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New taxa and notes on bark and bush crickets (Orthoptera, Grylloidea, Gryllidae, Landrevinae and Podoscirtinae) from Sabah

Running title: Landrevinae and Podoscirtinae from Sabah

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Abstract

From the eastern parts of Sabah, four new species of crickets are described, two of which are from the subfamily Landrevinae and two from the subfamily Podoscirtinae: *Duolandrevus (Duolandrevus) nobilis* **sp. nov.** and *Odontogryllodes spinifer* **sp. nov.**; and *Brevimunda trilineata* **sp. nov.** and *Varitrella (Cantotrella) tabin* **sp. nov.**, respectively. We also describe the calling songs for three species: *Duolandrevus (Bejorama) lambir* Gorochoch, 2017, *Duolandrevus (Duolandrevus) nobilis* **sp. nov.** and *Varitrella (Cantotrella) tabin* **sp. nov.** A new locality record (Sabah, Sepilok) for *Duolandrevus (Bejorama) lambir* Gorochoch, 2017, previously known from western Borneo (Sarawak, Lambir Hill and Brunei Darussalam, Kuala Belalong), was also reported.

Key words: Borneo, calling song, new locality, new species, taxonomy

Introduction

New species discovery of orthopterans in eastern Sabah pales comparatively to that in western Sabah that includes the hyper-biodiverse Mount Kinabalu and Trus Madi (Tan et al., 2017, 2019a). Nonetheless, since 2019, a few new cricket species have been described from eastern Sabah based on old museum specimens (e.g., *Nisitrus danum* Robillard & Tan, 2021 from Danum Valley) and new collected materials [e.g., *Cycloptiloides bimaculata* Tan, Japir & Chung, 2021, *Falcerminthus sandakan* (Tan et al., 2019), *Varitrella (Cantotrella) suikei* Tan et al., 2020 and *Vescelia sepilokensis* Tan et al., 2019 from Sepilok] (Tan et al., 2019b, 2019c, 2020, 2021a, b). Recently, orthopteran surveys were conducted in different parts of eastern Sabah, i.e., Kabili Sepilok Forest Reserve, Mount Silam, Kawag Forest Reserve and Tabin Wildlife Reserve. Here, we describe four species new to science of the family Gryllidae from Sabah: *Duolandrevus (Duolandrevus) nobilis* **sp. nov.** and *Odontogryllodes spinifer* **sp. nov.** from the subfamily Landrevinae; and *Brevimunda trilineata* **sp. nov.** and *Varitrella (Cantotrella) tabin* **sp. nov.** from the subfamily Podoscirtinae. We also describe the calling songs for three species: *Duolandrevus (Bejorama) lambir* Gorochoch, 2017, *Duolandrevus (Duolandrevus) nobilis* **sp. nov.** and *Varitrella (Cantotrella) tabin* **sp. nov.** Lastly, we also present a new locality record (Sabah, Sepilok) for *Duolandrevus (Bejorama) lambir* Gorochoch, 2017, previously known from western Borneo (Sarawak, Lambir Hill and Brunei Darussalam, Kuala Belalong).

Materials and Methods

Fieldwork was conducted in different parts of eastern Sabah between 11 and 19 May 2022: Kabili Sepilok Forest Reserve, Mount Silam, Kawag Forest Reserve and Tabin Wildlife Reserve. Specimens were collected by sight during day and night. Whenever possible, in-situ images were taken using a Canon EOS 500D digital SLR camera with a compact-macro lens EF 100 mm f/2.8 Macro USM and Canon Macro Twin Lite MT-24EX was used for lighting and flash.

Sound recording was done using a modified Condenser Microphone Capsule CM16 (Avisoft Bioacoustics, Berlin), connected to a Fostex FR-2LE digital field recorder (96 kilo-samples per second sampling frequency, 16 bit) or a Wildlife Acoustics Song Meter (SM) Mini acoustic recorder programmed to record continuously with a sampling frequency of 96 kilo-samples per second and channel gain of 18 dB (16 bit). This was done either in the field or in

the laboratory. In the laboratory, the cricket was kept isolated in a small insect cage with nylon cover and the microphone was placed at most 30 cm away beside the cage with the microphone pointing horizontally towards the cage. A temperature logger, HOBO 8K Pendant® Temperature logger (model: UA-001-08, Onset, Bourne, MA), was used to record the ambient temperature.

The specimens were preserved in absolute analytical-grade ethanol and later pinned and dry-preserved. Close-up images of morphological features (including male genitalia) were done using a macro photo lens MP-E 65 mm 1:2.8 USM (1–5×). Canon Macro Twin Lite MT24EX was used for lighting and flash. Image editing was accomplished using Adobe Photoshop CC 2014. Measurements were done using a vernier caliper. Male genitalia were dissected from softened specimens and removed by squeezing the cerci against one another laterally. The male genitalia were then cleaned using aqueous KOH and subsequently preserved in glycerine or hand sanitiser. Terminology used to describe the male genitalia follows Desutter-Grandcolas (2003) and also Gorochov (2015) [in square brackets]:

Pseudepiphallus (ps) [epiphallus]

Pseudepiphallic lophi (ps l) [posterolateral epiphallic lobe]

Pseudepiphallic posteromedial lophi (ps m) [posteromedial epiphallic lobe]

Pseudepiphallic paramere (ps p) [ectoparamere]

Ectophallic fold (ec f) [rachis (= guiding rod)]

Ectophallic apodeme (ec ap) [endoparameral apodeme]

Endophallic sclerite (en s) [formula (= mold of spermatophore attachment plate)]

Rami (ra)

A single leg was preserved in absolute analytic-grade ethanol for future molecular work. The specimens were eventually deposited in:

FRC Forest Research Centre (Sepilok), Sabah Forestry Department, East Malaysia

MNHN Muséum national d'Histoire naturelle, Paris, France

ZRC Zoological Reference Collection, Lee Kong Chian Natural History Museum, Singapore

Abbreviations for general morphology:

I, II, III = front, median, hind respectively (femora, legs, tibiae)

F = femur

FW = forewing (tegmen)

T = tibia

Ta = tarsus

Abbreviations for measurements:

PronL = pronotum length

PronW = pronotum width

FWL = forewing length

HWT = hindwing tail

FIIL = length of hind femora

TIIL = length of hind tibiae

OL = ovipositor length

The basic cricket song terminology generally follows Baker & Chesmore (2020):

Calling song = spontaneous song produced by an isolated male to attract a female;

Dominant frequency = frequency with highest energy from the mean spectrum;

Echeme = a first-order assemblage of syllables;

Echeme-sequence = a first-order assemblage of echemes;

Interval = silent interval between calls and/or pulses, or down-time;

Syllable = single complete stridulatory movement (i.e., opening and closing of wings);

Parameters of the temporal domain (e.g., durations and intervals) were measured manually using Raven Lite 2.0.0.

The peak frequency was obtained using the 'spectro_analysis' function from the R package warbleR version 1.1.27 (Araya-Salas & Smith-Vidaurre, 2017) in the R software version 4.1.3.

Taxonomy Part

Superfamily Grylloidea Laicharting, 1781

Family Gryllidae Laicharting, 1781

Subfamily Landrevinae Saussure, 1878

Genus *Duolandrevus* Kirby, 1906

Duolandrevus – Kirby, 1906: 50; Chopard, 1969: 147; Otte, 1988: 283; Gorochov, 1996: 35; Gorochov, 2016: 25 (key to subgenera)

Type species. *Gryllus brachypterus* Haan, by original designation

***Duolandrevus (Bejorama) lambir* Gorochov, 2017**

(Figs 1, 2)

Duolandrevus (Bejorama) lambir – Gorochov, 2017: 230; Tan & Wahab, 2018: 128

Duolandrevus (Bejorama) nr. *luzonensis* – Tan & Wahab, 2017: 442 [tentative identification prior to species described by Gorochov (2017)]

Material examined. EAST MALAYSIA • 2♂; Sabah State, Sandakan, Sepilok, Rainforest Discovery Centre; N5.87511, E117.94206, 41.5±7.7 m.a.s.l.; 17 May 2022, 19h22; calling underneath the bark of a large tree; coll. M.K. Tan & T. Robillard; SBH.22.121, 122 (FRC)

Remarks. This species was previously known from Lambir Hill in Sarawak and Kuala Belalong in Brunei Darussalam, both to the west of Borneo. Our specimens (Fig. 1) appear to resemble the descriptions from Lambir Hill by Gorochov (2017) and the figures in Tan & Wahab (2017). It should be noted that the pseudepiphallid lophi [posterolateral epiphallid lobes] appear narrower in lateral view in the Bruneian specimen (Tan & Wahab, 2017: Fig. 2C). Here, we add a new locality record for this species in the east of Borneo and describe its calling song for the first time.

Ecology. This species seems to be relatively common. Multiple males were heard singing at night underneath barks of large trees.

Distribution. Borneo, Sarawak State (Lambir Hill) and Sabah State (Sepilok), Brunei Darussalam (Kuala Belalong).

Type locality. EAST MALAYSIA, Sarawak State, Lambir Hill

Calling song (2♂, in the field, 26.5°C) (Fig. 2). The calling song consists of an echeme made up of 40–47 syllables. The first few syllables are of lower amplitude but the amplitude of subsequent syllables increases to a maximum and remains consistent. Each echeme has an average duration of 0.66±0.03 s (0.61–0.71 s). The interval between consecutive echemes is 0.87±0.14 s (0.70–1.15 s). Each syllable has an average duration of 11.6±0.7 ms (10.9–12.9 ms) and the interval between consecutive syllables is 3.5±0.8 ms (2.1–4.3 ms). The dominant frequency is 5.89±0.06 kHz (5.72–5.91 kHz).

***Duolandrevus (Duolandrevus) nobilis* sp. nov.**

(Figs 3–6)

Material examined. Holotype: EAST MALAYSIA • 1♂; Sabah State, Sabah State, Mount Silam, near Lahad Datu; N4.97667, E118.19135, 428.3±7.9 m.a.s.l.; 13 May 2022, 21h36; on the ground along the trail; coll. M.K. Tan, T. Robillard & R. Japir; SBH.22.62 (FRC)

Paratypes: • 1♂; Sabah State, Tabin Wildlife Reserve; N5.19438, E118.50294, 93.7±11.0 m.a.s.l.; 15 May 2022, 19h35; calling from a burrow on the clayey bank of a forest stream; coll. M.K. Tan, T. Robillard & R. Japir; SBH.22.84 (ZRC) • 1♂, 1♀; Sabah State, Mount Silam, near Lahad Datu, lowland forest; N4.97589, E118.19060, 341 m.a.s.l.; 13 May 2022, 21h10, video of male calling song (TR00022); male at the base of a large tree under the bark; female on the ground, near the entrance of burrow; coll. T. Robillard, M.K. Tan & R. Japir; TR22-12; MNHN-EO-ENSIF11147, MNHN-EO-ENSIF11148

Other material examined: EAST MALAYSIA • 1♀ juvenile; Sabah State, Sandakan, Sepilok, Rainforest Discovery Centre; N5.87395, E117.93871 (SAB14), 54 m.a.s.l.; 19 May 2022; coll. T. Robillard & M.K. Tan; TR22-39; MNHN

Diagnosis. This new species differs from other species of the nominal subgenus *Duolandrevus* by the shape of the pseudepiphallid [epiphallid], metanotal gland and FW venation. Its male genitalia is most similar to *Duolandrevus (Duolandrevus) kalimantan* Gorochov, 2016 from Kalimantan; but the new species differs by FW with a larger harp area and more strongly curved oblique veins (instead of mostly straight), the metanotal gland more transverse; dorsal projection of the pseudepiphallid lophi [posterolateral epiphallid lobe], when viewed

laterally, with the apex rounded (instead of subacute). It is also similar to *Duolandrevus* (*Duolandrevus*) *brachypterus* (Haan, 1844) from Java; but differs by the FW without a mirror area, more strongly curved oblique veins and the shapes of pseudepiphallic posteromedial lophi and pseudepiphallic lophi [posteromedial and posterolateral epiphallic lobes, respectively]. From other Bornean species of the subgenus: this new species differs from *Duolandrevus* (*Duolandrevus*) *kubah* Gorochov, 2016 and *Duolandrevus* (*Duolandrevus*) *sabah* Gorochov, 2016 by the absence of mirror on the FW and the dorsal projection of the pseudepiphallic lophi [posterolateral epiphallic lobe] broadly rounded (instead of slender or humped, respectively); from *Duolandrevus* (*Duolandrevus*) *balikpapan* Gorochov, 2016 and *Duolandrevus* (*Duolandrevus*) *spinicauda* Gorochov, 2016 by the pseudepiphallic lophi [posterolateral epiphallic lobe] not elongated and slender; from *Duolandrevus* (*Duolandrevus*) *matang* Gorochov, 2017 by the dorsal projection of the pseudepiphallic lophi [posterolateral epiphallic lobe] broadly rounded (instead of hooked).

Remarks. This new species is placed under the nominal subgenus *Duolandrevus* according to these characters: the hindwings well surpassing metanotal gland; the male anal plate without a bundle of strong setae directed dorsad; the male genitalia with dorsal denticle at or near base of each pseudepiphallic lophi [posterolateral epiphallic lobe].

Etymology. The species name refers to the rarity of finding landrevine males forming burrows on the clayey bank of a forest stream. Often, landrevines call among cavity and crevices of tree trunk or branches.

Description. Typical of the genus, body dorso-ventrally compressed and not pubescent, dark red-brown in colouration. Head rostrum not pubescent, about 1.7 times as wide as scapes, with apex broadly rounded (in dorsal view) (Fig. 4A). Scapes brown (Fig. 4A). Eyes medium-sized, rather rounded (in profile view). Maxillary palpi yellow brown; with apical (fifth) segment yellow, longer than third and subapical (fourth) segments, slightly enlarged apically, with apex obtusely rounded; subapical segment, widens slightly apically, slightly longer than third segment (Fig. 4B). Head in anterior view slightly wider than tall (Fig. 4C). Lateral ocelli posterior of scapes oval; median ocellus between scapes small circular (Fig. 4C). Pronotum transverse, 1.7 times as broad as long; anterior margin as wide as posterior margin; dorsal disc with anterior margin lined with a row of setae and concave, and posterior margin feebly substraight (Fig. xA). Pronotal lateral lobe about 1.3 times as long as wide; anterior half about 1.6 times as tall as posterior half, with ventral margin straight (Fig. 4B). TI with both tympana open and having oval tympanal membrane, inner one larger than outer one. TIII inner and outer margins with 4–5 stout articulated spurs (also known as movable spines) on each dorsal side; and 3 inner and ca. 9 outer basal spines, much smaller. TaIII with about 4 inner and 5 outer denticles.

Male. FW glossy red-brown, harp area transparent (Figs 4D, 4E). Dorsal field not distinctly longer than lateral field, apical field stout (Fig. 4E). Venation (Figs. 4D, 4E): no distinct mirror present; harp area very large with 6 oblique veins (3 strongly curved long posterior veins and 3 substraight small anterior veins). Lateral field wide, R and M closely-spaced. Sc parallel to R and M, with four longitudinal and parallel branches; third vein (from dorsal) bifurcate in middle. Hind wings well surpassing metanotal gland (Fig. 4F). Metanotal gland with anterior margin with a row of strong setae, anterior lateral ends slightly swollen; two shallowly sunken divided from each other by a narrow longitudinal ridge; posterior margin broadly and faintly concave (Fig. 4F).

Anal plate triangular with truncated apex, with setae along posterior margin but without bundle of strong setae directed dorsad (Fig. 5A). Male pseudepiphallus [epiphallus] (Figs 5B–D) notched in the middle, anterior half not raised. Pseudepiphallic posteromedial lophi [posteromedial epiphallic lobules] triangular, not elongated with obtuse apex; these lobules separated from each other by very shallow and narrow notch, appears fused together with a groove. Pseudepiphallic lophi [posterolateral epiphallic lobes] forming narrow plate-like projection, pointing dorsad at the apex (when viewed laterally); with a shorter and smaller projection pointing posteriorly (when viewed laterally); ventrally folded internally (when viewed dorsally or ventrally), also with a small projection pointing interno-posteriorly. Dorsal and posterior projections with apices bearing a few setae; apex of dorsal projection more broadly rounded, apices of posterior projections narrowly obtuse. Ectophallic fold [rachis] when viewed ventrally faintly surpassing pseudepiphallic posteromedial lophi, but not reaching the posterior end of pseudepiphallic lophi; very slender with acute apex. Each ectophallic apodeme [endparamere] forked posteriorly, and forming a Y-shape structure. Endophallic sclerite [formula] when viewed ventrally fairly stout, narrow anteriorly, widened and truncated at the posterior end. Rami not fused together by the anterior ends.

Measurements (2♂, in mm). PronL = 2.7–2.9 (mean = 2.8); PronW = 4.6–5.3 (5.0); FWL = 7.1; FIIL = 12.7; TIIL = 8.9.

Ecology. One of the males was found calling from a burrow on the clayey bank of a forest stream (Fig. 3). Another male was found on the ground along the trail. These suggest that this species is a more ground-dwelling landrevine.

Distribution. Borneo, Sabah State: Mount Silam near Lahad Datu, Tabin Wildlife Reserve.

Type locality. EAST MALAYSIA, Sabah State, Mount Silam near Lahad Datu.

Calling song (1 ♂, in the field, 23.3°C) (Fig. 6). The calling song consists of an echeme made up of 32–48 syllables. The first few syllables are of lower amplitude but the amplitude of subsequent syllables increases to a maximum and remains relatively consistent. Each echeme has an average duration of 0.60 ± 0.07 s (0.46–0.70 s).

The interval between consecutive echemes is 5.01 ± 1.84 s (3.19–8.47 s). Each syllable has an average duration of 9.1 ± 0.5 ms (8.5–10.0 ms) and the interval between consecutive syllables is 5.6 ± 0.6 ms (4.4–6.1 ms). The dominant frequency is 3.90 ± 0.03 kHz (3.86–3.95 kHz).

Genus *Odontogrylodes* Chopard, 1969

Odontogrylodes – Chopard, 1969: 153; Gorochov, 1982: 151; Otte, 1988: 284; Otte, 1994: 83; Tan & Kamaruddin, 2016: 562, 564

Type species. *Odontogrylodes brevicauda* Chopard, 1969, by original designation.

Remarks. This genus previously consisted of six species from Malay Peninsula, Sumatra and Java prior to the new species described from Borneo. These crickets are characterised by a cylindrical body; males with short FWs and completely lack stridulatory apparatus; metanotal gland present; tympanum absent; females with short ovipositor (Gorochov, 2016). Tan & Kamaruddin (2016) presented a key to species.

Odontogrylodes spinifer sp. nov.

(Figs 7–11)

Material examined. Holotype: EAST MALAYSIA • ♂; Sabah State, Mount Silam, near Lahad Datu; N4.96786, E118.17203, 722.3±6.7 m.a.s.l.; 12 May 2022, 20h22; on a branch of a small tree; coll. M.K. Tan, T. Robillard & R. Japir; SBH.22.33 (FRC)

Paratypes: EAST MALAYSIA • 1 ♂; Sabah State, Mount Silam, near Lahad Datu; N4.96609, E118.17285, 717.8±8.6 m.a.s.l.; 12 May 2022, 20h05; on a foliage of a small tree; coll. M.K. Tan, T. Robillard & R. Japir; SBH.22.29 • 1 ♂; Sabah State, Sandakan, Sepilok, Rainforest Discovery Centre; N5.87342, E117.94214, 64.4±7.1 m.a.s.l.; 17 May 2022, 21h36; on a branch of a small tree; coll. M.K. Tan & T. Robillard; SBH.22.135 • 1 ♀; Sabah State, Sandakan, Sepilok, Kabili Sepilok Forest Reserve; N5.86984, E117.93806, 68.3±6.5 m.a.s.l.; 3 October 2019, 20h19; on a branch; coll. M.K. Tan & J. Lee Yukang; SDK.19.100 (all ZRC)

Other material examined: EAST MALAYSIA • 1 ♀; Sabah State, Tabin Wildlife Reserve; N5.19541, E118.50370, 117.7±6.7 m.a.s.l.; 15 May 2022, 21h32; on a branch near the ground; coll. M.K. Tan, T. Robillard & R. Japir; SBH.22.92 (FRC) [need a male from the same locality to confirm the species]

Diagnosis. The new species differs from all of the congeners by the anterior half of the male pseudepiphallus [epiphallus] curved upwards and with lateral squarish lobes (these two lateral lobes have spine-like setae); and by the pseudepiphallic lophi [posterolateral epiphallic lobe] forming narrow-triangular dorsal lobules pointing dorsad with subacute apices (in lateral view), and ventral lobules stout and obtuse (all lobules with setae); the male FW with the apical area of the dorsal field narrowly-obtuse.

Remarks. This represents the first record of *Odontogrylodes* in Borneo (previously known from Malay Peninsula, Sumatra and Java).

Etymology. The species name refers to the numerous prickly-like setae on the pseudepiphallus; in Latin from *spīna* (“thorn, spine, prickly”) + *-fer* (“carrying”).

Description. Typical of the genus, body slightly cylindrical and densely pubescent, red-brown in colouration (Fig. 7). Head rostrum very densely pubescent, about 1.2 times as wide as scapes, with apex truncated (in dorsal view) (Fig. 8A). Scapes yellow brown. Eyes fairly small, vertically elongated (in profile view) (Fig. 8B). Maxillary palpi with apical (fifth) segment yellow, swollen and pyriform, longer than third and subapical (fourth) segments, with apex obtusely rounded; subapical segment pale-brown, widens apically, slightly longer than third segment; third segment pale-brown, cylindrical (Fig. 8B). Head in anterior view 1.1 times as tall than wide (Fig. 8C). Face dark brown, clypeus whitish. Median ocellus small and circular, between scapes; lateral ocelli small and circular, posterior of scapes. Pronotum 1.1 times as long as broad; very densely setose but anterior and posterior margins with strong hairs (Fig. 8A). Dorsal disc slightly widening with posterior margin 1.2 times as wide as anterior margin; with anterior margin feebly concave in the middle and posterior margin feebly convex in the middle (Fig. 8A). Pronotal lateral lobe about 1.3–1.4 times as long as wide; anterior half about 2.2 times as tall as posterior half; with ventral margin straight (Fig. 8B). TI without tympanum. TIII inner and outer margins with 4 stout articulated apical spurs (also known as movable spines) on each dorsal side; with 7 (3 small and 4 longer) inner and 6 (2 small and 4 longer) outer subapical spines. TaIII with two rows of denticles, 4–5 on each side.

Male. FW red-brown, densely pubescent (not as dense as pronotum) between veins; barely reaching posterior end of metanotum; spaced well apart and not touching each other (Figs 8D, 8E). Dorsal field distinctly longer than lateral field; venations obsolete, except R and M straight, widely spaced apart and parallel; apical area narrowly-obtuse (Fig. 8D). Lateral field wide, with four longitudinal veins; dorsal two longitudinal veins most spaced-apart,

dorsal most longitudinal vein straight to faintly sinuous, second and third veins (from dorsal) parallel and gently curved in the middle (Fig. 8E). Hind wings absent. Metanotal gland seemingly under-developed. Anal plate triangular with truncated apex, with sparse setae along posterior margin (Fig. 9A). Male pseudepiphallus [epiphallus] (Figs 9B–D) in dorsal view notched in the middle; anterior half curved upwards and with two lateral squarish lobes; lateral lobe with spine-like setae. Pseudepiphallic posteromedial lophi [posteromedial epiphallic lobe] stout with obtuse apex; these lobules separated from each other by shallow and narrow notch. Pseudepiphallic lophi [posterolateral epiphallic lobe] forming dorsal lobules in lateral view narrow-triangular and pointing dorsad with subacute apices, with spine-like setae on the dorsal and ventral (fewer) margins; ventral lobules stout and obtuse, also with a few setae. Ectophallic fold [rachis] barely reaching apex of pseudepiphallic posteromedial lophi [posteromedial epiphallic lobe] (when viewed ventrally), slender and faintly raised and tapering to subacute apex (when viewed laterally); vertically lamellar plates of the ectophallic fold [rachis] having microscopic ridges on their lateral sides. Each ectophallic apodeme [endparamere] forked posteriorly, and together with its long anterior apodeme forming a Y-shape structure; inner branch shorter and with obtuse apex, outer branch longer (reaching bottom of pseudepiphallic notch) and with truncated apex. Endophallic sclerite [formula] elongated; faintly tapering posteriorly into obtuse to truncated apex (when viewed ventrally). Rami not fused together by the anterior ends.

Female. Habitus not different from males (Figs 10A, 10B). FW characteristic of genus, small and rounded, with 7–8 longitudinal veins in both dorsal and lateral fields; FWs not touching each other. Subgenital plate typical of genus, broader than long, with posterior margin concave (Fig. 10C). Ovipositor slightly curved, short, barely reaching middle of cerci; having characteristic denticulate lateral edges of the distal part of upper valves (Fig. 10D).

Measurements (3♂, 1♀, in mm). PronL = ♂ 2.8–2.9 (2.9), ♀ 2.9; PronW = ♂ 3.2–3.3 (3.3), ♀ 3.3; FWL = ♂ 2.2–2.4 (2.3), ♀ 1.4; FIIL = ♂ 7.6–8.3 (8.0), ♀ 8.4; TIIL = ♂ 4.6, ♀ 4.9; OL = 4.6.

Ecology. This species is found among branches and tree trunks, usually around and above breast height (rather than near the ground).

Distribution. Borneo, Sabah State: Mount Silam near Lahad Datu, Kabili Sepilok Forest Reserve (including Rainforest Discovery Centre).

Type locality. EAST MALAYSIA, Sabah State, Mount Silam near Lahad Datu.

Calling song. Unknown.

Subfamily Podoscirtinae Saussure, 1878

Tribe Aphonoidini Gorochov, 2008

Genus *Brevimunda* Gorochov, 2007

Brevimunda – Gorochov, 2007: 286; Gorochov, 2008: 49

Type species. *Brevimunda variegata* Gorochov, 2007, by original designation

Remarks. This small genus consists of two species, both from Mount Kinabalu in Borneo: *B. kinabalu* Gorochov, 2007 and *B. variegata* Gorochov, 2007. The genus is characterised by the TI with only a small inner tympanum; the apical segment of the maxillary palpi particularly widened; the lateral field of the FW with parallel longitudinal veins; the hindwings shorter than FWs; and the male anal plate short and with a pair of characteristic small transverse lobes at the upper (proximal) half. Below, a species from the eastern part of Sabah is described, first for the genus, but it also exhibits some deviations from the above-mentioned generic characters.

Brevimunda trilineata sp. nov.

(Figs 12–14)

Material examined. Holotype: EAST MALAYSIA • ♂; Sabah State, Sepagaya Waterfall, near Lahad Datu; N4.98364, E118.14537, 172.1±6.4 m.a.s.l.; 13 May 2022, 12h10; on a foliage of an understory plant; coll. M.K. Tan & T. Robillard; SBH.22.57 (FRC)

Paratypes: 1♂; Sabah State, Sandakan, Sepilok, Kabili Sepilok Forest Reserve; N5.86948, E117.93913, 36.4±8.8 m.a.s.l.; 1 October 2019, 19h49; on a foliage; coll. M.K. Tan, R. Japir & J. Lee Yukang; SDK.19.72 (ZRC)

Diagnosis. The new species differs from currently known *Brevimunda* by the apical segment of the maxillary palpi less strongly widened; the hind wings surpassing the FWs; by the pseudepiphallic lophi [apical epiphallic lobe] more elongated, slenderer and pointing dorsad (vs. broad in *B. variegata*) and nearly perpendicular to the pseudepiphallus [epiphallus] (vs. pointing postero-dorsad in *B. kinabalu*); the pseudepiphallic paramere [ectoparamere] in ventral view more elongated and slenderer. The new species also differs from *B. variegata* by

the cream-coloured/ yellow spot on the posterior margin of pronotal lateral lobe (instead of anterior-ventral angle) and from *B. kinabalu* by a darker overall colouration.

The pseudepiphallalic lophi [apical epiphallalic lobe] of the new species is also slender and pointing dorsad, somewhat resemble that of *Misthenkoana pileata* Gorochoy, 2008 from the Solomon Islands, but the new species differs from the latter by its distinct darker colouration.

Generic remarks. This new species certainly bears similarities with currently known *Brevimunda* such as the apical segment of the maxillary palpi strongly widened (but not so strongly widened as described by Gorochoy [2007]); the lateral field of the FW with longitudinal veins parallel; and the male anal plate short and with a pair of characteristic small transverse lobes at upper (proximal) half. However, there also some key differences: the apical segment of the maxillary palpi (described above); the TI with both tympana open (instead of a small inner tympanum and no outer tympanum); the hind wings surpassing the FWs.

Etymology. The species name refers to the characteristic the three elongated white/ cream-coloured spots along M on the FW: at the basal third, in the middle (largest) and near the apical third.

Description. Habitus typical of the genus, medium sized, head, pronotum and FW mostly dark-coloured (Fig. 12). Head with dorsum flattened, pubescent. Rostrum darked-coloured with two lateral white stripes, about 0.7 times as wide as scapes, with apex roundly truncated (in dorsal view) (Fig. 13A). Scapes dark-coloured. Eyes distinctly projected anteriorly in dorsal view (Fig. 13A). Median ocellus round and small; lateral ocelli oval, located near eyes. Maxillary palpi cream-coloured; with apical segment longest, dorso-posteriorly dark-coloured, flattened and widened, with obliquely-truncated apex; with subapical segment very short, cylindrical and expanding apically, dark-coloured at both ends; third segment longer than subapical segment, cylindrical (Fig. 13B). Face in anterior view 1.1 times taller than wide; dorsum half black, ventral half (including clypeus) cream-coloured (Fig. 13C). Gena cream-coloured with tint of dark (Fig. 13B). Pronotal disc dark brown, pubescent; about as wide as long, barely widening posteriorly (posterior margin 1.1 times as wide as anterior margin); finely pubescent, with a row of strong setae along posterior and anterior margins; anterior margin of disc broadly concave; posterior margin of disc angularly convex (Fig. 13A). Pronotal lateral lobe 1.4 times as long as high, dark-coloured, with a cream-coloured spot in the middle along the posterior margin (Fig. 13B). Metanotal gland absent (Fig. 13D). TI slightly swollen; with inner tympanum open and having elongate, oblong tympanal membrane; with outer tympanum also open and having smaller oval tympanal membrane; TIII with 5 inner and 5 outer long spines in distal half, with small denticles before most proximal spines. Legs generally cream-coloured with irregular and sparse dark spots; Fs with more dark spots in the apical half; Ts generally with more dark spots. FIII with a black ring at apical third, knees dark-coloured. TIII with dark rings. TaIII with basal half cream-coloured and posterior half dark-coloured. Thoracic and abdominal segments dark coloured.

Male. FW (Figs xE, xF) covering abdomen and surpassing apex of FIII. Colouration: yellow brown, with darker infumated spots; at the base with a diagonal white stripe across FW; along M with three elongated white/ cream-coloured spots at the basal third, in the middle (largest) and near apical third. Lateral field with intercalary triangle transparent, otherwise dark-coloured with dorsal half of cells between branches of Sc cream-coloured. Venation: without stridulatory organs, with longitudinal veins parallel; lateral field with R and M narrowly spaced apart, parallel and with transverse veins (especially in the basal half); branches of Sc parallel. Hind wings clearly surpassing FWs.

Anal plate at anterior half with a pair of characteristic small transverse lobes at upper (proximal) half yellow in colouration, posterior half with two rounded indentation, cream-coloured with dark margins; cerci cream-coloured; posterior margin emarginated in the middle (Fig. 14A). Subgenital plate typical of subgenus, cream-coloured with small dark spots. Male genitalia as shown in (Figs 14B–D): pseudepiphallus [epiphallus] elongated, tapering slightly posteriorly, divided into two parts at posterior end and roundly and narrowly excised; posterior end produced into pseudepiphallalic lophi [apical epiphallalic lobe]. Pseudepiphallalic lophi [apical epiphallalic lobe] in dorsal view long and slender and pointing posterior-externally with apex obtuse; in lateral view with also slender, pointing dorsad (nearly perpendicular to pseudepiphallus [epiphallus]), apex rounded and with one or a few strong setae. Pseudepiphallalic paramere [ectoparamere] in ventral view elongated and slender (more so than congener), slightly curved, anterior end widened lamellate fan-like. Ectophallic fold [rachis] small, slender and straight, taper posteriorly with apex obtuse.

Female. Unknown.

Measurements (2♂, in mm). PronL = 2.1–2.2 (2.2); PronW = 2.2; FWL = 10.3–11.2 (10.8); HWT = 3.3; FIIL = 9.3; TIIIL = 9.5.

Ecology. Unknown.

Distribution. Borneo, Sabah State: Sepagaya Waterfall, near Lahad Datu, Kabili Sepilok Forest Reserve

Type locality. EAST MALAYSIA, Sabah State, Sepagaya Waterfall, near Lahad Datu

Calling song. This species is mute.

Genus *Varitrella* Gorochov, 2003
Subgenus *Cantotrella* Gorochov, 2006

Varitrella (*Cantotrella*) – Gorochov, 2006: 33; Gorochov & Tan, 2014: 536; Tan et al., 2020: 264

Type species. *Varitrella palawanensis* Gorochov, by original designation

Remarks. This subgenus consists of 19 species from Indochina, Malay Peninsula, Java, Borneo, Philippines and Sulawesi. It can be distinguished from the nominotypical subgenus by the absence of metanotal gland in males, the apical part of the ectophallic fold [rachis] in the male genitalia widened and with comparatively smaller lobes (including a virga-like or finger-like median process), and the ectoparameres (if they are developed) probably originated from the lateral lobes of the pseudepiphallus [epiphallus] but not from the lateral lobes of the ectophallic fold [rachis] (Gorochov & Tan, 2014).

***Varitrella* (*Cantotrella*) *suikei* Tan, Japir & Chung, 2020**
(Figs 15, 16)

Varitrella (*Cantotrella*) *suikei* – Tan et al., 2020: 264

Material examined. Holotype: EAST MALAYSIA • ♂; Sabah State, Sandakan, Sepilok, Kabili Sepilok Forest Reserve; N5.86985, E117.93805, 69.8±7.7 m.a.s.l.; 1 October 2019; on a foliage; coll. M.K. Tan, R. Japir & J. Lee Yukang; SDK.19.78 (FRC)

Other material examined: EAST MALAYSIA • 1♂; Sabah State, Sandakan, Sepilok, Rainforest Discovery Centre; N5.87435, E117.94205, 49.9±5.7 m.a.s.l.; 17 May 2022, 20h17; among the branch and foliage, feeding on the fruits of *Leea*; coll. M.K. Tan & T. Robillard; SBH.22.132 (ZRC)

Remarks. This represents the second specimen for this species, having been previously described by a single holotype. The male resembles the holotype but we also illustrated the spermatophore (Fig. 15C).

Ecology. The recently collected specimen was observed to feed on the fruits of *Leea*, but it probably also fed on the flowers and leaves of this common plant at the Rainforest Discovery Centre (Fig. 16).

Distribution. Known only from the type locality, Sepilok (Borneo, Sabah State).

Calling song. The calling song of the holotype was described in Tan et al. (2020). The call structure and call parameters of *Varitrella* (*Cantotrella*) *suikei* are distinct from those of *Varitrella* (*Cantotrella*) *tabin* sp. nov.: the former consists of irregular trill instead of well-defined echeme-sequences (even though each echeme is made up of two syllables). The echeme and syllable durations of *Varitrella* (*Cantotrella*) *suikei* are shorter in duration; and the dominant frequency is slightly higher.

***Varitrella* (*Cantotrella*) *tabin* sp. nov.**
(Figs 17–19)

Material examined. Holotype: EAST MALAYSIA • ♂; Sabah State, Tabin Wildlife Reserve; N5.19447, E118.50259, 80.1±7.8 m.a.s.l.; 15 May 2022, 22h57; on a foliage of a tree along the forest edge; coll. M.K. Tan, T. Robillard & R. Japir; SBH.22.101 (FRC)

Diagnosis. The new species is most similar to *Varitrella* (*Cantotrella*) *sukau* Gorochov, 2014 from Sukau in Kinabatangan by the shape of male genitalia, but differs by the shape of ectoparamere. It also differs from *V. sukau* by the shape and pattern of anal plate. From species found nearby, this new species also differs from *Varitrella* (*Cantotrella*) *tawau* Gorochov, 2014 from Tawau (south of Tabin Wildlife Reserve) by the oval patch on anal plate nearly touching other and fusing (instead of widely spaced apart), the dorso-anterior pseudepiphallic spine (ds) larger and the pseudepiphallic paramere [ectoparamere] not short and membraneous; and from *Varitrella* (*Cantotrella*) *suikei* from Sepilok (north of Tabin Wildlife Reserve) by the dorso-anterior pseudepiphallic spine (ds) and the latero-apical lobular parts larger and more robust as well as the calling song (see above). The pronotum and FW colouration are somewhat similar to *Varitrella* (*Cantotrella*) *orion* Tan & Gorochov, 2014.

Etymology. The species is named after its type locality, Tabin Wildlife Reserve; noun in apposition.

Description. Habitus very typical of the genus, medium sized, generally grey-brown. Head with dorsum slightly flattened, very finely pubescent (Fig. 17A). Rostrum dark-coloured, about 0.8 times as wide as scapes, with apex broadly rounded (in dorsal view) (Fig. 17B). Eyes projected anteriorly in dorsal view (Fig. 17B). Median ocellus round and small; lateral ocelli oval, located near eyes. Maxillary palpi with apical segment longest, distinctly flattened and oblong with subobtusate apex; with subapical segment cylindrical and slightly expanding apically; third segment very short and stout (Fig. 17A). Gena greyish with tint of black patches (Fig. 17A). Face in anterior

view 1.1 times as tall as wide; with a black patch between antennal grooves (Fig. 17C). Pronotal disc brown with numerous dark spots (especially distinct along anterior margin); about 1.3 times as wide as long, faintly widening posteriorly (posterior margin 1.2 times as wide as anterior margin); finely and densely pubescent; anterior margin of disc broadly concave; posterior margin of disc nearly straight (Fig. 17B). Pronotal lateral lobe 1.4 times as long as high; with a longitudinal dark band in dorsal half, numerous black spots of different sizes in ventral half; with ventral margin faintly convex (Fig. 17A). Metanotal gland absent (Fig. 17D). TI slightly swollen; with inner tympanum slit-like; with outer tympanum open and having oval tympanal membrane. TIII with 6 inner and 5 outer long spines; with 2–4 denticles between spines; 4 denticles before most proximal spines; and with inner spurs (apical spines) longer than corresponding outer ones. Legs generally pale brown with irregular and sparse dark spots. Thoracic and abdominal segments yellow brown to brown.

Male. FW (Fig. 17E) covering abdomen and barely surpassing apex of FIII. Colouration: yellow brown, with darker infumation. Dorsal field of FW yellow brown with basal area, proximal part of region of chords, and apical area almost dark brown, and with large white spot between disto-lateral edge of mirror and stock of MP+CuA1. Lateral field of FW paler, light brown with blackish marks near Sc between branches of Sc. Venation: diagonal straight, with 5 oblique veins in harp area; mirror 1.7 times as long as wide, dividing vein typical of subgenus; lateral field around 16 branches on Sc (Fig. 17E). Hind wings clearly surpassing FWs.

Anal plate with anterior half broad and black; at base with two whitish oval parts fusing in the anterior half and appearing as cranium-shaped; posterior half truncated, faintly emarginated in the middle (Fig. 17F). Subgenital plate typical of subgenus.

Male genitalia as shown in (Fig. 18): Pseudepiphallus [epiphallus] stout, in profile view tall. Pseudepiphallus [epiphallus] with dorso-anterior pseudepiphallic spine (ds) strongly sclerotized with acute apex; elongated and slender in dorsal view; elongated pointing dorsad in profile view, with anterior margin straight and posterior margin slightly curved. Posterior end of pseudepiphallus [epiphallus] produced into two latero-apical lobular parts (al), in dorsal view broad, with apex obtuse; deeply V-emarginated between latero-apical lobules in dorsal view; in profile with posterior part rounded with a dorso-apical spinule and a row of widely-spaced small spinules on dorsal margin, dorsal margin convex in profile view. Pseudepiphallic paramere [ectoparamere] elongated, tapered abruptly into a slender and curved hooked-like apical third with apex acute, and pointing ventrad posteriorly. Ectophallic fold [rachis] rather long, slightly surpassing pseudepiphallus [epiphallus], produced into two broadly-obtuse lateral lobes (lo) at posterior end, with apical emargination wider between lateral lobes in dorsal view. Endophallic sclerite [formula] elongated, typical of genus. Spermatophore oval.

Female. Unknown.

Measurements (♂, in mm). PronL = 3.0; PronW = 3.3; FWL = 18.1; FIIIL = 13.2; TIIIL = 12.9.

Ecology. Unknown.

Distribution. Known only from type locality, Tabin Wildlife Reserve (Borneo, Sabah State).

Calling song (1 male, in the laboratory, 32.0°C) (Fig. 19). The calling song consists of a well-defined echeme-sequence made up of 6 or 7 echemes. The echeme-sequence has an average duration of 1.23 ± 0.10 s (1.10–1.39 s). The interval between consecutive echeme-sequence is 7.4 ± 1.2 s (6.1–10.5 s). Each echeme consists of two closely-spaced syllables and has an average duration of 114.7 ± 11.1 ms (100.1–127.9 ms). The interval between consecutive echemes is 92.3 ± 11.6 ms (72.6–107.5 ms). Each syllable has an average duration of 45.4 ± 5.0 ms (36.3–53.1 ms) and the interval between consecutive syllables is 17.5 ± 4.5 ms (9.5–22.2 ms). The dominant frequency is 6.28 ± 0.03 kHz (6.20–6.32 kHz).

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Figure captions



FIGURE 1. *Duolandrevus (Bejorama) lambir* Gorochov, 2017 ♂ habitus in dorsal view (A); genitalia in dorsal (B) and ventral (C) views. Scale bars: 5 mm (A); 0.1 mm (B, C).

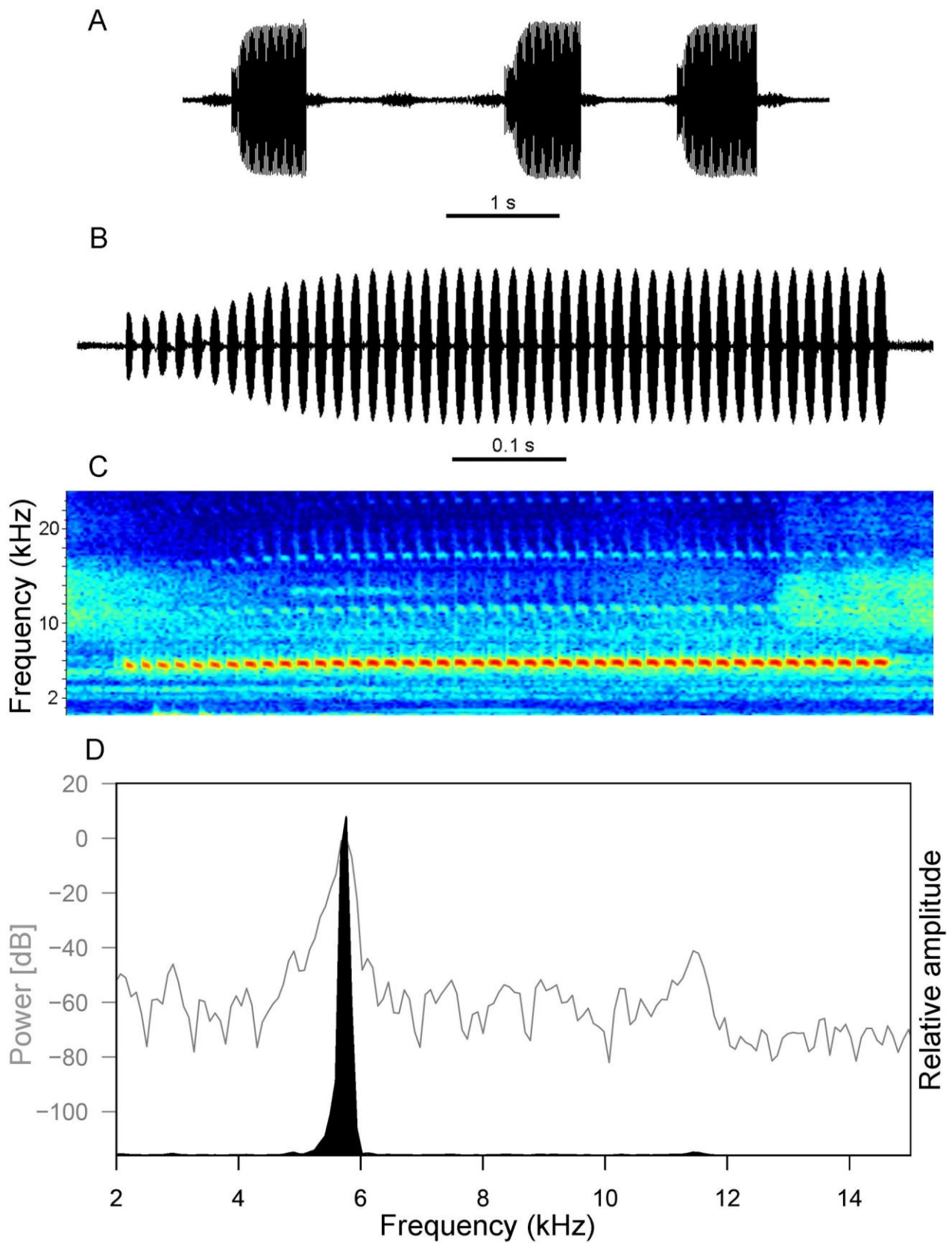


FIGURE 2. *Duolandrevus (Bejorama) lambir* Gorochoy, 2017 ♂ calling song: oscillograms showing three echemes (A) and one echeme (B); spectrogram of the same echeme (C); power spectra of a syllable (D) where the

grey line represents the power [dB] (axis name and scale in grey) and the black solid peak represents the relative amplitude (axis name in black).



FIGURE 3. *Duolandrevus (Duolandrevus) nobilis* sp. nov. ♂ in its natural environment at Mount Silam (MNHN-EO-ENSIF11147).

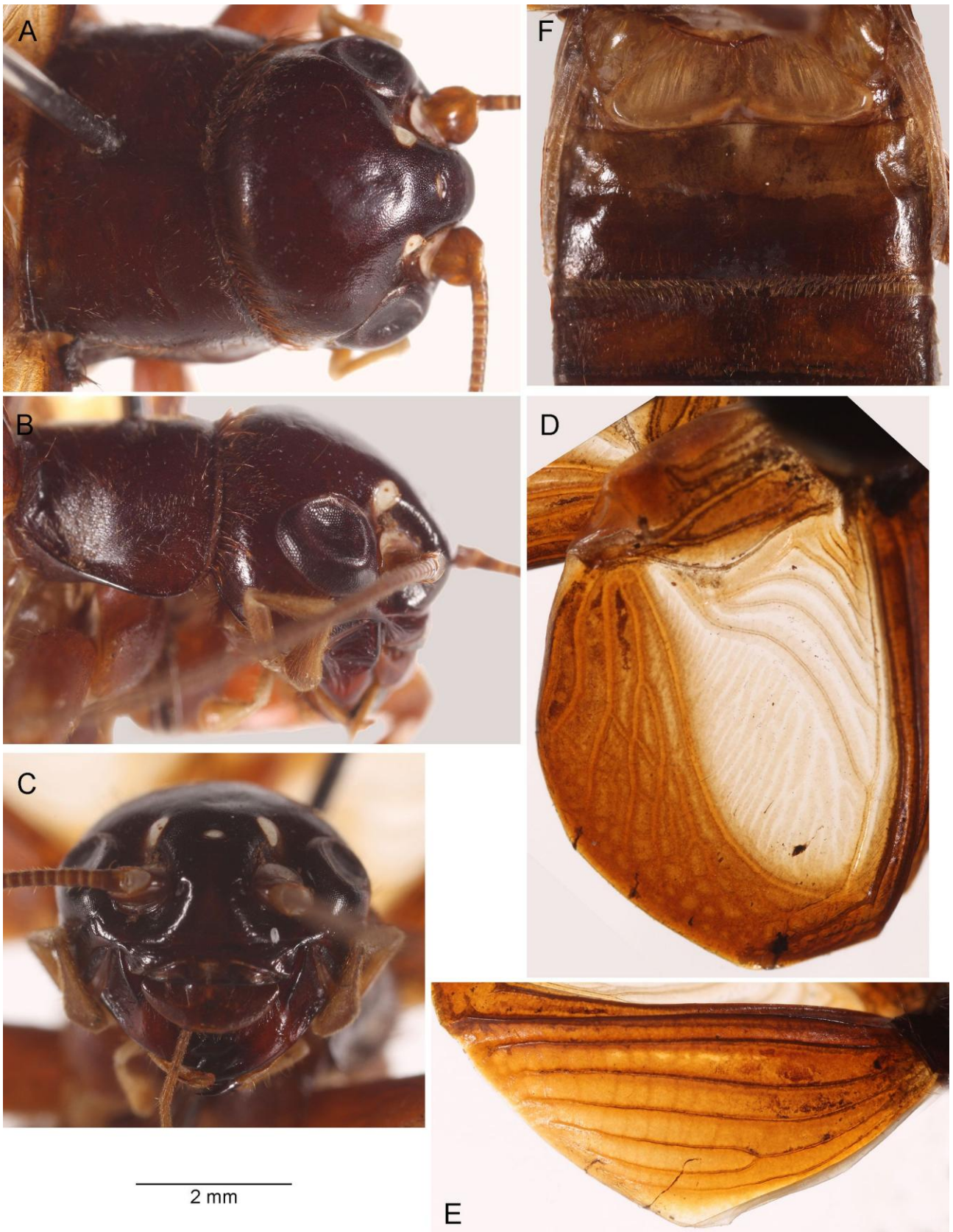


FIGURE 4. *Duolandrevus (Duolandrevus) nobilis* sp. nov. ♂: head and pronotum in dorsal (A) and lateral (B) views; face in anterior view (C); FW dorsal field in dorsal view (D); FW lateral field in lateral view (E); metanotal gland in dorsal view (F). Scale bar: 2 mm.

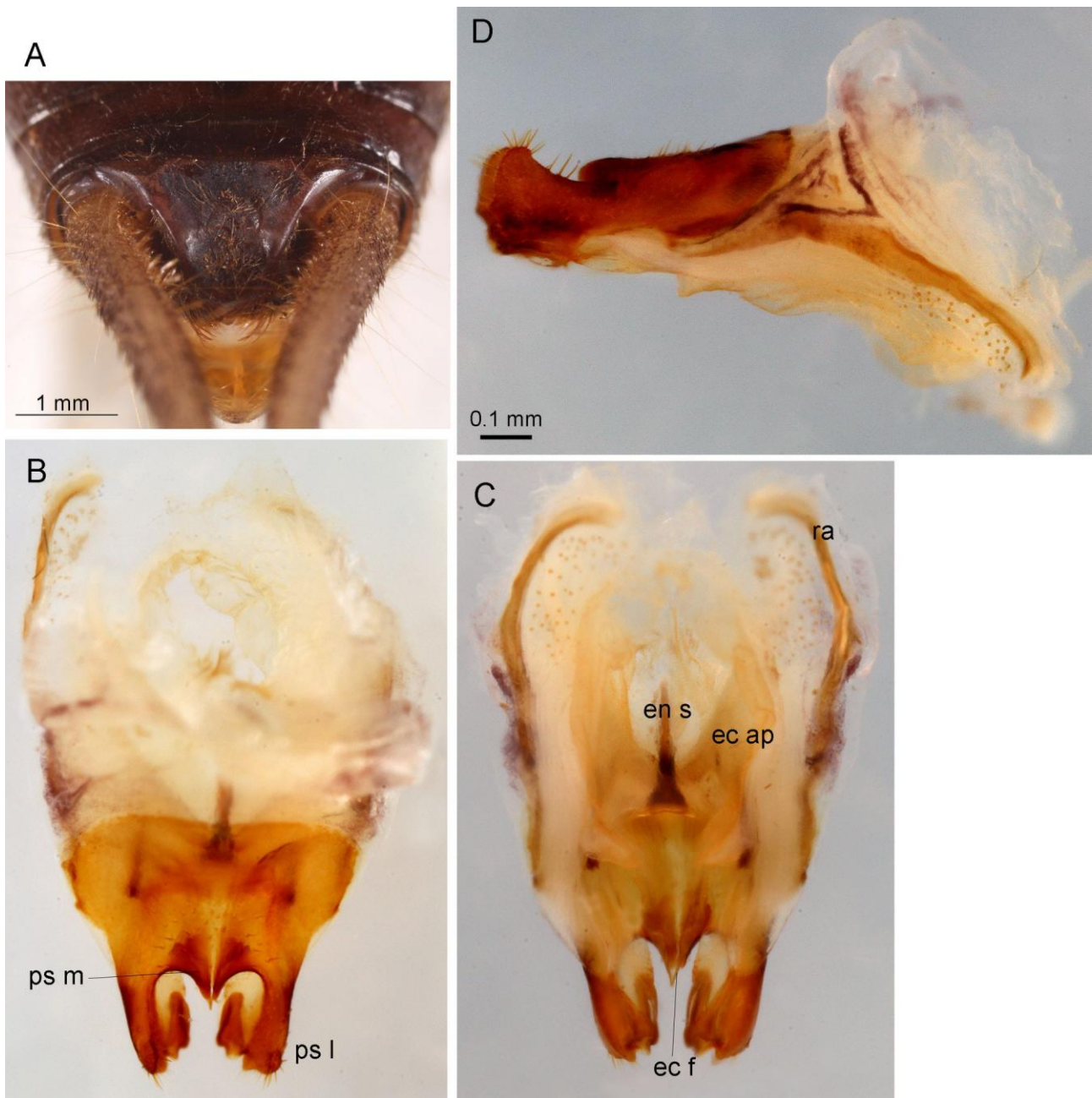


FIGURE 5. *Duolandrevus (Duolandrevus) nobilis* sp. nov. ♂: male abdominal apex in dorsal view (A); genitalia in dorsal (B), ventral (C) and lateral (D) views. Scale bars: 1 mm (A); 0.1 mm (B–D).

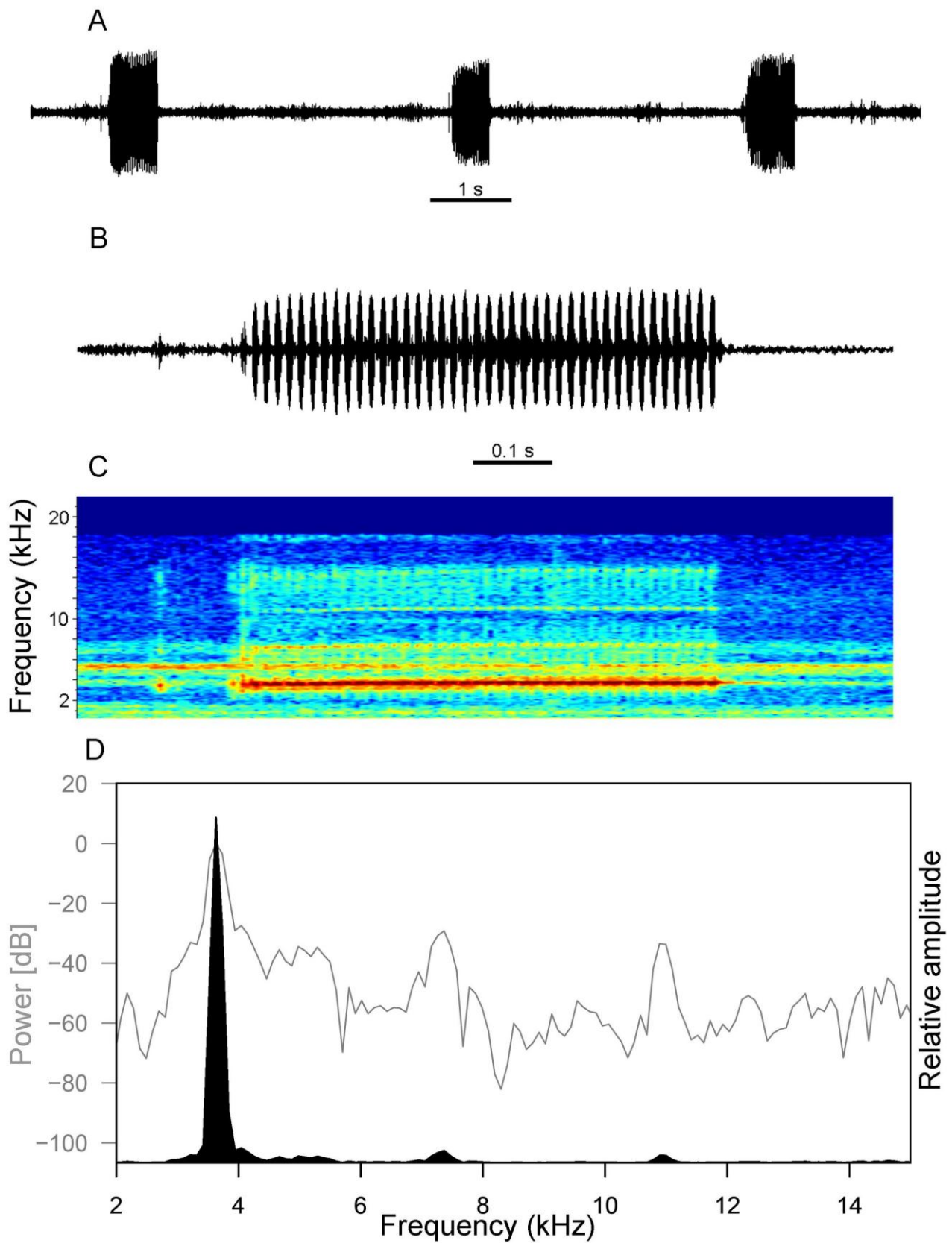


FIGURE 6. *Duolandrevus (Duolandrevus) nobilis* sp. nov. ♂ calling song: oscillograms showing three echemes (A) and one echeme (B); spectrogram of the same echeme (C); power spectra of a syllable (D) where the grey line

represents the power [dB] (axis name and scale in grey) and the black solid peak represents the relative amplitude (axis name in black).



FIGURE 7. *Odontogryllodes spinifer* sp. nov. ♂ in its natural environment: at Mount Silam (SBH.22.29) (A) and at Sepilok (SBH.22.135) (B).

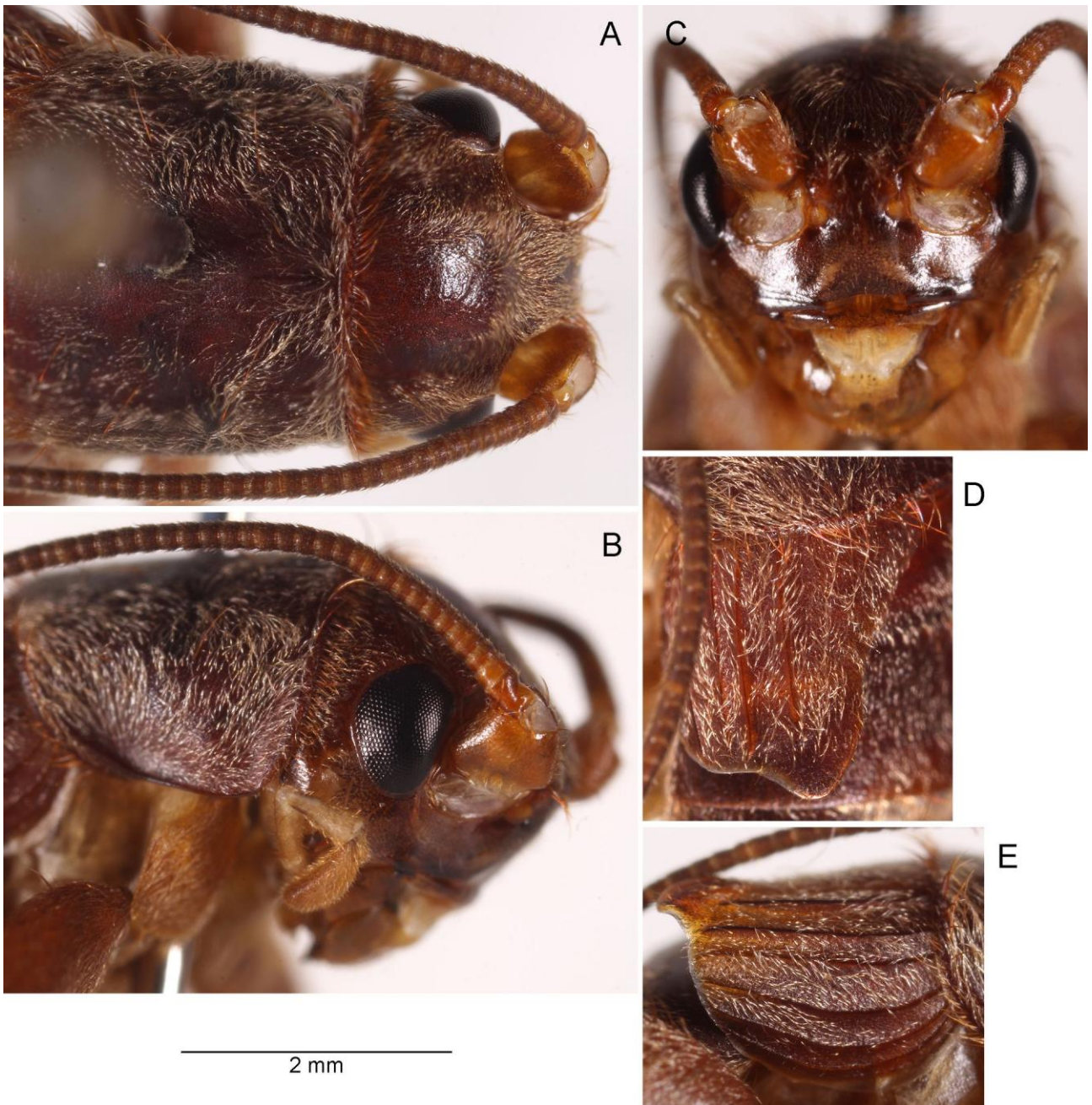


FIGURE 8. *Odontogrylodes spinifer* sp. nov. ♂: head and pronotum in dorsal (A) and lateral (B) views; face in anterior view (C); FW dorsal field in dorsal view (D); FW lateral field in lateral view (E). Scale bar: 2 mm.

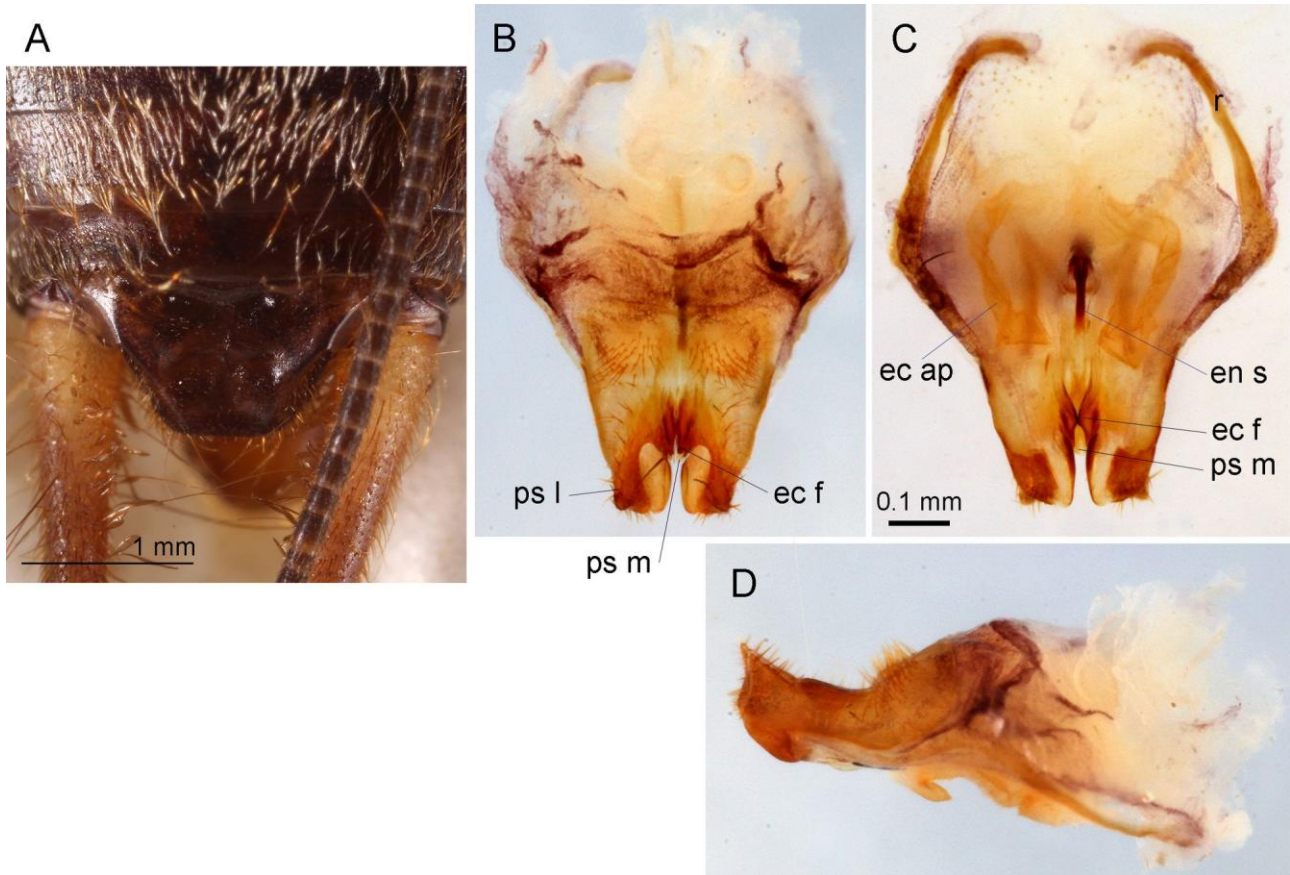


FIGURE 9. *Odontogrylodes spinifer* sp. nov. ♂: male abdominal apex in dorsal view (A); genitalia in dorsal (B), ventral (C) and lateral (D) views. Scale bars: 1 mm (A); 0.1 mm (B–D).



FIGURE 10. *Odontogryllodes spinifer* **sp. nov.** ♀ (SDK.19.100): living habitus at Sepilok (A); habitus in lateral view (B); FW in lateral view (C); ovipositor in lateral view (D). The blue arrow in (D) refers to the characteristic denticulate lateral edges of the distal part of upper valves. Scale bars: 5 mm (B), 1 mm (C, D).



FIGURE 11. *Odontogryllodes spinifer* **sp. nov.** ? ♀ in its natural environment at Mount Silam (A) and Tabin Wildlife Reserve (SDK.19.92) (B).



FIGURE 12. *Brevimunda trilineata* **sp. nov.** ♂ in its natural environment: at Sepilok (SDK.19.72) (A) and at Sepagaya Waterfall (SBH.22.57) (B).

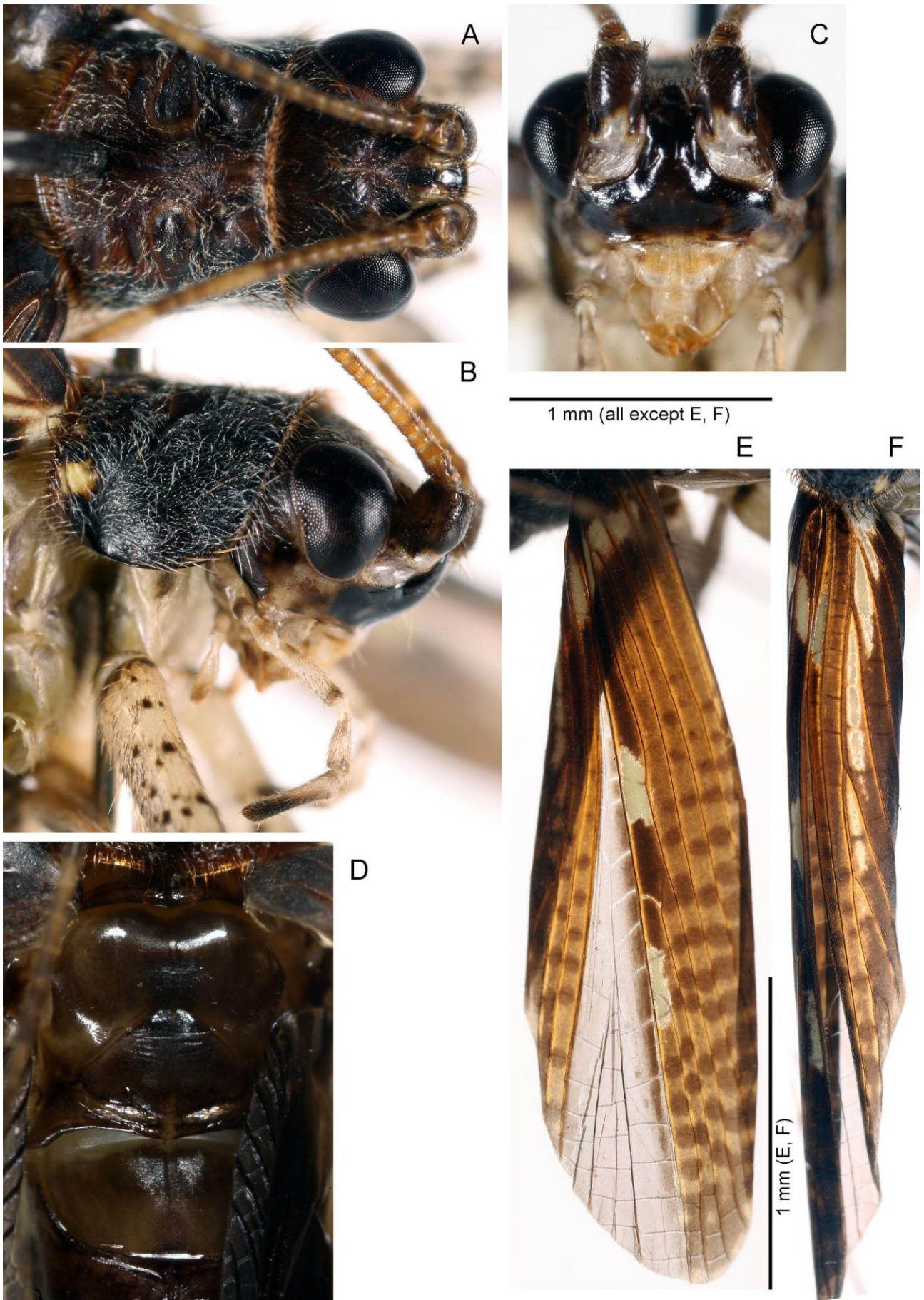


FIGURE 13. *Brevimunda trilineata* sp. nov. ♂ head and pronotum in dorsal (A) and lateral (B) views; face in anterior view (C); metanotal gland in dorsal view (D); FW dorsal field in dorsal view (E); FW lateral field in lateral view (F). Scale bars: 2 mm (E, F), 1 mm (rest).

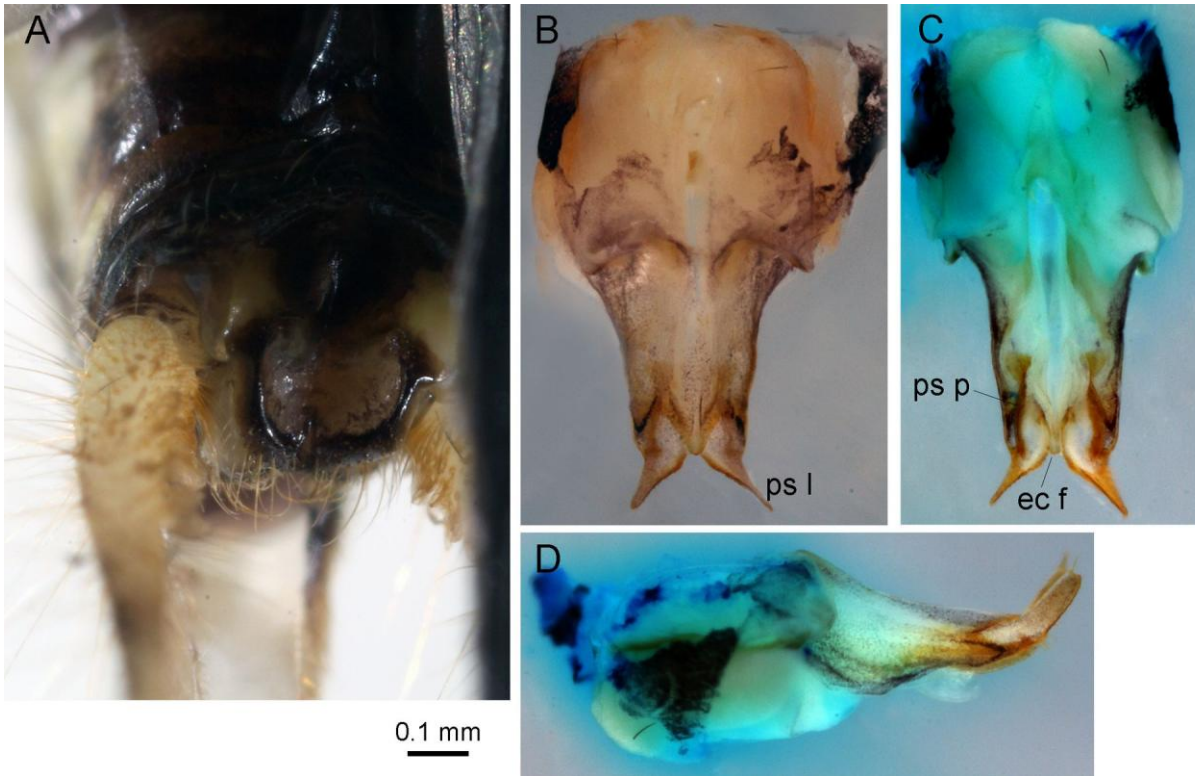


FIGURE 14. *Brevimunda trilineata* sp. nov. ♂: male abdominal apex in dorsal view (A); genitalia in dorsal (B), ventral (C) and lateral (D) views. Scale bar: 0.1 mm.

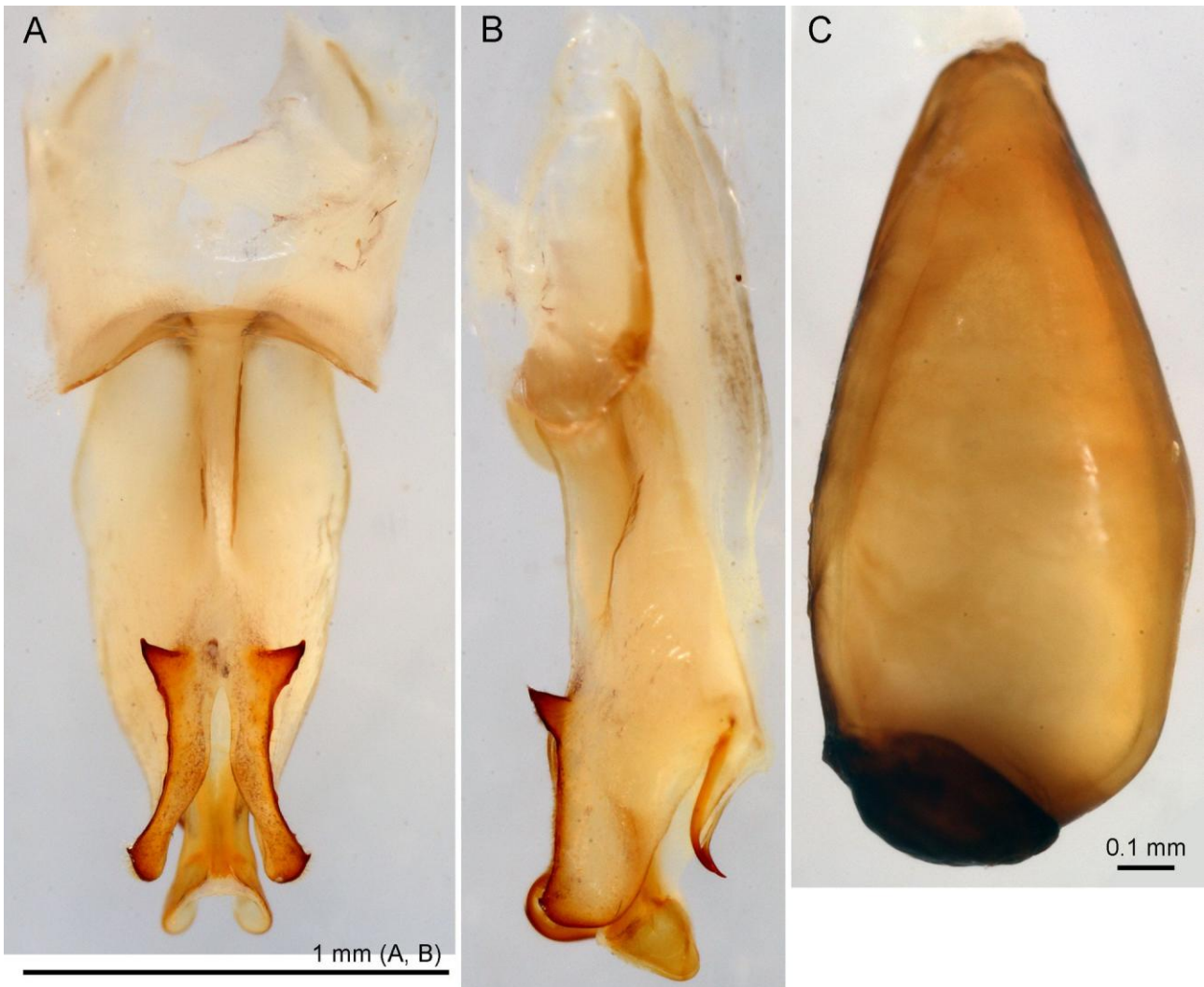


FIGURE 15. *Varitrella (Cantotrella) suikei* Tan, Japir & Chung, 2020 ♂: genitalia in dorsal (A) and lateral (B) views; spermatophore in lateral view (C). Scale bars: 1 mm (A, B); 0.1 mm (C).



FIGURE 16. *Varitrella (Cantotrella) suikei* Tan, Japir & Chung, 2020 ♂ feeding on fruits of *Leea* plant.

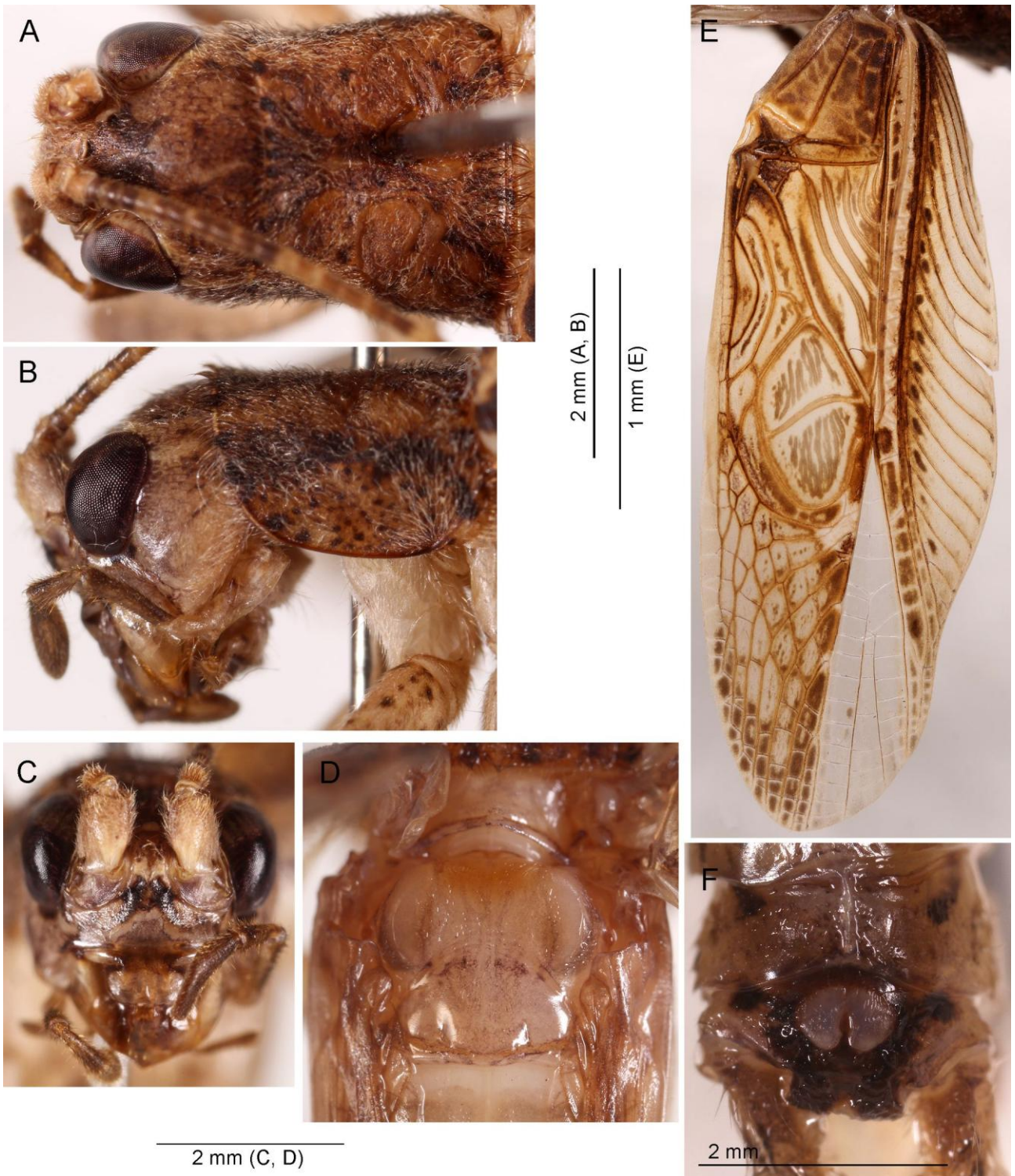


FIGURE 17. *Varitrella (Cantotrella) tabin* **sp. nov.** ♂ holotype: head and pronotum in dorsal (A) and lateral (B) views; face in anterior view (C); metanotal gland in dorsal view (D); FW in dorsal view (E); abdominal apex in dorsal view (F). Scale bars: 5 mm (E); 2 mm (rest).

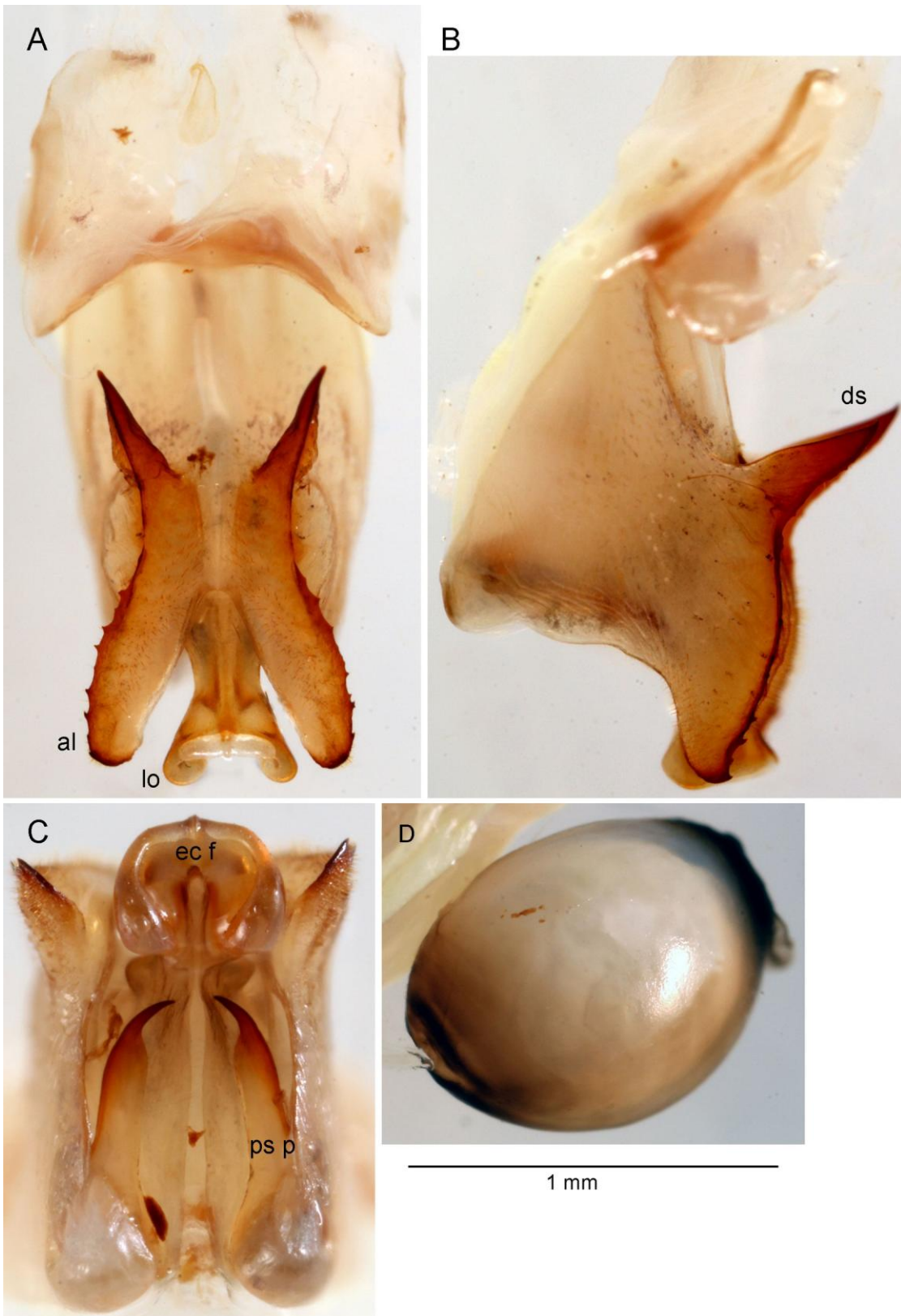


FIGURE 18. *Varitrella (Cantotrella) tabin* sp. nov. ♂: genitalia in dorsal (A), lateral (B) and posterior (C) views; spermatophore in lateral view (D). al = two latero-apical lobular part at the posterior end of pseudepiphallus; ds = dorso-anterior pseudepiphallic spine; lo = lateral lobe at the posterior end of ectophallic fold. Scale bar: 1 mm.

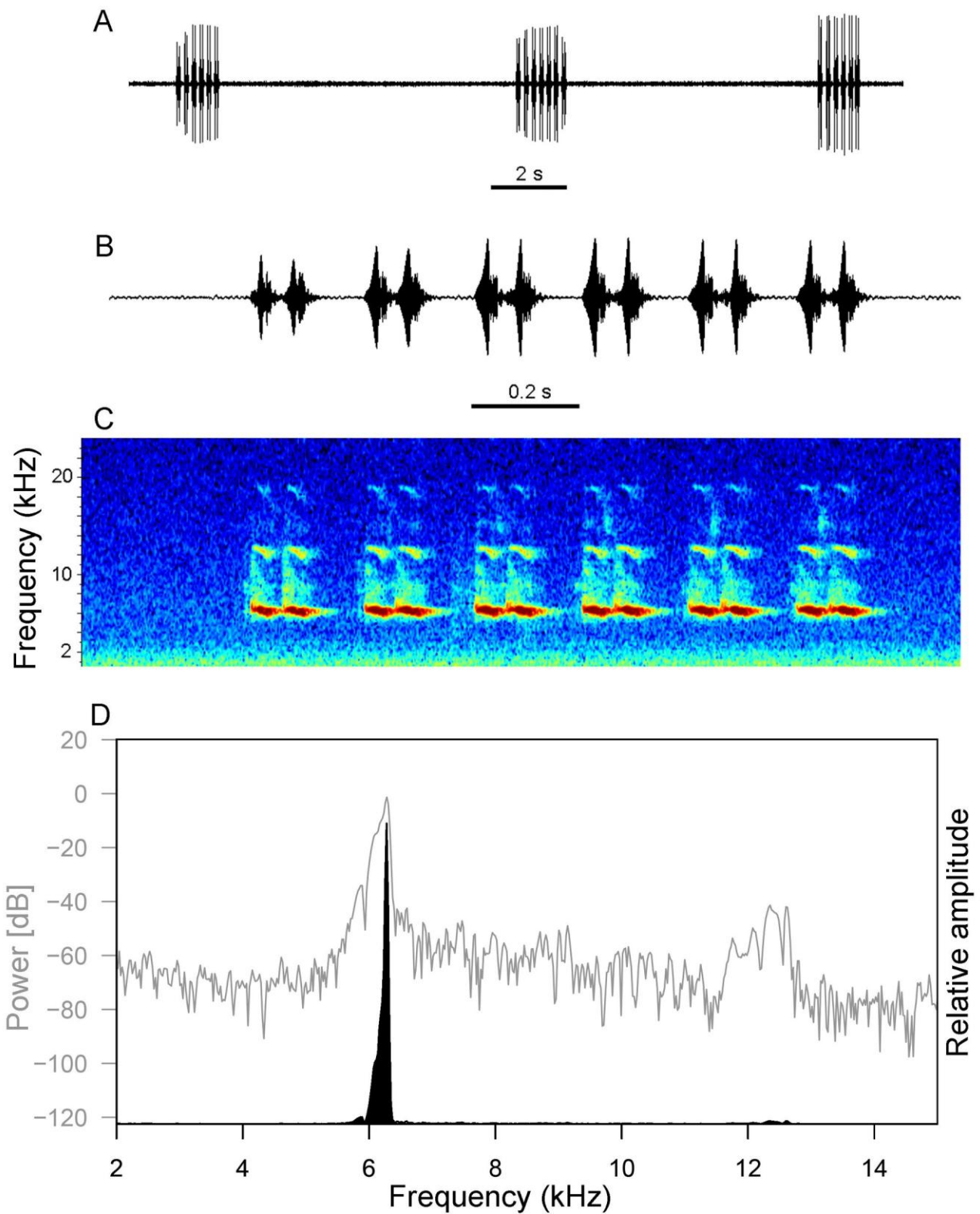


FIGURE 19. *Varitrella (Cantotrella) tabin* sp. nov. ♂ calling song: oscillograms showing three echeme-sequences (A) and one echeme-sequence showing six echemes of doublet syllables (B); spectrogram of the same echeme-

sequence (C); power spectra of a syllable (D) where the grey line represents the power [dB] (axis name and scale in grey) and the black solid peak represents the relative amplitude (axis name in black).