

***Ceratocombus sirindhorneae* sp. nov. (Hemiptera: Heteroptera: Dipsocoromorpha: Ceratocombidae): A New Species of the Minute Litter Bugs from Thailand**

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ABSTRACT.— A new species of the minute litter bug, *Ceratocombus sirindhorneae* sp. nov. is described from Thailand. Detailed morphological information including description, diagnosis, and brief biology of the new species are presented.

KEYWORDS: Dipsocoromorpha, Ceratocombidae, Ang Ka, Chiang Mai, Thailand

INTRODUCTION

The family Ceratocombidae (Insecta: Hemiptera: Heteroptera: Dipsocoromorpha) is a relatively small group within Heteroptera and is broadly distributed across biogeographical regions (Kerzhner, 1995; Schuh and Weirauch, 2020). This family, which comprises tiny, cryptic insects, is commonly associated with leaf litter, decaying organic matter, and other humid microhabitats, particularly those harboring interstitial spaces (Schuh and Weirauch, 2020). Members of Ceratocombidae are presumed to play a role in nutrient cycling and micro-arthropod interactions within these ecosystems as generalist predators (Schuh and Weirauch, 2020).

The genus *Ceratocombus* Signoret, 1852 is the type genus of Ceratocombidae and, among the members of this family, it is one of the relatively well-studied groups. Despite its wide distribution across multiple biogeographic regions (Poppius, 1910; 1914; McAtee and Malloch, 1925; Štys, 1977; Ren and Zheng, 1992; Jung et al., 2011; Roca-Cusachs et al., 2019), many aspects of the taxonomy and biology of this genus remain poorly understood, except for the species (e.g. *C. coleopteratus* (Zetterstedt, 1819)) with a broad distribution.

Ceratocombus currently comprises more than 26 described species distributed worldwide (Štys, 1995; Roca-Cusachs et al., 2019). Within the Oriental Region, the potential for high species diversity is evident due to the region's tropical climate and rich biodiversity (Štys, 1995). However, despite this potential, taxonomic studies on *Ceratocombus* in this region remain scarce, with only a few species recorded in historical literature (e.g., Poppius, 1914).

Published records indicate that unidentified *Ceratocombus* species have been collected from Thailand (e.g., Knyshov et al., 2021), but additional descriptive studies would be valuable to clarify species diversity in this region. *Ceratocombus* species richness is generally highest in tropical areas (Štys, 1995), and many species remain undescribed. Given the remarkably high insect biodiversity of this region (Charernsom and Suasa-ard, 2000), it is likely that numerous undiscovered species exist within the Oriental Region.

Recently, Roca-Cusachs et al. (2019) described *Ceratocombus stysi* Roca-Cusachs, García-Becerra & Jung, 2019, the first cave-dwelling species of the genus, and highlighted the adaptability of this species to extreme habitats. This finding suggests that *Ceratocombus* may occupy a wide range of ecological niches. The study also reinforced the importance of microhabitat conditions such as humidity and temperature in shaping species distribution.

During recent entomological surveys conducted in Thailand's highland forests by the second author, an undescribed species of *Ceratocombus* was collected. The high-altitude ecosystems of Thailand are known for their unique climatic conditions, which often support endemic insect species. The discovery of this new species highlights the need for further taxonomic and ecological research on Ceratocombidae in the Oriental Region, particularly in montane habitats that remain largely unexplored. Herein, we describe *Ceratocombus sirindhorneae* sp. nov. from Thailand. A detailed morphological description, illustrations, and comparisons with closely related taxa are provided. This study contributes to the understanding of Ceratocombidae diversity in the Oriental Region, reinforcing

the importance of highland habitats in hosting previously unrecognized insect species.

MATERIALS AND METHODS

The specimens were collected in Doi Inthanon National Park. Permission was granted by the Department of National Parks, Wildlife and Plant Conservation, Thailand for collecting insects. Photographs of the examined specimens were taken using a ZEISS Stemi 508 stereomicroscope equipped with an OPTIKA C-P6 Digital Camera. The figures were prepared using Adobe Photoshop 2020. Measurements, provided in millimeters (mm), were taken using TouView software installed on the OPTIKA C-P6 Digital Camera. To examine the specimen, the whole body was immersed in a 10% KOH solution for 5 minutes at 70°C until the internal structures became visible. For the examination of the male genitalia, the genital segment was detached under a light microscope, and each appendage was dissected and mounted on slides for detailed observation. The female genitalia were examined under a slide-mounted preparation as well. The slide-mounted specimens were prepared as follows: after being washed with distilled water, the material was placed in glacial acetic acid for 20 minutes and then transferred to clove oil for 60 minutes. Subsequently, the whole body and genitalia were mounted on a glass slide in Canada balsam, with xylene added when necessary. The type specimens, two dried specimens and two slide specimens, are deposited in the Entomology Collection of the Forest and Plant Conservation Research Office, Department of National Parks, Wildlife and Plant Conservation (ECNP), Bangkok, Thailand, and in the Zoological Collection of Duy Tan University (ZCDTU), Da Nang, Vietnam. Terminology primarily follows Štys (1977; 1982) and Kerzhner (1974) for external and Knyshov et al. (2018) for genital morphological structures. The morphology of the wings follows, in part, Štys (1977) and Knyshov (2021).

RESULTS

Taxonomy

Infraorder Dipsocoromorpha Miyamoto, 1961 Family Ceratocombidae Fieber, 1860

Genus *Ceratocombus* Signoret, 1852

Ceratocombus Signoret, 1852: 542. Type species: *Astemma mulsanti* Signoret, 1852 (= *Anthocoris coleoptrata* Zetterstedt, 1819).

Lichenobia Baerensprung, 1857: 165 (Synonymized by Dohrn, 1858: 229). Type species: *Lichenobia ferruginea* Baerensprung, 1857 (= *Anthocoris coleoptrata* Zetterstedt, 1819).

Subgenus *Xylonannus* Reuter, 1891

Xylonannus Reuter, 1891: 8 (as subgenus of *Ceratocombus*). Type species: *Ceratocombus corticalis* Reuter, 1889.

Ceratocombus sirindhornae sp. nov.

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(Figs 1–4)

Type materials.—[ECNP] Holotype: 1♂, Doi Inthanon National Park (18.5886°N, 98.4857°E), alt. 2565 m, Ban Luang, Chom Thong District, Chiang Mai, Thailand, 07.vii.2023, by light trap, K.J. Ignatius & T.S. Keetapithchayakul leg. (ECNP-HHD0001); [ECNP] Paratype: 1♀, same data as holotype (ECNP-HHD 0002-0004); [ZCDTU] Paratypes: 1♂, 1♀, same data as holotype (DTUHDC001–002; slide specimens).

Diagnosis.—Recognized by the following combination of characters in case of macropterous form: large sized body, more than 2 mm; the wide pronotum, posterior width longer than twice medial length, subequal to twice anterior width; maximum length of cubital cell longer than that of subcostal cell; anterior part of subcostal cell blunt; distal part of cubital vein longer than that of medial vein; discal cell similar to radial cell in size (Fig. 1D); mediotergite 8 with two rounded and papilliform projections medially (Fig. 3A); laterotergite 8 elongate and curved subapically in dorsal view, basal part thick and angled, apical part narrow and almost straight in lateral view (Fig. 3A–C); paramere with long apical process and broad basal part, apical process long and sharp (Fig. 3E).

Description.—**MALE:** *Coloration:* Body mostly unicolorous tone, brown. **Head:** Mostly brown, same color with pronotum and scutellum; vertex, frons, clypeus and maxillary plates entirely brown; remaining segments of antennae mostly pale brown; first segment mostly brown, with several small, irregular dark spots; second segment pale brown, apically brown; third and fourth segments missing; labium pale brown overall, with the distal portion distinctly lighter than the proximal portion. **Thorax:** Pronotum and scutellum entirely brown; hemelytra slightly paler than pronotum and scutellum; legs generally pale brown, coxae somewhat darker than distal parts of legs. **Abdomen:** entirely brown. *Surface and vestiture:* head, pronotum

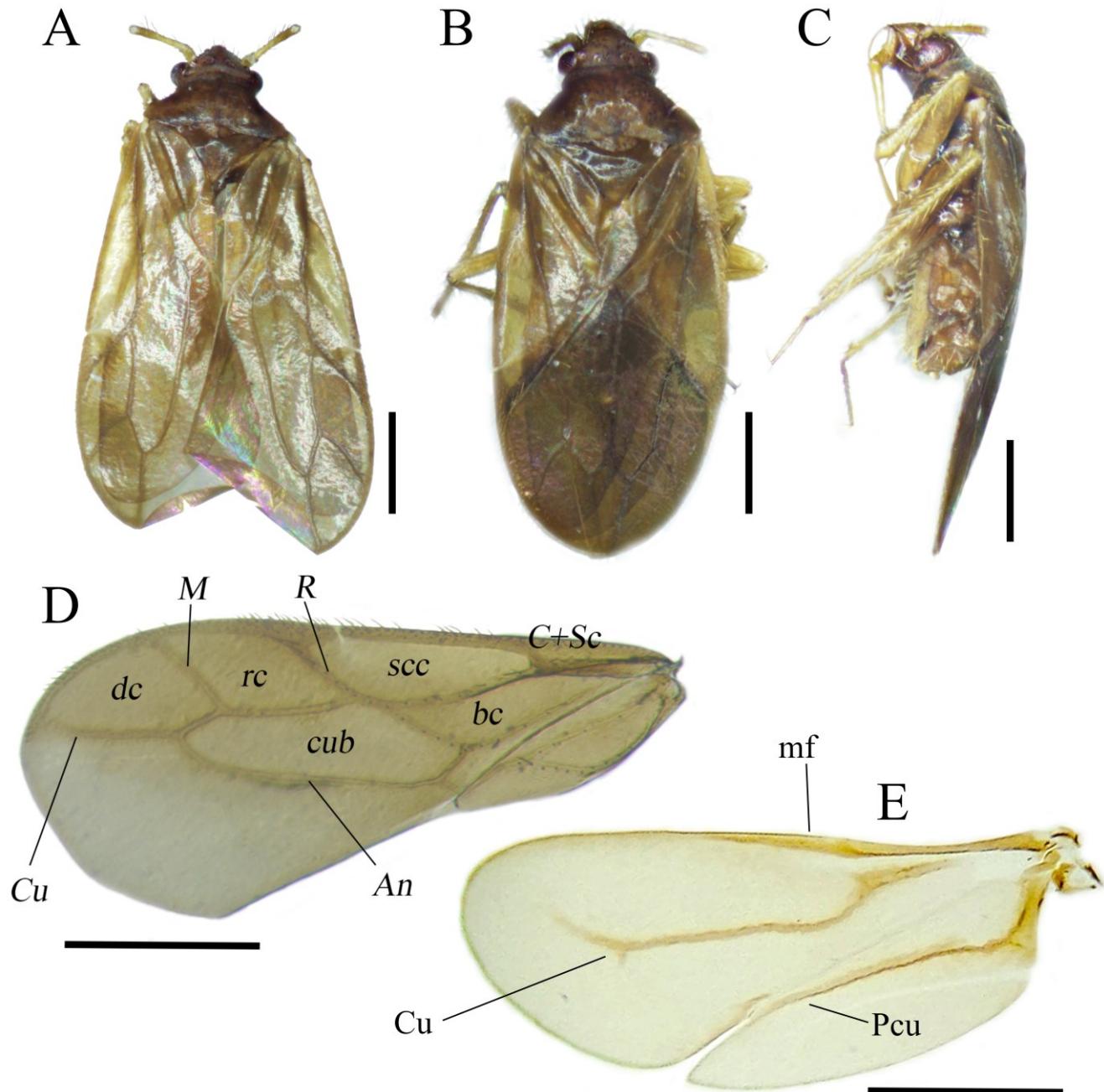


FIGURE 1. Habitus, wing and tarsus morphology of *Ceratocombus sirindhornae* sp. nov. **A.** holotype male in dorsal view; **B.** paratype female in dorsal view; **C.** *ditto*, in lateral view; **D.** fore wing; **E.** hind wing; *An*: anal vein; *C+Sc*: Costal and subcostal vein; *Cu*: cubital vein; *M*: medial vein; *R*: radial vein; *Pcu*: postcubitus vein; *mf*: medial fracture; *bc*: basal cell; *cub*: cubital cell; *dc*: discal cell; *rc*: radial cell; *scc*: subcostal cell. Scale bar: 0.5 mm.

and scutellum semi-glossy, impunctate, covered with short setae; first and second antennal segments covered with short setae; hemelytra somewhat glossy, sparsely covered with short setae at costal margin; femur and tibia with long and dense spines, densely covered with short setae, spine subequal to twice setae length; femora with spines and setae throughout; 1/3 basal part of fore and hind tibiae with setae only; 1/2 basal part of mid tibiae with setae only; abdomen densely covered

with long setae. **Structure:** Body 2.60–2.62 mm, elongated, macropterous. **Head:** elongated triangular, shorter than wide, longer than interocular distance; compound eye diameter larger than first antennal segment; ocelli located medially, nearly contiguous with midline of compound eye; combined length of first and second antennal segments subequal to head length; first segment as thick as second segment, second segment cylindrical; third and fourth segments missing; labium

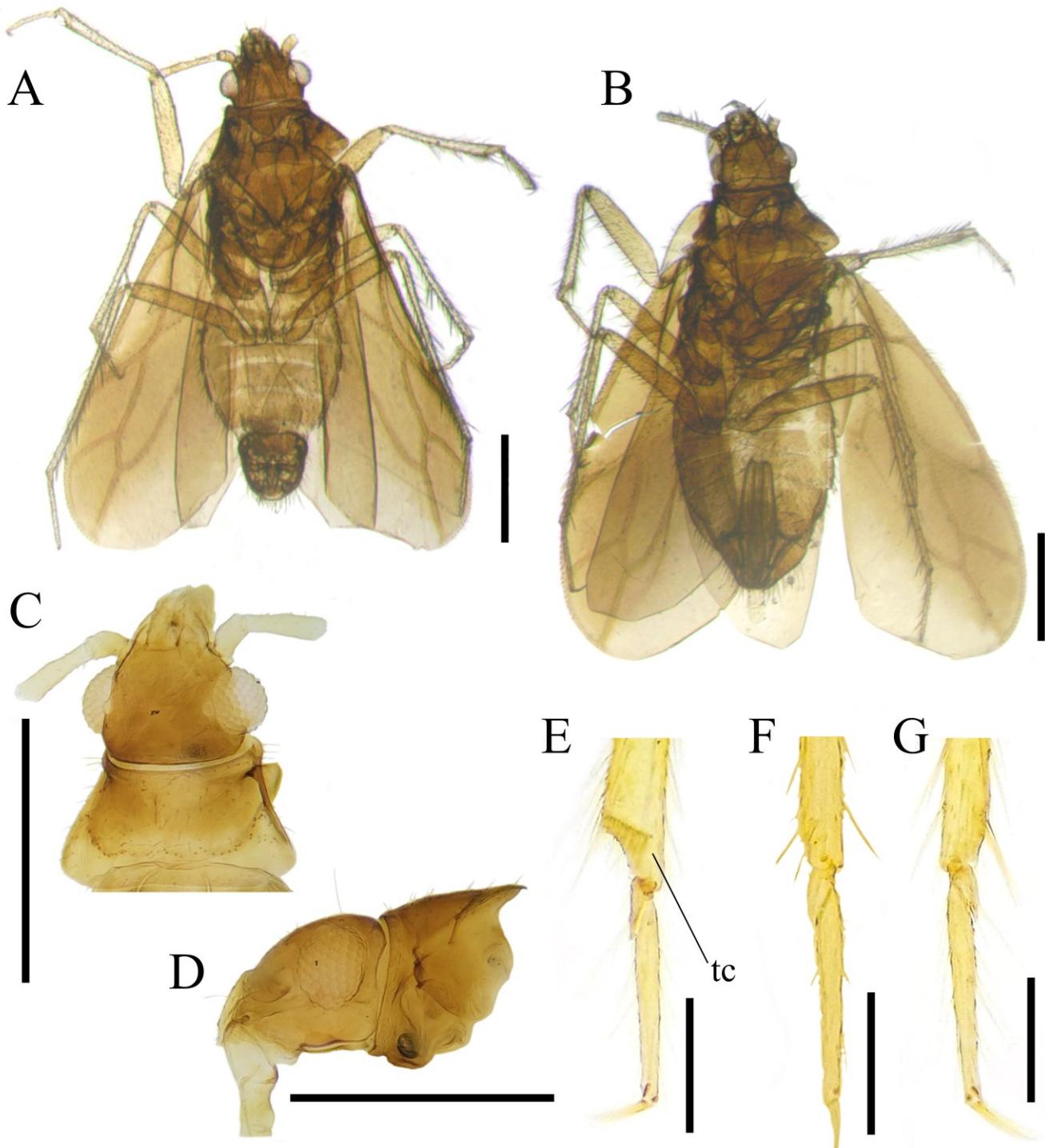


FIGURE 2. Habitus, head, pronotum and tarsus morphology of *Ceratocombus sirindhornae* sp. nov. **A.** paratype male, slide specimen; **B.** paratype female, slide specimen; **C.** head and pronotum in dorsal view; **D.** ditto, in lateral view; **E.** fore tarsus; **F.** mid tarsus; **G.** hind tarsus; *tc*: tibial comb. Scale bar: A–D: 0.5 mm; E–G: 0.2 mm.

reaching middle coxa. **Thorax:** pronotum trapezoidal with narrow top and wide base, anterior width subequal to 1/2 posterior width, posterior margin weakly concave (Fig. 2C); calli weakly developed with longitudinal sulcus; scutellum triangular, anteriorly wider than long, lateral margin somewhat concave; fore wing

covering whole abdomen, lateral margin nearly straight, distal margin rounded (macropterous for all examined specimens); veins well visible; costal and subcostal vein ($C+Sc$) not explanate, somewhat thin; subcostal cell (*scc*) elongate, subtriangular, outer margin almost straight; basal cell (*bc*) elongate, longer

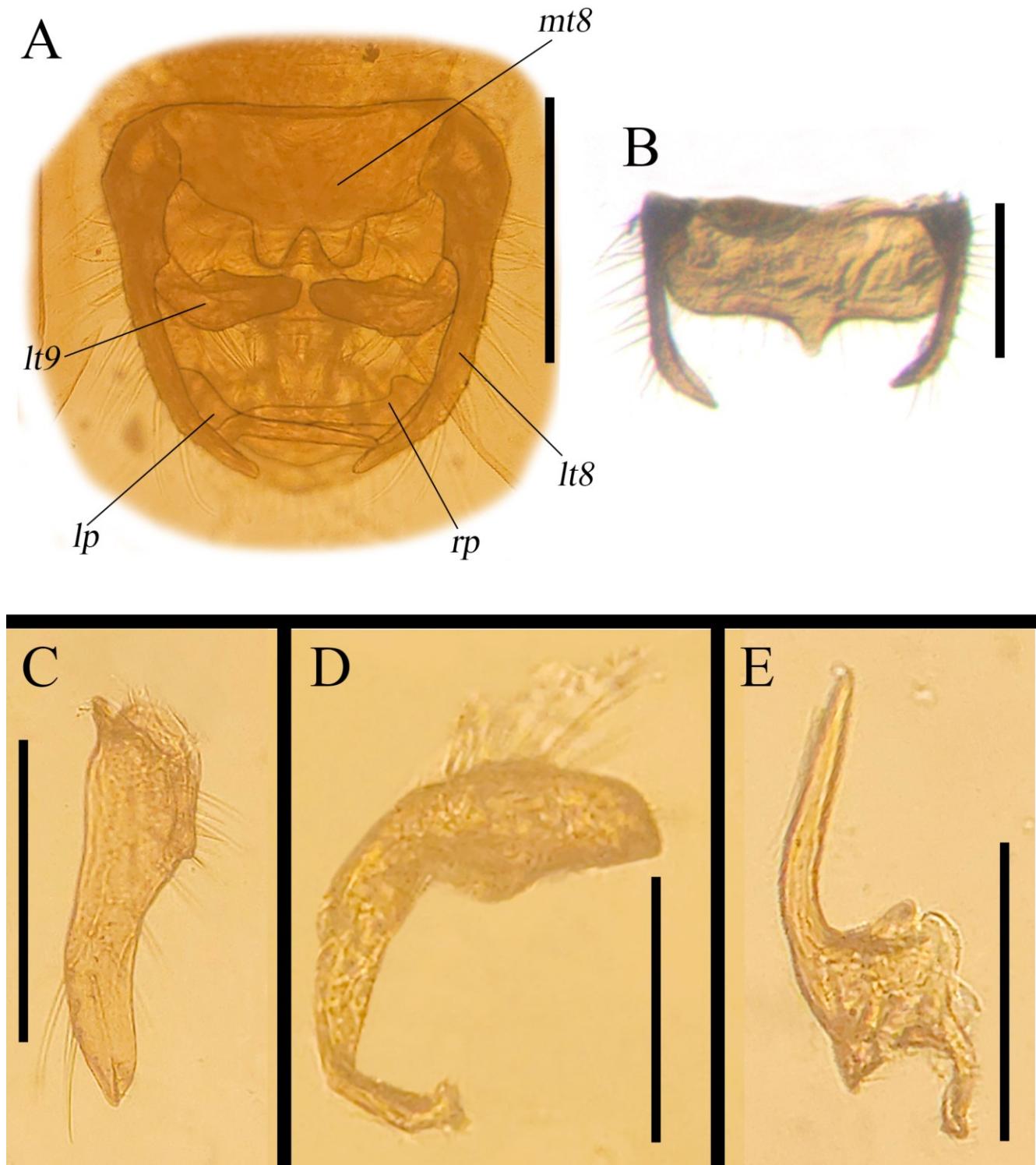


FIGURE 3. Male genitalia of *Ceratocombus sirindhornae* sp. nov. **A.** pygophore; **B.** laterotergite 8 connecting sternite 8 in dorsal view; **C.** left laterotergite 8, in lateral view; **D.** right laterotergite 9; **E.** right paramere; *lp*: left paramere; *lt*: laterotergite; *mt*: mediotergite; *rp*: right paramere. Scale bar: A–C: 0.2 mm; D–E: 0.1 mm.

than *scc*; cubital cell (*cub*) slightly larger than *scc*; discal cell (*dc*) similar to radial cell (*rc*) in size; distal part of anal vein (*An*) straight medially; medial vein (*M*) narrow; distal part of cubital vein (*Cu*) longer than distal part of *M*, longer than distal part of radial vein

(*R*) (Fig. 1D); hind wing as long as fore wing in length, lateral margin nearly straight, distal margin rounded; three veins well visible; medial fracture (*mf*) nearly straight along lateral margin; *Cu* long and curved subbasally and subapically, with short branches; postcu-

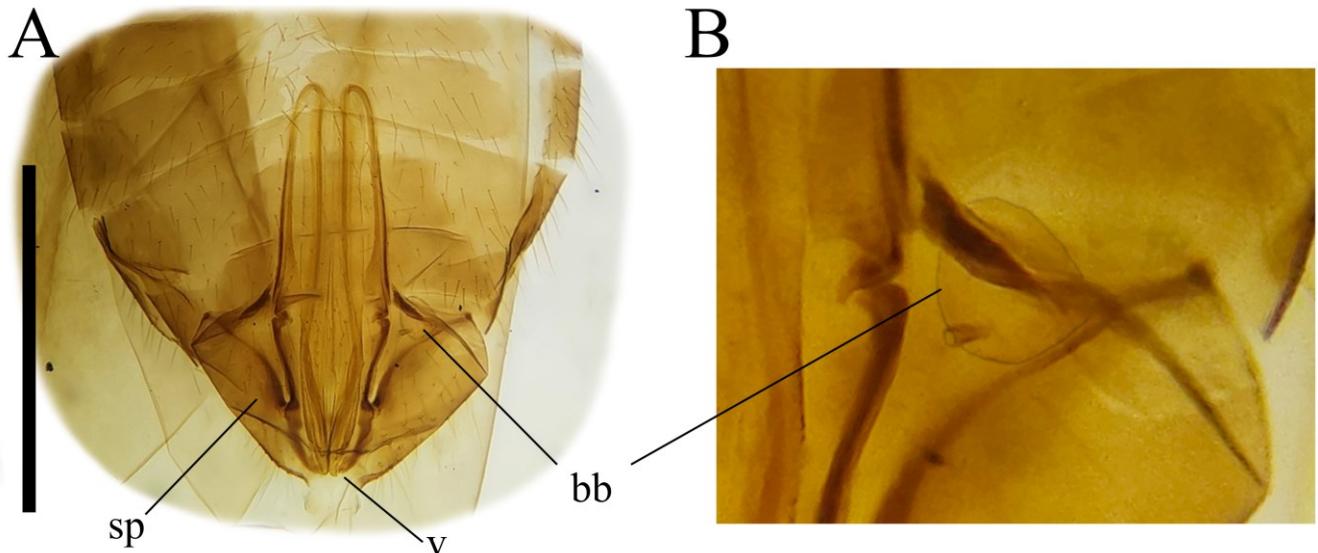


FIGURE 4. Female genital segment of *Ceratocombus sirindhornae* sp. nov. **A.** genital segment; **B.** enlarged part for bulbus; *bb*: bulbus; *sp*: subgenital plate; *v*: valvulae. Scale bar: 0.5 mm.

bitus vein (*Pcu*) straight (Fig. 1E); legs rather slender in thickness; fore femur thicker than other femora; middle femur as thick as hind femur; fore tibia with tibial combs, occupying most of the maximal diameter (Fig. 2E); middle and hind tibiae with spines apically; all tarsi two-segmented; all pretarsi long, symmetrical, without arolia (Fig. 2E–G). **Abdomen:** elongate-oval pregenital abdominal tergites with central areas sclerotized, anterior and posterior margins membranous. **Genitalia:** pygophore symmetrical, oval, with a pair of laterotergites (*lt*) 8. and 9. with a pair of parameres (*lp* and *rp*), and with mediotergite (*mt*) 8 (Fig. 3A); *mt* 8 with two rounded and papilliform projections medially (Fig. 3A); *lt* 8 elongate and curved subapically in dorsal view (Fig. 3A, B), basal part thick and angled, apical part narrow in lateral view (Fig. 3C), structures symmetrical in shape, with a slight difference in size; *lt* 9 angled, thick and broad apically with long setae, tumid at ventral margin, structures symmetrical in shape, with a slight difference in size (Fig. 3D); parameres symmetrical with broad basal part and short process, apical process long and sharp (Fig. 3E).

FEMALE: Body length 2.73–2.78 mm. *Coloration:* as in male. *Surface and vestiture:* as in male. *Structure:* as in male. **Genitalia:** last tergite exceeding subgenital plate (*sp*); outer margin of *sp* convergent and straight; apical part of valvulae (*v*) projecting beyond *sp*; bulbus (*bb*) with cylindrical apical pump, placed under dextral part in ventral view (Fig. 4A, B).

Measurements (in mm).— Male (n=2)/Female (n=2) Body length, head-apex of hemelytra: 2.60–2.62/2.73–2.78; head length: 0.37–0.38/0.38–0.38; head width, including compound eyes: 0.44–0.45/0.42–0.43; intero-

cular distance: 0.21–0.22/0.22–0.23; 1st antennal segment length: 0.08–0.08/0.07–0.08; 2nd antennal segment length: 0.28–0.29/0.27–0.27; mesal pronotal length: 0.28–0.28/0.31–0.32; posterior pronotal maximal width 0.67–0.68/0.70–0.71; anterior scutellar width: 0.51–0.52/0.57–0.58; mesal scutellar length: 0.29–0.29/0.31–0.32; hindleg (femur: tibia: tarsus): 0.57–0.58: 0.92–0.93:0.35–0.35/0.60–0.61:0.92–0.94:0.32–0.33.

Distribution.— Thailand (Northern).

Etymology.— The specific epithet is dedicated to Her Royal Highness Princess Maha Chakri Sirindhorn in commemoration of her 70th anniversary and in recognition of her enduring contributions to the promotion and support of initiatives with profound significance for biodiversity research and conservation efforts in Thailand. It is formed as a feminine genitive singular noun.

Biology.— The Ang Ka Nature Trail, located in Doi Inthanon National Park, Thailand, is a high-altitude montane cloud forest (~2,550 m a.s.l.), featuring a peat swamp forest, the highest of its kind in Thailand. The cool, humid conditions support a dense canopy of evergreen trees. The area hosts endemic and rare species, including *Rhododendron arboreum* subsp. *delavayi*, known in Thai as "กุหลาบพันปี" (gulap pun pee)." Although this species was collected using a light trap to sample small aquatic or semiaquatic insects from various types of cryptic pools, we infer that the collecting site is highly distinctive and likely associated with the habitat of the new species, considering

the general natural history of ceratocombids (Štys, 1995).

The environment is characterized by dense tree cover, where trunks and branches are covered in mosses and climbing plants. Scattered rocks, some of which are moss-covered, are distributed throughout the area. Mosses and ferns grow abundantly on rocks and tree roots, indicating persistently high moisture levels. The forest floor is blanketed by a thick layer of fallen leaves. The presence of mist and consistently damp conditions suggest a perpetually humid microclimate. Water seeping between rocks and leaf litter may give rise to ephemeral pools. The understory is composed of various herbaceous plants and climbing species, which are adapted to low-light conditions beneath the dense canopy (Fig. 5).

Remarks.—*Ceratocombus sirindhornae* sp. nov. is placed in the subgenus *Xylonannus* based on the absence of long bristles near compound eye; lateral sides of pronotum without macrochaetae, bearing only short setae; absence of triangular cell of hemelytra; and two-segmented tarsi. This species is easily distinguished by the large body, more than 2.5 mm in length, as many of the well known *Ceratocombus* species are smaller than 2 mm. *Ceratocombus corticalis* Reuter, 1889 is the only species larger than 2 mm among the Palaearctic species (including southern China and Taiwan), but it can be discerned by larger body, more than 2.6 mm (vs. less than 2.6 mm; macropterous male: 2.1; macropterous female: 2.45; see the key in Kerzhner (1974)).

On the other hand, Kerzhner (1974) provided a key and illustrations for *C. corticalis*. In the key, both macropterous and brachypterous forms are mentioned, and the species is characterized by its relatively large size and the strongly concave posterior margin of the pronotum. The illustrations depict the pronotum and forewing of several *Ceratocombus* species in detail. However, in the case of *C. corticalis*, the figures are explicitly based on a brachypterous female, and there is no indication whether macropterous individuals exhibit the same features; moreover a description of the male genitalia is lacking. Since even conspecific individuals can show structural differences in pronotum and venation depending on wing development, it remains uncertain whether these features alone can reliably separate this new species from *C. corticalis*. Further studies, particularly including macropterous material and male genitalia of *C. corticalis*, will be necessary to evaluate this issue more comprehensively.

Ceratocombus sirindhornae sp. nov. is also easily distinguished by the large sized body; the pronotum



FIGURE 5. Habitat of *Ceratocombus sirindhornae* sp. nov. (Ang Ka, Doi Inthanon National Park).

shape; and the wing morphology from species described from the other regions (e.g., *C. australiensis* Gross, 1950 from Australia; *C. enderleini* Poppius, 1910 and *C. mareki* Štys, 1977 from the Afrotrropical Region; and *C. vagans* McAtee & Malloch, 1925 from the Nearctic Region). The new species is most similar to the Chinese congener, *C. guizhouensis* Ren & Yang, 1993, in its wing venation, but it can be distinguished by the larger body size (vs. small body, 1.7 mm); labium reaching mid coxae (vs. reaching hind coxae); discal cell similar to radial cell in size (vs. discal cell smaller than radial cell, see fig. 2 in Ren and Yang (1993)); mediotergite 8 with two papilliform projections medially (vs. with two narrow and outward-facing projections medially, see fig. 7 in Ren and Yang (1993)); basal part of laterotergite 8 angled, apical part almost straight in lateral view (vs. basal part rounded, apical part curved apically in lateral view, see fig. 3 in Ren and Yang (1993)); apical part of laterotergite 9 blunt (vs. apical part folded toward the base and bifurcate, see figs 3, 4 in Ren and Yang (1993)); and apex of paramere tapered (vs. apex of paramere hamatus, see fig. 6 in Ren and Yang (1993)).

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