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***Trichadenotecnum* species from Peninsular Malaysia and Singapore (Insecta: Psocodea: 'Psocoptera': Psocidae)**

KAZUNORI YOSHIZAWA¹, CHARLES LIENHARD² & IDRIS ABD. GHANI³

¹*Systematic Entomology, School of Agriculture, Hokkaido University, Sapporo 060-8589, Japan.*

E-mail: psocid@res.agr.hokudai.ac.jp

²*Muséum d'histoire naturelle, C.P. 6434, CH-1211 Genève 6, Switzerland*

³*Center for Insect Systematics, Faculty of Sciences and Technology, Universiti Kebangsaan Malaysia, 43600 Bangi, Malaysia*

Abstract

Species of the bark louse genus *Trichadenotecnum* Enderlein (Insecta: Psocodea) from Peninsular Malaysia and Singapore are revised with illustrations and identification keys. Twenty species are here recognised, with four new species and ten recorded for the first time from this region, together with an unnamed species represented by a single female. The previously described species *T. marginatum* New & Thornton is not included because its generic assignment is questionable. Females of *T. cinnamomum* Endang & New, *T. imrum* New & Thornton and *T. sibolangitense* Endang, Thornton & New, and the male of *T. kerinciense* Endang & New are described for the first time. A new species group is defined for *T. krucilense* Endang, Thornton & New.

Key words: *Trichadenotecnum*, Psocidae, new species, Malaysia, Singapore

Introduction

The free living Psocodea or "Psocoptera" is now recognized as a paraphyletic assemblage (Yoshizawa & Johnson 2003, 2006, 2010), within which *Trichadenotecnum* Enderlein is one of the most species-rich genera (Lienhard & Smithers 2002; Lienhard 2011). Previous studies on the Oriental fauna have revealed enormous species diversity within this genus (Hong Kong—Thornton 1961, Yoshizawa & Lienhard 2004; Indonesia—Endang & Thornton 1992, Endang *et al.* 2002, Endang & New 2005; Japan—Yoshizawa 2001, 2003; China—Li 2002; Nepal—Yoshizawa *et al.* 2007). Peninsular Malaysia is designated as one of the biodiversity hotspots in the world (e.g., Ceballos & Ehrlich 2006). However, the *Trichadenotecnum* fauna of Peninsular Malaysia has been considered in only a few scattered papers, with only five species (excluding the questionable *T. marginatum*) recorded from the region to date (New 1975; New & Thornton 1976; New & Lee 1992). Even including the species from Singapore, the total number of *Trichadenotecnum* known from this region is only six (New & Lienhard 2007), in contrast to the 20 species known from the neighboring island, Sumatra (Endang & New 2005).

Within *Trichadenotecnum*, several species groups have been proposed based mainly on male and female genitalia. However, considerable morphological gaps among the species groups, or even among some species within a group, render morphology-based phylogenetic estimation and estimation of morphological transformation series difficult. High diversity of *Trichadenotecnum* in the Oriental Region, and lack of extensive investigation of some areas within the region, suggest that undiscovered species may help to fill such morphological gaps. Faunal surveys of this region may also help in understanding the phylogeny and morphological evolution within this genus.

The samples examined here were mostly collected through the Development of Insect Inventory Project in Tropical Asia led by Prof. Osamu Yata (Kyushu University). Methods and terminology follow Yoshizawa (2001, 2003), but the more widely adopted term spermapore plate (e.g., Endang *et al.* 2002) is used instead of internal plate (Betz 1983; Yoshizawa 2001, 2003). Depository abbreviations are: MHNG: Muséum d'histoire naturelle,

Geneva, Switzerland; SEHU: Systematic Entomology, Hokkaido University, Japan; UKM: Universiti Kebangsaan Malaysia. Frequently appearing collector names are abbreviated as follow. CL: C. Lienhard; DHM: D. H. Murphy; HK.etal: H. Kojima, S. Nomura, N. Takahashi & K. Yoshizawa; NT: N. Takahashi; KY: K. Yoshizawa.

***Trichadenotecnum* Enderlein**

For definition and synonymy see: Yoshizawa (2001, 2003), Yoshizawa *et al.* (2007) and Yoshizawa *et al.* (2008). In addition to the species from Peninsular Malaysia treated below, *T. umbratum* New & Thornton, 1976 was transferred to *Atrichadenotecnum* by Endang *et al.* (2002), and *T. marginatum* New & Thornton, 1976, judging from the original description, appears to be close to *Cryptopsocus cynostigmus* Li, 2002 from China, and is therefore not discussed further in this paper.

Key to species groups of *Trichadenotecnum* from Peninsular Malaysia and Singapore

1. Forewing extensively covered by tiny spots (Fig. 1B–M) 2
- Forewing not extensively covered by tiny spots (Fig. 1A, N–U) 3
2. Anterior region of basal band around Rs-M fusion well developed (Fig. 1B–D) *corniculum* group
- Anterior region of basal band around Rs-M fusion obscure (Fig. 1E–M) *spiniserrulum* group
3. Forewing Rs forking at right angle, third section of vein CuA1 (distal margin of areola postica) directed posteriorly to posterobasally (Fig. 1N–U). 4
- Forewing Rs forking at acute angle, third section of vein CuA1 directed posterodistally (Fig. 1A) *circularoides* group
4. Male hypandrium asymmetrical; phallosome lacking pseudoparamere (e.g., Figs 18, 27) *majus* group
- Male hypandrium symmetrical; phallosome with pseudoparamere (Fig. 29). Female unknown *krucilense* group

The *circularoides* group

***Trichadenotecnum circularoides* Badonnel**

(Fig 1A)

Trichadenotecnum circularoides Badonnel, 1955: 229; New & Lee, 1992: 154 (first record from Malaysia).

Specimen examined. [Singapore] 1 female, Botanic Gardens, Rain Forest, beating, 25m, 16.xii.1987, CL (MHNG).

Remarks. See Badonnel (1955) and Yoshizawa (2001) for diagnosis of this species and Yoshizawa (2004) and Yoshizawa *et al.* (2008) for the phylogenetic placement of the species group. This is the first record of this species from Singapore.

The *corniculum* group

Key to species

1. Large, forewing length over 3 mm (Fig. 1BC); hypandrium lacking process left to plate-like right process (Fig. 2C); egg guide almost parallel sided (Fig. 3A) *cinnamonum*
- Small, forewing length ca. 2.2 mm (Fig. 1D); hypandrium with process left to plate-like right process (Fig. 4C); egg guide slightly narrowing toward apex (Fig. 5A). *imrum*

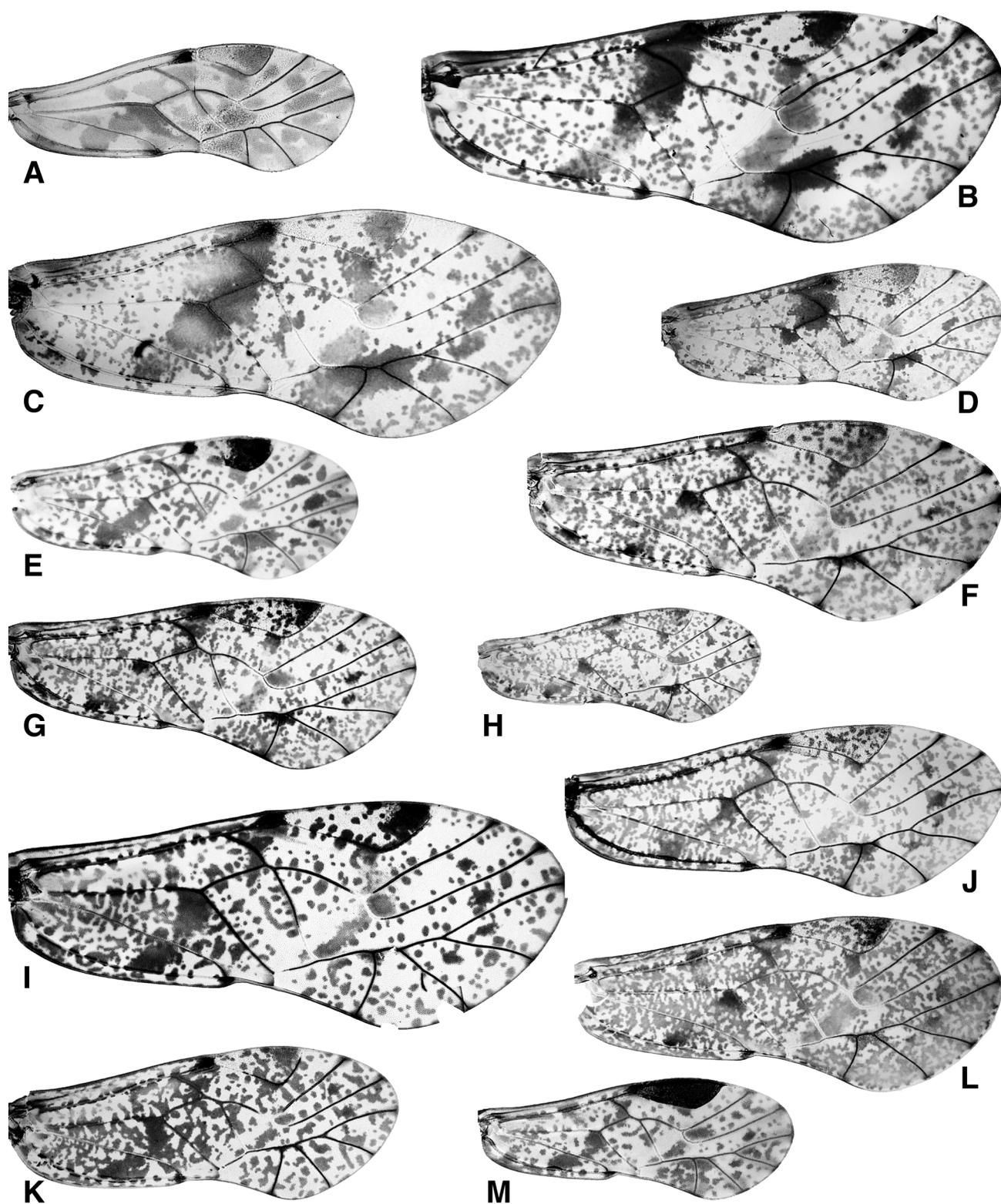


FIGURE 1.1. Forewings of *Trichadenotecnum* spp.: A: *T. circularoides*, female; B: *T. cinnamomum*, male; C: ditto, female; D: *T. imrum*, male; E: *T. pardus*, female; F: *T. yatai*, holotype male; G: *T. kojimai*, holotype male; H: *T. adika*, male; I: *T. endangae*, holotype male; J: *T. hammani*, female; K: *T. sp.My19*, female; L: *T. gombakense*, female; M: *T. malayense*, male.

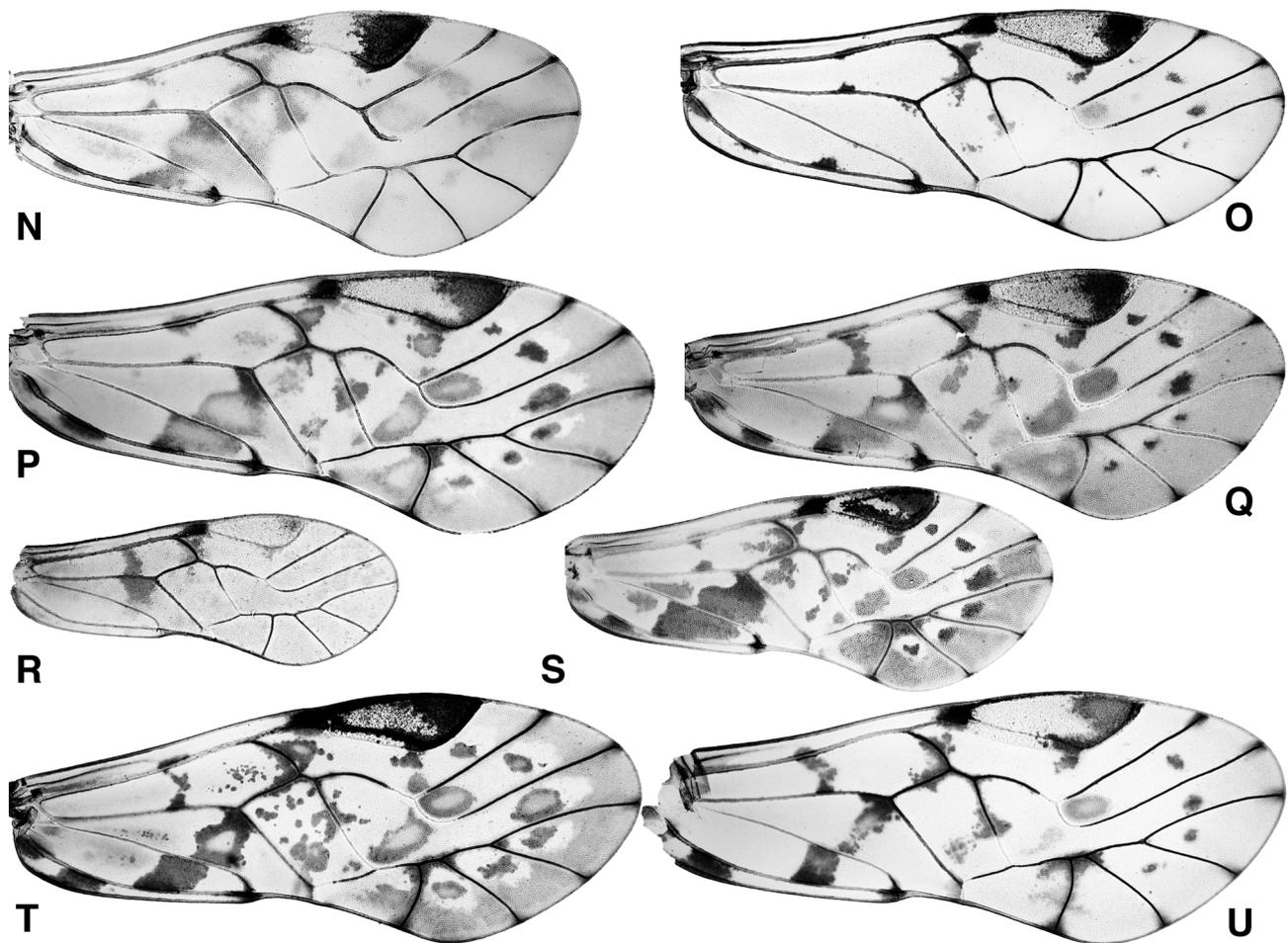


FIGURE 1.2. Forewings of *Trichadenotecnum* spp.: N: *T. sibolangitense*, male; O: *T. santosai*, female; P: *T. soenarti*, male; Q: *T. cornutum*, male; R: *T. anomalum*, holotype male; S: *T. rachimi*, female; T: *T. kerinciense*, female; U: *T. krucilense*, male.

***Trichadenotecnum cinnamomum* Endang & New**

(Figs 1BC, 2, 3)

Trichadenotecnum cinnamomum Endang & New, 2005: 35 (male).

[Not *T. cinnamomum* Endang & New, 2005: 36 (female): Misidentification.]

Specimens examined: [Malaysia] 1 male (KY347), Gunung Brinchang, Cameron Highland, Pahang, 13.vii.2003, H. Kojima (UKM); 1 female, Gunung Jasar, Path 10, Cameron Highland, Pahang, 14.vii.2003, KY (UKM).

Description of female genitalia. Egg guide long (Fig. 3A), much longer than basal width, parallel sided, distal margin almost straight; body of subgenital plate short and wide, posteriorly with shallow membranous region next to egg guide, with V-shaped membranous region anteromedially. Gonapophyses (Fig. 3B). Ventral valve long; dorsal valve with short distal process; posterior lobe of external valve narrow. Spermapore plate (Fig. 3C) weakly sclerotized, anterior membranous region asymmetrical.

Remarks. The male specimen examined here is in complete agreement with the original description of *T. cinnamomum*, except that the hypandrial structures are in mirror images between them (Fig. 2C). Because of the exact similarity, we concluded that the hypandrium illustrated in the original description is drawn from the reverse. This is the first record of this species from Peninsula Malaysia.

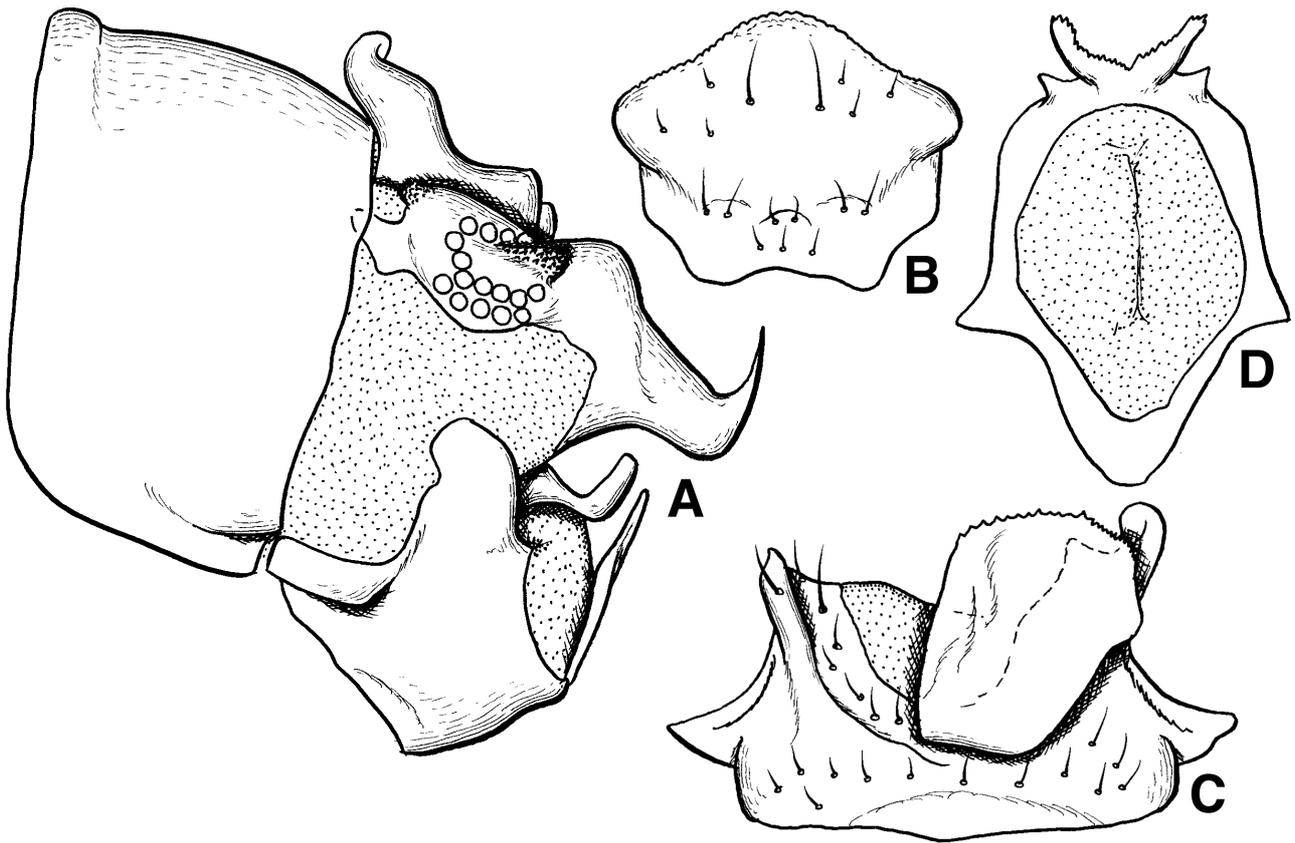


FIGURE 2. Male terminalia of *Trichadenotecnum cinnamonomum*. A: terminalia, lateral view; B: epiproct, dorsal view; C: hypandrium, ventral view; D: phallosome, ventral view.

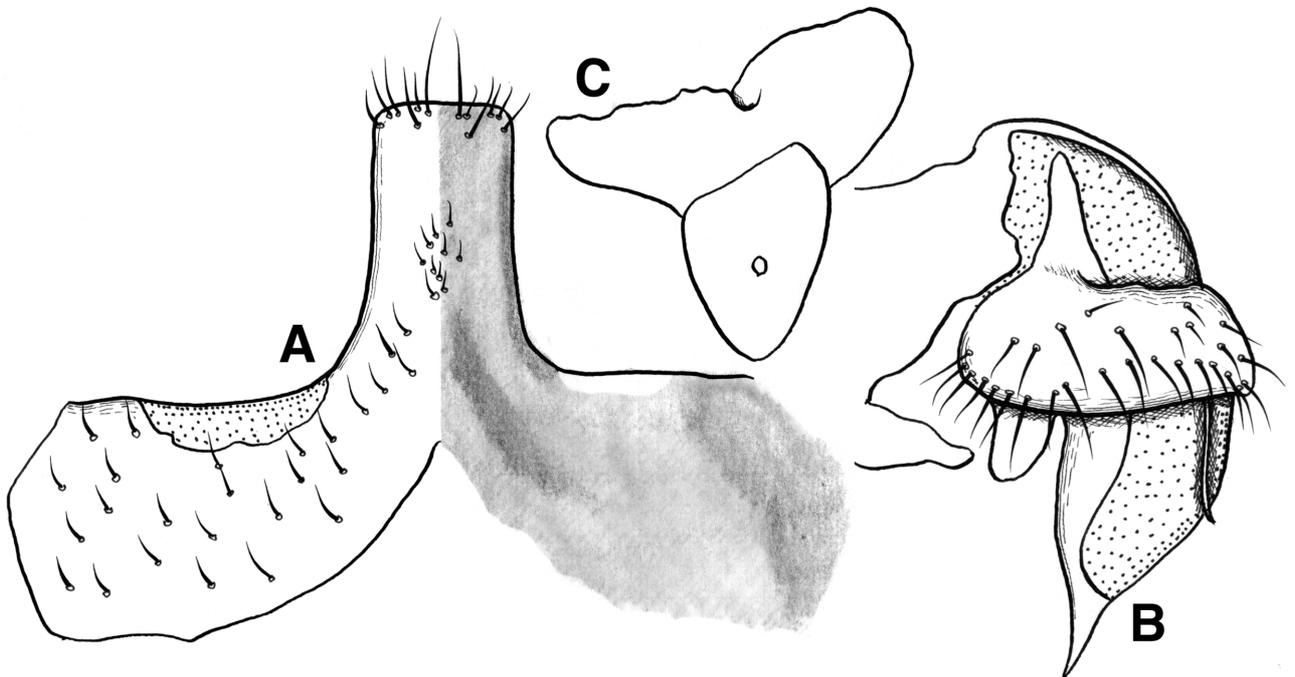


FIGURE 3. Female genitalia of *Trichadenotecnum cinnamonomum*, ventral view. A: subgenital plate; B: gonapophyses; C: spermapore plate.

Originally, the *corniculum* group was characterized by the presence of a process arising from the trichobothrial field of the male paraproct (Yoshizawa, 2003). Later, absence of this structure in *T. felix* Thornton, 1961 was reported, although the hypandrial structure strongly suggests its placement to the *corniculum* group (Yoshizawa & Lienhard, 2004). The hypandrial structure of *T. cinnamomum* is more similar to that of *T. felix* than to species with the trichobothrial process, but *T. cinnamomum* has a keel on the trichobothrial field which is most likely homologous with the trichobothrial process. This suggests that the trichobothrial process is secondarily absent in *T. felix*, and its presence is autapomorphic for the *corniculum* group. The assignment of *T. cinnamomum* to the *corniculum* group can be warranted by this structure.

The female specimen examined here differs significantly from the description of the paratype female given by Endang & New (2005); this clearly shows that they belong to different species. The paratype female of *T. cinnamomum* also looks significantly different from the holotype male in forewing markings (heavily spotted in female paratype whereas much more sparsely spotted in holotype male). In contrast, the female identified here as *T. cinnamomum* is more similar to the holotype male of this species in the forewing markings (Fig. 1BC). In addition, the female genital structures of the specimen examined here (Fig. 3) are very similar to those of *T. felix* and *T. imrum*, both of which are members of the *corniculum* group. In contrast, the genital structures of the paratype female, especially the absence of the posterior lobe of the external valve of gonapophyses, are more similar to the species of the *spiniserrulum* group (e.g., *Trichadenotecnum* sp.My19 or *T. malayense*, treated below: Figs 14 and 17, respectively). Therefore, we conclude that the female paratype of *T. cinnamomum* was misidentified as that species, and we here provide the first description of the female genital structures of *T. cinnamomum*.

***Trichadenotecnum imrum* New & Thornton**

(Figs 1D, 4, 5)

Trichadenotecnum imrum New & Thornton, 1976: 414.

Specimens examined: [Singapore] 1 male, Bukit Timah forest, 24 hr survey, section trap 7–9 am, 26.x.1969, DHM (MHNG); 1 male 1 female, Bukit Timah forest, beating foliage, 1.xi.1981, DHM (MHNG); 1 male, Bukit Timah Nature Reserve, between Summit hut and Car Park, along Tangga Rengas trail, Rock Path and Lower Path, 110–140 m, beating, 17.xii.1987, CL (SEHU).

Description of female genitalia. Egg guide long (Fig. 5A), much longer than basal width, slightly narrowing toward apex, distal margin only slightly arched, medially and laterally with longitudinal membranous regions; body of subgenital plate rather small, posterior margin with short and broad membranous region next to egg guide, anteromedially with broad membranous region. Gonapophyses (Fig. 5B). Ventral valve long; dorsal valve with long distal process; posterior lobe of external valve small. Spermapore plate (Fig. 5C) lightly pigmented anteriorly and around spermapore, symmetrical.

Remarks. The male specimens examined here match very well with the original description of this species, including genital structures (Fig. 4). This species was originally described from a single male from Selangor, Malaysia, and is here recorded from Singapore for the first time. The female of this species is described here for the first time.

This species is apparently closely related to *T. cinnamomum* but can be distinguished from the latter by the flattened epiproct (Fig. 4A), presence of the small projection placed left to the circular-plate on the hypandrium (Fig. 4C), and absence of the keel on the trichobothrial field (Fig. 4A) in male and the shape of the subgenital plate (Fig. 5A) in female. Furthermore, this species is very similar to *T. felix* in male and female genital structures, as also mentioned for *T. cinnamomum*. These three species apparently compose a monophyletic group within the *corniculum* group based on having the bifurcated posterior process on the phallosome (Figs 4D). They also share the following character state: the trichobothrial field is divided into two regions (Fig. 4A) (Thornton, 1961). The empty space of the trichobothrial field, observed in *T. felix* and *T. imrum*, corresponds to the keeled area of *T. cinnamomum* and other species of the *corniculum* group (Fig. 2A). As mentioned above, this situation strongly suggests that the presence of the trichobothrial process/keel is autapomorphic for the *corniculum* group and plesiomorphic within this group; its absence corresponds to an incomplete reversal leaving the empty area on the trichobothrial field (Fig. 4A).

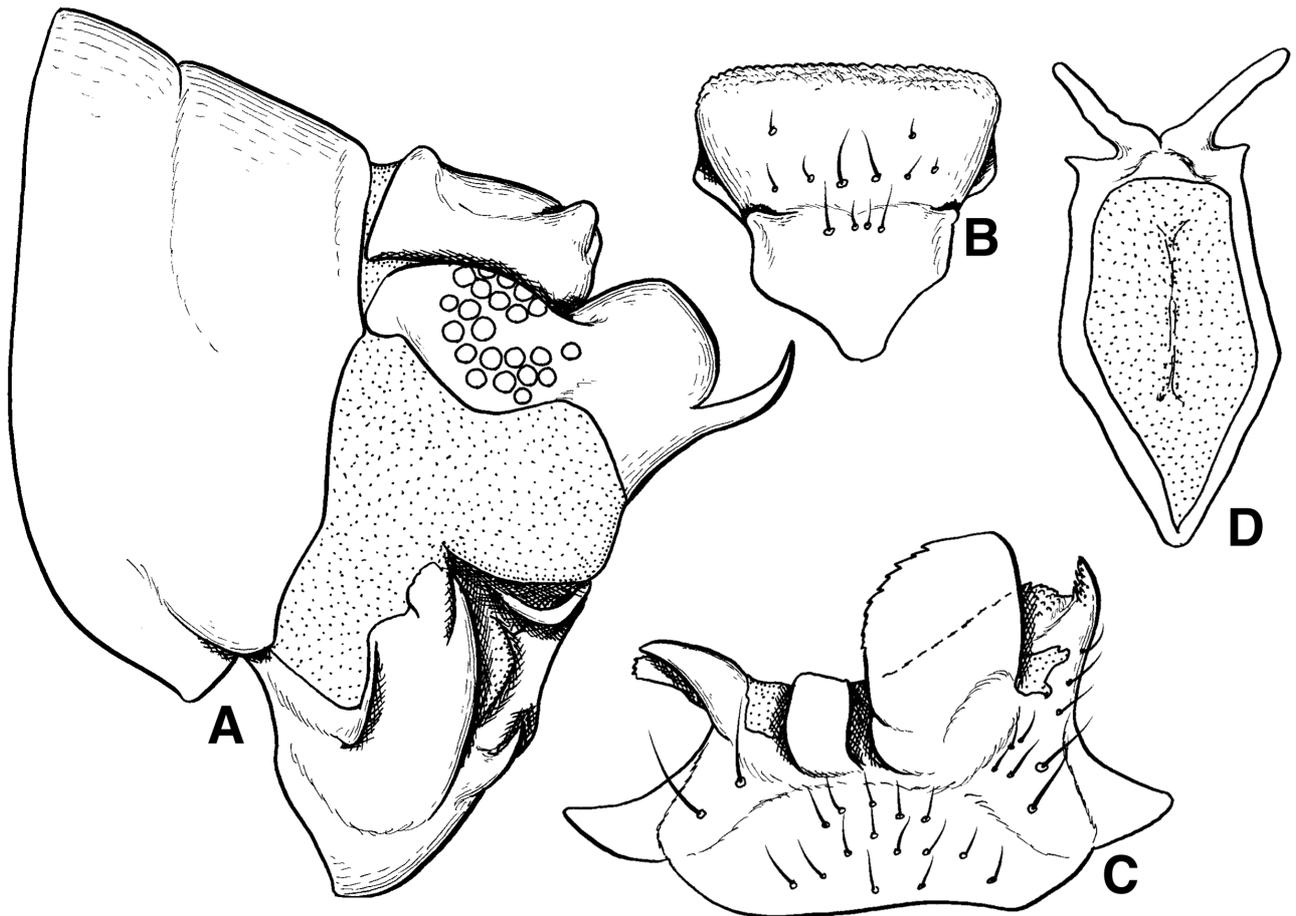


FIGURE 4. Male terminalia of *Trichadenotecnum imrum*. A: terminalia, lateral view; B: epiproct, dorsal view; C: hypandrium, ventral view; D: phallosome, ventral view.

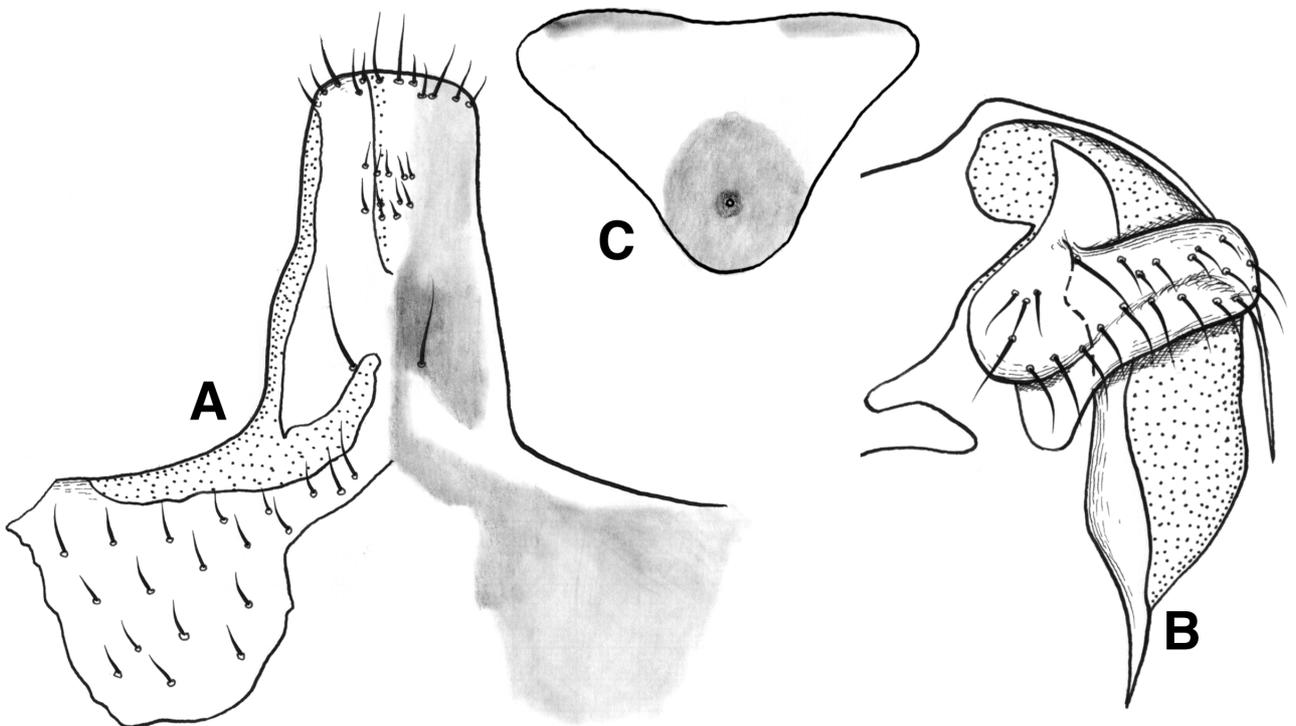


FIGURE 5. Female genitalia of *Trichadenotecnum imrum*, ventral view. A: subgenital plate; B: gonapophyses; C: spermapore plate.

The *spiniserrulum* group

Key to species

Male

1. Forewing length < 3 mm; hypandrium (excluding median tongue) symmetrical 2
- Forewing length > 3 mm (Fig. 1I); hypandrium clearly asymmetrical (Fig. 11C) *endangae* sp.n.
2. Hypandrial median tongue symmetrical or absent 3
- Hypandrial median tongue asymmetrical *gombakense*
3. Basal 3/4 of pterostigma unpigmented except for some tiny spots; hypandrium with movable median tongue 4
- Pterostigma mostly pigmented (Fig. 1M); hypandrium lacking median tongue (Fig. 16) *malayense*
4. Posterior margin of hypandrial median tongue almost straight or only shallowly notched 5
- Posterior margin of hypandrial median tongue deeply notched (Fig. 10D) *adika*
5. Epiproct trilobed in posterior view (Fig. 6B) *yatai* sp.n.
- Epiproct triangular in posterior view (Fig. 8B) *kojimai* sp.n.

Female

1. Ventral valve of gonapophyses long, exceeding external valve (Figs 7, 9, 12–14) 2
- Ventral valve of gonapophyses short, not reaching to external valve (Figs 15, 17) 7
2. Forewing length < 3 mm (Fig. 1E–H) 3
- Forewing length > 3 mm (Fig. 1I) *endangae* sp.n.
3. Basal region of egg guide with swelling medially, shoulder of subgenital plate with pointed projection or serrated hump (Figs 7A, 9A) 4
- Basal region of egg guide flat, shoulder of subgenital plate lacking any projection (Figs 13A, 14A) 6
4. Shoulder of subgenital plate with pointed projection (Fig. 9A) 5
- Shoulder of subgenital plate with small serrated hump (Fig. 7A) *yatai* n. sp.
5. Internal lobe of external valve of gonapophyses long, exceeding internal margin of dorsal valve *adika*
- Internal lobe of external valve of gonapophyses short, not exceeding internal margin of dorsal valve (Fig. 9B) *kojimai* n. sp.
6. Egg guide almost parallel sided, posterior margin only slightly arched (Fig. 13A); external valve of gonapophyses with small posterior lobe, internal lobe pointed (Fig. 13B) *hammani*
- Egg guide clearly constricted medially, posterior margin rounded (Fig. 14A); external valve of gonapophyses lacking posterior lobe, internal lobe rounded (Fig. 14B) sp.My19
7. Egg guide almost parallel sided (Fig. 15A) 8
- Egg guide clearly expanded anteriorly (Fig. 17A) *malayense*
8. Forewing densely covered with tiny spots, surface of spotted regions exceeds that of hyaline regions (Fig. 1L); external valve of gonapophyses with posterior lobe (Fig. 15B) *gombakense*
- Forewing rather sparsely covered with tiny spots, hyaline regions more extended than spotted regions (Fig. 1E); external valve of gonapophyses lacks posterior lobe (parthenogenetic) *pardus*

Trichadenotecnum pardus Badonnel

(Fig 1E)

Trichadenotecnum pardus Badonnel, 1955: 231.

Trichadenotecnum pardidum: New, 1975: 258. [Misidentification]

[Not *Trichadenotecnum pardidum* Thornton, 1961: 16.]

Specimen examined. 1 female, Singapore, Botanic Gardens, Rain Forest, beating, 25m, 16.xii.1987, CL (MHNG).

Remarks. See Yoshizawa (2001) and Yoshizawa & Lienhard (2004) for diagnosis of this species.

Trichadenotecnum yatai Yoshizawa & Lienhard, sp.n.

(Figs 1F, 6, 7)

Holotype. Male, Malaysia, Gunung Jasar, Cameron Highland, Pahang, 9.iii.2003, K. Yoshizawa (UKM).

Paratypes: Malaysia, 3 females, same data as holotype (UKM); 1 male, Gunung Berembun, Cameron Highland, Pahang, 10.iii.2003, NT (UKM); 1 male 3 females, type locality, 14.iii.2003, KY (SEHU & MHNG); 1 male 2 females, same locality, 14.vii.2003, KY (SEHU & MHNG).

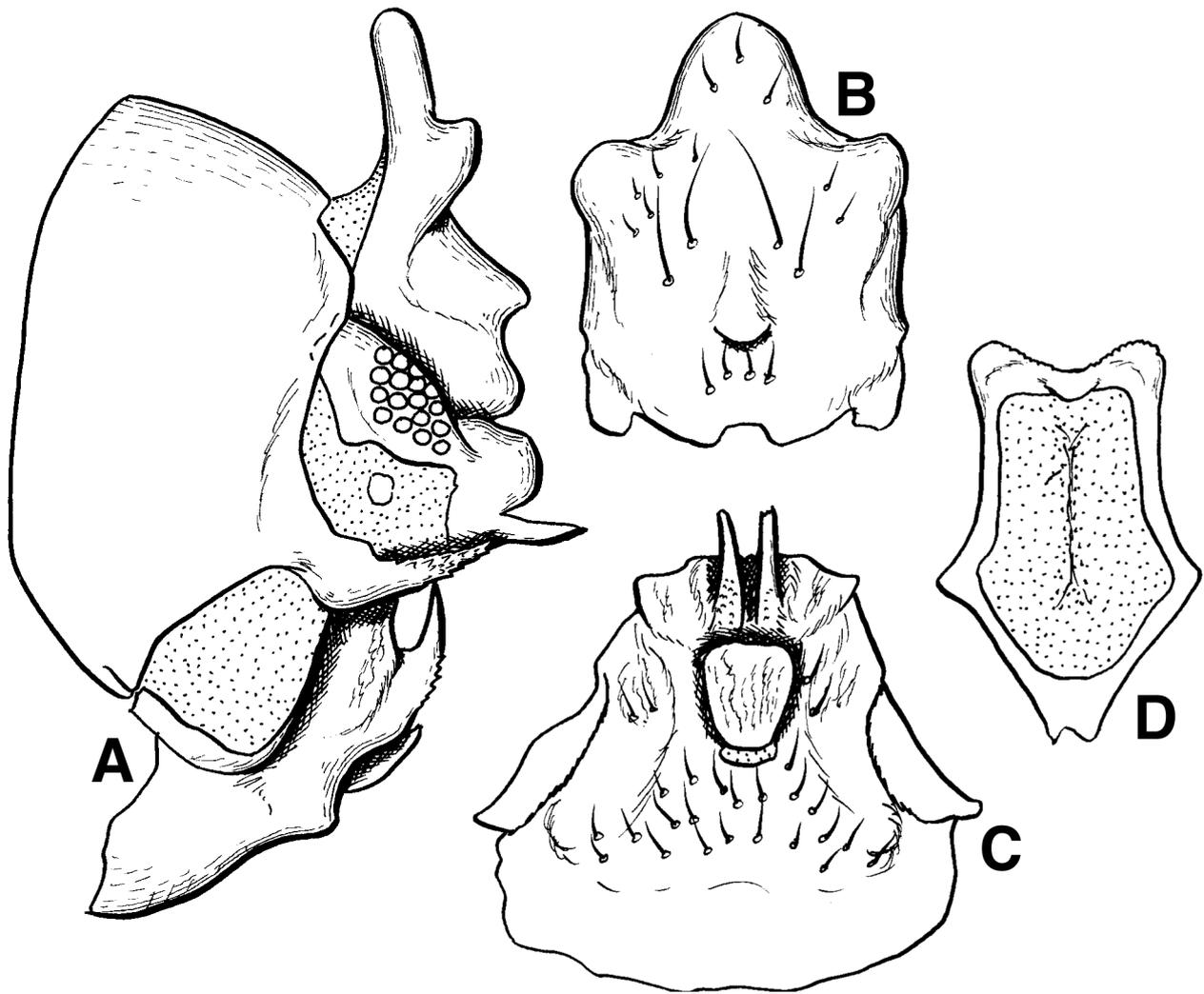


FIGURE 6. Male terminalia of *Trichadenotecnum yatai*. A: terminalia, lateral view; B: epiproct, dorsal view; C: hypandrium, ventral view; D: phallosome, ventral view.

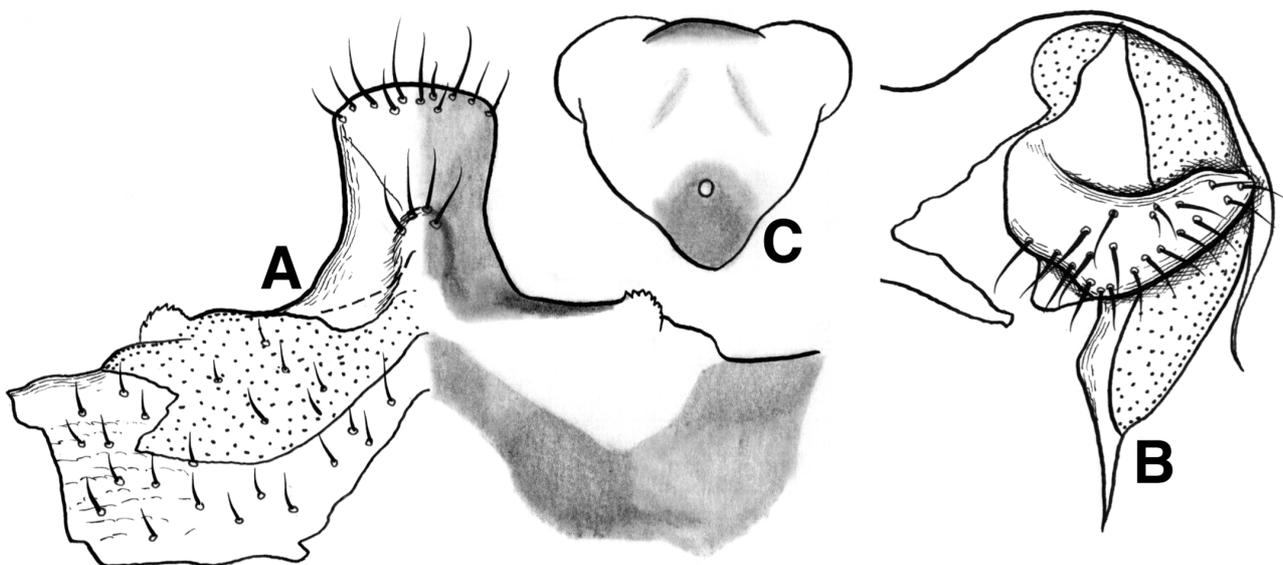


FIGURE 7. Female genitalia of *Trichadenotecnum yatai*, ventral view. A: subgenital plate; B: gonapophyses; C: spermapore plate.

Description. Male. Head. Yellowish white in ground color; vertical markings blackish brown, each marking touching with neighbors; with pair of blackish brown markings anterior to vertical markings; orbital markings blackish brown; coronal suture black; epicranial suture blackish brown, laterally with blackish brown marking dorsally; frons with central pair of brown bands reaching to oceller region dorsally, and with lateral pair of blackish brown broader band not reaching to epicranial suture dorsally, central and lateral bands fused with each other ventrally; eye dark gray, IO/D = 0.8; ocelli white, ocellar field black; gena with transversal blackish brown band medially, ventral and eye margins blackish brown; postclypeus mostly blackish brown ventrally except ventrolateral corner white, dorsal region white with four rows of blackish brown spots; anteclypeus blackish brown. Antenna brown, scape and pedicel blackish brown. Mouthparts brown.

Thorax. Prothorax blackish brown. Mesonotum mostly brown, scutum with yellowish white bands along posterolateral margins of anterior lobe, at middle from anterior to posterior ends of scutum, and along anterior margin of lateral lobe. Metanotum brown, median part and anterior region of lateral lobe of scutum yellowish white. Meso- and metapleuron brown except membranous regions.

Legs. Mostly blackish brown, ventral surface of distal half of fore femur and tip of hind femur white, tibiae paler.

Forewing (Fig. 1F). Extensively and densely covered with tiny spots. Distal spot in cell a1 distinct, basal spots distinct. Opposing spots in cell r obscure. Basal band narrow and faint except for dark spots around Rs-M fusion, below M-Cu fork, and in posterior half of cell cup. Distal band faint. Spot on roof of cell m3 narrow but distinct. Submarginal spots distinct in cells r3 and r5, faint but visible in cells m1 and m2, obscure in other cells. Marginal clouds faint. Hindwing hyaline; veins brown.

Terminalia. 8th sternum with single sclerite completely fused with hypandrium posteriorly (Fig. 6C). Clunial arm directed posteroventrally in basal half, directed posteriorly and covered with denticles in distal half, apically pointed (Fig. 6A). Epiproct (Fig. 6AB) medially with conical projection directed posteriorly; epiproct lobe strongly expanded dorsally, three lobed. Paraproct (Fig. 6A) with tiny sclerite ventral to trichobothrial field; distal lobe rounded; distal process short, directed posteriorly. Hypandrium (Fig. 6C) symmetrical, triangular in overall shape, posterior region wrinkled; left and right processes closely associated, arising from posteromedian region and directed posteriorly, their ventral margin denticulated basally; median tongue broadened distally, with only slightly arched distal margin, ventral surface wrinkled. Phallosome (Fig. 6D) with denticulated distal margin concave medially, nearly parallel sided distally, strongly expanded laterally at basal 1/3 and narrowing to anterior tip, without distinct anterior process.

Measurements. B 1.7–2.0, Fw 2.7–2.9, Hw 2.0–2.2.

Female. General morphology almost as in male. IO/D = 1.7.

Genitalia. Egg guide (Fig. 7A) ventrally with longitudinal swelling basally, longer than basal width, slightly constricted at basal 1/4, distal margin slightly arched; body of subgenital plate widely membranous, sclerotized portion laterally expanded W-shaped, with denticulated tubercles posteriorly. Gonapophyses (Fig. 7B). Ventral valve long. Dorsal valve with long distal process. Posterior lobe of external valve small; internal lobe narrow. Spermapore plate (Fig. 7C) roughly triangular, pigmented portions at posterior tip and median region of anterior margin.

Measurements. B 1.9–2.0, Fw 2.8–2.9, Hw 2.0–2.1.

Etymology. The species epithet refers to Prof. Emer. Osamu Yata, who led the Tropical Asia Inventory Project.

Remarks. The female of this species is very similar to *T. alobum* Endang & New, 2005 described from Sumatra, Indonesia. However, the external valve of gonapophyses of *T. alobum* lacks the posterior lobe that is present in *T. yatai* (Fig. 7B). The hypandrial structures (Fig. 6C) and the long ventral valve of gonapophyses (Fig. 7B) suggest close relationship between this species and *T. ianobidens* Yoshizawa & Lienhard, 2004, the male of which was originally described as the male of *T. bidens* Thornton, 1961 but later recognized as a different species.

***Trichadenotecnum kojimai* Yoshizawa & Lienhard, sp.n.**

(Figs 1G, 8, 9)

Holotype. Male, Malaysia, Gunung Berembun, Path 3, Cameron Highlands, Pahang, 14.vii.2003, H. Kojima, S. Nomura, N. Takahashi & K. Yoshizawa (canopy fogging, St. 6) (UKM).

Paratypes. 2 males 1 female, same data as holotype; 1 male 1 female, type locality, 15.vii.2003, HK.etal (canopy fogging, St. 9) (SEHU & UKM).

Description. Male. Head. Yellowish white in ground color; vertical markings blackish brown, each marking touching with neighbors; with pair of triangular blackish brown markings anterior to vertical markings; orbital markings blackish brown; coronal suture black; epicranial suture bordered with blackish brown band dorsally; frons with central pair of brown bands reaching to oceller region dorsally, and with lateral pair of blackish brown broader band not reaching to epicranial suture dorsally, central and lateral bands fused with each other ventrally; eye dark gray, IO/D= 0.6; ocelli white, ocellar field black; gena mostly blackish brown, with pair of oval whitish areas arranged vertically; postclypeus mostly blackish brown ventrally except ventrolateral corner white, dorsal region white with four rows of blackish brown spots; anteclypeus blackish brown. Antenna brown, scape and pedicel blackish brown. Mouthparts brown.

Thorax. Prothorax blackish brown. Mesonotum mostly brown, scutum with yellowish white bands along posterolateral margins of anterior lobe, at middle from posterior end to middle of anterior lobe of scutum, and along anterior margin of lateral lobe. Metanotum brown, median part and anterior region of lateral lobe of scutum yellowish white. Meso- and metapleuron brown except membranous regions.

Legs. Mostly blackish brown, ventral surface of distal half of fore femur and tip of hind femur white, tibiae paler.

Forewing (Fig. 1G). Extensively and densely covered with tiny spots, spots rather sparse in cell r3. Distal spot in cell a1 distinct, basal spots distinct. Opposing spots in cell r obscure. Basal band narrow and faint except for dark spots around Rs-M fusion, below M-Cu fork, and in posterior half of cell cup. Distal band faint. Spot on roof of cell m3 narrow but distinct. Submarginal spots distinct in cells r3, r5, and m1, very small but distinct in cell m2, obscure in other cells. Marginal clouds faint. Hindwing hyaline; veins brown.

Terminalia. 8th sternum with triangular sclerite completely fused to hypandrium posteriorly (Fig. 8C). Clunial arm (Fig. 8A) directed posteroventrally in basal half, directed posterodorsally and with some denticles in distal half. Epiproct (Fig. 8AB) with strong posterodorsal extension, triangular in lateral view; epiproct lobe strongly expanded dorsally, single-lobed but with weak lateral expansion medially. Paraproct (Fig. 8A) with weakly developed triangular basal process; distal lobe broad and rounded; distal process long and fine, almost straight and directed posterodorsally. Hypandrium (Fig. 8C) symmetrical, roughly triangular in shape, distal region wrinkled; left and right processes closely associated, narrow, directed posteriorly; median tongue broad, parallel sided, posterior margin shallowly notched medially, ventral surface wrinkled. Phallosome (Fig. 8D) with slightly rugous posterior margin, medially with shallow notch, lateral margins slightly broadened toward lateral projection and acutely narrowing toward pointed anterior tip.

Measurements. B 1.9–2.0, Fw 2.3–2.5, Hw 1.9–2.1.

Female. General morphology almost as in male. IO/D = 1.9.

Genitalia. Egg guide (Fig. 9A) gradually extended from body of subgenital plate, basally constricted, anterior margin rounded, ventral surface with slight swelling basally; body of subgenital plate widely sclerotized, posteriorly with strongly projecting triangular processes, postero medially with triangular membranous region continuing to anterior trapezoidal membranous region. Gonapophyses (Fig. 9B). Ventral valve long. Dorsal valve with long distal process. Posterior lobe of external valve broad but weakly projecting; internal lobe short. Spermapore plate (Fig. 9C) broad and short, triangular in shape, anterior margin with small notch, broadly pigmented but darker around spermapore and median region of anterior margin.

Measurements. B 2.0, Fw 2.5–2.6, Hw 1.9–2.0.

Etymology. The species epithet refers to Prof. Hiroaki Kojima who led the Canopy Fogging investigation at Cameron Highland.

Remarks. This species is close to *T. yatai*, described above, but differs by the shape of male epiproct (Figs 6A, 8A) and female subgenital plate (Figs 7A, 9A). *T. kojimai* differs also from *T. yatai* in the possession of the posterolateral projections on the subgenital plate in the female and the shapes of the lateral clunial arm and epiproct lobe in male. In having a pair of posterolateral projections on the female subgenital plate (Fig. 9A), *T. kojimai* is similar to *T. adika* and *T. paradika* Endang & New, 2005 from Indonesia. However, *T. kojimai* differs clearly from *T. adika*, by the shape of the lateral clunial arms, epiproct lobe, and distal part of the hypandrium. *T. paradika* is known from female only, and it differs from *T. kojimai* by the shapes of the posterolateral projection on the subgenital plate and the external valve of the gonapophyses.

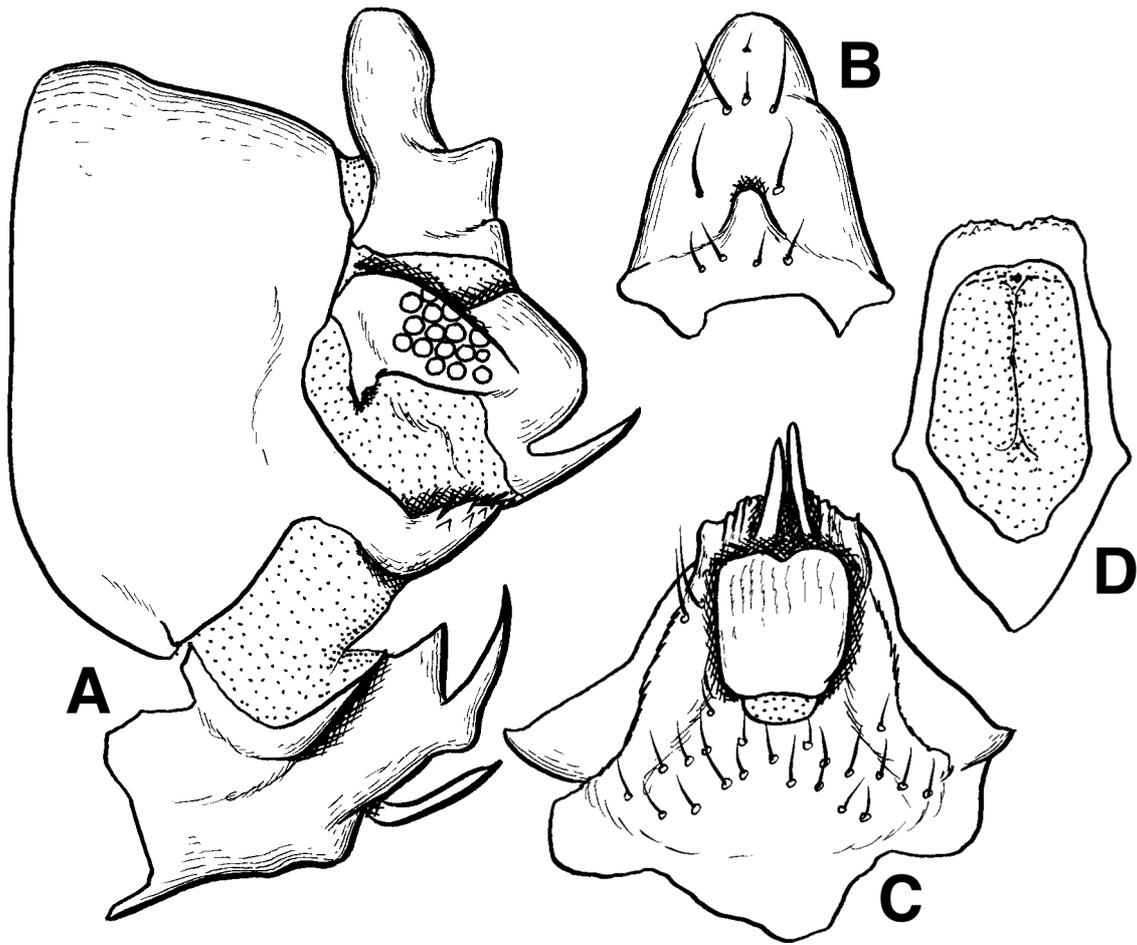


FIGURE 8. Male terminalia of *Trichadenotecnum kojimai*. A: terminalia, lateral view; B: epiproct, dorsal view; C: hypandrium, ventral view; D: phallosome, ventral view.

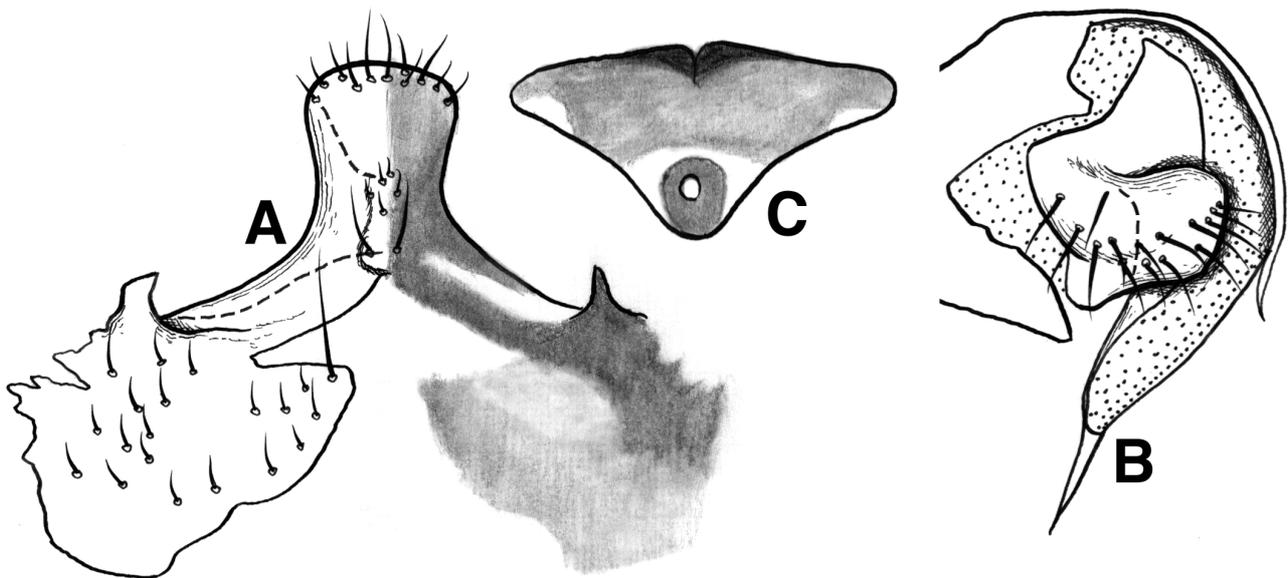


FIGURE 9. Female genitalia of *Trichadenotecnum kojimai*, ventral view. A: subgenital plate; B: gonapophyses; C: spermapore plate.

***Trichadenotecnum adika* Endang, Thornton & New**
(Figs 1H, 10)

Trichadenotecnum adika Endang, Thornton & New, 2002: 166.

Specimen examined. 1 male, Singapore, See Soon, Rifle Range Swamp Forest, beating, 18.xii.1987, CL (MHNG).

Remarks. The specimen examined here agrees well with *T. adika* in male genital structures. In contrast, it is significantly smaller (forewing length 1.8 mm) than the male holotype of *T. adika* from Java (forewing length 2.6 mm). The small form could provisionally be interpreted as a lowland form (cf. Bergmann's rule): all Indonesian specimens were collected between 700 and 1460 m (Endang *et al.*, 2002; Endang & New, 2005). Therefore, we identified the above specimen as *T. adika*. This is the first record of this species from the region.

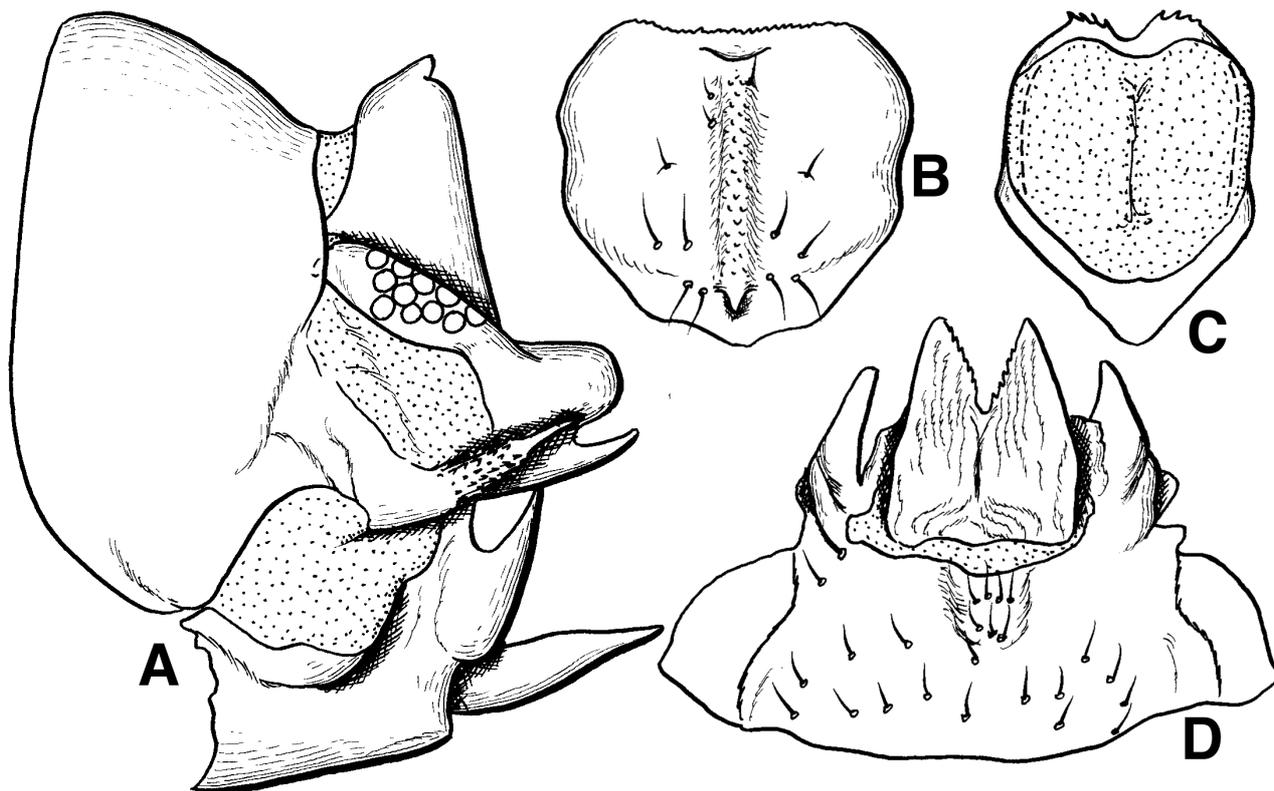


FIGURE 10. Male terminalia of *Trichadenotecnum adika*. A: terminalia, lateral view; B: epiproct, dorsal view; C: hypandrium, ventral view; D: phallosome, ventral view.

***Trichadenotecnum endangae* Yoshizawa & Lienhard, sp. n.**
(Figs 1I, 11, 12)

Holotype. Male, Malaysia, Gunung Brinchang, Cameron Highlands, Pahang, 11.iii.2003, K. Yoshizawa (UKM).

Paratype. 1 female, Malaysia, Gunung Jasar, Cameron Highlands, Pahang, 9.iii.2003, KY (UKM).

Description. Male. Head. Yellowish white in ground color; vertical markings blackish brown, each marking fused with neighbors; with pair of blackish brown markings anterior to vertical markings; orbital markings blackish brown; coronal suture black; epicranial suture broadly bordered with blackish brown band dorsally; frons mostly blackish brown, with pair of dorsal white spots and pair of lateral white bands; eye black, IO/D= 1.3; ocelli white, ocellar field black; gena mostly blackish brown; postclypeus mostly blackish brown, dorsally with six white bands; anteclypeus blackish brown. Antenna brown, scape and pedicel blackish brown. Mouthparts brown.

Thorax. Prothorax blackish brown. Mesonotum blackish brown, medially with trifurcated white marking. Metanotum blackish brown, medially with white spot. Meso- and metapleuron brown except for white membranous regions.

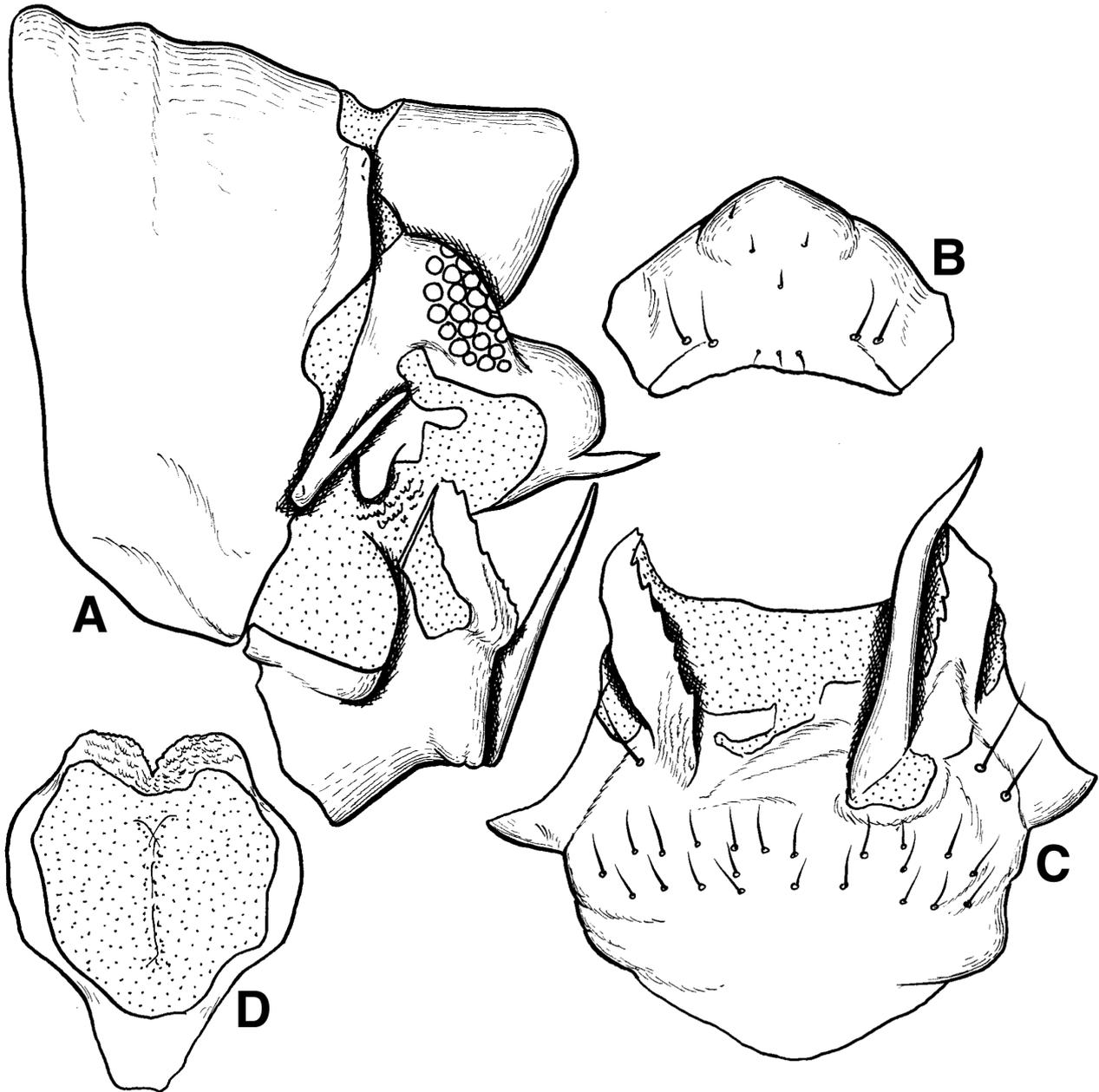


FIGURE 11. Male terminalia of *Trichadenotecnum endangae*. A: terminalia, lateral view; B: epiproct, dorsal view; C: hypandrium, ventral view; D: phallosome, ventral view.

Legs. Mostly blackish brown, distal half of ventral surface of fore femur and distal tip of hind femur white, tibiae paler.

Forewing (Fig. 11). Extensively covered with tiny spots, dense basally from basal band, sparse distally from basal band. Distal spot in cell a1 distinct, basal spots obscure. Opposing spots in cell r obscure. Basal band narrow but distinct, broadly interrupted above M-Cu fork, narrowly interrupted above CuP vein. Distal band narrow but distinct. Spot on roof of cell m3 faint, only distinct at top of areola postica. Submarginal spots distinct in cells r3 to m2, obscure in other cells. Marginal clouds almost absent. Hindwing hyaline; veins brown.

Abdomen dark brown, with irregular white spots.

Terminalia. 8th sternum with single short triangular sclerite fused to hypandrium (Fig. 11AC). Clunium (Fig. 11A) without well developed clunial arm. Epiproct (Fig. 11AB) conical in shape, shorter than wide, extended posteriorly. Paraproct (Fig. 11A) with well developed complex basal process; distal lobe short and rounded; distal process straight, directed posteriorly. Hypandrium (Fig. 11C) asymmetrical, posteromedially with broad

membranous region; long, narrow, weakly sinuous and distally pointed process arising from right side; posterolateral corner with saw-like posterior projection. Phallosome (Fig. 11D) with rugous posterior margin, medially with deep notch, laterally rounded, posteriorly with broad anterior process.

Measurements. B 2.4, Fw 3.5, Hw 2.6.

Female. General morphology almost as in male. IO/D = 2.5.

Genitalia. Egg guide (Fig. 12A) broad basally, strongly constricted to middle and slightly broadened to slightly arched distal margin, laterally with membranous regions; body of subgenital plate broad, anteriorly with broad membranous regions and anteromedially with deep V-shaped membranous region. Gonapophyses (Fig. 12B). Ventral valve long. Dorsal valve with long distal process. External valve lacking posterior lobe, narrow. Spermapore plate (Fig. 12C) with strongly pigmented area posteriorly.

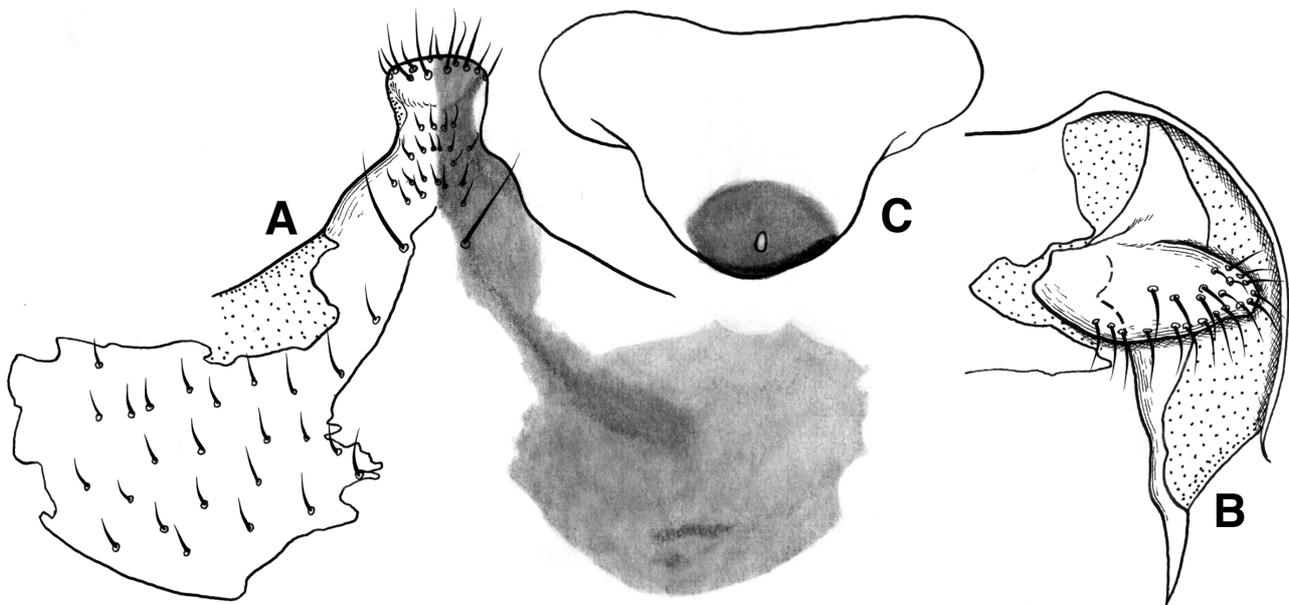


FIGURE 12. Female genitalia of *Trichadenotecnum endangae*, ventral view. A: subgenital plate; B: gonapophyses; C: spermapore plate.

Measurements. B 2.3, Fw 3.1, Hw 2.4.

Etymology. The species epithet honors the memory of Endang Sri Kentjonowati, author of several important contributions to the knowledge of Indonesian Psocoptera, especially of the family Psocidae. She died, much too young, on 29 April 2010.

Remarks. This species is very close to *T. bromoense* Endang, Thornton & New, 2002 from Java, Indonesia, but differs from it by the shape of the paraproctal lateral process (Fig. 11A). In the original description, the long hypandrial process of *T. bromoense* arises from the left side. However, in ventral (external) view, the process arises from the right side in *T. endangae* (Fig. 11C), as well as in close relatives such as *T. godavarensense* New, 1971 and *T. sclerotum* New, 1978. Therefore, it is very likely that the illustration of the hypandrium of *T. bromoense* is drawn in dorsal (internal) view or reproduced in reversed position.

***Trichadenotecnum hammani* Endang, Thornton & New**
(Figs 1J, 13)

Trichadenotecnum hammani Endang, Thornton & New, 2002: 161

Specimen examined. [Malaysia] 1 female, Gunung Berembun, Cameron Highlands, Pahang, 14.vii.2003, HK.etal (canopy fogging, St. 7) (UKM).

Remarks. This species was originally described from Java, Indonesia, and is here recorded from Peninsula Malaysia for the first time. The specimen examined here matched very well with the original description of this species, especially the shape of external valve of gonapophyses (Fig. 13B) that is characteristic for this species.

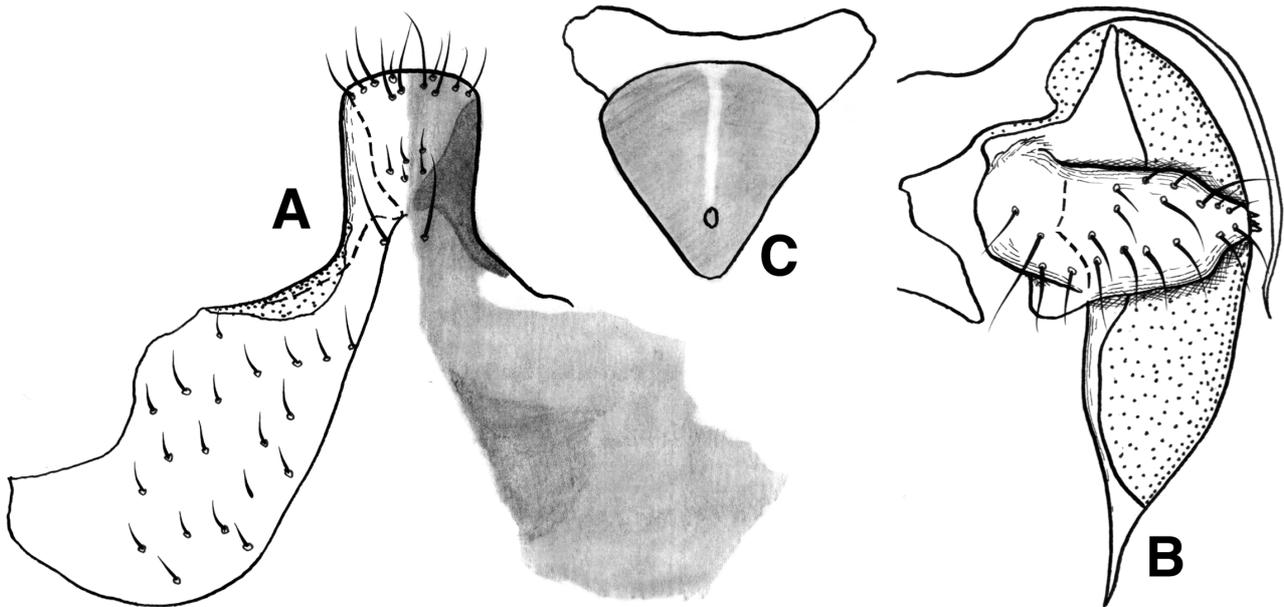


FIGURE 13. Female genitalia of *Trichadenotecnum hammani*, ventral view. A: subgenital plate; B: gonapophyses; C: spermapore plate.

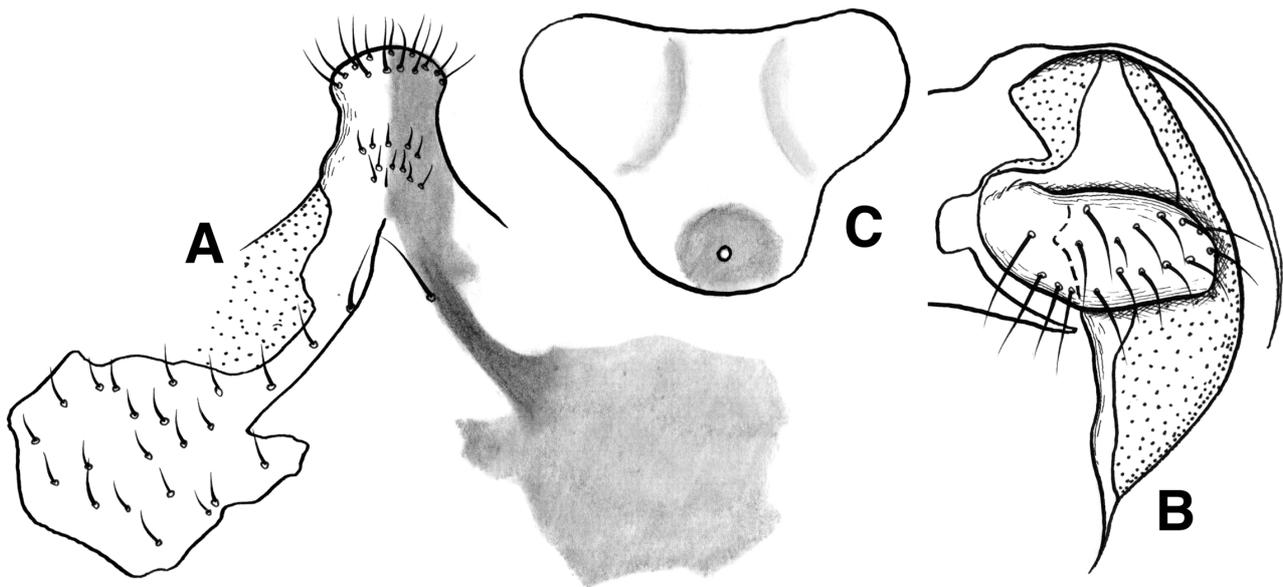


FIGURE 14. Female genitalia of *Trichadenotecnum* sp.My19, ventral view. A: subgenital plate; B: gonapophyses; C: spermapore plate.

***Trichadenotecnum* sp.My19**

(Figs 1K, 14)

Specimen examined. [Malaysia] 1 female, 7 miles from Tapah, Pahang, 10.iii.2003, KY (UKM).

Remarks. This species is known only from a single female. Genital structures (overall shape of subgenital plate, long ventral valve and small external valve of gonapophyses, and overall shape of spermapore plate: Fig. 14) are very similar to those of *T. endangae*, suggesting their close relationship. However, body size (body length = 1.7 mm, forewing length = 2.4 mm) and forewing markings (Fig. 11K) are significantly different between them. Because *T. sp.My19* is known only from a female, we prefer not to name it here.

***Trichadenotecnum gombakense* New & Lee**

(Figs 1L, 15)

Trichadenotecnum gombakensis [sic!] New & Lee, 1992: 155.

Trichadenotecnum gombakense; Endang & New, 2005: 22.

Specimens examined. [Malaysia] 1 female, Fraser's Hill, Pahang, 7.iii.2003, KY (UKM); 1 female, Gunung Jasar, Cameron Highlands, Pahang, 14.iii.2003, KY (SEHU).

Remarks. This species was described from a single female obtained from Gombak, Malaysia (New & Lee, 1992). The female specimen examined here is in good agreement with the original description (Figs 1L, 15). Although the present material does not include the male of this species, it was described by Endang & New (2005) from Sumatra, which clearly shows that this species is closely related to *T. falx* Yoshizawa, 2001 from Japan and *T. isseii* Yoshizawa & Lienhard, 2007 from Nepal due to the possession of the asymmetrical and sickle-shaped hypandrial median tongue. The hypandrial median tongue illustrated by Endang & New (2005) is left-skewed whereas that of the other species is right-skewed. The illustration given by Endang & New (2005) is very likely drawn in dorsal (internal) view or reproduced in reversed position (Yoshizawa *et al.*, 2007).

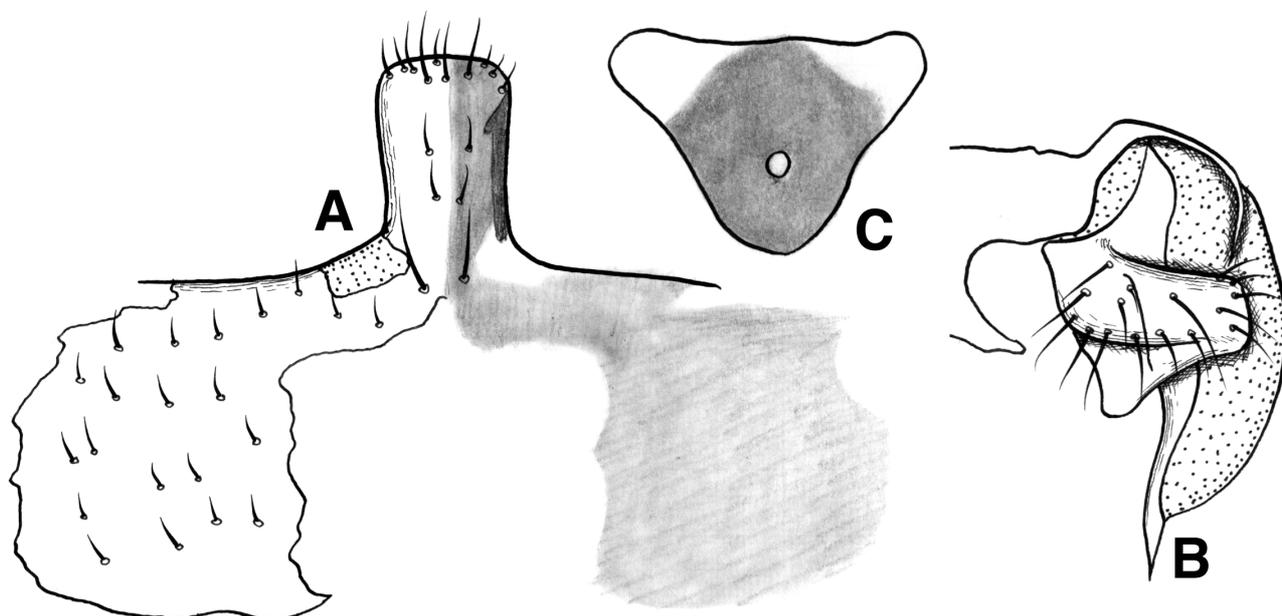


FIGURE 15. Female genitalia of *Trichadenotecnum gombakense*, ventral view. A: subgenital plate; B: gonapophyses; C: spermapore plate.

***Trichadenotecnum malayense* New**

(Figs 1M, 16, 17)

Trichadenotecnum malayense New, 1975: 257; New & Lee, 1992: 156; Endang, Thornton & New, 2002: 156; Endang & New, 2005: 24.

Specimens examined. [Malaysia] 1 female, Fraser's Hill, Pahang, 5.iii.2003, KY (UKM); 2 males (KY334), Endau Rompin National Park, Johor, 7.vii.2003, KY (UKM & SEHU); 1 female, University Forest of UKM, Bangi, Selangor, 6.iii.2005, NT (SEHU).

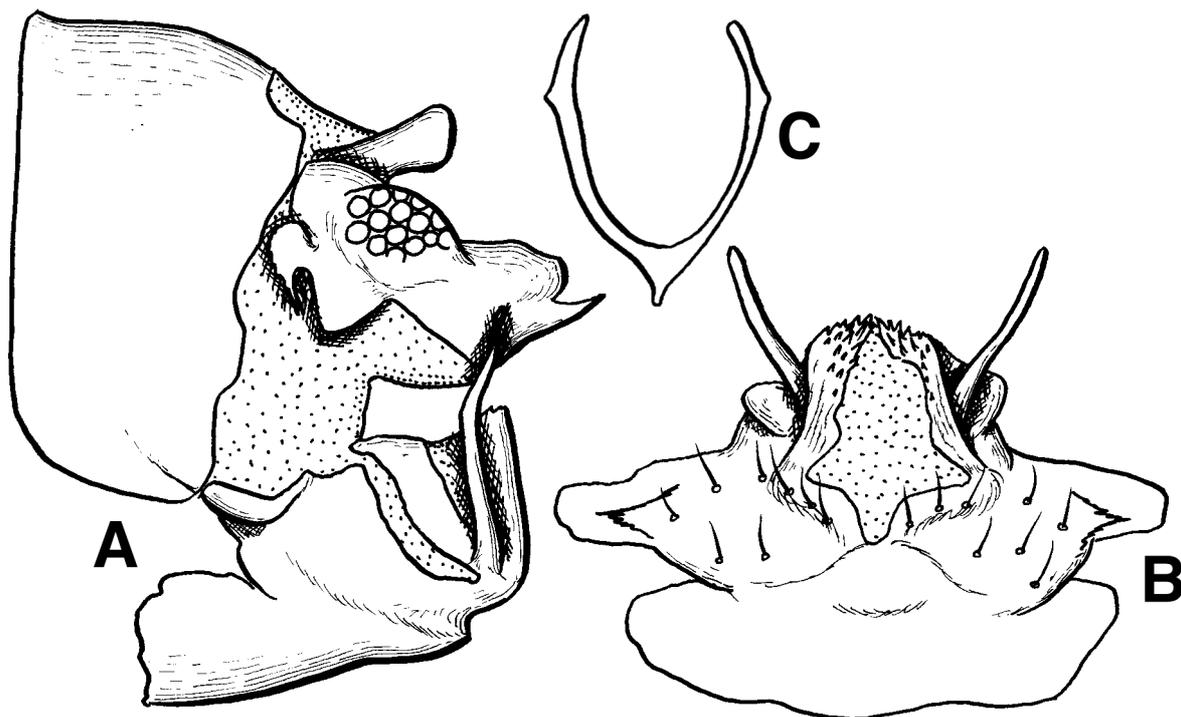


FIGURE 16. Male terminalia of *Trichadenotecnum malayense*. Note that illustration of the epiproct is unavailable because the epiproct was destroyed during dissection. A: terminalia, lateral view; B: hypandrium, ventral view; C: phallosome, ventral view.

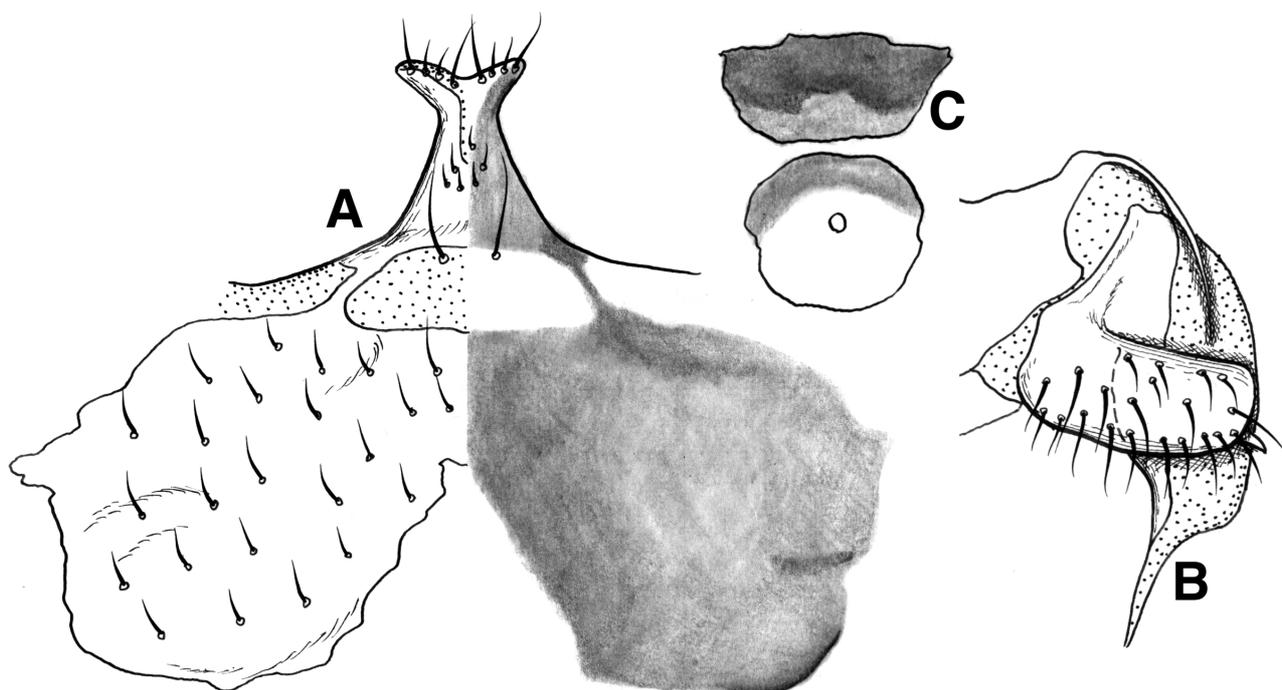


FIGURE 17. Female genitalia of *Trichadenotecnum malayense*, ventral view. A: subgenital plate; B: gonapophyses; C: spermapore plate.

Remarks. This species was originally described only on female specimens from Malaysia, and the male of this species was later identified from Sumatra, Indonesia by Endang & New (2005). The female genital structures examined here (Fig. 17) are in complete agreement with those described by New (1975), and male terminal structures of the specimens examined here (Fig. 16) agree very well with the description given by Endang & New

(2005) except for the difference of the phallosome [illustrated as if it were closed in Endang & New (2005: fig. 16) whereas it is widely opened in the presently examined specimen (Fig. 16C)]. Based on the densely spotted forewings, the presence of a basal process on the male paraproct, and the short ventral valve of the gonapophyses, assignment of this species to the *spiniserrulum* group is unquestioned (Yoshizawa, 2001). However, male and female terminal structures are quite distinct from the other species of this group. Complete absence of the posterior lobe of the external valve of gonapophyses may indicate close affinity between *T. malayense* and *T. pardus*, treated above, or *T. godavarensis* New, 1971 (see Yoshizawa *et al.*, 2007 for taxonomic status of the latter species).

The *majus* group

Key to species

Male

1. Hyandrium without median tongue 2
- Hyandrium with unmovable median tongue 4
2. Forewing extensively spotted; epiproct lobe bilobed (Figs 18B, 20B) 3
- Forewing without distinctive markings in distal half (Fig. 1R); epiproct lobe not bilobed (Fig. 25B) *anomalum* sp.n.
3. 8th sternum without sclerite (Fig. 18C) *sibolangitense*
- 8th sternum with transversal sclerite (Fig. 20C) *santosai*
4. Epiproct lobe broadly expanded dorsally 5
- Epiproct lobe not expanded (Fig. 27B) *kerinciense*
5. Epiproct lobe not bilobed (Fig. 22B); hypandrial median tongue not strongly skewed (Fig. 22C) *soenarti*
- Epiproct lobe bilobed dorsally (Fig. 24B); hypandrial median tongue strongly skewed leftward (Fig. 24C) *cornutum*

Female

1. Posterior margin of subgenital plate lacks projections other than egg guide 2
- Posterolateral corner of subgenital plate with projections (Fig. 19A) *sibolangitense*
2. Ventral valve of gonapophyses short, not exceeding external valve 3
- Ventral valve of gonapophyses long, far exceeding external valve (Fig. 28B) *kerinciense*
3. Forewing markings fully developed 4
- Forewing markings reduced, basal band only distinct at Rs-M fusion (Fig. 1O) *santosai*
4. Forewing length > 2.5 mm (Fig. 1P) *soenarti*
- Forewing length < 2.5 mm (Fig. 1S) *rachimi*

Trichadenotecnum sibolangitense Endang & New (Figs 1N, 18, 19)

Trichadenotecnum sibolangitense Endang & New, 2005: 27.

Specimens examined. [Malaysia] 1 female, Gunung Jasar, Cameron Highlands, Pahang, 14.iii.2003, KY; 1 male (KY345) Gunung Berembun, Cameron Highlands, Pahang, 10.iii.2005, NT. [Singapore] 1 female, Botanic Gardens, Forest (low foliage), 6.xi.1981, DHM (MHNG).

Description of female genitalia. Egg guide (Fig. 19A) short, shorter than basal width, ventrally membranous and dorsally widely sclerotized, distal margin concave; body of subgenital plate broadly sclerotized, anteromedially with wide membranous region, posterior margin with pair of long, narrow and sharply pointed lateral processes. Gonapophyses (Fig. 19B). Ventral valve not exceeding external valve; dorsal valve broad, with deep pouch posteromedially, distal process long; external valve with broad membranous region anteriorly and with flap-like expansion posteriorly, posterior lobe broad, internal lobe narrow. Spermapore plate (Fig. 19C) symmetrical, pigmented around spermapore.

Remarks. This species was originally described from Sumatra, Indonesia based on a single male and is here recorded from Peninsula Malaysia for the first time. The male specimens examined here agree exactly with the original description except for the hypandrial structures being in mirror image (Fig. 18C). Given the exact similarity of each structure, we concluded that the illustration of the hypandrium of this species presented in Endang & New (2005) is drawn in dorsal (internal) view or reproduced in reversed position. This species is

apparently closely related to *T. alinguum* Endang, Thornton & New, 2005 and, in *T. sibolangitense*, the right side of the hypandrium is strongly expanded, as illustrated in Fig. 18C. Given the lack of the hypandrial median tongue and the triangular shape of the hypandrium, this species is considered to be closely related to *T. arciforme* (Thornton, 1961; Yoshizawa & Lienhard, 2004). In contrast, these species are clearly different in the condition of the epiproct: strongly expanded over the clunium in *T. sibolangitense* (Fig. 18A) whereas almost flat and covered by the clunial flap in *T. arciforme*. The state as observed in *T. arciforme* is unique even among the tribe Ptyctini, in which *Trichadenotecnum* is classified. Because of this highly unusual feature, Yoshizawa & Lienhard (2004) did not assign *T. arciforme* to any species group, although they pointed out that *T. arciforme* is possibly closely related to *T. apertum*. The strongly expanded epiproct as observed in *T. sibolangitense* and similarities of the hypandrial structure between this species and *T. arciforme* corroborate the idea that *T. arciforme* (hypandrial median tongue absent and ventral valve of gonapophyses short) is closely related to *T. apertum* and its relatives, and that the highly specialized condition of the epiproct-clunium interface has to be considered as an autapomorphy of *T. arciforme*.

The female of *T. sibolangitense* is described here for the first time. As shown in Fig. 19A, it is characterized by possession of a pair of sharp processes arising from the posterior margin of the subgenital plate. Similar structures have been reported from some species such as *T. suwai* Yoshizawa & Lienhard, 2007 from Nepal or *T. laticornutum* Endang *et al.*, 2002 and *T. waykananense* Endang & New, 2005 from Indonesia. The former species is phylogenetically distant (belonging to the *spiniserrulum* group) from *T. sibolangitense* so that presence of these processes can be recognized as convergence. In contrast, although the species-group assignments of *T. laticornutum* and *T. waykananense* have not been proposed in the original descriptions (Endang *et al.*, 2002; Endang & New, 2005), their close affinity with *T. sibolangitense* is very likely.

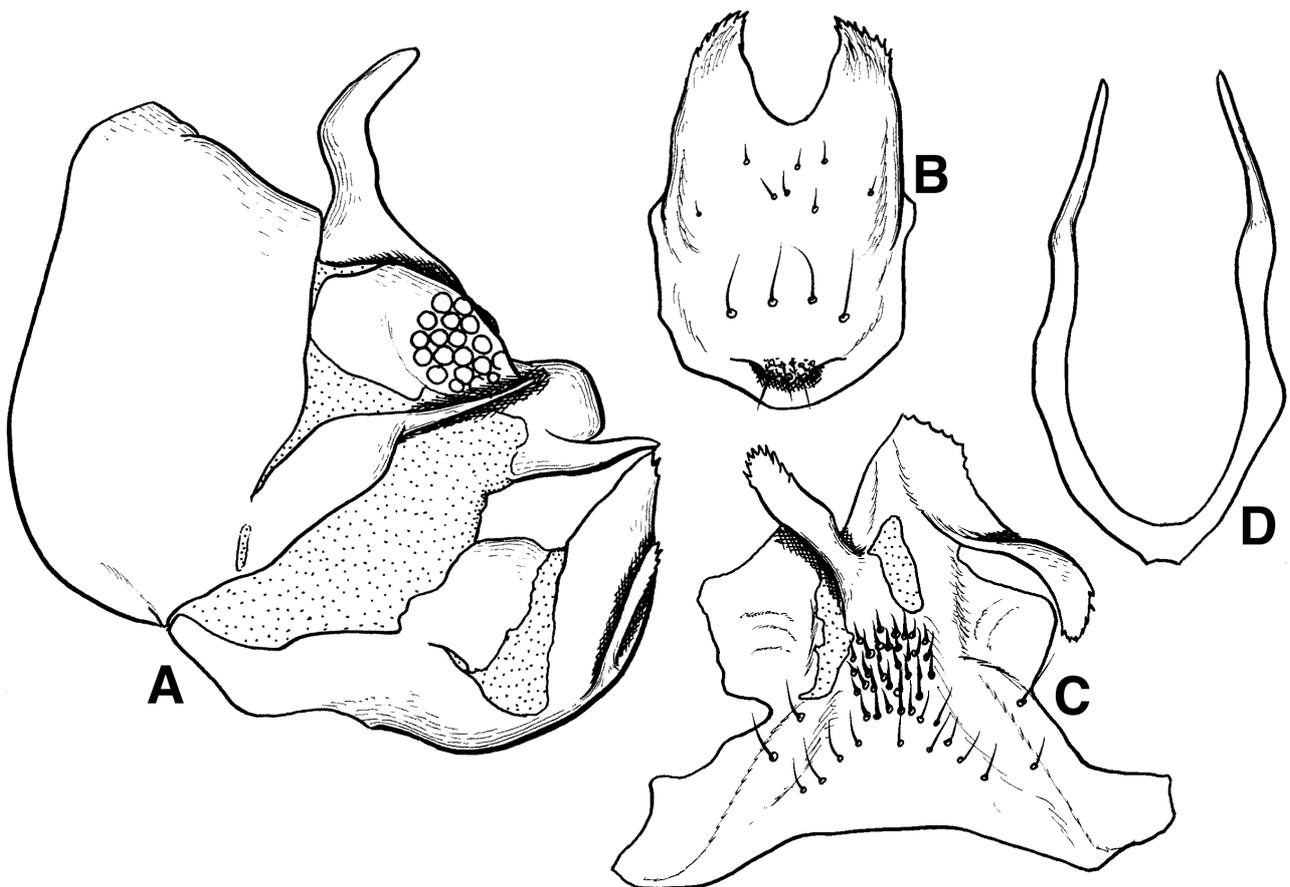


FIGURE 18. Male terminalia of *Trichadenotecnum sibolangitense*. A: terminalia, lateral view; B: epiproct, dorsal view; C: hypandrium, ventral view; D: phallosome, ventral view.

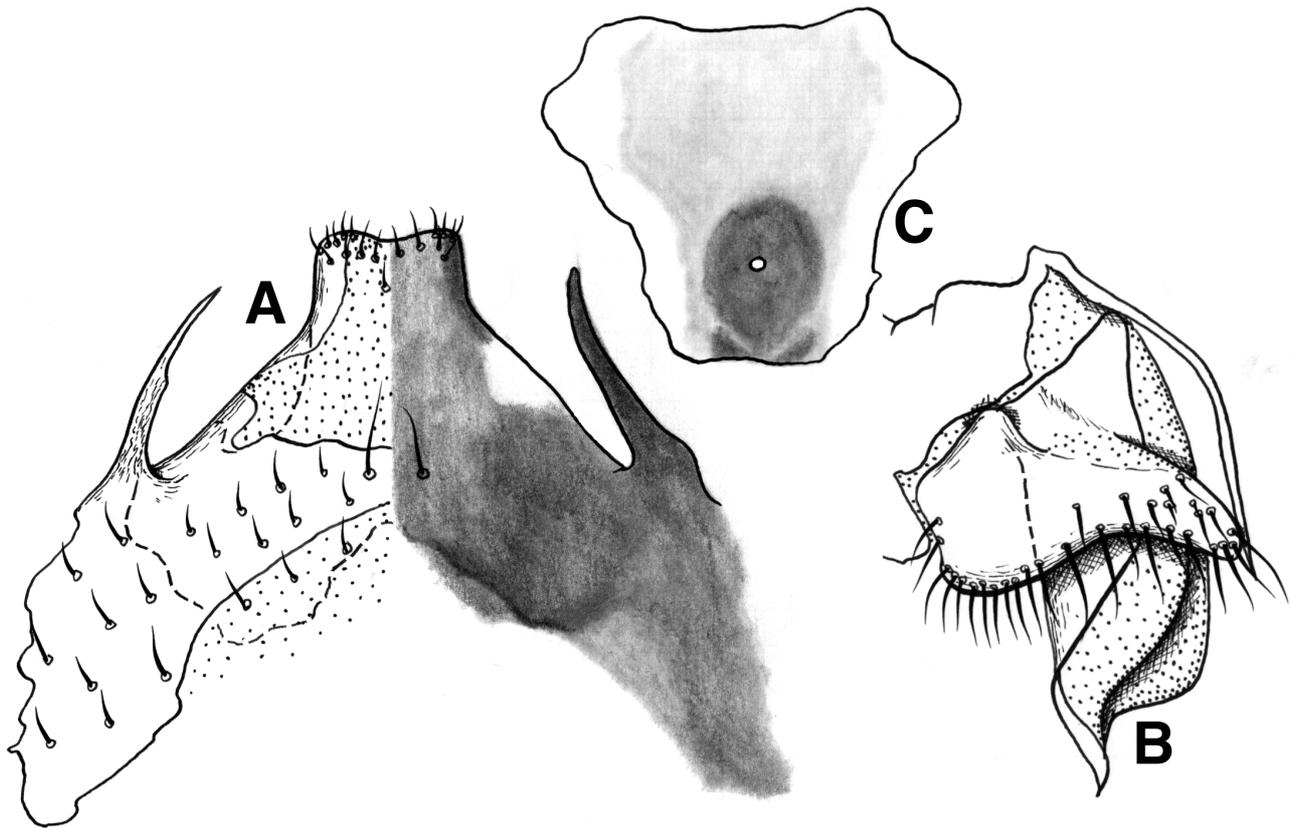


FIGURE 19. Female genitalia of *Trichadenotecnum sibolangitense*, ventral view. A: subgenital plate; B: gonapophyses; C: spermapore plate.

***Trichadenotecnum santosai* Endang & Thornton**

(Figs 1O, 20, 21)

Trichadenotecnum santosai Endang & Thornton, 1992: 364.

Specimens examined. [Malaysia] 1 female, Gunung Mentigi, Cameron Highlands, Pahang, 14.iii.2003, NT (UKM); 1 male, Gunung Brinchang, Cameron Highlands, Pahang, 11.iii.2003, KY (SEHU); 2 females (KY190), Gunung Beremban, Cameron Highlands, Pahang, 14.vii.2003, HK.etal (canopy fogging, St. 7) (UKM and SEHU); 2 males (KY333) 2 females, same locality and collectors, 15.vii.2003 (canopy fogging, St. 9) (UKM and SEHU).

Remarks. This species was originally described from Bali (type locality) and Lombok, Indonesia and is here recorded from Peninsula Malaysia for the first time. The specimens examined in this study match very well with the original description, including male terminalia (Fig. 20; Note: original figure of hypandrium in mirror image, probably drawn in dorsal (internal) view or reproduced in reversed position) and female genitalia (Fig. 21). This species is very closely related to *T. auritum* Yoshizawa & Lienhard, 2004 and, based on male and female genital structures, the close affinity of these species with *T. apertum* Thornton, 1961 is undoubted (Yoshizawa & Lienhard, 2004).

***Trichadenotecnum soenarti* Endang, Thornton & New**

(Figs 1P, 22, 23)

Trichadenotecnum soenarti Endang, Thornton & New, 2002: 162.

Specimens examined. [Malaysia] 1 male 1 female, Gunung Mentigi, Cameron Highlands, Pahang, 13.iii.3003, NT

(UKM); 1 male, Gunung Jasar, Cameron Highlands, Pahang, 14.iii.2003, KY (UKM); 1 male, Gunung Berembun, Cameron Highlands, Pahang, 13.vii.2003, NT; 1 female, same locality, 15.vii.2003, KY (SEHU); 2 male, Gunung Jasar, Path 12, Cameron Highlands, 14.vii.2003, KY (SEHU); 1 male, Fraser's Hill, Pahang, 5.iii.2003, KY (UKM).

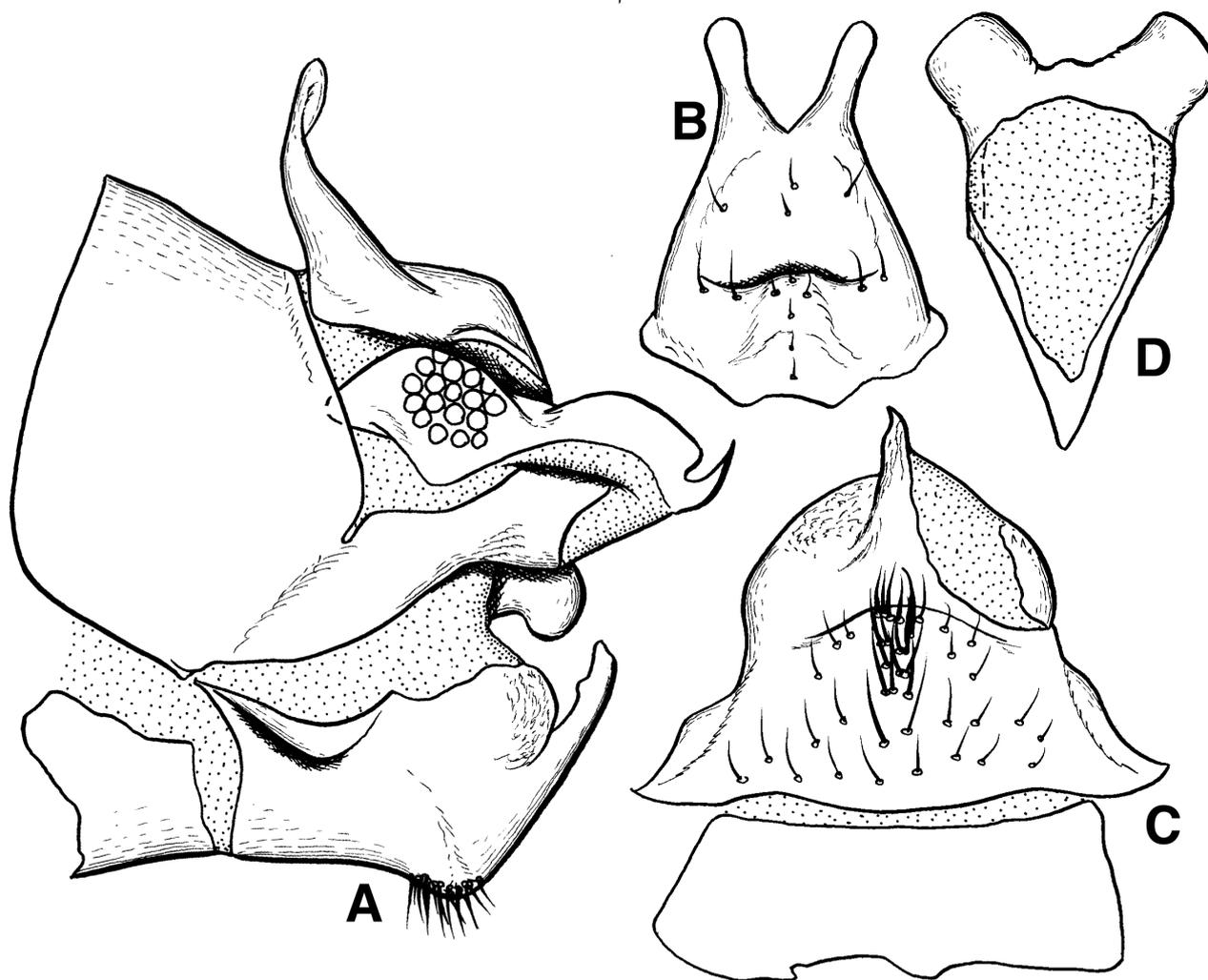


FIGURE 20. Male terminalia of *Trichadenotecnum santosai*. A: terminalia, lateral view; B: epiproct, dorsal view; C: hypandrium, ventral view; D: phallosome, ventral view.

Remarks. This species was originally described from Java, Indonesia and is here recorded from Peninsula Malaysia for the first time. Morphological characters of the specimens identified here as *T. soenarti* agreed with that described in the original description except for one point: the hypandrial structures are in mirror image (Fig. 22C). Therefore, we concluded that the illustration of the hypandrium presented in the original description is drawn in dorsal (internal) view or reproduced in reversed position.

The female of this species resembles *T. medium* and its relatives in having a short anteromedian sclerotized band on the subgenital plate (Fig. 23A). However, the hypandrial structure (Fig. 22C) and the short ventral valve of the gonapophyses (Fig. 23B) strongly suggest that this species is closely related to *T. apertum* and its relatives. The hypandrial median tongue is relatively well developed (Fig. 22C), as observed in *T. majus* and its relatives, representing a plesiomorphic condition within the *majus* group. As mentioned by Endang *et al.* (2002), *T. quadrispinosum* is very closely related to *T. soenarti*.

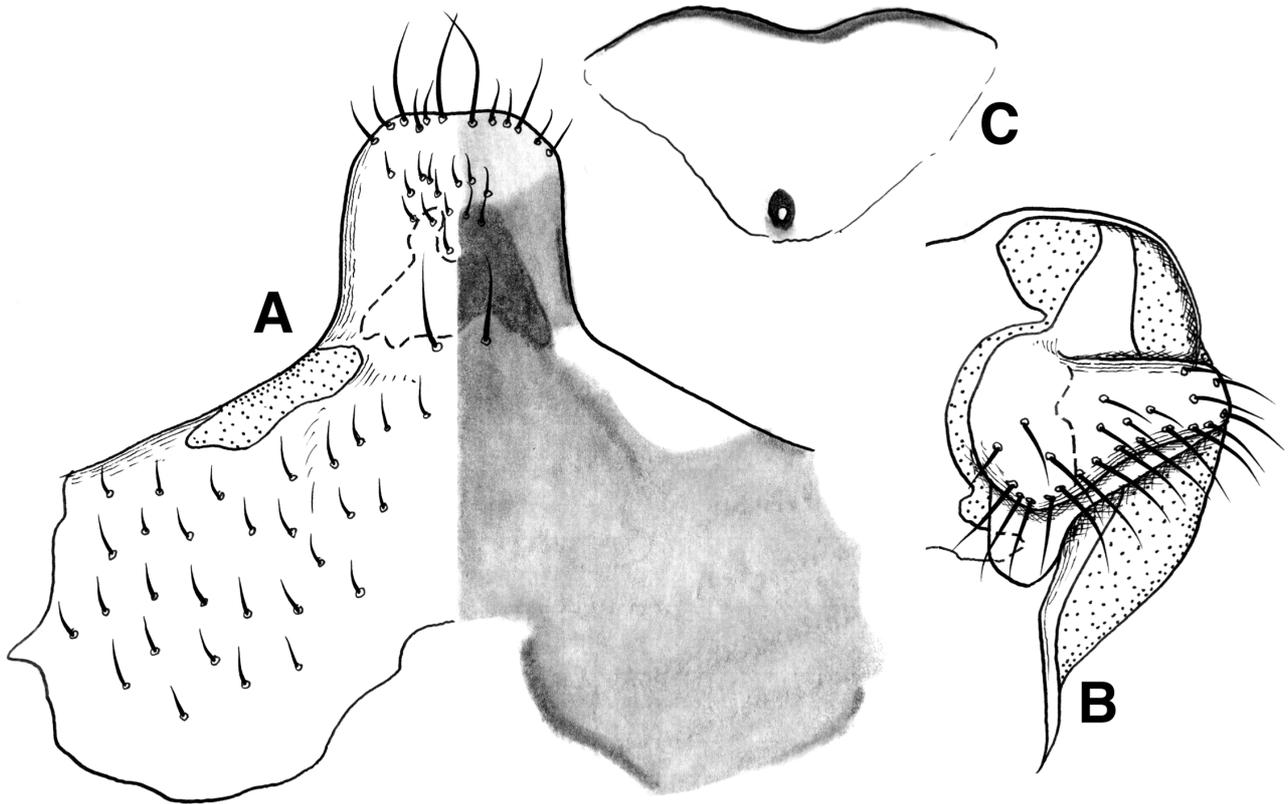


FIGURE 21. Female genitalia of *Trichadenotecnum santosai*, ventral view. A: subgenital plate; B: gonapophyses; C: spermapore plate.

***Trichadenotecnum cornutum* Endang & New**
(Figs 1Q, 24)

Trichadenotecnum cornutum Endang & New, 2005: 28.

Specimens examined. [Malaysia] 1 male, Endau Rompin, Johor, 9.vii.2003, NT (UKM); 1 male, Fraser's Hill, Pahang, 6.iii.2003, KY (UKM).

Remarks. This species was originally described from Sumatra, Indonesia based on a single male and is here recorded from Peninsula Malaysia for the first time. The specimens examined here are in good agreement with the original description of *T. cornutum* (Fig. 24). However, Endang & New (2005) described the phallosome of *T. cornutum* as open posteriorly, whereas, in the presently examined specimens, this structure is closed (Fig. 24D). However, the figure of the strongly deformed phallosome in the original description clearly shows that it was broken before being illustrated. Apart from the posteromedian part, the phallosomal structure of the present specimens is also in good agreement with the original illustration of *T. cornutum*. Therefore, we concluded that the difference between the present specimens and the original description corresponds to an artifact, and that the specimens examined here are conspecific with *T. cornutum*. Examination of the complete phallosome showed a very particular, long posteromedian spine, which is uniquely observed in this species within the genus *Trichadenotecnum*.

Because the female of this species remains unknown, identification of its close relatives among the *majus* group is difficult. Presence of the median tongue resembles *T. majus* and its relatives, but it represents a plesiomorphic condition within the group. *T. cornutum* resembles *T. soenarti*, for which both sexes are known, in male hypandrial structures (median tongue present) and in the structure of the phallosome (posterior margin strongly extended ventrally). Their close affinity is undoubted so that *T. cornutum* is also likely to be closely related to *T. apertum* and its relatives, as well as *T. soenarti*.

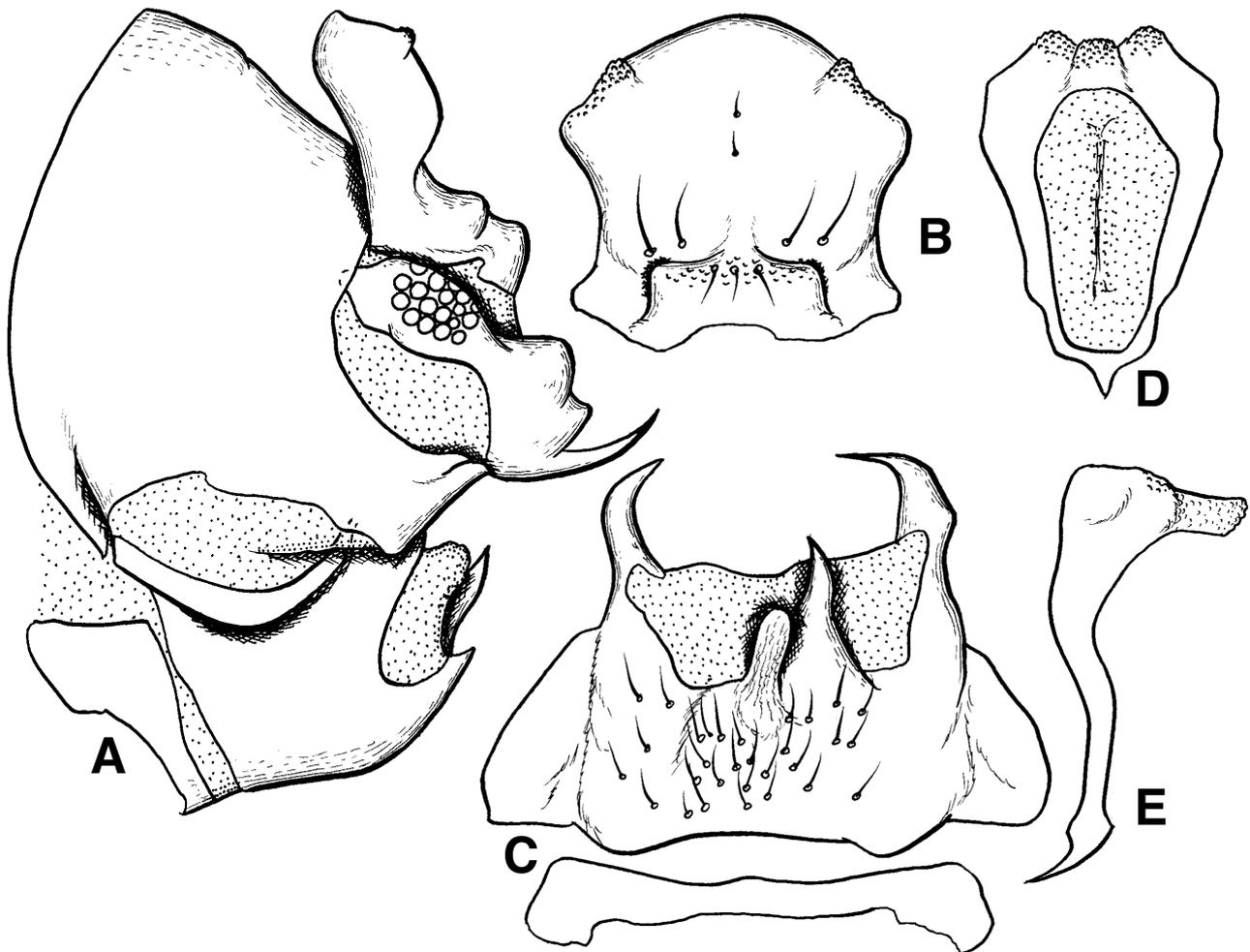


FIGURE 22. Male terminalia of *Trichadenotecnum soenarti*. A: terminalia, lateral view; B: epiproct, dorsal view; C: hypandrium, ventral view; D: phallosome, ventral view; E: phallosome, lateral view.

***Trichadenotecnum anomalum* Yoshizawa & Lienhard, sp.n.**

(Figs 1R, 25)

Holotype. Male, Singapore, Bukit Timah forest, 24 hr survey, section trap 5–9 am, 26.x.1969, D.H. Murphy (MHNG).

Description (note that the condition of the specimen is bad). **Male. Head.** Yellowish in ground color; vertical markings and orbital markings obscure; coronal suture black; epicranial suture faintly bordered with brown band dorsally; frons with faint markings; eye black, IO/D= 1.1; ocelli white, ocellar field brown; gena mostly yellowish; postclypeus with seven rows of spots dorsomedially; anteclypeus brown. Antenna pale brown. Mouthparts brown.

Thorax. Prothorax brown. Mesonotum yellowish, lateral lobe of scutum with faint marking, anterolateral corners of scutellum brown. Metanotum yellowish, lateral lobe of scutum with faint marking, lateral corner of scutellum brown. Meso- and metapleuron pale brown except for white membranous regions.

Legs. Mostly pale brown, foretibia and tarsi of all legs darker.

Forewing (Fig. 1R). Hyaline, lacking almost all marking elements characteristic for *Trichadenotecnum* except following: opposing spots in cell r distinct, fused to single marking; basal band only distinct around Rs-M fusion and in cell cua.

Terminalia. 8th sternum with pair of sclerotized portions (Fig. 25AC). Clunium (Fig. 25A) with broad lateral arms, about parallel sided and with strong dorsal expansion apically. Epiproct (Fig. 25AB) strongly expanded dorsally and anteriorly over clunium, posteriorly with small conical projection medially; dorsal margin of epiproct

lobe broad and posterior surface convex. Paraproct (Fig. 25A) with small distal lobe and with short and almost straight distal process directed posteriorly. Hypandrium (Fig. 25C) asymmetrical, without median tongue but with tongue-shaped projection medially near anterior margin, anterolaterally with pair of areas densely covered with tiny denticles, distally with two processes, one arises medially (= right process), acute conical in shape, the other arises left to this process (= left process), broad with diagonally truncated distal end; right posterolateral corner with denticulated longitudinal keel and with broadly expanded plate with serrated distal and internal margins. Phallosome (Fig. 25D) with broad distal margin slightly concave medially, about parallel sided and narrowing to pointed anterior end, lacking anterior process.

Measurements. B 1.5, Fw 2.0, Hw 1.5.

Female. Unknown.

Remarks. This species is very unusual in its forewing markings (Fig. 1R). Although density is variable, the forewings of all known *Trichadenotecnum* species are broadly spotted (Fig. 1A-Q, S-U). Especially, in less heavily spotted species, six characteristic submarginal spots are always clearly visible, and this is considered to be an autapomorphy of the genus. In contrast, the forewings of *T. anomalum* are mostly transparent except for some markings in the basal half (Fig. 1R). The condition of the holotype specimen is poor, with many body markings faded. However, the basal band of the forewing can be seen clearly in the holotype so that absence of the marking characteristics of *Trichadenotecnum*, such as the submarginal row of spots, is probably not due to the poor condition of the specimen. The 9th tergite of *T. anomalum* possesses posterolateral arms (Fig. 25A), a character which is uniquely observed in *Trichadenotecnum* among Psocidae. Other diagnostic characters of the genus, such as the triangular areola postica, can also be seen (Fig. 1R). Therefore, the species is here considered as a member of *Trichadenotecnum*. The species seems to be closely related to *T. apertum* and its relatives because of the absence of the hypandrial median tongue and other resemblances of the terminal structures. The unique forewing markings are probably autapomorphic to this species.

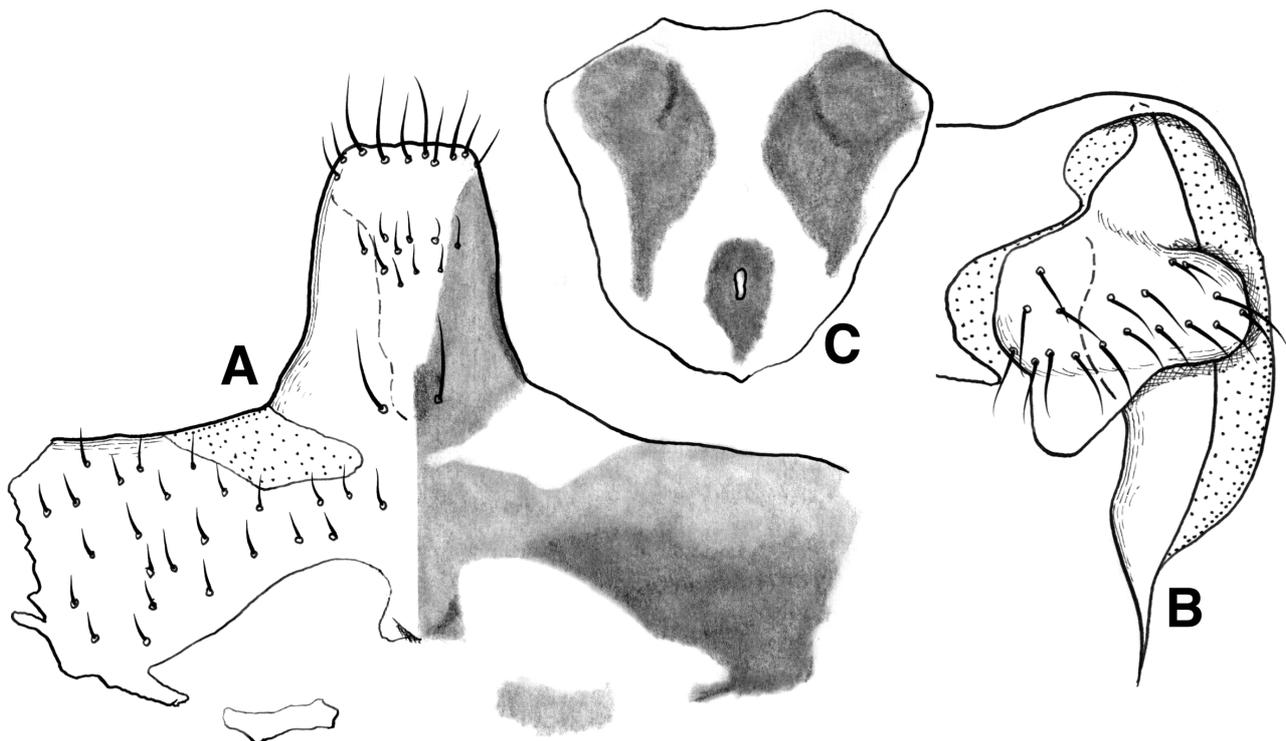


FIGURE 23. Female genitalia of *Trichadenotecnum soenarti*, ventral view. A: subgenital plate; B: gonapophyses; C: spermapore plate.

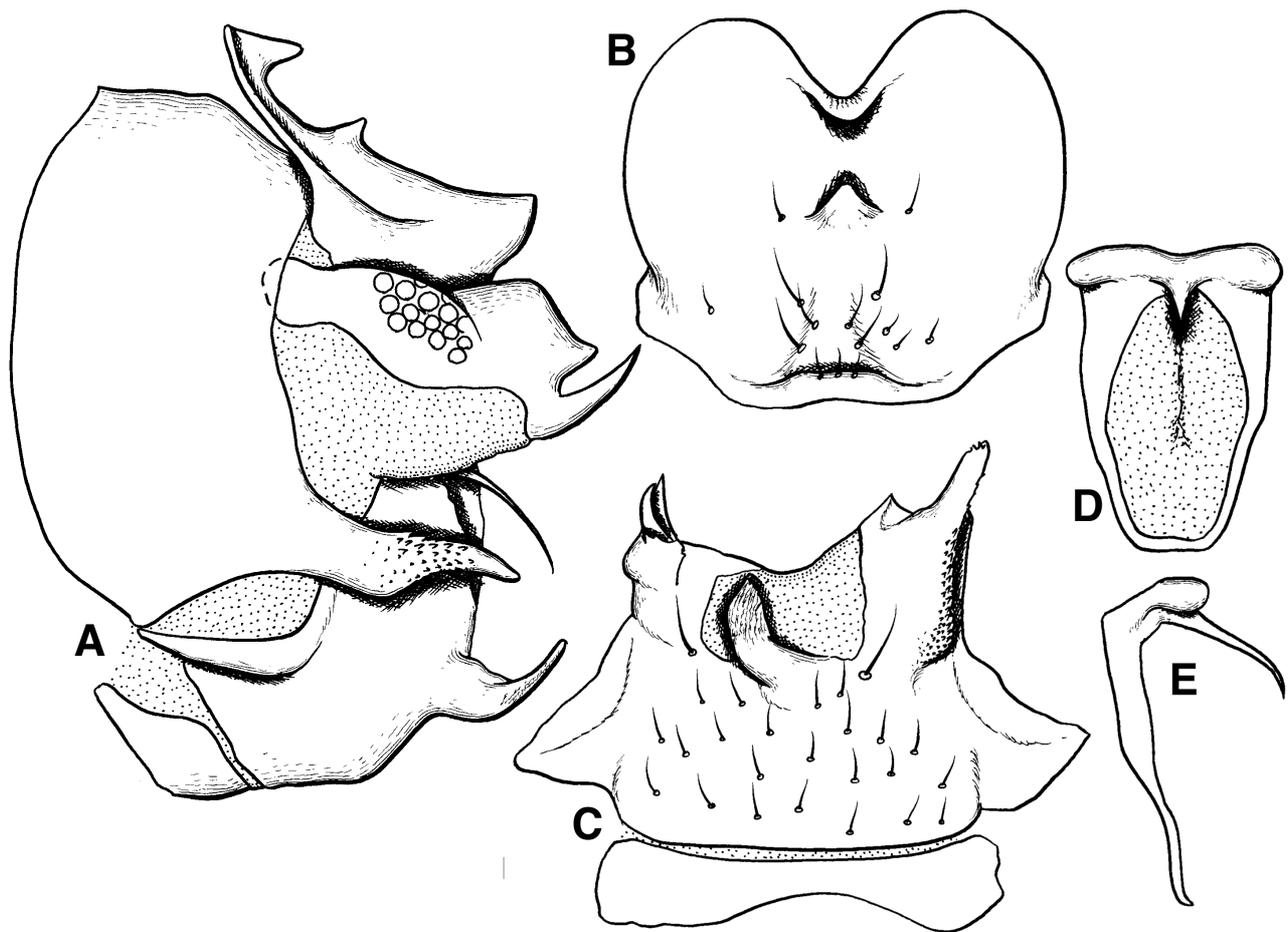


FIGURE 24. Male terminalia of *Trichadenotecnum cornutum*. A: terminalia, lateral view; B: epiproct, dorsal view; C: hypandrium, ventral view; D: phallosome, ventral view; E: phallosome, lateral view.

***Trichadenotecnum rachimi* Endang & Thornton**

(Figs 1S, 26)

Trichadenotecnum rachimi Endang & Thonton, 1992: 363.

Trichadenotecnum arciforme: New & Lee, 1992: 155. [Misidentification]

[Not *Trichadenotecnum arciforme* Thornton, 1961: 11; Yoshizawa & Lienhard, 2004: 141. (Hong Kong)]

[Not *Trichadenotecnum arciforme*: Thornton, 1984: 157. (Indonesia)]

Specimens examined. [Singapore] 1 female, Botanic Gardens, Rain Forest, beating, 25m, 16.xii.1987, CL (MHNG); 1 female, See Soon, Rifle Range, Swamp Forest, beating, 18.xii.1987, CL (MHNG); 1 female, Botanic Gardens, 20–30m, 5.xii.1988, CL (SEHU).

Remarks. Judging from the wing markings and female genitalia, the specimens listed above were identified as *T. rachimi*. This species was described originally from Lombok, Indonesia, and is here recorded from Peninsular Malaysia for the first time. The females examined here are also undoubtedly conspecific with the females recorded under the name of *T. arciforme* from Peninsular Malaysia by New & Lee (1992). However, the Malaysian females are clearly different from the female of *T. arciforme* described from Hong Kong (Yoshizawa & Lienhard, 2004). Female *T. arciforme* recorded from Bali and Lombok, Indonesia (Thornton, 1984) differs from both Malaysian and Hong Kong species recorded under the name.

The short ventral valve of gonapophyses (Fig. 26B) strongly suggests that these females are closely related to *T. apertum* and its relatives. Among the species examined here, the females of *T. anomalum* and *T. cornutum* are unknown to date. *T. cornutum* is significantly larger than *T. rachimi* and has different forewing markings (Fig. 1Q and S) so that its conspecificity is less likely. *T. anomalum* and *T. rachimi* are significantly different in their

forewing markings (Fig. 1R and S), although *T. anomalum* is known only from a single male and its intraspecific variation cannot be evaluated.

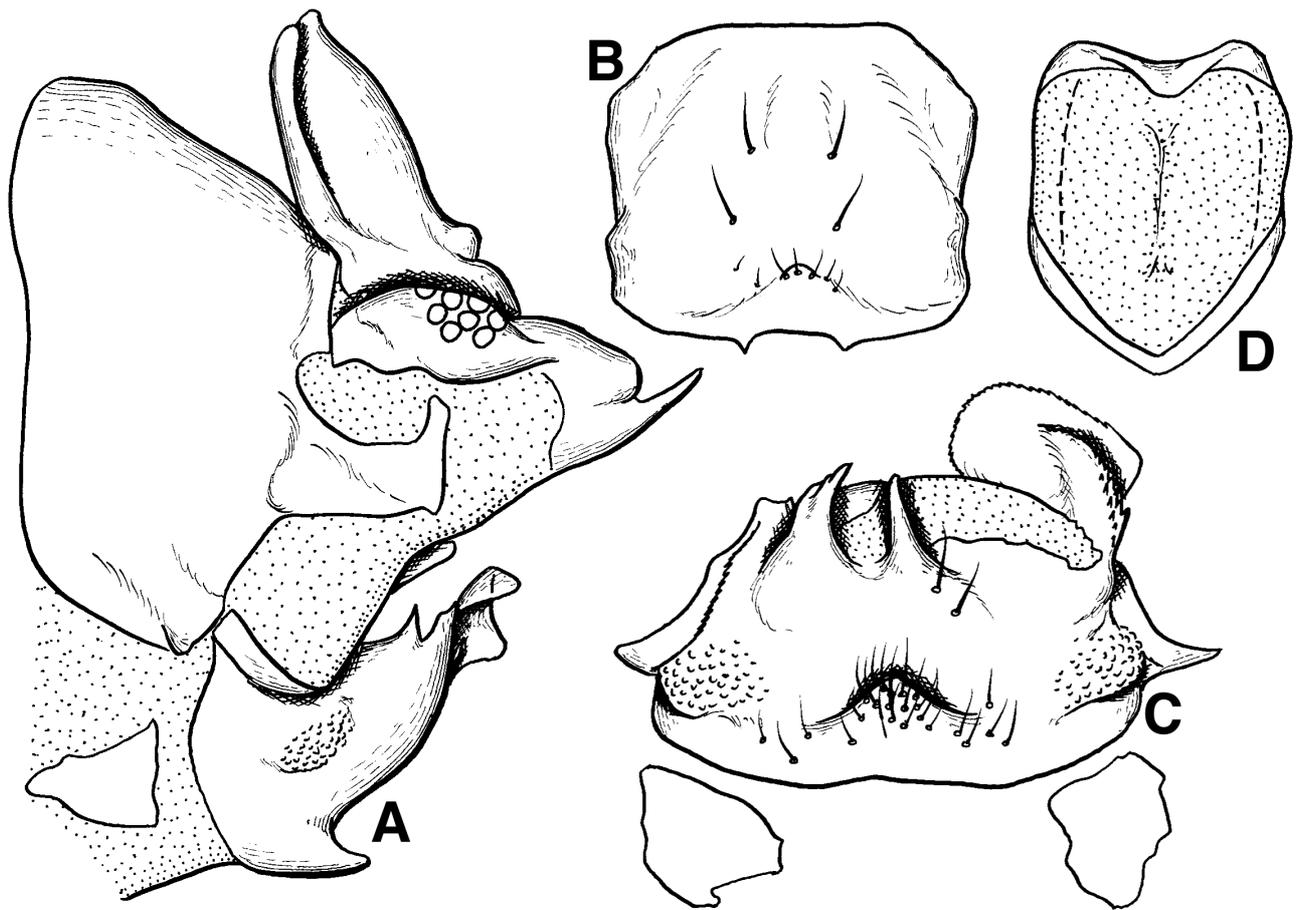


FIGURE 25. Male terminalia of *Trichadenotecnum anomalum*. A: terminalia, lateral view; B: epiproct, dorsal view; C: hypandrium, ventral view; D: phallosome, ventral view.

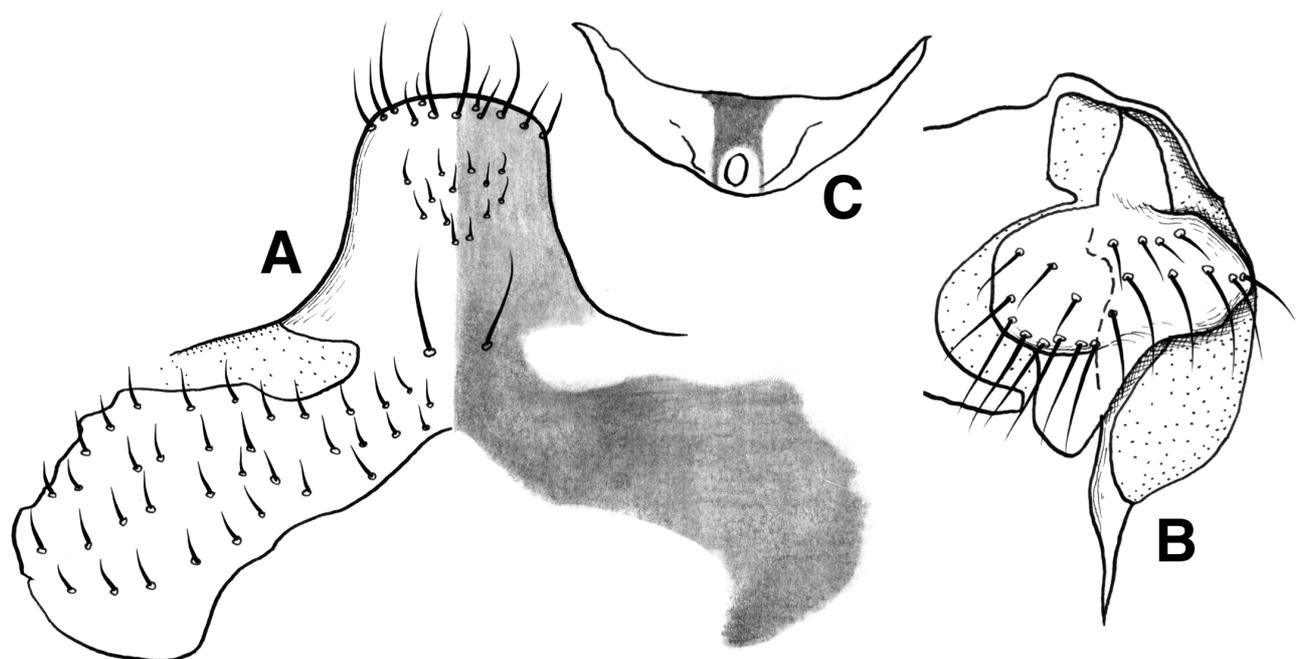


FIGURE 26. Female genitalia of *Trichadenotecnum rachimi*, ventral view. A: subgenital plate; B: gonapophyses; C: spermapore plate.

***Trichadenotecnum kerinciense* Endang & New**
(Figs 1T, 27, 28)

Trichadenotecnum kerinciense Endang & New, 2005: 26.

Specimens examined. [Malaysia] 1 male (KY376) 2 females (KY191), Gunung Berembun, Path 3, Cameron Highlands, Pahang, 14.vii.2003, HK.etal (canopy fogging, St. 6) (UKM); 2 females, Gunung Berembun, Cameron Highlands, Pahang, 15.vii.2003, HK.etal (canopy fogging, St. 8) (UKM); 1 female, same locality, date, collectors (canopy fogging, St. 9) (SEHU).

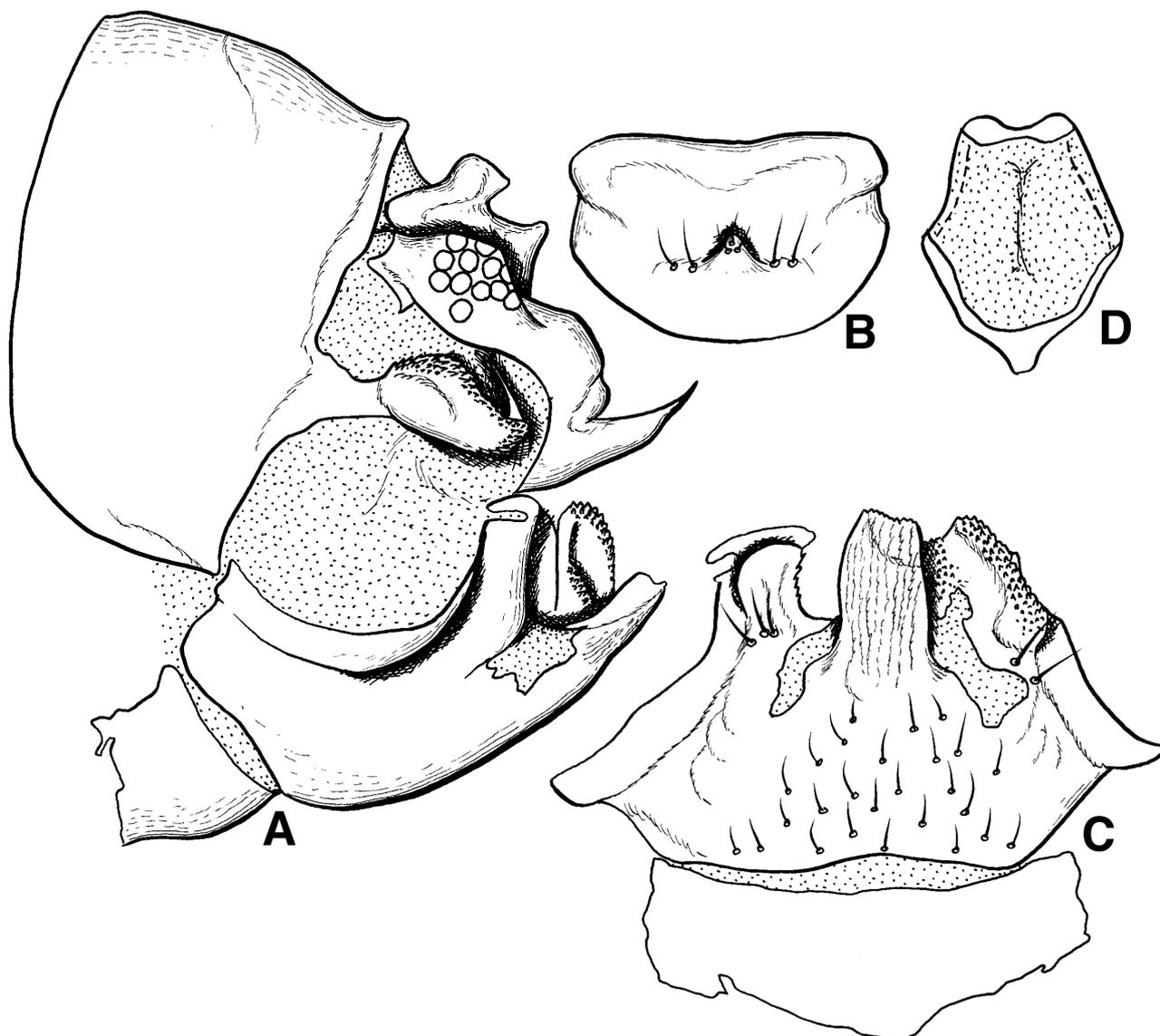


FIGURE 27. Male terminalia of *Trichadenotecnum kerinciense*. A: terminalia, lateral view; B: epiproct, dorsal view; C: hypandrium, ventral view; D: phallosome, ventral view.

Description of male terminalia. 8th sternum with single large transversal sclerite closely placed to hypandrium (Fig. 27AC). Clunium (Fig. 27A) with well developed lateral arm, its dorsal to ventro-distal region covered by denticles, apically with dorso-anteriorly directed needle-like process. Epiproct (Fig. 27AB) with conical process medially; epiproct lobe weakly developed, not strongly expanded dorsally and anteriorly. Paraproct (Fig. 27A) with weakly developed distal lobe and with long and straight distal process directed posteriorly. Hypandrium (Fig. 27C) asymmetrical, with broad membranous region lateral and distal to median tongue; median tongue well developed but unmovable, its ventral surface covered by wrinkles; left process weakly projecting,

serrated internally; right process keel-like, densely covered by denticles ventrally. Phallosome (Fig. 27D) broad on posterior margin with shallow concavity in middle, broadened laterally, narrowing to somewhat truncated anterior end, without anterior process.

Remarks. The species was originally described from Sumatra, Indonesia based only on female specimens and is here recorded from Peninsula Malaysia for the first time. The male of *T. kerinciense* is also described here for the first time. Female genitalia (Fig. 28) match very well with the original description of this species, especially in the characteristic body part of the subgenital plate. Judging from the male hypandrium structure, especially the unmovable median tongue (Fig. 27C), its placement within the *majus* group is unquestionable. The hypandrial median tongue is well developed and the ventral valve of gonapophyses is long, both characters are widely observed in other species group and thus are plesiomorphic conditions within the *majus* group.

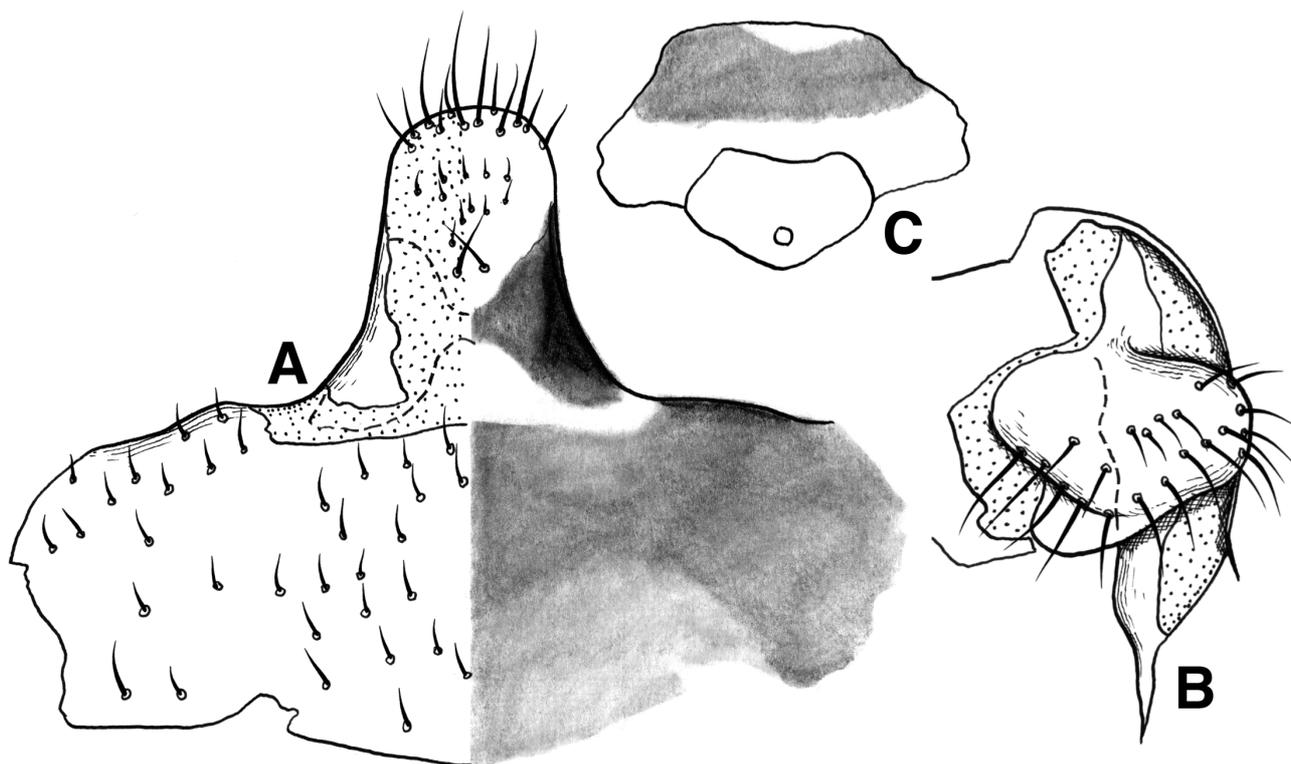


FIGURE 28. Female genitalia of *Trichadenotecnum kerinciense*, ventral view. A: subgenital plate; B: gonapophyses; C: spermapore plate.

The *krucilense* group (new species group)

This group is so far represented by a single species, *T. krucilense*, known only from males. Forewing not extensively covered with small spots (Fig. 1U). Eighth sternum with single sclerite separated from hypandrium (Fig. 29AC). Epiproct chair-shaped, epiproct lobe long, protruding over clunium (Fig. 29AB). Hypandrium symmetrical, median tongue absent (Fig. 29C). Phallosome closed apically, with pseudoparameres (Fig. 29D).

***Trichadenotecnum krucilense* Endang, Thornton & New** (Figs 1U, 29)

Trichadenotecnum krucilense Endang, Thornton & New, 2002: 165; Endang & New, 2005: 23.

Specimen examined. [Malaysia] 1 male, Gnung Berembun, Path 3, Cameron Highlands, Pahang, 14.vii.2003, HK.etal (canopy fogging, St. 6).

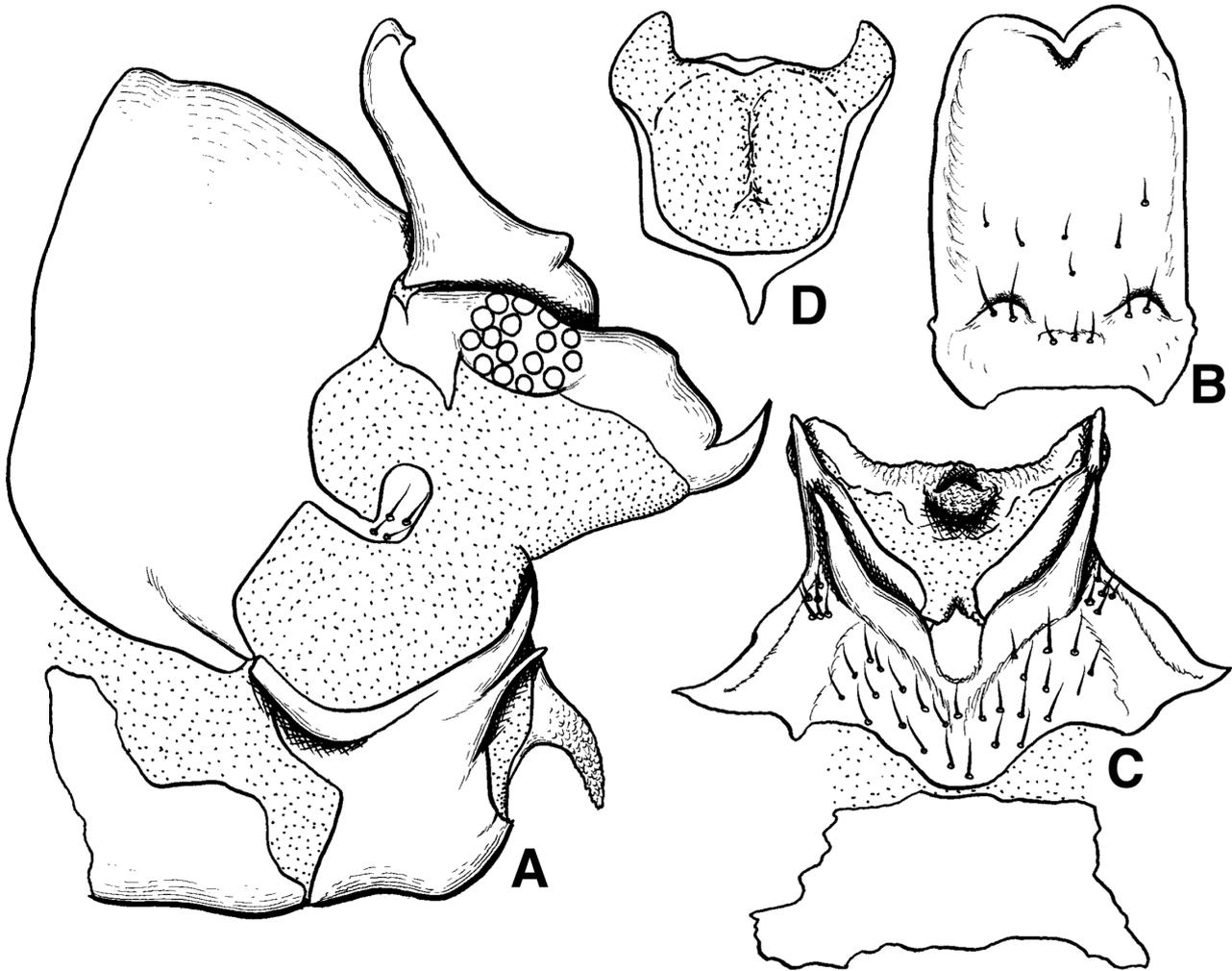


FIGURE 29. Male terminalia of *Trichadenotecnum krucilense*. A: terminalia, lateral view; B: epiproct, dorsal view; C: hypandrium, ventral view; D: phallosome, ventral view.

Remarks. The species was originally described from Java, Indonesia, later also recorded from Sumatra, Indonesia, and is here recorded from Peninsula Malaysia for the first time. The variation of the hypandrial structure, three (Javanese) or four (Sumatran) hypandrial spikes, has been pointed out by Endang & New (2005). The presently examined specimen has four hypandrial spikes. Judging from the original hypandrial illustration published by Endang *et al.* (2002: fig. 333), missing of some hypandrial parts on the left side of the specimen seems evident; on that side only one spike is figured whereas two on the other side. It is likely that the variation pointed out by Endang & New (2005) is actually an artifact caused by dissection or preparation.

The hypandrium of this species (Fig. 29C) is unique, very different from that of any other known species. Absence of the hypandrial median tongue may indicate its close affinity with *T. apertum* and its close relatives. In the original description of this species, the phallosome is illustrated in highly deformed condition, but the present examination clearly shows that this species has the pseudo-parameres on the phallosome (Fig. 29D). The presence of this structure is a synapomorphy of the *sexpunctatum*, *medium* and New World species groups (see Yoshizawa *et al.*, 2008) so that assignment of *T. krucilense* into the *majus* group is excluded. However, this species cannot be assigned to the *sexpunctatum*, *medium* or New World species groups because of lack of apomorphies characterizing any of these species group so that a new species group for its own is proposed here. Females of this species are unknown to date.

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APPENDIX. New species group assignments proposed for some species not treated in the main text.

The *spiniserrulum* group

Trichadenotecnum paradika Endang & New, 2005 (from Indonesia)

The *majus* group

Trichadenotecnum arciforme Thornton, 1961 (from Hong Kong)

Trichadenotecnum laticornutum Endang, Thornton & New, 2002 (from Indonesia)

Trichadenotecnum quadrispinosum Endang, Thornton & New, 2002 (from Indonesia)

Trichadenotecnum waykananense Endang & New, 2005 (from Indonesia)