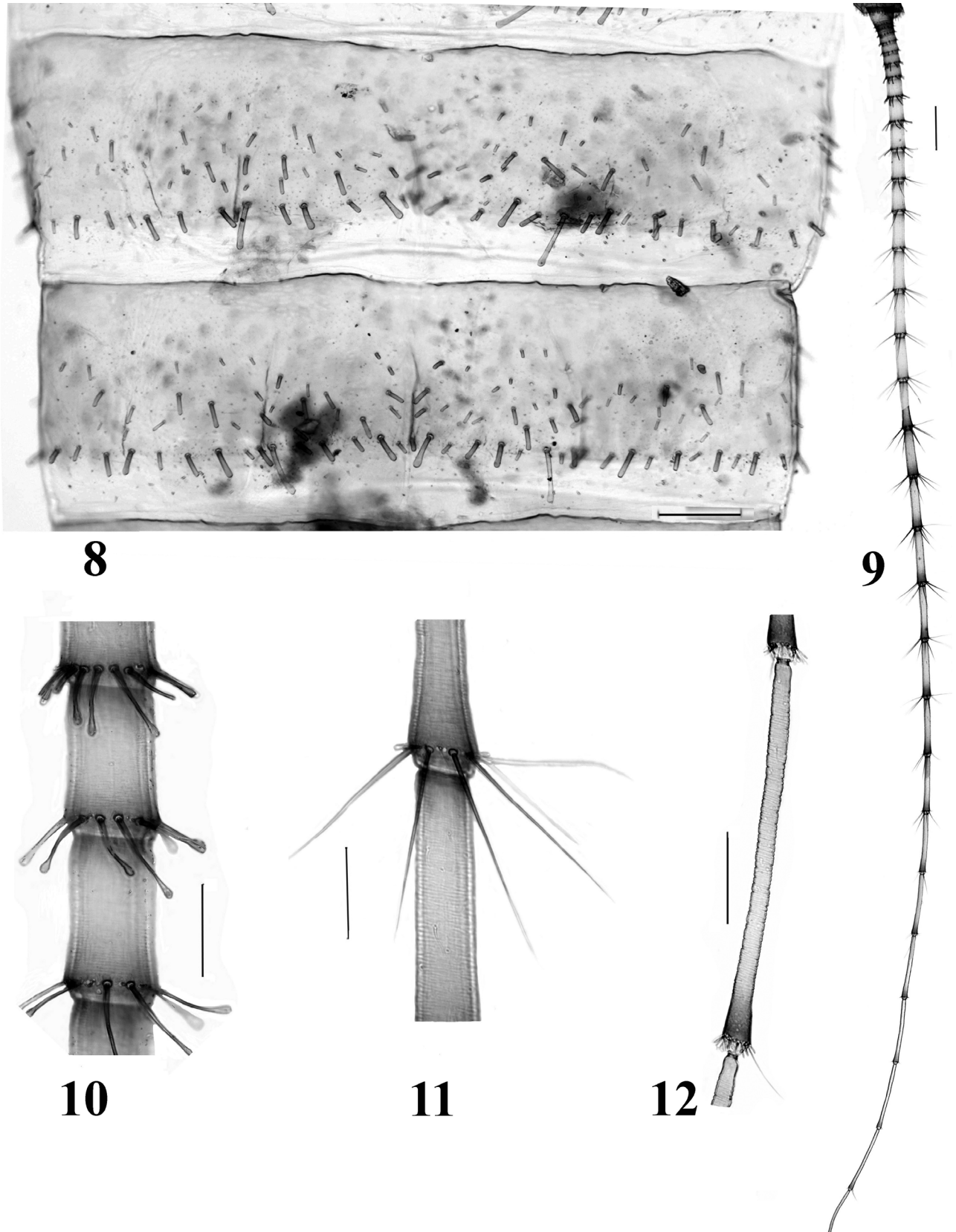
Diagnosis. The larvae of *N. papilla* can be separated from known larvae of East-Asian *Nemoura* species by mottled contrasting body pattern, long antenna, cerci exceeding the body length, weak but conspicuous variable setation on the legs and cerci. Setal fringe of the pronotum sparse with club-shaped bristles, club-shaped bristles of different size present also in setal fringes along outer wing pad margin, outer femur margin, posterior margins of terga and in the apical whorls on basal cercal segments. Setation of femur also includes a few long club-shaped bristles and special spatulate bristles. The medial apical whorl of the cerci differs from the apical whorl on basal segments having long acute bristles not exceeding 59% of segment length at cercal segments 16–17. Intercalary setation on cercal segments sparse and almost indiscernible.



FIGURES 1–2. Larva of *Nemoura papilla*, habitus, dorsal view, not to scale.



FIGURES 3–7. Larva of *Nemoura papilla*. 3. Club-shaped bristles near midline on anterior margin of pronotum. 4. Setae on disc and setal fringe of right anterior corner of pronotum. 5. Bristles on outer margin and rows of tiny setae on wing pad. 6. Right fore leg. 7. Setal fringe on outer femur margin on hind leg with five long club-shaped bristles Scale (mm): 3–5=0.1; 6=0.3; 7=0.05.



FIGURES 8–12. Larva of *Nemoura papilla*. 8. Chaetotaxy of terga 5–6. 9. Left cercus. 10. Cercus segments 8–10 with club-shaped bristles. 11. Cercus segments 15 & 16 with long, acute bristles. 12. Apical cercus segments. Scale (mm): 8, 10–12=0.1; 9=0.3.

Distribution. *Nemoura papilla* is an East Asian mainland and insular, widely distributed species originally described from Japan, but also known from the southern Kuril Islands, Sakhalin Island, mainland Russian Far East (RFE), China, and Korea (Teslenko, 2015). The flight period extends from May to July. Larvae of *N. papilla* inhabit mountain streams and rivers, occurring in pools with silty substrate.

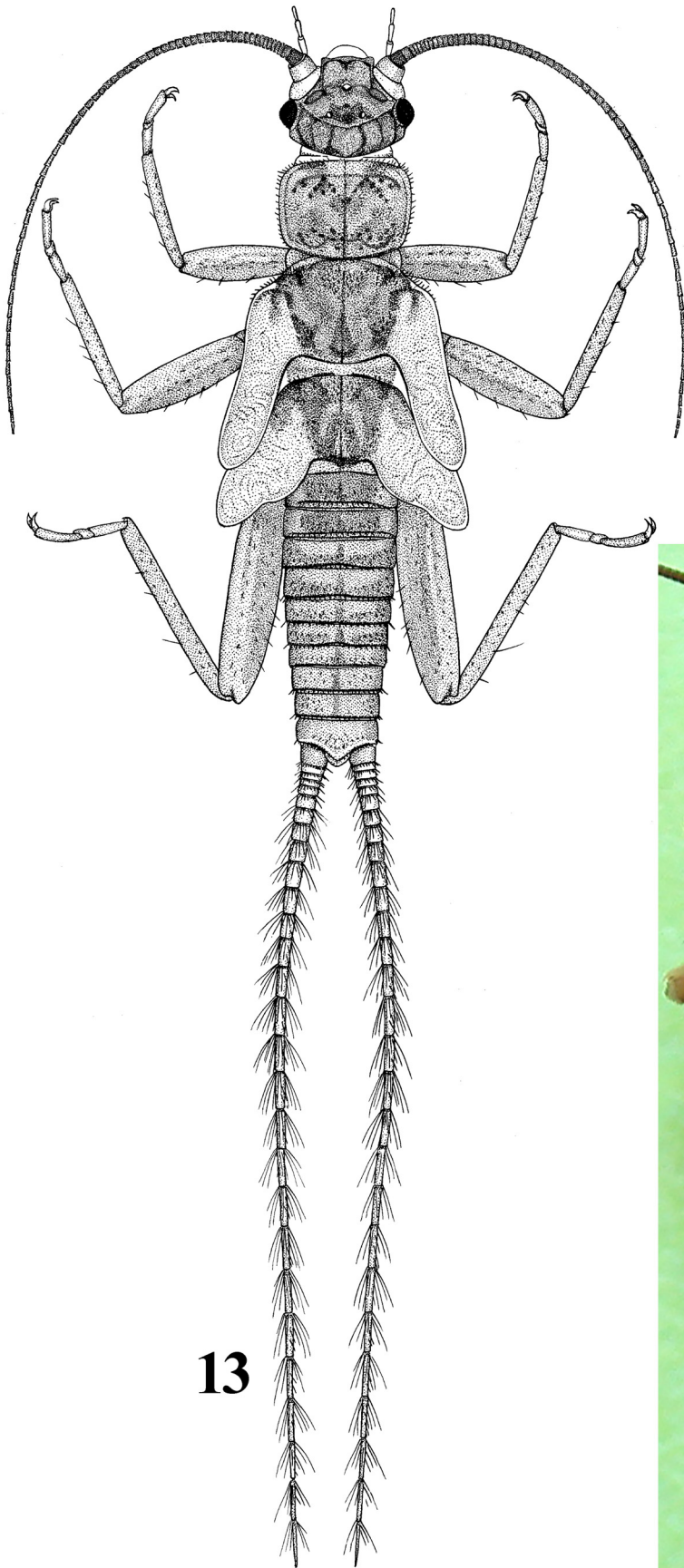
***Nemoura ussuriensis* Zhiltzova, 1997 in Teslenko & Zhiltzova, 1997**
(Figs. 13–23).

Material examined. Russian Far East, Primorsky Region: 4 mature larvae of males, Anan'evka River, Razdol'naya River. Basin, near road bridge, at Venevitinovo Sett., N 43°24.476' E131°44.302', 27.04.2004, coll. I. Tiunov; 2 larvae of females, Vtoraya Rechka River, Razdol'naya River. Basin, near road bridge, 3.05.2013, coll. I. Tiunov; 1 mature male larva, Gladkaya River, near Gvozdevo Sett., 26.04.2013, coll. I. Tiunov.

Mature larva. Mature larvae are large, body length 7.2–7.7 mm in males; 8.3–9.6 mm in females. General color brown with conspicuous head pattern: tentorial callosities brown, contoured by narrow dark bands extending to the clypeus, resembling the Russian letter П with mesal notch; clypeus with prominent rounded anterior corners. The interocellar area bears a diffuse dark spot attaining the posterior ocelli (Figs. 13, 14). Occiput with three pairs of pale spots surrounded by thread-like brown loops, posterior margin darkened. Antenna brown, long, up to 85–100% of body length, scape paler than both head or pedicel and flagellum. Pronotum approximately 1.5 X wider than long, pattern indistinct, with small dark brown spots together resembling the letter X (Figs. 13, 14). Mesonotum and metanotum with U-shaped brown band and diffuse pale patch anteromedially. Legs brown, outer margin of femora darker than inner, the fore femur is 2.6 X longer than wide (Fig. 18), the hind femur 3.3 X longer than wide, hind legs are long. Abdomen relatively slender, integument light, matte in appearance, terga brown with a mesal row of dark brown patches which forms a longitudinal band on 1–8 segments (Figs. 13, 14). Cerci pale, strongly hairy, long, with 31–32 segments, length reaches 100–118% of body length (Figs. 13, 14, 20).

Setation distinct. Setal fringe around the pronotum consisting of occasional long hairs, and cylindrical bristles, the apices rounded and often slightly wider than the base; length of bristles on lateral margins and anterior and posterior corners greater than on anterior and posterior margins; fringe on lateral pronotal margins relatively regular and denser than on anterior and posterior margins, because of bristles stand in two or three rows (Figs. 15, 16). Length of the longest cylindrical bristles at the anterior and posterior pronotal corners reaches 3.4% of pronotal width. Pronotal disc with occasional long hairs, short cylindrical setae and tiny procumbent setae with short acute hooked apices. These tiny setae are concentrated on the lateral fields of pronotum (Fig. 16). Outer wing pad margin covered with slender club-shaped bristles, and occasional long hairs; cylindrical setae and occasional long hairs in the lines on the wing-pads (Fig. 17). All femora bear fine numerous procumbent setae and dense short blunt bristles. Setal fringe on the outer femur margin short, including a few long thin hairs and short blunt bristles in irregular arrangement (Fig. 18); the longest bristle reaches approximately 22% of femur width on the fore leg and 20% on the hind leg. Setation of tibia and tarsi very similar to femur. Terga covered mainly with short cylindrical bristles and sparse tiny procumbent setae (Fig. 19). Setae along the posterior tergal margin heterogeneous: most apically rounded cylindrical bristles are relatively short (Fig. 19), while one conspicuous pair of long bristles turns apically into fine, thin hairs that are easily overlooked; on the posterior margin of terga 5–6 hairs reach 47% of segment length (Figs. 19, 23). Cerci densely covered with acute bristles of different length: in apical whorl on basal cercal segments the bristles shorter the segment; on cercal segment 8 the longest acute bristles reach 148% of segment's length, intercalary setation visible (Fig. 21); in cercal segments 16–17 the longest bristles do not exceed 95% of segment length, the intercalary setae reach 128% of the segment's length (Fig. 22). Setal ring of apical cercal segments sparse, intercalary hairs noticeable. Additionally to the long thin acute bristles there are tiny setae with rounded apex and a few thin long hairs in the apical whorl.

Diagnosis. The larvae of *N. ussuriensis* can be easily distinguished from the known larvae of *Nemoura* in the RFE by the head pattern, long and the “fuzzy-like” appearance of the cerci exceeding the body length with distinctive setation. Setal fringe around pronotum, outer wing pad margin and posterior tergal margins consisting of cylindrical bristles with apices rounded and often a little wider than the base, but not club-shaped. Fringe on lateral pronotal margins regular and dense, cylindrical bristles placed in two or three rows, tiny procumbent setae on pronotal lateral fields with short acute hooked apices. The outer femur margin bears bristles of another type, they



FIGURES 13–14. Larva of *Nemoura ussuriensis*, habitus, dorsal view, not to scale.

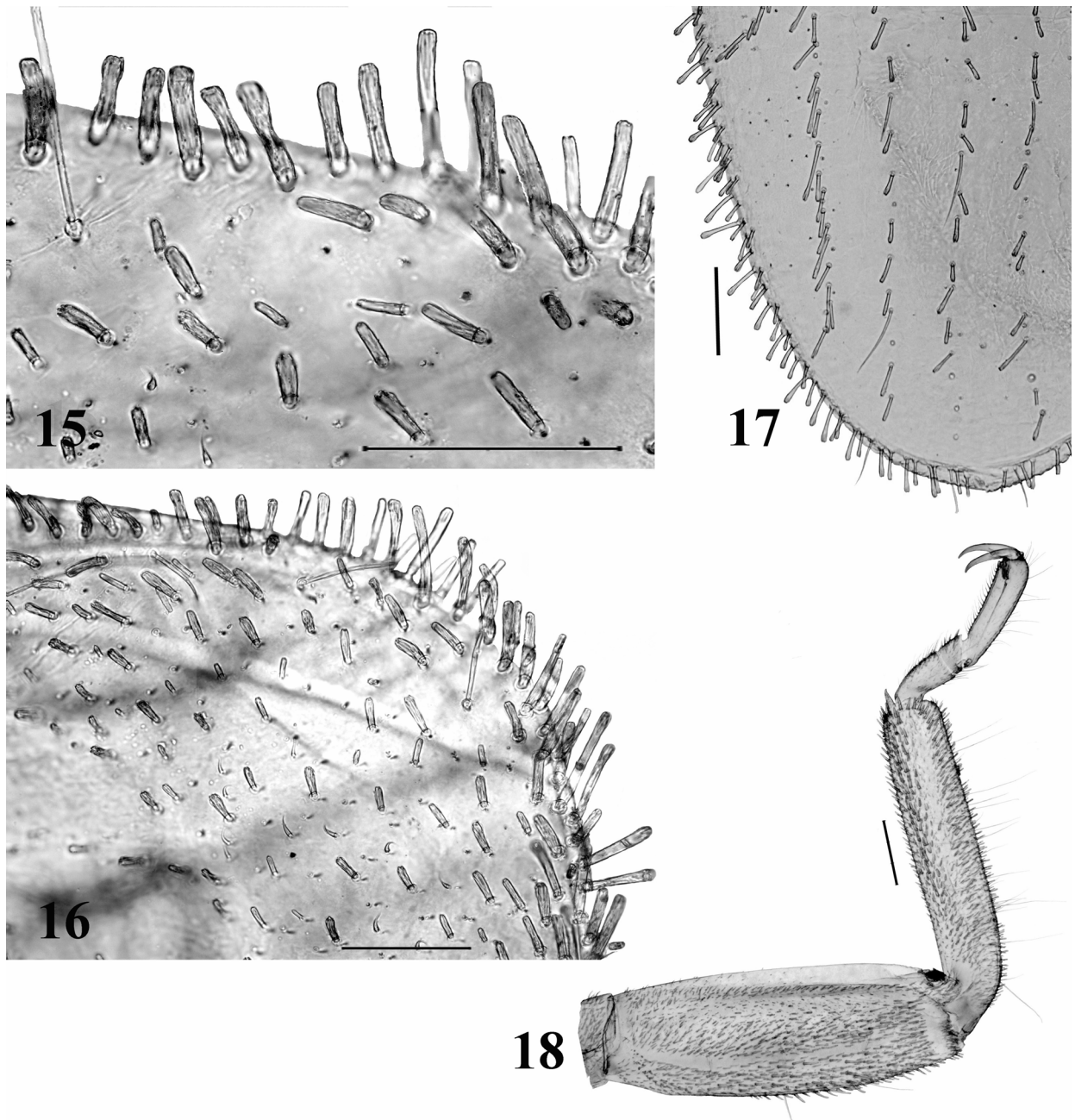
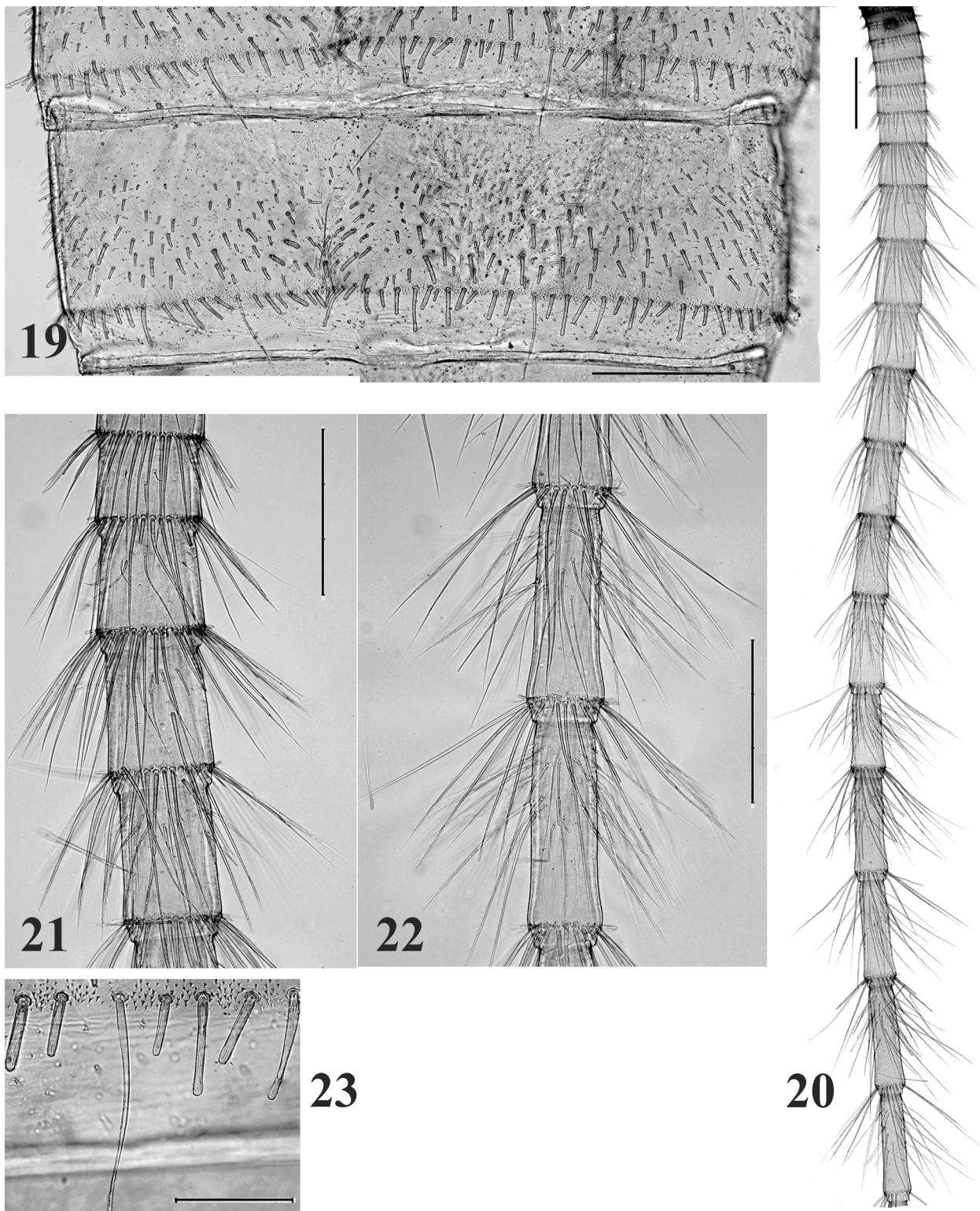


FIGURE 15–18. Larva of *Nemoura ussuriensis*. 15. Cylindrical bristles with rounded apices on anterior margin of pronotum. 16. Chaetotaxy on disc, right anterior pronotal corner and lateral margin with dense cylindrical bristles. 17. Cylindrical and club-shaped bristles on outer margin and in the rows on wing pad. 18. Right fore leg. Scale (mm): 15–17=0.1; 18=0.3.

are short and blunt. The posterior tergal margins 5–6 feature conspicuous paired long, thin cylindrical bristles (like hairs) reaching 47% of the length of segment (Figs. 19, 23) among the mostly short cylindrical bristles. Cerci have homogeneous setation of long acute bristles. In the apical whorl of cercal segment 8 the longest acute bristles reach 148% of the segment's length, intercalary setation visible; in apical whorl of 16–17 cercal segments the longest acute bristles do not exceed 95% of the segment's length and the longest intercalary setae reach 128% of the segment's length.

Distribution. *Nemoura ussuriensis* is currently considered an East Asian mainland endemic species with a restricted distribution south of Primorsky Region of the RFE in the Razdol'naya River Basin and small salmon streams flowing into Peter the Great Bay of the Sea of Japan (Teslenko & Zhiltzova 2009). Zwick (2010) has suggested that the description of the Korean species, *N. espera* Ham & Lee, 1999 is very similar to *N. ussuriensis* and may be a junior synonym. Certainly, this suggestion requires further study of comparative material. However,

it seems that *N. ussuriensis* should be encountered in streams of China and the Korean Peninsula, because the transboundary Razdol'naya River flows through China and Russia, and small salmon streams originate in the spurs of the Black Mountains of the Changbai Mountain Range shared with China and Korea Peninsula. The flight period extended from the end of April to the beginning of June.



FIGURES 19–23. Larva of *Nemoura ussuriensis*. 19. Chaetotaxy of terga 5–6. 20. Left cercus. 21. Cercus segments 8–11 with acute bristles in whorl cercus and acute intercalary bristles. 22. Cercus segments 16 & 17 with long, acute bristles in cercus whorl and intercalary bristles. 23. Cylindrical bristles and one of the paired long slightly curved thin bristle on the posterior margin of terga 5–6. Scale (mm): 19, 21, 22=0.1; 20=0.3; 23=0.05.

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