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TYLOPUS MILLIPEDES IN VIETNAM (DIPLOPODA: POLYDESMIDA: PARADOXOSOMATIDAE: SULCIFERINI), WITH DESCRIPTIONS OF FIVE NEW SPECIES

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ABSTRACT. — Taxonomy of millipedes of the genus *Tylopus* Jeekel, 1968 in Vietnam is revised. Five new species are described: *Tylopus phanluongi*, *T. golovatchi*, *T. roseiparaterga*, *T. spinisterna*, and *T. sapaensis*. Data on recently collected specimens of *T. hilaris* (Attems, 1937), *T. nodulipes* (Attems, 1953), *T. strongylosomoides* (Korsós & Golovatch, 1989), *T. procurvus* Golovatch, 1984, *T. crassipes* Golovatch, 1984, and *T. topali* Golovatch, 1984 are provided. A key to the Vietnamese *Tylopus* species and their distributions are also presented.

KEY WORDS. — Vietnam, Paradoxosomatidae, Sulciferini, *Tylopus*, new species

INTRODUCTION

Tylopus is one of the largest genera in the family Paradoxosomatidae Daday, 1889, with 41 valid species distributed in mountainous areas in Indochina and the southern part of China (Likhitrakarn et al., 2010). Taxonomy of the genus has been revised by Golovatch & Enghoff (1993) and Likhitrakarn et al. (2010), but species occurring in areas other than Thailand are poorly studied.

In Vietnam, 13 *Tylopus* species have been recorded prior to the present study. These species have been found only from the type localities in the original descriptions. In the present paper, additional locality records of some species are provided and five new species are described, to contribute to a better understanding of the Vietnamese *Tylopus* fauna (Table 1).

MATERIAL AND METHODS

Most of material examined in this study was collected during field trips organised by the Vietnamese-Russian Tropical Center, Hanoi, Vietnam. The material was preserved in 75% ethanol and kept in the collection of the Institute of Ecology and Biological Resources (IEBR), Hanoi, Vietnam. Line drawings were made with the aid of a drawing tube attached to a stereoscopic dissecting microscope LEICA M50. Scanning Electron Microscope (SEM) images were taken using the ABT 32 (Topcon Technohouse Co. Ltd, Tokyo) in the Faculty of Science, Ibaraki University, Mito, Japan. Morphological terminology follows Golovatch & Enghoff (1993) and Likhitrakarn et al. (2010). Measurements of the holotypes are given in square parentheses. All holotypes and paratypes of species described herein are deposited in the IEBR collection.

TAXONOMY

Tylopus Jeekel, 1968

Agnesia Attems, 1953: 174. Type species: *Agnesia nodulipes* Attems, 1953, by original designation. Preoccupied by *Agnesia* De Koninck, 1883 (molluscan genus)

Tylopus Jeekel, 1968: 60, 151, replacement name for *Agnesia* Attems, 1953; Golovatch & Enghoff, 1993: 86; Likhitrakarn et al., 2010: 24

Paratylopus Korsós & Golovatch, 1989: 215. Type species: *Paratylopus strongylosomoides* Korsós & Golovatch, 1989, by original designation. Synonymised by Golovatch & Enghoff, 1993: 86

Diagnosis. — This genus can be distinguish from other genera in the tribe Sulciferini of the subfamily Paradoxosomatinae by the combination of the following gonopod characters: femorite grooved mesally, demarcated from postfemoral region by a complete cingulum or a sulcus laterally; postfemoral region with lateral basal lamina **l**, lobes **m** and **n** present mesally or absent, and also being supplied with a process **h** and spine **z**; solenomere flagelliform, and completely sheathed by sigmoid or coiled solenophore (Golovatch & Enghoff, 1993; Likhitrakarn et al., 2010).

Table 1. Checklist of *Tylopus* species from Vietnam (from Attems, 1937, 1938, 1953; Golovatch, 1984; Korsós & Golovatch, 1989; and present study)

No.	Species	Locality
1	*Tylopus crassipes* Golovatch, 1984	Sa Pa, Van Ban (Lao Cai Province)
2	*Tylopus golovatchi*, new species	Xuan Son National Park (Phu Tho Province)
3	*Tylopus granulatus* Golovatch, 1984	Cuc Phuong National Park (Ninh Binh Province)
4	*Tylopus hilaris* (Attems, 1937)	Ba Na National Park (Da Nang city); Ngoc Linh Mts. (Kon Tum Province); Bach Ma National Park (Thua Thien Hue Province)
5	*Tylopus hilaroides* Golovatch, 1984	Cuc Phuong National Park (Ninh Binh Province)
6	*Tylopus maculatus* Golovatch, 1984	Sa Pa (Lao Cai Province)
7	*Tylopus magicus* Golovatch, 1984	Sa Pa (Lao Cai Province)
8	*Tylopus mutilatus* (Attems, 1953)	Ba Na National Park (Da Nang city)
9	*Tylopus nodulipes* (Attems, 1953)	Sa Pa, Nam Xay (Lao Cai Province); Pu Mat National Park (Nghe An Province); Huong Son (Ha Tinh Province)
10	*Tylopus phanluongi*, new species	Ngoc Linh Mts. (Kon Tum Province)
11	*Tylopus procurvus* Golovatch, 1984	Sa Pa (Lao Cai Province)
12	*Tylopus roseiparaterga*, new species	Tam Dao National Park (Vinh Phuc Province)
13	*Tylopus sapaensis*, new species	Sa Pa (Lao Cai Province)
14	*Tylopus sigma* (Attems, 1953)	Sa Pa (Lao Cai Province)
15	*Tylopus spinisterna*, new species	Bi Doup–Nui Ba National Park (Lam Dong Province)
16	*Tylopus strongylosomoides* (Korsós & Golovatch, 1989)	Tam Dao National Park (Vinh Phuc Province); Xuan Son National Park (Phu Tho Province)
17	*Tylopus tamdaoensis* Korsós & Golovatch, 1989	Tam Dao National Park (Vinh Phuc Province)
18	*Tylopus topali* Golovatch, 1984	Cuc Phuong National Park (Ninh Binh Province); Xuan Son National Park (Phu Tho Province)

***Tylopus phanluongi*, new species**
(Figs. 1, 2, 18)

Material studied. — Holotype: Male in the bottle **IEBR-100H**, with a label "Kon Tum Province, Dak Glei District, Ngoc Linh Mountain (15°00'–15°18'N, 107°41'–08°01'E), primary forest, 1800–1900 m a.s.l., coll. Nguyen Duc Anh, 11 Mar.2006 – 9 Apr.2006.
Paratypes: 1 female (**IEBR-100P)**, collected together with holotype; 4 males, 2 females (**IEBR-101**), Kon Tum Province, Dak Glei District, Ngoc Linh Mountain (15°00'–15°18'N, 107°41'–08°01'E), secondary forest, 1700 m a.s.l., coll. Nguyen Duc Anh, 25 Mar.2004 – 11 Apr.2004; 4 males, 2 females (**IEBR-102**), Kon Tum Province, Dak Glei District, Ngoc Linh Mountain (15°00'–15°18'N, 107°41'–08°01'E), primary forest, 1900–2100 m a.s.l., coll. Nguyen Duc Anh, 21 Mar.2006 – 9 Apr.2006.

Diagnosis. — The species is very similar to *Tylopus hilaris* and *T. hilaroides* in general appearance and gonopod conformation, but it can be distinguished from them in having the gonopod process **h** with two branches (one spiniform, and the other a serrated lamina).

Etymology. — "*phanluongi*", named in honour of Dr. Phan Luong of the Vietnamese-Russian Tropical Center for his major contribution to the ecological surveys in Vietnam.

Description. — Size: Body length 37–[40]–41 mm (male), 38–42 mm (female), width of midbody prozona 3.1–[3.3]–3.4 mm (male) and 3.2–3.6 mm (female), and metazona 4.1–[4.3]–4.4 mm (male) and 4.2–4.6 mm (female).

Colouration: Body generally castaneous brown, but margin of posterior part of prozona, anterior area of metazona, metatergal transverse sulcus, distal part of antennomere 6, and whole antennomere 7 blackish brown. Legs, paraterga and sterna brownish yellow.
Head: Slightly broader than collum. Region between antennal sockets with sparse setae, labrum more setose. Frons slightly convex, divided into two parts by a distinct epicranial suture. Antenna long, claviform, reaching body ring 4 laterally. Antennomere 3=4=5>6=2>1&7 in length.
Collum: Slightly narrower than body ring 2; surface shining, finely rugose in anterior half and strongly rugose in posterior half, without granules or tubercles, with a row of 4+4 setae near anterior margin. Transverse sulcus vestigial, partly obliterated. Paratergum minute, sub-semicircular.
Body ring 3<2=4<5 in width, body parallel-sided on rings 5–16, thereafter gradually tapering towards telson. Surface of prozona shining, smooth. Metatergal surface shining, slightly rugulose on anterior half and considerably rugose on posterior half. Metatergal transverse sulcus present on body rings 5–19, finely striate, reaching base of paraterga (Fig. 1A). Metaterga of body rings 2–16 with rows of 2+2 and of 3+3 setae in front of and behind transverse sulcus, respectively.
Metaterga: Body rings 17–18 with three rows of 2+2, 1+1 and 4+4 setae; second and third rows located behind transverse sulcus. Metatergum 19 with rows of 2+2 and 5+5 setae in front of and behind transverse sulcus, respectively.
Pleura: With dense microgranules. Pleurosternal keels

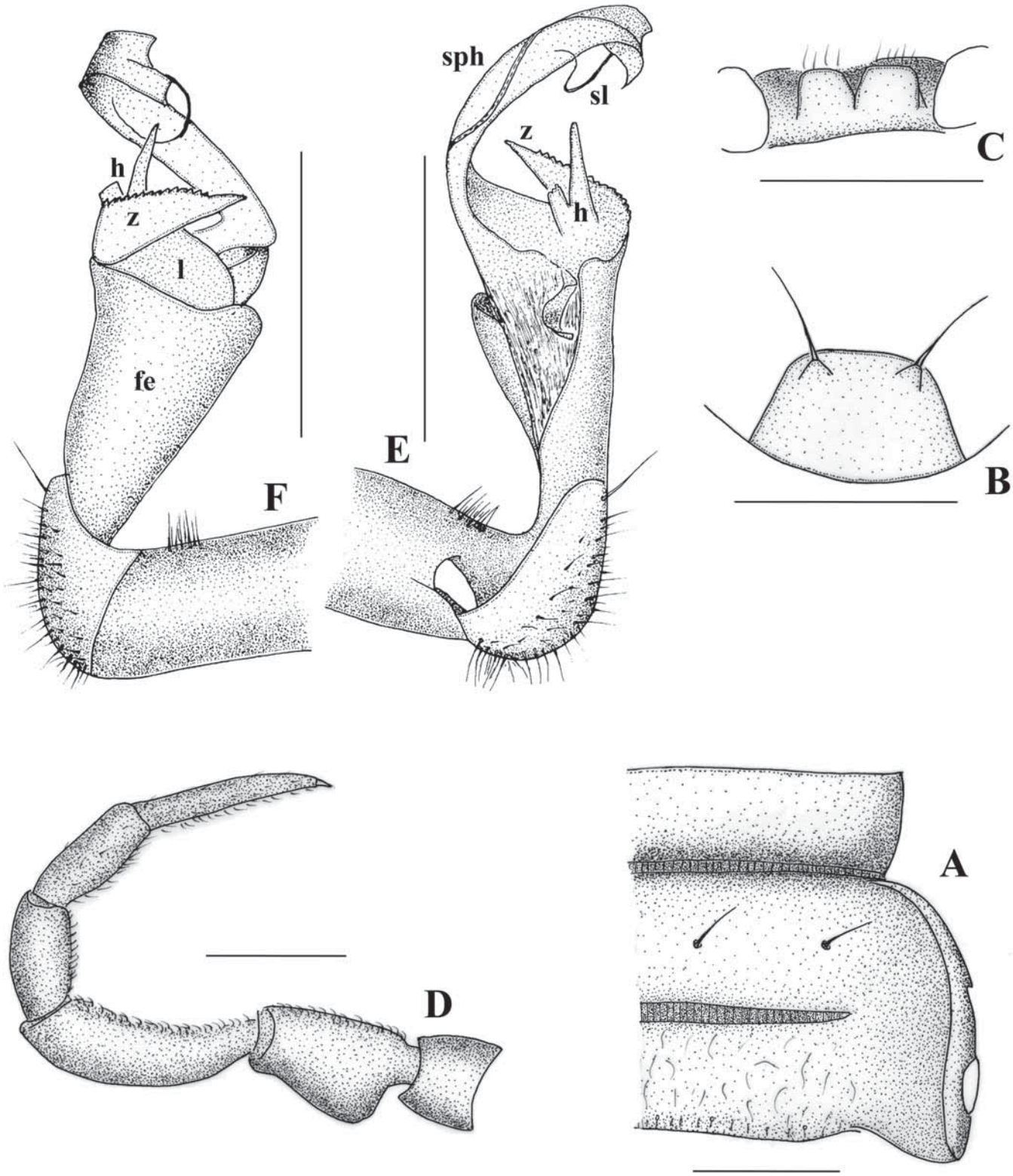

Fig. 1. *Tylopus phanluongi*, new species, holotype: body ring 10, dorsal view (A); hypoproct, ventral view (B); sternite 5, posterioventral view (C); leg 9 (D); right gonopod, mesal view (E)and lateral view (F). Scale bars = 1 mm.

small, beak-like or spiniform on body rings 2–5, absent on subsequent body rings. Axial line evident only in anterior half of metaterga. Waist between pro- and metazona narrow, deep, finely striate.

Paraterga: Well developed, slightly lower than metatergal surface, beak-like on body rings 5–14, more protruding on body rings 15–19. Paraterga surpassing posterior contour of metaterga. Calluses small, with one or two setiferous incisions on lateral side of poreless and pore-bearing paraterga, respectively. Ozopores located on lateral side of paraterga of body rings 5, 7, 9–10, 12–13, 15–19 (Fig. 1A).

Telson: Epiproct short, broadly truncated, with two small terminal tubercles. Tip with four spinnerets. Hypoproct trapeziform, with two distolateral setiferous knobs (Fig. 1B).

Sterna densely setose, without any modification; transverse and longitudinal sutures distinct. Male sternum 5 with a setiferous bifid lamina between coxae 4 (Fig. 1C).

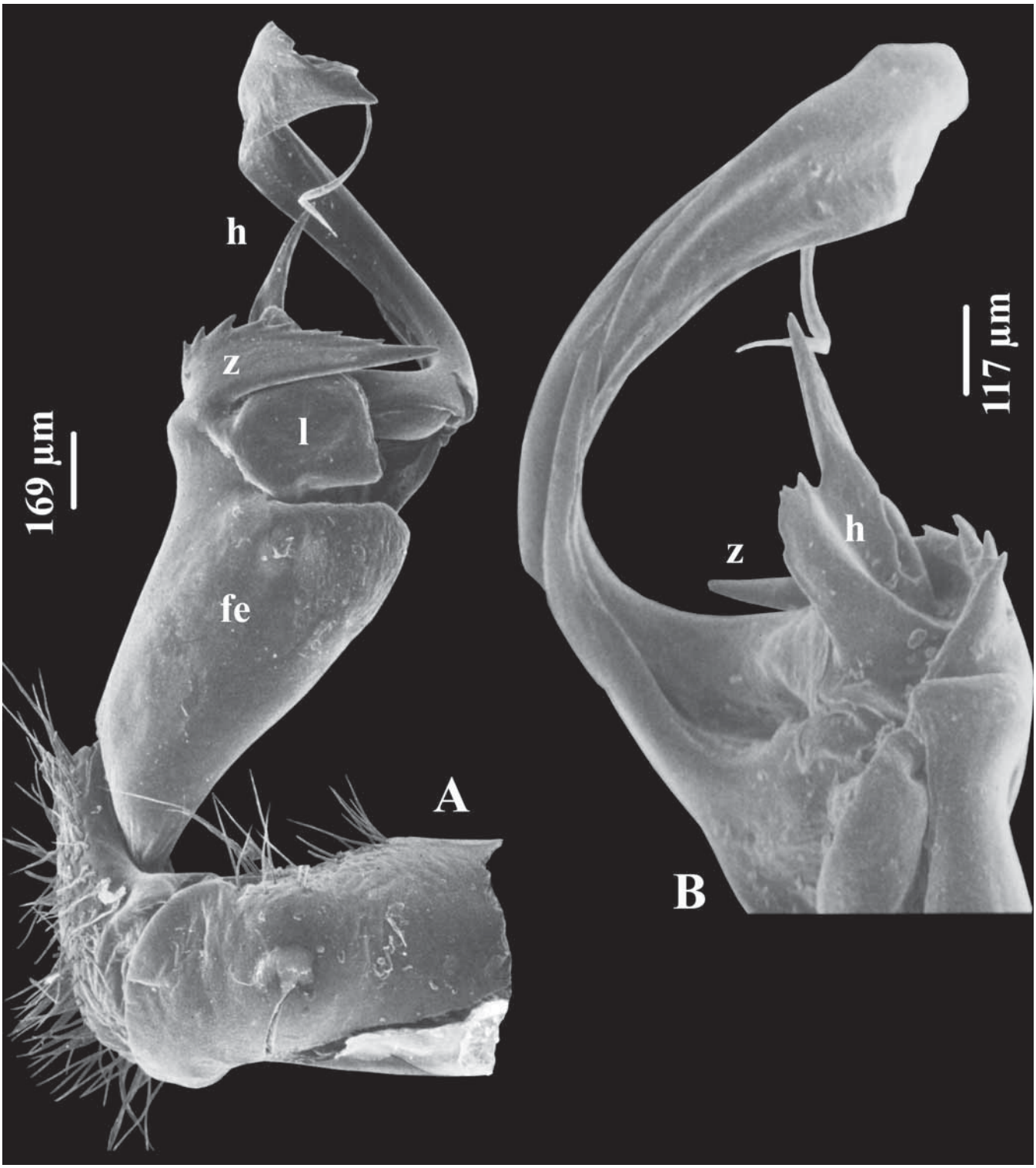

Fig. 2. *Tylopus phanluongi*, new species, holotype: right gonopod, mesal view (A); postfemoral region, mesal view (B).

Legs: Slender, about 1.8–2 times as long as midbody height, without tarsal brushes. Prefemora swollen dorsally. Ventral part of prefemora and femora with dense microtubercles (Fig. 1D).
Gonopods (Figs. 1E,F, 2A,B): Coxite cylindrical, slightly shorter than femorite; distoventral part sparsely setose. Prefemorite densely setose, set off from femorite by an oblique sulcus on lateral side. Femorite stout, expanded distally. Postfemoral region demarcated from femorite by a distinct sulcus laterally. Lamina **l** present, somewhat overlapped by a well-developed, serrated process **z.** Process **h** short, with 2 branches, one longer and spiniform, the other shorter and slightly serrated. Lobes **m** and **n** absent. Solenophore strongly coiled, completely sheathing flagelliform solenomere.

Distribution. — Known only from the type locality (Fig. 18)

Tylopus spinisterna, new species
(Figs. 3, 4, 18)

Material examined. — Holotype: Male in the bottle **IEBR-142H**, with a label "Lam Dong Province, Bi Doup-Nui Ba National Park (12°00'–12°19'N, 108°21'–108°44'E), corn field, 1400 m a.s.l., pitfall traps, coll. Nguyen Duc Anh, 2–9 Apr.2008".
Paratypes: 7 males, 5 females (**IEBR-142P**), same data as holotype.

Diagnosis. — The species can be distinguished from its congeners by the combination of the following characters: all sterna except for sternum 5 with four projections; metaterga strongly rugose, with two rows of 2+2 and 2+2 setiferous knobs/tubercles; solenophore and process **h** of gonopod subequal; gonopod lamina **l** present, suboval-shaped, but lobe **m** and spine **z** absent.

Etymology. — "*spinisterna*" is a noun in apposition and emphasizes the presence of spiniform projections on the sterna.

Description. — Size: Body length 16–[19]–20 mm (male), 23–24 mm (female). Width of midbody prozona 1.4–[1.5] mm (male), 2.0–2.2 mm (female) and metazona [1.8]–1.9 mm (male), 2.6–2.7 mm (female).
Colouration: Head, pleura, prozona, and anterior half of metaterga brown; posterior half of metaterga divided into three regions: a black one in middle surrounded by two paler regions. Paraterga, legs, sterna and antenna brownish yellow except for distal part of antennomere 6 and whole antennomere 7 blackish brown.
Head: Slightly broader than collum; labrum densely setose. Epicranial suture deep, dividing frons into two parts; each part of frons with 2+2 long setae along epicranial suture. Antenna claviform, long, reaching body ring 4 laterally. Antennomere 3=4=5>6=2>1&7 in length.
Collum: Slightly narrower than body ring 2, subtrapeziform; surface considerably rugose, with row of 3+3 setae in anterior half, and two additional rows of 1+1 knobs and 2+2 setiferous tubercles in posterior half. Paratergum small, with a setiferous incision laterally.
Body ring 3<4<2=5 in width, body parallel-sided on rings 5–16, thereafter gradually tapering towards telson. Prozona dull. Metaterga strongly rugose, with rows of 2+2 and 2+2 setiferous knobs in front of and behind transverse sulcus, respectively. Metatergal transverse sulcus broad, finely striate, and present on body rings 4–19, but fully developed (reaching base of paraterga) on body rings 5–19 (Fig. 3A). Pleura with dense microgranules. Pleurosternal keels well developed on body rings 2–7, reduced to small acute spines on body rings 8–11, and obliterated on body ring 12 and subsequent body rings. Axial line evident. Waist between pro- and metazona broad, finely striate.
Paraterga: Well developed, with two lateral setiferous incisions more obvious on poreless paraterga. Caudal corner acute, exceeding posterior contour of metaterga. Calluses largely reduced (Fig. 3A). Ozopores located on lateral side of paraterga of body rings 5, 7, 9–10, 12–13, 15–19.
Telson: Epiproct long, broadly truncated with two small terminal tubercles. Tip with four spinnerets. Hypoproct subtriangular, with two small distolateral setiferous knobs (Figs. 3B).
Sterna: Densely setose; transverse and longitudinal sutures poorly developed. Each sternum with four small projections near coxae (Fig. 3C); anterior pairs of projections slightly stronger and longer than posterior pairs. Male sternum 5 with a bifid lamina between coxae 4 (Fig. 3D).
Legs: Thin and slender, about 1.3 (male), 1.2 (female) times as long as midbody height. Tarsal brushes present on leg pairs 1–15, missing on subsequent leg pairs. Prefemora not swollen. Neither large nor micro tubercles present ventrally.
Gonopod (Figs. 3E,F, 4A,C): Coxite stout, slightly shorter than femorite; distoventral part densely setose. Prefemur densely setose, set off from femorite by an oblique sulcus laterally. Femorite slender, somewhat expanded distally and grooved mesally. Postfemoral region demarcated from femorite by an oblique suture laterally. Suboval lamina **l** and process **h** present, but spine **z** and both lobe **m, n** absent. Process **h** weakly twisted, as high as solenophore. Solenomere flagelliform, completely sheathed by modestly coiled solenomere.

Distribution. — Known only from the type locality (Fig. 18)

Tylopus roseiparaterga, new species
(Figs. 5, 6, 18)

Material examined. — Holotype: Male in the bottle **IEBR-97H**, with a label "Vinh Phuc Province, Tam Dao National Park (21°21'–21°42'N, 105°23'–105°44'E), forest, 900–1000 m a.s.l., coll. Nguyen Duc Anh & Jun-ichi Kojima, 15–18 Oct.2010".
Paratypes: 6 males, 1 female (**IEBR-97P**), same data as holotype.

Etymology. — "*roseiparaterga*", a noun in apposition, and emphasizes the pink paraterga.

Diagnosis. — The species can be distinguished from its congeners by the pink paraterga and by gonopod conformation: lamina **l** subtrapeziform; process **h** short, thin,

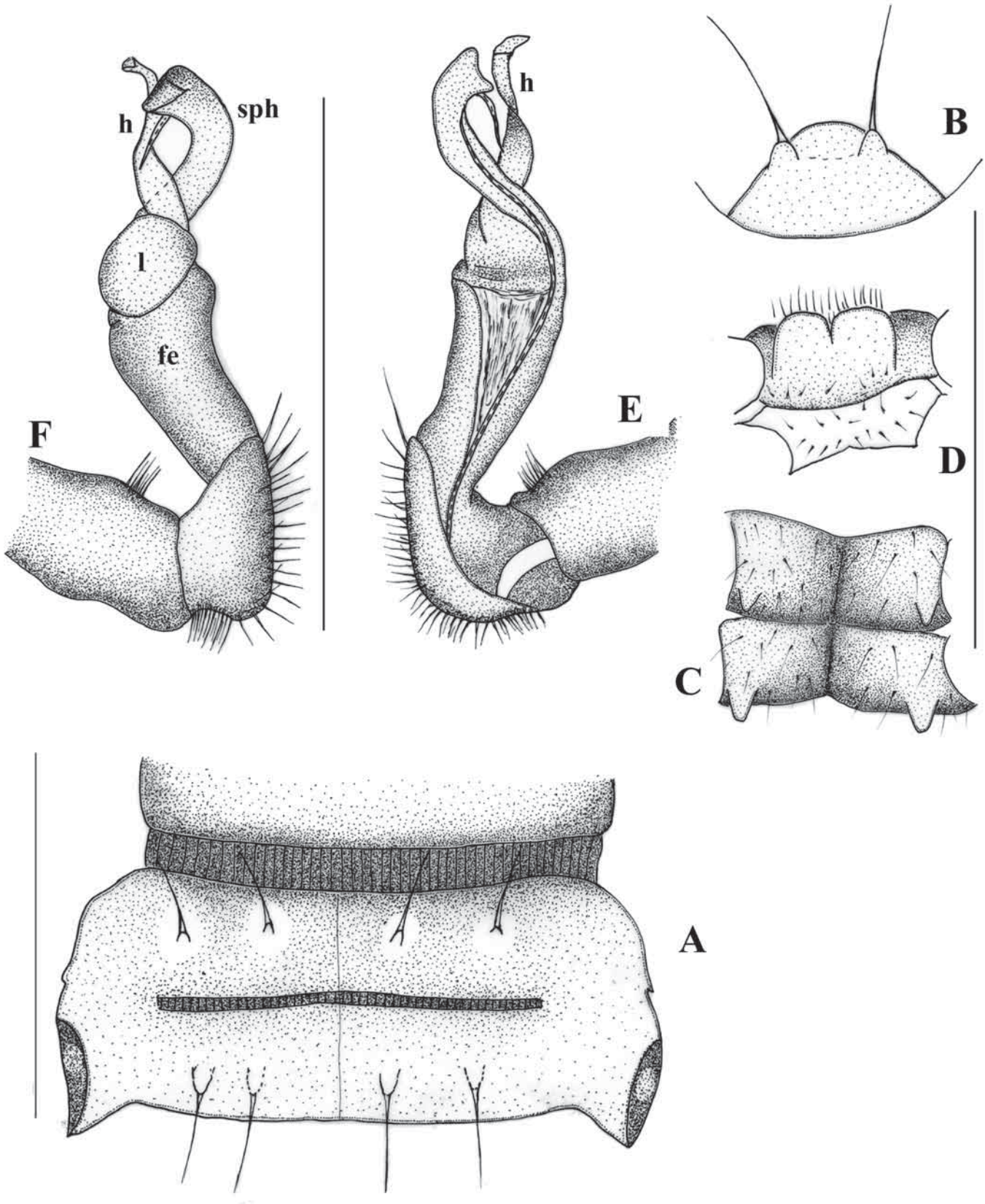

Fig. 3. *Tylopus spinisterna*, new species, holotype: body ring 10, dorsal view (A); hypoproct, ventral view (B); sternite X, ventral view (C); sternite 5, posterioventral view (D); left gonopod, mesal view (E) and lateral view (F). Scale bars = 1 mm.

finger-shaped; solenophore strongly coiled; lobe **m** present; lobe **n** and spine **z** absent.

Description. — Size: Body length 34–[36] mm (male), 30–31 mm (female). Width of prozona [2.6]–2.8 mm (male), 2.4–2.5 mm (female) and metazona 3.4–[3.5] mm (male), 3.2–3.3 mm (female).

Colouration: Prozona and metaterga with a median broad whitish-yellow stripe and two paramedian small brown regions. Paraterga pink (living specimens) or paler (preserved specimens). Pleura and distal podomeres brown. Sterna yellowish brown. Most antennomeres brown except for distal part of antennomere 6 and whole antennomere 7 blackish brown.

Head: Slightly broader than collum. Labrum densely setose. Epicranial suture thin, evident, dividing frons into two parts; each part with 2 setae along epicranial suture. Antenna claviform, long, reaching body ring 4 laterally. Antennomere 3>2=4=5>6>1&7 in length.

Collum: Slightly narrower than body ring 2; surface shining, more or less smooth, with two rows of 3+3 and 1+1 setae. Axial line evident. Paratergum very small, with a setiferous incision laterally.

Body ring 4<3<2=5 in width, body parallel-sided on rings 5-16, thereafter gradually tapering towards telson. Surface of metaterga 2–4 more or less smooth whereas other metaterga considerably rugose. Transverse sulcus narrow, concave, present on metaterga 4-19, but fully developed (reaching

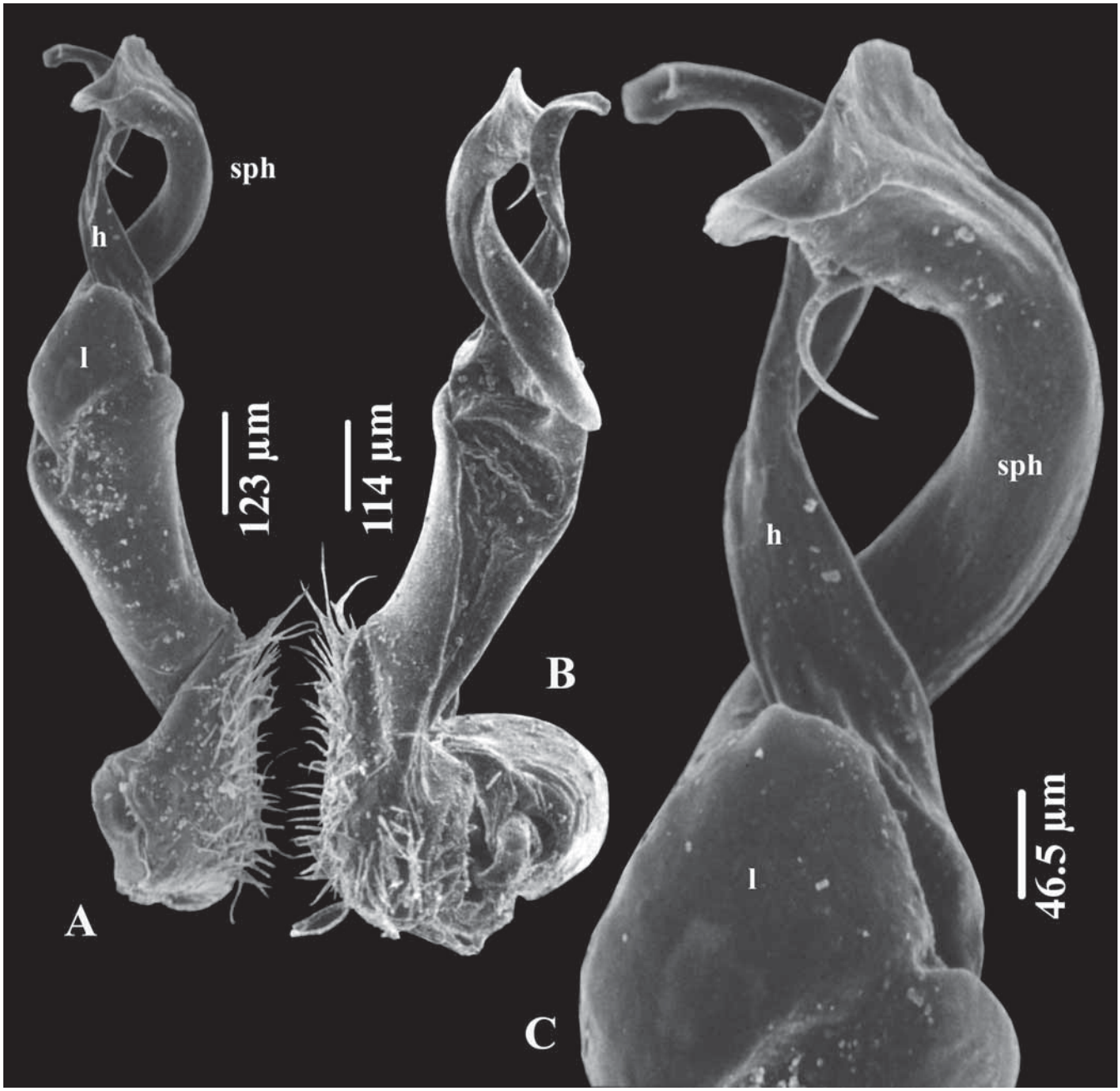

Fig. 4. *Tylopus spinisterna*, new species, holotype: left gonopod, lateral view (A) and submesal view (B); postfemoral region, lateral view (C).

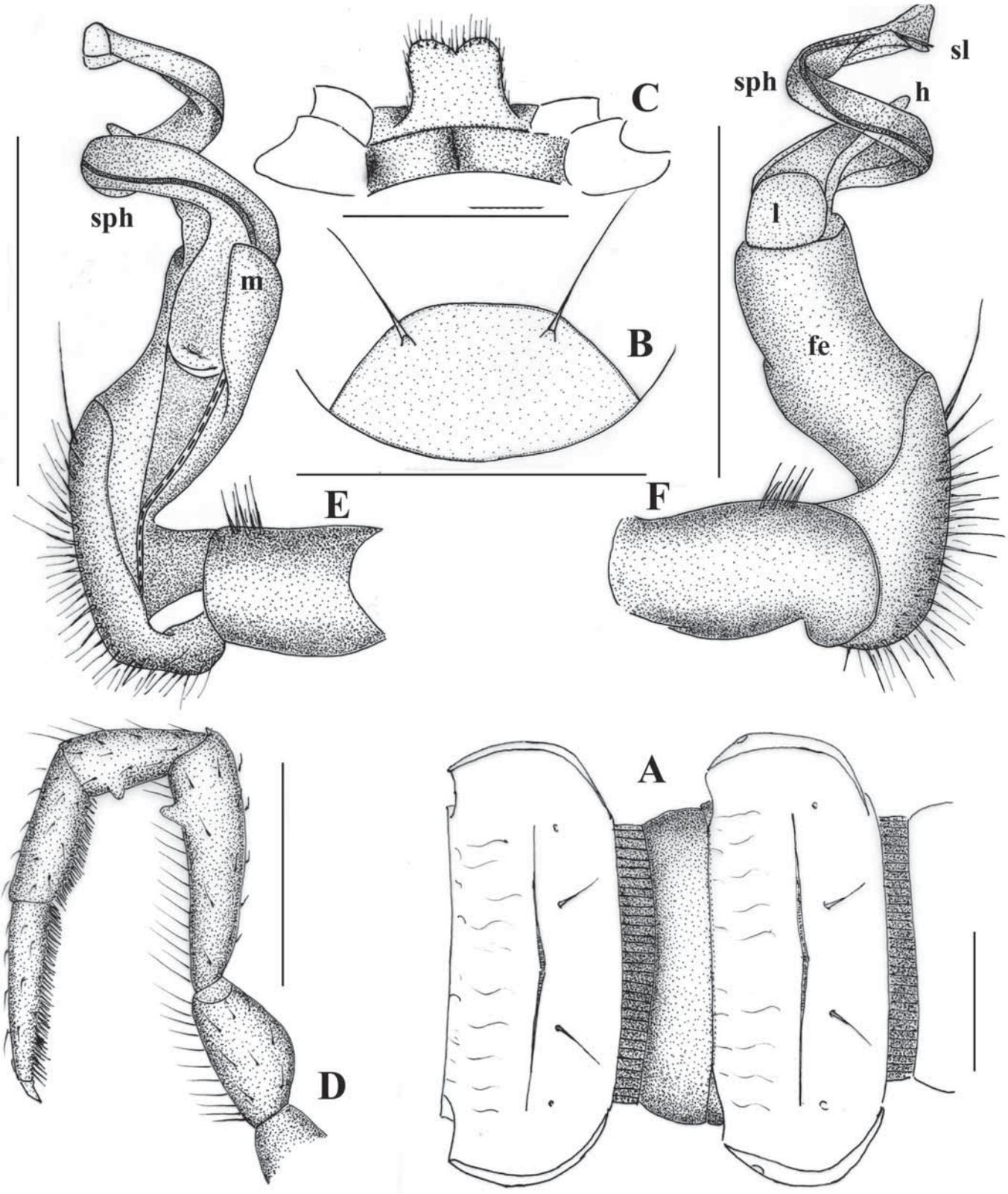

Fig. 5. *Tylopus roseiparaterga*, new species, holotype: body rings 10–11, dorsal view (A); hypoproct, ventral view (B); sternite 5, posterioventral view (C); legs 9, (D); left gonopod, mesal view (E) and lateral view (F). Scale bars = 1 mm.

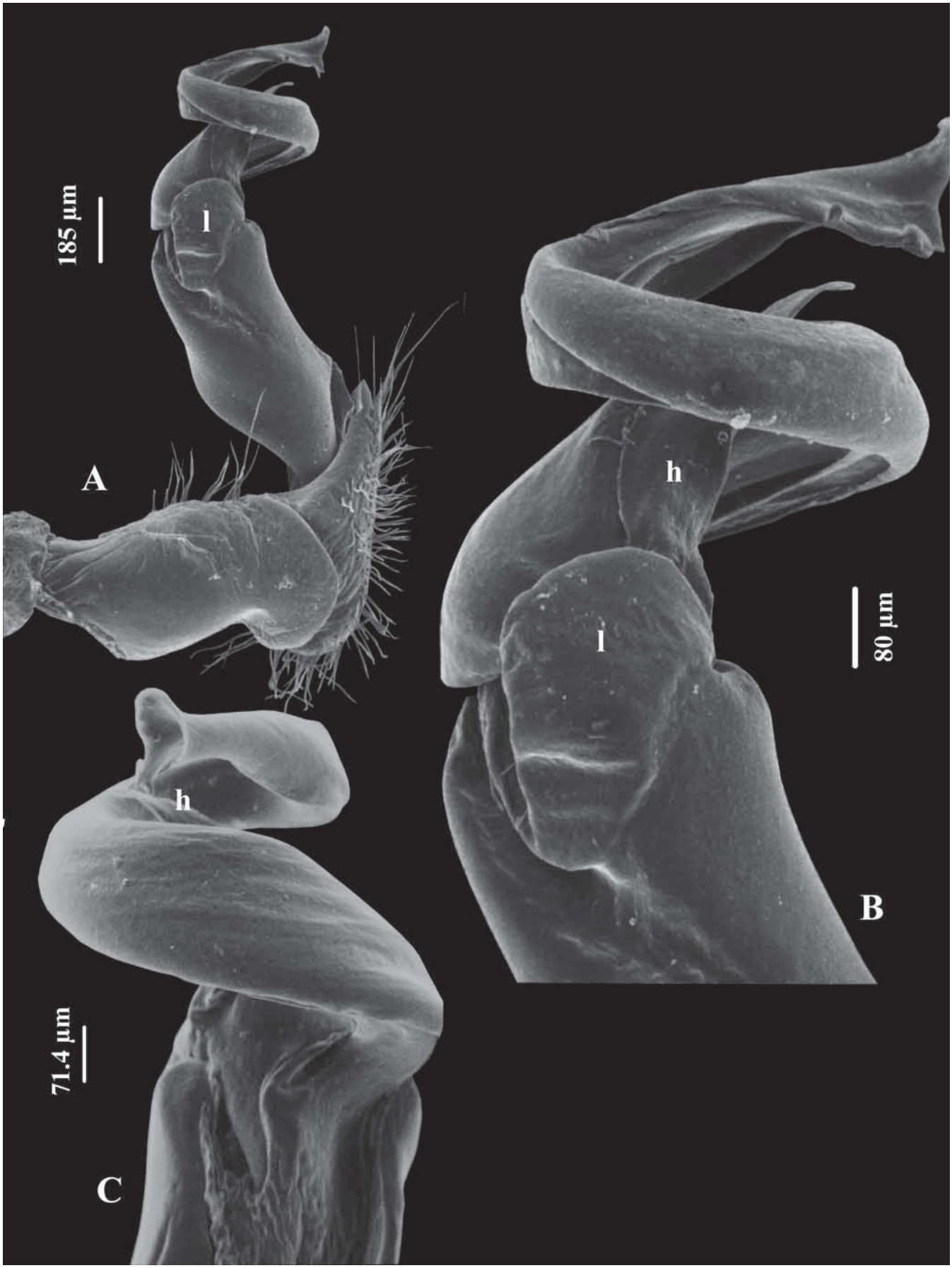

Fig. 6. *Tylopus roseiparaterga*, new species, holotype: left gonopod, lateral view (A); postfemoral region, lateral view (B) and submesal view (C).

base of paraterga) from metatergum 5. Anterior half of metaterga 2–19 with row of 2+2 setae (Fig. 5A). Axial line only evident in anterior half of metaterga. Waist between pro- and metazona broad, finely striate. Pleura with dense microgranules. Pleurosternal keels well developed on body rings 2–4, reduced as small caudal spine on body rings 5–9, and completely absent on subsequent body rings.
Paraterga: Well developed, slightly lower than metatergal surface. Caudal corner somewhat rounded on body rings 2–13, but gradually protruding, acute on body rings 14–19. Paraterga not surpassing posterior contour of metaterga 2–13, but surpassing posterior contour of metaterga 14–19. Calluses very small, somewhat reduced on poreless paraterga, but more developed on pore-bearing paraterga, with two traces of setiferous incisions laterally.
Telson: Epiproct long, truncated with two small terminal tubercles. Tip concave, with four spinnerets. Hypoproct subtrapeziform, with two small distolateral setiferous knobs (Fig. 5B).
Sterna: Sparsely setose, without any modifications; longitudinal and transverse sutures obvious. Male sternum 5 with a highly elevated, setiferous, bifid lamina between coxae 4 (Fig. 5C).
Legs: Thin and slender, about 1.3–1.4 times as long as midbody height. Prefemora not swollen. Ventral tubercles present on all legs. Tarsal brushes present on leg pairs 1–15, thinner on leg pairs 16–21 and absent on subsequent leg pairs. Ventral part of prefemora and femora with long setae (Fig. 5D).
Gonopod (Figs. 5E,F, 6A–C): Coxite cylindrical, slightly shorter than femorite; distoventral part sparsely setose. Prefemorite densely setose, set off from femorite by an oblique sulcus laterally. Femorite slender, slightly twisted, and demarcated from postfemoral region by a distinct transverse sulcus laterally. Lamina **l** present, subtrapeziform; spine **z** absent. Process **h** thin, short and finger-shaped. Lobe **m** moderate whereas lobe **n** absent. Solenophore completely sheathing solenomere and twisted twice.

Distribution. — Known only from the type locality (Fig. 18)

Tylopus golovatchi, new species
(Figs. 7, 8, 18)

Material examined. — Holotype: Male in a bottle **IEBR-141H** with a label "Phu Tho province, Xuan Son National Park (21°03'–21°12'N, 104°51'–105°01'E), primary forest, coll. Nguyen Van Quang, 15 Jan.2006".
Paratype: 1 female (**IEBR-141P**), collected together with holotype.

Etymology. — "*golovatchi*", named in honor of Dr. S. I. Golovatch, an outstanding specialist of millipedes for his major contribution to global myriapodology.

Diagnosis. — The species is very similar to *Tylopus strongylosomoides*, but it can be easily distinguished from the latter by the presence of a long, slender, finger-shaped process **h** on the gonopod.

Description. — Size: Body length about [17.9] mm (male), 21.3 mm (female). Width of midbody prozona [1.6] mm (male), 2.2 mm (female) and metazona [1.9] mm (male), 2.6 mm (female).
Colouration: Body generally yellowish brown except legs and sterna paler; whole antennomere 6 and 7 blackish brown. Prozona and metaterga with several small blackish brown areas. Female generally yellowish.
Head: Slightly broader than collum. Epicranial suture obviously distinct. Antenna claviform, reaching body ring 4 laterally. Antennomere 2=3>4=5>6>7 in length.
Collum: Slightly narrower than body ring 2, subtrapeziform; surface shining, finely rugulose, with traces of row of 2+2 setae near front margin. Paratergum poorly developed, rounded.
Body ring 3<4<2=5 in width, parallel-sided on body rings 5–17, thereafter gradually tapering towards telson. Prozona shining, somewhat smooth. Metatergal surface shining, finely rugose, with rows of 2+2 and 3+3 small knobs in front of and behind transverse sulcus, respectively. Transverse sulcus poorly-developed on body rings 2–4, but more distinct and well developed (reaching base of paraterga) on body rings 5–19. Pleura with dense microgranules. Pleurosternal keels well developed on body rings 2–4, beak-shaped on body rings 5–7, reduced on body rings 8–11, and completely absent on subsequent body rings. Waist between pro- and metazona broad, finely striate. Axial line evident.
Paraterga: Poorly developed, somewhat rounded, slightly lower than metatergal surface, not surpassing posterior contour of metaterga 2–17. Caudal corner rounded, neither pointed nor acute. Calluses minute, almost reduced, without any incision laterally. Ozopores located near caudal corner on lateral side of paraterga 5, 7, 9–10, 12–13, 15–19.
Telson: Epiproct short, broadly truncated without terminal tubercles. Tip with four spinnerets. Hypoproct somewhat parabolical, rounded with two distolateral setiferous knobs (Fig. 7A).
Sterna: Sparsely setose, without any modifications; longitudinal and transverse sutures obvious. Male sternum 5 with two tooth-shaped laminae and a pair of cones between coxae 4 (Fig. 7B).
Legs: Strong (male), thin (female), about 1.4 (male) and 1.3 (female) times as long as midbody height. Prefemora normal, not swollen. Ventral part with large tubercles. Tarsi without setose brushes.
Gonopod (Figs. 7C–E, 8A–D): coxite short, with sparsely setose part distoventrally. Prefemur densely setose, set off from femorite by an oblique sulcus laterally. Femorite enlarged distally, slightly twisted and grooved mesally, demarcated from postfemoral region by a V-shaped sulcus laterally. Lamina **l** subrectangular, concealing a long, slender, finger-shaped process **h**. Process **z**, lobes **m** and **n** absent. Solenophore strongly coiled, completely sheathing flagelliform solenomere. Tip of solenophore with process **k**.

Distribution. — Known only from the type locality (Fig. 18)

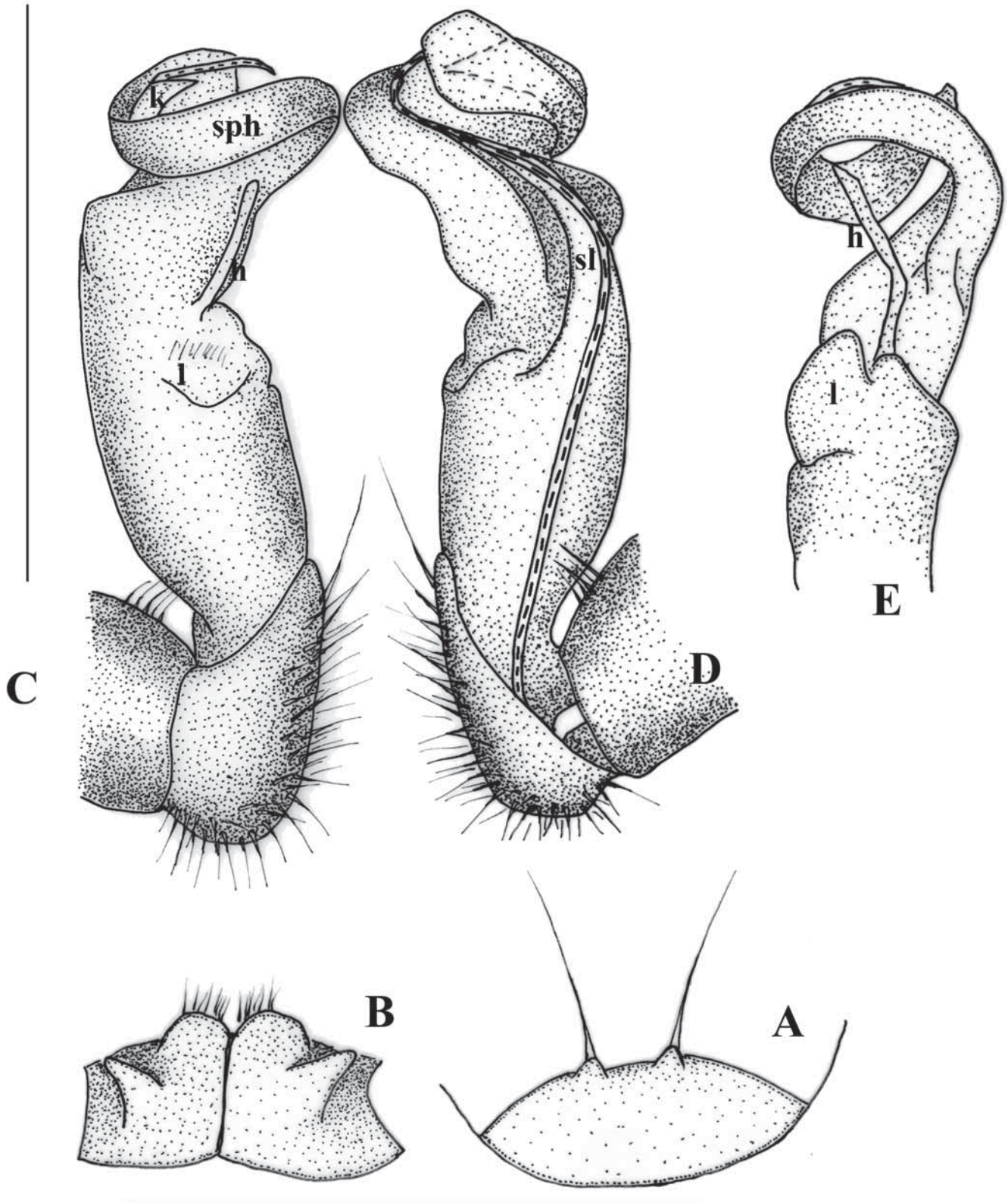

Fig. 7. *Tylopus golovatchi*, new species, holotype: hypoproct, ventral view (A); sternite 5, posterioventral view (B); left gonopod, lateral view (C), mesal view (D); postfemoral region, dorsal view (E). Scale bars = 1 mm.

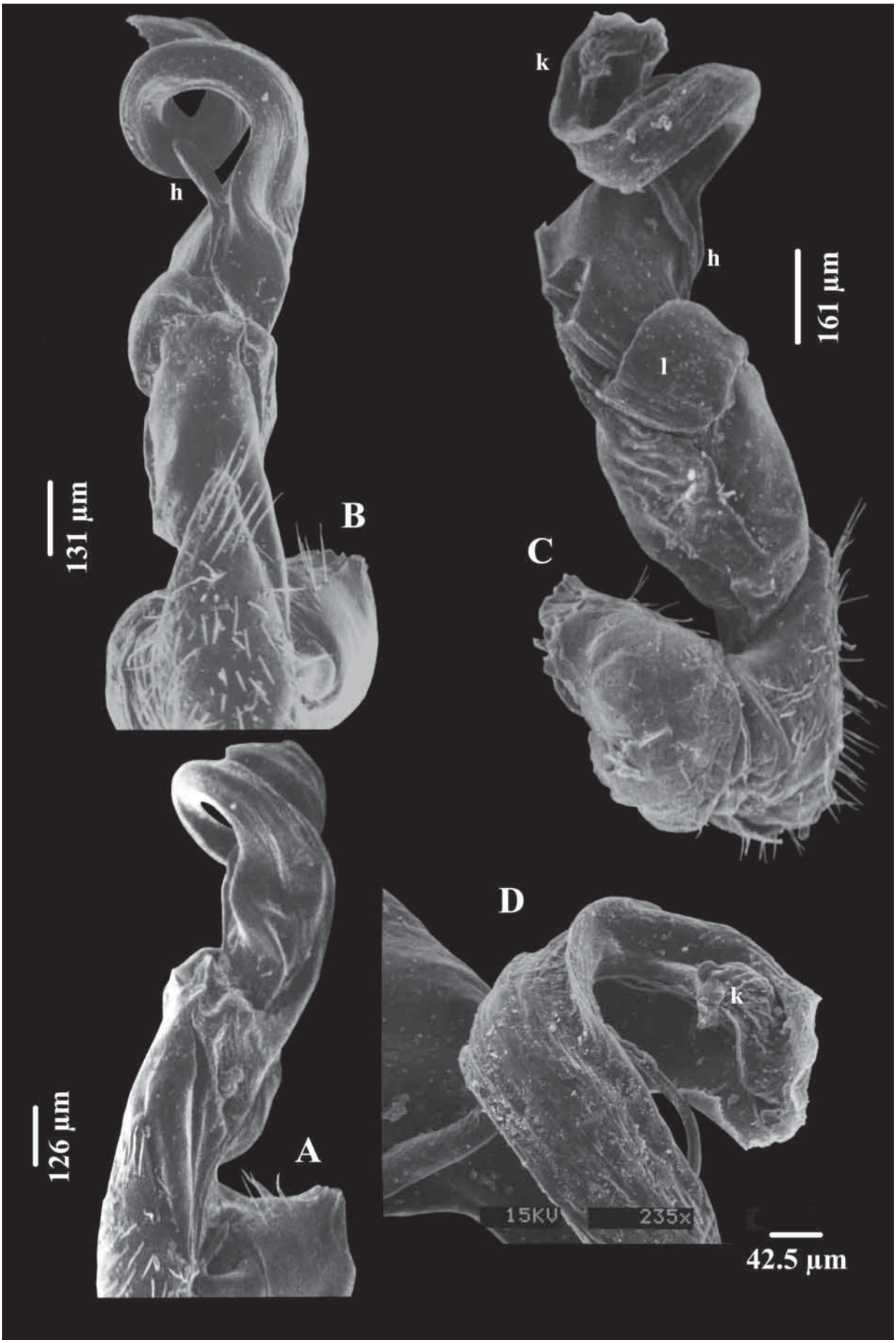

Fig. 8. *Tylopus golovatchi*, new species, holotype: left gonopod, mesal view (A), ventral view (B), and lateral view (C); postfemoral region, lateral view (D).

Tylopus sapaensis, new species
(Figs. 9, 10, 18)

Material examined. — Holotype: 1 male in the bottle **IEBR-93H** with a label "Lao Cai Province, Sa Pa, Hoang Lien National Park (22°08'–22°23'N, 103°45'–104°00'E), primary forest, 2000 m a.s.l., coll. Nguyen Duc Anh, 17 Jul.2007".
Paratypes: 2 males, 1 female (**IEBR-93P**), same collection data as holotype.

Etymology. — "*sapaensis*", an adjective to refer to the type locality.

Diagnosis. — This species is closely related to *Tylopus topali*, but differs from the latter in the larger body size of a mature individual, the setal formula on the metaterga, the prefemur and femorite of legs with microtubercles, and the gonopod process **h** shorter than spine **z**.

Description. — Size: Body length 29–[30] mm (male), 31–33 mm (female). Width of prozona 2.2–[2.3] mm (male), 2.3–2.9 mm (female) and metazona 3.0–[3.2] mm (male), 3.2–4.0 mm (female).
Colouration: Body castaneous brown or reddish brown, but prozona and pleura somewhat paler. Legs and antenna brownish yellow. Distal part of antennomere 6 and whole antennomere 7 blackish brown.
Head: Slightly broader than collum; labrum setose, supralabral parts less setose. Epicranial suture thin, distinct and dividing slightly convex frons into two parts; each part with 2 setae along epicranial suture. Antenna claviform, reaching body ring 4 laterally. Antennomere 2=3=4=5=6>7&1 in length.
Collum: Slightly narrower than body ring 2, subtrapeziform. Surface somewhat smooth, shining, with two rows of 3+3 and 1(2)+1(2) setae. Axial line evident. Paratergum poorly developed, rounded with a setiferous incision laterally.
Body ring 4<3<2=5 in width, body parallel-sided on rings 5–16, thereafter gradually tapering towards telson. Metaterga 2–4 shining, somewhat smooth, without rugosity, but with a row of 2+2 setae on front half. Metaterga 5–18 shining, rugulose, especially on posteriormost body rings. Transverse sulcus present on metaterga 5–19, reaching base of paraterga on metaterga 7–19. Metaterga 5–17 with rows of 2+2 and 2+2 setae in front of and behind transverse sulcus, respectively. Metaterga 18–19 also with rows of 3+3 and 4+4 setae in front of and behind transverse sulcus, respectively. Axial line traceable. Waist between pro- and metazona deep, finely striate. Pleura with dense microgranules. Pleurosternal keels well developed on body rings 2–4, reduced as long caudal spine on body rings 4–15, completely absent on subsequent body rings (Fig. 9A).
Paraterga (Fig. 9A): Well-developed, slightly lower than metatergal surface. Caudal corner acute on body rings 2–5, beak-like on subsequent body rings, especially more protruding and pointed on body rings 13–19. Paraterga not surpassing posterior contour on body rings 2–12, but exceeding posterior contour on body rings 13–19. Calluses with one or two traces of setiferous incision on poreless or pore-bearing paraterga. Ozopores located on lateral side of paraterga 5, 7, 9–10, 12–13, 15–19.
Telson: Epiproct short, broadly truncated with two small terminal tubercles. Tip concave, with four spinnerets. Hypoproct trapeziform, with two small distolateral setiferous knobs (Fig. 9B).
Sterna: Male sterna sparsely setose; longitudinal suture faint, indistinct whereas transverse suture obviously visible. Sterna without any modification except for sternum 5 with a setiferous emarginated bifid trapeziform lamina between coxae 4 (Fig. 9C).
Legs: Slightly slender, about 1.5–1.7 times as long as midbody height, without tarsal brushes. Prefemora swollen. Ventral part of prefemora, femora densely setose and with dense microtubercles, but without larger tubercles.
Gonopod (Figs. 9D,E, 10A–D): Coxite cylindrical, long, subequal to femorite in length; distoventral part densely setose. Prefemur densely setose, and set off from femorite by an oblique sulcus. Femorite strong, grooved mesally, weakly constricted in middle, and enlarged distally, well demarcated from lamina **l** by a parabolically rounded sulcus laterally. Lamina **l** well developed, distal part produced into an erect, long spine **s**. Process **h** erect, shorter than spine **s**. Lobes **m** present, small whereas lobe **n** absent. Solenophore strongly coiled, completely sheathing flagelliform solenomere. Tip of solenophore pointed.

Distribution. — Known only from the type locality (Fig. 18)

Tylopus hilaris (Attems, 1937)
(Figs. 11, 12, 18)

Anoplodesmus hilaris Attems, 1937: 105–106, Fig. 136; Attems, 1938: 215, Figs. 29–41
Agnesia hilaris:— Jeekel, 1965: 98
Tylopus hilaris:— Jeekel, 1968: 60; Enghoff, Golovatch & Nguyen, 2004: 40

Material examined. — 1 male, (**IEBR-57**), Thua Thien Hue Province, Bach Ma National Park (16°05'–16°16'N, 107°43'–107°53'E), 14 Aug.2005; 1 male, 1 female, (**IEBR-55**), Kon Tum Province, Ngoc Linh Mountain (15°00'–15°18'N, 107°41'–08°01'E), primary forest, 1800–1900 m a.s.l., coll. Nguyen Duc Anh, 21 Mar.2006 – 9 Apr.2006.

Remarks. — The specimens examined here more or less agree well with the original description, but they differ in the following minor details: the body is smaller (width of prozona 3.2 mm and metazona 4.2 mm vs. 3.4 mm and 5.0 mm in the original description); pleurosternal keels are present on the body rings 2–6.

Tylopus nodulipes (Attems, 1953)
(Figs. 13, 18)

Agnesia nodulipes Attems, 1953: 174, Figs. 70–74; Jeekel, 1965: 98
Tylopus nodulipes:— Jeekel, 1968: 60; Golovatch, 1984: 70, Fig. 27; Golovatch & Enghoff, 1993: 106, Figs. 71–74; Enghoff, Golovatch & Nguyen, 2004: 40

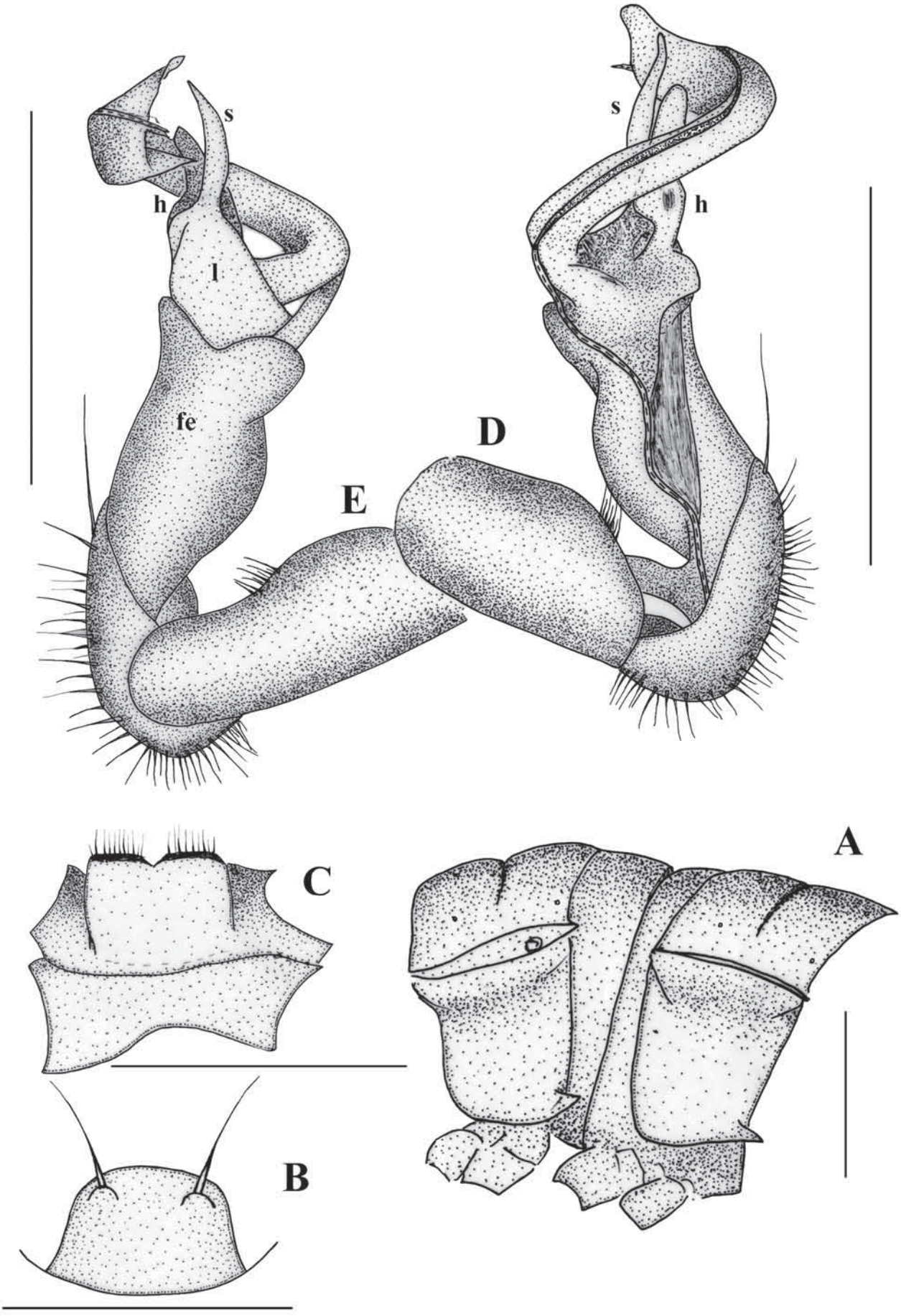

Fig. 9. *Tylopus sapaensis*, new species, holotype: body rings 10–11, lateral view (A), hypoproct, ventral view (B); sternite 5, posterioventral view (C); right gonopod, mesal view (D) and lateral view (E). Scale bars = 1 mm.

Material examined. — 1 male, 2 females (**IEBR-91**), Lao Cai Province, Van Ban District, Nam Xay commune (22°05'N, 104°05'E), primary forest, 1000 m a.s.l., coll. Nguyen Duc Anh, 31 Mar.2005 – 15 Apr.2005; 1 male (**IEBR-104**), Ha Tinh Province, Huong Son District, Son Tay commune, secondary forest, 600 m a.s.l., coll. Nguyen Duc Anh, 3 May 2004; 4 males, 5 females (**IEBR-105**), Ha Tinh Province, Huong Son District, Son Tay commune, secondary forest, 600 m a.s.l., coll. Nguyen Duc Anh, 25 May 2004; 2 males, 2 females (**IEBR-153**), Nghe An Province, Pu Mat National Park (18°46'–19°12'N, 104°24'–104°56'E), Chem Waterfall, secondary forest, 430 m a.s.l, coll. Nguyen Duc Anh, 4–10 Apr.2011; 1 male, 1 female (**IEBR-154**), same date as sample IEBR-153.

Remarks. — The specimens examined agree well with the original description, but their body is larger (metazonal width 3.3-3.7 mm vs. 3.0 mm in the original description). *T.*

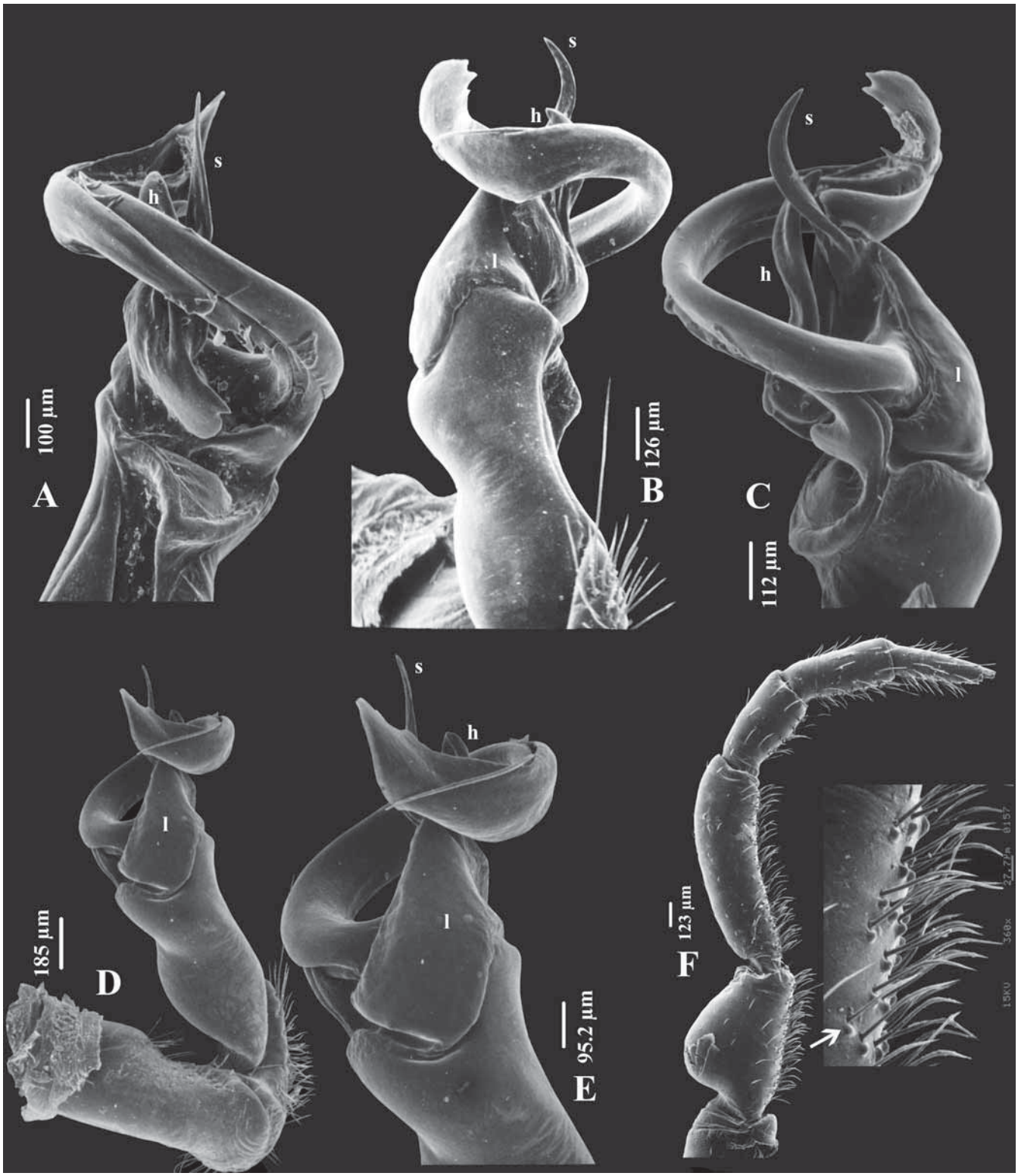

Fig. 10. *Tylopus sapaensis*, new species, holotype: left gonopod, mesal view (A), lateroventral view (B), dorsal view (C), and lateral view (D, E); Leg 9 (F).

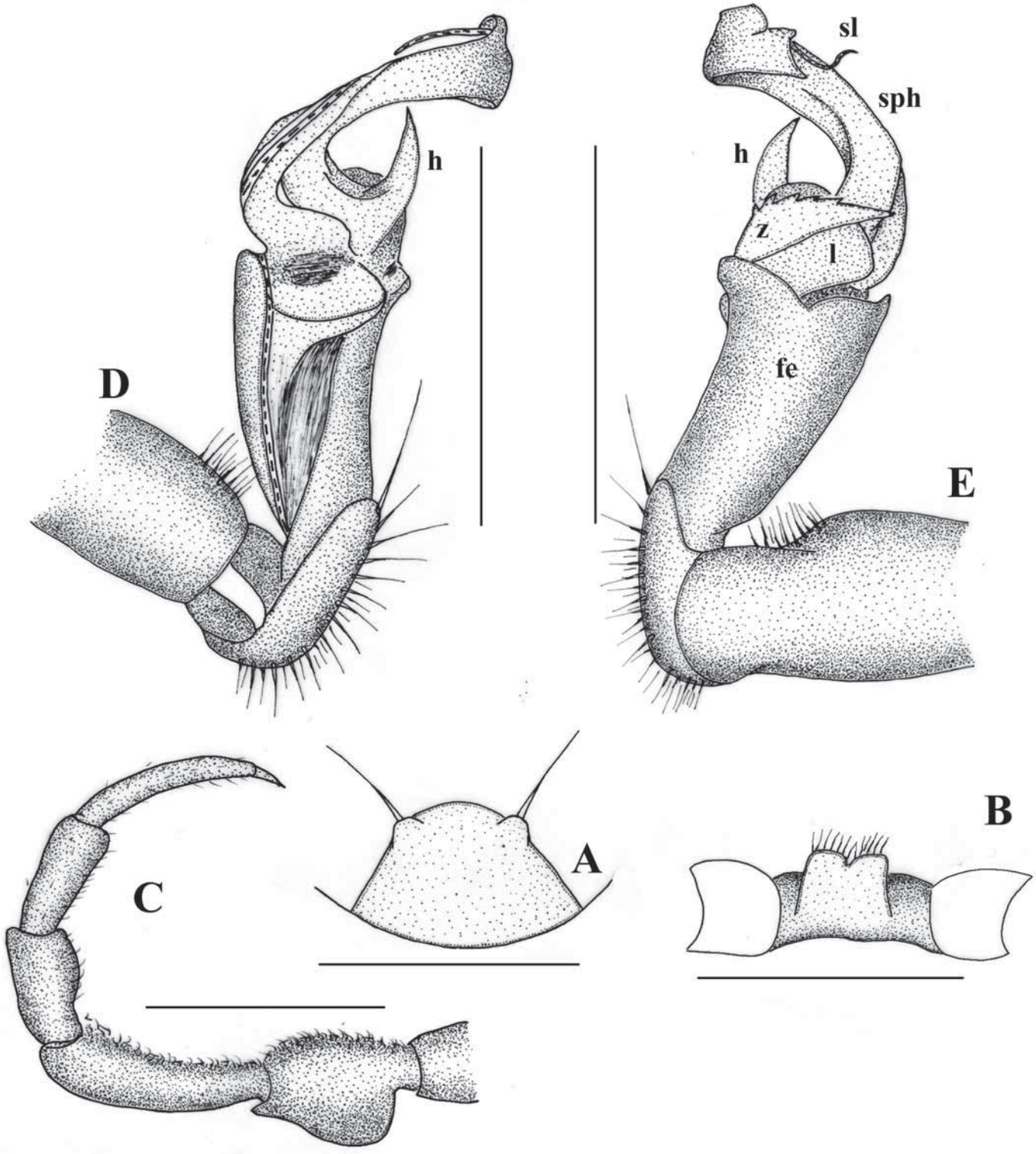

Fig. 11. *Tylopus hilaris* (Attems, 1937) from Ngoc Linh Mt.: hypoproct, ventral view (A); sternite 5, posterioventral view (B); leg 9 (C); right gonopod, mesal view (D) and lateral view (E). Scale bars = 1 mm.

nodulipes has been known from Luong Prabang (Laos) and Fanxifan Mt. (Vietnam) (Attems, 1953), and the new records presented here suggest that this species is distributed widely in the northern part of Vietnam.

Tylopus crassipes Golovatch, 1984
(Figs. 14, 18)

Tylopus crassipes Golovatch, 1984: 62, Figs. 14–16; Enghoff, Golovatch & Nguyen, 2004: 40

Material examined. — 10 males **(IEBR-92)**, Lao Cai Province, Van Ban District, Nam Xay commune (22°05'N, 104°05'E), bamboo forest, coll. Nguyen Duc Anh, 27 Mar.2005 – 15 Apr.2005; 11 males, 17 females (**IEBR-95**) Lao Cai Province, Sa Pa, Hoang Lien National Park (22°08'–22°23'N, 103°45'–104°00'E), primary forest, 2000 m a.s.l., coll. Nguyen Duc Anh, 20 Nov.2005 – 15 Dec.2005.

Remarks. — Van Ban District (**new record**) is about 40 km south-east of the type locality of this species (Sa Pa).

Tylopus strongylosomoides (Korsós & Golovatch, 1989)
(Figs. 15, 18)

Paratylopus strongylosomoides Korsós & Golovatch, 1989: 215, Figs. 6–10
Tylopus strongylosomoides:— Golovatch & Enghoff, 1993: 90; Enghoff, Golovatch & Nguyen, 2004: 40

Material examined. — 1 male (**IEBR-127**), Phu Tho Province, Xuan Son National Park (NP) (21°03'–21°12'N, 104°51'–105°01'E), primary forest, coll. Nguyen Van Quang, 15 Jan.2006.

Remarks. — This species was described from Tam Dao NP under *Paratylopus* Korsós & Golovatch, 1989, which was

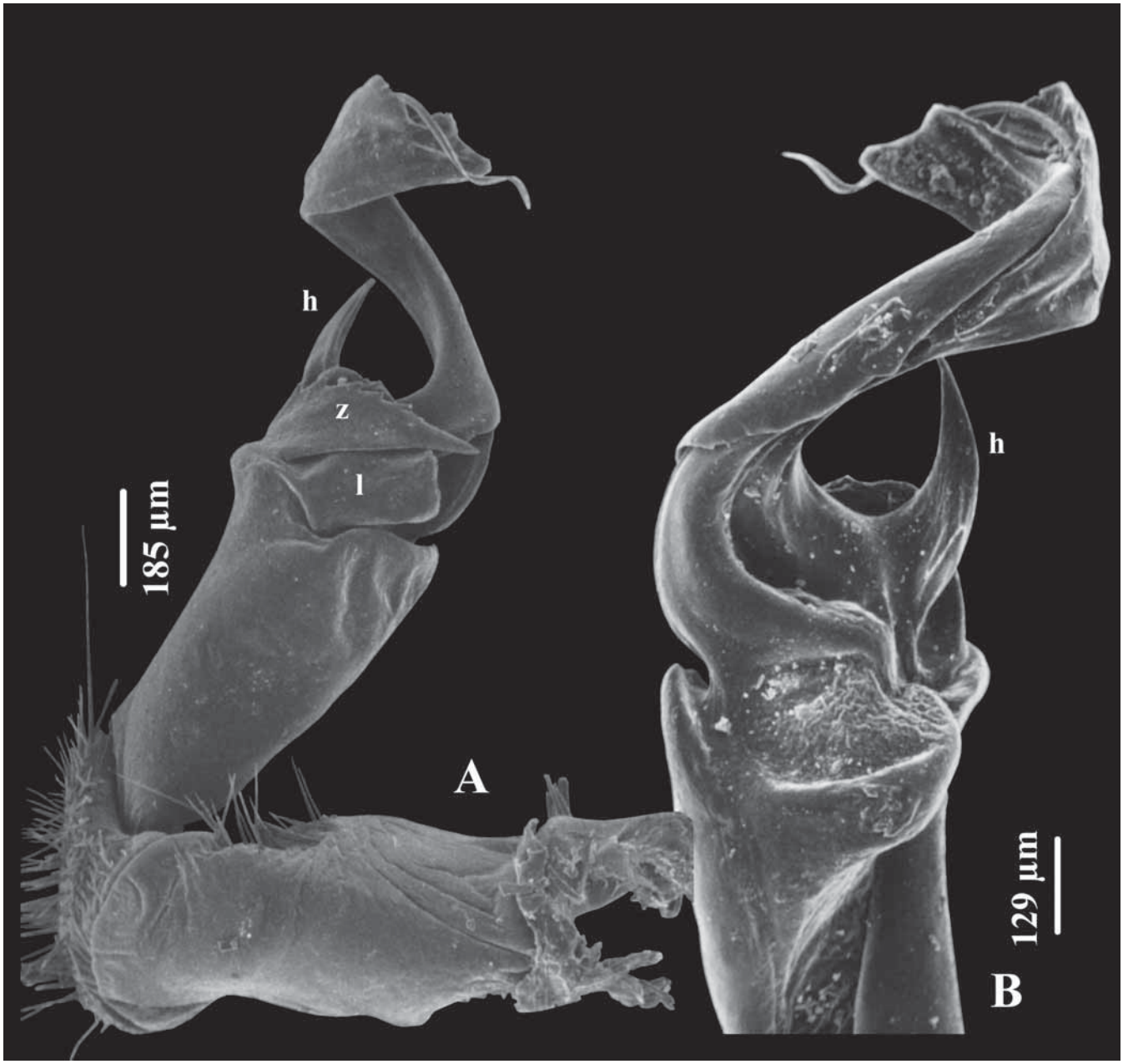

Fig. 12. *Tylopus hilaris* (Attems, 1937) from Ngoc Linh Mt.: right gonopod, lateral view (**A**) and mesal view (**B**).

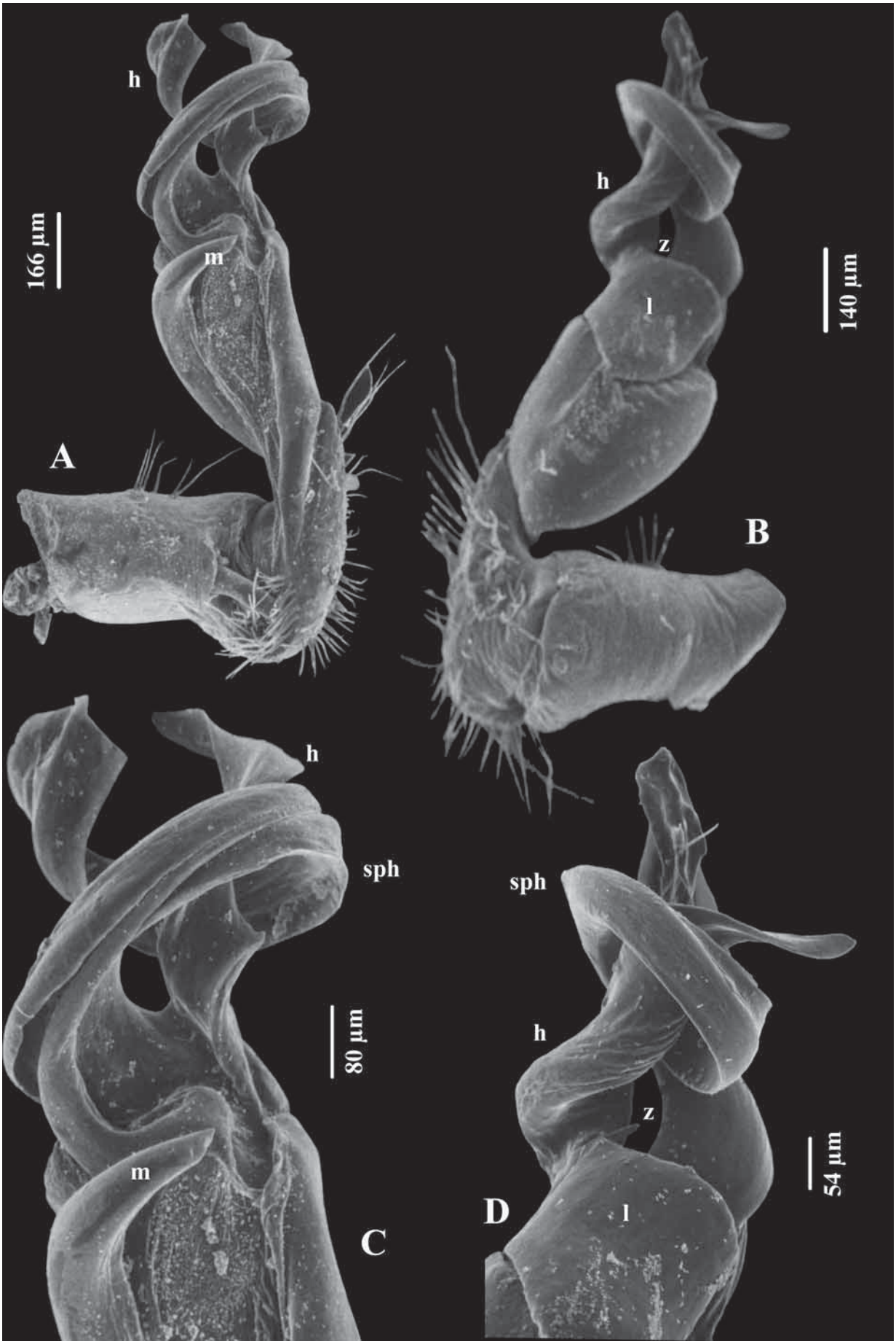

Fig. 13. *Tylopus nodulipes* (Attems, 1953) from Van Ban Distr., Lao Cai: right gonopod, mesal view (A) and lateral view (B); postfemoral region, mesal view (C) and lateral view (D).

later synonymized with *Tylopus* Jeekel, 1968 by Golovatch & Enghoff (1993). Xuan Son NP (**new record**) is about 80 km west of the type locality of this species.

Remarks. — Xuan Son NP (**new record**) is about 160 km north-west of the type locality of this species (Cuc Phuong NP).

Tylopus procurvus Golovatch, 1984
(Figs. 16, 18)

Tylopus procurvus Golovatch, 1984: 64, Figs. 17–19; Enghoff, Golovatch & Nguyen, 2004: 40

Material examined. — 3 males, 1 female (**IEBR-94**), Lao Cai Province, Sa Pa, Hoang Lien National Park (22°08'–22°23'N, 103°45'–104°00'E), primary forest, 2000 m a.s.l., coll. Nguyen Duc Anh, 17 Jul.2007.

Remarks. — To date, this species has been known only from its type locality: Sa Pa (Lao Cai Province).

Tylopus hilaroides Golovatch, 1984
(Fig. 18)

Tylopus hilaroides Golovatch, 1984: 58, figs. 7-8; Golovatch & Enghoff, 1993: 121; Enghoff, Golovatch & Nguyen, 2004: 40

Material examined. — 2 males, 2 females (**IEBR-5**), Ninh Binh Province, Cuc Phuong National Park (20°14' - 20°24'N, 105°29' - 105°44'E), Dang to Dang, forest, coll. Luu Van Hien, May 2006.

Remarks. – To date, this species has been known only from its type locality: Cuc Phuong National Park (Ninh Binh Province)

Tylopus topali Golovatch, 1984
(Figs. 17, 18)

Tylopus topali Golovatch, 1984: 65, Figs. 20–23; Enghoff, Golovatch & Nguyen, 2004: 40

Material examined. — 2 males, 1 female (**IEBR-159**), Phu Tho Province, Xuan Son National Park (21°03'–21°12'N, 104°51'–105°01'E), forest, 500 m a.s.l., coll. Nguyen Thi Phuong Lien, 15–16 Jun.2006; 1 male, 1 female (**IEBR-482**), Ninh Binh Province, Cuc Phuong National Park (20°14'–20°24'N, 105°29'–105°44'E), forest, coll. Luu Van Hien, 30 Apr.2006 – 1 May 2006.

Tylopus tamdaoensis Korsós & Golovatch, 1989
(Fig. 18)

Tylopus tamdaoensis Korsós & Golovatch, 1989: 212, Figs. 1–5; Enghoff, Golovatch & Nguyen, 2004: 40

Material examined. — 4 males (**IEBR-473**), Vinh Phuc Province, Tam Dao National Park (21°21'–21°42'N, 105°23'–105°44'E), forest around the town, 900–1000 m a.s.l., coll. Hoang Long, May 2011.

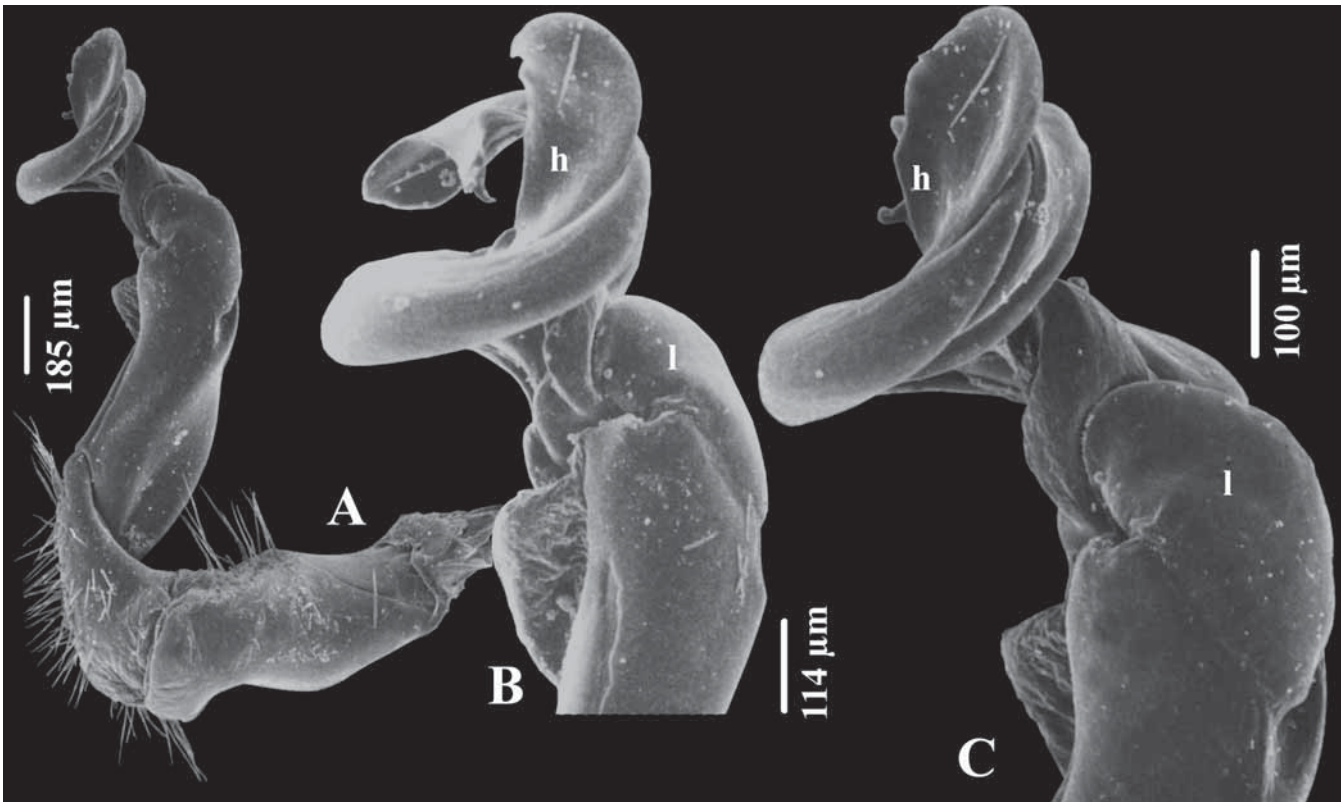

Fig. 14. *Tylopus crassipes* Golovatch, 1984: right gonopod, lateral view (A); postfemoral region, sublateral view (B) and lateral view (C).

Remarks. — To date, this species has been known only from its type locality: Tam Dao National Park (Vinh Phuc Province).

Key to *Tylopus* species known from Vietnam (male)

This key was made based on examined material and literature (Attems, 1937, 1953; Golovatch, 1984; Korsós & Golovatch, 1989; Golovatch & Enghoff, 1993; Likhitrakarn et al., 2010).

1. Sterna except sternum 5 without any modifications **2**
– All sterna with modifications **17**
2. Sternum 5 with more than two processes between coxae 4. Tip of gonopod with process **k** (Figs. 8D, 15B) **3**
– Sternum 5 with one or two processes between coxae 4. Tip of gonopod without process **k** **4**
3. Both gonopod process **h** and spine **z** absent (Fig. 15). .... *T. strongylosomoides* (Korsós & Golovatch, 1989)
– Gonopod process **h** present, thin, long and finger-shaped; spine **z** absent (Figs. 7C,D, 8A–D) ..... *T. golovatchi*, new species
4. Paraterga pink. Metatergal surface smooth. Gonopod process **h** present, short; process **z** absent (Figs. 5E,F, 6A–C) .... *T. roseiparaterga*, new species
– Paraterga not pink. Metatergal surface rugulose or rugose. Gonopod process **h** present; spine **z** present or absent **5**
5. Gonopod spine **z** present **6**
– Gonopod spine **z** absent **13**
6. Gonopod spine **z** strong, horizontal, coarsely serrated along distal margin **7**
– Gonopod spine **z** erect or bent mesad, not serrated along distal margin **9**
7. Spine **z** only coarsely serrated along 2/3 distal margin. Process **h** short, hook-shaped or strongly spiniform (Figs. 11D,E, 12A,B) **8**

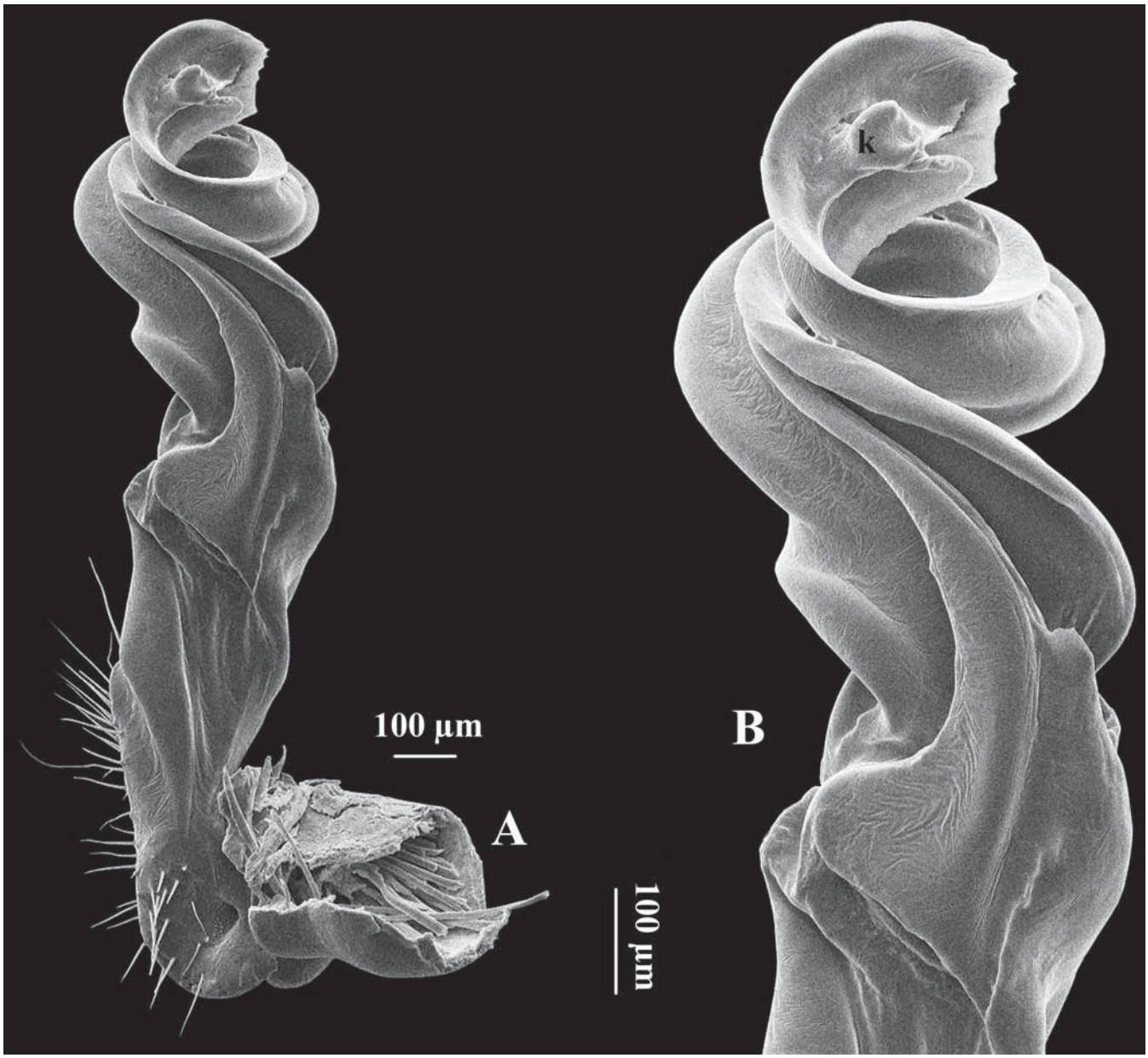

Fig. 15. *Tylopus strongylosomoides* (Korsós & Golovatch, 1989): left gonopod, mesal view (A); postfemoral region, lateral view (B).

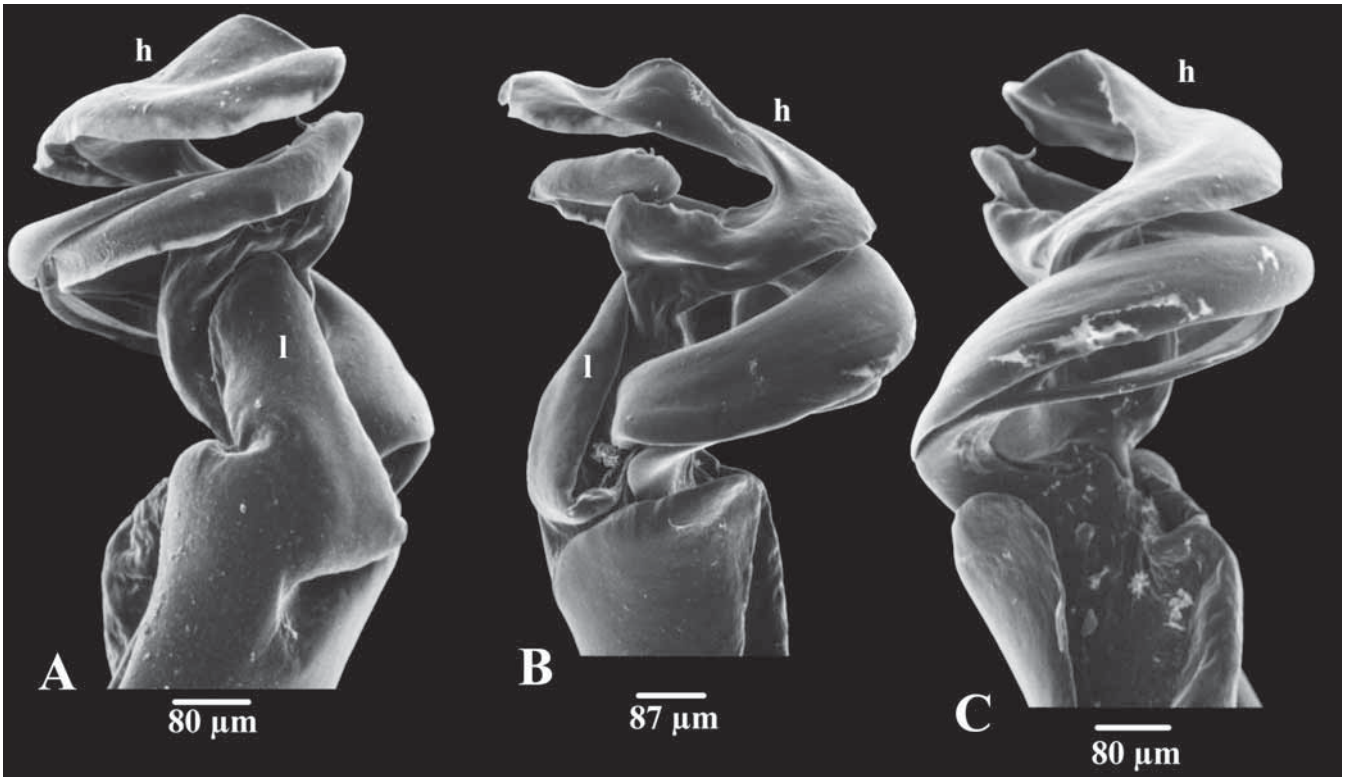

Fig. 16. *Tylopus procurvus* Golovatch, 1984: right gonopod, postfemoral region, lateral view (A), dorsal view (B), and mesal view (C).

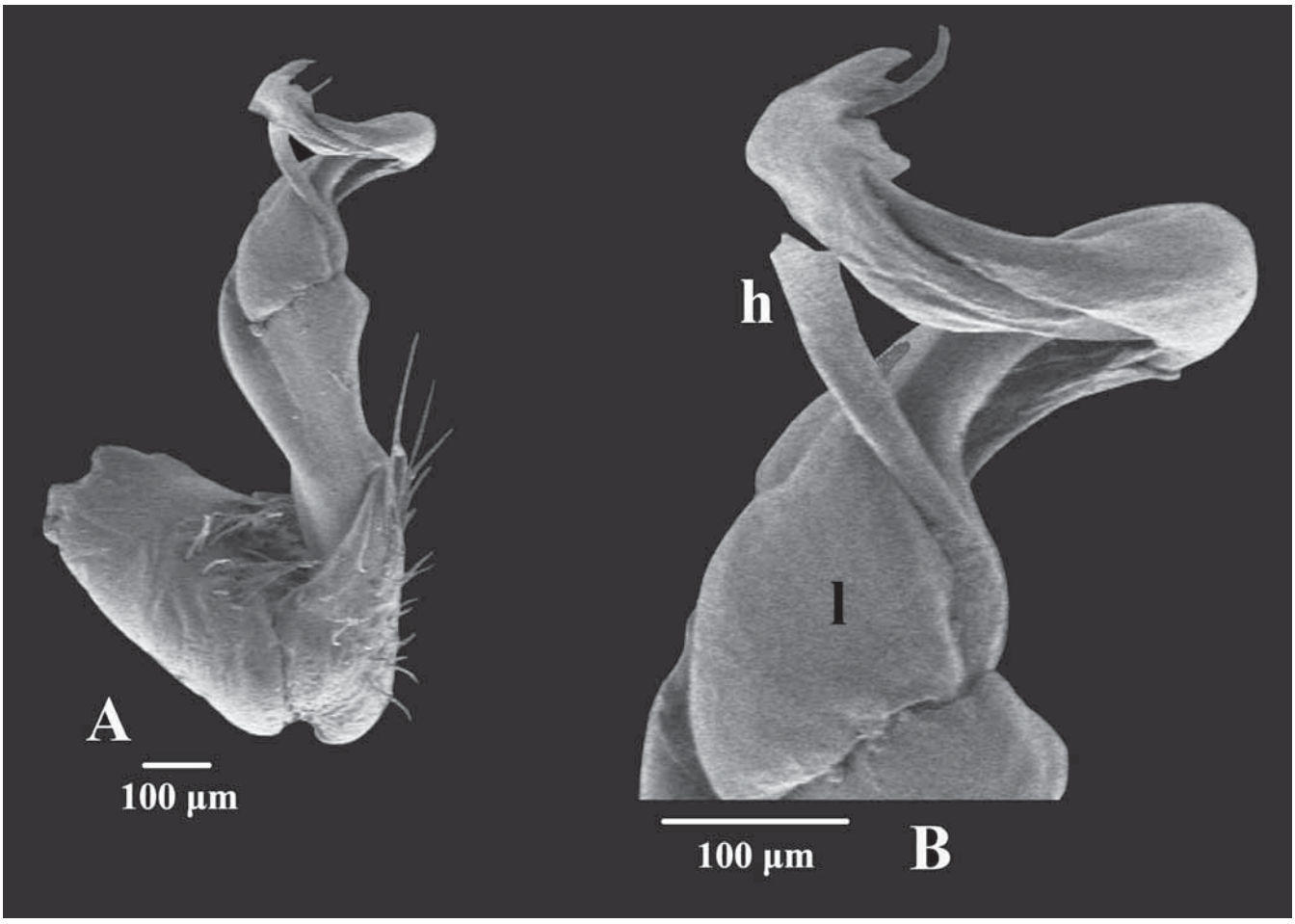

Fig. 17. *Tylopus topali* Golovatch, 1984: right gonopod, sublateral view (A); postfemoral region, sublateral view (B).

– Spine **z** coarsely serrated along whole distal margin. Process **h** with two branches, one spiniform, the other a serrated lamina (Figs. 1E,F, 2A,B) ..... *T. phanluongi*, new species

8. Metatergal transverse sulcus present from body ring 5. Metatergum 18 with only a single row of 2+2 setae on anterior half. (North Vietnam) ..... *T. hilaroides* Golovatch, 1984
– Metaterga transverse sulcus present from body ring 4. Metatergum 18 with two transverse rows of setae: 2+2 before and 3+3 after sulcus (southern part of Central Vietnam) .... *T. hilaris* (Attems, 1937)
9. Gonopod with three more or less spiny processes including process **h** and spine **z** near base of lamina **l**. Male legs without tubercles ..... *T. mutilatus* (Attems, 1953)
– Gonopod with only process **h** and spine **z** near base of lamina **l**. Male legs with or without tubercles **10**
10. Gonopod lamina **l** normal. Spine **z** very small, dentiform. Process **h** large, lamellate, sigmoid **11**
– Gonopod lamina **l** well-developed, distal part produced into long, erect spine **z**. Process **h** erect, spiniform without evidence of torsion **12**
11 Spine **z** bent mesad. Lobe **m** strongly developed, spiniform (Fig. 13) ..... *T. nodulipes* (Attems, 1953)
– Spine **z** normal. Lobe **m** modestly developed, somewhat lamellate, not spiniform ..... *T. granulatus* Golovatch, 1984
12. Body shorter than 20 mm. Large tubercles present on male legs, especially femora 6, 9 and 10 with proximal finger-shaped tubercles crowned with a bunch of setae. Gonopod process **h** obviously longer than spine **z** (Fig. 17A,B) .... *T. topali* Golovatch, 1984

Fig. 18. Distribution map of the millipede genus *Tylopus* Jeekel, 1968 in Vietnam. 1: **Sa Pa, Lao Cai Prov.** (*T. crassipes*, *T. procurvus*, *T. nodulipes*, *T. sigma*, *T. sapaensis*, *T. maculatus*, *T. magnicus*); 2: **Van Ban, Lao Cai Prov.** (*T. crassipes*, *T. nodulipes*); 3: **Xuan Son NP** (*T. strongylosomoides*, *T. golovatchi*); 4: **Tam Dao NP** (*T. tamdaoensis*, *T. roseiparaterga*, *T. strongylosomoides*); 5: **Cuc Phuong NP** (*T. granulatus*, *T. hilaroides*, *T. topali*); 6: **Pu Mat NP** (*T. nodulipes*); 7: **Huong Son, Ha Tinh prov.** (*T. nodulipes*); 8: **Bach Ma–Ba Na NP** (*T. hilaris*, *T. multilatus*); 9: **Ngoc Linh Mts., Kon Tum prov.** (*T. hilaris*, *T. phanluongi*); 10: **Bi Doup–Nui Ba NP** (*T. spinisterna*).

– Body longer than 20 mm. Microtubercles present on male legs (Fig. 10F). Femora 6, 9, 10 without tubercles crowned with a bunch of setae. Gonopod process **h** obviously shorter than spine **z** (Figs. 9D,E, 10A–E) ..... *T. sapaensis*, new species

13. Metatergal transverse sulcus present from body ring 4, but fully developed and reaching base of paraterga from body ring 5 ..... **14**
– Metatergal transverse sulcus present from body ring 5 ..... **15**
14. Process **h** with an outgrowth at middle (Fig. 16) .... *T. procurvus* Golovatch, 1984
– Process **h** without an outgrowth at middle (Fig. 14) .... *T. crassipes* Golovatch, 1984
15. Body small, width < 1.6 mm. Gonopod process **h** short, spiniform ..... *T. sigma* (Attems, 1953)
– Body large, width > 1.6 mm. Gonopod process **h** well-developed, not spiniform, somewhat lamellate **16**
16. Midbody metaterga with a single row of 2+2 setae after transverse sulcus. Process **h** sub-transverse, coiled with an additional spine at base ..... *T. magicus* Golovatch, 1984
– Midbody metaterga with two rows of 2+2 and 3+3 setae before and after transverse sulcus, respectively. Process **h** suberect, without any additional spine .... *T. tamdaoensis* Korsós & Golovatch, 1989
17. Metaterga strongly rugose with two rows of 2+2 and 2+2 setiferous knobs before and after transverse sulcus. Each sternum with four projections (Fig. 3C). Gonopod simple with a long, slightly twisted process **h**. Solenophore suberect, coiled, and as high as process **h** (Figs. 3E,F, 4A–C) .... *T. spinisterna*, new species
– Metaterga rugose, with two rows of 2+2 and 3+3 setiferous tubercles. Each sternum with a pair of small spines at base of posterior legs. Gonopod process **h** poorly developed. Solenophore strongly coiled, completely sheathing solenomere .... *T. maculatus* Golovatch, 1984

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