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A contribution to the millipede fauna of China: descriptions of four new species of the genus *Nepalmatoiulus* Mauriès, 1983 from high-altitude areas of Yunnan Province (Diplopoda, Julida, Julidae)

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Abstract

Four new species of the millipede genus *Nepalmatoiulus* Mauriès, 1983 (Julida, Julidae) are described from high-altitude areas of Yunnan Province in China: *N. angustus* **sp. nov.**, *N. arcuatus* **sp. nov.**, *N. belousovi* **sp. nov.** and *N. kabaki* **sp. nov**. A new faunistic record for the Laojunshan Mts. is given for *N. emarginatus* Mikhaljova, 2020. A brief overview of the Yunnan *Nepalmatoiulus* species is given. Taxonomic remarks are provided for nearly all new species.

Key words: new taxa, new record, taxonomy, southeast China

Introduction

The present work is a prolongation of the study of a collection of Chinese *Nepalmatoiulus* specimens stored in the Zoological Museum, State University of Moscow (Russia).

Originally described as a subgenus *Chromatoiulus* Verhoeff, 1894 (Mauriès 1983) and raised to full genus status by Enghoff (1987), at the moment the genus *Nepalmatoiulus* contains 76 species (including new species described herein) distributed in Myanmar, India, Thailand, Malaysia, Vietnam, Nepal, Bhutan, Japan and China including Taiwan (Enghoff 1987; Korsós & Lazányi 2013; Zhang *et al*. 1997; Mikhaljova 2020a, 2020b, 2023).

Mainland China, and within it—Yunnan Province, are the best studied regions regarding their *Nepalmatoiulus* fauna. At present, 20 species of the genus are recorded from Yunnan Province alone, including the four species described below: *N. acutidentatus* Mikhaljva, 2020b; *N. alternus* Mikhaljova, 2023; *N. angustus* **sp. nov.**; *N. arcuatus* **sp. nov.**; *N. belousovi* **sp. nov.**; *N. deqenensis* Mikhaljova, 2020b; *N. emarginatus* Mikhaljova, 2020b; *N. hexiensis* Mikhaljova, 2020b; *N. immaturus* Mikhaljova, 2020a; *N. kabaki* **sp. nov.**; *N. lanpingensis* Mikhaljova, 2020b; *N. malaisei* Enghoff, 1987; *N. pallidus* Mikhaljova, 2020a; *N. parvulus* Mikhaljova, 2020b; *N. simultaneous* Mikhaljova, 2023; *N. tianbaoshanensis* Mikhaljova, 2020b; *N. tuoxiaensis* Mikhaljova, 2023; *N. uncinatus* Mikhaljova, 2020b; *N. weixi* Mikhaljova, 2020a; *N. yunnanensis* Enghoff, 1987.

Material and methods

Material treated here is kept in the collection of the Zoological Museum of the State University of Moscow, Russia (ZMUM).

Specimens were kept in 70–75% ethanol. During the study, the gonopods and some other parts were dissected from a limited number of specimens and mounted in glycerin as temporary micro-preparations. Specimens were studied using standard stereomicroscopic equipment. SEM micrographs were prepared at the Centre for Collective Use "Biotechnology and Gene Engineering" of the Federal Scientific Center of the East Asia Terrestrial Biodiversity, Far Eastern Branch of the Russian Academy of Sciences (FSCB) in Vladivostok, Russia, using a Merlin 62–15 and

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a Zeiss Evo 40 scanning electron microscopes. Mounts for SEM were cleaned in an ultrasonic bath (50 Hz) for 5 to 10 seconds, and then were further prepared by air-drying after transfer to acetone from 96% alcohol, mounting on stubs, and coating with chromium. After examination, SEM material was removed from stubs and returned to alcohol. SEM images were edited in Adobe Photoshop.

A "body ring formula" indicates the number of podous (including gonopod ring and collum) and apodous rings before the telson in an individual. This formula is x (–y) where x = sum of podous and apodous body rings excluding telson and y = number of apodous body rings before telson.

The term "nonapical stipital setae of gnathochilarium" means a field of setae at level with or slightly basal to prementum (after Enghoff 1987). The term "limbus" means the hyaline posterior edge of metazonite (after Enghoff 1987). The term "coxa 2 with one or two mesapical oral setae" means the setae directed to the body front (after Enghoff 1987).

Taxonomic part

Nepalmatoiulus angustus sp. nov.

Figs 1–12

Material examined. Holotype: male (dissected) (ZMUM), China, Yunnan Province, SSW Lanping, left bank Qijing R., 2.8 km SSE Dacuntuocun, 26°14′03′′ N, 99°17′03′′ E, H = 2650 m, 27.05. 2018, leg. I. Belousov, I. Kabak. Paratypes: 1 female (dissected) (ZMUM), same data as for holotype; 1 male (dissected) (ZMUM), China, Yunnan Province, WSW Lanping Qing & Qijing div., 4.5 km SE Yulongchang, 26°24′25′′ N, 99°16′59′′ E, H = 3355 m, 22.05. 2018, leg. I. Belousov, I. Kabak.

Diagnosis. Differs from congeners mainly by the mesomeral process with relatively short and thick apex (**a** in Fig. 8), by the very narrow velum, by the promere distally slightly expanded and apically very slightly obliquely rounded, by the male coxa 2 with two mesapical oral setae. To a certain degree similar to *Nepalmatoiulus muli* Mikhaljova, 2020a but differs from the latter by specific characters (see Remarks below).

Description. *Male*. Length in alcohol 32.0–34.0 mm, midbody vertical diameter about 2.5 mm, vertical diameter of anterior body part about 2.0 mm with 55(–2) (in holotype) and 53(– 1) (in paratype) rings, excluding telson. Coloration in alcohol: from dark gray with a pale swoop (in paratype) to gray-dark brown (in holotype) with light brown longitudinal broad stripe and with dark brown narrow middorsal longitudinal line. Legs light brown with dark brown distal parts. Antennae dark brown. Eye patches black. Head dark brown with yellow anterior part. Gnathochilarium yellow. Apical portion of the marbled brown mandible stipital lobe with yellow border.

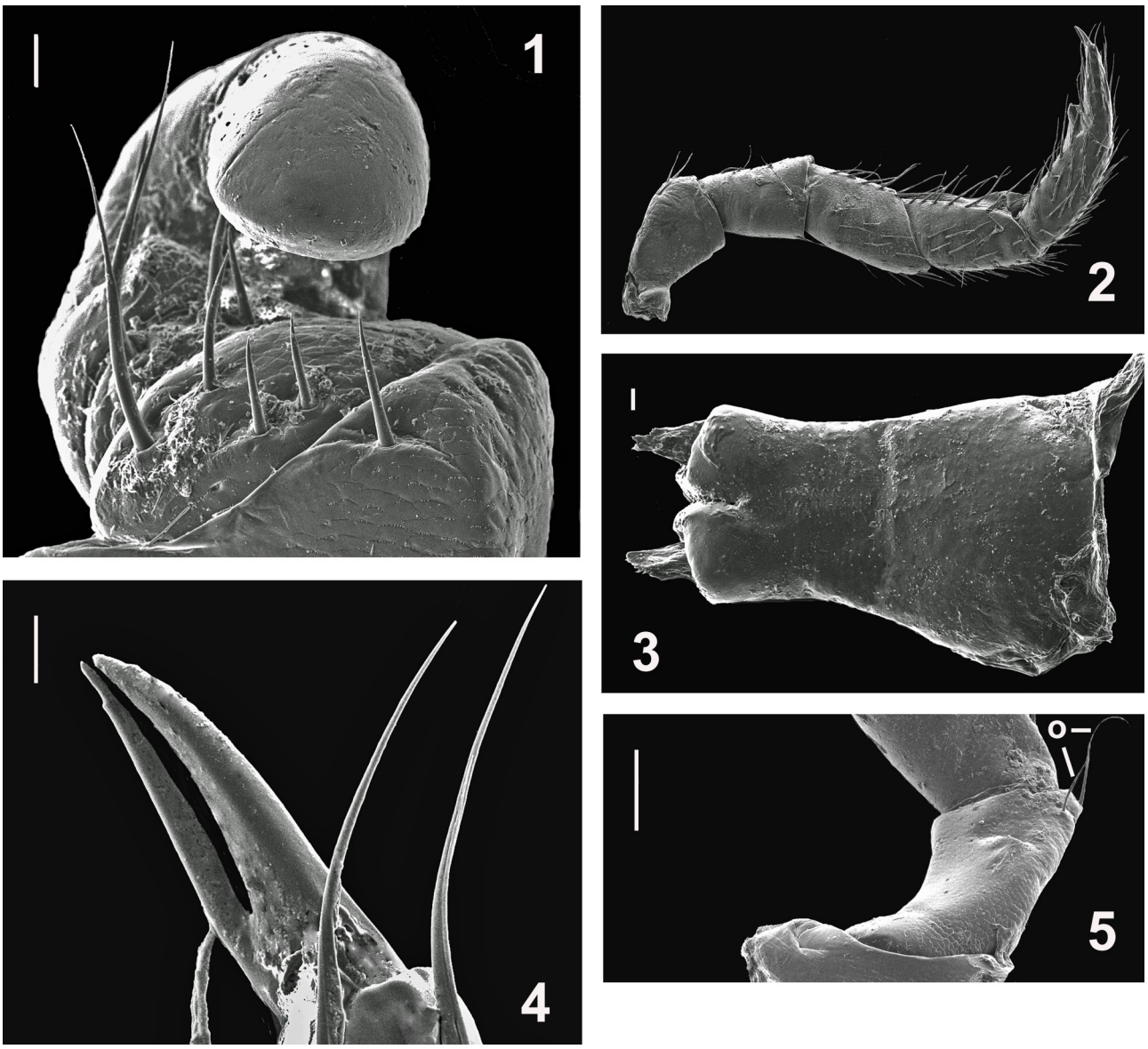
Head smooth, 1+1 epicranial setae, 4 supralabral setae, not less than 32 labral setae. Eye patches almost oval, composed of not less than 46 ommatidia. Antennae medium-sized, rather slender and clavate. Antennomeres 5 and 6 with incomplete distodorsal corolla of sensilla basiconica. Mandibular stipites with oval, lenticular smooth lobes. Gnathochilarium with not less than 12 nonapical stipital setae; lamellae linguales each with 4 or 5 setae arranged longitudinally.

Collum laterally with distinct striae of different length at posterior margin not reaching to anterior margin, dorsally with distinct short striae at posterior margin. A transverse row of very sparse thin setae at hind edge of collum.

Body rings circular. Prozona smooth. Metazona with dense, regular, longitudinal striae reaching hind margin (20 or 21 striae in an approximate square with sides equal to metazonital length of a dorsal side of a midbody ring). Limbus straight, smooth (of Type 1 in Enghoff 1987). A transverse row of sparse, thin setae at hind edge of metazonites, setae gradually growing denser toward telson. Ozopores small, lying behind suture between pro- and metazona without touching it. Caudal dorsal projection of telson straight and long, densely covered with setae and carrying at tip a claw-shaped process curved dorsally. Preanal ring and anal valves densely setose; subanal scale densely setose along caudal edge.

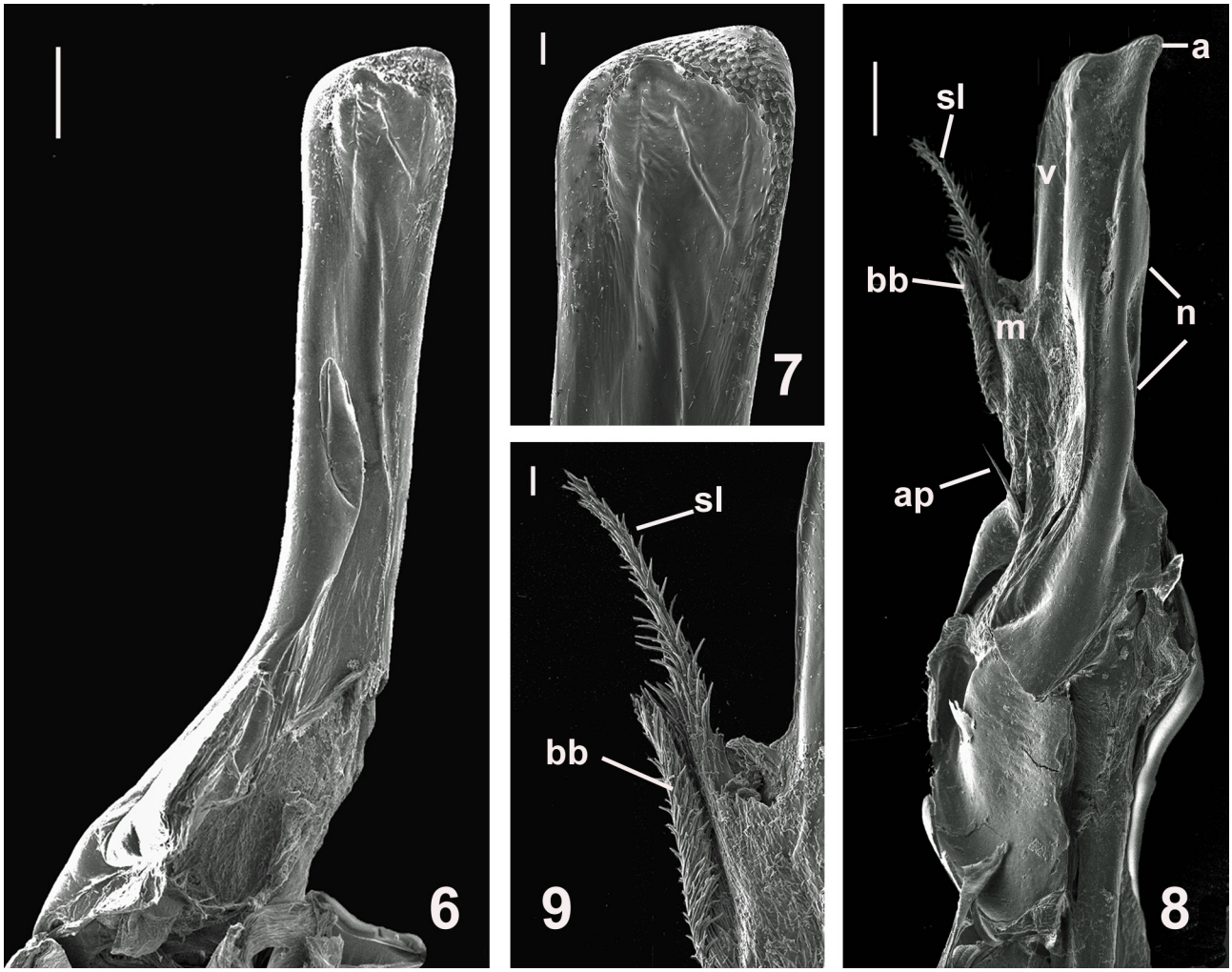
Legs relatively short and slender. Very delicately serrate ventral pads present on postfemur and tibia, starting from legs 2 (Fig. 2); pads decreasing in size towards telson, totally disappearing on postfemur and remaining only on the most extreme tibial apex of hind legs. Claw of all legs at base with a setiform accessory claw ventrally, accessory claw relatively short (equal to claw length) in the anterior body part (Fig. 4) and long (longer than claw) in the posterior body part. Leg pair 1 forming hook, the distal segment not in close contact with the basal

segments ("Open hook" type in Enghoff 1987): coxa with one seta; postfemur with scaly-rugose ventral surface; distal segment without tarsal remnant and setae (Fig. 1). Coxa 2 with two mesapical oral setae (**o**), a gland opening positioned in central and apical position (Fig. 5) according to Enghoff (1987). Penis with an expanded basal part (a bit like a pear), about 1.5 × longer than wide (Fig. 3).



FIGURES 1–5. *Nepalmatoiulus angustus* **sp. nov.**, male holotype (ZMUM). **1**. Leg 1, anterior view. **2**. Leg 5. **3**. Penis, caudal view. **4**. Claw 5. **5**. Coxa 2, anterior view. **Abbreviation: o**, mesapical oral seta. Scales: 10 μm (Fig. 4), 20 μm (Figs 1, 3), 100 μm (Figs 2, 5).

Gonopods slightly protruding. Anterior gonopod distally slightly expanded, apically very slightly obliquely rounded, distal margins of the apical excavation papillate (especially mesal margin), rudimentary telopodite as elongated oval, with seta (Figs 6, 7). Flagellum slender, of medium length, caudally covered with cuticular conical spikes in the distal part, excluding glabrous apical portion (Fig. 10) (failed to see the basal part of the flagellum). Posterior gonopods very slender (Figs 8, 11). Mesomeral process with relatively short and thick, slightly arched forward papillate apex (**a**). Anterior surface of the mesomeral process with longitudinal subbasal deepening (**n**) (Fig. 8). Velum (**v**) very narrow, very steeply sloping, its margin smooth, without a notch near mesomeral process. Additional membrane (**m**) with a serrate edge. Acicular process (**ap**) of a flagellum-guiding flap arising from posterior margin of solenomeral furrow long. Solenomere (**sl**) spinose, basally with blade (**bb**), covered with spikes throughout (Figs 8, 9).

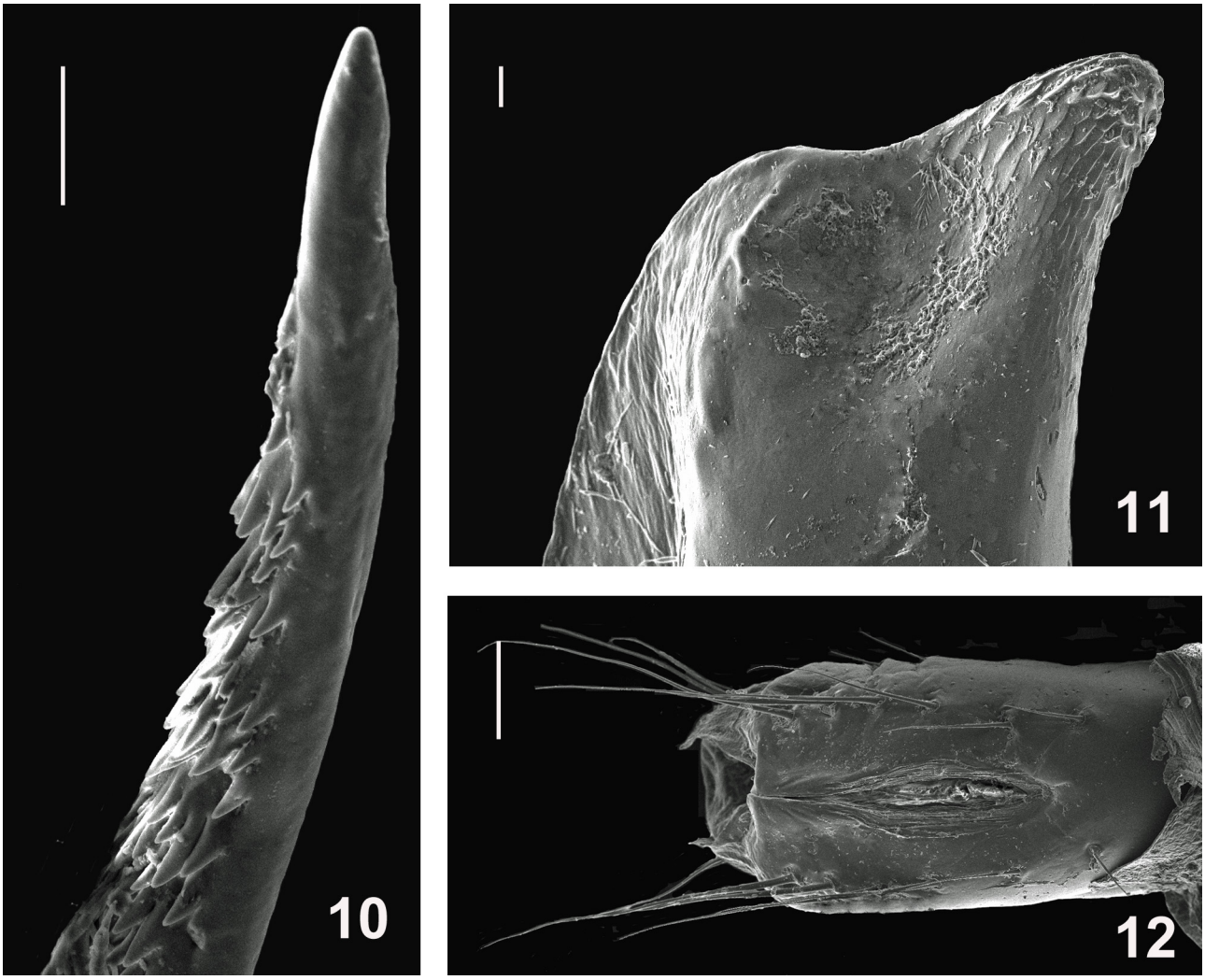


FIGURES 6–9. *Nepalmatoiulus angustus* **sp. nov.**, male holotype (ZMUM). **6**. Right promere, posterior view. **7**. Distal part of right promere, posterior view. **8**. Opisthomere, mesal view. **9**. Solenomere, mesal view. **Abbreviations: a**, apex; **ap**, acicular process; **bb**, basal blade; **m**, accessory membrane; **n**, deepening; **sl**, solenomere; **v**, velum. Scales: 20 μm (Figs 7, 9), 100 μm (Figs 6, 8).

Female. Length in alcohol about 33.0 mm, midbody vertical diameter about 2.5 mm, vertical diameter of anterior body part about 2.0 mm with 53(–2) rings, excluding telson. Coloration of the ring lateral surfaces darker than one in male. Vulva as in Fig. 12.

Etymology. The specific epithet refers to the narrow velum of the posterior gonopods. Adjective.

Remarks. *Nepalmatoiulus angustus* **sp. nov.** differs from *N. muli* mainly by the larger body length (about 33.0 mm) and smaller midbody vertical diameter (about 2.5 mm) (vs. length—about 25.0 mm, midbody vertical diameter—about 3.0 mm in *N. muli*), by the slenderer posterior gonopods, by the shorter and thicker apex (**a** in Figs 8, 11) of the mesomeral process, by the narrower velum, by the shorter solenomere, by the promere distally slightly expanded, apically very slightly obliquely rounded (vs. promere distally not expanded, apically very obliquely rounded in *N. muli*), by the male coxa 2 with two mesapical oral setae and a gland opening positioned in central and apical position (vs. male coxa 2 with one mesapical oral seta and a gland opening positioned in central and axial position in *N. muli*), by the ovale, lenticular smooth lobes of gnathochilarium mandibular stipites (vs. subrectangular lobes in *N. muli*).



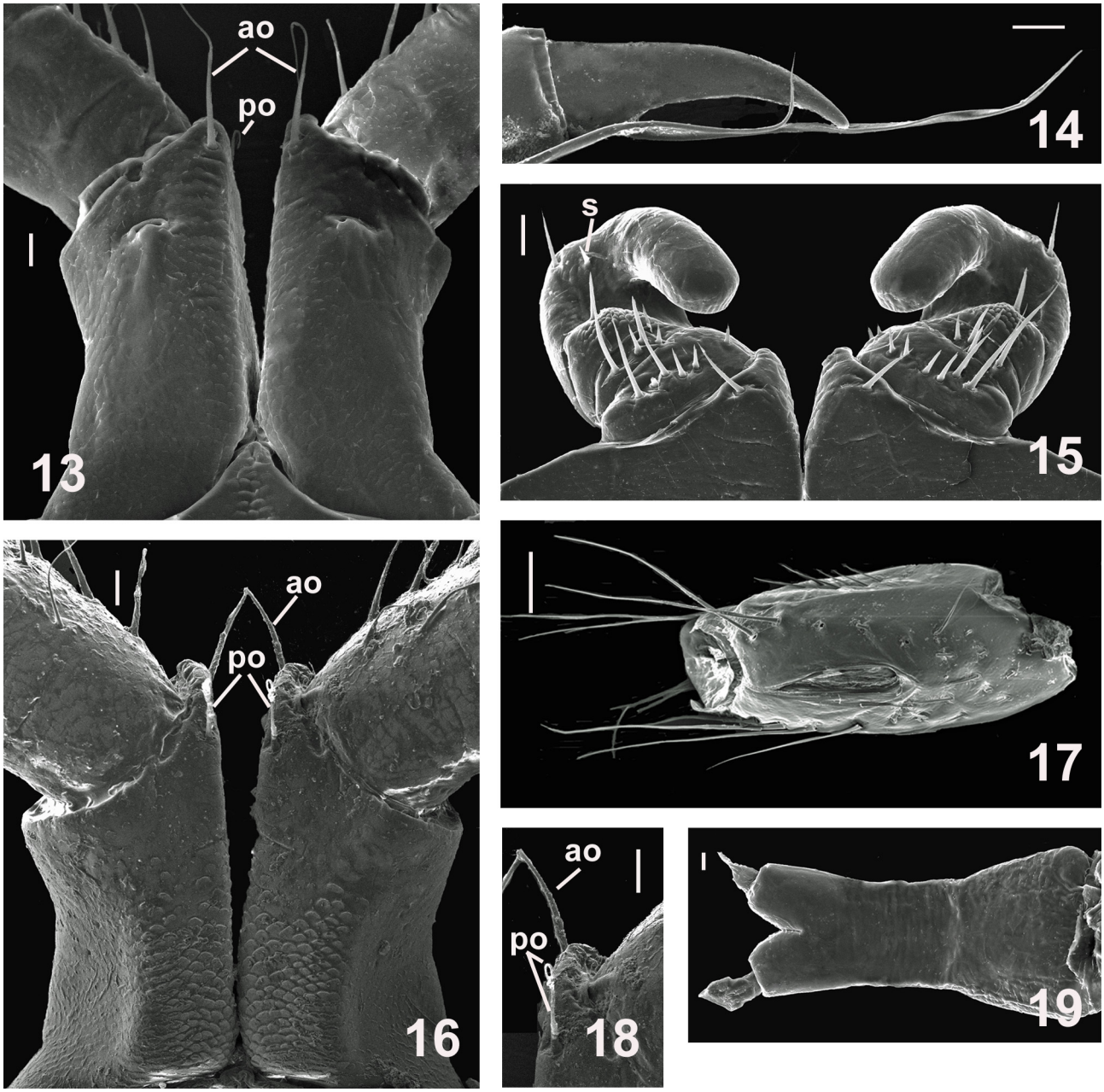
FIGURES 10–12. *Nepalmatoiulus angustus* **sp. nov.**, male holotype (Figs 10, 11) and female paratype (Fig. 12) (ZMUM). **10**. Flagellum apex, mesal view. **11**. Distal part of mesomeral process, mesal view. **12**. Vulva, posterior view. Scales: 10 μm (Figs 10, 11), 100 μm (Fig. 12).

***Nepalmatoiulus arcuatus* sp. nov.**
Figs 13–24

Material examined. Holotype: male (dissected) (ZMUM), China, Yunnan Province, 11.5 km W Lanping SE Lajing, 3 km SE Jiaolieshan, 26°27′16′′ N, 99°18′42′′ E, H = 3050 m, 19.05. 2018, leg. I. Belousov, I. Kabak. Paratype: 1 female (dissected) (ZMUM), same data as for holotype.

Diagnosis. Differs from congeners mainly by the perfectly arcuate margin of the velum, by the slender mesomeral process devoid of outgrowth, by the strongly obliquely rounded promere apex, by the absence of a notch of velum margin near the mesomeral process, by the male coxa 2 with two mesapical oral setae, one of which is very short/thin and practically not visible in anterior view. To a certain degree similar to *Nepalmatoiulus pallidus* Mikhaljova, 2020a but differs from it by specific characters (see Remarks below).

Description. *Male*. Length in alcohol about 29.0 mm, midbody vertical diameter about 1.5 mm, with 53(–1) rings, excluding telson. Coloration in alcohol marbled dark grey with brown narrow transverse line on caudal margin of each metazonite. Antennae and distal parts of legs dark brown; basal parts of legs light brown. Head dark brown with light brown anterior part. Eye patches black. Gnathochilarium marbled brown with yellow distal part. Apical portion of the dark brown mandibular stipital lobe with yellow border.



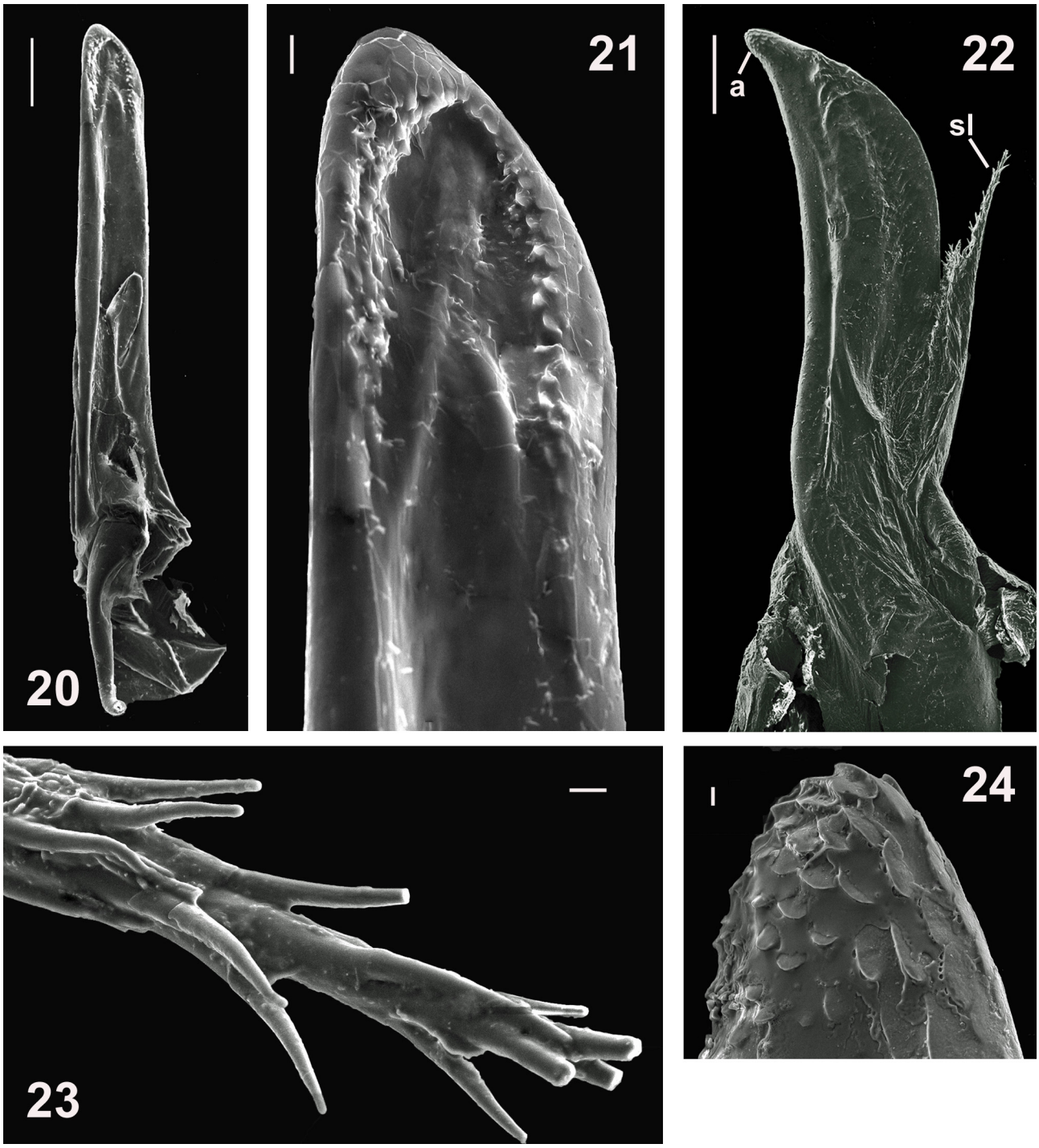
FIGURES 13–19. *Nepalmatoiulus arcuatus* **sp. nov.**, male holotype (Figs 13–16, 18, 19) and female paratype (Fig. 17) (ZMUM). **13**. Coxae 2, anterior view. **14**. Claw of hind most leg. **15**. Leg pair 1, anterior view. **16**. Coxae 2, posterior view. **17**. Vulva, posterior view. **18**. Mesapical oral setae, posterior view. **19**. Penis, posterior view. **Abbreviations: ao**, anterior mesapical oral seta; **po**, posterior mesapical oral seta; **s**, abnormal seta. Scales: 10 μm (Fig. 14), 20 μm (Figs 13, 16, 19), 30 μm (Fig. 15), 100 μm (Fig. 17).

Head smooth, 1+1 epicranial setae, 4 supralabral setae, not less than 28 labral setae. Eye patches almost oval, composed of not less than 46 ommatidia. Antennae medium-sized, rather slender and clavate. Antennomeres 5 and 6 with incomplete distodorsal corolla of sensilla basiconica. Mandibular stipites with subtrapezoidal smooth lobes. Gnathochilarium with not less than 17 nonapical stipital setae on left side and not less than 10 nonapical stipital setae on right side; lamellae linguales each with 6 or 7 setae arranged longitudinally.

Collum laterally with distinct striae of different length at posterior margin not reaching to anterior margin, dorsally with distinct short striae at posterior margin. A transverse row of very sparse setae at hind edge of collum.

Body rings circular. Prozona smooth. Metazona with dense, regular, longitudinal striae reaching hind margin (14 or 15 striae in an approximate square with sides equal to metazonital length of a dorsal side of a midbody

ring). Limbus straight, smooth (of Type 1 in Enghoff 1987). A transverse row of sparse, thin setae at hind edge of metazonites, setae gradually growing denser and longer toward telson. Ozopores small, lying behind suture between pro- and metazona without touching it. Caudal dorsal projection of telson straight and long, covered with setae and carrying at tip a claw-shaped process curved dorsally. Preanal ring and anal valves densely setose; subanal scale densely setose along caudal edge.



FIGURES 20–24. *Nepalmatoiulus arcuatus* **sp. nov.**, male holotype (ZMUM). **20**. Left promere, posterior view. **21**. Distal part of left promere, posterior view. **22**. Opisthomere, mesal view. **23**. Distal part of solenomere, mesal view. **24**. Apex of mesomeral process. **Abbreviations: a**, apex; **sl**, solenomere. Scales: 2 μm (Figs 23, 24), 10 μm (Fig. 21), 100 μm (Figs 20, 22).

Legs relatively short and slender. Very delicately serrate ventral pads present on postfemur and tibia, starting from legs 2; pads decreasing in size towards telson, totally disappearing on postfemur and remaining only on the

tibial apex of hind legs. Claw of all legs at base with a very long (much longer than claw) setiform accessory claw ventrally (Fig. 14). Leg pair 1 forming hook, the distal segment not in close contact with the basal segments ("Open hook" type in Enghoff 1987): coxa with one seta; postfemur with scaly-rugose ventral surface; distal segment without tarsal remnant, but with one seta laterally (probably, the second seta (**s**) on the left is a deviation from the norm); tip ventrally very slightly rugose (Fig. 15). Coxa 2 with one long mesapical oral seta (**ao**) clearly visible from the anterior surface and one short/thin mesapical oral seta (**po**) clearly visible just from the posterior surface (apex of **po** is only slightly visible in the anterior surface in Fig. 13) (Figs 13, 16, 18), a gland opening positioned in central and axial position (Fig. 13) according to Enghoff (1987). Penis slender, with an expanded basal part (a bit like an hourglass figure), about 1.9 × longer than wide (Fig. 19). Ventral margin of body ring VII with lobes similar to figures 32, 33 in Enghoff (1987) (i.e. with ventrad subtriangular apically rounded lobes).

Gonopods slightly protruding. Anterior gonopod with parallel margins, apically strongly obliquely rounded, distal margins of the apical excavation sparingly papillate, rudimentary telopodite without seta (Figs 20, 21). Flagellum slender, of medium length, probably (because poorly visible on the micropreparation), covered with cuticular spikes in the distal part. Posterior gonopods very slender (Figs 22–24). Mesomeral process slightly arched forward, its apex (**a**) covered with papillae (Figs 22, 24). Velum very steeply sloping, its margin evenly correctly arcuate, smooth, without a notch near the mesomeral process. Anterior surface of the mesomeral process with longitudinal shallow deepening (not visible in Fig. 22). Solenomere (**sl**) spinose, covered with spikes, mainly in front and apically (Figs 22, 23).

Female. Length in alcohol about 40.0 mm, midbody vertical diameter about 3.5 mm, with 56(–1) rings, excluding telson. Caudal dorsal projection of telson shorter than one in male, covered with dense setae; curved dorsally claw-shaped process at tip smaller than one in male. Vulva as in Fig. 17.

Etymology. The specific epithet refers to the arcuately curved velum edge. Adjective.

Remarks. *Nepalmatoiulus arcuatus* **sp. nov.** differs from *N. pallidus* mainly by the body coloration: marbled dark grey with a brown narrow transverse line on caudal margin of each metazonite (vs. yellow-grayish, with a narrow middorsal dark line and two broad lateral marbled brown stripes in *N. pallidus*), by the perfectly arcuate margin of the velum (vs. not evenly, not perfectly arcuate margin in *N. pallidus*), by the strongly obliquely rounded promere apex (vs. rectangular promere apex in *N. pallidus*), by the absence of a notch of velum margin near the mesomeral process (vs. presence of a tiny notch in *N. pallidus*), by a thinner and slenderer apex of the mesomeral process, by a poorly spinose solenomere: mainly in front and apically (vs. solenomere spinose throughout in *N. pallidus*), by the subtrapezoidal smooth lobes of gnathochilarium mandibular stipites (vs. triangular lobes in *N. pallidus*), by the penis almost as an hourglass figure (vs. subtrapezoidal in *N. pallidus*), by the ventral pads on male legs gradual decreasing in size towards telson (vs. such pads not decreasing in size towards telson in *N. pallidus*).

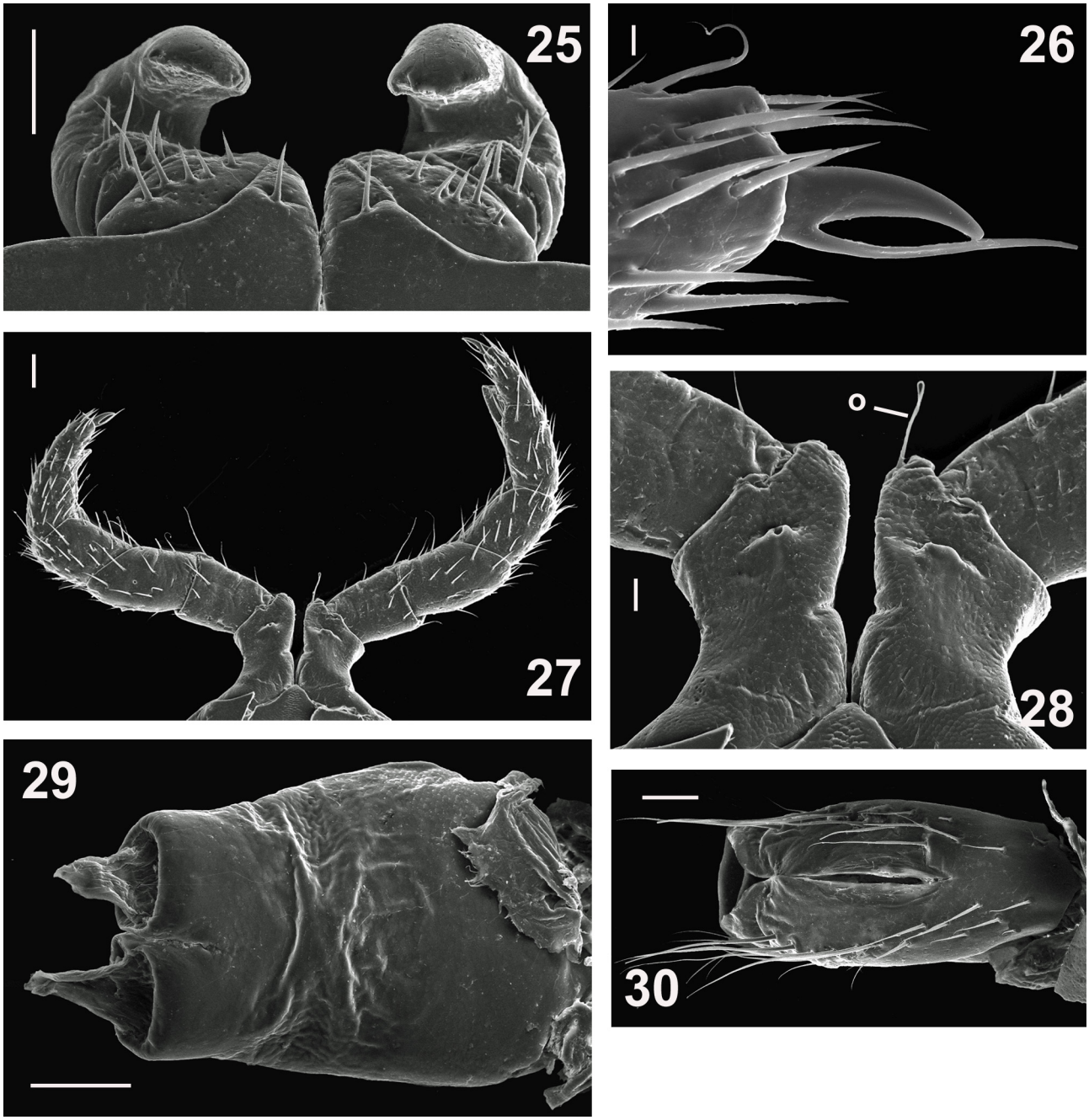
Nepalmatoiulus belousovi sp. nov.

Figs 25–36

Material examined. Holotype: male (ZMUM), China, Yunnan Province, Laojunshan watershed Yushi & Chongjiang r., 26°39′22′′ N, 99°41′3′′ E, H = 4020 m, 22.06. 2014, leg. I. Belousov, I. Kabak. Paratypes: 1male (dissected), 1 female (dissected) (ZMUM), same data as for holotype.

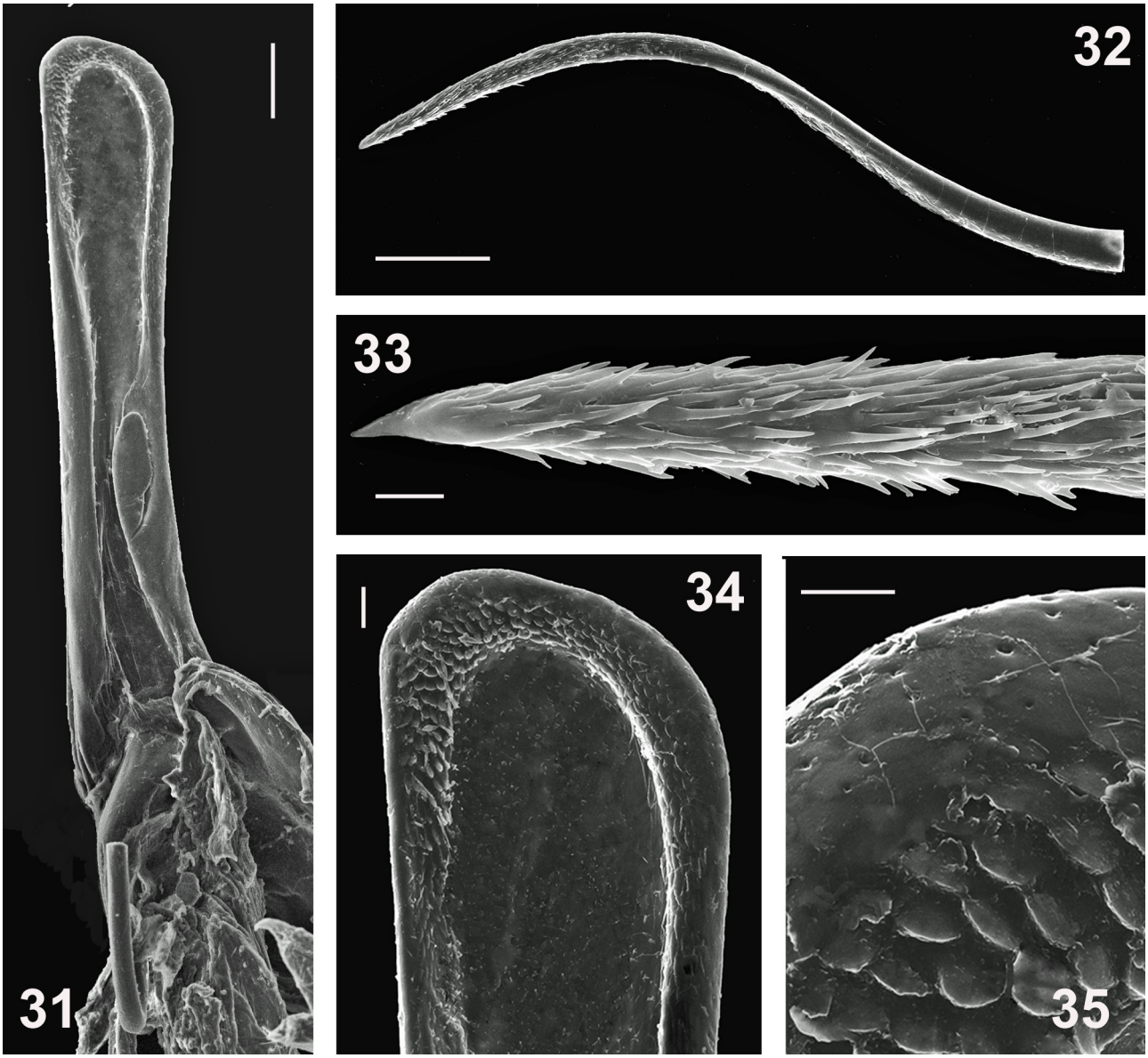
Diagnosis. Differs from congeners mainly by the mesomeral process with an arcuate apical part and a median ledge (**le** in Fig. 36), by the relatively short velum couple with a medium-length solenomere not reaching the apex of mesomeral process and a promere distally very slightly expanded and apically relatively obliquely rounded.

Description. *Male*. Length in alcohol 34.0–35.0 mm, midbody vertical diameter about 2.5 mm, with 52(–1) (in holotype) and 53(–1) (in paratype) rings, excluding telson. Coloration in alcohol uniformly dark grey with brownish narrow transverse line on caudal margin of each metazonite. Legs and antennae dark brown. Head dark brown with light brown anterior part. Eyepatches black. Gnathochilarium marbled brown with yellow distal part. Apical portion of the marbled dark brown mandibular stipital lobe with yellow border.



FIGURES 25–30. *Nepalmatoiulus belousovi* **sp. nov.**, male (Figs 25–29) and female (Fig. 30) paratypes (ZMUM). **25**. Leg pair 1, anterior view. **26**. Claw 2, anterior view. **27**. Leg pair 2, anterior view (mesapical oral seta on the left broken off). **28**. Coxae 2, anterior view (mesapical oral seta on the left broken off). **29**. Penis, posterior view. **30**. Vulva, posterior view. **Abbreviation: o**, mesapical oral seta. Scales: 10 μm (Fig. 26), 30 μm (Fig. 28) 100 μm (Figs 25, 27, 29, 30).

Head smooth, 1+1 epicranial setae, 4 supralabral setae, not less than 28 labral setae (in paratype), and a group of tiny setae on forehead. Eye patches almost oval, composed of about 50 ommatidia (in paratype). Antennae medium-sized, rather slender and clavate. Length ratios of antennomeres 3–7 as 4.3:4.4:5.6:3.7:1, width ratios as 1.8:1.8:2.3:2.0:1. Antennomeres 5 and 6 with incomplete distodorsal corolla of sensilla basiconica. Mandibular stipites with subrectangular smooth lobes. Gnathochilarium: not less than 12 nonapical stipital setae; lamellae linguales each with not less than 5 setae arranged longitudinally.



FIGURES 31–35. *Nepalmatoiulus belousovi* **sp. nov.**, male paratype (ZMUM). **31**. Left promere, posterior view. **32**. Flagellum. **33**. Distal part of flagellum. **34**. Distal part of left promere, posterior view. **35**. Section of promere apex. Scales: 10 μm (Figs 33, 35), 20 μm (Fig. 34), 100 μm (Figs 31, 32).

Collum laterally with distinct lower striae of different length at posterior margin not reaching to anterior margin, dorsally with distinct short striae at posterior margin. A transverse row of very sparse setae at hind edge of collum.

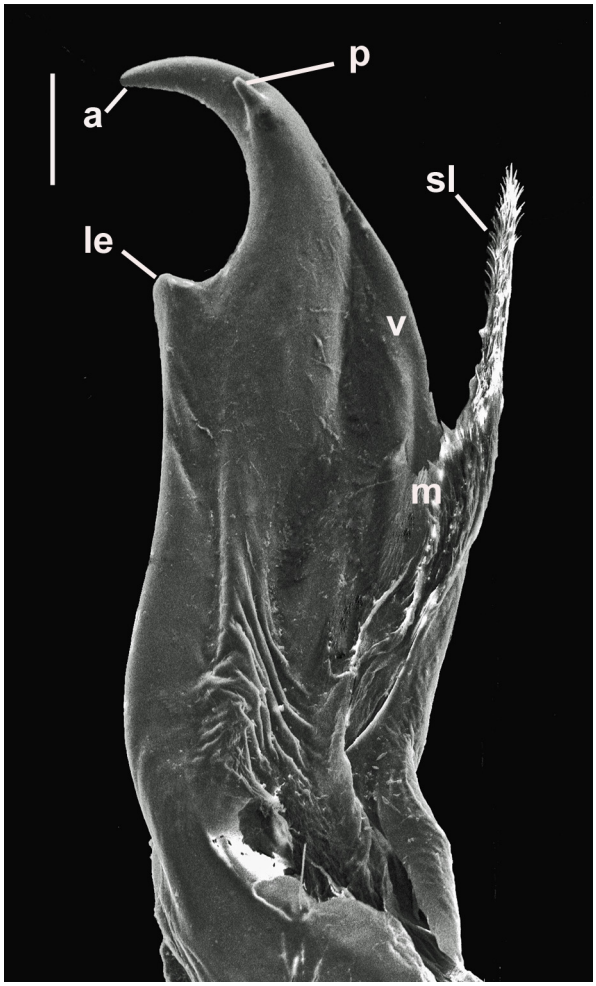
Body rings circular. Prozona smooth except for ventral part with very indistinct obliquely located striae. Metazona with dense, regular, longitudinal striae reaching hind margin (21 or 22 striae in an approximate square with sides equal to metazonital length of a dorsal side of a midbody ring). Limbus straight, smooth (of Type 1 in Enghoff 1987). A transverse row of sparse, thin setae at hind edge of metazonites, setae gradually growing denser and longer toward telson. Ozopores small, lying behind suture between pro- and metazona without touching it. Caudal dorsal projection of telson straight and long, covered with setae and carrying at tip a claw-shaped process curved dorsally.

Preanal ring of telson covered with sparse, relatively long setae. Anal valves setose, their distal portions densely setose. Subanal scale densely setose, especially along caudal edge.

Legs relatively short and slender. Very delicately serrate ventral pads present on postfemur and tibia, starting from legs 2 (Fig. 27); the pads somewhat decreasing in size towards telson. The hind most legs without ventral

pads. Claw of all legs at base with a long (longer than claw) setiform accessory claw ventrally (Fig. 26). Leg pair 1 forming a hook, the distal segment not touching basal segments ("Open hook" type in Enghoff 1987): coxa with one seta, postfemur with slightly scaly-rugose ventral surface, tip indistinctly wrinkly; distal segment without seta and tarsal remnant (Fig. 25). Coxa 2 with one mesapical oral seta (**o**), a gland opening positioned in apical and axial position according to Enghoff (1987) (Figs 27, 28; mesapical oral seta on the left is broken off). Penis almost pear-shaped, about 1.3 × longer than wide (Fig. 29). Ventral margin of body segment VII with lobes similar to figure 32 in Enghoff (1987).

Gonopods protruding. Anterior gonopod distally very slightly expanded, apically relatively obliquely rounded, distal margins of the apical excavation papillate, rudimentary telopodite without seta (Figs 31, 34, 35). Flagellum enough long, slender, caudally covered with scales in the basal half; distal part densely covered with cuticular conical denticles throughout (Figs 32, 33). Mesomeral process with median ledge (**le**) and slender, arcuate apical part bearing small subapical protrusion (**p**) located on mesal side (Fig. 36). Apex (**a**) of the mesomeral process glabrous. Anterior surface of the mesomeral process with longitudinal subbasal deepening (not visible in Fig. 36). Velum (**v**) relatively short, with strongly sloped smooth margin, without a notch near the mesomeral process. Margin of accessory membrane (**m**) serrate. Solenomere (**sl**) medium-length (not reaching the apex of mesomeral process), spinose throughout.



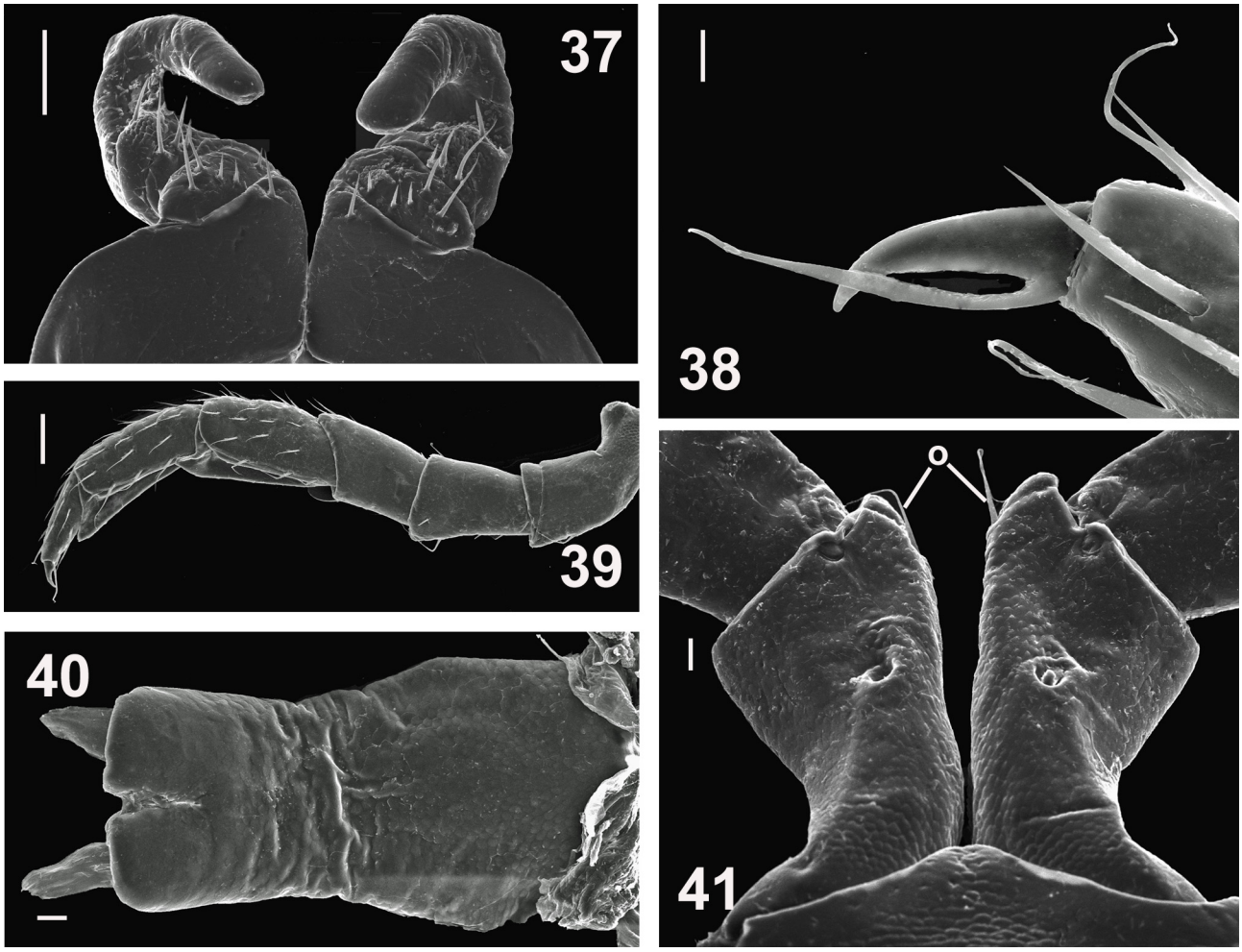
FIGURES 36. *Nepalmatoiulus belousovi* **sp. nov.**, male paratype (ZMUM). Opisthomere, mesal view. **Abbreviations: a**, apex; **le**, ledge; **m**, accessory membrane; **p**, protrusion; **sl**, solenomere; **v**, velum. Scale: 100 μm.

Female. Length in alcohol about 37.0 mm, midbody vertical diameter about 3.0 mm, with 50(–1) rings, excluding telson. Vulva as in Fig. 30.

Etymology. Honours Dr. I. A. Belousov, one of the collectors of this material. A noun in genitive.

***Nepalmatoiulus kabaki* sp. nov.**
Figs 37–48

Material examined. Holotype: male (dissected) (ZMUM), China, Yunnan Province, Laojunshan watershed rivers to Shigu & Liming, 26°53′32′′ N, 99°39′43′′ E, H = 3795 m, 03.06. 2014, leg. I. Belousov, I. Kabak. Paratype: 1 female (dissected) (ZMUM), same data as for holotype. Nontype: 1 male (dissected) (ZMUM), same data as for holotype.

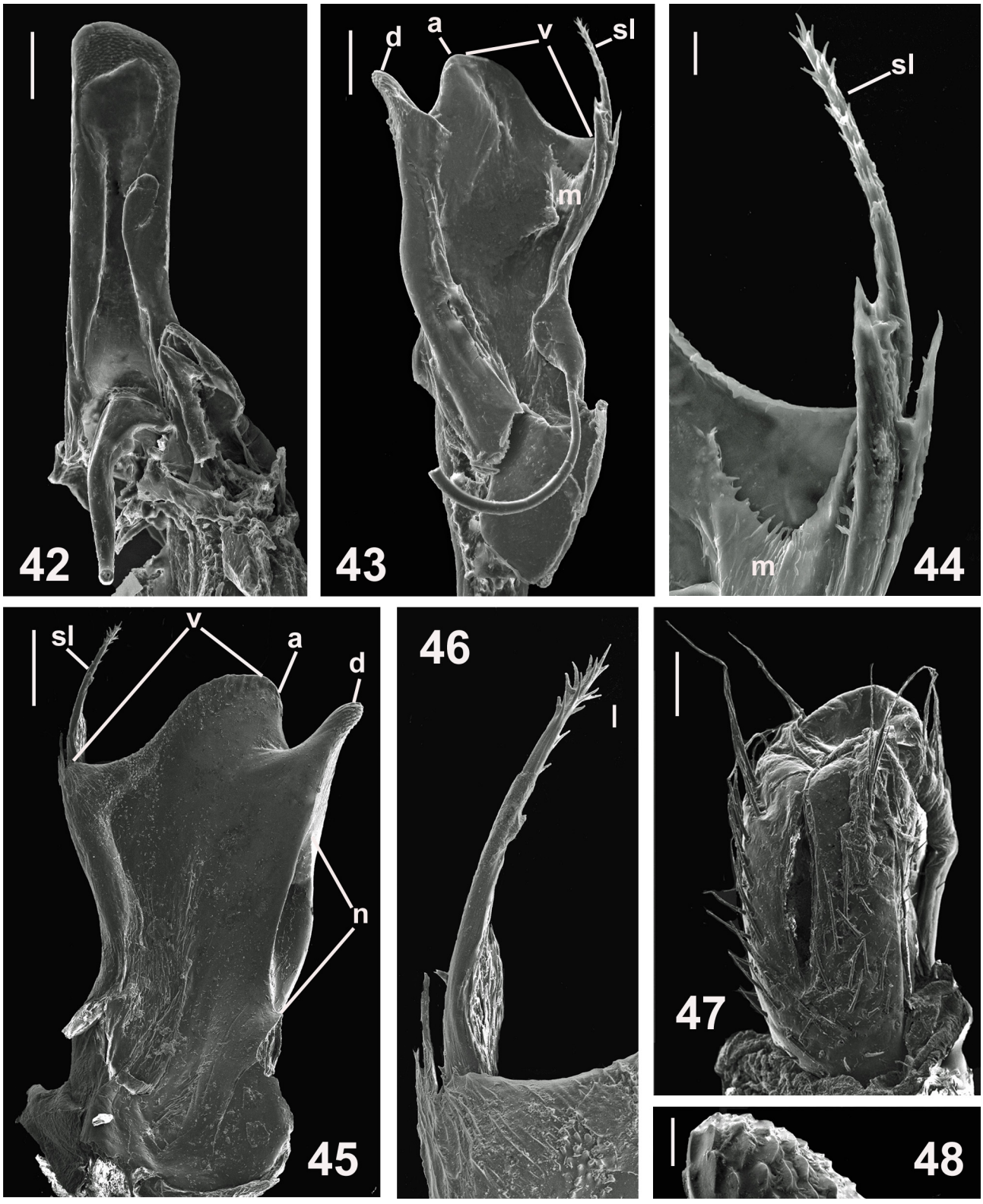


FIGURES 37–41. *Nepalmatoiulus kabaki* **sp. nov.**, male holotype (ZMUM). **37**. Leg pair 1, anterior view. **38**. Claw 2. **39**. Mid-body leg. **40**. Penis, posterior view. **41**. Coxae 2, anterior view. **Abbreviation: o**, mesapical oral seta. Scales: 10 μm (Fig. 38), 20 μm (Figs 40–41) 100 μm (Figs 37, 39).

Diagnosis. Differs from congeners mainly by the mesomeral process with rounded apex (**a** in Figs 43, 45) and very long (length reaching the apex of mesomeral process) subapical outgrowth (**d** in Figs 43, 45), as well as by the arcuate curved margin of the velum without a notch near the mesomeral process. In certain degree similar to *Nepalmatoiulus simultaneus* Mikhaljova, 2023 but differs from it by specific characters (see Remarks below).

Description. *Male*. Length in alcohol 24.0–26.0 mm, midbody vertical diameter 1.8–2.0 mm, with 51(–1) rings, excluding telson. Coloration in alcohol from marbled brown-grey to dark grey with broad longitudinal lighter dorsal strip. Legs and antennae dark brown; ventral parts of legs lighter. Axial suture dark brown. Head dark brown with light brown anterior part. Eyes black. Gnathochilarium marbled brown with yellow distal part. Apical portion of the dark brown mandible stipital lobe with lighter border. Head smooth, 2+1 epicranial setae, 4 supralabral setae, not less than 24 labral setae and a several setae on forehead. Eye patches almost oval, composed of not less than 47

ommatidia. Antennae medium-sized, rather slender and clavate. Antennomeres 5 and 6 with incomplete distodorsal corolla of sensilla basiconica. Mandibular stipites with ovale smooth lobes. Gnathochilarium: not less than 10 nonapical stipital setae; lamellae linguales each with not less than 5 setae arranged longitudinally.



FIGURES 42–48. *Nepalmatoiulus kabaki* **sp. nov.**, male holotype (Figs 42–46, 48) and female paratype (Fig. 47) (ZMUM). **42**. Left promere, posterior view. **43**. Opisthomere, mesal view. **44**. Solenomere and accessory membrane, mesal view. **45**. Opisthomere, lateral, slightly anterior, view. **46**. Solenomere, lateral, slightly anterior, view. **47**. Vulva, posterior view. **48**. Apex of subapical outgrowth of mesomeral process. **Abbreviations: a**, apex; **d**, subapical outgrowth; **m**, accessory membrane; **n**, deepening; **sl**, solenomere; **v**, velum. Scales: 10 μm (Figs 46, 48), 20 μm (Fig. 44), 100 μm (Figs 42, 43, 45, 47).

Collum laterally with distinct lower striae at posterior margin not reaching to anterior margin, dorsally with distinct short striae at posterior margin. A transverse row of very sparse setae at hind edge of collum.

Body rings circular. Prozona smooth. Metazona with dense, regular, longitudinal striae reaching hind margin (16–20 striae in an approximate square with sides equal to metazonital length of a dorsal side of a midbody ring). Limbus straight, smooth (of Type 1 in Enghoff 1987). A transverse row of sparse, thin setae at hind edge of metazonites, setae gradually growing denser and longer toward telson. Ozopores small, lying behind suture between pro- and metazonite slightly touching the suture in anterior body part, slightly set off from the suture in the second half of the body. Caudal dorsal projection of telson straight and long, covered with setae and carrying at tip a claw-shaped process curved dorsad. Preanal ring setose, anal valves densely setose; subanal scale densely setose along caudal edge.

Legs relatively short and slender. Very delicately serrate ventral pads present on postfemur and tibia, starting from legs 2 (Fig. 39). Claw of all legs at base with a long (longer than claw) setiform accessory claw ventrally (Fig. 38). Leg pair 1 forming a hook, the distal segment not touching basal segments ("Open hook" type in Enghoff 1987): coxa with one seta, postfemur with scaly-rugose ventral surface, tip practically not wrinkly, distal segment without seta and tarsal remnant (Fig. 37). Coxa 2 with one mesapical oral seta (**o**), a gland opening positioned in central and axial position according to Enghoff (1987) (Fig. 41). Penis relatively long, slender, slightly hourglass-shaped, about 0.5 × longer than wide (Fig. 40). Ventral margin of body segment VII with lobes similar to figure 32 in Enghoff (1987).

Gonopods protruding. Anterior gonopod with parallel margins, apically relatively obliquely rounded, distal margins of the apical excavation papillate (the papillary field is quite extensive), rudimentary telopodite without seta (Fig. 42). Flagellum relatively long, slender, caudally covered with cuticular spikes in the distal part. Mesomeral process with rounded glabrous apex (**a**) and subapical, cone-shaped, very long (length reaching the apex of mesomeral process, as a result the mesomeral process proper looks forked), apically papillate outgrowth **(d)** (Figs 43, 45, 48). Velum (**v**) merging with the apex of the mesomeral process. Velum margin smooth, arcuate, without a notch near the mesomeral process (see Discussion below). Margin of accessory membrane (**m**) serrate (Figs 43, 44). Anterior surface of the mesomeral process with longitudinal subbasal deepening (**n**) (Fig. 45). Slender long solenomere (**sl**) spinose nearly throughout, excluding laterocaudal surface of the basal half (Figs 44, 46).

Female. Length in alcohol about 27.0 mm, midbody vertical diameter about 2.5 mm, with 49(–1) rings, excluding telson. Coloration in alcohol marbled gray-brown with broad longitudinal light brownish-pale dorsal strip. Vulva as in Fig. 47.

Etymology. Honours Dr. I. I. Kabak, one of the collectors of this material. A noun in genitive.

Remarks. *Nepalmatoiulus kabaki* **sp. nov.** differs from *N. simultaneus* mainly by rounded apex (vs hook-shaped in N. *simultaneus*) and much longer subapical outgrowth of the mesomeral process, as well as arcuate curved margin of the velum (vs velum with a rather sharply sloped margin in N. *simultaneous*).

The second male was not assigned to the type series for the following reasons. Both solenomeres of this male are shorter than those of the male holotype because they are broken off. This is evidenced by the uneven edges of their apex, as well as the different length of the right and left fragments of the solenomeres. In addition, the coloration of male nontype in alcohol has a gray tint in contrast to the clear coloration of the male holotype. Other main distinguishing characters as in the male holotype. However, the left coxa 1 (anterior view) of the male nontype has two setae, while the right one has one seta. I consider two setae as a random deviation from the norm. Also, the head of the male nontype has 1+1 epicranial setae while the one of the male holotype with 2+1 such setae. I also consider the 2+1 epicranial setae in the male holotype as abnormality.

Nepalmatoiulus emarginatus Mikhaljova, 2020b

Nepalmatoiulus emarginatus Mikhaljova 2020b: 107–110, figs 27–36.

Material examined. 1 male, 1 female (ZMUM), China, Yunnan Province, Laojunshan Mts., 6.26 km SSW Segengsheng, 27°0′20′′ N, 99°28′33′′ E, H = 3575 m, 03.06. 2014, leg. I. Kabak, G. Davidian.

Distribution. China (northwestern part of Yunnan Province).

Remarks. The studied male is deprived of the head, collum and 3–4 front rings.

The species is known only from the original description from NW Yunnan, China (Mikhaljova 2020b). It is found only in high-altitude biotopes at an altitude of more than 3400 m a s. l.

Discussion

According to Enghoff (1987), some *Nepalmatoiulus* species (*N. tibetanus* Enghoff, 1987 from China, *N. rugiflagrum* Enghoff, 1987 from Bhutan) may have a process of the velum. The appearance of the opisthomere of *N. kabaki*, **sp. nov.** resembles a structure having a rounded outgrowth of the velum (Figs 43, 45). However, in fact, the structure here is different. Following Enghoff (1987) I accept the mesomeral process as a thickened structure, while the velum is membranoid. Since the border of the membranous velum (**v**) and the strong thickened mesomeral process are clearly visible (despite the merging of the velum with the apex of the process (**a** in Figs 43, 45) and the absence of a velum notch near the thickened apical part of the mesomeral process), I am inclined to treat **a** as a derivative of the mesomeral process proper, and the velum as a uniform structure (without any outgrowth).

Conclusion

At present, 20 species of *Nepalmatoiulus* (including the four new species described above) are known from Yunnan Province, China. The *Nepalmatoiulus* fauna of this province is the most studied in comparison with other administrative regions of China. In Sichuan Province, this genus is represented by 7 species. Other Chinese provinces, with the exception of three (Hubei, Guangdong and Kiang-si), in each of which only one species is known (Enghoff 1987; Zhang *et al*. 1997), remain completely unexplored in terms of their *Nepalmatoiulus* fauna.

Most of the territory of Yunnan Province is covered by mountains with a maximum height slightly above 6700 m above sea level. All currently known Yunnan species (except *N. yunnanensis*, whose collection height is unknown) are alpine, they have been collected at an altitude of 2500 to 4285 m above sea level. Only two (*N. emarginatus* and *N. tianbaoshanensis*) are relatively widespread and have been recorded in three to seven different, rather closely spaced localities of the province. Most of the other species have been recorded in a single locality.

All Yunnan species (excluding Burmese *N. malaisei* registered in the province near the Burmese border) are region endemics.

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