

Morphologically novel members of the ant-mimetic
plant bug genus *Pilophorus* Hahn found in Thailand,
with descriptions of three new species
(Heteroptera: Miridae: Phylinae: Pilophorini)

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ABSTRACT

Morphologically novel species of the ant-mimetic plant bug genus *Pilophorus* Hahn from Thailand are reviewed, with photographic images of live individuals. Three species, *Pilophorus barbiger*, *P. giraffoides*, and *P. portentosus*, are described as new, in addition to two known Thai species, *P. maculatus* (Schuh) and *P. pleiku* (Schuh), which are also diagnosed. The female of *P. pleiku* is reported for the first time. The biology and immature forms are documented for *P. pleiku* and *P. barbiger*, which were observed to be associated with ants on the rubiaceous broad-leaf, *Gardenia sootepensis* Hutch. The systematic position of such morphologically novel species is discussed. *Pilophorus palawanus* (Schuh) is newly recorded from Singapore.

INTRODUCTION

Pilophorus Hahn of the subfamily Phylinae is a well-known plant bug genus, including myrmecomorphic but always macropterous members that often co-occur with ants. This genus is currently composed of approximately 110 valid species from the most zoogeographical regions except for Australia and South America (Schuh, 1991, 1995).

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FIG. 1. Habitus images in life of *Pilophorus* spp. in Thailand. A. *P. maculatus*, male adult. B. Same, female adult. C. *P. pleiku*, male adult. D. Same, fifth instar nymph. E. *P. giraffoides*, male. F. Same, female. G. *P. josi-fovianus* (from Kathmandu Valley, Nepal).

This paper represents part of recent attempt to document the plant bug fauna of Thailand (Yasunaga and Yamada, 2009; Yasunaga et al., 2010; Yasunaga, 2010), and treats five conspicuously ant-mimetic or otherwise morphologically novel members of the genus *Pilophorus*. Two myrmecomorphic species with the modified pronotum, *P. barbiger* and *P. giraffoides*, are described as new. In addition, a single, peculiar male adult that has excessively long antennae, labium, and legs is confirmed to represent an undescribed species of *Pilophorus*. The form of



FIG. 2. Habitus images in life of *Pilophorus* spp. in Thailand. A. *P. barbiger*, male adult. B. Same, female adult. C. Same, fourth instar nymph. D. Same, fifth instar nymph. E. *P. portentosus*, holotype male. F. *P. typicus* (from SERS).

the male genitalia and pattern of the scalelike setae warrant its placement in this genus, and it is described as *P. portentosus* herein.

Two Thai species described by Schuh (1984), *P. maculatus* (Schuh) and *P. pleiku* (Schuh), are also diagnosed and figured; the adult female of the latter is reported for the first time. Biology and immature forms are documented for *P. barbiger* and *P. pleiku*. Photographs of live

individuals are provided for all known Thai species. *Pilophorus palawanus* (Schuh), which was previously known only from Palawan Island in the Philippines, is recorded from Singapore; *P. josifovianus* Duwal and Yasunaga recently described from Nepal is reexamined and recognized as one of the morphologically novel members.

MATERIALS AND METHODS

Specimens examined are deposited in the following institutions or collections: American Museum of Natural History, New York (AMNH); Suranaree University of Technology, Nakhon Ratchasima, Thailand (SUT); and Yasunaga collection, Nagasaki, Japan (TYCN). Matrix code labels were attached to all specimens, which uniquely identify each specimen, and are referred to as *unique specimen identifiers* (USIs). The USI codes (e.g., AMNH_PBI 000777) comprise an institution and project code (AMNH_PBI) and a unique number (000777). Generally, each USI label corresponds to a single specimen; however, some USI labels correspond to a few specimens belonging to a single species mounted on one pin. Please visit the website of the Planetary Biodiversity Inventory (PBI) Project (<http://research.amnh.org/pbi/heteropteraspeciespage>), or <http://www.discoverlife.org> for additional information on specimens examined.

All specimens examined in this study were collected by Yasunaga and his colleagues from June 2008 to June 2012, mainly as a part of international cooperative program on biodiversity between the Rajamangala University of Technology Suvarnabhumi, Ayutthaya, Thailand (RMUTSB) and the Japan International Cooperation Agency, Senior Volunteers (JICA-SV). One of the localities investigated, Sakaerat Environmental Research Station, Sakaerat Biosphere Reserve, Ministry of Science and Technology, Wang Nam Khieo District, Nakhon Ratchasima Province, Thailand, is simply abbreviated as SERS, because almost all the specimens used in this paper were collected there; for further information on this research station, access the official website (<http://www.tistr.or.th/sakaerat/index.php>). Digital images of live individuals were taken by T.Y. with Canon EOS Kiss digital camera body + Olympus OM-System (Zuiko 38 mm macrolens + Auto Extension Tube + T10 Ringflash).

All measurements are in millimeters (mm). Terminology follows major works treating the Phylinae (Schuh, 1984; Wheeler, 2001; Yasunaga, 2001); terminology of the genitalia mainly follows Cassis (2008), Schuh and Wu (2009), and Yasunaga (2010). In the synonymic lists only selected references are cited, as a comprehensive catalog covering other literatures is now available (Schuh, 1995; continuously updated web version: <http://research.amnh.org/pbi/catalog/>).

TAXONOMY

Genus *Pilophorus* Hahn, 1826

Pilophorus Hahn, 1826: 22 (n. gen.), type species by designation under ICZN plenary powers:

Cimex clavatus L., 1767; Schuh, 1995: 458 (cat.); Kerzhner and Josifov, 1999: 280 (cat.).

Bilirania Carvalho, 1956: 215 (n. gen.), type species by original designation: *B. myrmecoides* Carvalho, 1956 (syn. by Schuh, 1989: 10).

Biliranoides Schuh, 1984: 27 (n. gen.), type species by original designation: *B. kathleenae* Schuh, 1984 (syn. by Schuh, 1989: 10).

Strictotergum Zou, 1983: 283, 287 (n. gen.), type species by original designation: *S. castaneus* Zou, 1983 (syn. by Schuh, 1989: 10).

DIAGNOSIS: Primarily recognized by the myrmecomorphic, elongate, and always macropterous body form; more or less aggregated, scalelike setae on apex of the scutellum; presence of the anterior band of scalelike setae on the corium (the posterior band variable, sometimes scattered); weakly or moderately flattened metatibia; parempodia fleshy, recurved, apically convergent; usually strongly splayed-out left paramere; ovoid to elongate oval right paramere; and C- to J-shaped endosoma, often furnished with a median spine or barb. Some species are strikingly antlike due to strong modifications of the pronotum (figs. 1–5). Further diagnostic characters and synapomorphies are provided by Schuh (1984, 1991) and Schuh and Schwartz (1988).

DISTRIBUTION: Holarctic, Oriental and Afrotropical regions, New Guinea, and some Pacific islands.

BIOLOGY: Most members of *Pilophorus* appear to be host-plant specific, but the genus is also assumed to comprise many predators, preying on aphids, scales, mites, and dipteran and lepidopteran larvae, among other possible prey taxa (Wheeler, 2001; Yasunaga, 2001). In Japan, *P. typicus* (Distant) (fig. 2F) and some of its congeners are regarded as effective, indigenous natural enemies for biological control programs, feeding on serious agricultural pests, such as aphids, thrips, whiteflies, and spider mites (Ito et al., 2011; Yasunaga, 2001). The host-plant range includes forbs, broadleaf woody angiosperms, and conifers.

One generation per year is assumed for temperate and cold-temperate species that as a rule overwinter in the egg stage. Most members occurring in warm temperate zone, subtropics, and tropics have multivoltine life cycles. Both adults and immature forms are often associated with various ants (fig. 3).

Pilophorus maculatus (Schuh, 1984)

Figures 1A–B, 4, 6

Bilirania maculata Schuh, 1984: 22 (n. sp.).

Pilophorus maculata: Schuh, 1989: 10 (n. comb.); Schuh, 1995: 464 (cat.).

DIAGNOSIS: Easily recognized by the generally castaneous coloration, dense, stiff setae on the head that is wider than high in frontal view, large eye, confluent anterior and posterior lobes of the moderately constricted pronotum (not forming a distinct neck), a golden, large, claval macula just posterior to the apex of the scutellum (the macula formed by aggregation of golden, reclining setae), and somewhat modified, L-shaped, apically broadened endosoma. Detailed description provided by Schuh (1984).

MEASUREMENTS: ♂/♀: Total body length 2.8–3.0/ 3.0–3.2; length from apex of clypeus to cuneal fracture 2.59–2.67/ 2.47–2.88; head width across eyes 0.81–0.84/ 0.82–0.86; head height 0.82–0.84/ 0.90–0.92; vertex width 0.27–0.30/ 0.32–0.36; lengths of antennal segment I–IV 0.26–0.29, 1.17–1.29, 0.36–0.39, 0.39–0.45/ 0.24–0.28, 1.09–1.24, 0.34–0.37, 0.39–0.44; labial

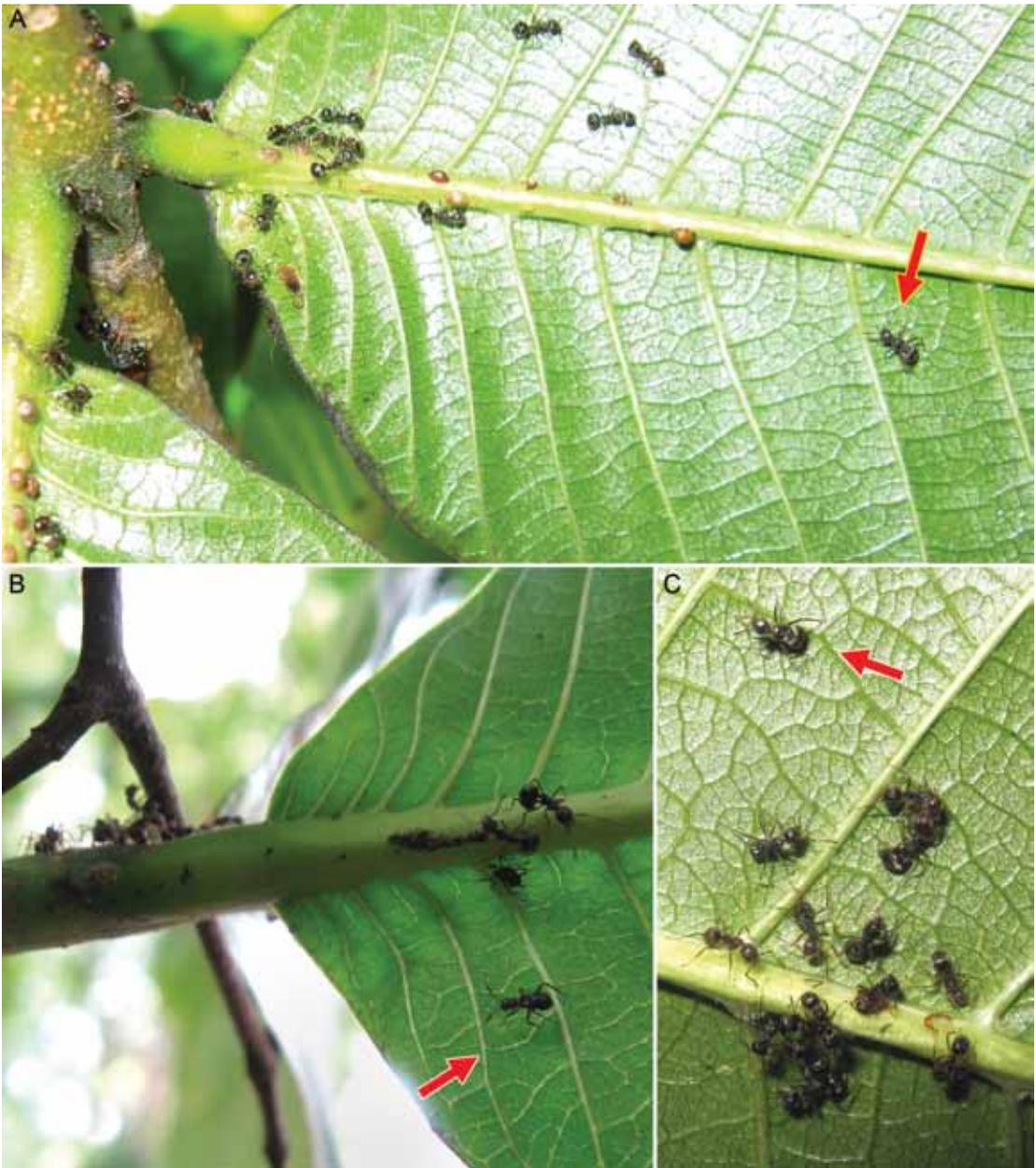


FIG. 3. *Pilophorus pleiku* (arrowed) associated with workers of an unidentified ant species on a broadleaf, *Gardenia sootepensis* Hutch. A, C, adult; B, fifth instar nymph.

length 1.05–1.20/ 1.05–1.22; mesal pronotal length 0.61–0.75/ 0.70–0.75; basal pronotal width 0.78–0.84/ 0.79–0.84; width across hemelytra 1.02–1.11/ 1.09–1.25; and lengths of metafemur, tibia, and tarsus 1.11–1.16, 1.78–1.86, 0.32–0.36/ 1.15–1.20, 1.80–1.92, 0.31–0.35.

DISTRIBUTION: Thailand (Chanthaburi, Chiang Mai, Chonburi, Nakhon Nayok, and Nakhon Ratchasima provinces).

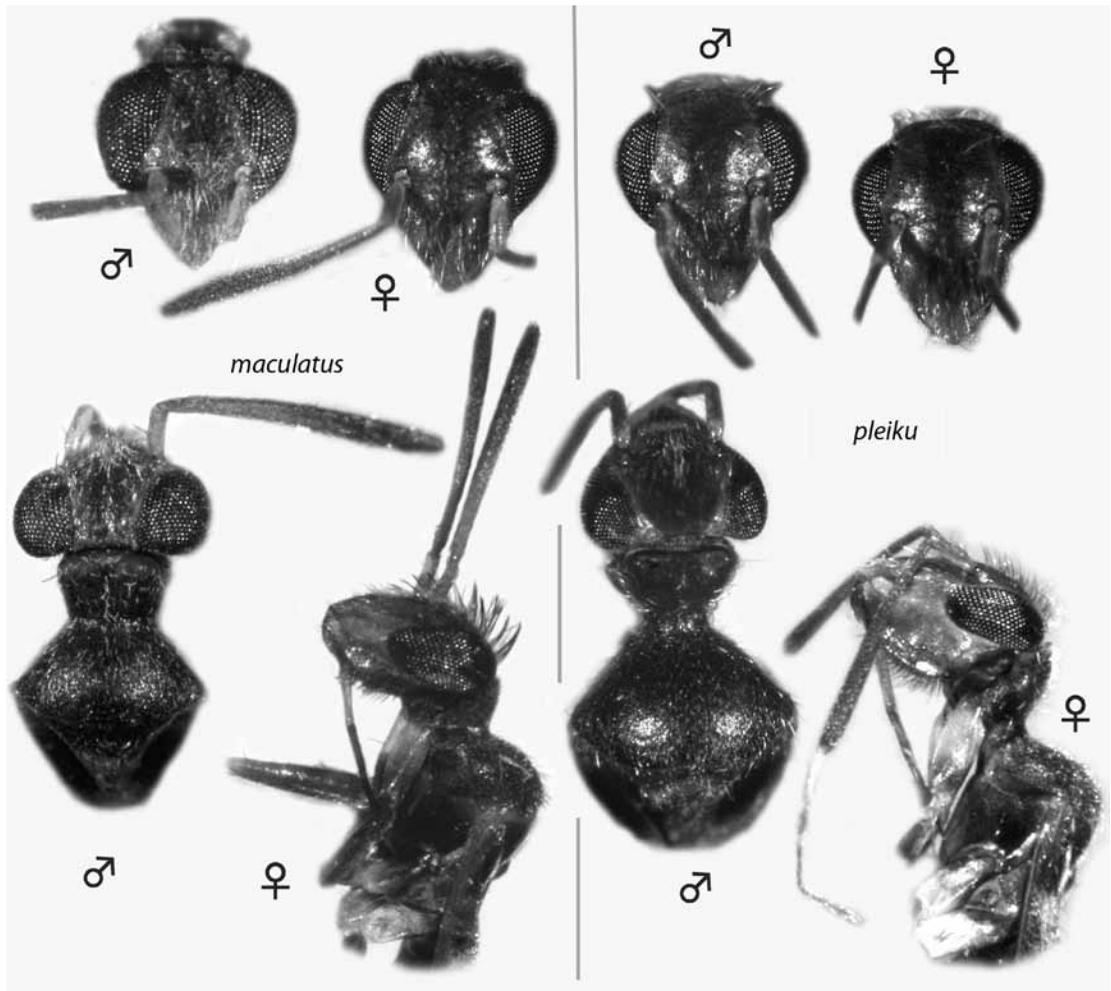


FIG. 4. Habitus images of *Pilophorus maculatus* and *P. pleiku*.

BIOLOGY: Adults are occasionally collected by sweeping inflorescences of various broadleaves, such as *Tectona grandis* L. (Lamiaceae) and *Mallotus* sp. (Euphorbiaceae), and by light traps, sometimes in large numbers. The adults are found almost throughout the year, but immature forms are yet to be discovered. One male adult was associated with an unidentified ant species (fig. 3) on a broadleaf, *Gardenia sootepensis* Hutch. (Rubiaceae), together with *P. pleiku* and *P. barbiger*.

MATERIAL EXAMINED: **THAILAND:** **Nakhon Nayok Prov.:** Sarika, Wat Tham Sarika (Buddhist temple), 14°17'22"N, 101°16'25"E, sweeping teak (*Tectona grandis*) flowers, 18 Jun 2009, T. Yasunaga, 1 ♀ (AMNH_PBI 00379447) (TYCN). **Nakhon Ratchasima Prov.:** SERS, Lodge, 14°30'38"N, 101°55'50"E, 385 m alt., on *Gardenia sootepensis* with ants, 20 Aug 2008, T. Yasunaga, 1 ♂ (00379448) (TYCN); SERS, 14°30'27"N, 101°55'39"E, 410 m alt., light trap, 20 Aug 2008, T. Yasunaga, B. Shishido, 1 ♂ 1 ♀ (00379449) (TYCN); SERS, same site, light trap, 16 Sep

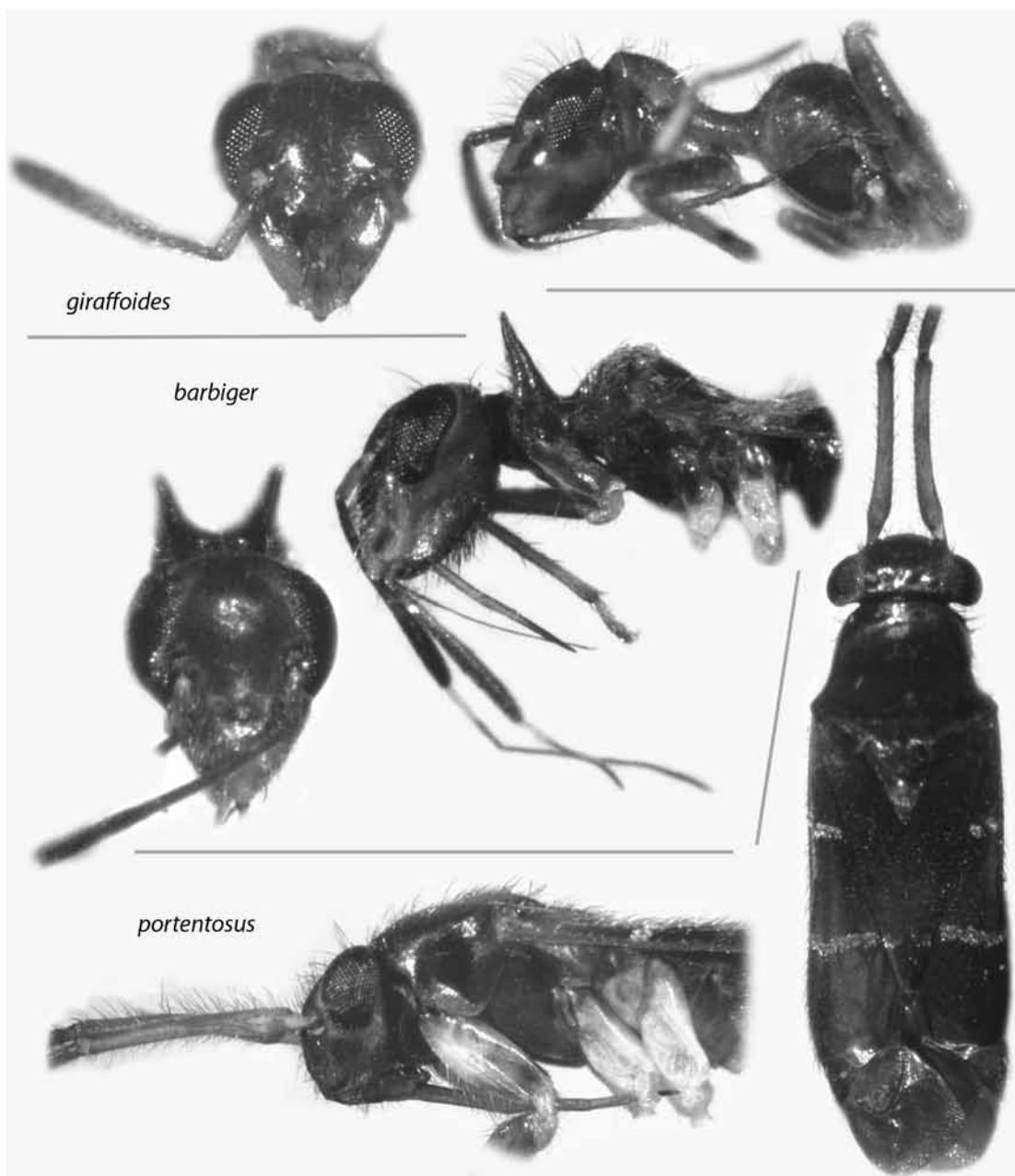


FIG. 5. Habitus images of *Pilophorus giraffoides*, *P. barbiger*, and *P. portentosus*.

2008, T. Yasunaga, 2♂ 4♀ (00379450–00379454) (TYCN); SERS, same site, sweeping flowers of a broadleaf, 23 and 25 Jan 2009, T. Yasunaga, 2♀ (00379455–00379456) (TYCN); SERS, same site, light trap, 25 Jan 2009, T. Yasunaga, 3♂ 1♀ (00379457–00379458) (TYCN); SERS, Lodge-Dam, 14°30'38"N, 101°55'50"E, 385 m alt. 14°29'49"N, 101°54'57"E, 500 m alt., sweeping flowers, 27 Feb 2009, T. Yasunaga, 2♀ (00379459–00379460) (TYCN); SERS, 14°30'27"N,

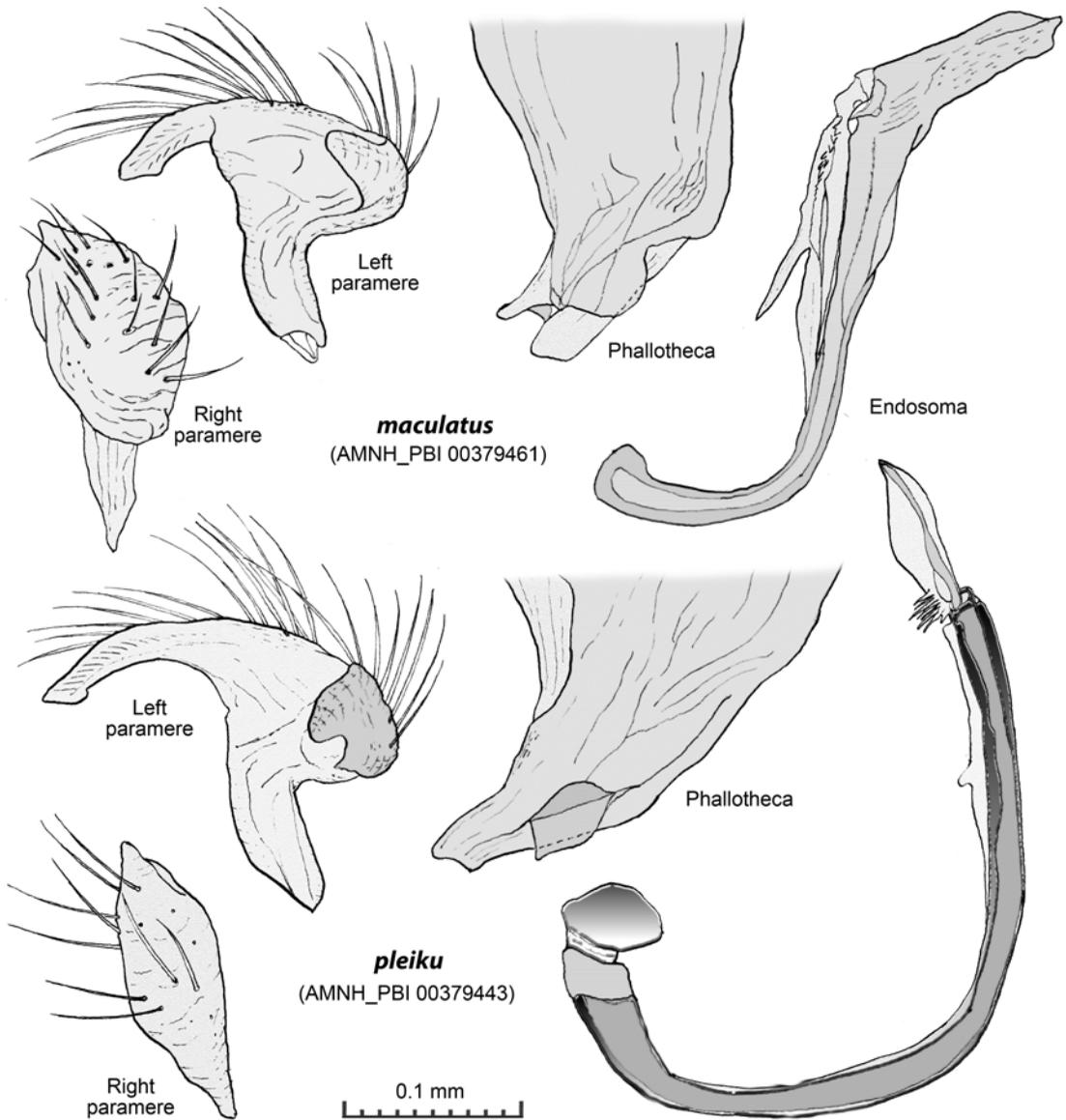


FIG. 6. Male genitalia of *Pilophorus maculatus* and *P. pleiku*.

101°55'39"E, 410 m alt., light trap, 12–14 Jun 2009, T. Yasunaga, K. Yamada, 38♂ 12♀ (00379461–00379480) (AMNH, SUT, TYCN); SERS, 14°30'27"N, 101°55'39"E, 410 m alt., light trap, 29–31 May 2012, T. Yasunaga, 6♂ 8♀ (00379501–00379507) (TYCN).

Pilophorus pleiku (Schuh, 1984)

Figures 1C–D, 3, 4, 6

Bilirania pleiku Schuh, 1984: 24 (n. sp.).

Pilophorus pleiku: Schuh, 1989: 10 (n. comb.); Schuh, 1995: 466 (cat.).

DIAGNOSIS: Recognized by the generally coffee-brown coloration, head higher than wide in frontal view, comparatively small eye, rather long antennal segments III and IV, short neck-like construction of the pronotum, obscure claval macula composed of short, sparse golden setae, and a very short, spurlike projection on the endosoma. No difference between male and female recognizable, except for the body size. Detailed description of adult male provided by Schuh (1984).

MEASUREMENTS; ♂/♀: Total body length 2.8–3.0/ 3.0–3.2; length from apex of clypeus to cuneal fracture 2.64–2.69/ 2.70–2.96; head width across eyes 0.76–0.79/ 0.80–0.84; head height 0.81–0.86/ 0.91–0.93; vertex width 0.31–0.35/ 0.40–0.42; lengths of antennal segment I–IV 0.23–0.27, 1.18–1.20, 0.45–0.47, 0.63–0.65/ 0.25–0.29, 1.12–1.20, 0.42–0.45, 0.57–0.63; labial length 1.20–1.22/ 1.18–1.23; mesal pronotal length 0.79–0.90/ 0.84–0.85; basal pronotal width 0.88–0.93/ 0.87–0.89; width across hemelytra 1.20–1.23/ 1.21–1.25; and lengths of metafemur, tibia, and tarsus 1.21–1.29, 1.90–1.94, 0.30–0.34/ 1.29–1.32, 1.95–2.03, 0.30–0.33.

DISTRIBUTION: Thailand (Chanthaburi, Chiang Mai, Chonburi, Nakhon Nayok, and Nakhon Ratchasima provinces), Viet Nam.

BIOLOGY: The adult and final instar nymph of *P. pleiku* were found on a broadleaf, *Gardenia sootepensis* Hutch. On this tree the bugs were usually observed walking around with ants but always keeping a certain distance from them (fig. 3). The worker of this unidentified ant species, which is very similar in shape to the mirid, is aggressive, and sometimes produces a painful bite. This pilophorine is assumed to feed on scale insects (fig. 3A–B) protected by the ant species.

MATERIAL EXAMINED: **THAILAND: Nakhon Nayok Prov.:** Sarika (lodge), N14°18'07" E101°18'09", at light, 15 Jun 2009, T. Yasunaga, K. Yamada, 1 ♀ (AMNH_PBI 00379438) (TYCN). **Nakhon Ratchasima Prov.:** SERS, 14°30'27"N, 101°55'39"E, 410 m alt., light trap, 12–14 Jun 2009, T. Yasunaga, K. Yamada, 4 ♀ (00379439–00379440) (TYCN); SERS, Lodge, 14°30'38"N, 101°55'50"E, 385 m alt., on *Gardenia sootepensis* with ants, 15 Sep 2008, T. Yasunaga, 1 ♂ (00379441) (TYCN); SERS, 14°30'27"N, 101°55'39"E, 410 m alt., light trap, 16 Sep 2008, T. Yasunaga, 1 ♂ (00379442) (TYCN); SERS, same site, sweeping Asteraceae weed, 26 Oct 2008, T. Yasunaga, 1 ♂ (00379443) (TYCN); SERS, same site, light trap, 25 Feb 2009, T. Yasunaga, 1 ♀ (00379444) (TYCN); SERS, Lodge-Dam, 14°30'38"N, 101°55'50"E, 385 m alt. 14°29'49"N, 101°54'57"E, 500 m alt., sweeping flowers, 27 Feb 2009, T. Yasunaga, 2 ♂ (00379445–00379446) (TYCN).

Pilophorus barbiger, new species

Figures 2A–D, 5, 7

HOLOTYPE: **THAILAND: Nakhon Ratchasima Prov.:** SERS, Lodge, 14°30'38"N, 101°55'50"E, 385 m alt., on *Gardenia sootepensis* with ants, 20 Aug 2008, T. Yasunaga, ♂ (AMNH_PBI 00379430) (SUT).

DIAGNOSIS: Recognized by the fuscous general coloration, long, straight, conical pronotal horn as long as an eye (fig. 5), and form of the male genitalia. These diagnostic characters distinguish this new species from the superficially similar congeners *P. culion* (Schuh) and *P. kathleenae* (Schuh), which also have a pair of pronotal horns.

DESCRIPTION: Body generally velvety dark brown, elongate, comparatively large in size; dorsal surface somewhat dull, with uniformly distributed, long, erect setae; golden, short, reclining setae distributed on pronotum and hemelytron (fig. 2A, B). Head higher than wide in frontal view, densely furnished with beardlike setae ventrally; eye rather small, about half length of head height; vertex wide. Antenna dark brown; entire segment I and at least basal half of II pale or reddish brown; basal half of III and base of IV yellowish brown. Labium somber brown, short, slender, reaching apex of procoxa; segment IV dark brown. Pronotum with a short necklike constriction; horn on anterior lobe shining, conical, acute, almost equal in length to an eye, with uniformly distributed, silky, semierect setae (fig. 5); scutellum somewhat convex mesially; episternum with several scalelike setae along lateral margin. Hemelytron strongly deflected at cuneal fracture, with a short band of scalelike setae on anterior 1/3 of corium; posterior half of clavus and anterior half of corium shagreened; membrane uniformly dark smoky brown. Apical part of each coxa more or less pale. Leg dark brown; tibia flattened; apical halves of pro- and mesotibiae, almost entire metatibia and all tarsi, except for tarsomeres III, pale brown, partly tinged with red. Abdomen shiny fuscous. *Male genitalia* (fig. 7): Parameres generally tumid; left paramere with comparatively elongate hypophysis; right paramere elongate ovoid. Endosoma with a broad median projection and subapical notches posteriorly.

MEASUREMENTS: ♂/♀: Total body length 3.1–3.5/ 3.3–3.6; length from apex of clypeus to cuneal fracture 2.95–3.29/ 3.12–3.15; head width across eyes 0.85–0.86/ 0.87–0.90; head height 0.96–0.98/ 1.00–1.05; vertex width 0.36–0.37/ 0.41–0.42; lengths of antennal segment I–IV 0.28–0.30, 1.29–1.35, 0.37–0.45, 0.60–0.72/ 0.28–0.30, 1.26–1.28, 0.39–0.41, 0.58–0.62; labial length 1.02–1.05/ 1.03–1.05; mesal pronotal length 0.82–0.86/ 0.79–0.84; basal pronotal width 0.85–0.95/ 0.79–0.84; width across hemelytra 1.15–1.37/ 1.18–1.20; and lengths of metafemur, tibia, and tarsus 1.20–1.23, 1.92–2.04, 0.33–0.35/ 1.26–1.40, 1.95–2.00, 0.31–0.35.

ETYMOLOGY: From Latin, *barbiger* (= wearing a beard), referring to the dense, stiff setae on the ventral surface of head of this new species.

DISTRIBUTION: Thailand (Nakhon Nayok and Nakhon Ratchasima provinces).

BIOLOGY: Adult and late-instar immatures of this new species were observed to co-occur with an unidentified ant species (fig. 3), sometimes together with *P. maculatus* or *P. pleiku* on the broadleaf, *Gardenia sootepensis* Hutch. Several adults were also collected by sweeping inflorescences of various broadleaves, and by a light trap. During our very recent investigations at SERS, 10 adults and several third to fifth instar immatures were found with an ant species (possibly the same as shown in fig. 3) from evergreen broadleaved trees, including *Litsea glutinosa* (Lour.) C. B. Rob. (Lauraceae), *Schleichere oleosa* (Lour.) Oken (Sapindaceae) and *Siphonodon celastrineus* Griff. (Celastraceae), and an asteraceous herb; therefore, this pilophorine is assumed not to be host plant specific. The collection records suggest *P. barbiger* has three or more generations per year.

PARATYPES: THAILAND: Nakhon Nayok Prov.: Sarika (lodge), N14°18'07" E101°18'09", at light, 6 Jun 2012, T. Yasunaga, 1 ♂ (AMNH_PBI 00379500) (TYCN). **Nakhon Ratchasima Prov.:** SERS, 14°30'27"N, 101°55'39"E, 410 m alt., light trap, 20 Aug 2008, T. Yasunaga, B Shishido, 1 ♂ (00379431), 1 ♀ (00375908) (TYCN); same data as for holotype, 1 ♂ (00379432) (TYCN); SERS, 14°29'49"N, 101°54'57"E, 500 m alt., 17 Sep 2008, T. Yasunaga, 1 ♀ (00379433)

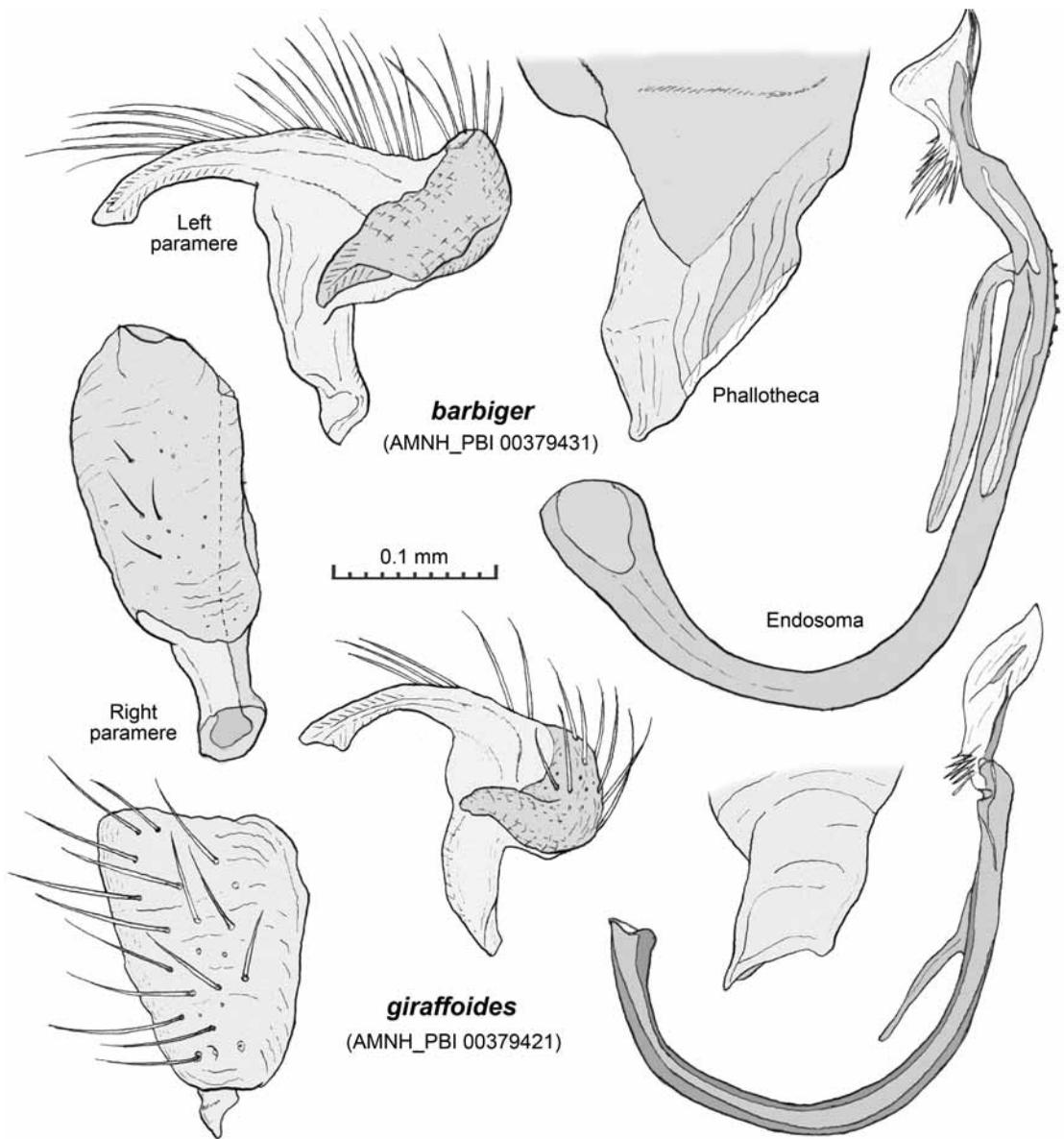


FIG. 7. Male genitalia of *Pilophorus barbiger* and *P. giraffoides*.

(TYCN); SERS, 14°30'27"N, 101°55'39"E, 410 m alt., 24 Jan 2008, T. Yasunaga, 1 ♂ (00379434) (TYCN); SERS, 14°29'49"N, 101°54'57"E, 500 m alt., 26 Feb 2009, T. Yasunaga, 1 ♀ (00379435) (TYCN); SERS, 14°30'27"N, 101°55'39"E, 410 m alt., light trap, 12–14 Jun 2009, T. Yasunaga, K. Yamada, 2 ♀ (00379436–00379437) (TYCN); SERS, 14°30'27"N, 101°55'39"E, 410 m alt., 31 May 2012, T. Yasunaga, 1 ♂ 1 ♀ (00379499) (TYCN); SERS, 14°30'38"N, 101°55'50"E, 380 m alt., on evergreen broadleaved trees, *Litsea glutinosa* (Lour.) C. B. Rob. (Lauraceae), *Schleichera oleosa* (Lour.) Oken (Sapindaceae) and *Siphonodon celastrineus* Griff., and an asteraceous herb, all with ants, 24–26 Dec 2012, T. Yasunaga, B. Shishido, 6 ♂ 4 ♀ (00379603–00379612) (TYCN).

Pilophorus giraffoides, new species

Figures 1C–D, 5, 7

HOLOTYPE: ♂, THAILAND: Nakhon Ratchasima Prov.: SERS, 14°30'27"N, 101°55'39"E, 410 m alt., light trap, 12–14 Jun 2009, T. Yasunaga, K. Yamada (AMNH_PBI 00379421) (SUT).

DIAGNOSIS: Easily distinguished from all congeners by the slender body, ochraceous brown and partly amber basic coloration, long necklike constriction of the pronotum, scattered scalelike setae on the hemelytron, castaneous cuneus and posterior 1/4 of corium, and form of the male genitalia.

DESCRIPTION: Body ochraceous brown, partly tinged with amber, elongate, slender; dorsal surface with sparsely distributed, simple, erect setae (fig. 1C–D). Head pale castaneous, polished, slightly higher than wide in frontal view; vertex narrow. Antenna brown; basal half of segment II reddish brown; basal 1/4 of segment III and extreme base of IV creamy white. Labium shiny pale brown, a little exceeding apex of procoxa; apical part of segment IV dark brown. Pronotum shiny, elongate, with a long, cylindrical necklike constriction; scutellum with bundles of scalelike setae laterally and apically; propleuron shining, episternum with a bundle of scalelike setae along posterior margin. Hemelytron with a short band of scalelike setae on anterior 1/4 of corium, and 5 scattered bundles of scalelike setae (each one on basal inner corner of cuneus and apical 1/4 of clavus, and three obliquely arranging on apical 1/4 of corium) (fig. 1F); cuneus and posterior 1/4 of corium castaneous; membrane pale smoky brown. All coxae and legs pale brown; all femora and tarsomeres III partly darkened; each tibia weakly flattened. Abdomen shiny castaneous. *Male genitalia* (fig. 7): Right paramere broadened. Phallosome rather simple in form. Endosoma slender, with a relatively long median projection.

MEASUREMENTS: ♂/♀: Total body length 3.0–3.1/ 3.24; length from apex of clypeus to cuneal fracture 2.49–2.64/ 2.64; head width across eyes 0.70–0.75/ 0.69; head height 0.75–0.77/ 0.83; vertex width 0.21–0.23/ 0.29; lengths of antennal segment I–IV 0.25–0.27, 0.90, 0.28–0.32, 0.40–0.44/ 0.29, 0.92, 0.35, 0.45; labial length 0.97–0.99/ 1.05; mesal pronotal length 0.90–0.95/ 0.87; basal pronotal width 0.75–0.77/ 0.72; width across hemelytra 0.91–0.93/ 0.96; and lengths of metafemur, tibia, and tarsus 0.90–0.99, 1.33–1.35, 0.26–0.27/ 0.93, 1.44, 0.27.

ETYMOLOGY: Named for its slender, elongate necklike constriction of the pronotum, which alludes to the long neck of the giraffe.

DISTRIBUTION: Thailand (Nakhon Ratchasima Province).

BIOLOGY: Unknown; all available specimens were collected by a light trap. The collection records suggest *P. giraffoides* has at least two generations per year.

PARATYPES: THAILAND: Nakhon Ratchasima Prov.: same data as for holotype, 1♂ 1♀ (AMNH_PBI 00379422–00379423) (TYCN); same locality, light trap, 25–27 Feb 2009, T. Yasunaga, 1♂ (00379509) (AMNH).

Pilophorus portentosus, new species

Figures 2E, 5, 8

HOLOTYPE: THAILAND: Nakhon Ratchasima Prov.: SERS, 14°30'27"N, 101°55'39"E, 410 m alt., light trap, 16 Sep 2008, T. Yasunaga, ♂ (AMNH_PBI 00379420) (SUT).

DIAGNOSIS: Readily recognized by its elongate, parallel-sided body, excessively long antennae, labium, and legs (fig. 2E). These conspicuous characters distinguish this new species from any other known members belonging to the tribe Pilophorini.

DESCRIPTION: *Holotype* ♂: Body generally coffee brown, elongate, parallel sided; dorsal surface weakly shining, with sparsely distributed, simple, erect setae (fig. 2E). Head oblique, wider than high in frontal view; vertex wide. Antenna brown except for widely pale brown segment I, longer than body; segment I and II particularly elongate, with uniformly distributed, erect setae that are almost equal in length to diameter of respective segments; length of segment I greater than head width across eyes, equal to basal width of pronotum; segments III and IV filiform. Labium pale brown, long, reaching apex of metacoxa; segment I reddish brown; apical part of segment IV dark brown. Pronotum not modified in shape; scutellum shallowly and transversely wrinkled, with a bundle of scalelike setae apically. Hemelytron with uniformly distributed, silky, short, reclining setae and with two narrow bands of scalelike setae (anterior one interrupted on clavus) (fig. 5); cuneus shiny; membrane dark smoky brown. All coxae yellowish brown; apical 1/4 of procoxa reddish brown. All legs brown, very long; tarsomere III dark brown. Abdomen shiny chestnut brown. *Male genitalia* (fig. 8): Left paramere stout, with elongate hypophysis; right paramere oval, small. Endosoma C-shaped, slender, with a rather short median projection. *Female:* Unknown.

MEASUREMENTS: *Holotype* ♂: Total body length 3.79, length from apex of clypeus to cuneal fracture 2.98; head width across eyes 0.95; head height 0.74; vertex width 0.45; lengths of antennal segment I–IV 1.10, 1.87, 0.75, 0.38; labial length 1.65; mesal pronotal length 0.72; basal pronotal width 1.10; width across hemelytra 1.20; and lengths of metafemur, tibia, and tarsus 2.00, 3.12, 0.60.

ETYMOLOGY: From Latin, *portentosus* (= extraordinary, monstrous), referring to the unique, extremely long antennae and legs of this new species.

DISTRIBUTION: Thailand (Nakhon Ratchasima Prov.).

BIOLOGY: Unknown; a single available specimen was collected by a light trap.

ADDITIONAL SPECIES EXAMINED

Pilophorus josifovianus Duwal and Yasunaga, 2008

Figure 1G

Pilophorus josifovianus Duwal and Yasunaga, 2008: 80 (n. sp.).

DISTRIBUTION: Nepal (Kathmandu Valley).

MATERIAL EXAMINED: **NEPAL:** Kathmandu Valley: Samakhusi, 27.433795°N, 85.190299°E, light trap, 30 Jun 2005, T. Yasunaga, 1 ♀ (00379424) (paratype, TYCN); same data except for date 23 Jul 2005 (00379425), 1 ♂ (paratype, TYCN); Bhaktapur, Dadhikot, 15 Aug 2006, T. Yasunaga, 1 ♂ 1 ♀ (00379426–00379427) (paratypes, TYCN).

Pilophorus palawanus (Schuh, 1984)

Figure 8

Bilirania palawana Schuh, 1984: 23 (n. sp.).

Pilohorus palawana Schuh, 1989: 10 (n. comb.); Schuh, 1995: 465 (cat.).

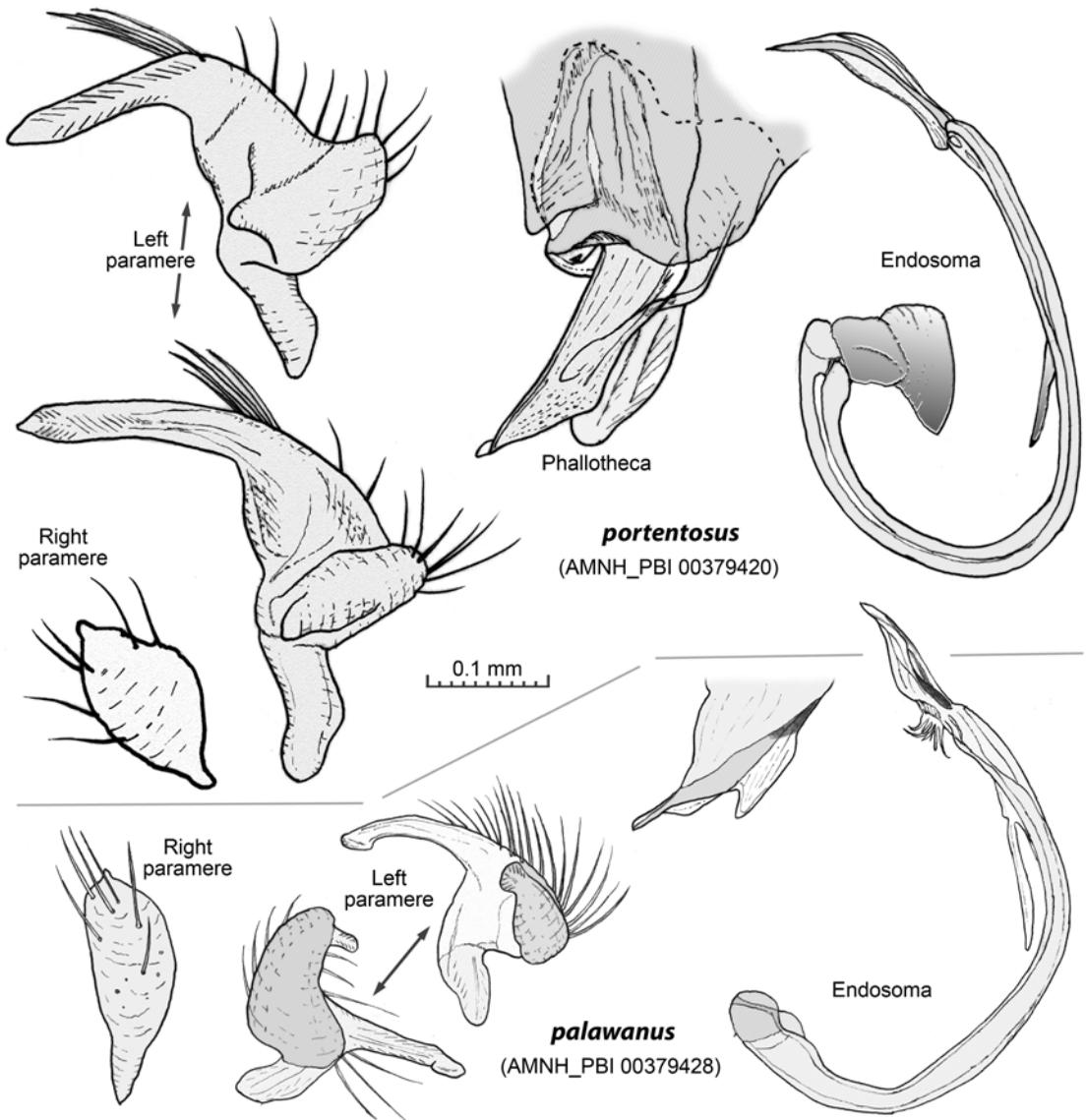


FIG. 8. Male genitalia of *Pilophorus portentosus* and *P. palawanus* (from Singapore).

DISTRIBUTION: Philippines (Palawan Island), Singapore (new record).

MATERIAL EXAMINED: **SINGAPORE:** Bukit Timah, sweeping flowers of broadleaf, 7 Aug 1989, T. Yasunaga, 1♂ 1♀ (AMNH_PBI 00379428–00379429) (TYCN).

DISCUSSION

Pilophorus species may be more or less strongly myrmecomorphic (figs. 1, 2), and some species are strikingly antlike, which promoted the establishment of three independent genera, *Biliranina* Carvalho, *Biliranoides* Schuh, and *Strictotergum* Zou. These genera were all described

on the basis of the modified pronotum that is mesially constricted (*Bilirania* and *Strictotergum*), or constricted and horned (*Biliranooides*). These structural modifications are now regarded simply as autapomorphies for a few species occurring principally in SE Asia (Schuh, 1989, 1991). The latest phylogenetic analysis of the tribe Pilophorini based on both morphology and DNA sequence data may support the conclusion (Schuh and Menard, 2011). The aggregations of scalelike setae on the dorsum and thoracic pleuron are synapomorphic for the genus. If we try to draw the line somewhere to distinguish these morphologically modified species from typical *Pilophorus* members, we will either provide a very vague diagnosis for the bizarre ones or need to establish numerous genera, because there are several types of modifications to the pronotum. We could also reiterate that the genus *Pilophorus* is currently best diagnosed by the setal patterns, which are distinctive, no matter the shape of the pronotum.

Among congeners, the strikingly myrmecomorphic species are as follows: *P. borneensis* (Carvalho), *P. castaneus* (Zou), *P. culion* (Schuh), *P. josifovianus* Duwal and Yasunaga, *P. kathleenae* (Schuh), *P. maculatus* (Schuh), *P. myrmecoides* (Carvalho), *P. palawanus* (Schuh), *P. pleiku* (Schuh), *P. prolixus* Schuh, *P. sumatranus* (Schuh), and *P. sundae* (Schuh) as well as two new species described herein, *P. barbiger* and *P. giraffoides*; all of them are known from the warm temperate, subtropical, and tropical zones of the Oriental Region or around the Himalayas.

As pointed out by Schuh (1989, 1991), there is no evidence to suggest that *Pilophorus* species that do not have such novel pronotal shapes form a monophyletic group. The prominent modifications of the pronotum found in 14 above-mentioned species are most reliably inferred to be autapomorphic. The male genitalia of these members do not much resemble each other. It is likely that such strong modifications of the pronotum may derive from close association with certain ant species. Further ecological surveys will be required to test a scenario on co-evolution (including morphological specialization) between the mirids and ants.

One of the new species, *P. giraffoides*, is particularly characteristic in having its amber light brown general coloration and slim body. This pilophorine is supposed to be associated with a certain ant species that similarly has brownish or amber coloration and slender body form, such as very aggressive *Oecophylla* species (Formicinae). If this conjecture is right, the modifications of *P. giraffoides* would represent Batesian mimicry.

On the other hand, the other new species, *P. portentosus*, exhibits the peculiar form of having the excessively long antennae and legs. This appears to be a morphological resemblance to wasps rather than ants. It is unknown whether a resemblance to wasps conveys certain advantage to the mirids (Wheeler, 2001), although has been observed that some orthotyline of the genus *Cyllecoris* Hahn, which also have the long antennae and legs, often behave like wasps, at least when captured (Yasunaga, 1999, 2001). The endosoma of *P. portentosus* is similar to that of *P. alstoni* (Schuh), a typically shaped pilophorine known widely from the Oriental Region.

During examination of related taxa from Southeast Asia, specimens from Singapore were found to fit *P. palawanus* (Schuh, 1984), a species formerly known only from Palawan Island in the Philippines. This finding implies that this species may represent a Sundaland element. Accordingly, *P. borneensis* described by Carvalho (1986) from Sandakan, Borneo (Kalimantan), a part of the Sundaland, may be conspecific with *P. palawanus*, because these are very similar

to each other in both external appearance and male genitalic structure (fig. 8). The definitive systematic status of *P. borneensis*, however, is beyond the scope of this study.

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REFERENCES

- Carvalho, J.C.M. 1956. On a new genus of mirid from the Biliran Island (Hemiptera). *Anais da Academia Brasileira de Ciencias* 28: 215–216.
- Carvalho, J.C.M. 1986. On a new genus and three new species of myrmecomorphic Miridae with two taxonomical notes (Hemiptera). *Annales de la Societe Entomologique de France* (n. s.) 22: 215–221.
- Cassis, G. 2008. The *Lattinova* complex of Austromirine plant bugs (Hemiptera: Heteroptera: Miridae: Orthotylinae). *Proceedings of Entomological Society of Washington* 110: 845–939.
- Duwal, R.K., and T. Yasunaga. 2008. A new species of the pilophorine plant bug genus *Pilophorus* Hahn from Nepal (Heteroptera, Miridae, Phylinae). In S. Grozeva and N. Simov (editors), *Advances in Heteroptera research. Festschrift in honor of Michail Josifov*: 79–84. Sofia: Pensoft Publishers.
- Hahn, C.W. 1826. *Icones ad monographiam cimicum*. Nürnberg: Lechner: 1 p., 24 pls.
- Ito, K., et al. 2011. Analysis of genetic variation and phylogeny of the predatory bug, *Pilophorus typicus*, in Japan using mitochondrial gene sequences. *Journal of Insect Science* 2 (18): 1–13.
- Kerzhner, I.M., and M. Josifov. 1999. Catalogue of the Heteroptera of the Palearctic region, Volume 3. In B. Aukema and C. Rieger (editors), *Cimicomorpha II*. Netherlands Entomological Society, Amsterdam. xiv + 577 pp.
- Schuh, R.T. 1984. Revision of the Phylinae (Hemiptera, Miridae) of the Indo-Pacific. *Bulletin of the American Museum of Natural History* 177: 1–476.
- Schuh, R.T. 1989. Old World Pilophorini: descriptions of nine new species with additional synonymic and taxonomic changes (Heteroptera: Miridae: Phylinae). *American Museum Novitates* 2945: 1–16.

- Schuh, R.T. 1991. Phylogenetic, host and biogeographic analysis of the Pilophorini (Heteroptera: Miridae: Phylinae). *Cladistics* 7: 157–189.
- Schuh, R.T. 1995. Plant bugs of the world (Insecta: Heteroptera: Miridae): systematic catalog, distributions, host list, and bibliography. New York Entomological Society, i–xii, 1329 pp.
- Schuh, R.T., and K. Menard. 2011. Santatalean-feeding plant bugs: ten new species in the genus *Hypseloecus* Reuter from Australia and South Africa (Heteroptera: Miridae: Phylinae): their hosts and placement in the Pilophorini. *Australian Journal of Entomology* 50: 365–392.
- Schuh, R.T., and M.D. Schwartz. 1988. Revision of the New World Pilophorini (Heteroptera: Miridae: Phylinae). *Bulletin of the American Museum of Natural History* 187 (2): 101–201.
- Schuh, R.T., and G. Wu. 2009. Review of *Eminoculus* Schuh (Heteroptera: Miridae: Phylinae) from South Africa, with the description of five new species. *Entomologica Americana* 115: 36–66.
- Wheeler, A.G., Jr. 2001. *Biology of the plant bugs (Hemiptera: Miridae), pests, predators, opportunists.* Ithaca, NY: Cornell University Press, xv+507 pp.
- Yasunaga, T. 1999. The plant bug tribe Orthotylini in Japan (Heteroptera: Miridae: Orthotylinae). *Tijdschrift voor Entomologie* 142: 143–183.
- Yasunaga, T. 2001. Family Miridae Hahn, plant bugs. *In* T. Yasunaga, M. Takai, and T. Kawasawa (editors), *A field guide to Japanese bugs 2*: 1–96, 111–351. Tokyo: Zenkoku Noson Kyoiku Kyokai, Publishing Co. Ltd. [in Japanese]
- Yasunaga, T. 2010. Plant bugs of the tribe Phylini in Thailand (Heteroptera: Miridae: Phylinae), with descriptions of six new species from additional areas in tropical and subtropical Asia. *Entomologica Americana* 116: 50–92.
- Yasunaga, T., and K. Yamada. 2009. Three new species of the orthotyline plant bugs recently found in central Thailand (Heteroptera, Miridae, Orthotylinae). *Nouvelle Revue d'Entomologie (N. S.)* 25: 281–287.
- Yasunaga, T., K. Yamada. and A. Taksin. 2010. First record of the plant bug subfamily Psallopinae (Heteroptera: Miridae) from Thailand, with descriptions of new species and immature forms. *Tijdschrift voor Entomologie* 153: 1–8.
- Zou, H.G. 1983. A new genus and three new species of Pilophorini Reuter from China (Hemiptera: Miridae). *Acta Zootaxonomica Sinica* 8: 283–287. [in Chinese with English descriptions of new taxa]

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