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A review of the genus *Changiola* (Orthoptera: Grylloidea: Pteroplistinae) and description of the first species from Borneo

Running title: *Changiola*—review and new species from Borneo

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Abstract

The taxonomy of the little-known cricket genus *Changiola* from the subfamily Pteroplistinae is reviewed here. This genus consisted of three species, two from Malay Peninsula and one from Indochina. Here, we describe a new species from Borneo, the first from the island: *Changiola sarawakensis* n. sp. We also provide a key to the species, although it is likely that more species will be added to this genus with more sampling in the region.

Key words: Gryllidae, key to species, Sarawak, Southeast Asia, taxonomy

Introduction

The subfamily Pteroplistinae is a small and poorly known group of crickets defined by Chopard (1936) and found mostly in Asian countries. Currently, it consists of nine genera and 36 species and subspecies (Cigliano *et al.*, 2021). A recent multi-loci molecular phylogeny suggested that Pteroplistinae forms a monophyletic group, but its broader relationships with other Grylloidea remains uncertain (Chintauan-Marquier *et al.*, 2016), and nothing is known about the phylogenetic relationships among genera, since only a small proportion of the known species were represented in this study, partly owing to the limited material and information known about these little studied species. These crickets have a cryptic lifestyle. They are typically found hiding among fissures or dead parts of tree bark or among shrivelled up dried leaves on branches, and only rarely along branches at night (Gorochov, 2004). Males also tend to sing inside their hiding refuge (Gorochov, 2004). Since its definition (Chopard, 1936), the subfamily has received very little attention until recently. New genera and species have been regularly discovered recently (Gorochov, 2004, 2011, 2015, 2018; Gorochov & Tan, 2012; Tan *et al.*, 2019), suggesting that a large part of their diversity remains unknown.

Here, we focus on the genus *Changiola* Gorochov, 2004. We examine the taxonomy of two species from the Malay Peninsula, *Changiola pahangi* Gorochov, 2011 and *Changiola perakensis* (Chopard, 1969) and describe a new species from Borneo, the first member of the genus recorded from this island: *Changiola sarawakensis* n. sp. We also provide a key to the species, although it is likely that more species will be added to this genus with more sampling in the region where sampling remains incomplete (Tan *et al.*, 2017).

Materials and Methods

Specimens examined were based on material from:

MP Muzium Perak, Perak, Peninsular Malaysia

ZMLU Lunds Universitet, Zoologiska Institutionen, Lund, Sweden

Close-up images of habitus and morphological features were done using a Canon EOS 6D digital SLR camera with a macro photo lens MP-E 65 mm f/2.8 USM (1–5×). Close-up images of habitus and morphological features of the female holotype and male allotype of *Pteroplistes perakensis* Chopard, 1969 was done using Dino-Lite Pro AM413ZT and Olympus OM-D E-M5 interchangeable lens camera with DIGIeye 37 mm Pro Digital Precision Wide Converter with Macro lens attached. Male genitalia were dissected from specimens softened using dilute KOH, and genitalia were removed by squeezing the cerci against one another laterally. The male genitalia were then cleaned using aqueous KOH and subsequently preserved in glycerine. Photographs of male genitalia were done with either a binocular microscope Leica MZ16 with AmScope Microscope Eyepiece Camera (MU1000, 10 MP Aptina Colour, CMO50) attached via an AmScope FMA050 fixed microscope adaptor and the montage software AMScope version ×64, 3.7; or a Canon EOS 500D digital SLR camera with a macro photo lens MP-E 65 mm f/2.8 USM (1–5×). Image editing was accomplished using Adobe Photoshop CC2014. Terminology used to describe the male genitalia follows Gorochov (2015).

Measurements of specimen were made using ImageJ 1.51j8 (Wayne Rasband, Research Services Branch, National Institute of Mental Health, Bethesda, MD, USA). In the measurements, the following abbreviations are used: BL = body length; PL = pronotum length; PW = pronotum width (at posterior margin); TL = tegmen length; TW = tegmen (dorsal field) width; HFL = hind femur length; HTL = hind tibia length; OL = ovipositor length.

Classification and nomenclature of species was based on the OSF (Cigliano *et al.*, 2021).

Taxonomy part

Family Grylloidea Laicharting, 1781

Subfamily Pteroplistinae Chopard, 1936

Genus *Changiola* Gorochov, 2004

Type species: *Changiola subita* Gorochov, 2004; by original designation

Diagnosis (from Gorochov, 2004, Gorochov & Tan, 2012). The genus is similar in size, habitus and tegmen as *Kerinciola*, *Singapuriola*, *Tembelingiola* and *Tramlapiola*. Male subgenital plate is similar to that of *Tramlapiola* and *Tembelingiola*, but posterior margin with a median notch. Male genitalia distinctly differs by: epiphallus complete, with a H-shaped distal part and S-shaped proximal parts; rachis (= guiding rod) moderately long, without upper process; endoparameres moderately long, curved, not connected with formula (= mold of spermatophore) attachment plate; ectoparameres and additional plate-like sclerites developed (absent in all Pteroplistinae genera). Ovipositor short.

Biogeography notes (Fig. 1). The genus currently comprises of three species, two from Malay Peninsula and one from Indochina (Thailand). The two species from Malaysia [*Changiola perakensis* (Chopard, 1969) and *Changiola pahangi* Gorochov, 2011] are found in lower montane forests whereas *Changiola subita* Gorochov, 2004 from Thailand is found in lower coastal mountains. We describe a new species from Borneo, the first for the genus.

Changiola pahangi Gorochov, 2011

(Figs. 1, 2)

Changiola pahangi Gorochov, 2011: 178 (original description); Tan & Kamaruddin, 2014: 12, 44 (record in checklist, natural history notes)

Pteroplistes perakensis—Chopard, 1969: 232 (male described probably belongs to *C. pahangi*)

Type material. Male holotype, **Malaysia**, Pahang, Fraser's Hill, 17–18 km SW of Raub Town, 1000–1300 m, coll. A.V. Gorochov, M. Berezin, E. Tkatsheva, 15–23 April 2010 (ZRC).

Other material examined. Male allotype of *Pteroplistes perakensis* [= *Changiola pahangi*], **Malaysia**, Pahang, Fraser's Hill, 4500 ft.a.s.l., coll. H.M. Pendlebury, 19 July 1936 (MP).

Distribution. MALAY PENINSULA: **Malaysia:** Pahang: Bukit Fraser.

Type locality. **Malaysia:** Pahang: Bukit Fraser.

Diagnosis. This species differs from known congeners by male genitalia with distinctly longer posterolateral lobes of epiphallus and proximal part of ectoparameres; and male subgenital plate faintly notched at the posterior margin.

Remarks. In his original description of *Changiola perakensis*, Chopard (1969) described the female holotype from Perak, and assigned a male allotype collected from Bukit Fraser. The drawing of the male genitalia (Chopard, 1969) appears more similar to that of *C. pahangi* described in Gorochov (2011) than our male specimen collected from the base of Bukit Larut. This supports Gorochov (2011)'s hypothesis that the male allotype described by Chopard (1969) is probably *C. pahangi* described from Bukit Fraser and that *C. perakensis* is probably restricted to Perak.

***Changiola perakensis* (Chopard, 1969)**

(Figs. 1, 3–6)

Pteroplistes perakensis Chopard, 1969: 232 (original description); Otte, 1988: 284 (record in checklist)
Changiola perakensis—Gorochov, 2004: 386 (transfer to new genus); Tan & Kamaruddin, 2014: 12, 44 (record in checklist, natural history notes)

Changiola nr. *perakensis*—Tan & Kamaruddin, 2016: 32 (record in checklist)

Type material examined. Female holotype of *Pteroplistes perakensis* [= ?*Changiola perakensis*], **Malaysia**, Perak, "Larut Hill" [= Bukit Larut], 4500 ft.a.s.l., coll. H.M. Pendlebury, 22 February 1932 (MP).

Other material examined. 1 male (LAR.15.16), **Malaysia**, Perak, Taiping, near Taiping War Cemetery, circa N4.85812, E100.75697, 46.2±5.0 m, young secondary forest edge, along road, calling in hollow branch of tree, coll. M.K. Tan, S.T. Toh, K.N. Kamaruddin, 17 June 2015, 2021–2226 h (ZRC); 1 female (LAR.15.129), same locality, en route and near Sungei Larut, circa N4.85596, E100.75881, 52.2±5.0 m, secondary forest/ forest edge, on branch, coll. M.K. Tan, S.T. Toh, K.N. Kamaruddin, 19 June 2015, 2035–2205 h (ZRC).

Distribution. MALAY PENINSULA: **Malaysia:** Perak: Bukit Larut.

Type locality. **Malaysia:** Perak: Bukit Larut.

Distribution notes. Our specimens were collected in the lowland forest whereas *Changiola perakensis* (Chopard, 1969) was described from Bukit Larut lower montane forest (1370 m a. s. l.).

Diagnosis. This species is similar to *C. subita* in male epiphallus with posterolateral lobes distinctly shorter than *C. pahangi*, short rachis and shapes of formula and additional sclerite plates; but differs by the male subgenital plate deeply notched at the posterior margin. This species also differs from *C. pahangi* by shorter posterolateral lobes of epiphallus and male subgenital plate deeply notched (instead of faintly notched). The female differs from *C. pahangi* by female subgenital plate about as wide as long (rather than longer than wide) and not narrowing anteriorly.

Discussion. In the original description, the holotype was deposited in "Selangor Museum" [SMKM Selangor] (Chopard, 1969). However, this museum is no longer functional, and the holotype was transferred to the Muzium Perak (Perak Museum) in Taiping, Perak, Malaysia.

The female holotype specimen is in a poor state, and it was difficult to examine and compare the its subgenital plate with our specimens. We describe the species, including the male genitalia for the first time, based on new material collected from Bukit Larut.

Redescription. Body generally brown, with head and pronotum pubescent (Figs. 3, 4). Head dark brown. Head rostrum slightly wider than scapes, with apex truncated (in dorsal view). Scapes and pedicel dark brown; scapes with apical part black; antennal segments generally yellow brown with brown or dark brown rings. Face uniformly black (Fig. 3C). Maxillary palpi elongated, with apical, subapical and third segments about equally long; apical segment brown, subapical and third segments white; apical segment distinctly obliquely swollen. Eyes ovular; median ocellus small; lateral ocelli large, located near eyes posterior to scapes. Gena dark brown. Pronotal disk brown, lateral lobes dark brown. Pronotal disk 1.5 times as long as wide, with strong setae along anterior margin; anterior and posterior margins of disk straight; not widening posteriorly. Pronotal lateral lobe 1.6 times as long as high, with ventral margin

rising posteriorly. Anterior tibia with oval tympana on both sides, inner one larger than outer one. Legs generally pubescent. Posterior femur pubescent and flattened, without ventral spines; posterior tibia also pubescent, with about 13 small and stout spines on each dorsal side, with 2 ventral apical spurs; posterior basitarsus with about 5–7 denticles on each dorsal side. Coxa pale; anterior and middle femora pale with a dark brown ring at apical third (more contrasting in middle femur), tibiae pale to yellow brown with yellow brown rings in the middle and at apex, tarsi with basal segment brown. Posterior femur mostly pale with brown setae; brown at apical third and knee area; posterior tibia brown with pale ventral spots with brown spines; posterior tarsus with basal segment pale, apical third brown. Thoracic and abdominal segments yellow brown.

Tegmen not pubescent, brown, extending beyond abdominal apex, with dorsal field distinctly longer than lateral field. Dorsal field with five oblique veins in harp area. Tegminal mirror large, 1.2 times as wide as long, with anterior margin angular, with posterior margin widely rounded, and with two parallel dividing veins which gently-curved and located close to one another; anal area of tegmen distinctly shorter than length of mirror (Fig. 5A). Tegminal lateral field wide, with 16 branches of Sc and about 12 cross-veins (anterior ones are less distinct) between R and M; R and M diverge anteriorly, then run parallel, strongly converging towards the apex. Hind wings slightly surpassing tegmina.

Subgenital plate stout, hexagonal, slightly wider than long, anterior margin wide, posterior margin truncated, with a distinct deep angular notch (Fig. 5B).

Male genitalia as shown in Figs. 5C–E: epiphallus (ep) with strongly transverse median part broad, anterior margin concaved in the middle, with posterolateral lobes strongly sclerotized, stout, gently curved and apex obtuse. Rachis (ra) strongly sclerotized, short and triangular, apex narrow and subacute. Ectoparamere (ec) long, straight and slender, surpassing posterolateral lobes of epiphallus, apex hooked in dorsal view. Endoparameres (en) strongly sclerotized, slender, with apex curved and subacute. Formula (f) elongated and lamellate; rami (r) strongly S-shaped, not lamellate. Additional sclerite plate (p) characteristic of *Changiola* triangular.

Female. Subgenital plate triangular, about as wide as long, small; lateral margins tapering into a subacute apex angularly notched (Fig. 4F). Ovipositor as shown in Fig. 4G.

Measurements (in mm). male BL = 12.9; PL = 2.4; PW = 3.5; TL = 9.6; TW = 4.8; HFL = 8.5; HTL = 5.0; female BL = 12.9; PL = 2.9; PW = 3.8; TL = 8.5; TW = 3.9; HFL = 8.4; HTL = 5.0; OL = 7.1.

Natural history. A male was found calling at night while hiding in the crevice of a tree branch (Fig. 6).

Changiola sarawakensis new species (Figs. 1, 7–9)

Type material. Male holotype, **Malaysia**, Borneo, “Sarawak” state, Samarahan Division, Simunjan District, Ulu Sebuyau, Kampung Tuba, “Tuba”, coll. “Gardebhors, Hall, Hansson, Samuelsson”, 16–22 January 1979 (ZMLU).

Distribution. BORNEO: **Malaysia:** Sarawak: Samarahan

Diagnosis. This new species distinctly differs from all known species by male subgenital plate truncated and with a small median nodule at posterior margin (Fig. 8G) (instead of faintly or deeply notched); posterolateral lobes of epiphallus of male genitalia very narrow and straight; rachis long and fairly broad; formula stout and strongly forked anteriorly; and shape of additional sclerite plate slender and angularly bent.

Genus status. The male genitalia shows some resemblance with the species from the genus *Kerinciola* Gorochoy, 2004 (known from Malay Peninsula and Sumatra, but not Borneo), specifically by the posterior end of rachis (= guiding rod) somewhat pointing ventrad. The two genera also share similarities in the genitalia: rachis moderately long, without upper process; endoparameres not connected with formula (= mold of spermatophore) attachment plate. Until the relationships between the genera can be clarified, we tentatively place this new species in *Changiola* owing to the epiphallus being H-shaped in the distal part and S-shaped in the proximal parts.

Description. Body dorsoventrally compressed, generally brown, with head and pronotum sparsely pubescent (Figs. 7, 8A, 8D). Head brown, sparsely mottled yellow brown (Fig. 8A). Head rostrum slightly wider than scapes, with apex truncated (in dorsal view) (Fig. 8A). Scapes and pedicel and antennal segments yellow brown; scapes rectangular (Fig. 8A). Face brown with yellow brown spots (Fig. 8C). Maxillary palpi elongated, with apical, subapical and third segments equally long; apical segment brown, subapical and third segments yellow brown at the apex; apical segment obliquely swollen (Fig. 8C). Eyes

ovular; median ocellus small; lateral ocelli large, located near eyes posterior of scapes (Fig. 8B). Gena with a small oval spot ventrad of eyes; posterior of eye with yellow brown ring (Fig. 8D). Pronotum dark brown, lateral lobes slightly darker (Fig. 7). Pronotal disk 1.4 times as long as wide, with strong setae along anterior margin; anterior margin of disc slightly concave; barely widening posteriorly; posterior margin of disk straight (Fig. 8A). Pronotal lateral lobe 1.6 times as long as high, with ventral margin rising posteriorly (Fig. 8D). Anterior tibia with minute oval tympana on both sides; anterior and middle legs generally pubescent. Posterior femur pubescent and flattened, without ventral spines. Posterior tibia also pubescent, with about 13 small and stout spines on each dorsal side, with 2 long ventral apical spurs; posterior basitarsus with about 6 denticles on each dorsal side. Coxa yellow brown; anterior and middle femora yellow brown and mottled brown (especially on dorsal surface), tibiae brown with yellow brown rings in the middle and at apex, tarsi with basal segment brown. Posterior femur mostly yellow brown with spots of brown; brown at the apex and knee area; posterior tibia and tarsus brown with brown spines (Fig. 7). Thoracic and abdominal segments yellow brown to brown.

Tegmen not pubescent, extending beyond abdominal apex, with dorsal field distinctly longer than lateral field. Tegminal dorsal field generally brown, apical field with some cells darkened or cells bordering the veins (and cross-veins) darkened (Fig. 8E); lateral tegminal field brown, with veins slightly paler (Fig. 8F). Dorsal field with five parallel oblique veins in harp (Fig. 8E). Mirror large, 1.4 times as wide as long, with anterior margin angular, with posterior margin widely rounded, and with two parallel dividing veins, gently-curved and located close to each other; anal area slightly shorter than length of mirror (Fig. 8E). Tegminal lateral field wide, with 11 branches of Sc and about nine cross-veins (anterior ones less distinct) between R and M; R and M diverge anteriorly, then run parallel, strongly converging towards the apex (Fig. 8F). Hind wings slightly surpassing tegmina (Fig. 7A).

Subgenital plate rectangular, slightly longer than wide, slightly narrowing posteriorly, anterior margin wide, posterior margin truncated and with a small median nodule (Fig. 8G).

Male genitalia as shown in Fig. 9: epiphallus (ep) with strongly transverse median part broad, with posterolateral lobes strongly sclerotized, moderately long, faintly diverging from each other and apex truncated. Rachis (ra) strongly sclerotized, cylindrical, long and fairly broad; anterior half gently curved, bent in the middle, posterior half cylindrical before tapering into a subacute apex. Ectoparamere (ec) long and slender, surpassing posterolateral lobes of epiphallus, apex spatulate in lateral view. Endoparameres (en) strongly sclerotized, slender, with anterior parts curved ventrad and posteriorly and apex acute; apodemal endoparamere (ap) forming a large plate connected to (but not fused to) endoparamere. Formula (f) X-shaped and somewhat lamellate; rami (r) strongly S-shaped, widened and lamellate in the middle part. Additional sclerite plate (p) characteristics of *Changiola* slender slightly curved with anterior apex acute and posterior apex obliquely truncated.

Female. Unknown.

Measurements (in mm). BL = 14.3; PL = 3.2; PW = 4.4; TL = 11.3; TW = 5.3; HFL = 10.4; HTL = 6.6.

Etymology. The species is named after the type locality, Sarawak.

***Changiola subita* Gorochov, 2004**

(Fig. 1)

Changiola subita—Gorochov, 2004: 386 (original description)

Type material. Male holotype, **Thailand**, Trat, Chang Island (Siam Bay), lower mountains near sea, forest, coll. A.V. Gorochov, 5–20 November 2000 (ZRC).

Distribution. INDOCHINA: **Thailand:** Trat: Chang Island.

Type locality. **Thailand:** Trat: Chang Island

Diagnosis. This species differs from congeners by male tegmen with mirror about as long as wide (instead of transverse); male genitalia with distinctly shorter posterolateral lobes of epiphallus and male subgenital plate somewhat longer than broad, without notch at the posterior margin.

Key to species of *Changiola*

1. Male subgenital plate notched at the posterior margin. Distribution: Malay Peninsula.....2

- Male subgenital plate without notch at the posterior margin. Distribution: Outside Malay Peninsula.....3
- 2. Male subgenital plate deeply notched. Epiphallus with shorter posterolateral lobes. Female subgenital plate about as wide as long (rather than longer than wide) and not narrowing anteriorly. Distribution: Malaysia (Perak) *C. perakensis*
- Male subgenital plate faintly notched. Epiphallus with longer posterolateral lobes. Female subgenital plate longer than wide, narrowing anteriorly. Distribution: Malaysia (Pahang)..... *C. pahangi*
- 3. Male tegmen with mirror area more transverse. Male subgenital plate with minute nodule in middle of posterior margin. Female unknown. Distribution: Borneo (Sarawak) *C. sarawakensis*
- Male tegmen with mirror area about as long as wide. Male subgenital plate without minute nodule in middle of posterior margin. Female unknown. Distribution: Thailand..... *C. subita*

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<https://doi.org/10.11646/zootaxa.4111.1.2>

Figure captions



FIGURE 1. Map of parts of Southeast Asia showing the distribution of *Changiola*.

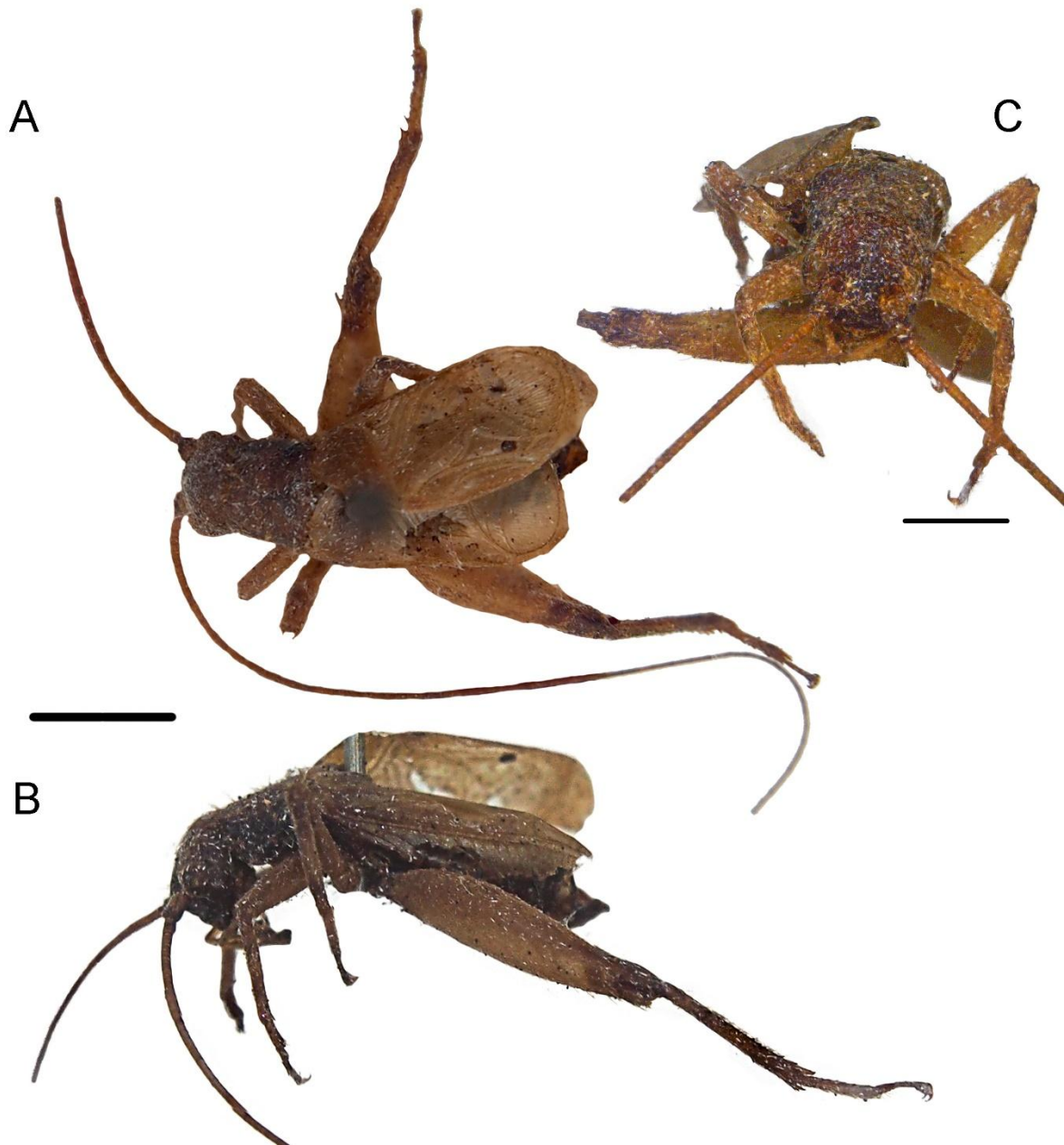


FIGURE 2. Male allotype of *Pteroplistes perakensis* [= *Changiola pahangi*]: habitus in dorsal (A) and lateral (B) views; head in anterior view (C). Scale bars: 2 mm.

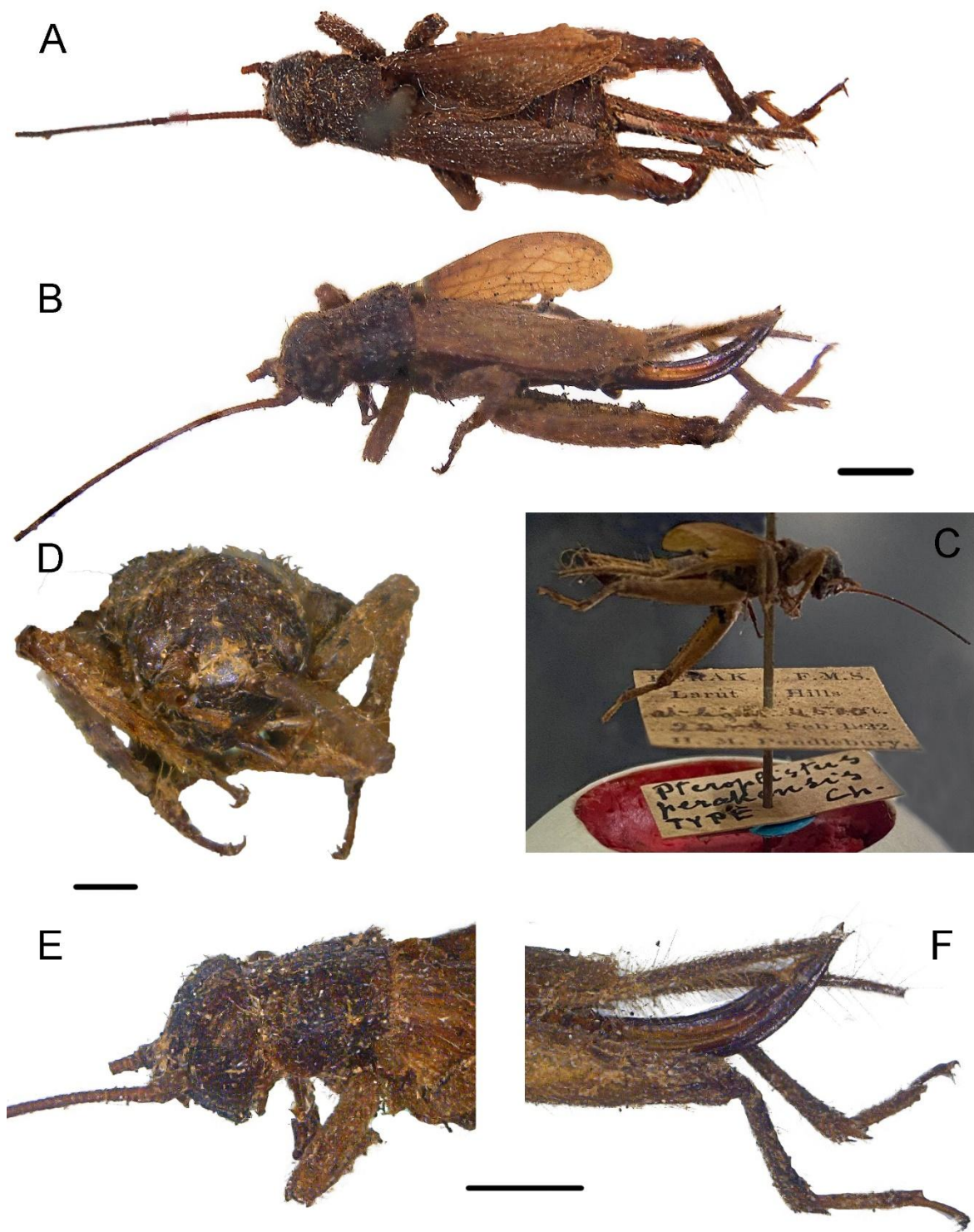


FIGURE 3. Female holotype of *Pteroplistes perakensis* [= ?*Changiola perakensis*]: habitus in dorsal (A) and lateral (B) views; specimen with label (C); head in anterior view (D); head and pronotum in lateral view (E); ovipositor in lateral view (F). Scale bars: 1 mm (D), 2 mm (A, B, E, F).

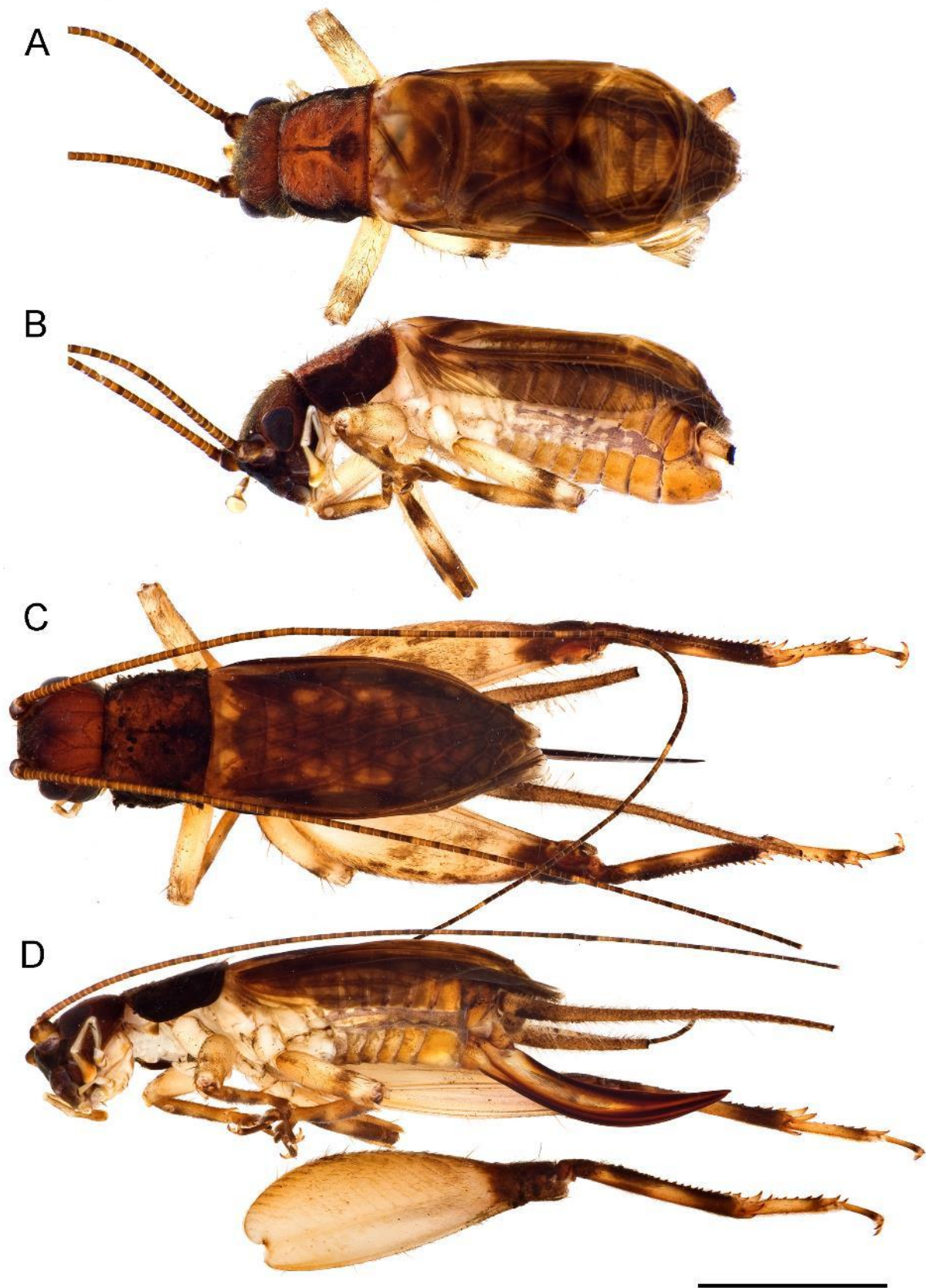


FIGURE 4. *Changiola perakensis* male (A, B) and female (C, D) habitus in dorsal (A, C) and lateral (B, D) views. Scale bars = 5 mm.

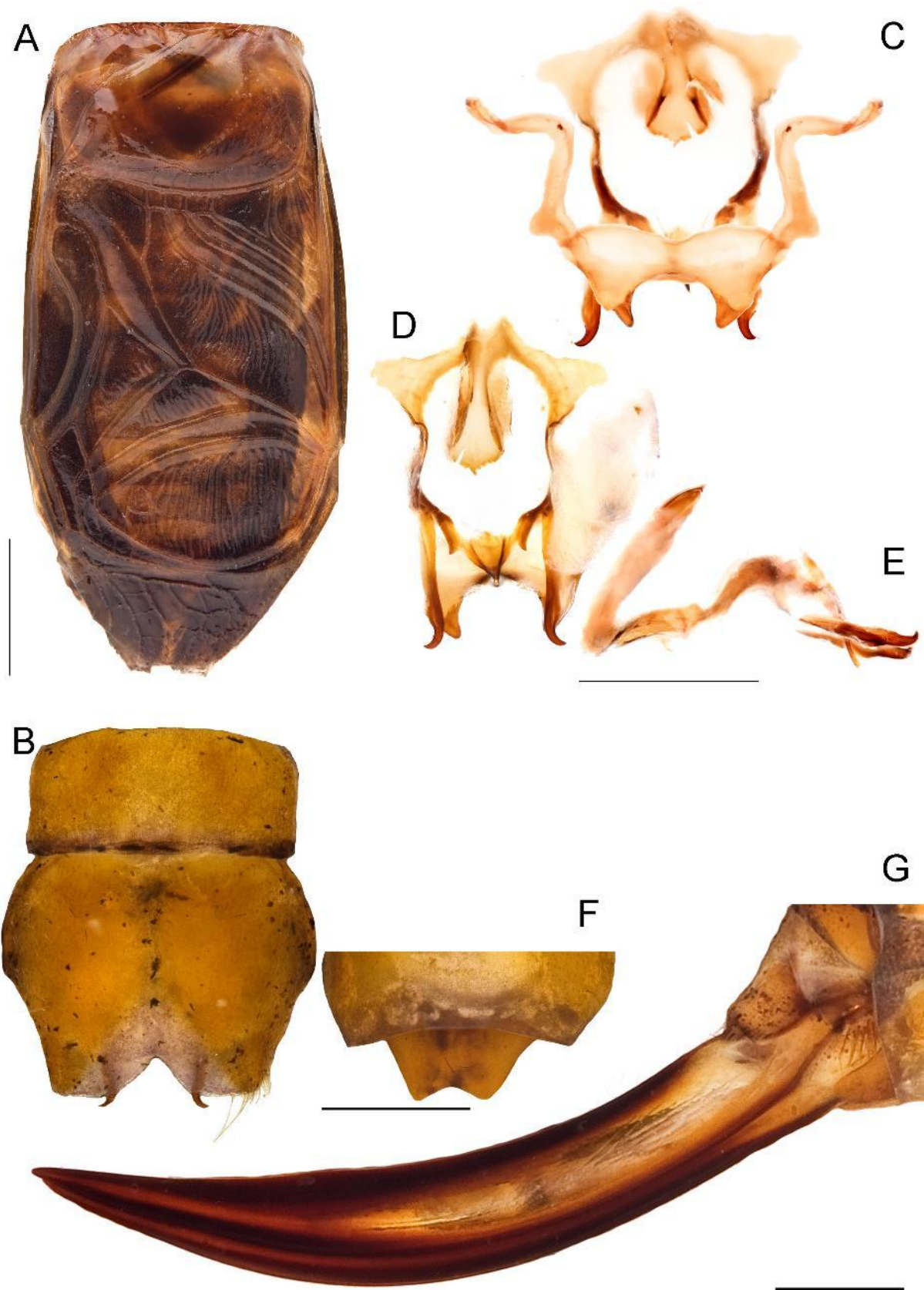


FIGURE 5. *Changiola perakensis*: male tegminal dorsal field in dorsal view (A); male subgenital plate in ventral view (B); male genitalia in dorsal (C), ventral (D) and lateral (E) views; female subgenital plate in ventral view (F); ovipositor in lateral view (G). Scale bars: 2 mm (A); 1 mm (others).



FIGURE 6. *Changiola perakensis* male calling while remaining cryptic in the hollowed tree branch.



FIGURE 7. *Changiola sarawakensis* n. sp. male habitus in dorsal (A) and lateral (B) views. Scale bars = 5 mm.

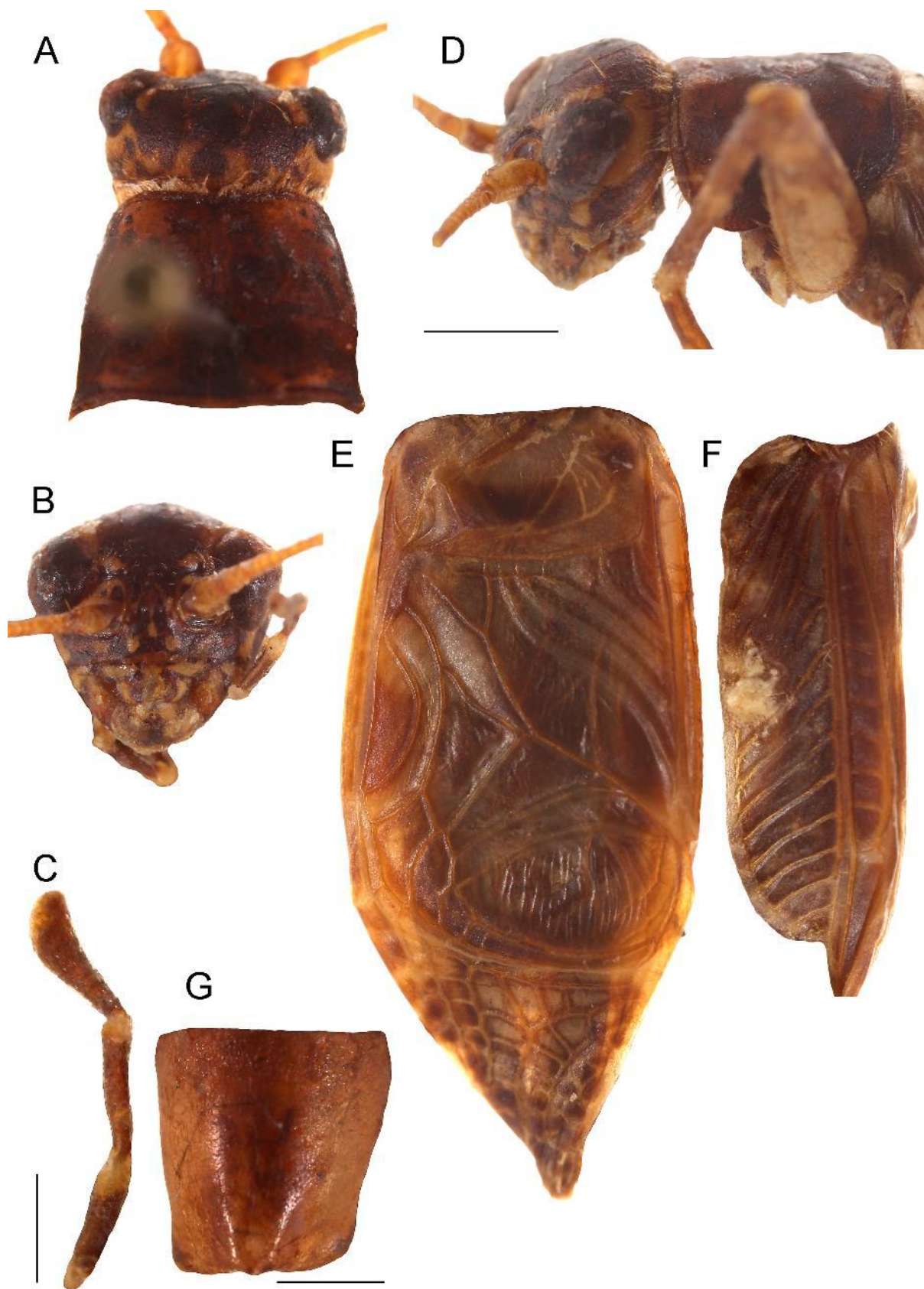


FIGURE 8. *Changiola sarawakensis* n. sp. male: head and pronotum in dorsal (A) and lateral (D) views; head in anterior view (B); maxillary palps showing the apical three segments (C); tegminal dorsal field in dorsal view (E) and lateral field in lateral view (F); subgenital plate in ventral view (G). Scale bars: 2 mm (A, B, D–F), 1 mm (C, G).

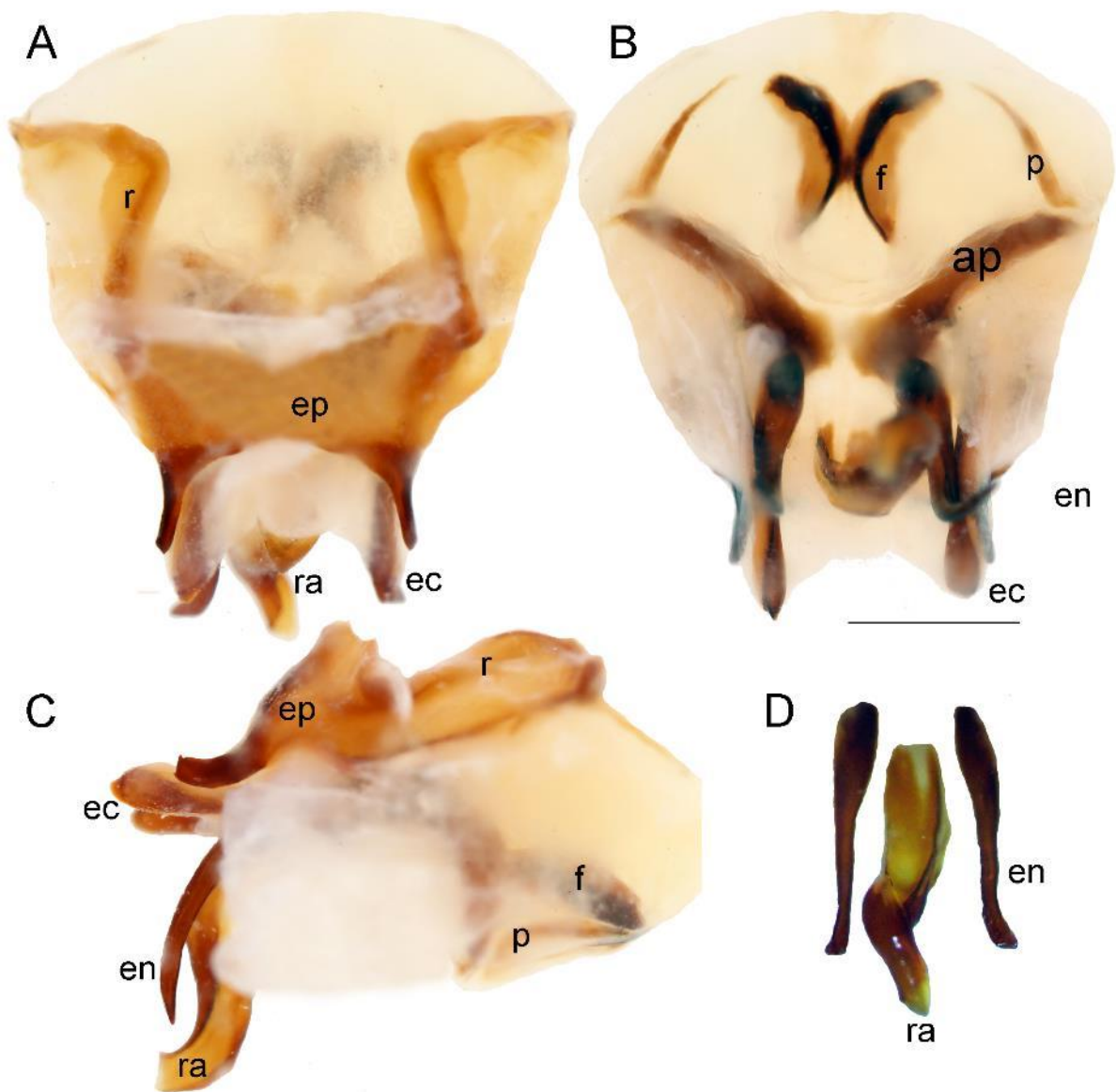


FIGURE 9. *Changiola sarawakensis* n. sp. male genitalia in dorsal (A), ventral (B) and lateral (C) views; rachis (ra) and endoparameres (en) (D). Scale bar: 1 mm.