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Koponenius gen. nov., a new genus of the millipede family Haplodesmidae from the Himalayas of India and Nepal (Diplopoda: Polydesmida)

SERGEI I. GOLOVATCH[1,3] & DIDIER VANDENSPIEGEL[2]

[1]*Institute for Problems of Ecology and Evolution, Russian Academy of Sciences, Leninsky prospekt 33, Moscow 119071, Russia.*
[2]*Department of African Zoology, Royal Museum for Central Africa, Leuvensesteenweg 13, B-3080 Tervuren, Belgium.*
[3]*Corresponding author. E-mail: sgolovatch@yandex.ru*

Abstract

The first, apparently westernmost indigenous representatives of Haplodesmidae are reported, from the Himalayas of Nepal and India. Both new species belong to a new genus, *Koponenius* gen. nov., with *K. unicornis* sp. nov., the type species from Darjeeling District, NE India, and *K. biramus* sp. nov., from Nepal. The new genus is superficially very similar to *Prosopodesmus* Silvestri, 1910, most species of which seem to be native to tropical Australia, partly also to southern Japan. However, *Koponenius* gen. nov. is easily distinguished in showing only 19 body segments, a special ozopore formula (5, 7–18), 4 transverse rows of setigerous isostictic tubercles per postcollum metatergum, and a clearly helicoid, twisted prefemoral portion of the gonopod so that the seminal groove runs mostly laterally, not mesally.

Key words: Diplopoda, Haplodesmidae, taxonomy, new genus, new species, key, Nepal, India

Introduction

The rather small East Asian to Australasian millipede family Haplodesmidae has recently been reviewed and shown to contain 70+ species from 6 accepted genera (Golovatch *et al.* 2009a, 2009b, 2010; Mesibov 2009, 2012, 2013; Liu & Tian 2013). Of them, 40 currently belong to the largest and especially widespread genus *Eutrichodesmus* Silvestri, 2010, which ranges from southern Korea, southern Japan and Taiwan in the northeast, through southern continental China, Indochina, Malay Peninsula and Indonesia, to New Guinea and Melanesia in the southeast. Thus, the indigenous distribution of this genus largely repeats that of the entire family, except for its absence from Australia.

Few haplodesmid species have attained larger distributions and this is through human introductions, e.g. the largely pantropical *Cylindrodesmus hirsutus* Pocock, 1889, *Prosopodesmus jacobsoni* Silvestri, 1910 and *P. panporus* Blower & Rundle, 1980 (Golovatch *et al.* 2001; Mesibov 2012). Most species have localised distributions, including many species that seem to be troglobites (Golovatch *et al.* 2009a, 2009b; Liu & Tian 2013). The westernmost indigenous records of *Eutrichodesmus*, and of Haplodesmidae, were previously in the Yunnan Province, southern China (Golovatch *et al.* 2009a, 2009b). All the more important is the discovery of two new haplodesmids from the Himalayan regions of Nepal and India, both these species being epigean and representing a new genus. A new key is provided to all 7 currently known genera of Haplodesmidae.

Material and methods

Part of the material treated below had been taken in Nepal and long ago sent to us for identification by Jochen Martens (Mainz University, Germany). Additional samples, from India, have recently been provided by Konstantin Tomkovich (Moscow, Russia). The holotype and most of the paratypes of the Nepalese species are housed in the Senckenberg Museum, Frankfurt/M. (SMF), Germany, with only a few duplicates deposited in the collection of the

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Zoological Museum, Moscow State University (ZMUM), Russia. In contrast, most of the types of the Indian species are in ZMUM, only a few being donated to SMF, as indicated below. All 3 males used for scanning electron microscopy (SEM) are retained in the ZMUM collection. Digital images of the specimens were taken in the laboratory and assembled using the Zerene Stacker software.

FIGURE 1. Habitus of *Koponenius unicornis* sp. nov., male paratype. A: dorsal view. B: lateral view. Pictures by K. Makarov, not taken to scale.

Taxonomic part

Koponenius gen. nov.

Name: Honours Seppo Koponen, a prominent colleague arachnologist from Turku University, Finland, on the occasion of his 70th birthday; masculine in gender.

Diagnosis: Differs from the other 6 known haplodesmid genera by only 19 body segments in both sexes, combined with a rather pyrgodesmid-like body shape and a special ozopore formula (5, 7–18), ozopores being borne on porosteles, as well as 4 transverse rows of setigerous isostictic tubercles per postcollum metatergum and a clearly helicoid, twisted prefemoral portion of the gonopod so that the seminal groove runs mostly laterally, not mesally (see also Key below).

Description: Body with 19 segments in both sexes, subcylindrical, not capable of volvation. Head, collum and following metaterga clothed with a dense cerategument. Ozopores borne on simple porosteles, pore formula 5, 7–18. Collum relatively large, sometimes covering the head from above. Paraterga 2 considerably enlarged, but not so as to ensure complete volvation, instead subtending the head laterally. Each postcollum metatergum usually with 4 transverse rows of isostictic setigerous tubercles. Telson strongly flattened dorsoventrally, subtruncate at tip, fully concealing a small epiproct tip from above. Spiracles seem to be absent.

Gonopods of a facies rather typical of Haplodesmidae, *in situ* both held nearly parallel to each other: coxae elongate, non-globose, subcylindrical, both well fused anteromedially, each carrying an elongated cannula on mesal face; telopodites elongated, slender, each clearly subdivided into an elongated, clearly helicoid, twisted prefemoral (= densely setose) part on which the seminal groove runs mostly laterally, not mesally; acropodites curved caudad, slender, uni- or biramous; seminal groove borne on a long solenomere, terminating apically, devoid both of an accessory seminal chamber and a hairy pulvillus.

Type species: *Koponenius unicornis* sp. nov.

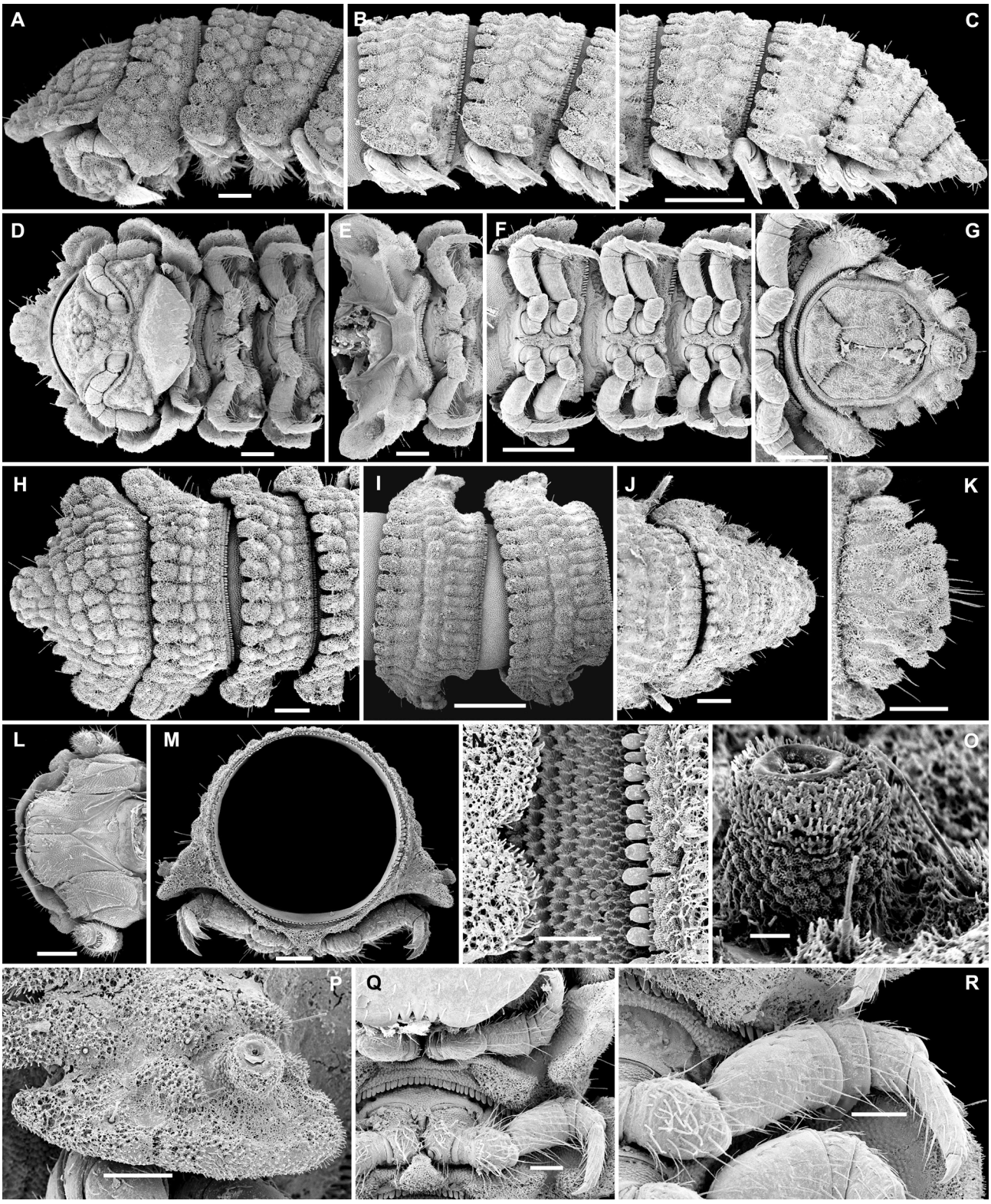

FIGURE 2. *Koponenius unicornis* sp. nov., male paratype. A, D, E, H, Q: anterior body part, lateral, ventral, ventral, dorsal and ventral views, respectively. B, F, I: midbody segments, lateral, ventral and dorsal views, respectively. C, G, J, K: posterior body part, lateral, ventral, dorsal and dorsal views, respectively. L: head, ventral view. M: cross-section of a midbody segment. N–P: tergal texture, dorsal views. R: midbody leg, subventral view. Scale bars: B, C, F, G, I, M, 0.5 mm; A, D, E, H, J–L, 0.2 mm; P–R, 0.1 mm; N, 0.05 mm; O, 0.02 mm.

Other species included: *Koponenius biramus* sp. nov.

Remarks: The family Haplodesmidae hitherto contained six genera. Most of them can be conveniently

divided into two morphological groups: (1) The "haplodesmid" type usually shows ozopores borne on special, mostly boletiform porosteles or tubercles, while paraterga are absent from body segment 3 onwards, and (2) The "doratodesmid" type is normally devoid of porosteles, whereas the paraterga are present on all segments, often ensuring complete volvation (Golovatch *et al.* 2009a).

Koponenius gen. nov. seems to be especially similar to *Prosopodesmus* Silvestri, 1910, likewise being intermediate between the two groups described above in showing quite strongly developed paraterga, coupled with the presence of porosteles. However, all 7 known *Prosopodesmus* species (mostly native to tropical Australia, but a few to southern Japan) are considerably more pyrgodesmid-like in body shape, the collum being strongly flabellate, its fore margin 12-lobulated, covering the head from above. In addition, they have 20 body segments, only 3 transverse rows of isostictic tubercles per postcollum metatergum, varying pore formulas, but not (5, 7–18), usually mushroom-shaped porosteles, and the seminal groove on falcate and unbranched gonopod telopodites which runs only on the mesal side and is typically supplied with a hairy pulvillus near its orifice (Mesibov 2012). The above similarities between these two genera are also reflected in an updated key which concludes this paper.

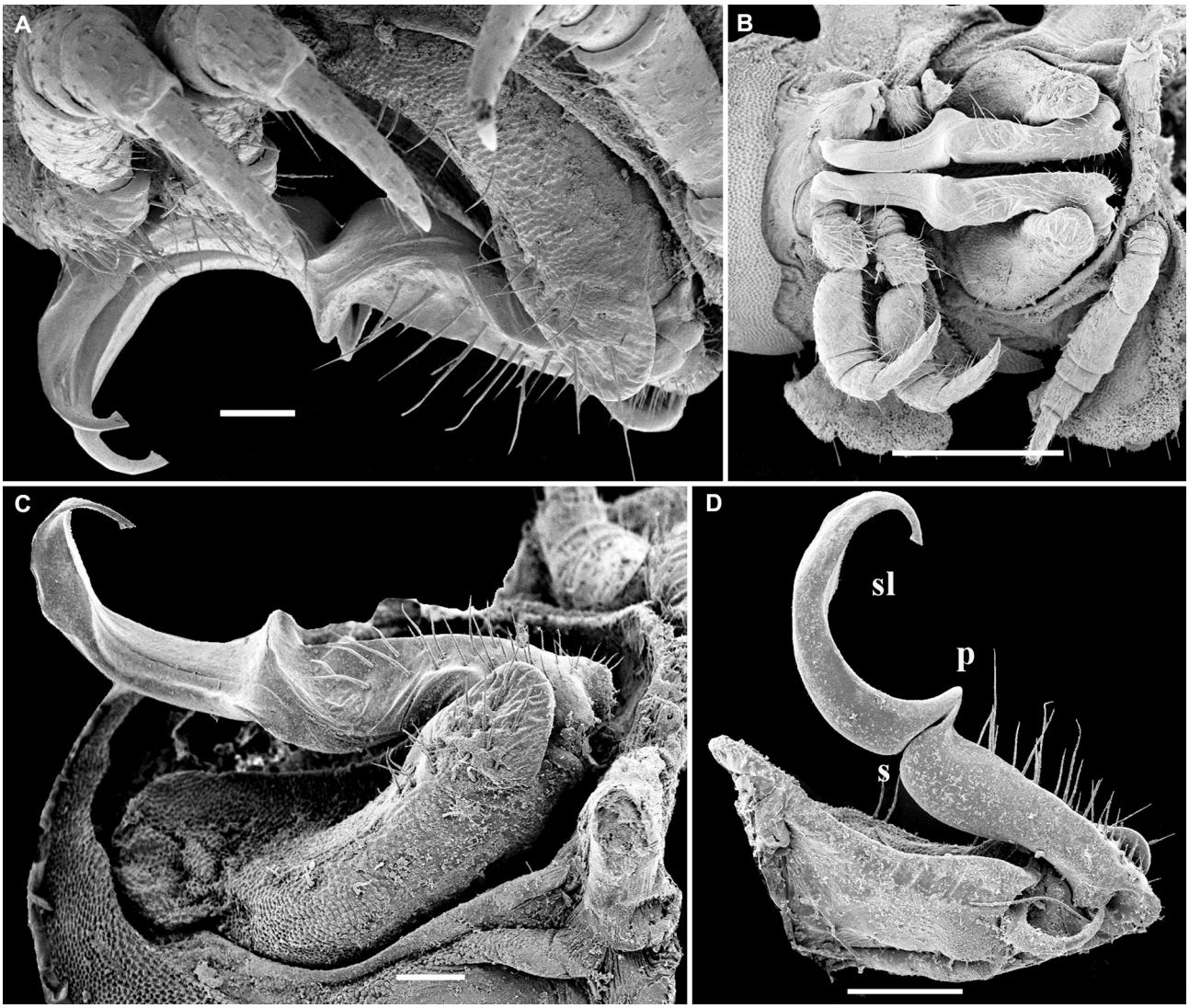

FIGURE 3. *Koponenius unicornis* sp. nov., male paratype. A–D: gonopods, lateral, ventral, lateral and mesal views, respectively. Scale bars: B, 0.5 mm; D, 0.2 mm; A, C, 0.1 mm. Designations explained in text.

***Koponenius unicornis* sp. nov.**
Figs 1–4

Material examined: Holotype male (ZMUM), India, West Bengal, Darjeeling District, Kalimpong (Gandhi

Ashram), 27,06ºN, 88,45ºE, ca 880 m a.s.l., 5–15 November 2013, leg. K. Tomkovich. Paratypes: 7 males, 8 females (ZMUM), 1 male, 1 female (SMF), 2 males (SEM), same data, together with holotype.

Name: To emphasize the conspicuous central projection at the fore margin of the collum in both sexes; adjective.

Diagnosis: Differs clearly from the only other known congener, *K. biramus* sp. nov., in the presence of a highly conspicuous central process at the fore margin of the collum in both sexes, coupled with a uniramous gonopod telopodite.

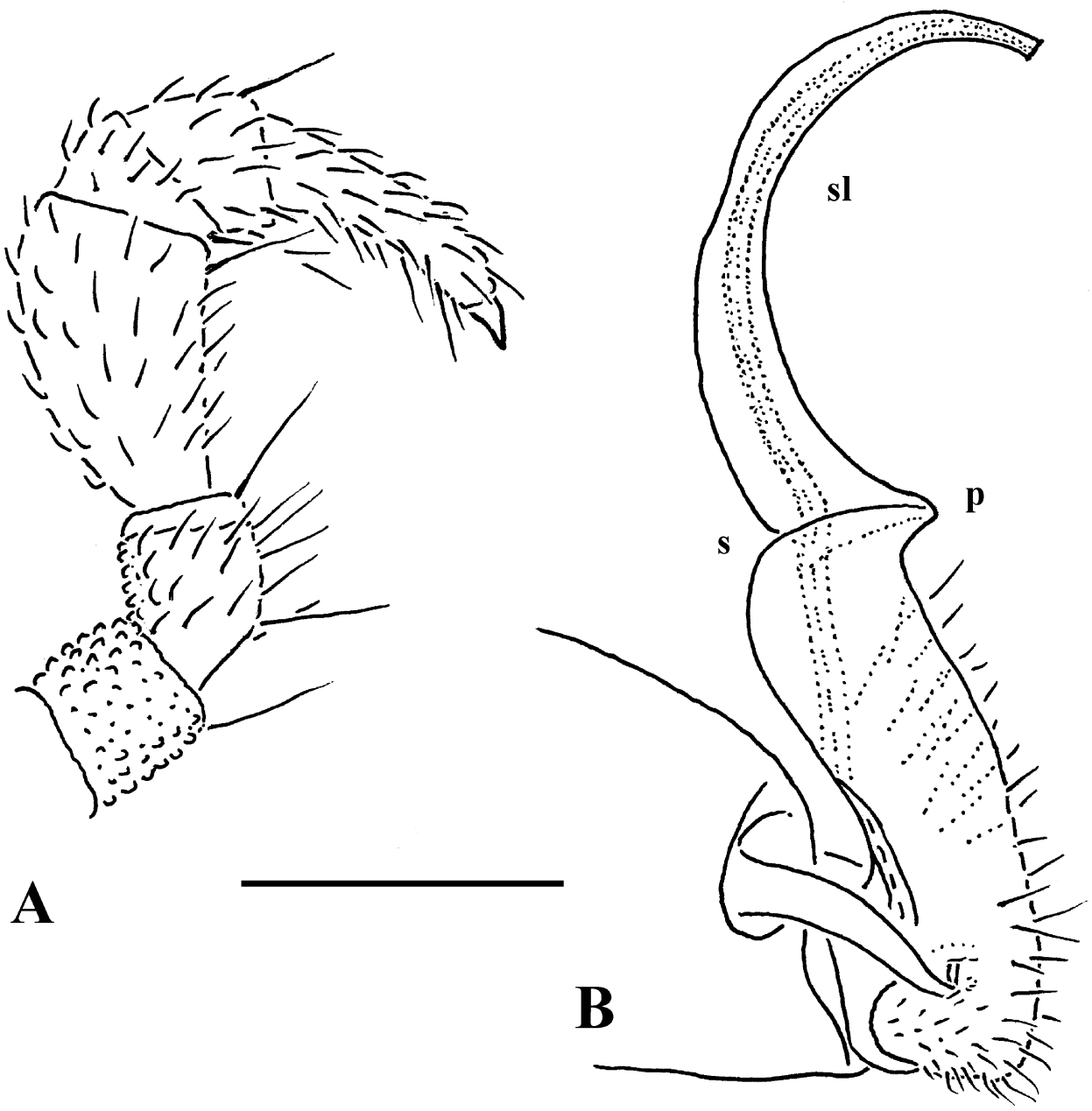

FIGURE 4. *Koponenius unicornis* sp. nov., male paratype. A: leg 7, lateral view. B: left gonopod, mesal view. Scale bar: 0.3 mm. Designations explained in text.

Description: Length in both sexes ca 12–14 mm, width ca 1.3–1.5 and 1.8–2.0 mm on midbody pro- and metazonae, respectively. Holotype ca 13 mm long, 1.3 and 1.8 mm wide on midbody pro- and metazonae, respectively. Coloration in alcohol mostly brown to dark grey-brown, including vertigial region of head, as well as most of pleurosternal and midsternal regions, but pattern evident due to contrasting pale, whitish to light greyish clypeolabral and occipital regions of head, antennae, prozonae, porosteles, legs, epi-, hypo- and paraprocts (Fig. 1).

Body with 19 segments in both sexes, subcylindrical, not capable of volvation. Collum and following metaterga clothed with a dense, dull, microvillose cerategument crust (Fig. 2M–P); vertigial region down to a well-expressed border with clypeolabral region clearly granular (Fig. 2D). Clypeolabral region densely setose (Fig. 2D, Q). Antennae short and clavate, *in situ* each placed inside a deep, transverse, nearly C-shaped groove (Fig. 2D); in length, antennomere 6 > 2 > 1 > 3=4=5; both antennomeres 5 and, especially, 6 with a tight dorso-apical group of bacilliform sensilla (Fig. 2A, D, L). Ventral surface of cardo and gnathochilarium largely finely squamate (Fig. 2L).

FIGURE 5. Habitus of *Koponenius biramus* sp. nov., male paratype, lateral view. Picture by K. Makarov, not taken to scale.

In width, head < collum = segment 3 = 4 < 2 = 5=16, thereafter body gradually tapering towards telson (Fig. 2H–J). Collum at fore margin dentate, with a highly conspicuous, central, tuberculate protuberance overhanging the head and concealing it from above (Fig. 2A, D, H). Paraterga rather well developed, strongly declined, mostly wing-shaped, set low (at about lower ¼ of midbody height), starting from collum, laterally vaguely lobulate (Figs 1 & 2A–J, M, P). Paraterga 2 clearly enlarged, subtending the head on both sides. Dorsum very convex (Fig. 2M). Postcollum metaterga usually with 4, rarely 5, regular, transverse rows of rather flat, sometimes rather clearly obliterated, setigerous, isostictic (= regular in axial direction), mostly roundish bosses or tubercles (Figs 1 & 2A–C, H–J); caudal row of particularly elongate bosses forming a faint waist (Fig. 2I), a series of lobulations and ending up in a distinct crenulate limbus (Fig. 2I, N); fore row likewise forming a row of similar lobulations (Figs 1 & 2A–C, H–J, N, P). Caudolateral corner of postcollum paraterga mostly well rounded, nearly pointed only in segments 17 and 18 (Fig. 2J, K). Ozopores borne on conspicuous dorsolateral porosteles, these lying close to caudolateral corners of paraterga; pore formula 5, 7–18 (Figs 1 & 2A–C, I, M, O, P). Tergal setae filiform, rather long (Fig. 2O, P). Epiproct strongly flattened dorsoventrally, lobulated laterally, subtruncate caudally, but tip ventral, invisible from above (Fig. 2C, G, J, K). Hypoproct subtrapeziform (Fig. 2G).

Sterna narrow, but evident, mostly slightly elevated due to small subtriangular lobules observed between both coxae (Fig. 2D–F). Spiracles seem to be absent. Legs mostly tightly appressed to venter, densely setose, short and stout, about as long as body height and subequally incrassate in both sexes (Figs 1 & 2B–F, M, Q, R), but only male coxae and, to a lesser degree, prefemora micropapillate (Fig. 4A).

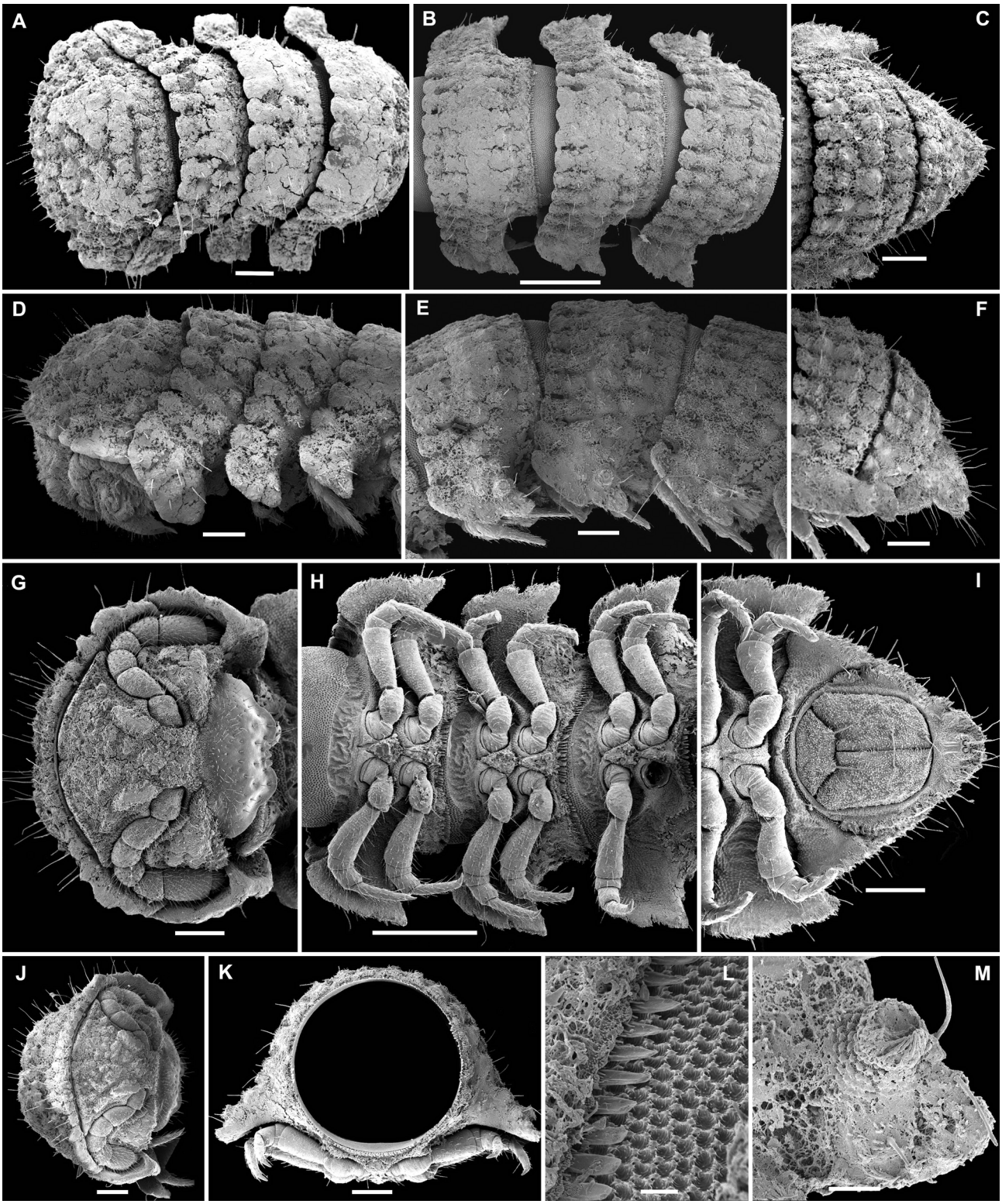

FIGURE 6. *Koponenius biramus* sp. nov., male paratype. A, D, G, J: anterior body part, dorsal, lateral, ventral and frontoventral views, respectively. B, E, H: midbody segments, dorsal, lateral and ventral views, respectively. C, F, I: posterior body part, dorsal, lateral and ventral views, respectively. K: cross-section of a midbody segment. L: tergal texture, dorsal view. M: ozopore region, dorsolateral view. Scale bars: H, 0.5 mm; A–G, I–L, 0.2 mm; N, 0.05 mm; L, 0.02 mm.

Gonopods (Figs 3 & 4B) with large, subcylindrical, mediobasally fused coxae carrying a few long setae ventrally and a small, but evident, rounded, lateral lobe apically; cannulae long and slender. Telopodite strongly elongated, considerably longer than coxae, slender; prefemoral (= densely setose) portion suberect, about half as

long as entire telopodite, set off from a subfalcate, rather gradually attenuating and narrowly truncate acropodite (= solenomere, **sl**) by a strong sulcus (**s**) on mesal face and by a ventral projection (**p**); seminal groove rapidly shifted laterad due to a twisted prefemoral portion, thereafter running only on lateral side all over **sl** extent. Neither an accessory seminal chamber nor a hairy pulvillus.

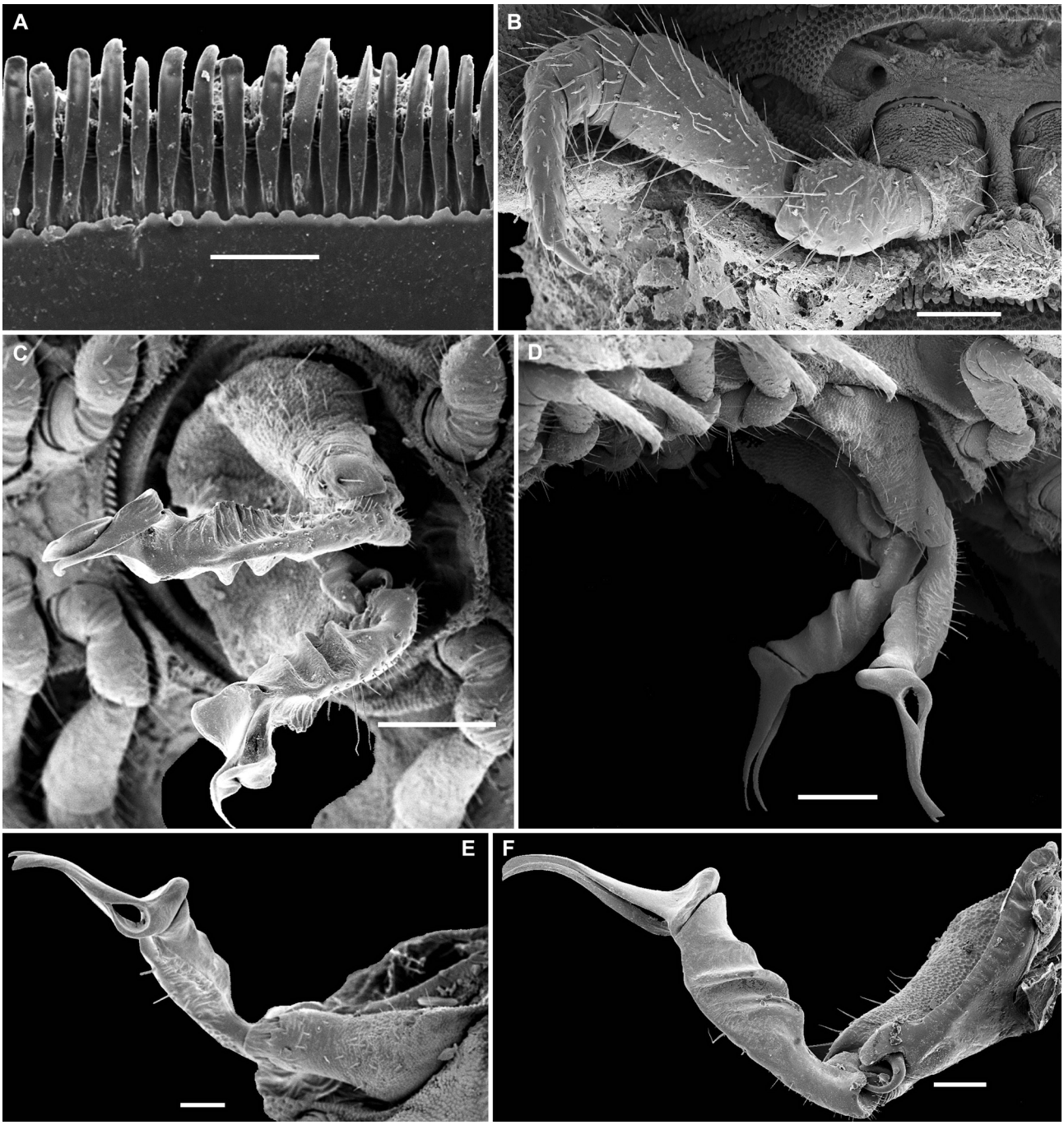

FIGURE 7. *Koponenius biramus* sp. nov., male paratype. A: limbus, dorsal view. B: midbody leg, ventral view. C–F: gonopods, ventrolateral, sublateral, lateral and mesal views, respectively. Scale bars: C, D, 0.2 mm; B, E, F, 0.1 mm; A, 0.05 mm.

***Koponenius biramus* sp. nov.**
Figs 5–8

Material examined: Holotype male (SMF), Nepal, Lalitpur District, Godawari, 27°36´N, 85°24´E, foot of Mount

Phulchoki, ca 1750 m, secondary broadleaved forest, 9 August 1970, leg. J. Martens. Paratypes: 12 males, 1 female (SMF), 2 males (ZMUM), 1 male (SEM), same data, together with holotype.

Name: To emphasize the biramous gonopod telopodite; adjective.

Diagnosis: Differs from the sole congener, the type species *K. unicornis* sp. nov., in the lack of a fore projection on the collum, as well as by the biramous gonopod telopodite.

Description: Length in both sexes ca 11–12 mm, width of pro- and metazonae 1.2–1.3 and 1.6–1.8 mm, respectively. Holotype ca 11 mm long, 1.2 and 1.6 mm wide on pro- and metazonae, respectively. Coloration in alcohol rather uniformly grey-brown to dark bown (Fig. 5).

All characters as in *K. unicornis* sp. nov., except as follows.

Collum's fore margin regularly rounded, faintly lobulated, but covering the head from above, totally devoid of a fore protuberance (Figs 5 & 6A, D, G, J). Paraterga more wing-shaped and their caudolateral corners usually more acute (Fig. 6A–F, H, I). Metatergal bosses usually more strongly obliterated (Figs 5 & 6A–F, J, K). Limbus not crenulate, but long, dense, sharp blades (Figs 6L & 7A).

Gonopods (Figs 7C–F & 8B) with two conspicuous, oblique, mesal, prefemoral ribs basal to main sulcus (**s**) demarcating a slender, biramous, equally long acropodite consisting of a subflagelliform solenomere (**sl**) and a similarly slender and long process (**p**).

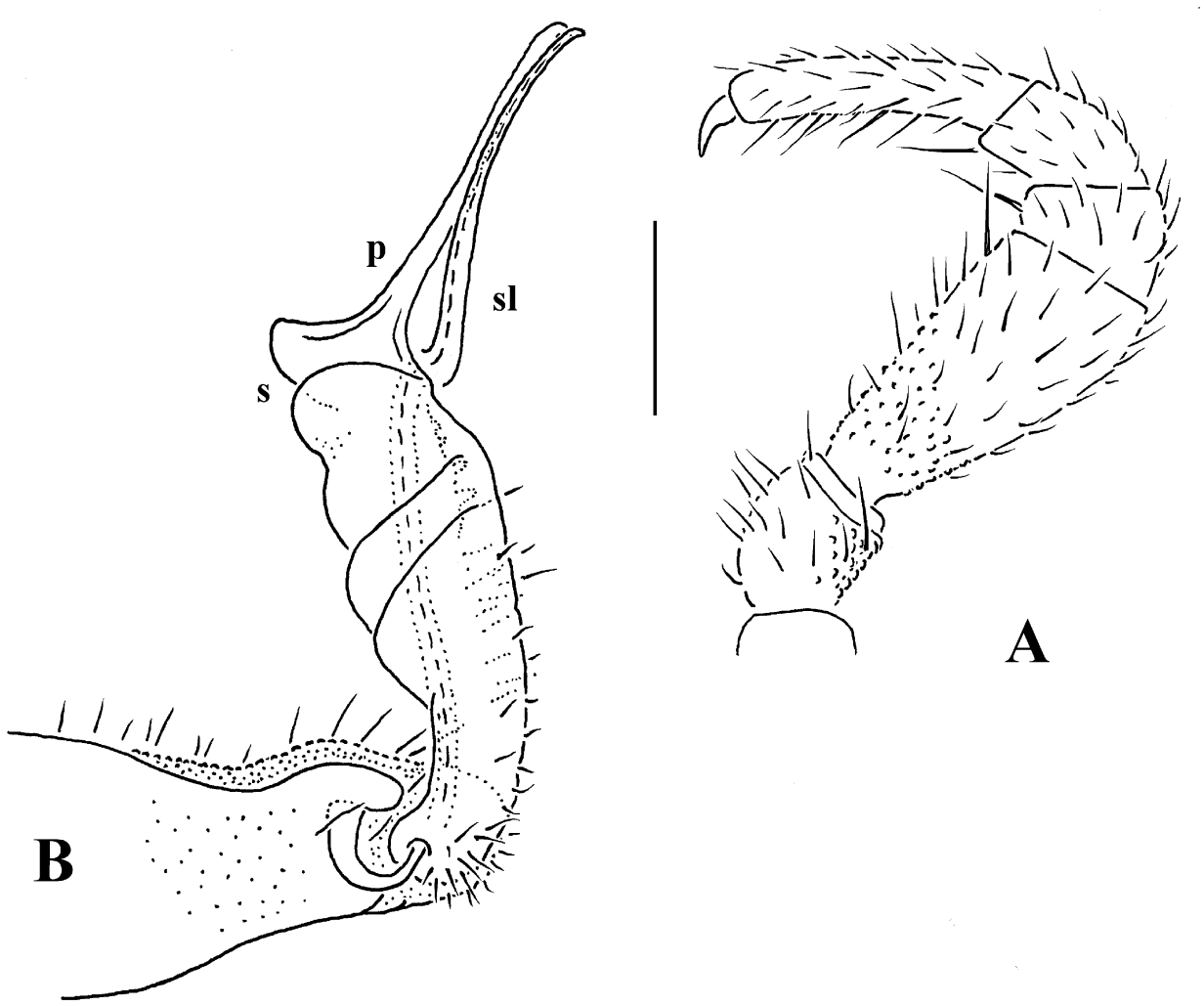

FIGURE 8. *Koponenius biramus* sp. nov., male paratype. A: leg 6, lateral view. B: left gonopod, submesal view. Scale bar: 0.2 mm. Designations explained in text.

Key to the known genera of Haplodesmidae, based mainly on male characters:

1 Body more or less pyrgodesmid-like, not capable of volvation, with rather well developed and strongly declivous paraterga. Head largely invisible from above, being concealed under a large, flabellate, usually clearly lobulated collum. Ozopores usually borne on porosteles 2

– Body either vermiform, subcylindrical, not capable of volvation and devoid of paraterga starting from segment 3 or "doratodesmid", with or without mid-dorsal projections, but always with well-developed and strongly declivous paraterga, typically capable of complete conglobation. Porosteles mostly absent 3

2 Collum's fore margin strongly 12-lobulated. Body with 20 segments. Postcollum metaterga with 3 transverse rows of tuberculations. Entire gonopod telopodites falcate, uniramous, seminal groove mesal, usually terminating in a hairy pulvillus. . . . . *Prosopodesmus* Silvestri, 1910

– Collum's fore margin either regularly rounded and only vaguely lobulated or with a prominent median projection at fore margin. Body with 19 segments. Postcollum metaterga with 4 transverse rows of tuberculations. Only distal halves of gonopod telopodites curved caudad, uni- or biramous, seminal groove running mostly on lateral side, terminating on a simple and slender solenomere devoid of a hairy pulvillus . . . . . *Koponenius* **gen. nov.**

3 Body vermiform, subcylindrical, not capable of volvation, with paraterga 2 rather well developed, but following ones represented mostly by lateral swellings. Gonopods simplified 4

– Body "doratodesmid", with or without mid-dorsal projections; mostly capable of complete conglobation, with paraterga 2 always very strongly enlarged laterally, all following paraterga more or less strongly declivous while collum somewhat reduced. Gonopods usually rather elaborate 6

4 Body with 19 (male) or 20 (female) segments, collum and all following metaterga with abundant setation in part represented by long, bisegmented, tactile setae. Gonopods especially simple; telopodite = solenomere sometimes with a lateral outgrowth at midway; seminal groove terminating subapically and devoid of a hairy pulvillus. . . . . *Cylindrodesmus* Pocock, 1889

– Body with 19 or 20 segments regardless of sex, collum and all following metaterga without abundant irregular setation, usually tuberculate. Paraterga 2 rather well developed, but following ones mostly represented by lateral swellings. Gonopods aberrant. 5

5 Body with 19 segments. Collum still large, covering the head from above, with 4–5 transverse rows of setigerous tubercles or pits. Following paraterga with three rows of similar tubercles or pits. Gonopods with poorly setose gonocoxae and a considerably shortened prefemoral (= setose) part, deeply biramous thereafter, with a very long and flagelliform solenomere devoid of a hairy pulvillus. . . . . *Helodesmus* Cook, 1896

– Body with 19 or 20 segments. Collum small, not covering the head from above; tergal trichome wanting. Metaterga often irregularly multituberculate. Gonopod coxae virtually bare and reduced; telopodites strongly geniculate at about midway, with neither a coxal cannula nor a seminal groove . . . . . *Agathodesmus* Silvestri, 1910

6 Gonopod telopodite typically stout and strongly enlarged laterally towards end of femorite, with or without a short solenomere branch thereafter; acropodite variable, from absent to well-developed . . . . . *Doratodesmus* Cook *in* Cook & Collins, 1895

– Gonopod telopodite usually slender, not enlarged towards end of femorite, but with a more or less distinct process or outgrowth laterally, opposite recurvature point of seminal groove; solenomere thereafter taking up most of telopodite, sometimes elaborate; seminal groove terminating distally to subapically, with or without a hairy pulvillus; acropodite small to nearly absent. . . . . *Eutrichodesmus* Silvestri, 1910

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