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The *Trichadenotecnum corniculum* species group from Thailand (Psocodea: Psocidae)

El grupo de especies de *Trichadenotecnum corniculum* de Tailandia (Psocodea: Psocidae)

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ABSTRACT

Five new species of the *corniculum* species group of the psocid genus *Trichadenotecnum* Enderlein, *T. alfonsoi*, *T. lingens*, *T. palmula*, *T. affinifelix* and *T. separatum* were described from Thailand. These species share a couple of male genital apomorphies with the other Oriental species of this species group recorded from China, Hong Kong, Malaysia, Singapore and Indonesia. The Japanese species of the *corniculum* group are considered to form a different clade placed as the sister to the rest of Oriental species.

Key words: Psocoptera, taxonomy, new species, male genitalia, Oriental region.

RESUMEN

Se describen cinco especies del grupo de especies *corniculum* del género de psócidos *Trichadenotecnum* Enderlein de Tailandia: *T. alfonsoi*, *T. lingens*, *T. palmula*, *T. affinifelix* and *T. separatum*. Estas especies comparten un par de apomorfias en el genital masculino con otras especies Orientales de este grupo de especies registradas para China, Hong Kong, Malasia, Singapur e Indonesia. Las especies japonesas del grupo *corniculum* se consideran que forman un clado diferente ubicado como hermano del resto de las especies Orientales.

Palabras clave: Psocoptera, taxonomía, especie nueva, genitalia masculina, región Oriental.

The *corniculum* species group of the psocid genus *Trichadenotecnum* was first proposed by Yoshizawa (2003) for two Japanese species characterized by two male genital autapomorphies: the conical process on the paraproctal trichobothrial field (trichobothrial process) and the denticulate or serrated hypandrial right corner. Subsequently, several species from China, Hong Kong, Malaysia, Singapore and Indonesia were assigned to this group (Yoshizawa & Lienhard 2004; Yoshizawa *et al.* 2014). The monophyly of this group and its deep divergence within the genus *Trichadenotecnum* were suggested by morphological data (Yoshizawa 2003), and later confirmed by extensive molecular phylogenetic analyses (Yoshizawa *et al.* 2016, 2017).

Through the TIGER project (Thailand Inventory Group for Entomological Research: <http://sharkeylab.org/tiger> [accessed on Feb 25, 2020]), many psocids (Psocodea: 'Psocoptera'), including about 50 species of the genus *Trichadenotecnum*, were collected and entrusted to the Geneva Natural History Museum. Of them, the *alinguum* and the *marginatum* species groups have already been studied (Yoshizawa & Lienhard 2015a, b). For this paper, we studied the *corniculum* species group from the TIGER material.

MATERIALS AND METHODS

All specimens examined in this study were collected through the TIGER project with Malaise traps; T-numbers are TIGER project sample numbers. The specimens were preserved in 80% ethanol. Type material will be deposited in the Queen Sirikit Botanical Gardens, Thailand.

As discussed below, all species described in this paper are superficially very similar to each other. Based on mor-

phology, male-female association for separately collected specimens could not be established, and there were no samples in which possibly conspecific males and females were collected simultaneously. Therefore, the following descriptions are exclusively based on male specimens.

Abbreviations used in the descriptions: BL = body length; FW = forewing length; HW = hindwing length; IO/D = shortest distance between compound eyes divided by longitudinal diameter of compound eye in dorsal view of head.

RESULTS

The *corniculum* group

See Yoshizawa (2003) and Yoshizawa & Lienhard (2004) for group diagnosis. In addition to the diagnostic characters mentioned by these authors, the following male genital features are present in all species examined here: paraproct with dorsal swelling at base of distal lobe; hypandrial median tongue well developed and thin; hypandrial right lateral corner densely covered by denticles; phallosome bifurcated apically.

Trichadenotecnum alfonsoi Yoshizawa and Lienhard, n. sp.

(Figs 1A, 2)

<http://zoobank.org/6AF52839-A95B-40BB-B79B-27662D8137DB>

Holotype. Male. THAILAND, Sakon Nakhon, Phu Phan NP, behind forest protection unit at Huay Wien Prai, 17°6.863'N 104°0.327'E, 387m, Malaise trap, 17–25. ii.2007, Winlon Kongnara leg. T1692 (Tiger 2).

Paratypes. 2 males, same locality as holotype, 10–17.ii.2007, Winlon Kongnara leg. T1687 and T1689; 1 male THAILAND, Sakon Nakhon, Phu Phan NP, Nam Hom Waterfall # Sao Hi, 17°7.34'N 104°0.788'E, 344m, Malaise trap, 4–10.iii.2007, Sailom Tongboonchai leg. T2368.

Description. Male. Head. Almost uniformly blackish brown, including mouthparts and antennae, except for pair of white spots next to ocellar field, pair of pale regions on frons, and white dorsal region of postclypeus. Eyes black, IO/D 0.8; ocellar field black.

Thorax. Blackish brown except for white membranous region and white longitudinal line in middle of mesoscutum; metascutum with small white spot on posterior end of each scutum lobe.

Legs. Blackish brown.

Forewing. As in Fig. 1A.

Terminalia. Epiproct (Fig. 2AB) with conical lobe anteromedially. Paraproct (Fig. 2A) without trichobothrial process but with wrinkled area medially; with dorsal swelling at base of distal lobe; distal process slender. Hypandrium (Fig. 2C) with well-developed left process; median tongue circular in shape, with weak serration on left posterior margin; right corner strongly projecting posterolaterally, with keel-like lateral expansion. Phallosome (Fig. 2D) with pair of simple posterior processes.

Measurements (in mm). BL 1.8–2.1; FW 2.4–2.6; HW 1.8–2.0.

Female. Unknown.

Etymology. The species epithet honors our friend and colleague, Alfonso Neri García Aldrete, for his eminent contributions to the study of psocoptera.

Remarks. This species resembles *T. pycnacanthum* (Li, 2002) by the epiproctal and hypandrial structures but can be distinguished from it by the smaller body size, lack of the trichobothrial process, and by the apical shape of the phallosome.

***Trichadenotecnum lingens* Yoshizawa and Lienhard, n. sp.**

(Figs 1B, 3)

<http://zoobank.org/58786FC5-8180-455B-A20C-7E8541606D50>

Holotype. Male. THAILAND, Suphanburi, Pu Toei NP, *Pinus merkusii* forest, 14°58.4'N 99°26.017'E, 763m, Malaise trap, 8–15.viii.2008, Saunbua L. leg. T3144 (Tiger 46).

Description. Male (head and prothorax missing).

Thorax. Brown except for white membranous region and white longitudinal line in middle of mesoscutum; with white region on posterior region of each metascutum lobe.

Legs. Missing except for brown mid and hind coxae.

Forewing. As in Fig. 1B.

Terminalia. Epiproct (Fig. 3AB) with small anteromedian lobe dorsally covered with papillae. Paraproct (Fig. 3A) with tubercular trichobothrial process covered with denticles; with weak dorsal swelling at base of distal lobe; distal process slender. Hypandrium (Fig. 3C) with well-developed left process; median tongue elongated, apically broadened, posterointernal margin serrated; right corner with posterolateral projection. Phallosome (Fig. 3D) with broad and medially concave distal process, its posterolateral corners denticulate.

Measurements. BL unavailable (head and prothorax missing); FW 2.4; HW 1.9.

Female. Unknown.

Etymology. Named after the strongly extended hypandrial median tongue; *lingens* means licking in Latin (present participle of the verb *lingere* = to lick).

Remarks. This species can be distinguished from all other species of the *corniculum* group by its unique, strongly extended hypandrial median tongue.

***Trichadenotecnum palmula* Yoshizawa and Lienhard, n. sp.**

(Figs 1C, 4)

<http://zoobank.org/99B363E6-5EC5-4B6E-A156-57DE220FFF36>

Holotype. Male. THAILAND, Chanthaburi, Khao Khitchakut NP, Sala/Chang-sae waterfall, 12°49.33'N 102°9.4'E, 290m, Malaise trap, 6–13.xi.2008, Sutuida & Charoenchai leg. T3977 (Tiger 1).

Description. Male. Head. Almost uniformly blackish brown including mouthparts, except for four white spots around ocellar field, pair of white patches on frons, and white dorsal region of postclypeus. Eyes black, IO/D 0.6; ocellar field black.

Thorax. Blackish brown except for white membranous region and white longitudinal line in middle of mesoscutum; metascutum with small white spot on posterior end of each scutum lobe.

Legs. Blackish brown, fore femur paler.

Forewing. As in Fig. 1C.

Terminalia. Epiproct lobe (Fig. 4AB) only weakly swelling, broadly covered with papillae. Paraproct (Fig. 4A) with keel-like trichobothrial process covered with denticles; dorsal swelling basal to distal lobe not obvious; distal process broad basally, gradually narrowing to pointed tip. Hypandrium (Fig. 4C) with small left process; with weakly sclerotized median projection left to median tongue; median tongue elongated, parallel-sided, distal margin diagonally truncated and serrated; right corner strongly expanded posteriorly. Phallosome (Fig. 4D) with pair of broadly separated, slender, and strongly curved distal processes.

Measurements. BL 2.0; FW 2.4; HW 1.8.

Female. Unknown.

Etymology. Named after the blade-like hypandrial median tongue; *palmula* (a noun in apposition) means an oar's blade in Latin.

Remarks. The elongated and parallel-sided hypandrial median tongue is unique to this species within the *corniculum* group.

***Trichadenotecnum affinfelix* Yoshizawa and Lienhard, n. sp.**

(Figs 1D, 5)

<http://zoobank.org/46F45502-E565-4944-9356-781B8F0701AF>

Holotype. Male. THAILAND, Chanthaburi, Khao Khitchakut NP, Khao Prabant peak/ 150m S of forest base, 12°50.45'N 102°9.81'E, 875m, Malaise trap, 6–13.ii.2009, Suthida & Charoenchai leg. T4035 (Tiger 3).

Description. Male. Head. Vertex white in ground color, with blackish brown vertical and orbital markings; frons white, with pair of pale brown bands at middle; dorsal region of postclypeus white; other head structures including mouthparts and antennae blackish brown. Eyes black, IO/D 0.7; ocellar field black.

Thorax. Mostly blackish brown, mesoscutum with white longitudinal line in middle; metanotum pale in ground color, each scutum lobe with large brown marking; membranous region white.

Legs. Blackish brown, fore femur paler.

Forewing. As in Fig. 1D.

Terminalia. Epiproct (Fig. 5A) lobe strongly expanded anterodorsally (dorsal illustration not available, epiproct lost during dissection). Paraproct (Fig. 5A) with keel-like trichobothrial process covered with denticles; with conical dorsal projection posterior to trichobothrial field; distal process broad. Hypandrium (Fig. 5B) without left process; with pair of tubercular processes left to median tongue; median tongue broad, with serrated left distal margin; right corner with broad internal expansion. Phallosome (Fig. 5C) with pair of apically denticulate processes each bearing a small internal subapical process.

Measurements. BL 2.1; FW 2.6; HW 2.0.

Female. Unknown.

Etymology. This species is very similar to *T. felix* Thornton, 1961 (*affinis* means “related to” in Latin).

Remarks. This species resembles *T. felix* Thornton, 1961 in male genital structures but can be distinguished from the latter by the apical structure of the phallosome.

***Trichadenotecnum separatum* Yoshizawa and Lienhard, n. sp.**

(Figs 1E, 6)

<http://zoobank.org/E6F92D60-8A01-4CC2-8EDA-BFF-F9A82E787>

Holotype. Male. THAILAND, Suphanburi, PU Toei NP, *Pinus merkusii* forest, 14°58.4'N 99°26.017'E, 763m, Malaise trap, 24–31.vii.2008, Sanbua L. leg. T3140 (Tiger 3').

Description. Male (head missing).

Thorax. Dark brown except for white membranous region and white longitudinal line in middle of mesoscutum.

Legs. Missing, except for dark brown coxae.

Forewing. As in Fig. 1E.

Terminalia. Epiproct (Fig. 6AB) flat, well expanded anteriorly, with weak swelling posteromedially. Paraproct (Fig. 6A) with small and acutely pointed trichobothrial process; trichobothria broadly separated into two groups; distal lobe with broad dorsal swelling basally; distal process slender. Hypandrium (Fig. 6C) with laterally expanded keel near distal end of left corner, its posterior margin serrated; with pair of processes left to base of median tongue, left one short and broad, slightly bilobed, with rugose surface, right one well-developed, reaching to middle of median tongue; median tongue broad, distally rounded, with weakly serrated posterointernal margin; right corner not strongly developed, about same height of left corner. Phallosome (Fig. 6D) with pair of apically bifurcated processes, dorsointernal part of each process denticulate.

Measurements. BL unavailable (head missing); FW 2.4; HW 1.8.

Female. Unknown.

Etymology. Named after the widely separated paraproctal trichobothria; *separatus* means separated in Latin.

Remarks. This species is similar to *T. pycnacanthum* (Li, 2002) in some aspects of the hypandrial structures but is distinguished from it by the shape of the epiproct and the broadly separated paraproctal trichobothrial fields.

DISCUSSION

All five species treated here are superficially very similar (Fig. 1) but show significant differences in male genital structures (Figs 2–6). Except for *T. alfonsoi* n.sp. their descriptions are based on a single male specimen. However, judging from the intraspecific variations observed in *T. alfonsoi* n. sp. or in the previously known species of the *corniculum* group (Yoshizawa 2003; Yoshizawa *et al.* 2014), the variations observed between the males examined for this study far exceed the known intraspecific variability. Thus, describing new species based on a single specimen clearly appears justified.

To date, species of the *corniculum* group are recorded from the Oriental (China including Hong Kong, Malaysia, Singapore and Indonesia) and the eastern Palearctic (Japan) regions. All species described here from Thailand share two morphological characters with the previously known Oriental species: thin lamellate hypandrial median tongue and apically bifurcated phallosome. Both characters are apparently apomorphic, because they are not observed in the sister group of the *corniculum* group, the *longimucronatus* species group, and are also very rarely observed in other species of the genus *Trichadenotecnum*. Based on these synapomorphies, the Oriental species of the *corniculum* group likely form a monophyletic group representing the sister group of the clade composed of the two Japanese species. The latter also share a unique apomorphic character: the trichobothrial process arises from the distal end of the trichobothrial field (Yoshizawa, 2003).

Within the Oriental clade, one monophyletic group composed of *T. palmula* n. sp., *T. affinifelix* n. sp., *T. separatum* n. sp., *T. felix* Thornton, 1961 (Hong Kong), *T. imrum* New and Thornton, 1976 (Malaysia and Singapore), and *T. cinnamomum* Endang and New, 2014 (Malaysia and Indonesia) can be recognized, which is characterized by the presence of one or two tubercular processes left to the hypandrial median tongue, both apparently representing an apomorphic condition (never observed in other *Trichadenotecnum*). *T. pycnacanthum* (Li, 2002) (China) may also belong to this clade because this species shares two apomorphies with *T. separatum* n. sp.: presence of a keel on the hypandrial left corner and apically forked phallosomal processes. However, the hypandrial tubercular processes are not illustrated for *T. pycnacanthum* (Li, 2002). Some of the hypandrial structures of *T. pycnacanthum* are not clearly illustrated in the original description so that the examination of the type material of this species is needed to decide its phylogenetic placement. Among the species from Thailand, *T. alfonsoi* n. sp. and *T. lingens* n. sp. are characterized by the presence of a well-developed hypandrial left process. However, the hypandrial left process is widely observed throughout *Trichadenotecnum*, and a less developed left process can also be seen in *T. palmula* n. sp. and *T. imrum*, both belonging to the clade with the tubercular hypandrial processes.

The TIGER material contains five species of the *corniculum* group, which far exceeds the previously known diversity of this group in other countries or regions: two species from Japan, two from China including Hong Kong, and two from Malaysia + Singapore + Indonesia. This strongly suggests that the diversity of the *corniculum* group is in reality much higher, especially in the Oriental region. The present results show the efficiency of the sampling conducted by

the TIGER project and the great importance of this project for uncovering insect diversity in Thailand.

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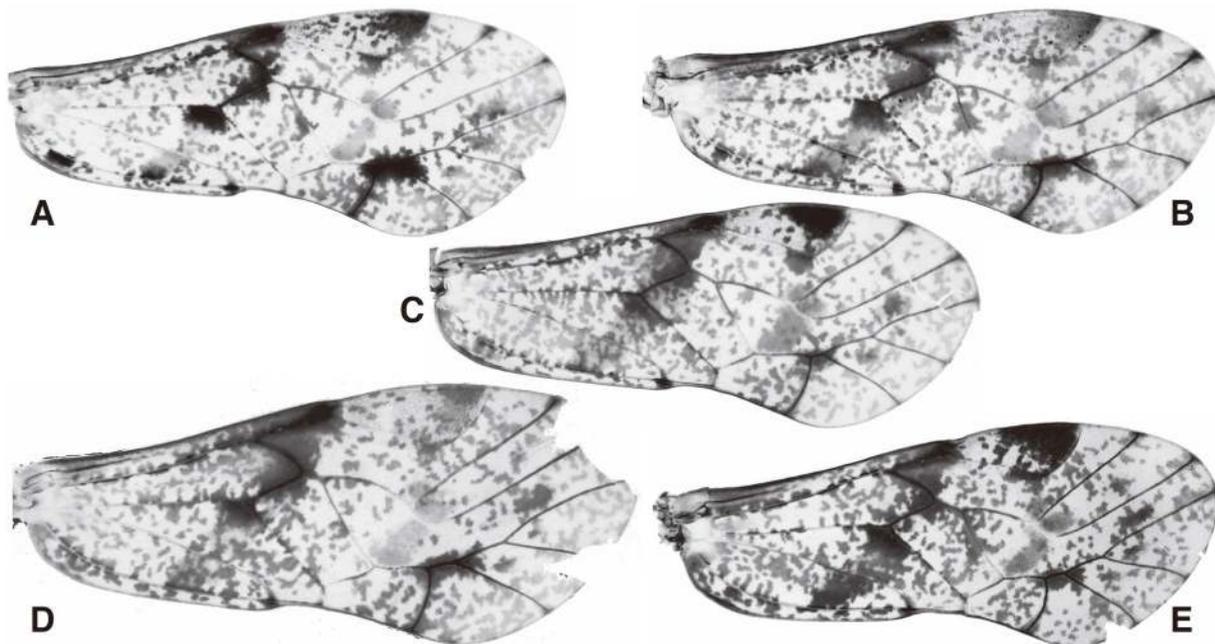


Figure 1. Male right forewing of the new species of the *Trichadenotecnum corniculum* group (holotypes). A. *T. alfonsoi*. B. *T. lingens*. C. *T. palmula*. D. *T. affinfelix*. E. *T. separatum*.

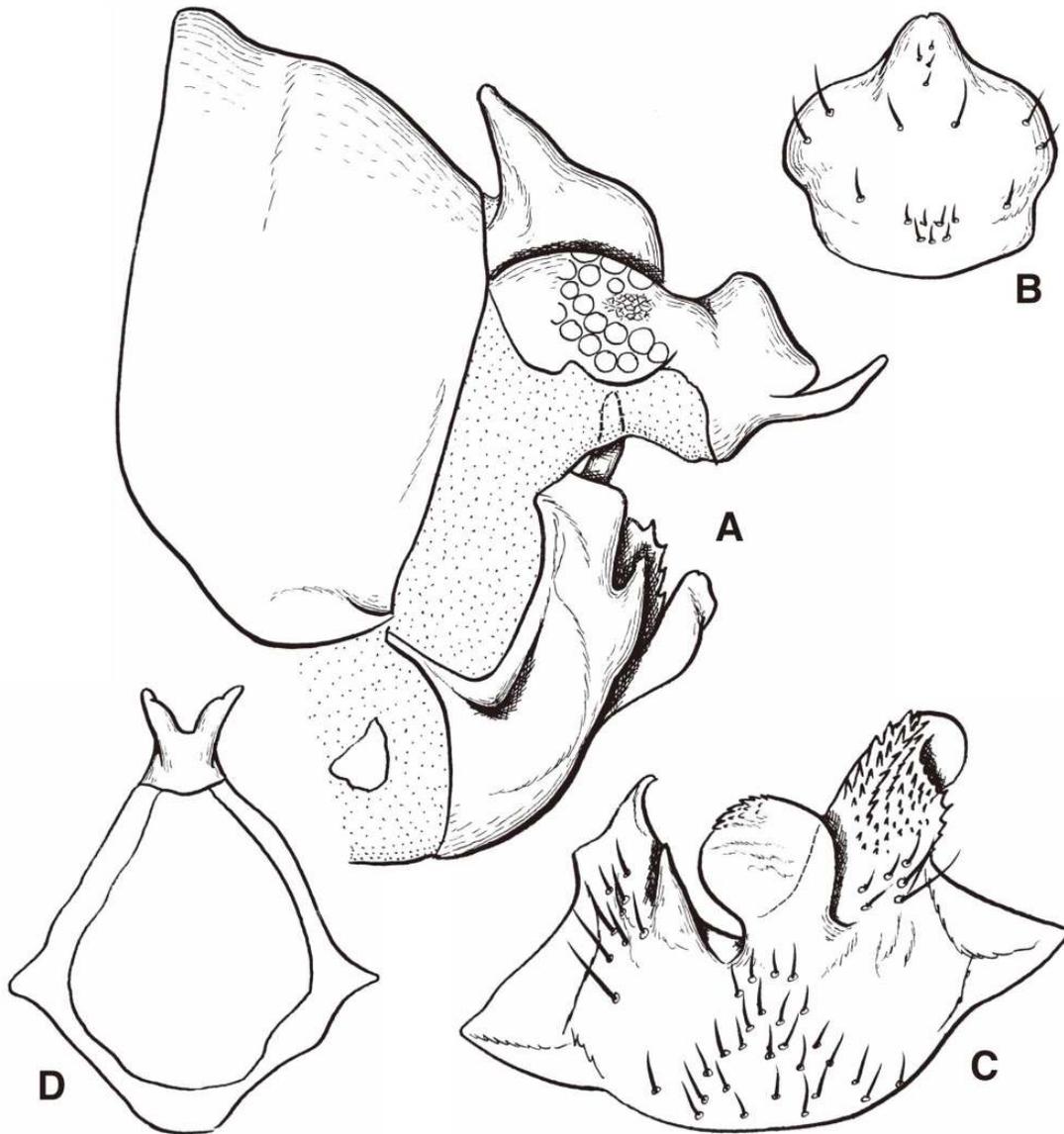


Figure 2. Male terminalia of *Trichadenotecnum alfonsoi* n. sp. (holotype). A. Terminalia, lateral view. B. Epiproct, dorsal view. C. Hypandrium, posteroventral view. D. Phallosome, ventral view.

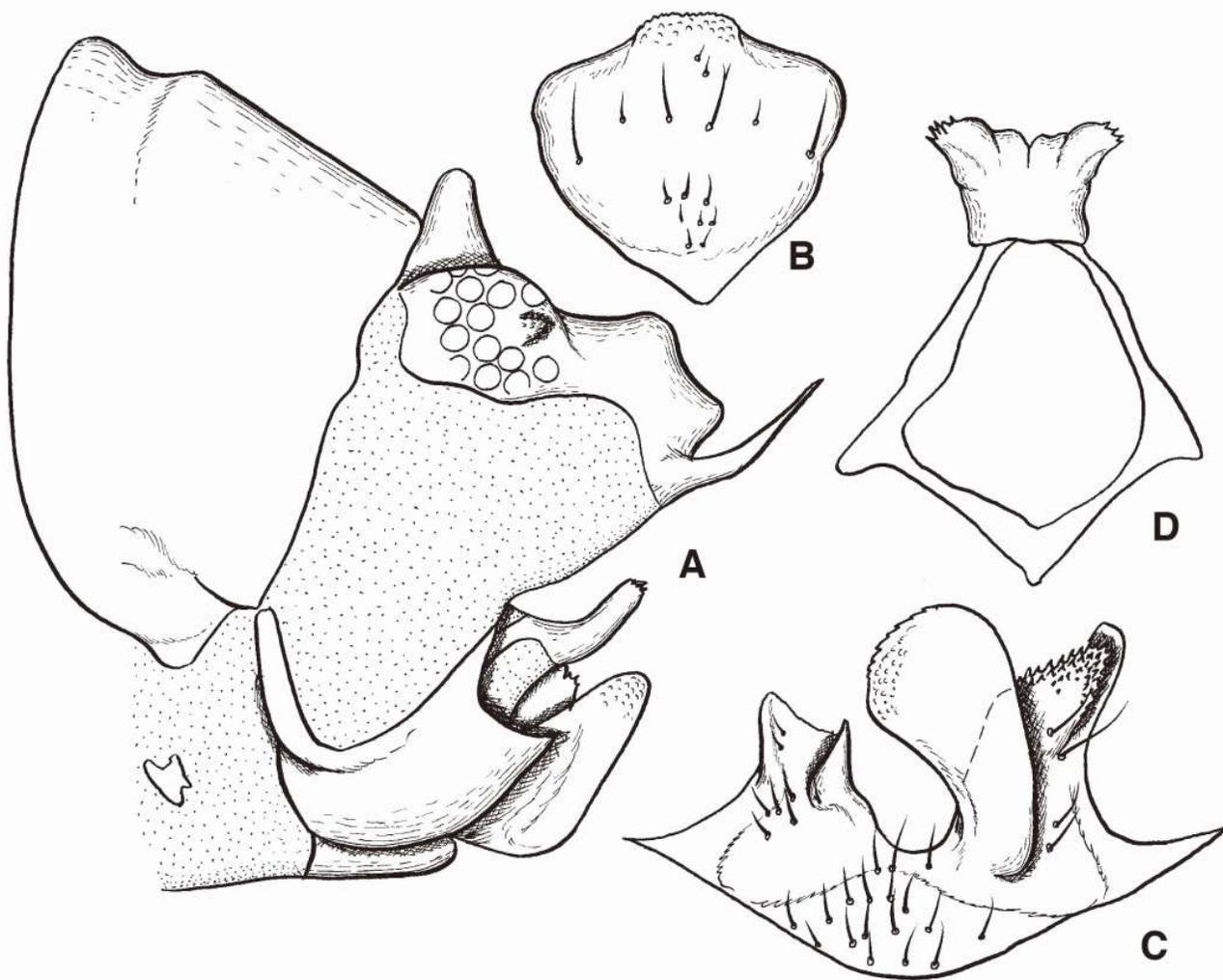


Figure 3. Male terminalia of *Trichadenotecnum lingens* n. sp. (holotype). A. Terminalia, lateral view. B. Epiproct, dorsal view. C. Hypandrium, posteroventral view. D. Phallosome, ventral view.

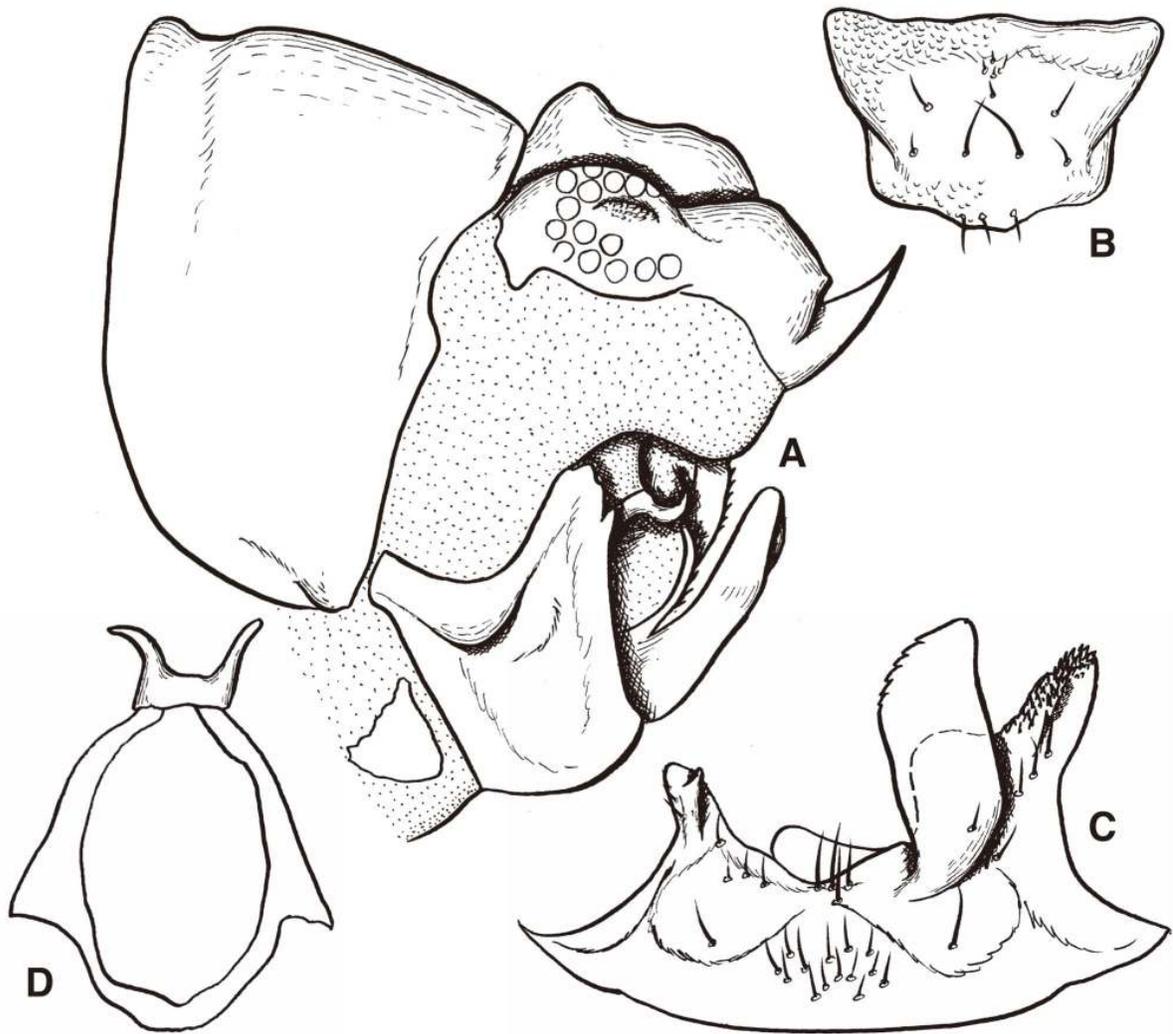


Figure 4. Male terminalia of *Trichadenotecnum palmula* n. sp. (holotype). A. Terminalia, lateral view. B. Epiproct, dorsal view. C. Hypandrium, posteroventral view. D. Phallosome, ventral view.

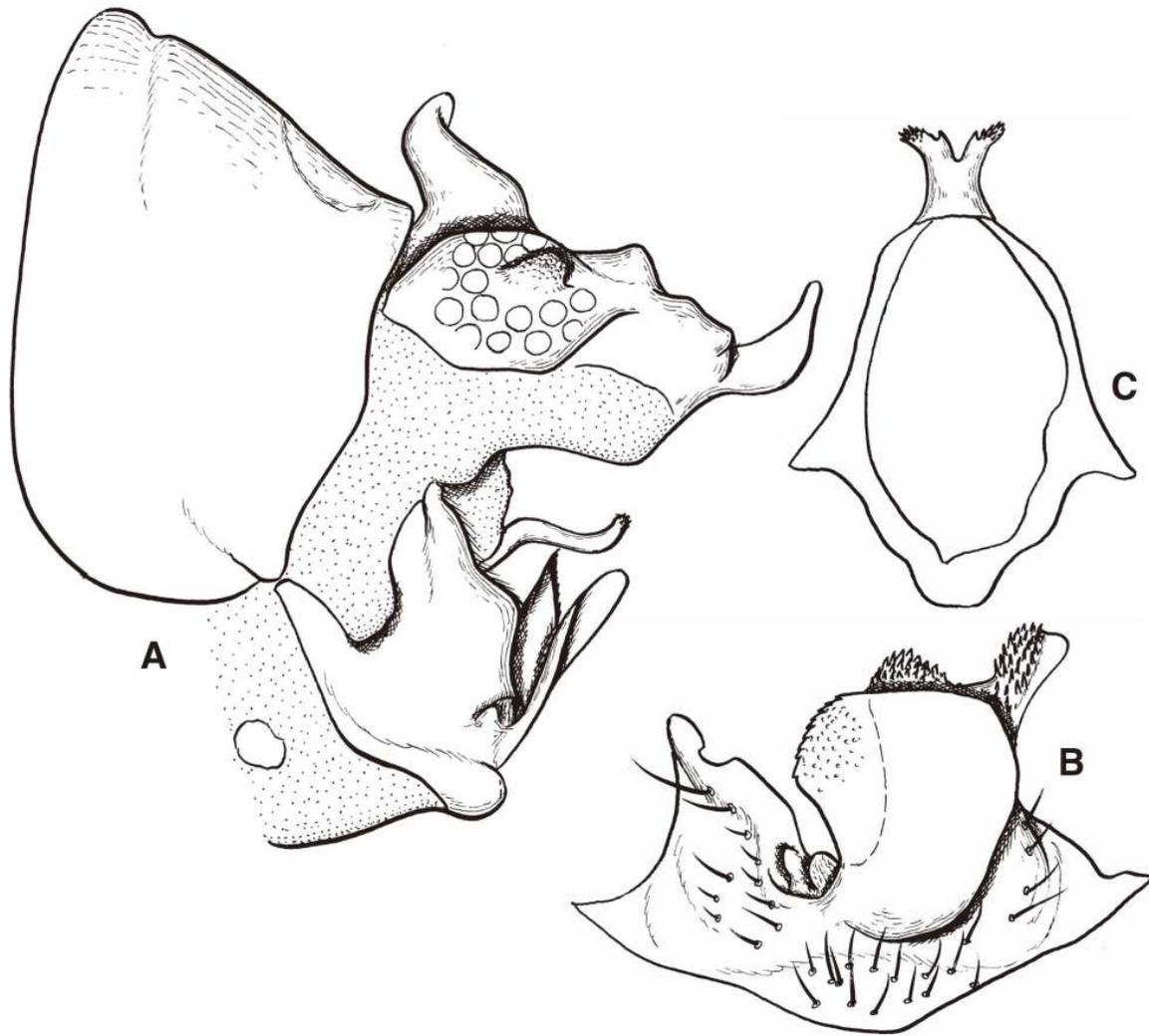


Figure 5. Male terminalia of *Trichadenotecnum affinfelix* n. sp. (holotype). A. Terminalia, lateral view. B. Hypandrium, posteroventral view. C. Phallosome, ventral view.

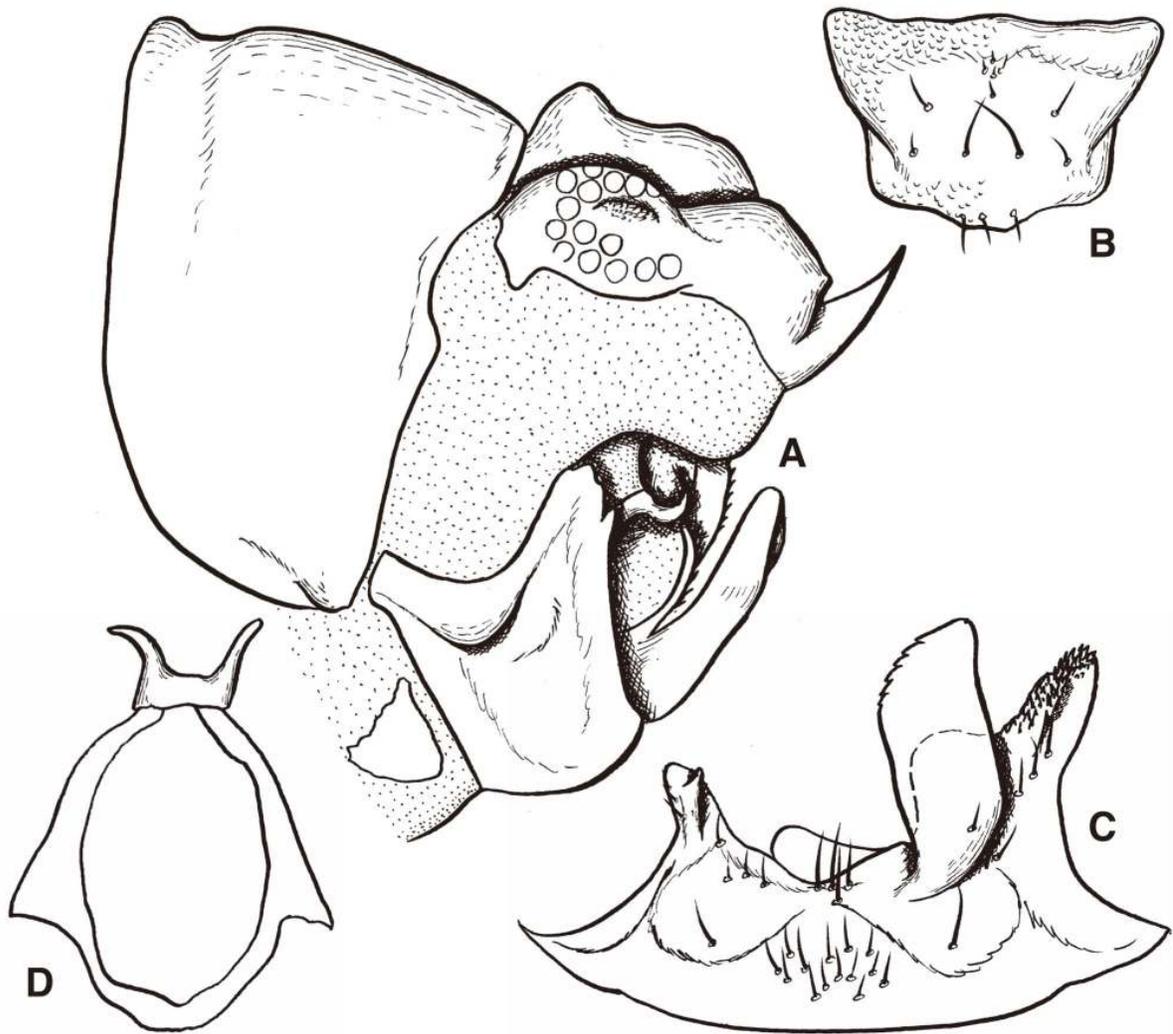


Figure 6. Male terminalia of *Trichadenotecnum separatum* n. sp. (holotype). A. Terminalia, lateral view. B. Epiproct, dorsal view. C. Hypandrium, posteroventral view. D. Phallosome, ventral view.