



<http://dx.doi.org/10.11646/zootaxa.3974.2.10>

<http://zoobank.org/urn:lsid:zoobank.org:pub:14F68A59-0568-40ED-86D2-4A59C5A7881C>

Genus *Leptoiulus* Verhoeff, 1894 new to the fauna of the Asian part of Russia, with description of a new species from the Altai and its comparison with the European *Leptoiulus trilineatus* (C.L. Koch, 1847) (Diplopoda, Julida, Julidae)

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Abstract

The diplopod genus *Leptoiulus* Verhoeff, 1894 is new to the fauna of the Asian part of Russia, due to the discovery of *L. tigirek* sp. nov. from the south-western part of the Altai Province, Siberia. A description of the new species and information on its habitats, numbers and locomotor activity as well as comparison with the European *Leptoiulus trilineatus* (C.L. Koch, 1847) are presented.

Key words: millipede, julids, *Leptoiulus*, new species, description, juxtaposition, Siberia, Russia

Introduction

Knowledge of the millipede fauna of the Altai is still incomplete. Evidence of this is that a new species of *Leptoiulus*, not recorded previously from the Asian part of Russia (Mikhaljova 2004), has been found in the southwestern part of the Altai Province. This large genus, with more than 70 species, is widely distributed in Europe and it has also been recorded in Azerbaijan and Georgia, Caucasus (Jawłowski 1929; Lohmander 1936) and Iran (Lohmander 1932; Enghoff & Moravvej 2005). The present find is the easternmost known record of *Leptoiulus*. This contribution describes the new species, provides data on its habitats, numbers and locomotor activity as well as comparison with the European *Leptoiulus trilineatus*.

Material and methods

Material on the new species treated here has been shared between the collections of the Institute of Biology and Soil Science, Far Eastern Branch, Russian Academy of Sciences, Vladivostok, Russia (IBSS), Altai State University, Barnaul, Russia (ASU) and Zoological Museum, State University of Moscow, Russia (ZMUM), as indicated in the text. In addition, one male of *Leptoiulus trilineatus* from the Natural History Museum of Denmark (Zoological Museum), University of Copenhagen, Denmark (ZMUC) was examined and the sample was transferred to IBSS.

Specimens were preserved in 70% ethanol. In the process of studying the material, the gonopods and some other parts were dissected from a limited number of males and females and mounted in glycerin as temporary micropreparations. Specimens were studied and illustrated using standard stereomicroscopic and drawing equipment. Coloration of the specimens is described from alcohol material. SEM micrographs were prepared at the Centre of Collective Use “Biotechnology and Gene Engineering” of the Institute of Biology and Soil Science, Far Eastern Branch, Russian Academy of Sciences, Vladivostok, Russia (IBSS) using a Zeiss Evo 40 scanning electron

microscope. Mounts for SEM were made through air-drying after transfer to acetone via 96% alcohol, mounting on stubs, and coating with gold and platinum. After examination, SEM material was removed from stubs and returned to alcohol, all such samples being kept at IBSS.

A “body segment formula” indicates the number of podous (including gonopod segment) and apodous segments before the telson in an individual. This formula is $x(-y)$ where x = sum of podous and apodous body segments excluding telson, y = number of apodous body segments before telson.

***Leptoiulus tigirek* sp. nov.**

Figs 1–13

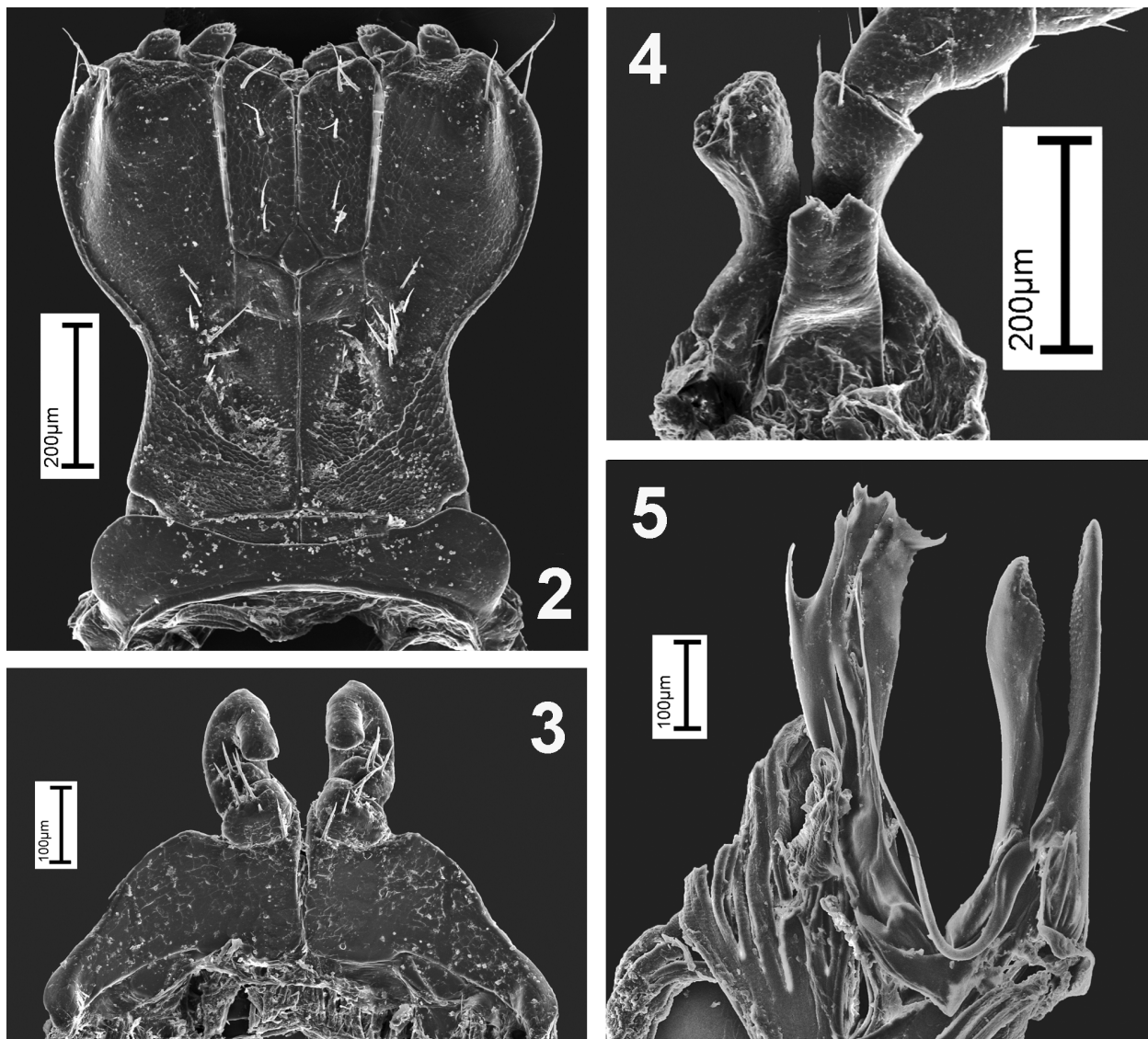
Material examined. *Holotype*: 1 male (ZMUM: ρ 2656), Russia, Siberia, Altai Province, Krasnoshchekovo District, Tigirek State Nature Reserve, Khankhara site, shrub-reed *Larix* forest, 21–31 August 2012, collected by L.A. Trilikauskas; *Paratype*: 1 male, 1 female (IBSS), 1 male, 1 female (ZMUM: 1m, 1f— ρ 2657), together with holotype, 21–31 August 2012, collected by L.A. Trilikauskas; 1 male, 1 female, 1 juvenile (ASU), Russia, Siberia, Altai Province, Krasnoshchekovo District, Tigirek State Nature Reserve buffer zone, 1.1 km SW Tigirek, 51°09'235'' N, 83°01'155'' E, meadow steppe, E slope of stone hill, 525 m a.s.l., pitfall traps, 1–6 July 2013, collected by Yu.V. Dyachkov; 1 male, 1 female (ASU), Russia, Siberia, Altai Province, Krasnoshchekovo District, Tigirek State Nature Reserve buffer zone, 1.5 km NW Tigirek, 51°09'219'' N, 83°01'146'' E, Kozyr Mt, *Larix sibirica* forest, 639 m a.s.l., 2 July 2013, collected by Yu.V. Dyachkov; 2 males, 2 females, 2 juveniles (IBSS), 2 males, 2 females, 11 juveniles (ASU), Russia, Siberia, Altai Province, Krasnoshchekovo District, Tigirek State Nature Reserve buffer zone, 1.2 km SW Tigirek, 51°07'765'' N, 83°01'706'' E, S slope of bottom of Chainaya Mt, *Caragana* and *Lonicera* thicket, 619 m a.s.l., 5 July 2013, collected by Yu.V. Dyachkov; 1 male, 2 females, 14 juveniles (ASU), Russia, Siberia, Altai Province, Krasnoshchekovo District, Tigirek State Nature Reserve buffer zone, 3.5 km SW Tigirek, 51°07'212'' N, 83°00'481'' E, chern taiga forest, 645 m a.s.l., 8 July 2013, collected by Yu.V. Dyachkov; 4 juveniles (ASU), Russia, Siberia, Altai Province, Krasnoshchekovo District, Tigirek State Nature Reserve buffer zone, environs of Tigirek, 51°09'135'' N, 83°01'196'' E, NE slope near top of Kozyr Mt, *Larix sibirica* and *Betula* forest, 650 m a.s.l., pitfall traps, 18–28 May 2014, collected by T.M. Krugova; 5 juveniles (ASU), Russia, Siberia, Altai Province, Krasnoshchekovo District, Tigirek State Nature Reserve, Tigirek site, 1.3 km SE Tigirek, 51°08'247'' N, 83°02'531'' E, stone hill, shrub thicket of *Pentaphylloides fruticosa*, 514 m a.s.l., pitfall traps, 1–6 July 2013, collected by Yu.V. Dyachkov; 2 males, 1 female, 45 juveniles (ASU), same locality, 10 July 2013, collected by Yu.V. Dyachkov; 1 male (ZMUM: 1m— ρ 2658), 4 males, 5 females, 1 fragment (ASU), Russia, Siberia, Altai Province, Krasnoshchekovo District, Tigirek State Nature Reserve, Tigirek site, environs of Tigirek, 51°08'115'' N, 83°02'501'' E, left bank of Malyi Tigirek River, bottom of Chainaya Mt, *Caragana* and *Lonicera* thicket, 500 m a.s.l., pitfall traps, 18–28 May 2014, collected by T.M. Krugova; 2 males (ASU), Russia, Siberia, Altai Province, Krasnoshchekovo District, Tigirek State Nature Reserve, Tigirek site, environs of Tigirek, 51°07'549'' N, 83°00'488'' E, right bank of Malyi Tigirek River, NE slope of bottom of Lvyni Kamen Mt, chern taiga forest, 675 m a.s.l., pitfall traps, 18–28 May 2014, collected by T.M. Krugova; 4 males, 6 females, 1 fragment (ASU), Russia, Siberia, Altai Province, Krasnoshchekovo District, Tigirek State Nature Reserve, Khankhara site, 7 km NW Tigirek, 51°09'10.36'' N, 82°56'25.85'' E, *Salix* thicket, swamp, 17 August 2014, collected by Yu.V. Dyachkov; 2 males, 14 females (ASU), Russia, Siberia, Altai Province, Krasnoshchekovo District, Tigirek State Nature Reserve, Khankhara site, 6.1 km NW Tigirek, 51°09'15.75'' N, 82°56'36.35'' E, *Betula* and *Salix* forest, 675 m a.s.l., 18 August 2014, collected by Yu.V. Dyachkov; 2 males, 6 females, 5 juveniles (ASU), Russia, Siberia, Altai Province, Zmeinogorsk District, Tigirek State Nature Reserve, Beloretsk site, 51°00'277'' N, 82°45'830'' E, chern taiga forest, 550 m a.s.l., pitfall traps, 28 May–5 June 2013, collected by T.M. Krugova; 2 males (ASU), Russia, Siberia, Altai Province, Zmeinogorsk District, Tigirek State Nature Reserve, Beloretsk site, 51°00'188'' N, 82°45'812'' E, right bank of Glukharikha River at the confluence to Belaya River, upper part of W slope, chern taiga forest, pitfall traps, 2–9 June 2014, collected by T.M. Krugova; 4 females, 1 juvenile (ASU), same locality, pitfall traps, 20–28 August 2014, collected by T.M. Krugova; 3 males (ASU), Russia, Siberia, Altai Province, Zmeinogorsk District, Tigirek State Nature Reserve, Beloretsk site, 51°00' N, 82°45' E, right bank of Glukharikha River at the confluence to Belaya River, lower part of W slope, chern taiga forest, pitfall traps, 3–9 June 2014, collected by T.M. Krugova; 2 females, 4 juveniles (ASU), same locality, pitfall traps, 20–28 August 2014, collected

by T.M. Krugova; 2 males, 1 juvenile (ASU), Russia, Siberia, Altai Province, Zmeinogorsk District, Tigirek State Nature Reserve, Beloretsk site, 51°00'211'' N, 82°45'815'' E, right bank of Glukharikha River at the confluence to Belaya River, clearing in chern taiga forest, 562 m a.s.l., pitfall traps, 1–9 June 2014, collected by T.M. Krugova; 1 female (ZMUM: 1f—ρ 2659), 1 female, 3 juveniles (ASU), same locality, pitfall traps, 20–28 August 2014, collected by T.M. Krugova.

Diagnosis. Differs from congeners mainly by the absence of a basal outgrowth on the gonopod promere, more slender gonopod opisthomere and large, blade-shaped phylacum with bifurcated apex.



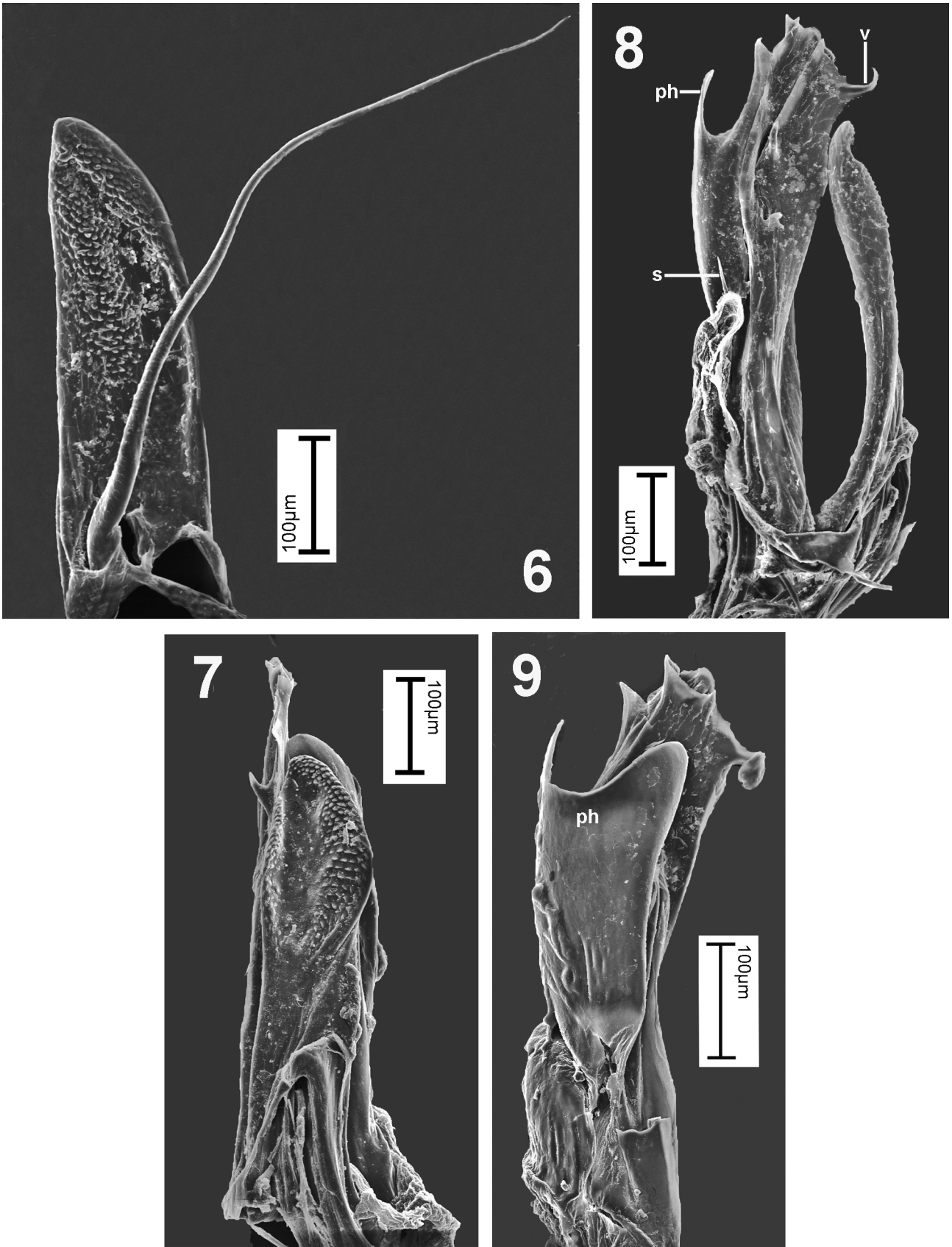
FIGURE 1. *Leptoiulus tigirek* sp. nov., male paratype. Habitus in lateral view. Photographed not to scale.



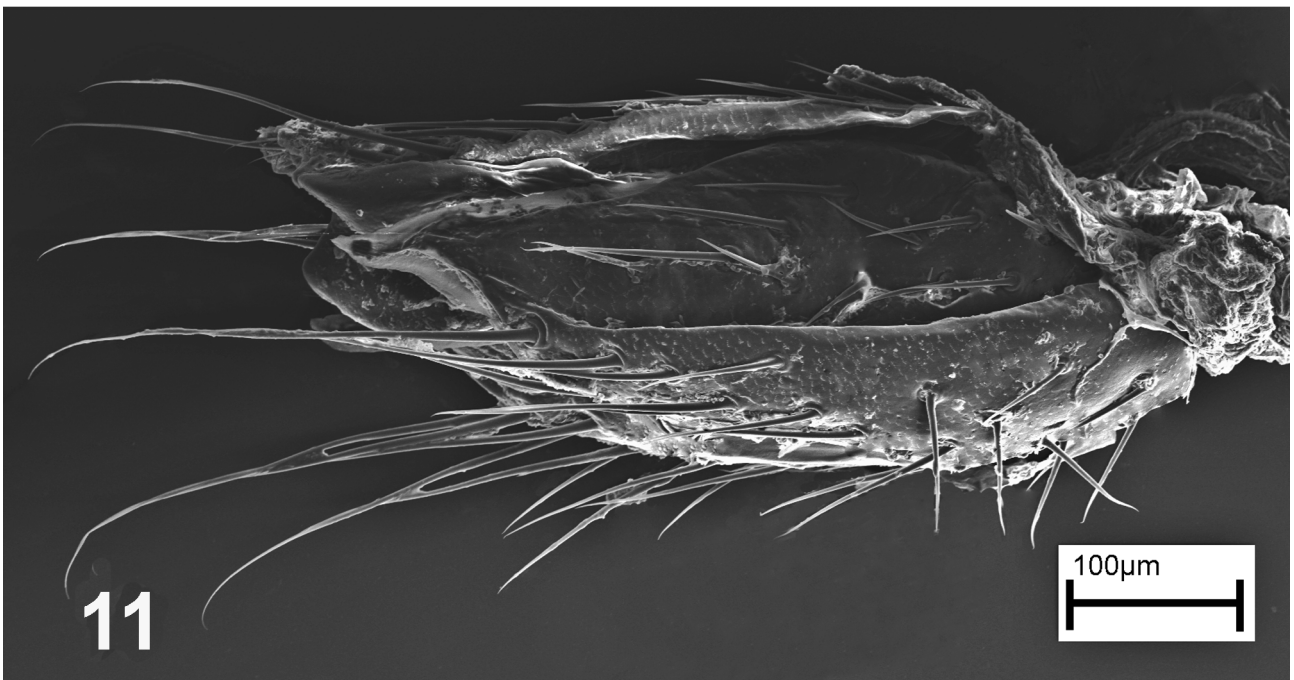
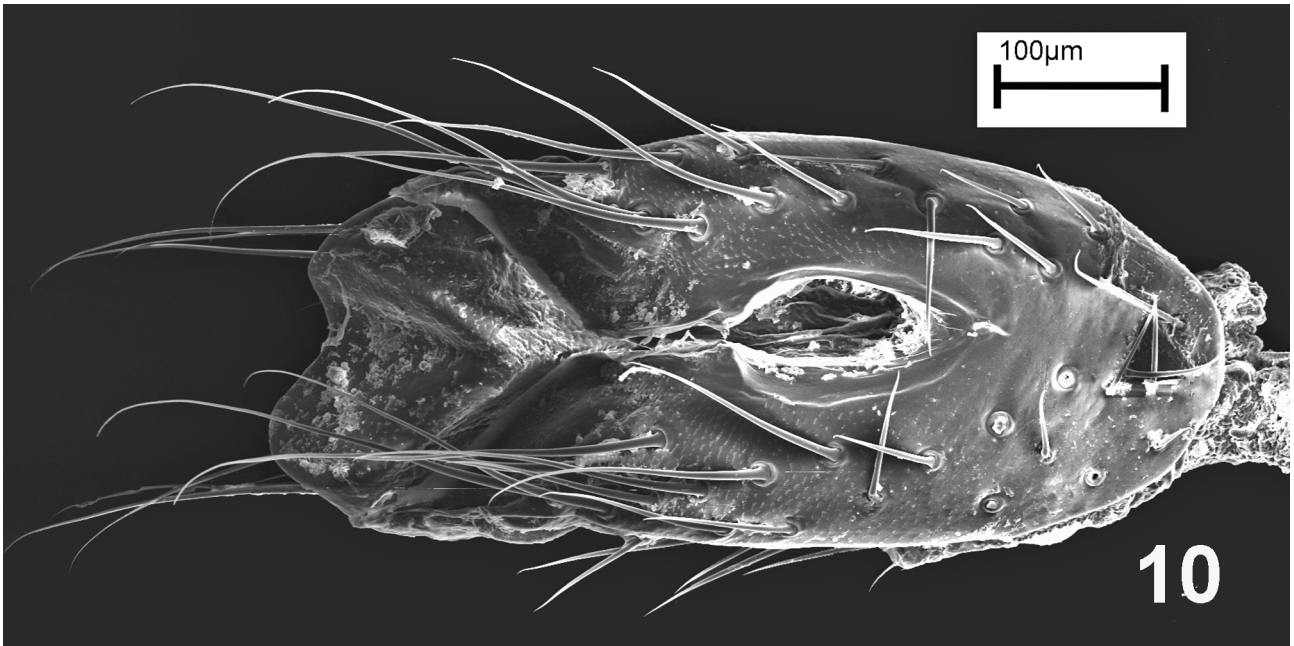
FIGURES 2–5. *Leptoiulus tigrek* sp. nov., male paratype. 2, gnathochilarium; 3, leg pair 1 (front view); 4, penes and coxae 2; 5, gonopods (mesal view).

Description. Male (Fig. 1). Length 20.4–27.7 mm (males with body length 24–25 mm are more common), vertical diameter 1.1–1.3 mm, with 42(–2), 43(–2), 44(–1), 44(–2), 45(–2), 46(–2), 46(–3), 47(–2) body segments, excluding telson [according to Enghoff *et al.* (1993), each alternative formula would thus be 40+2+T, 41+2+T, 43+1+T, 42+2+T, 43+2+T, 44+2+T, 43+3+T, 45+2+T] (males with 45(–2) body segments, excluding telson, are more common). Coloration in alcohol dark brown with bluish tinge. Front and caudal parts of body with marbled transverse strips on metazonites. Ventral part of body lighter. Preanal ring of telson dark brown or brown. Head dark brown, clypeolabral region of head brown, ventral part of head light brown. Collum with two transverse, large, marbled brown spots. Antennae dark brown, legs marbled brown, eye patches black.

Eye patches subquadrate, composed of at least 28–30 slightly convex ocelli in adult. Clypeus with or without setae. 1+1 epicranial setae in a transverse row. Supralabral setae 2+2 in a transverse row, labral ones 7+7, 8+8. Antennae rather slender and clavate in situ extending behind to segments 3–4. Length ratios of antennomeres 2–7 as 3.8:3.2:3.2:3.6:1.9:1, width ratios as 1.6:1.7:1.7:2.1:1.7:1, respectively. Antennomeres 5 and 6 with an incomplete distodorsal corolla of not less than 6 sensory bacilli. Gnathochilarium distally with two setae on outer edge of each stipites and with one seta closer to medial portion and with low papillate swelling as well as with a group of short setae approximately in the middle of the stipites (Fig. 2). Each lamella lingualis with 4–5 setae arranged longitudinally; length of setae increasing towards apex of lamellae linguales. Genae unmodified. Collum without peculiarities.



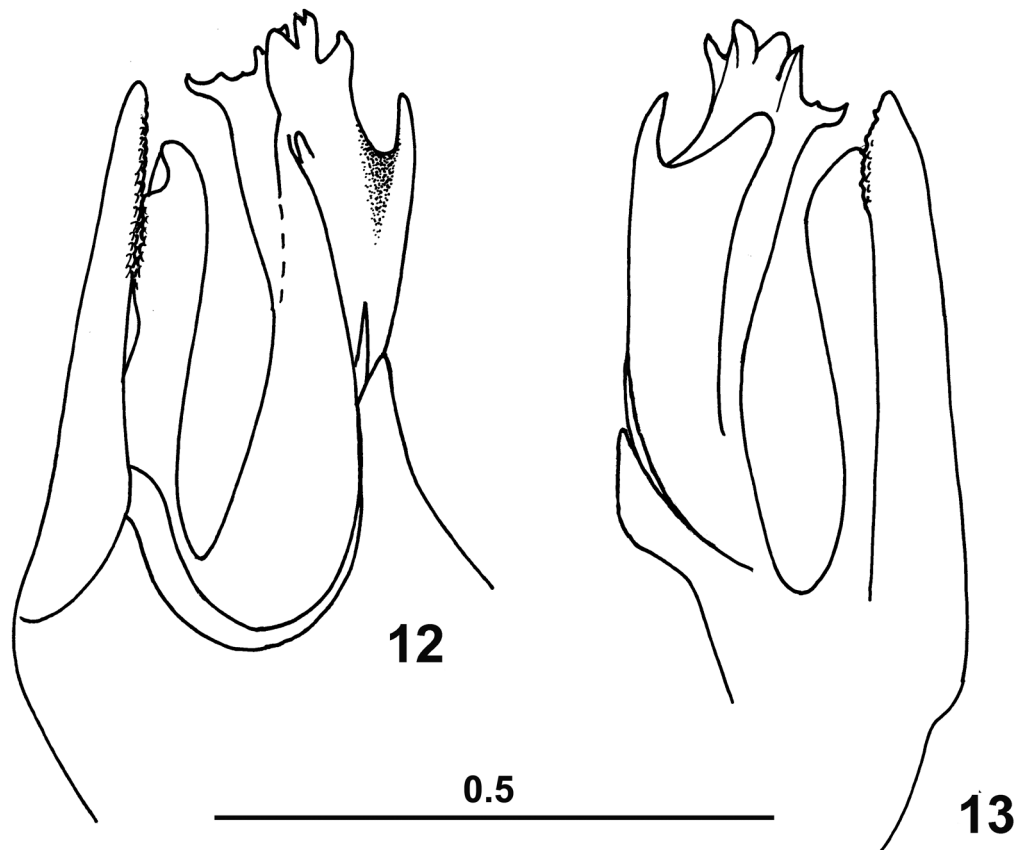
FIGURES 6–9. *Leptoiulus tigrek* sp. nov., male paratype. 6, gonopod promere (caudal view); 7, gonopod opisthomere and mesomere (front view); 8, gonopod opisthomere and mesomere (mesal view); 9, gonopod opisthomere (nearly caudal view); **ph**, phylacum; **v**, velum; **s**, interior parabasal spine.



FIGURES 10–11. *Leptoiulus tigrek* sp. nov., female paratype. 10, vulva (caudal view); 11, vulva (lateral view).

Body subcylindrical, slender, somewhat compressed laterally. Prozonite and metazonite separated by distinct suture. Prozonites smooth. Metazona with striae not reaching hind margin dorsally and laterally, but reaching hind margin ventrally. 8–9 striae on metazonital surface between dorsal midline and ozopore. Ozopores small, lying behind suture between pro- and metazona without touching it. Transverse row of sparse, thin, relatively short setae at hind edge of metazonites. Metazonital setae gradually growing longer and denser toward telson. Telson with a relatively long, caudal subcylindrical (at base flattened dorsoventrally) setose projection of epiproct carrying a sharp claw-shaped process directed caudad and somewhat ventrad. Preanal ring of telson covered with relatively long setae. Distal portions of anal valves densely setose. Anal scale subtriangular, setose only along caudal edge.

Slender legs with broad, very delicately serrate sole pads on tibiae and postfemora; these pads gradually growing reduced towards posterior body end to totally disappear on last legs. Claw at base with a thin, setiform accessory claw ventrally but without accessory claw dorsally.



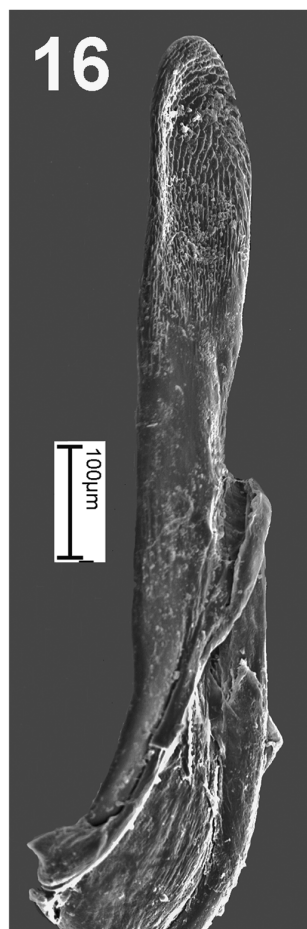
FIGURES 12–13. *Leptoiulus tigirek* sp. nov., male paratype. 12, gonopods (mesal view); 13, gonopods (lateral view). Scale in mm.

Leg pair 1 (Fig. 3) unciform, with sparse and low papillae apically, 2-segmented telopodites carrying strong setae ventrally, and rounded, low, knob-shaped outgrowth of telopoditomere 2. Each coxa of leg pair 1 with a distal seta. Leg pair 2 unmodified, penes relatively short, apically double, without setae (Fig. 4).

Gonopod pro- and mesomere closely attached to each other (Fig. 5, 12–13). Coxosternal region poorly developed. Promere (Fig. 6) flattened, caudally papillate, with a flagellum as whip but without remnants of a telopodite and a basal outgrowth. Mesomere (Figs 5, 7, 12) very feebly curved caudodistally, distal portion frontally with a shallow spoon-shaped excavation covered with papillae. Opisthomere (Figs 8–9) slender with large broad blade-shaped phylacum (**ph**) bifurcated apically, claw-shaped velum (**v**), interior parabasal spine (**s**), apical and subapical processes.

Female. Length 18.4–36.2 mm (females with body length 31–33 mm are more common), vertical diameter 1.4–2.2 mm, with 43(–2), 44(–1), 44(–2), 45(–1), 46(–1), 46(–2), 47(–1) body segments, excluding telson [according to Enghoff *et al.* (1993), each alternative formula would thus be 41+2+T, 43+1+T, 42+2+T, 44+1+T, 45+1+T, 44+2+T, 46+1+T] (females with 46(–1) and 47(–1) body segments, excluding telson, are more common). Clypeus with or without setae. Labral setae 7+8, 9+9. Ocelli about 36 in most of the females. About 11 striae on metazonital surface between dorsal midline and ozopore in large females. Other nonsexual characters as in male. Vulvae as in figs 10–11. Operculum with subtriangular apical incision. Two longitudinal rows of setae on operculum each with not less than 10 setae, apical setae longest. Not less than 30 setae on posterior median bursal sclerite; 16–17 setae on lateral and mesal sclerites of the bursa together. Bursal setae gradually elongated to apex of vulva.

Juvenile. Shorter, length of examined specimens varies from 8.9 mm to 20.3 mm, vertical diameter from 0.7 mm to 1.3 mm. Body with 28(–7), 39(–2), 40(–5), 41(–3), 41(–4), 42(–4), 43(–4), 43(–5), 44(–3), 44(–4), 45(–4) segments, excluding telson [according to Enghoff *et al.* (1993), each alternative formula would thus be 21+7+T, 37+2+T, 35+5+T, 38+3+T, 37+4+T, 38+4+T, 39+4+T, 38+5+T, 41+3+T, 40+4+T, 41+4+T]. Among the juveniles can be recognized subadult males and (possibly) females with 42(–4), 43(–4), 44(–3), 44(–4) body segments,



FIGURES 14–17. *Leptoiulus trilineatus* (C.L. Koch, 1847), male. 14, gonopods (mesal view); 15, gonopod promere (caudal view); 16, gonopod mesomere (front view); 17, gonopod opisthomere (nearly caudal view, slightly laterally); s, interior parabasal spine.

excluding telson [according to Enghoff *et al.* (1993), each alternative formula would thus be 38+4+T, 39+4+T, 41+3+T, 40+4+T]. Subadult males with normal leg pair 1 and body segment 7 devoid of any extremities; possible subadult females have lesser vulvae.

Name. The specific epithet refers to the type locality, a noun in apposition.

Distribution. The species appears to occur only in the south of Siberia, Russia: Altai Province.

Remarks. The earliest mention of *Leptoiulus tigirek* **sp. nov.** as an “undescribed species of Julidae” belongs to Nefediev *et al.* (2014), Dyachkov (2014). The species inhabits mainly low-mountain forest and shrub thicket sites at 500–675 m a.s.l., such as chern taiga forests with *Abies sibirica* and *Populus tremula*, *Larix sibirica* and *Betula pendula* forest, *Betula pendula* and *Salix* forest, *Salix* thicket, shrub thicket of *Pentaphylloides fruticosa*, *Caragana* and *Lonicera* thicket, and also meadow steppe. It predominates in shrub thickets and dark-coniferous forests, making up 74% of all millipede abundance in both types of biotopes (Nefediev *et al.* 2014). The numbers range from 1 to 8 ind./m² in forest biotopes, and from 10 to 24 ind./m² in shrub thicket sites. The maximum locomotor activity is observed in shrub thicket biotopes, ranging from 10 to 22 ind./100 traps per day, whereas the minimum locomotor activity is recorded in forest sites, where it ranges from 1 to 8 ind./100 traps per day.

Discussion

Dr. Enghoff, after confirming that the specimens belonged to the genus *Leptoiulus*, noted its greater or lesser similarity to the European *L. trilineatus*, and sent one specimen of the species to us for comparison. This male was labelled: Turkey, Prov. Bursa, S of Sojjukpinar (S of Ulu Dağ), 700 m, decid. forest at small river, 2.V.1995, H. Enghoff, M. Frater & H. Read leg.—Zool. Mus. Copenhagen. *Leptoiulus trilineatus* H. Read det.

A direct comparison of the specimens of *L. tigirek* **sp. nov.** with the male of *L. trilineatus* has revealed their morphological differences. The latter species differs from the first one mainly by the following characters: caudal surface of gonopod promere poorly papillate with shallow excavation for the mesomere; gonopod mesomere at base with oblique ridge, distal portion of the mesomere frontally without a shallow spoon-shaped excavation; phylacum rounded apically; velum longer and more slender, interior parbasal spine of gonopod opisthomere longer and more slender.

In addition, *L. trilineatus* differs from *L. tigirek* **sp. nov.** mainly by the following nonsexual characters: the body coloration lighter with a somewhat different pattern on the pro- and metazona; body vertical diameter about 1.5 mm; body segments without telson 51(–1); metazonital setae at hind edge of metazonites rather longer; ventral setiform accessory claw at base of leg claw much longer (as two lengths of a leg claw); penes longer (higher than coxae of leg pair 2).

On the other hand, the following morphological resemblance of *L. tigirek* **sp. nov.** with *L. trilineatus* has been revealed (including the main distinguishing characters of *Leptoiulus*): gonopods with large blade-shaped phylacum and claw-shaped velum; gonopod coxosternal region generally poorly developed; gonopod promere without telopodite remnant; the absence of a basal outgrowth on the gonopod promere; slender gonopod opisthomere; 1+1 epicranial setae in a transverse row; male genae unmodified; male antennomeres 5 and 6 with an incomplete distodorsal corolla of not less than 6 sensory bacilli; identical structure and hairiness of telson, gnathochilarium, male leg pair 1; subcylindrical body; identical morphology of metazonital striation; the presence of sole pads on tibiae and postfemora of walking legs.

Gonopods of *L. trilineatus* have never been shown in an SEM micrograph. Therefore they are illustrated here (Figs 14–17).

Acknowledgements

We are most grateful to Dr. L.A. Trilikauskas (Institute for Systematics and Ecology of Animals, Siberian Branch of the Russian Academy of Sciences, Novosibirsk, Russia) and Dr. T.M. Krugova (Tigirek State Nature Reserve, Barnaul, Russia) who provided some of material for the present study. We are very much obliged to Dr. H. Enghoff (Copenhagen, Denmark) both for the confirmation of the identification of the treated material as a species of *Leptoiulus* and supplying us with a specimen of *L. trilineatus* for comparison. Our special thanks are extended to

Dr. N.N. Naryshkina (IBSS, Vladivostok, Russia) for the help in preparation of scanning electron micrographs. Mrs. G.A. Sinelnikova (IBSS, Vladivostok, Russia) helpfully inked the line drawings. We are also grateful to Dr. M.M. Silantieva and Dr. N.Yu. Speranskaya (both ASU, Barnaul, Russia) who kindly provided us the facilities to take picture of the species in the Environmental Monitoring Laboratory of Geosphere-Biosphere Processes (ASU). Special thanks are also addressed to unknown reviewer for comments. Dr. W.A. Shear edited the paper for English usage.

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