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New *Pilophorus* species associated with myrmecophilous *Macaranga* trees from the Malay Peninsula and Borneo (Heteroptera: Miridae: Phylinae)

Y. Nakatani, T. Komatsu, T. Itino, U. Shimizu-kaya, T. Itioka, R. Hashim & S. Ueda

Seven new species of the phyline plant bug genus *Pilophorus* Hahn, 1926, namely, *P. aurifasciatus* Nakatani & Komatsu, *P. gracilipennis* Nakatani & Komatsu, *P. lambirensis* Nakatani & Komatsu, *P. laticollaris* Nakatani & Komatsu, *P. longirostris* Nakatani & Komatsu, *P. multivillus* Nakatani & Komatsu, and *P. unifasciatus* Nakatani & Komatsu, are described from the Malay Peninsula and Borneo (Sarawak). These new species are associated with myrmecophilous *Macaranga* spp. (Euphorbiaceae), which are well-known as myrmecophytes. All the new species have a uniquely protruded scutellum; the phylogenetic significance of this modification is discussed.

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Introduction

The phyline plant bug genus *Pilophorus* Hahn, 1926, is the largest group within the tribe Pilophorini with 106 valid species globally. In the Asian fauna, more than 40 congeners have been described e.g. by Poppius (1914a, b), Zou (1983, 1987, 1989), Carvalho (1986), Schuh (1984, 1989), Duwal & Yasunaga (2008), Zhang & Liu (2009). Schuh (1984) provided a comprehensive revision of the phyline fauna in the Indo-Pacific, and treated 28 *Pilophorus* species, of which 15 were new. However, it is certain that numerous undescribed taxa still remain in Asia, especially in the species-rich tropical and subtropical zones.

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Ant–plant mutualism between *Crematogaster* (*Decacrema*) ants (Formicidae) and *Macaranga* trees (Euphorbiaceae) in Asia is well-known and is a highly species specific association (Itino et al., 2001). Itino & Itioka (2001) reported that some mirid bugs colonized ant colonies on *Macaranga* trees, and that once the bugs were present the inhabiting ant population decreased and the plant tended to suffer more leaf damage by generalist herbivores. During our studies on the *Crematogaster–Macaranga* associations, one of the authors, T. Komatsu, observed that some *Pilophorus* species fed on the food bodies that *Macaranga* trees produce as food for ants. Herein we provide detailed descriptions, including habitus and live photographs, line illustrations of the male genitalia, measurements, and a key to species, for seven undescribed *Pilophorus* species on *Macaranga* from the Malay Peninsula and Borneo (Sarawak) (Fig. 1). These new species share a characteristic feature; all have the scutellum distinctly elevated, forming a conical or horn-like process. However, other morphological characters suggest these so-called "horn-backed" species are not closely related to each other. We discuss the likelihood that the unique horn-like scutellum is either a synapomorphy or simple homoplasy.

Materials and methods

All new species are accredited to Nakatani & Komatsu. All material examined in this study was collected from *Macaranga* spp. in the Malay Peninsula and Borneo (Sarawak). Specimens were preserved in absolute ethanol when collected, and later kept as dried specimens. The terminal segments of the abdomen were boiled in 5% KOH solution for five minutes to observe the genital structures. All measurements are given in millimeters. The following acronyms are used in the text: Forest Research Center, Sarawak, Malaysia (FRCS) and National Institute for Agro-Environmental Sciences, Tsukuba, Japan (NIAES). Matrix code labels were attached to material examined, which uniquely identified each specimen, and are referred to as unique specimen identifiers (USIs). The use of USI codes is noted in Yasunaga & Schuh (2013); see the website of the Planetary Biodiversity Inventory (PBI) Project (http://research.amnh.org/pbi/), or http://www.discoverlife.org for additional information on specimens examined.

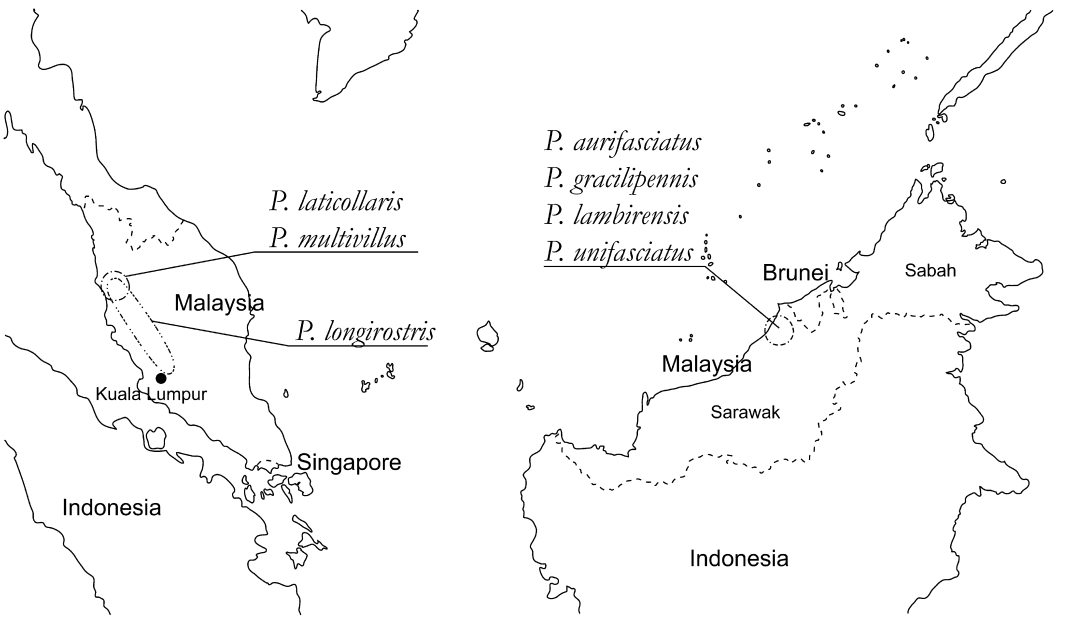

Fig. 1. Distribution map of *Pilophorus* spp.

Descriptions of new species

Pilophorus aurifasciatus Nakatani & Komatsu sp. n.

Figs. 2A–B, 3, 4A–D

Type material. Holotype: ♂, **Malaysia**, Sarawak, Miri, Lambir Hills National Park, 2.VI.2011, U. Shimizu-kaya leg. (AMNH_PBI 00379631) (FRCS).

Diagnosis

Recognized by dark body with bright brown head and a transverse band composed of golden setae on hemelytra. Distinguished from *P. laticollaris* sp. n. by the broader body, narrower pronotal collar, and different genital structures.

Description

Moderately slender-bodied, length apex tylus-cuneal fracture 2.25.

Coloration. Body dark with transverse broad band composed of golden appressed setae, appendages yellowish brown with dark markings. Head bright brown, somewhat tinged with red; vertex infuscate. Antennal segment II reddish brown with infuscate apical 1/3; other segments pale yellowish brown. Labium pale yellow with infuscate tip. Thorax, hemelytra, and abdomen mostly dark brown; prosternum pale yellowish brown; lateral margin of hemelytra narrowly pale. Legs yellowish white; outer surface of middle and hind coxae with reddish markings; apical half of hind femora with two reddish brown stripes; middle of hind tibia with wide reddish brown ring.

Surface and vestiture. Head, pronotum, and scutellum polished. Dorsum mostly with brown reclining setae. Apex of scutellum with patch of scalelike setae. Hemelytra broadly matte; posterior part of corium and cuneus polished; anterior band of scalelike setae complete on corium at level of apex of scutellum; posterior band of scalelike setae interrupted and widely separated on corium; dense golden appressed setae forming transverse band between levels of apices scutellum and clavus; scalelike setae on mesepimeron in two patches. Abdominal segments II–IV each with two patches of scalelike setae.

Structure. Face broad in frontal view. Antennal segment II weakly tumid. Labium short, barely reach-

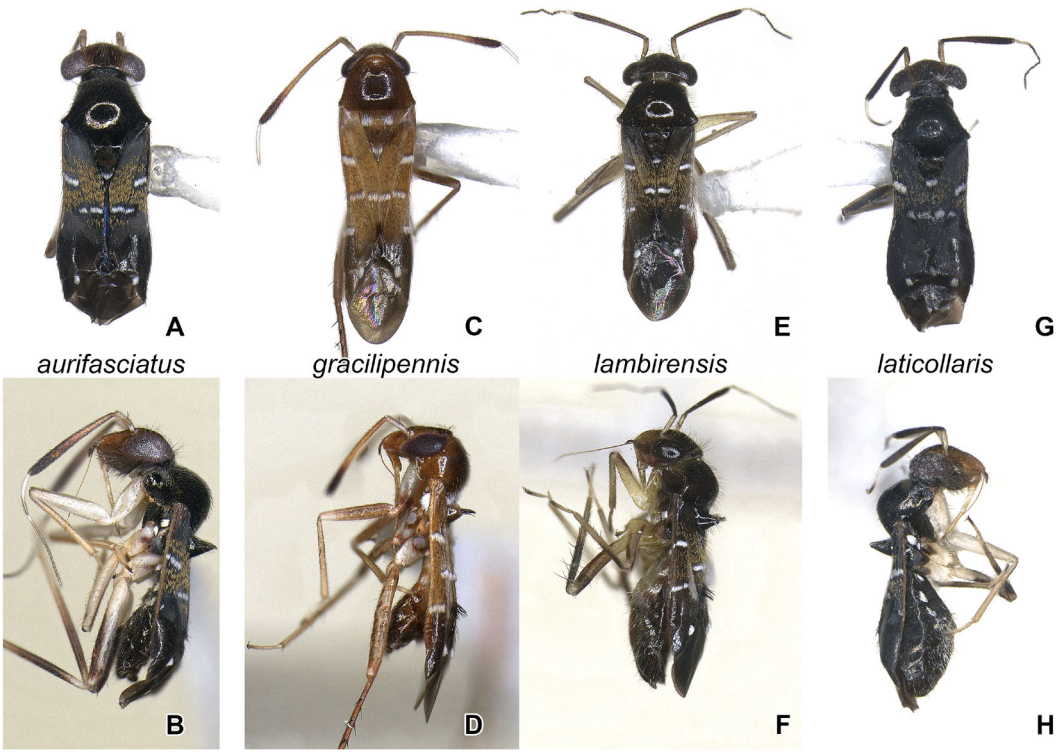

Fig. 2. *Pilophorus* spp. – A, C, E & G, dorsal aspect; B, D, F & H, lateral aspect; A–B, *P. aurifasciatus*, holotype, male; C–D, *P. gracilipennis*, holotype male; E–F, *P. lambirensis*, paratype, female; G–H, *P. laticollaris*, holotype, female.

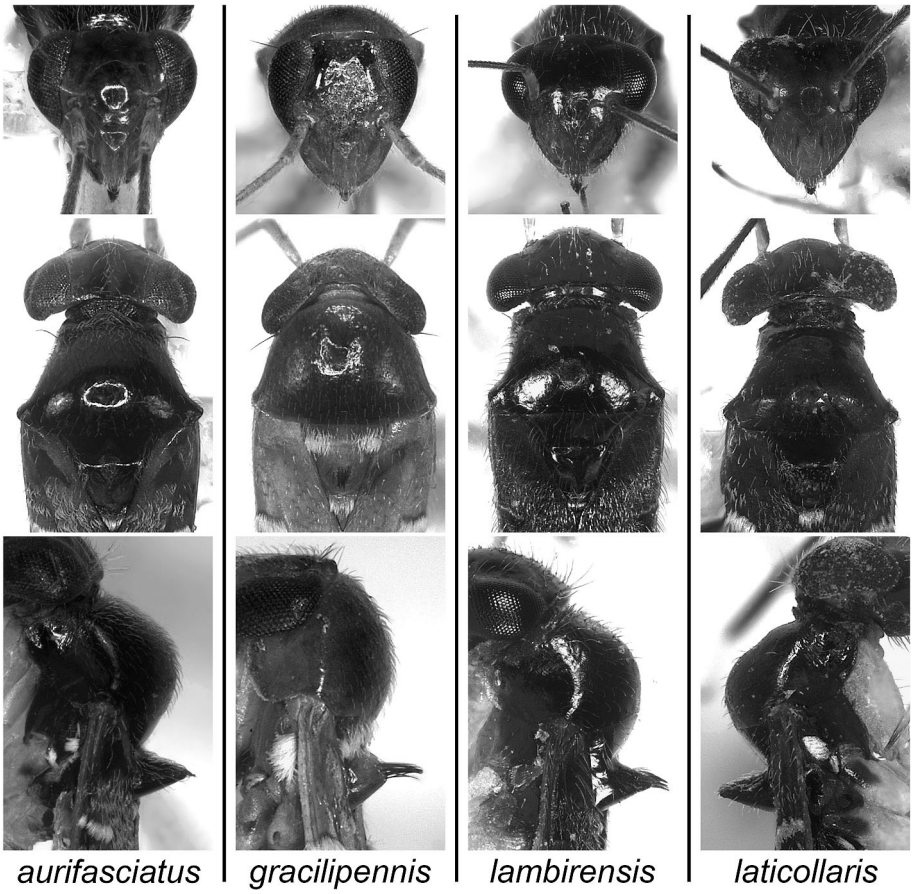

Fig. 3. Habitus images of *Pilophorus aurifasciatus*, *P. gracilipennis*, *P. lambirensis*, and *P. laticollaris*. – Upper row: head, frontal aspects; middle row: head and pronotum, dorsal aspects; pronotum and scutellum, lateral aspects.

ing anterior part of middle coxae. Pronotum strongly swollen and elevated posteriorly and narrowed anteriorly; anterior margin extended mesially; posterolateral corner protruding; pronotal collar developed. Mesoscutum broadly exposed; scutellum swollen and elevated, forming conical process with sharp apex. Sensory lobe of left paramere with thick and pointed process. Right paramere slender. Endosoma thin J-shaped, without process medially.

Dimensions (♂). Total body length: 2.61; maximum width across hemelytra: 0.91; head width: 0.81; distance from tip of tylus to vertex: 0.74; vertex width: 0.33; length of antennal segments I–IV: 0.26, 1.02, 0.41, 0.77; length of labial segments I–IV: 0.26, 0.19, 0.15, 0.26; width of pronotum: 0.87 length of hind femur, tibia, and tarsus: 1.10, 1.48, 0.42.

Host plant

Collected on *Macaranga beccariana* Merr., 1950.

Etymology

From Latin, aurum (gold) and fascia (band), referring to a transverse fascia composed of golden setae on hemelytra.

Pilophorus gracilipennis Nakatani & Komatsu sp. n.

Figs. 2C–D, 3, 4E–H

Type material. Holotype: ♂, **Malaysia**, Sarawak, Miri, Lambir Hills National Park, 14.VII.2011, U. Shimizu-kaya leg. (AMNH_PBI 00379632) (FRCS).

Diagnosis

Recognized by extremely slender body and pale coloration; separated from other *Pilophorus* species with a conical scutellum by the patches of scalelike setae laterally on mesoscutum.

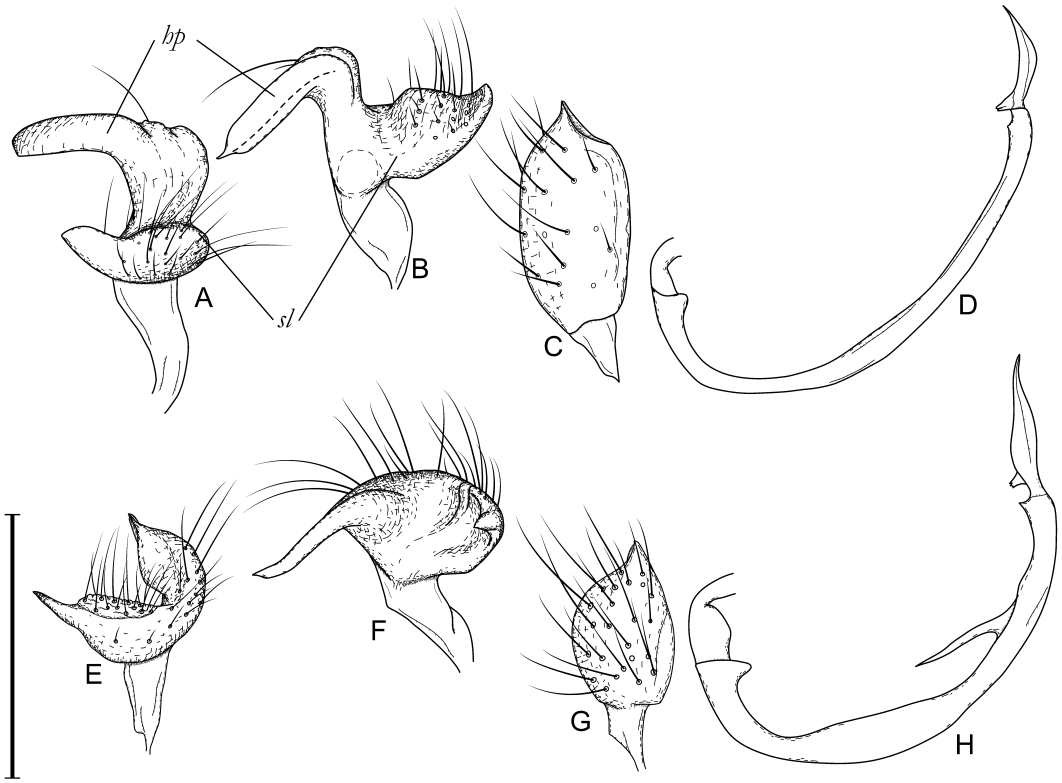

Fig. 4. Male genitalia of *Pilophorus* spp. – A–B & E–F, Left paramere; C & G, right paramere; D & H, endosoma; A–D, *P. aurifasciatus*, holotype, male; E–H, *P. gracilipennis*, holotype, male. – Abbreviations: *sl* = sensory lobe; *hp* = hypophysis. Scale: 0.2 mm.

Description

Bright brown, slender-bodied, length apex tylus-cuneal fracture 2.25.

Coloration. Body and appendages yellowish brown, hemelytra somewhat paler anterior to change in surface texture. Head entirely yellowish brown. Apical 1/3 of antennal segment II dark reddish brown. Labium pale yellow with infuscate tip. Thorax mostly yellowish brown; scutellum slightly paler. Hemelytra widely pale yellowish brown, somewhat darkened posterior to change in surface texture; membrane smoky brown. Legs yellowish brown; coxae widely pale. Abdomen yellowish brown.

Surface and vestiture. Head, pronotum, scutellum, and posterior part of hemelytra polished. Dorsum covered with short brown reclining setae. Mesoscutum with two patches of scalelike setae on lateral sides. Scutellum with patch of scalelike setae at apex; tip of process with tuft of dark bristles. Hemelytra broadly matte; posterior part of corium and cuneus polished; anterior band of scalelike setae on corium placed at level of apex of scutellum; posterior band of scalelike setae disjunct at R+M vein, inner part adjacent to band on clavus and outer part at level of apex of clavus; golden appressed setae scattered on matte area of clavus and corium. Mesepimeron widely covered by a patch of scalelike setae. Abdominal segments II and III both with two patches of scalelike setae.

Structure. Face relatively narrow in frontal view. Antennal segment II slender and weakly tumid apically. Labium relatively elongate, extending beyond hind coxae. Pronotum weakly and roundly elevated, with lateral margin straight. Mesoscutum exposed; scutellum swollen and elevated, but not as pronounced as in other congeners treated herein. Sensory lobe of left paramere with sharp-pointed process. Endosoma widened from basal 1/5 to middle, with simple and slender process medially.

Dimensions (♂). Total body length: 2.93; maximum width across hemelytra: 0.69; head width: 0.68; distance from tip of tylus to vertex: 0.70; vertex width: 0.26; length of antennal segments I–IV: 0.29, 1.23, 0.41, –; length of labial segments I–IV: 0.33, 0.36, 0.29, 0.40; width of pronotum: 0.75; length of hind femur, tibia, and tarsus: 1.15, 1.74, 0.48.

Host plant
Collected on *Macaranga beccariana* Merr., 1950.

Etymology
From Latin, gracilis (slender) and pennis (wing), referring to the slender hemelytra.

Pilophorus lambirensis Nakatani & Komatsu sp. n.

Figs. 2E–F, 3, 5A–D

Type material. Holotype: ♂, **Malaysia**, Sarawak, Miri, Lambir Hills National Park, 13.V.2012, U. Shimizu-kaya leg. (AMNH_PBI 00379633) (FRCS); paratypes: 1♀, 12.XIII.2011, 1♀, 24.X. 2011, 4♀, 7–15.V.2012, same locality and collector as for holotype (00379634–00379639) (FRCS & NIAES).

Diagnosis
Recognized by the slender and parallel-sided brown body and tuft of bristles on apex of clavus.

Description
Body slender. Head, pronotum, and hemelytra nearly equal in width, length apex tylus-cuneal fracture 2.32–2.35.

Coloration. Body castaneous; appendages yellowish brown with dark markings. Head widely pale yellowish brown; vertex, mandibular plates and genae infuscate. Most of antennal segments II–IV and apical 1/3 of III infuscate. Labrum castaneous. Labium pale yellow with infuscate tip. Pronotum broadly castaneous, with narrow anterior margin paler; prosternum pale yellowish brown; meso- and metasternum pale yellowish brown. Hemelytra entirely castaneous; outer margin of posterior corium slightly tinged with red; membrane dark gray. Legs pale yellow; two reddish brown stripes on both sides of middle and hind femora; brown stripes on outer sides of each tibiae. Mesal parts of abdominal segments III–V widely pale.

Surface and vestiture. Dorsum with brown erect setae. Head, pronotum, and scutellum polished. Apex of scutellum with patch of scalelike setae; tip of process on scutellum with tuft of bristles. Hemelytra broadly matte; posterior part of outer side of corium and cuneus polished; anterior band of scalelike setae on corium at level of apex of scutellum; posterior band of scalelike setae placed at level of apex of clavus; clavus with band of scalelike setae and with tuft of bristles apically; golden appressed setae forming wide band on area between levels of process of scutellum

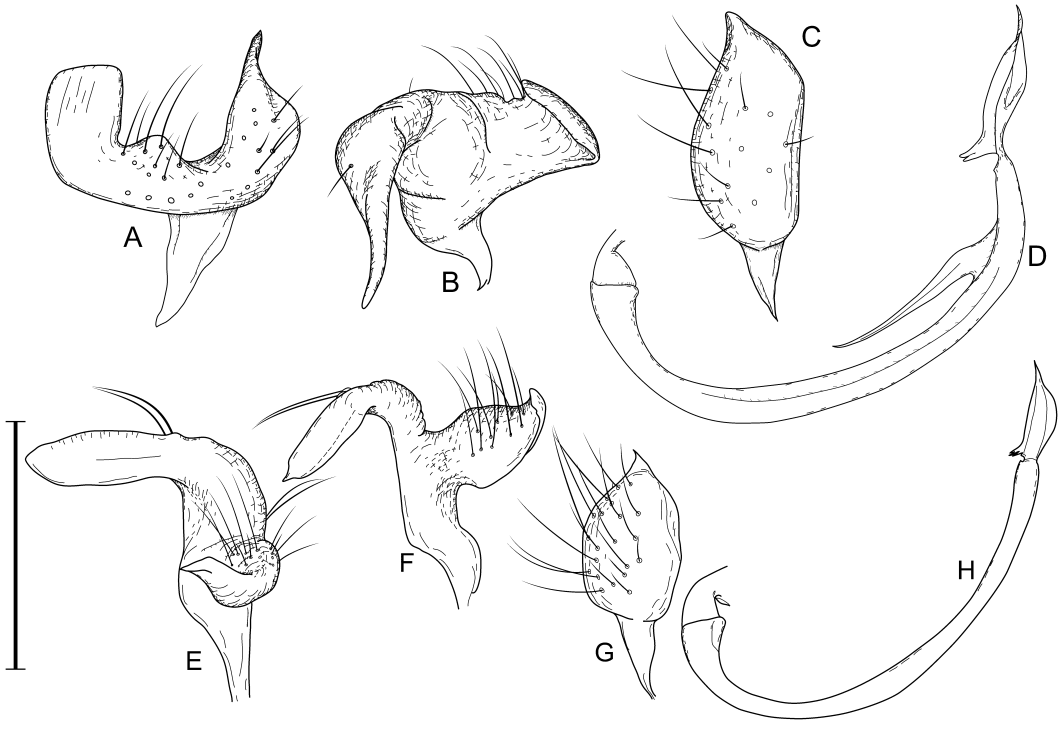

Fig. 5. Male genitalia of *Pilophorus* spp. – A–B & E–F, Left paramere; C & G, right paramere; D & H, endosoma; A–D, *P. lambirensis*, holotype, male; E–H, *P. laticollaris*, paratype, male. – Scale: 0.2 mm.

and posterior band of corium. Scalelike setae on mesepimeron forming a patch. Abdominal segments II–IV each with two patches of scalelike setae.

Structure. Face relatively broad in frontal view. Antennal segment II almost tubular. Labium reaching base of hind coxa. Pronotum moderately swollen and elevated posteriorly and lateral margin slightly concave. Mesoscutum narrowly exposed; scutellum strongly swollen and elevated, forming process with sharp apex. Sensory lobe of left paramere with flattened rectangular process; hypophysis elongate apically. Endosoma with an elongate process medially.

Dimensions (♂/♀). Total body length: 3.16/3.16; maximum width across hemelytra: 0.85/0.83; head width: 0.88/0.90; distance from tip of tylus to vertex: 0.82/0.83; vertex width: 0.45/0.47; length of antennal segments I–IV: 0.29/0.31, 0.98/0.91, 0.42/0.25, 0.66/0.69; length of labial segments I–IV: 0.37/0.40, 0.36/0.38, 0.22/0.23, 0.29/0.25; width of pronotum: 0.83/0.86; length of hind femur, tibia, and tarsus: 1.24/1.20, 1.75/1.73, 0.45/0.44.

Host plants

Collected on *Macaranga rufescens* S.J. Davies, 2001 and *M. hosei* King ex Hook.f., 1887.

Etymology

Named for the collection site, Lambir Hills National Park, Sarawak, Malaysia.

Pilophorus laticollaris Nakatani & Komatsu sp. n.

Figs. 2G–H, 3, 5E–H

Type material. Holotype: ♀, **Malaysia**, Perak, Taiping, Maxwell Hill [= Bukit Larut], 4.X.2011, T. Komatsu & M. Maruyama leg. (AMNH_PBI 00379640) (NIAES); paratypes: 2♂ (teneral or incomplete specimens), same data as for holotype (00379641–00379642) (NIAES).

Diagnosis

Slender, black-bodied species. Recognized by the following characters: hemelytra with a transverse band of scattered golden setae; pronotum demarcated anteriorly as a collar; scutellum with a sharply pointed process. Closely related to *P. aurifasciatus*, from which it is distinguished by its slender body, broader collar, and genital structures.

Description

Slender bodied, length apex tylus-cuneal fracture 2.05–2.56.

Coloration. Body blackish brown with pale appendages. Head widely pale except vertex and genae castaneous. Antenna castaneous except outer side of segment I paler, basal half of III, and extreme base of IV. Labium pale yellow, apex infuscate. Prosternum pale yellow. Lateral margin of hemelytra narrowly pale; membrane dark gray. Legs pale yellow; dark markings on outer sides of base of middle and hind coxae; dark reddish brown stripes on apical 2/3 dorsally and apical 1/3 ventrally of middle and hind femora; basal half of hind tibia dark reddish brown except base. Abdomen blackish brown.

Surface and vestiture. Dorsum with scattered, short, brown reclining setae. Head, pronotum, and scutellum strongly polished. Head with scattered brown erect setae; longer on genae. Apex of scutellum with patch of scalelike setae. Hemelytra broadly matte; posterior part of corium and cuneus polished; anterior band of scalelike setae at level of apex of scutellum; posterior band of scalelike setae disjunct, divided into distant two small patches, inner one continuously connected with band on clavus; band of golden appressed setae between process on scutellum and posterior band of scalelike setae. Scalelike setae on mesepimeron in form of two patches. Abdominal segments II–IV each with two patches of scalelike setae.

Structure. Face relatively elongate in frontal view. Antennal segment II slightly tumid in male, tubular in female. Labium short, barely reaching base of middle coxae. Pronotum strongly swollen and elevated posteriorly with concave lateral margin; anterior part of pronotum rugose and clearly distinct from remainder by fold, forming collar. Mesoscutum broadly exposed; scutellum strongly swollen and elevated, forming sharply pointed process. Process of sensory lobe of left paramere thinner than that of *P. aurifasciatus* and bent apically. Right paramere short and rounded. Endosoma thin J-shaped, without process medially.

Dimensions (♂/♀). Total body length: 2.57/2.98; maximum width across hemelytra: 0.83/0.99; head width: 0.81/0.90; distance from tip of tylus to vertex: 0.78/0.84; vertex width: 0.32/0.33; length of antennal segments I–IV: 0.26/0.25, 1.02/0.95, 0.40/0.29, 0.73/0.58; length of labial segments I–IV: 0.27/0.26, 0.28/0.27, 0.18/0.18, 0.24/0.25; width of pronotum: 0.77/0.89; length of hind femur, tibia, and tarsus: 1.15/1.14, 1.57/1.51, 0.49/0.48.

Host plant

Collected on *Macaranga hypoleuca* (Rchb. f. & Zoll., 1866).

Etymology
From Latin, latis (broad, wide) and collaris (collar, neck band), referring to the distinct pronotal collar.

Biology
This new species was found on the undersides of young leaves of *Macaranga hypoleuca*. The host plant produces food bodies on young leaves where many *Crematogaster* ants aggregate and collect the food bodies. The plant bugs stay among these ants. Although the bugs appear to avoid touching ants, they do not seem to suffer aggression from ants. In the laboratory test, the bugs fed on food bodies of *M. hypoleuca*.

Pilophorus longirostris Nakatani & Komatsu sp. n.

Figs. 6A–B, 7A, 8, 9A–D

Type material. Holotype: ♂, **Malaysia**, Perak, Taiping, Maxwell Hill, 4.X.2011, T. Komatsu leg. (AMNH_PBI 00379643) (NIAES); paratypes: **Malaysia**: 1♂, 1♀, same data as for holotype (00379644–00379645) (NIAES); 1♀, Bukit Fraser, VII.2011, T. Komatsu leg. (00379646) (NIAES); 1♀, 4.X.2011, 1♂, 1♀, 23.V.2012, Ulu Gombak, Selangor, alt. 200 m, T. Komatsu leg. (00379647–00379649) (NIAES).

Diagnosis
Recognized by the elongate labium which is extending beyond the middle of abdomen, discontinuous posterior band of scalelike setae on the hemelytra, and thick process on scutellum.

Description
Small, short-bodied, length apex tylus-cuneal fracture 2.31–2.60.
Coloration. Body castaneous with several paler portions. Head widely pale except vertex castaneous. Antenna yellowish brown; apical 1/3 of II, apical 1/2 of III and most of IV infuscate. Pronotum castaneous; pleurites and sternites yellowish brown. Hemelytra anterior to change in surface texture paler than posterior part; membrane dark gray. Legs yellowish brown; fore coxae weakly infuscate apically; apical part of middle femora, and apical half of hind femora posteriorly with red markings; outer parts of base of mid-

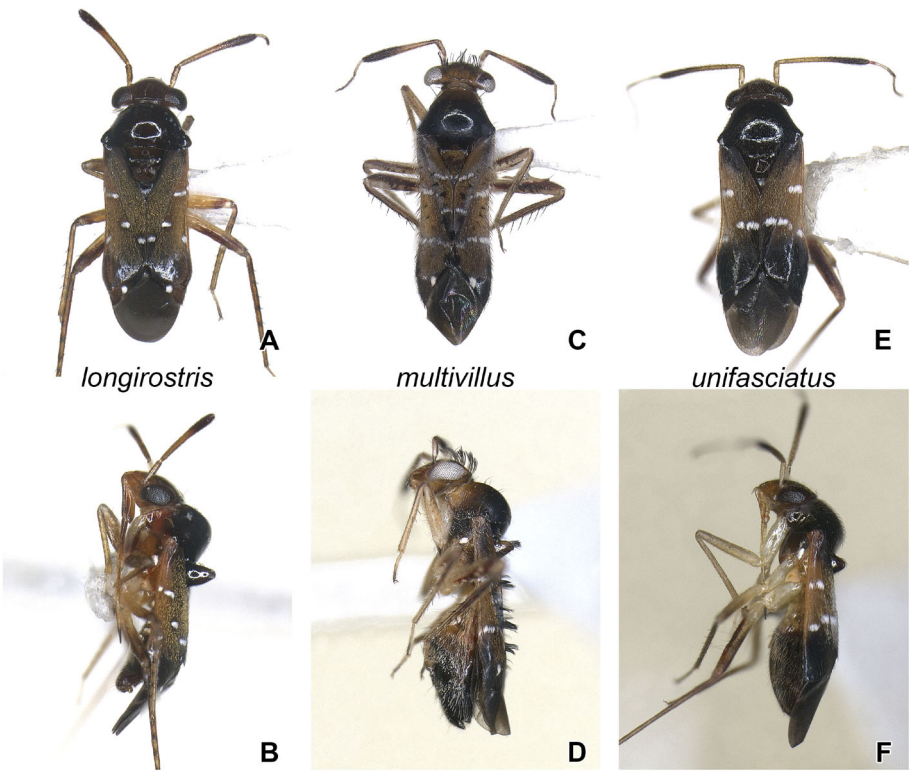

Fig. 6. *Pilophorus* spp. – A, C & E, dorsal aspect; B, D & F, lateral aspect; A–B, *P. longirostris*, holotype, male; C–D, *P. multivillus*, holotype, female; E–F, *P. unifasciatus*, paratype, female.

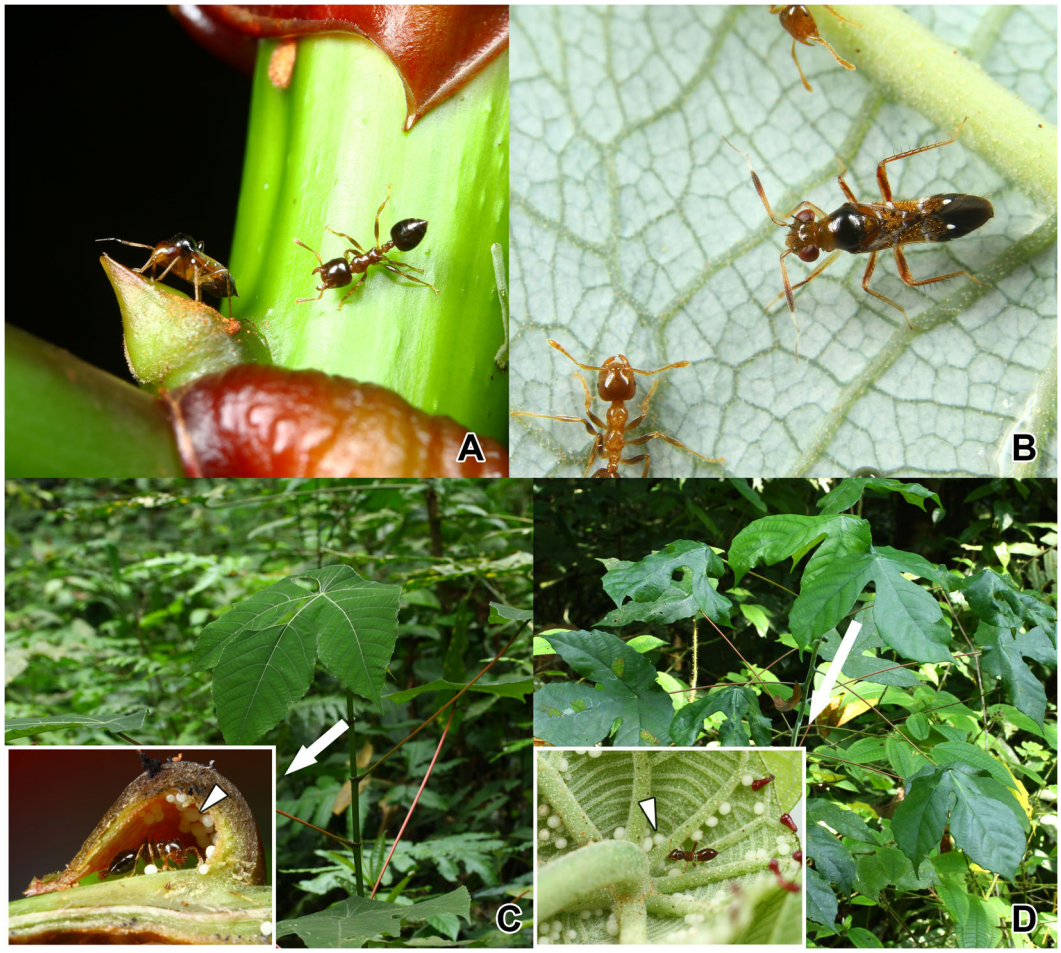

Fig. 7. *Pilophorus* spp. on the host plants with ants and its host plants. – A, *P. longirostris* on bud escaping from ant worker; B, *P. multivillus* on young leaf with ant workers; C, *M. bancana* and section of the stipule; D, *M. hypoleuca* and reverse side of the young leaf with nymph of *P. laticollaris*. – White arrows show food bodies produced by *Macaranga* trees.

dle and hind tibiae, and basal regions of tibial spines with brown patches. Abdomen castaneous.

Surface and vestiture. Head, pronotum, and scutellum strongly polished. Apex of scutellum with patch of scalelike setae. Hemelytra widely matte; posterior part of corium and cuneus polished; anterior band of scalelike setae at level of apex of scutellum and divided by R+M vein, the outer patch slightly placed anteriorly; posterior band of scalelike setae disjunct and discontinuous, appearing as two small patches, the outer one adjacent to R+M vein, and inner one adjacent to clavus; hemelytra anterior to change in surface texture broadly covered with golden appressed setae. Scalelike setae on mesepimeron forming patch. Abdominal segments II–V each with two patches of scalelike setae.

Structure. Antennal segment II weakly tumid apically. Labium elongate, extending beyond middle of abdomen. Pronotum strongly inflated. Mesoscutum broadly exposed; scutellum strongly swollen and elevated, forming thick conical process. Sensory lobe of left paramere thick, with flattened, spatula-like process. Endosoma C-shaped, without process medially.

Dimensions (♂/♀)**.** Total body length: 2.84/3.24; maximum width across hemelytra: 0.98/1.11; head width: 0.81/0.84; distance from tip of tylus to vertex: 0.70/0.75; vertex width: 0.34/0.41; length of antennal segments I–IV: 0.25/0.23, 0.98/1.05, 0.31/0.36, 0.64/0.65; length of labial segments I–IV: 0.45/0.52, 0.44/0.45, 0.41/0.43, 0.49/0.52; width of pronotum: 0.98/1.09; length of hind

Fig. 8. Habitus images of *Pilophorus longirostris*, *P. multivillus*, and *P. unifasciatus*. – Upper row: head, frontal aspect; middle row: head and pronotum, dorsal aspect; pronotum and scutellum, lateral aspect.

femur, tibia, and tarsus: 1.01/1.09, 1.38/1.49, 0.32/0.34.

Host plants
Collected on *Macaranga bancana* (Miq., 1866) and *M. hullettii* King ex Hook.f., 1887.

Etymology
From Latin, longis (long) and rostris (rostrum), refering to the elongate labium.

Biology
This new species was found mainly on stem stipules of *M. bancana*. The host plant produces food bodies from the stipules. The bugs appear to have no contact with *Crematogaster* ants. When ants approach, the bugs run away quickly (Fig. 9A). When they are disturbed by human activity, adults fly away, whereas nymphs do not drop from the plant but run about in circles on the stems. In the laboratory tests, the bugs fed on food bodies of *M. bancana*. In addition, a few individuals attempted to thrust their stylets into the stem stipules.

Pilophorus multivillus Nakatani & Komatsu sp. n.

Figs. 6C–D, 7B, 8, 9E–H

Type material. Holotype: ♀, **Malaysia**, Perak, Taiping, Maxwell Hill, 4.X.2011, T. Komatsu & M. Maruyama leg. (AMNH_PBI 00379650) (NIAES); paratypes: 2♂ (teneral specimens), same data as for holotype (00379651–00379652) (NIAES).

Diagnosis
Recognized by the slender and bright brown body, tufts of bristles on scutellum and hemelytra, two bands of scalelike setae on clavus and complete posterior band on corium.

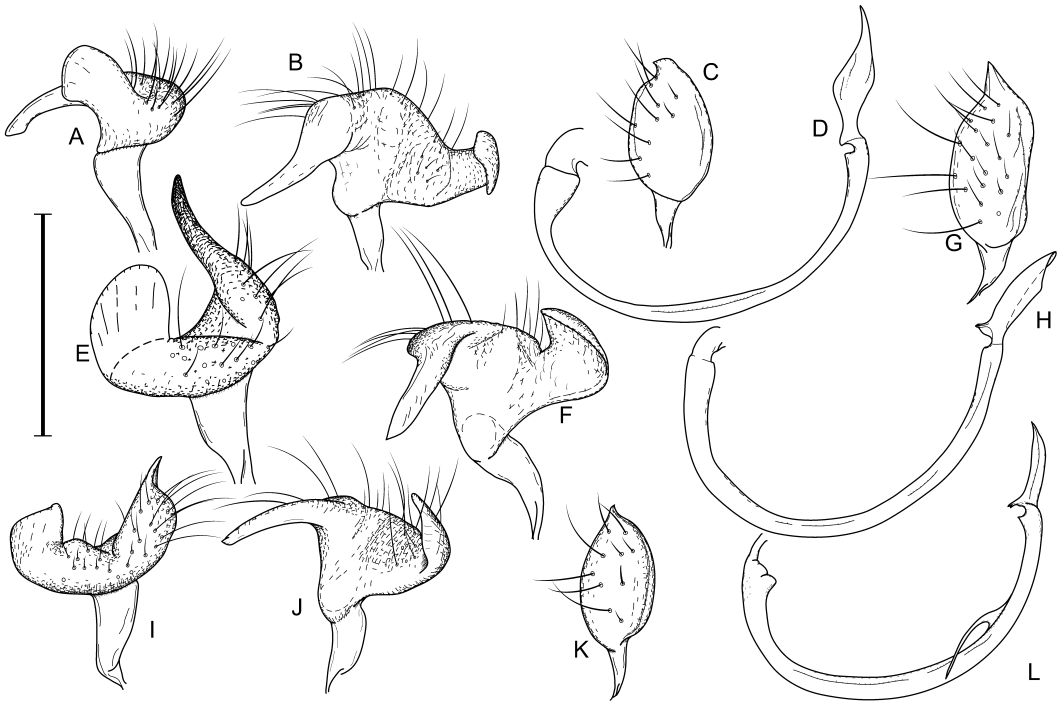

Fig. 9. Male genitalia of *Pilophorus* spp. – A–B, E–F & I–J, Left paramere; C, G & K, right paramere; D, H & L, endosoma; A–D, *P. longirostris*, holotype, male; E–H, *P. multivillus*, paratype, male; I–L, *P. unifasciatus*, holotype, male. – Scale: 0.2 mm.

Description

Slender-bodied, length apex tylus-cuneal fracture 2.18–2.91.

Coloration. Body bright brown with several dark portions. Head broadly pale yellowish brown. Antenna pale yellowish brown; thin reddish stripes on outer and inner sides of segment I; apical 1/3 and near base of segment II infuscate; segment IV widely infuscate. Labrum castaneous. Labium pale yellow, infuscate apically. Pronotum widely castaneous and gradually paler anteriorly; prosternum pale yellowish brown. Mesoscutum castaneous, scutellum paler; mesepisternum and mesepimeron castaneous. Hemelytra broadly bright brown; outer margin of clavus slightly infuscate; posterior part of marginal corium and cuneus castaneous; membrane dark gray. Legs pale yellow; reddish brown markings on outer side of base of middle and hind coxae; reddish brown stripes dorsally on middle femur, and dorsally and ventrally on hind femur; reddish brown stripes on outer side of basal 1/3 of middle tibia and basal half of hind tibia. Abdomen gradually darkened from yellowish brown to dark castaneous posteriorly.

Surface and vestiture. Dorsum with characteristic tufts composed of long, thick, black erect bristles. Head, pronotum and scutellum moderately polished. Head with black bristles forming three tufts on frons and row on hind margin of vertex; remaining area densely covered with yellow erect setae. Pronotum sparsely furnished with brown erect setae. Apex of scutellum with patch of scalelike setae; tip of process on scutellum with tuft of bristles. Hemelytra matte and densely covered with long reclining setae laterally; corium and cuneus polished posteriorly; anterior band of scalelike setae on corium at level of apex of scutellum; posterior band of scalelike setae complete, placed at level of apex of clavus: clavus with two bands of scalelike setae; five tufts of bristles on clavus; large tuft at inner margin and several small tufts at middle of corium; golden appressed setae scattered on area between two bands of setae on clavus and most of corium; scalelike setae on mesepimeron forming patch. Abdomen densely covered with long reclining setae; abdominal segments II–IV each with two patches of scalelike setae.

Structure. Face relatively broad in frontal view. Antennal segment II slightly tumid. Labium reaching base of middle coxa. Pronotum strongly swollen and elevated posteriorly, and lateral margin slightly concave. Mesoscutum broadly exposed; scutellum strongly swollen and elevated, forming process with

rounded apex. Sensory lobe of left paramere well developed, with flat and rounded process. Endosoma C-shaped, without process medially.

Dimensions (♂/♀). Total body length: 2.87/3.78; maximum width across hemelytra: 1.04/1.02; head width: 0.82/0.97; distance from tip of tylus to vertex: 0.79/0.85; vertex width: 0.34/0.44; length of antennal segments I–IV: 0.30/0.34, 1.01/1.06, 0.31/0.28, 0.58/0.42; length of labial segments I–IV: 0.32/0.38, 0.33/0.36, 0.21/0.27, 0.22/0.27; width of pronotum: 1.01/1.07 length of hind femur, tibia, and tarsus: 1.22/1.40, 1.71/1.85, 0.45/0.54.

Host plant

Collected on *Macaranga hypoleuca* (Rchb. f. & Zoll., 1866).

Etymology

From Latin, multi (many) and villus (tuft of hair), referred to bristles on dorsum.

Biology

This new species was observed on the undersides of young leaves of *M. hypoleuca*. In the laboratory, the bugs fed on food bodies of *M. hypoleuca*. The natural history of this species appears to be similar to that of *P. laticollaris*.

Pilophorus unifasciatus Nakatani & Komatsu sp. n.

Figs. 6E–F, 8, 9I–L

Type material. Holotype: ♂, **Malaysia**, Sarawak, Miri, Lambir Hills National Park, 2.VI.2011, U. Shimizu-kaya leg. (AMNH_PBI 00379653) (FRCS); paratypes: 2♀, 24.X.2011, same locality and collector as for holotype (00379654–00379655) (FRCS & NIAES).

Diagnosis

Recognized by the short brown body with a transverse broad paler band on hemelytra and continuous posterior band of scalelike setae.

Description

Small, short-bodied, length apex tylus-cuneal fracture 2.01–2.21.

Coloration. Body castaneous with transverse broad paler band and appendages yellowish brown with dark markings. Head castaneous, paler anteriorly genae pale brown. Antenna pale yellowish brown; apical 1/3 of antennal segments II, apical half of segment III, and most of IV except base infuscate. Labium pale yellow with apex infuscate. Pronotum castaneous, with narrow paler margin anteriorly; prosternum pale yellowish brown; mesepisternum and mesepimeron castaneous; ostiolar peritreme pale yellowish brown. Hemelytra widely bright brown; posterior part from posterior band of scalelike setae castaneous; membrane dark gray. Legs pale yellow; apical 3/4 of hind femora with reddish brown markings. Abdominal segments II–IV pale, remainder castaneous or reddish brown.

Surface and vestiture. Head, pronotum, and scutellum polished. Apex of scutellum with patch of scalelike setae. Hemelytra widely matte; infuscate area polished; anterior band of scalelike setae on corium at level of apex of scutellum; posterior band of scalelike setae combined with band on clavus, forming long transverse band of setae; hemelytra with scattered golden appressed setae anterior to posterior band of scalelike setae. Scalelike setae on mesepimeron forming a patch. Abdominal segments III and IV with minute pair of patches of scalelike setae posterolaterally.

Structure. Face relatively broad in frontal view. Antennal segment II tubular. Labium long, reaching abdominal segment V. Pronotum moderately swollen and elevated posteriorly, lateral margins slightly concave. Mesoscutum narrowly exposed; scutellum swollen and elevated, forming moderately protruded process with round apex. Endosoma with thin and curved process medially.

Dimensions (♂/♀). Total body length: 2.33/2.80; maximum width across hemelytra: 0.91/0.94; head width: 0.65/0.69; distance from tip of tylus to vertex: 0.58/0.61; vertex width: 0.31/0.35; length of antennal segments I–IV: 0.26/0.25, 0.92/0.94, 0.41/0.40, 0.52/0.65; length of labial segments I–IV: 0.31/0.34, 0.33/0.39, 0.25/0.23, 0.33/0.26; width of pronotum: 0.80/0.87 length of hind femur, tibia, and tarsus: 1.03/1.09, 1.50/1.63, 0.41/0.41.

Host plant

Collected on *Macaranga beccariana* Merr., 1950.

Etymology

From Latin, uni (one) and fascia (band), referring to the continuous posterior band of scalelike setae on hemelytra.

Key to "horn-backed" species of *Pilophorus* in Malaysia

1. Labium elongate, extending beyond the middle of abdomen . . . . . *longirostris*
– Labium short, at most reaching hind coxa only 2
2. Tufts of bristles on hemelytra 3
– Hemelytra without tuft of bristles 5

3. Head covered with long and thick bristles; hemelytra with many tufts of bristles .... *multivillus*
– Head without bristles; hemelytra with a tuft of bristles at apex of clavus 4
4. Body bright brown and extremely slender; dorsum covered with short appressed setae ..... *gracilipennis*
– Body castaneous; dorsum covered with brown erect setae ..... *lambirensis*
5. Labium reaching hind coxae; pronotal collar invisible; process of scutellum with round apex ..... *unifasciatus*
– Labium short, barely reaching middle coxa; pronotal collar distinct; process of scutellum pointed 6
6. Body slender; mesal part of pronotal collar shorter than anteriorly extended part of pronotum; process of sensory lobe of left paramere weakly bent; right paramere elongate ..... *aurifasciatus*
– Body broader; mesal part of pronotal collar equal in length or slightly longer than anteriorly extended part of pronotum; process of sensory lobe of left paramere bent apically; right paramere short ..... *laticollaris*

Discussion

All species described above have a modified scutellum that protrudes dorsally, forming a horn-like process. This character is unique in the genus, and in the New World is found only in *P. heidemanni* Poppius, 1914. At first glance the form of the scutellum appears to be a synapomorphy, which allows members of this "species group" to be recognized. Other morphological characters found in these "horn-backed" species, however, do not suggest a close relationship between them; only *P. aurifasciatus* and *P. laticollaris* might be closely related to each other.

Ecologically all the species inhabit leaves, stipules, or stems of *Macaranga* trees (Euphorbiaceae). These myrmecophytic trees provide nesting spaces and nutrients for the *Crematogaster* ants that protect them from herbivores. At least, three species of *Pilophorus* from the Malay Peninsula – *P. longirostris*, *P. multivillus* and *P. laticollaris* – were observed to feed on the food bodies without being attacked by ants.

Yasunaga & Schuh (2013) treated five Thai *Pilophorus* species, and inferred that strong modifications of the pronotum of some strikingly myrmecomorphic species may be homoplasious and derived from a close association with certain ant species. It is similar to the case of "horn-backed" species. The elevated scutellum of *Pilophorus* species might have arisen homoplasiously through the usage of *Macaranga* resources. That *Crematogaster* ants inhabiting *Macaranga* trees have a pair of spines on the propodeum might support this hypothesis. Elucidation of such a relationship, or coevolution between plants, ants, and plant bugs will require further investigation.

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