



HOKKAIDO UNIVERSITY

Title	Redefinition of Ptycta Enderlein (Psocodea: "Psocoptera": Psocidae) and taxonomic revision of the Japanese species
Author(s)	Bess, Emilie C.; Yoshizawa, Kazunori
Citation	Entomological Science, 10(3), 279-290 https://doi.org/10.1111/j.1479-8298.2007.00224.x
Issue Date	2007-09
Doc URL	https://hdl.handle.net/2115/35631
Rights	The definitive version is available at www.blackwell-synergy.com
Type	journal article
File Information	Yoshizawa-8.pdf



Unpublished for the purposes of Zoological Nomenclature (Art. 8.2)

**Redefinition of *Ptycta* Enderlein (Psocodea: ‘Psocoptera’: Psocidae) and a
Taxonomic Revision of the Japanese Species**

Emilie C. BESS 1,2 & Kazunori YOSHIZAWA 2*

1 Department of Entomology, University of Illinois at Urbana-Champaign, 320
Morrill Hall, 505 S. Goodwin Ave., Urbana, IL, 61801 USA and 2 Systematic
Entomology, Graduate School of Agriculture, Hokkaido University, Sapporo,
060-8589 Japan

*author for correspondence

吉澤和徳

060-8589 札幌市北区北9条西9丁目

北海道大学農学部昆虫体系学教室

psocid@res.agr.hokudai.ac.jp

011-706-2424

Abstract

The genera *Ptycta* Enderlein, 1925, and *Copostigma* Enderlein, 1903, are defined as a monophyletic complex based on morphology of male terminalia. *Ptycta* is redefined as those species of the *Copostigma-Ptycta* complex with forewing veins Rs+M fused for a length. Two new species of *Ptycta* from Japan are described, *P. recava* sp. nov. and *P. johnsoni* sp. nov., increasing the number of Japanese species to four, along with *P. parvidentata* Tsutsumi, 1964, and *P. micromaculata* Thornton, Lee, and Chui, 1972. Distributional information and illustrations of each species, and a key to Japanese species of *Ptycta* are included.

Key words: new species, phylogeny, Ptyctini, *Copostigma-Ptycta* complex, systematics

INTRODUCTION

Ptycta Enderlein, 1925, is a large genus in the family Psocidae ('Psocoptera') that includes more than 170 species from all zoogeographic regions of the world, with the greatest diversity in subtropical and tropical regions of Africa (29 species), Asia (43), and the Pacific Islands (63) (Lienhard & Smithers 2002, Lienhard 2003-2006 in Yoshizawa 2006). Two species of *Ptycta* are currently known from the subtropical region of southern Japan: *P. parvidentata* Tsutsumi, 1964, described from Ishigakijima Island, Ryukyus and *P. micromaculata* Thornton, Lee & Chui, 1972, from Chichijima Island, Ogasawara Islands.

The genus *Ptycta* was erected by Enderlein (1925) to include the Indonesian species *Clematostigma schillei* Enderlein, 1906, and the Hawaiian species *Psocus distinguendus* Perkins, 1899 and *Psocus haleakalae* Perkins, 1899, with *P. haleakalae* designated as type species. *Ptycta* was characterized as having the first section of forewing vein CuA1 shorter than the second section.

Badonnel (1967) argued that the characters used to define the genera *Ptycta*, *Copostigma* Enderlein, 1903, *Clematostigma* Enderlein, 1906, and *Maheella* Enderlein, 1931, were insufficient for distinguishing the genera and suggested that this complex of genera should be dealt with as a single unit until the relationships among them are clarified. He also suggested the synonymy of *Maheella* with *Ptycta*, which was accepted by Lienhard and Smithers (2002).

Wing vein characters have been the focus of taxonomy within the species complex. Smithers (1972) added a forewing character to Enderlein's description of *Ptycta*: a spur vein at the apex of the pterostigma. Thornton (1981) studied Fijian

species of *Ptycta* and concluded that the 8 species with a crossvein between Rs and M represent an endemic complex, while the single species with a Rs+M fused for a length represent a separate lineage. Smithers (1983) addressed the *Copostigma-Clematostigma-Ptycta-Maheella* complex and concluded that the character of forewing vein CuA1 with the first section shorter than the second as defined by Enderlein (1925) is variable within *Ptycta* and is shared by both *Copostigma* and *Indiopsocus* Mockford, 1974, and is not useful in diagnosing *Ptycta*. Smithers (1983) also redefined *Clematostigma*, distinguishing the genus as a separate lineage from *Copostigma-Ptycta*. Later, Smithers (1985) defined *Ptycta* as having forewing veins Rs+M fused for a short distance, whereas *Copostigma* has a crossvein connecting veins Rs-M in the forewing.

Smithers (1985) also described a novel character of the male terminalia, the rugose basal lobe of the paraproct, as a diagnostic character of *Copostigma*. Using the new definition, Smithers (1985) moved several species to *Copostigma*: four New Guinea species of *Mecampsis* Enderlein, 1925, with a basal paraproct lobe, and eight Fijian *Ptycta* species with an Rs-M crossvein.

Concurrently, the basal paraproct lobe was also observed in Hawaiian *Ptycta* by Thornton (1984). In redefining *Ptycta*, Thornton (1984) considered all 51 Hawaiian endemic species to be from a single lineage, a diagnosis that required “wider parameters than is usual in genera of Psocidae,” (p. 109). He referred to Enderlein’s original description of vein CuA1 and added three male genital characters: the presence of a distinct basal paraproct lobe, a rugose epiproct lobe, and denticles on the lateral margins of the hypandrial strap.

Several taxa have been added to *Ptycta* based on the Rs+M fusion, including species from the Melanesian islands (Smithers & Thornton 1990) and Indonesia

(Endang et al. 2002). However, this character is plesiomorphic within Psocidae (Yoshizawa 2005) and occurs in most other genera of the tribe Ptyctini. As a result, *Ptycta* appears to be an assemblage of many heterogeneous species (Lienhard & Smithers 2002). Substantial variation of the Rs+M character has been observed within species (i.e. Thornton 1981 discussion of *P. vitiensis*), and occasionally between the two wings of a single specimen (Yoshizawa, pers. obs.).

On the other hand, the basal paraproct lobe observed in *Copostigma* from New Guinea and Fiji (Smithers 1985; Yoshizawa, pers. obs.) and in *Ptycta* from Hawaii (Thornton 1984; Yoshizawa & Bess, pers. obs.), Indonesia (Endang et al. 2002), Australia (Yoshizawa & Smithers 2006), Malaysia (Yoshizawa, pers. obs.), and North America (Bess, pers. obs.) is likely to be a synapomorphy uniting *Ptycta* + *Copostigma*. The character is not observed in other genera of the tribe Ptyctini. Although the boundary between *Ptycta* and *Copostigma* remains unclear, their close relationship can be justified by the presence of the basal paraproct lobe.

Here, we redefine the genus *Ptycta* as those members of the *Copostigma-Ptycta* complex with Rs+M fusion and we describe two characters of male terminalia that are synapomorphies of *Copostigma* and *Ptycta*. We also describe two new species of *Ptycta* from Japan, including a key to Japanese *Ptycta* and illustrations and distributional data for all species.

MATERIALS AND METHODS

The specimens used in this study were fixed in 80% or 99% ethanol. Some specimens were preserved in 65% glycerol after fixation in ethanol. Description of the

color of specimens is based on alcohol material, with the exception of *Ptycta micromaculata*, preserved in glycerol. A Leica MZ12 binocular stereoscopic microscope and Zeiss Axiphoto compound light microscope were used for observation and illustration. Wing photographs were taken with a digital camera on a Zeiss Axiphoto compound microscope. All measurements are in mm.

The ratio between interocular space and eye-diameter (IO/D) is calculated from measurements on the front of the head (Pearman's method: Pearman 1934). On the phallosome, width and length (W/L) were measured from the internal margins of the phallosome ring; length of distal process (DP) was measured from internal margin of the phallosome ring at the base of the distal process to the apex of the distal process of the phallosome, and divided by the length of the internal length of the phallosome ring (DP/L). Body measurements are recorded as B (body length), FL (forewing length), and HL (hindwing length).

In illustrations, membranous areas are indicated by stippling, whereas sclerites are illustrated as plain areas. Broad cross-hatches mean that a structure has been left out. In figures of the female subgenital plate, structure (left half) and pigmentation (right half) are shown. Although the internal plate of the female is used for species delimitation in some genera of Psocidae, this structure is poorly sclerotized and is not useful for identification in *Copostigma-Ptycta* species. Illustrations of genital structures share a common scale and wing photos share a different common scale.

Methods and terminology follow Yoshizawa (2005), but terminology for forewing markings follow Günther (1974). The following abbreviations were used in the text: ELKU (Entomological Laboratory, Kyushu University, Fukuoka, Japan), INHS (Illinois Natural History Survey, USA), KY (K. Yoshizawa). Unless specified,

specimens are stored in the Hokkaido University Insect Collection (SEHU).

SYSTEMATICS

Tribe Ptyctini Mockford, 1993

Genus *Ptycta* Enderlein

Ptycta Enderlein, 1925: 102; Type species: *Psocus haleakalae* Perkins, 1899. Generic definitions: Smithers, 1972: 219; Smithers, 1983: 78; Chui & Thornton, 1972: 17-19; Thornton, 1984: 4; Mockford, 1993: 275.

Maheella Enderlein, 1931: 208. Type species: *Maheella laevidorsum* Enderlein.

Synonymy with *Ptycta* suggested by Badonnel, 1967: 193; synonymy accepted by Lienhard and Smithers, 2002: 450.

Diagnosis. Ptyctini with body white to pale yellow in ground color, with brown to blackish-brown markings on head, thorax, and abdomen. Antennal flagella with short cilia in both sexes. Forewing (Fig. 1) hyaline with brown to blackish-brown markings, usually with dark spot in pterostigma; spur vein of pterostigma variable; veins Rs and M fused for a short distance. Posterolateral region of male clunium strongly concave, widely membranous (e.g., Fig. 2A). Male epiproct chair-shaped (e.g., Fig. 2A, C). Male paraproct with basal lobe projecting laterally (e.g., Fig. 2A).

Key to Japanese species of the genus Ptycta

Forewings

1. Subcostal vein ends in costal cell, spur vein of pterostigma absent (Fig. 1A-D) 2
 - Subcostal vein continues to vein R, spur vein of pterostigma present (Fig. 1E) *P. parvidentata* Tsutsumi
2. Dark basal band present, discoidal band absent (Fig. 1A-C) 3
 - Basal band faint or absent, discoidal band of 4 spots from distal margin of pterostigma to basal edge of areola postica (Fig. 1D) *P. micromaculata* Thornton, Lee, and Chui
3. Dark band on anterior margin of pterostigma, nodal band fairly dark with large spots in cells cua and cup (Fig. 1B, C) *P. johnsoni* sp. nov.
 - Pterostigma with pigmentation only in distal 1/3, nodal band faint (Fig. 1A) *P. recava* sp. nov.

***Ptycta recava*, sp. nov.**

Holotype. Male. [Honshu] Ômoriyama Park, Akita City, 1. vii. 1997, KY.

Paratypes. [Honshu] many specimens, same locality as for holotype, 4. vii. 1993, KY (INHS & SEHU); 2 males 28 females, same data as for holotype; 1 female, Mt. Kinpokusan, Sadogashima Is., 8. vii. 1992, S. Yamaya; 1 female, Funaokayama, Ojiya City, Niigata Pref., 20. vii. 1992, KY; 1 male 12 females, Hakone - Lake Ashinoko, Kanagawa Pref., 24. vi. 1997, KY.

Diagnosis. Forewing with dark basal band, faint nodal band, and subcostal vein ending in costal cell (Fig. 1A). *Male terminalia* (Fig. 2). Posterodorsal margin of

clunium deeply concave, posteroventral process of clunium articulating with paraproct, median strap of the hypandrium wide, parallel-sided, symmetrical. Distributed from central to northern Honshu and on Sadogashima Island.

Description (after 9 years in 80% ethanol). *Male. Head.* Light brown in ground color; vertical markings broad dark brown bands on both sides of coronal suture; coronal suture black; orbital markings broad brown dorsal bands; frontal suture brown; frons with brown triangular marking between ocellar field and clypeus; gena dark brown; eye black, IO/D = 0.7; ocelli black, ocellar field dark brown; antennal socket dark brown; postclypeus with ca. 8 vertical dark brown stripes, ventrolateral corners without marking; anteclypeus with dark brown dorsal band. Antenna brown. Mouth parts pale brown; maxillary palps darker.

Thorax. Prothorax brown. Mesonotum pale brown; anterior surface of scutum dark brown, margins of anterior and lateral lobe sutures white bands; scutellum and postscutellum dark brown with black margins. Metanotum pale brown; scutum dark brown with paler anterior lobe; scutellum dark brown with triangular white markings on anterior margin. Meso- and metapleuron dark brown.

Legs. Brown; coxae dark brown; trochanters pale brown; distal 1/4 of tibiae dark brown; tarsi dark brown.

Forewing. (Fig. 1A). Basal band present. Faint nodal band with markings at junction of Rs+M veins and distal end of cell cup. Subcostal vein ends in costal cell. Pterostigma cloudy with basal 2/3 light brown and distal 1/3 dark brown, spur vein absent. Veins of areola postica pigmented except CuA2. *Hindwing.* Hyaline, veins without pigment.

Abdomen. White, each segment with transverse black band on posterior

margin. *Terminalia* (Fig. 2). Clunium with posteroventral projection articulating with paraproct (Fig. 2A); posterodorsal margin deeply concave with shallow median process at articulation with epiproct (Fig. 2B); posterolateral part deeply concave, widely membranous (Fig. 2A). Epiproct lobe (Fig. 2A,C) high with nearly straight lateral margins, surface smooth, dorsal margin recessed slightly, with microtrichia. Paraproctal basal lobe rugose, short, and in anterolateral orientation (Fig. 2A). Hypandrium (Fig. 2D) symmetrical, median strap wide, parallel sided, slightly broadening at apex, with denticles on basal 2/3 and at apex, apex with shallow notch; lateral corners with broad posterior extension of varying shape. Phallosome (Fig. 2E) ovate, twice as long as wide; distal process rugose, wide without expanded lobe at apex; $W/L=0.50$, $DP/L=0.18$.

Length. B 3.0-3.1; FL 3.1-3.2; HL 2.4.

Female. Similar to male except frons with white spot in center of brown triangular marking; $IO/D=1.4$.

Genitalia. (Fig. 3). Egg guide of subgenital plate (Fig. 3A) tapers slightly to rounded apex; sclerite on dorsal surface of egg guide with slightly concave lateral margins, distal margin of sclerite broad and rounded. External valve of gonapophyses (Fig. 3B) with rounded anterior and posterior margins; posterior lobe narrow, triangular.

Etymology. The specific epithet refers to the deeply concave posterodorsal margin of the male clunium.

Distribution. This species occurs from central to northern Honshu, and on Sadogashima Island (Fig. 10).

Remarks. This species is quite distinct from the other Japanese *Ptycta* in the

reduced pigmentation of the forewing and in the form of the male clunium: the posterodorsal margin is deeply concave with shallow median process at articulation with epiproct, and the posterolateral region is deeply concave and widely membranous.

***Ptycta johnsoni*, sp. nov.**

Ptycta sp. Yoshizawa & Johnson, 2003: 104; Johnson, Yoshizawa & Smith, 2004: 1774.

Ptycta sp. KY2002 GenBank (online database for gene sequences): accession numbers of gene sequences obtained from paratype male (voucher number KY235 collected at Cape Satamisaki) are AY139907 (12S rDNA), AY139954 (16S rDNA) and AY630553 (18S rDNA).

Holotype. Male. [Kyushu] Nokonoshima Is., Fukuoka, 14. vii. 2006, K. Yoshizawa & E. Bess.

Paratypes. [Tsushima] 1 female, Kamisaka, 17. vi. 1995; 4 males 1 female, Nita, 17. vi. 1995. [Kyushu] 2 females, same locality as holotype, 21. vi. 1993; 12 males 24 females, same data as for holotype (some specimens were collected as nymphs, reared to adults and fixed on 21. vii. 2006) (INHS & SEHU); 2 males, Chôjabaru, Kokonoe Cho, Oita Pref., 29. vii. 1996, KY; 6 males 6 females, Cape Satamisaki, Kagoshima Pref., 30. v. 1999, K. & S. Yoshizawa; [Ryukyus: Amami-ôshima] 1 male 6 females, Wano, 1. vi. 1993, KY; 2 females, same locality, 24. iv.

1996, KY; 1 female, Mt. Yuwandake, 30. v. 1993, KY. [Ryukyus: Okinawajima] 1 male 1 female, Gesashi, 17. iv. 1996, KY; 1 male, Yona, 20. v. 1993, KY; 1 male, same locality, 23. v. 1993, KY; 1 female, Mt. Yonahadake, 15. iv. 1996, KY; 9 males 16 females, Shuri, 19. v. 1993, KY.

Diagnosis. Forewing (Fig. 1B, C) with wide basal band and nodal band, pigmentation on anterior margin and apical 1/3 of pterostigma. *Male terminalia* (Fig. 4): Basal paraproct lobe short in anterodorsal orientation, posterior lobe of paraproct rounded; phallosome long with narrow basal margin. *Female genitalia* (Fig. 5): Sclerite of subgenital plate with broad triangular distal margin. Distributed from Tsushima Island to Okinawajima Island .

Description (coloration mainly based on samples freshly collected into 99% ethanol but, for description of wing markings, old 80% ethanol specimens were also used). *Male. Head.* White in ground color; vertical markings elongate black spots in band around coronal suture; pair of black markings between apex of vertical marking and ocelli; coronal suture black; orbital markings black; frontal suture black; frons with four broad bands between frontal suture and postclypeus; gena white; eye black, IO/D = 1.3; ocelli black, ocellar field white; antennal socket dark brown; postclypeus with ca. 14 vertical dark brown stripes; anteclypeus white with dark brown horizontal band in center. Antenna brown, pedicel and scape white. Mouth parts pale brown; maxillary palps darker.

Thorax. Prothorax dark brown. Mesonotum dark brown; scutum with yellow band at center and between anterior and lateral lobes; scutellum yellow with triangular brown marking at posterior. Metanotum brown; scutum brown with yellow bands along sutures of lateral lobes, posterior margin yellow; scutellum brown. Meso- and

metapleuron brown.

Legs. White; middle and hind coxae brown; femora with dark band on distal surface; tibiae with dark brown spines, distal 1/4 of tibiae dark brown; tarsi dark brown to black.

Forewing (Fig. 1B, C). Forewing markings with some geographical variation. Basal band present. Nodal band with dark spots at base of pterostigma, along veins Rs +M, in center of cell cua, and at apex of cell cup, and faint spots in cell r (nodal band fainter in specimens from Okinawajima and Tsushima). Subcostal vein ends in costal cell. Pterostigma with anterior margin pigmented (faint in specimens from Okinawajima), distal 1/3 pigmented with marking extending past posterior margin, spur vein absent. Veins of areola postica pigmented except CuA2. *Hindwing.* Hyaline, veins pigmented on apical 2/3.

Abdomen. Yellow to white, each segment with narrow transverse brown band at center. *Terminalia* (Fig. 4). Clunium posterodorsal margin nearly straight at articulation with epiproct (Fig. 4B); posterolaterally with moderate-sized membranous region (Fig. 4A). Epiproct lobe low (Fig. 4A), with nearly straight, wide dorsal margin, not rugose in texture (Fig. 4C). Paraproct basal lobe rugose, short, and in anterolateral orientation; posterior lobe rounded (Fig. 4A). Hypandrium (Fig. 4D) nearly symmetrical, median strap broad basally, constricted medially and broadening at apex, with denticles in comb-like arrangement on entire margins, apex with deep asymmetric notch; lateral corners narrow and tapering to point or small rounded process; hypandrial membrane with sclerites of varying size, sometimes absent. Phallosome (Fig. 4E) ring elongate, twice as long as wide: apical distal process rugose, wide without expanded lobe at apex; W/L=0.45, DP/L=0.18.

Length. B 2.8-3.0; FL 3.0-3.1; HL 2.1.

Female. Similar to male, except IO/D=1.5; abdominal segments with wider transverse brown bands.

Genitalia. (Fig. 5). Egg guide of subgenital plate (Fig. 5A) tapers slightly to truncate apex; sclerite on dorsal surface of egg guide triangular. External valve of gonapophyses (Fig. 5B) rectangular with rounded posterior margin; posterior lobe small and rounded.

Etymology. Specific epithet is dedicated to Kevin P. Johnson of Illinois Natural History Survey. The species was first mentioned as *Ptycta* sp. in co-authored paper by Yoshizawa & Johnson (2003).

Distribution. This species occurs in southern Japan, from Tsushima Is. to Okinawajima Is. (Fig. 10).

Remarks. This species is very similar to *Ptycta furcata* Li, 1993, from Guangdong Province, China. It can be distinguished by the pigmentation on the anterior margin of the pterostigma, the rounded posterior lobe of the paraproct, and the narrow, tapering lateral corners of the hypandrium.

***Ptycta micromaculata* Thornton, Lee & Chui**

Ptycta micromaculata Thornton, Lee & Chui, 1972: 139.

Material examined. [Ogasawara Is.: Hahajima Is.] 1 male 1 female, Okimura, 13. iv. 1993, KY; 1 male, Mt. Sekimon, 17. iv. 1993, KY; 9 males 14 females, Kitamura, 17. iv. 1993, KY (INHS & SEHU); 2 males 1 female, same locality and

collector, 19. iv. 1993; 1 male, Tamagawa, 18. iv. 1993, KY; 3 males 4 females, Nakanotaira, 18. iv. 1993, KY; 1 female, Mt. Chibusayama, 20. iv. 1993, KY.

Diagnosis. Forewing (Fig. 1D) with basal band faint or absent, discoidal band of 4 spots from distal margin of pterostigma to basal edge of areola postica. *Male terminalia* (Fig. 6) with posterolateral region of clunium broadly membranous, paraproct with long basal lobe in anterolateral orientation, posterior lobe of paraproct rectangular; hypandrium asymmetrical. Distributed on Chichijima and Hahajima of Ogasawara Islands.

Redescription of male terminalia (after 13 years in glycerol; Fig. 6). Clunium posterior margin only slightly concave at articulation with epiproct (Fig. 6B); posterolateral region broadly membranous (Fig. 6A). Epiproct lobe low (Fig. 6A), with narrow, lobed dorsal margin, surface spinous (Fig. 6C). Paraproct basal lobe rugose, narrow and long, and in anterolateral orientation; posterior lobe rectangular (Fig. 6A). Hypandrium asymmetrical (Fig. 6D), median strap narrow, curved, fine denticles along lateral margins visible with compound microscope, apex with deep notch; lateral corners shallow; hypandrial membrane with large asymmetric sclerites of varying size. Phallosome (Fig. 6E) with long, slender rugose distal process with expanded lobe at apex; $W/L=0.68$, $DP/L=0.33$.

Redescription of female genitalia (after 13 years in glycerol; Fig. 7). Ventral sclerotized area of egg guide of subgenital plate (Fig. 7A) tapers slightly and widens to slightly rounded apex; sclerite on dorsal surface of egg guide rounded posteriorly, protruding and pointed anteriorly. External valve of gonapophyses (Fig. 7B) large with rounded anterior and posterior margins; posterior lobe broad and rounded.

Distribution. This species occurs on Hahajima Island and Chichijima Island,

Ogasawara Islands, in southern Japan (Fig. 10).

Remarks. This species can be distinguished from other Japanese *Ptycta* by the dark discoidal band on the forewing, the shallow concavity of the posteroventral corner of the male clunium, and the long paraproct basal lobe with posterolateral orientation.

***Ptycta parvidentata* Tsutsumi**

Ptycta parvidentata Tsutsumi, 1964: 267

Material examined. Holotype female and allotype male, Kabira, Ishigakijima Is., 13. x. 1963, Y. Hirashima (ELKU). [Ryukyus: Ishigakijima Is.] 1 female, Itona, 9. v. 1993, KY; 1 male, Mt. Bannadake, 8. v. 1993, KY; 2 males 1 female, same locality, 15. v. 1993, KY; 1 male 1 female, same locality, 8. iv. 1996, KY; 2 male 3 females, Central Ishigaki City, 13. iv. 1996, KY (INHS & SEHU). [Ryukyus: Iriomotejima Is.] 5 females, Funaura, Iriomotejima Is., 10. v. 1993, KY; 4 females, Sonai, Iriomotejima Is., 12. iv. 1996, KY.

Diagnosis. Forewing (Fig. 1E) with subcostal vein continuing to vein r, spur vein present. *Male terminalia* (Fig. 8) with basal paraproct lobe mid-length in anterolateral orientation, clunium with moderately-size concave membranous region posterolaterally. Hypandrium symmetrical with median strap gradually narrowing and deep slightly asymmetrical notch at apex. Distributed on the Yaeyama Islands.

Redescription of male terminalia (after ten years in 80% ethanol; Fig. 8). Clunium posterior margin slightly concave at articulation with epiproct (Fig. 8B);

posterolateral membranous region moderate in size (Fig. 8A). Epiproct lobe low (Fig. 8A) with rounded dorsal margin, finely rugose surface (Fig. 8C). Paraproct basal lobe of moderate length, rugose, and in anterolateral orientation; posterior margin rectangular (Fig. 8A). Hypandrium symmetrical (Fig. 8D), median strap gradually narrowing, with denticles in comb-like arrangement on almost entire margins, apex with deep slightly asymmetric notch; lateral corners narrow and tapering to point or small rounded process; hypandrial membrane with large sclerites of varying shape. Phallosome (Fig. 8E) with long, slender, rugose apical distal process without expanded lobe at apex; $W/L=0.51$, $DP/L=0.26$.

Redescription of female genitalia (after ten years in 80% ethanol; Fig. 9). Egg guide of subgenital plate (Fig. 8A) tapers slightly to rounded apex; sclerite on dorsal surface of egg guide oval. External valve of gonapophyses (Fig. 8B) with rounded anterior and posterior margins; posterior lobe broad triangular and rounded.

Distribution. This species occurs on the Yaeyama Islands (Ishigakijima and Iriomotejima) of southern Japan (Fig. 10).

Remarks. This species can be distinguished from other Japanese *Ptycta* by the forewing with subcostal vein continuing to vein r, presence of a pterostigma spur vein, and the wide, gradually narrowing median strap of the hypandrium.

DISCUSSION

Definition of Ptycta and monophyly of the Copostigma-Ptycta complex

As discussed above, the original description and subsequent redefinitions of *Ptycta* have relied on plesiomorphic and/or highly variable characters of forewing

venation (Fig. 1). Enderlein (1925) erected the genus based on the vein CuA1 having the first section shorter than the second. However, this character varies among species of *Ptycta*, as does the pterostigma spur vein, suggested by Smithers (1972) to be diagnostic of *Ptycta*. Most recently, *Ptycta* was redefined by Smithers (1985) as having veins Rs+M fused for a short distance, whereas *Copostigma* has a cross vein connecting Rs-M. Although the Rs+M fusion is plesiomorphic within Psocidae and varies within species of *Ptycta*, this definition has been accepted by subsequent authors (e.g., Endang et al., 2002).

The use of plesiomorphic and variable venation characters in defining *Ptycta* has led to a heterogeneous “holding genus” (Endang et al. 2002; Lienhard & Smithers 2002). The primary problem with the current taxonomy of *Ptycta* is in defining the basal limit of the genus because there has been no autapomorphic character to define the genus and exclude heterogeneous species.

The secondary problem is in differentiating *Ptycta* from *Copostigma*. The Rs+M fusion (Fig. 1) is the only character that we are aware of that establishes a boundary between *Ptycta* and *Copostigma*. Until further study, we will retain this distinction between *Ptycta* and *Copostigma*, although we are aware that the relationship between veins Rs and M is variable and unreliable, and that defining *Ptycta* based on the Rs+M fusion will maintain its status as paraphyletic.

Although the boundary between *Copostigma* and *Ptycta* remains unclear, the two genera are strongly united by morphology of male terminalia. The basal paraproct lobe described by Thornton (1984), Smithers (1985) and Yoshizawa & Smithers (2006) is a prominent synapomorphy of the two genera (e.g., Fig. 2A). Non-homologous structures of the male paraproct similar to those of *Ptycta* and

Copostigma are seen in some other Psocidae taxa. The paraproctal basal process of *Trichadenotecnum* (Yoshizawa 2001) superficially resembles that of *Copostigma-Ptycta*, but that of *Trichadenotecnum* originated within the genus (the *spiniserrulum* group: Yoshizawa 2001, 2003, 2004) and thus is not homologous with the basal paraproct lobe of *Copostigma-Ptycta*. Moreover, the paraproctal basal process of *Trichadenotecnum* extends from the anteroventral margin of the paraproct, whereas the basal paraproct lobe of *Copostigma-Ptycta* is usually apart from the ventral margin of the paraproct (Fig. 6: see also Yoshizawa & Smithers 2006). A similar paraproct lobe is also observed in some species of *Hyalopsocus* (Yoshizawa, pers. obs.), but the genus belongs Psocini, not Ptyctini, and thus is distantly related to *Copostigma-Ptycta*.

Here, we also describe a second synapomorphy, the clunium with a strongly concave, membranous posterolateral region (e.g., Fig. 2A). The combination of these two synapomorphies will be helpful in excluding heterogeneous species currently held in *Ptycta*. These characters also distinguish *Copostigma-Ptycta* taxa from the potentially related genera, such as *Indiopsocus* Mockford, 1974, and *Atlantopsocus* Badonnel, 1944, which otherwise resemble *Copostigma-Ptycta* in morphology of male terminalia.

All of the *Ptycta* specimens we have examined have both of these apomorphic characters, including specimens from Hawaii (the type locality of the genus), Indonesia, Fiji, Malaysia, Australia, and North America. These observations indicate that many species from these regions are correctly classified in the *Copostigma-Ptycta* complex.

Information on these characters, particularly the clunium character, is rarely

available in published illustrations, however. This makes it difficult to draw conclusions about the validity of *Ptycta* from other regions. We found one species with the paraproct lobe clearly illustrated from Madagascar (Badonnel 1967) and another with both characters from the Galapagos Islands (Thornton & Woo 1973). *Ptycta* species that clearly lack these characters also fail to resemble other *Ptycta* in the morphology of the hypandrium, phallosome, and forewing, including species from Madagascar (Badonnel 1967), Angola (Badonnel 1969), and Mediterranean Europe (Lienhard 1998). Based on our redefinition of the genus, these species can be excluded from *Ptycta*. A thorough revision of the genus would be necessary to apply this new definition to all species currently included in *Ptycta* and to establish species groups within the *Copostigma-Ptycta* complex.

ACKNOWLEDGMENTS

We thank K. P. Johnson and two anonymous reviewers for critical reading of the manuscript. ECB thanks S. Akimoto for hosting her stay in Japan and V. S. Smith for helpful comments on the project proposal. KY thanks H. Makihara and T. Yasunaga for assistance in the field. ECB's stay in Japan was supported by the JSPS summer program and the NSF EAPSI program.

REFERENCES

Badonnel A (1944) Contribution à l'étude des Psocoptères de l'Atlantide. *Revue*

- française d'Entomologie* **11**: 47-60.
- Badonnel A (1967) Insectes Psocoptères. *Faune de Madagascar* **23**: 1-238.
- Badonnel A (1969) Psocoptères de l'Angola et de pays voisins avec révision de types africains d'Enderlein (1902) et de Ribaga (1911). *Publicações culturais da Companhia de Diamantes de Angola* **79**: 1-152.
- Chui VWD, Thornton IWB (1972) A numerical taxonomic study of the endemic *Ptycta* species of the Hawaiian Islands (Psocoptera: Psocidae). *Systematic Zoology* **21**: 7-22.
- Endang SK, Thornton IWB, New TR (2002) The Psocidae (Insecta : Psocoptera) of Java and the eastern islands of Indonesia. *Invertebrate Systematics* **16**: 107–176.
- Enderlein G (1903) Die Copeognathen des indo-australischen Faunengebietes. *Annales historico-naturales Musei nationalis Hungarici* **1**: 179-344.
- Enderlein G (1906) Die australischen Copeognathen. *Zoologische Jahrbücher (Abteilung Systematik)* **23**: 401-412.
- Enderlein G (1925) Beiträge zur Kenntnis der Copeognathen IX. *Konowia* **4**: 97-108.
- Enderlein G (1931) The Percy Sladen Trust Expedition to the Indian Ocean in 1905, under the leadership of Mr J. Stanley Gardiner, M.A. VIII. Die Copeognathen-Fauna der Seychellen. *Transactions of the Linnean Society of London, 2nd Series, Zoology* **19**: 207-240.
- Günther KK (1974) Staubläuse, Psocoptera. In: *Die Tierwelt Deutschlands. Jena*. 61. Teil.
- Johnson KP, Yoshizawa K, Smith VS (2004) Multiple origins of parasitism in lice. *Proceedings of the Royal Society of London (B)* **271**: 1771-1776.

- Li Fasheng (1993) Psocoptera of Shandong Province (Psocoptera: Troctomorpha, Psocomorpha). *Journal of Laiyang Agricultural College* **10**: 209-218.
- Lienhard C (1998) Psocoptères euro-méditerranéens. *Faune de France* **83**: 1-517.
- Lienhard C, Smithers CN (2002) *Psocoptera (Insecta) World Catalogue and Bibliography*. Muséum d'Histoire Naturelle, Geneva, Switzerland.
- Mockford EL (1974) Records and descriptions of Cuban Psocoptera. *Entomologica Americana* **48**: 103-215.
- Mockford EL (1993) *North American Psocoptera (Insecta)*. Sandhill Crane Press, Gainesville, Florida.
- Pearman JV (1934) New and little known African Psocoptera. *Stylops* **3**: 121-132.
- Perkins RCL (1899) Neuroptera. In: *Fauna Hawaiiensis*, pp. 77-87. Cambridge University Press, Cambridge.
- Smithers CN (1972) The classification and phylogeny of the Psocoptera. *Australian Museum Memoirs* **14**: 1-349.
- Smithers CN (1983) A reappraisal of *Clematostigma* Enderlein with notes on related genera (Psocoptera: Psocidae). *Australian Entomological Magazine* **9**: 71-79
- Smithers CN (1985) Redefinition of *Copostigma* Enderlein (Psocoptera: Psocidae). *Australian Entomological Magazine* **12**: 61-62.
- Smithers CN, Thornton IWB (1990) Systematics and distribution of the Melanesian Psocidae (Psocoptera). *Invertebrate Taxonomy* **3**: 431-468.
- Thornton IWB (1981) Psocoptera of the Fiji Islands. *Pacific Insects Monographs* **37**: 1-105.
- Thornton IWB (1984) Psocoptera of the Hawaiian Islands. Part III. The endemic *Ptycta* complex (Psocidae): systematics, distribution and evolution.

- International Journal of Entomology* **26**: 1-128.
- Thornton IWB, Lee SS, Chui VWD (1972) Insects of Micronesia: Psocoptera. *Insects of Micronesia* **8**: 45-144.
- Thornton IWB, Woo AKT (1973) Psocoptera of the Galapagos Islands. *Pacific Insects* **15**: 1-58.
- Tsutsumi C (1964) Two new species of Psocoptera from the Ryukyu Islands, Japan. *Kontyu* **32**: 265-269.
- Weinelt M *Online Map Creation*. Accessed 16 August 2006. "<http://www.aquarius.geomar.de>".
- Yoshizawa K (2001) A systematic revision of Japanese *Trichadenotecnum* Enderlein (Psocodea: 'Psocoptera': Psocidae: Ptyctini), with redefinition and subdivision of the genus. *Invertebrate Taxonomy* **15**: 159–204.
- Yoshizawa K (2003) Two new species that are likely to represent the most basal clade of the genus *Trichadenotecnum* (Psocoptera: Psocidae). *Entomological Science* **6**: 301–308.
- Yoshizawa K (2004) Molecular phylogeny of major lineages of *Trichadenotecnum* and a review of diagnostic morphological characters (Psocoptera: Psocidae). *Systematic Entomology* **29**: 383–394.
- Yoshizawa K (2005) Morphology of Psocomorpha (Psocodea: 'Psocoptera'). *Insecta Matsumurana, new series* **62**: 1-44.
- Yoshizawa K (2006) (ed.) Psocid News, the Psocidologists' Newsletter [periodical on the Internet]. Hokkaido University, Sapporo, Japan [Updated February 2006, cited October 2006]. Available from: <http://www.psocodea.org>.
- Yoshizawa K, Johnson KP (2003) Phylogenetic position of Phthiraptera (Insecta:

Paraneoptera) and elevated rate of evolution in mitochondrial 12S and 16S rDNA. *Molecular Phylogenetics and Evolution* **29**: 102-114.

Yoshizawa K, Smithers CN (2006) Systematic position of *Trichodenotecnum enderleini* (Roesler) (Psocodea: 'Psocoptera': Psocodae). *Records of the Australian Museum* **58**: 411-415.

Figure captions

Fig. 1. Forewings of Japanese *Ptycta*. A. *P. recava* sp. nov; B, C. *P. johnsoni* sp. nov., showing geographical variation of wing markings from northern end of Kyushu (Nokonoshima: B) to Okinawajima (C); D. *P. micromaculata*; E. *P.*

parvidentata.

Fig. 2. Male terminalia of *Ptycta recava*. A. Terminalia, lateral view; B. Clunium, dorsal view; C. Epiproct, posterior view; D. Hypandrium, posterior view; E. Phallosome, ventral view.

Fig. 3. Female genitalia of *Ptycta recava*, ventral view. A. Subgenital plate; B. Gonapophyses.

Fig. 4. Male terminalia of *Ptycta johnsoni*. A. Terminalia, lateral view; B. Clunium, dorsal view; C. Epiproct, posterior view; D. Hypandrium, posterior view; E. Phallosome, ventral view.

Fig. 5. Female genitalia of *Ptycta johnsoni*, ventral view. A. Subgenital plate; B. Gonapophyses.

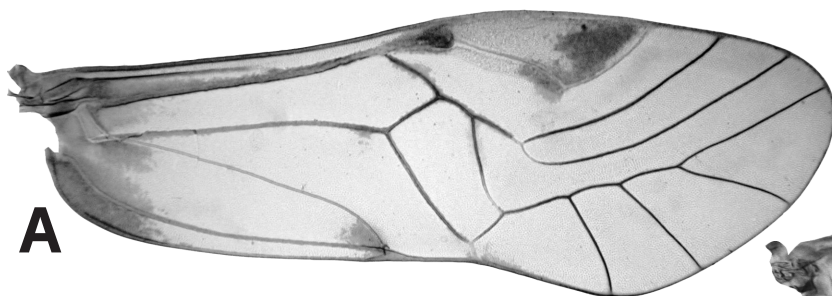
Fig. 6. Male terminalia of *Ptycta micromaculata*. A. Terminalia, lateral view; B. Clunium, dorsal view; C. Epiproct, posterior view; D. Hypandrium, posterior view; E. Phallosome, ventral view.

Fig. 7. Female genitalia of *Ptycta micromaculata*, ventral view. A. Subgenital plate; B. Gonapophyses.

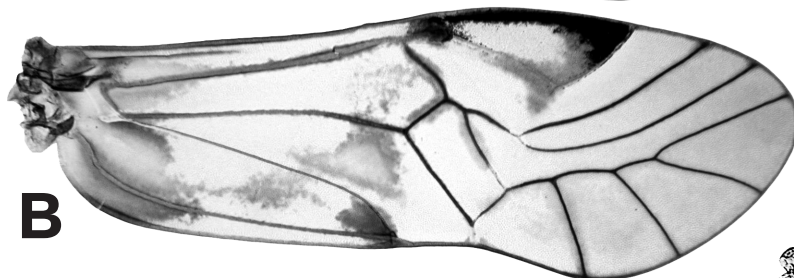
Fig. 8. Male terminalia of *Ptycta parvidentata*. A. Terminalia, lateral view; B. Clunium, dorsal view; C. Epiproct, posterior view; D. Hypandrium, posterior view; E. Phallosome, ventral view.

Fig. 9. Female genitalia of *Ptycta parvidentata*, ventral view. A. Subgenital plate; B. Gonapophyses.

Fig. 10. Map of the distribution of Japanese *Ptycta* species: j = *P. johnsoni*, m = *P. micromaculata*, p = *P. parvidentata*, r = *P. recava*.



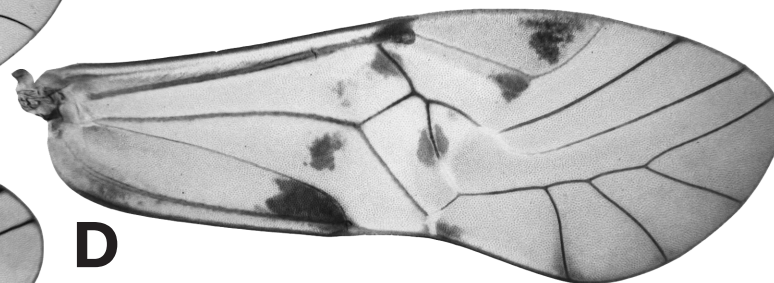
A



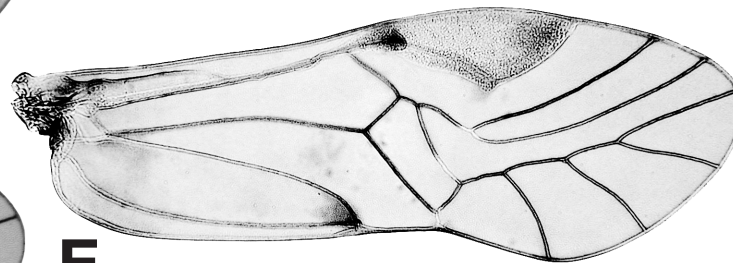
B



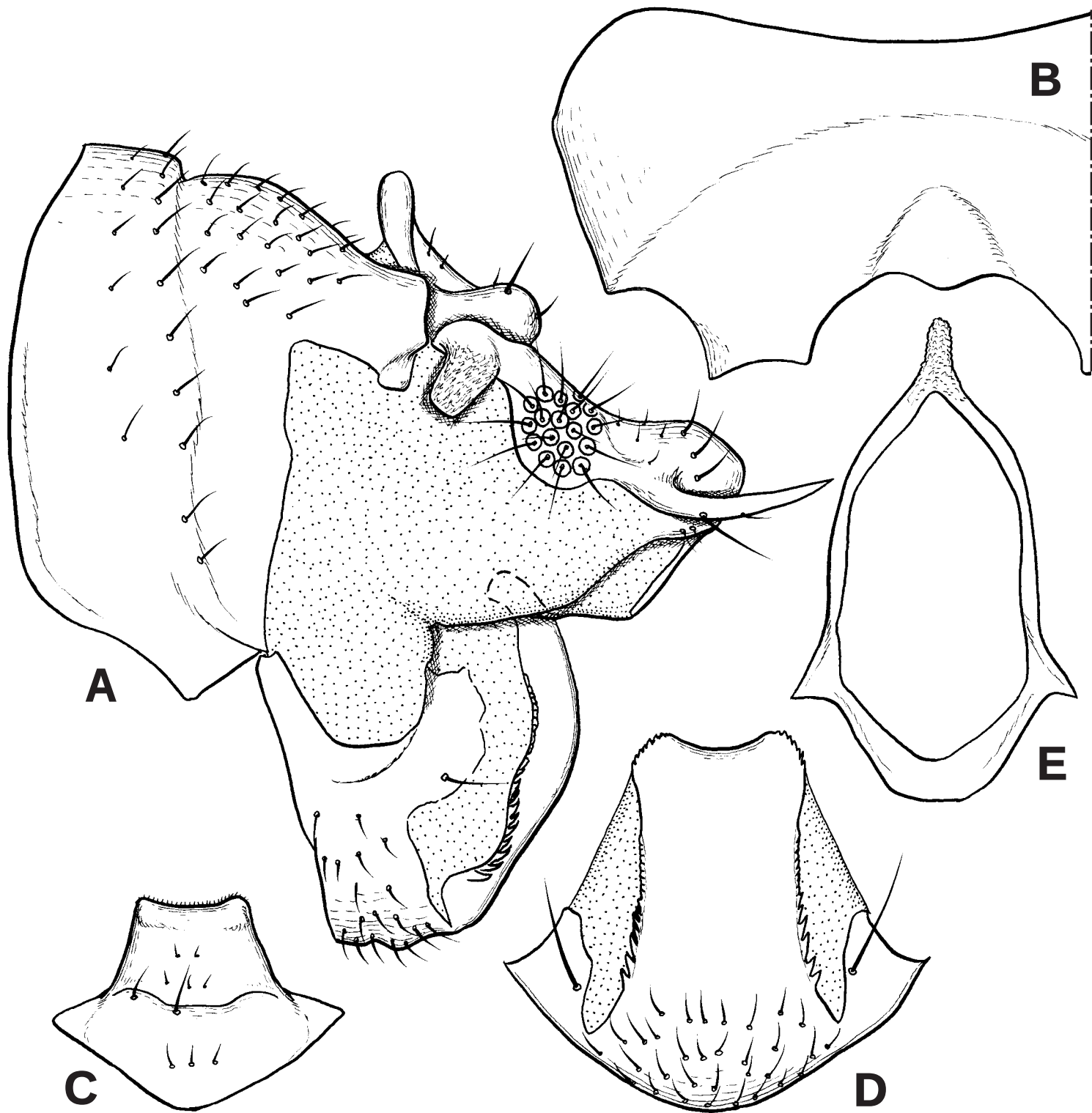
C

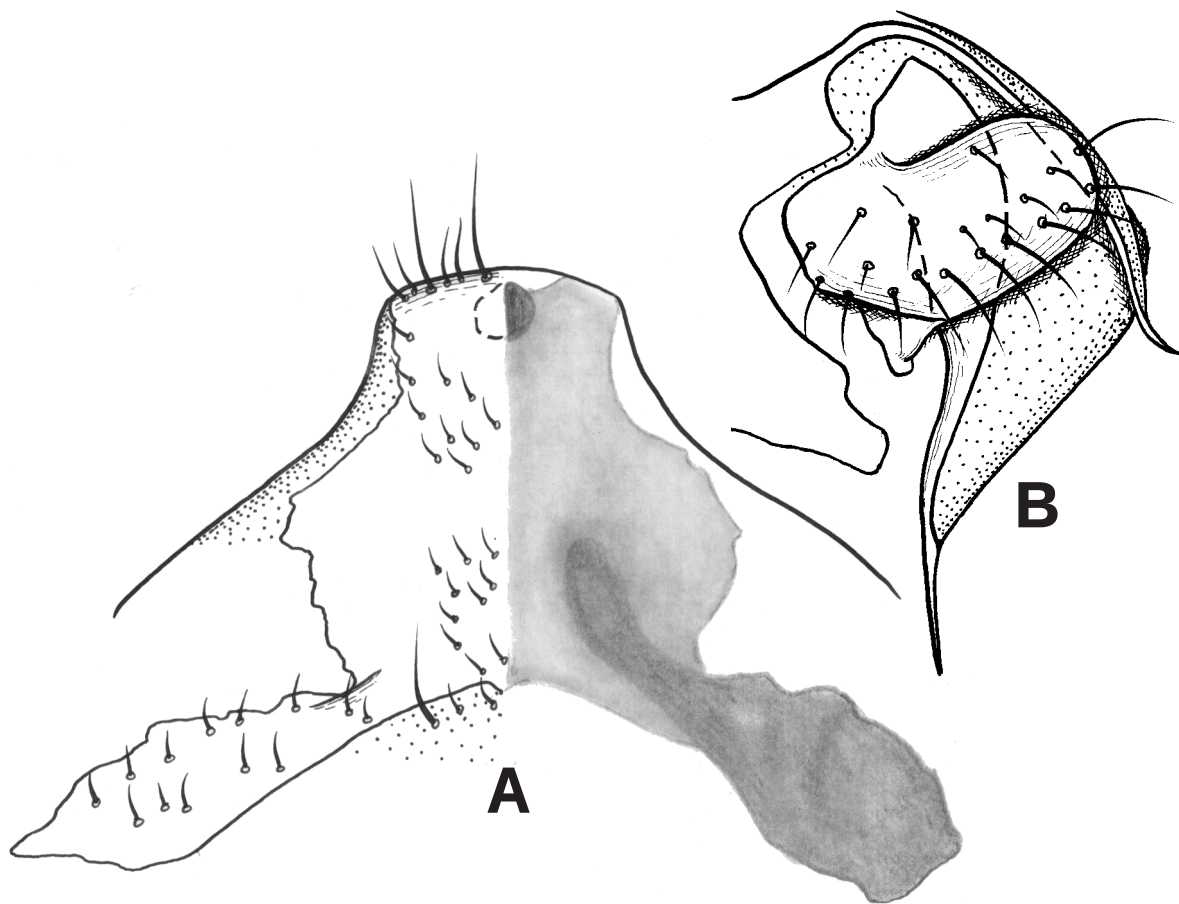


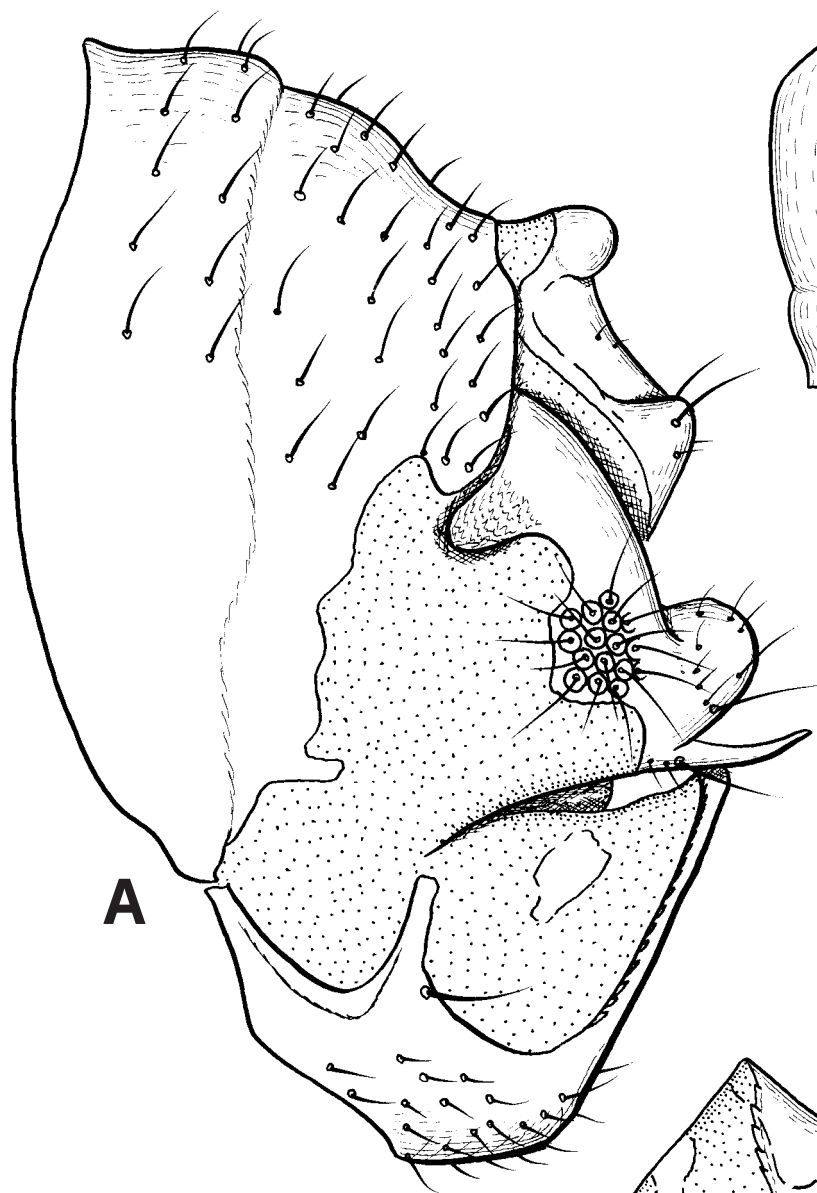
D



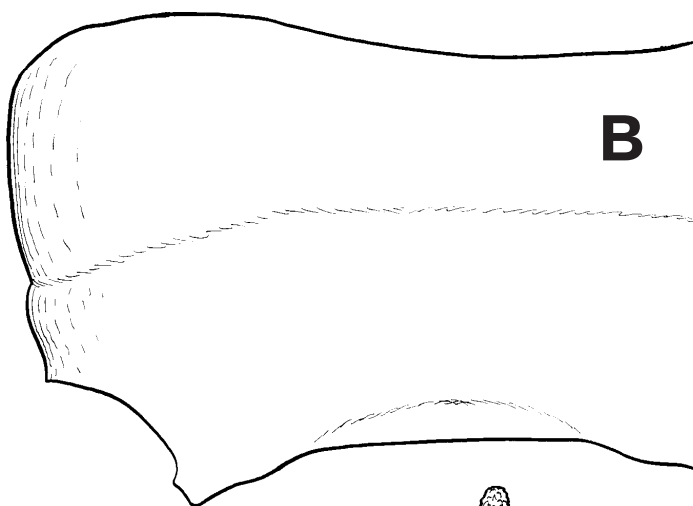
E



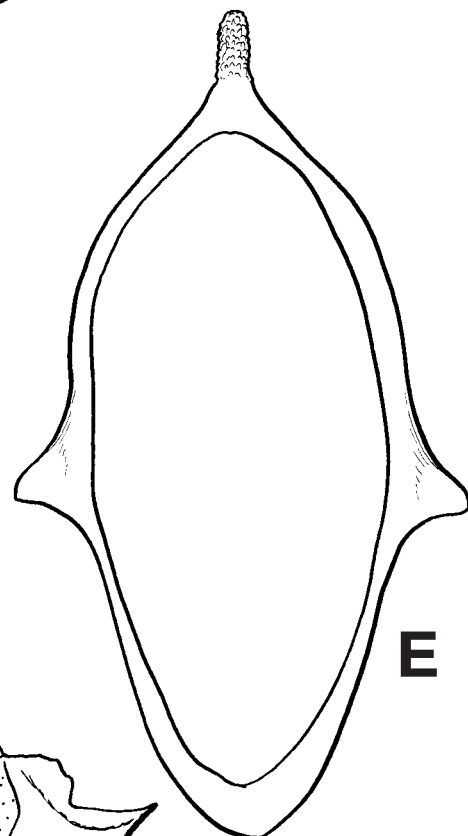




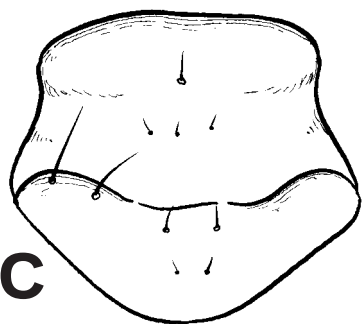
A



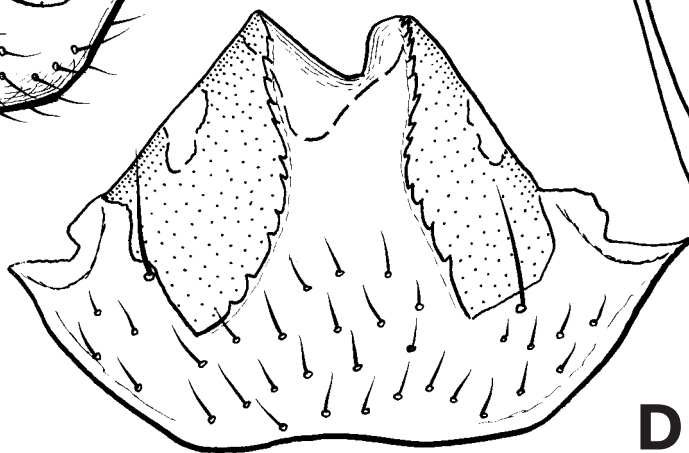
B



E



C



D

