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# New species of *Phaloria* (Orthoptera: Phalangopsidae: Phaloriinae) from West Papua (Indonesia)

**Running title:** New Phaloriinae from New Guinea

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## Abstract

The genus *Phaloria* belongs to the monophyletic cricket subfamily Phaloriinae. It is speciose group comprising of 68 species found across Southeast Asia and New Guinea. The numerical diversity of *Phaloria* in New Guinea is impressive, but more species are still awaiting for discovery owing to the large size and remoteness of the island to biodiversity explorers. Based on new material collected from Lobo and Kumawa in West Papua (Indonesia), we describe six new species: *Phaloria dischidia* Tan & Robillard, **sp. nov.** from Lobo; *Phaloria paradischidia* Tan & Robillard, **sp. nov.** from Kumawa; *Phaloria tukul* Tan & Robillard, **sp. nov.** from Lobo; *Phaloria brevis* Tan & Robillard, **sp. nov.** from Kumawa; *Phaloria berbeda* Tan & Robillard, **sp. nov.** from Lobo; *Phaloria lobulata* Tan & Robillard, **sp. nov.** from Kumawa. We also record new localities for a species widespread in Lobo and Kumawa: *Phaloria* nr. *aspersa* Gorochoch, 1996.

**Key words:** new species, New Guinea island, *Phaloria*, Southeast Asia, taxonomy

## Introduction

Phaloriinae is a monophyletic subfamily of crickets in the family Phalangopsidae (Chintauan-Marquier *et al.* 2016) distributed across Asia, Australia and western Pacific, as well as in tropical Africa. Currently, 18 genera and 1 extinct genus are recognised (Cigliano *et al.*, 2021). The type genus, *Phaloria* Stål, 1877 is diverse numerically, with 68 species and four subgenera currently known in Southeast Asia, specifically in the island of New Guinea. Recent work has led to the discovery of many morphologically cryptic species (Gorochoch, 1996, 1999, 2010, 2011, 2014; Desutter-Grandcolas, 2009; Gorochoch & Tan, 2012). Most of these species can only be distinguished by comparison of the male genitalia, which has diversified in this genus.

Despite this diversity, the cricket fauna in the hyper-diverse island of New Guinea is still remaining largely unsampled, and new species are still awaiting discovery and description, as recently shown for other cricket groups and insects in general (eg., Vicente *et al.*, 2015; Robillard *et al.*, 2016, 2020). Recent orthopteran surveys were done in West Papua, specifically in the region of Lengguru. This has led to the discovery of six new species described here: *Phaloria dischidia* Tan & Robillard, **sp. nov.** from Lobo; *Phaloria paradischidia* Tan & Robillard, **sp. nov.** from Kumawa; *Phaloria tukul* Tan & Robillard, **sp. nov.** from Lobo; *Phaloria brevis* Tan & Robillard, **sp. nov.** from Kumawa; *Phaloria berbeda* Tan & Robillard, **sp. nov.** from Lobo; *Phaloria lobulata* Tan & Robillard, **sp. nov.** from Kumawa. We also present new locality records for a species widespread in the region.

## Materials and Methods

### Collection and Materials

The new material was collected in the “Lengguru 2014” expedition in Papua, Indonesia and will be deposited in the collections of the Muséum national d'Histoire naturelle Paris, France (MNHN) and in the Museum Zoologicum Bogoriense, Bogor, Indonesia (MZB). The crickets were collected mostly by sight, night and day, in order to observe the habitat and activity of the species. Square brackets in the list of specimens are used for additional information not mentioned on the specimen labels or translated from French labels.

## Morphology

Male genitalia have been dissected in softened specimens by cutting the membranes between the paraprocts and the subgenital plate; they have been observed after cleaning with cold KOH, and then kept in glycerine. Male genitalia are named according to Desutter (1987), modified in Desutter-Grandcolas (2003) as well as to Gorochov (2015) [in square brackets]. Abbreviations: see below.

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×). Imaging stacking was done using Helicon Remote version 9.3.1. W and Helicon Focus 6.8.0. Photographs of male genitalia were done with a Canon EOS 500D digital SLR camera with a macro photo lens MP-E 65 mm f/2.8 USM (1–5×) and Canon Macro Twin Lite MT-24EX used for lighting and flash. Image editing was accomplished using Adobe Photoshop CC2014.

## Abbreviations

Male genitalia:

ec arc: ectophallic arc;  
ec ap: ectophallic apodeme [endoparameral apodeme];  
ec f: ectophallic fold [rachis, or guiding rod];  
ec p: ectopahallic paramere  
en ap: endophallic apodeme;  
en s: endophallic sclerite [formula];  
ps: pseudepiphallus [epiphallus]  
ps l: pseudepiphallic lophi  
ps p: pseudepiphallic paramere [ectoparamere];  
r: rami.

Measurements:

FIIL: length of hind femora;  
FIIW: width of hind femora;  
FWL: forewing length;  
FWW: forewing width (at the level of maximal width);  
OL: ovipositor length;  
PronL: pronotum length;  
PronW: pronotum width;  
TIIL: length of hind tibiae

## Systematic part

### Family Phalangopsidae Blanchard, 1845

### Subfamily Phaloriinae Gorochov, 1985

### Genus *Phaloria* Stål, 1877

**Diagnosis (based on Gorochov, 1996).** This genus is characterised by inner and outer tympana open but relatively small; male ectophallic apodeme [rachis] isolated from endophallic sclerite [formula], rami separated from each other (instead of connected in the anterior parts), and pseudepiphallic paramere [ectoparamere]; apex of female ovipositor with 2–4 and 1–4 large rounded lateral teeth on the upper and lower valves, respectively.

**Remarks.** This speciose genus is split into four subgenera, and now comprises 68 described species. The genus is distributed from the islands of western Indian Ocean, across the Southeast Asian mainland and archipelago, Australia to the western Pacific islands.

The subgenera are differentiated exclusively by characters in the male genitalia. The subgenus *Papuloria* Gorochov, 1996 is more speciose, consisting of 42 species, of which 22 are recorded from New Guinea. The nominal subgenus *Phaloria* consists of 17 species, of which one is recorded from New Guinea. The subgenera *Sulaweloria* Gorochov, 2011 (from Sulawesi) and *Trelloria* Gorochov, 1996 (from New Guinea and Solomon Islands) consist of one and two species, respectively. Six species do not have an assigned subgenus. The monophyly of the subgenera will have to be demonstrated using phylogenetic analyses in future studies.

Here, we describe six new species from West Papua, New Guinea:

- Phaloria dischidia* Tan & Robillard, **sp. nov.** from Lobo  
*Phaloria paradischidia* Tan & Robillard, **sp. nov.** from Kumawa  
*Phaloria tukul* Tan & Robillard, **sp. nov.** from Lobo  
*Phaloria brevis* Tan & Robillard, **sp. nov.** from Kumawa  
*Phaloria berbeda* Tan & Robillard, **sp. nov.** from Lobo  
*Phaloria lobulata* Tan & Robillard, **sp. nov.** from Kumawa

#### Key to subgenera of *Phaloria*

1. Pseudeiphallus with a pair of lateral lophi.....2
- Pseudeiphallus with two pairs of lophi: one pair of longer lateral lophi and another pair of shorter medial lophi.....3
2. Endophallic sclerite with large unpaired apodeme directed anteriorly..... subgenus *Trelloria*
- Endophallic sclerite without large unpaired apodeme directed anteriorly.....subgenus *Papuloria*
3. Pseudeiphallus with median part “ribbon-like”. Endophallic sclerite strongly reduced. Distribution: only Sulawesi..... subgenus *Sulaweloria*
- Pseudeiphallus without median part “ribbon-like”. Endophallic sclerite not strongly reduced. Distribution: not Sulawesi (Malay Peninsula, Taiwan, Philippines, Maluku, New Guinea, Solomon Islands, western Pacific islands, Australia).....subgenus *Phaloria*

#### *Phaloria dischidia* Tan & Robillard, **sp. nov.**

(Figs. 1A, 2A, 3A, 4A, 5A, 5B, 6A, 6B)

**Material examined.** **Holotype** (male, LEN2014-TR213), New Guinea, **Indonesia**, West Papua, Lobo, S3.7033056, E134.071444 (LOBO6), 221 m.a.s.l., forêt proche PK8/ route Lobo-Kaimana, crête prox. camp, forêt primaire [forest near PK8 / Lobo-Kaimana road, ridge proximately camp, primary forest], 21–30.x.2014, nuit [night], sur plante [on plant], T. Robillard (MZB).

Paratype: 1 male (LEN2014-TR214), same locality and details as holotype, molecular sample P1 (MNHN-EO-ENSIF1730).

**Type locality.** New Guinea, **Indonesia**, West Papua, Lobo

**Etymology.** The species name refers to the characteristic shape of pseudeiphallus parameres with basal inner lobe distinctly clefted (schidius, in Latin for cleft), forming two triangular lobules (dis, in Greek for two).

**Diagnosis.** This new species is unique among congeners by genitalia: pseudeiphallic lobes slender and tapering before enlarging into rhomboidal apex; pseudeiphallic parameres with a rectangular and distinctly clefted basal inner lobe, and a stout and curved hook-like apical outer process; ectophallic apodeme inner apical arm straight pointing inner before bending posteriorly and outer apical arm with apex enlarged and ovate with the narrower end at the base.

This new species is most similar to *P. beybienkoi* Gorochov, 2005 from Supiori Island (north of West Papua) in habitus, colour patterns and male genitalia. It differs by pseudeiphallic parameres with inner basal lobe more rectangular and forming two angular lobules (instead of rounded margin) and pseudeiphallic lobes more angular rather than rounded. It is also similar to *P. similis* Chopard, 1968 and *P. parasimilis* Gorochov, 1999 from New Guinea by pseudeiphallic parameres with rectangular lobe but differs by the presence of long apical hooked-like process (absence in both species).

**Subgeneric status.** This species should belong to the subgenus *Papuloria* based on the pseudeiphallus with a pair of lateral lophi and endophallic sclerite without large unpaired apodeme directed anteriorly.

**Description.** Medium sized among congeners (Fig. 1A). Head dorsum yellow brown, more reddish posteriorly (Fig. 2A). Fastigium red brown. Scapes yellow to red brown. Antennae yellow brown. Fastigium verticis dark brown, frons dark brown with some yellow brown spots; clypeus yellow brown with a pair of triangular dark brown lateral spots; mouthparts generally yellow brown (Fig. 3A). Maxillary palpi pale coloured, apices of segments slightly brownish (Fig. 3A). Lateral part of head yellow to red brown; with a dark brown stripe running ventro-anteriorly from the ventro-anterior part of eyes; with another dark brown stripe running posteriorly from behind eye. Pronotal disk dark purple brown with some parts red brown; posterior margin straight (Fig. 2A). Lateral lobes of pronotum with dorsal half dark purple brown, ventral half red brown. Legs pale yellow brown with brown rings. Inner tympanum relatively small and oval; outer tympanum similarly sized, but slightly more oblong. FIs and FIIs with 2 incomplete rings near knees, basally with some brown spots on the dorsal and inner surface. TIs with three brown rings; one each after tympanum, in the middle, and near apex. FIIs yellow brown

with red brown patterns and three oblique bands, knees brown. TIIIs yellow brown with brown bands. Tergites brown.

Male. FW 1.9–2.0 times longer than wide, surpassing abdominal apex, mostly yellow brown, some parts hyalinous (Fig. 4A). FW venation typical of genus, 6 strongly sinuous veins in harp; mirror 0.9 times as long as wide, very large and separated by two dividing veins: basal one mostly straight, distal one obliquely curved (slightly sinuous). Apical field short, 0.6 times shorter than length of mirror. Lateral field with R and M diverging posteriorly, with 6 faint cross-veins; Sc with 22 projections. Hind wings reaching apex of FW, not exceeding FWs.

Male genitalia (Figs. 5A, 5B). Pseudepiphallos with lateral margins slightly converging posteriorly; with posterior margin angularly, deeply and broadly incised in the middle. Pseudepiphallic lobe elongated, slightly curved internally and tapering before enlarging into rhomboidal apex. Rami short, only slightly longer than half the pseudepiphallos length, bent apically, but not connected. Pseudepiphallic parameres strongly sclerotized, elongated and slightly curved, with a dorso-basal process curved with subacute apex, with a rectangular ventro-basal inner lobe and a stout and curved hook-like apical outer process; basal inner lobe distinctly clefted, forming two triangular lobules. Ectophallic apodemes fork-shaped, with basal end narrow; inner apical arm straight, pointing inner (parallel to anterior margin of pseudepiphallos) before bending posteriorly into a narrow apex; outer apical arm straight, with apex enlarged and ovate with the narrower end at the base. Ectophallic fold forming two elongated plate-like structures; lateral margins widened posteriorly, posterior end broader than base, with apex truncated but with a small obtuse lateral lobe. Endophallic sclerite plate-like, wider than long.

Female. Unknown.

Measurements (in mm). Male holotype PronL = 2.4, PronW = 4.1, FWL = 11.4, FWW = 6.1, FIIL = 9.0, FIIW = 3.0, TIIL = 9.3; male paratype PronL = 2.2, PronW = 4.0, FWL = 11.4, FWW = 5.7, FIIL = 9.0, FIIW = 3.1, TIIL = 9.0.

#### ***Phaloria paradischidia* Tan & Robillard, sp. nov.**

(Figs. 1B, 2B, 3B, 4B, 5C, 5D, 6C, 7)

**Material examined.** **Holotype** (male, LEN2014-TR634) New Guinea, **Indonesia**, West Papua, Kumawa, S4.0518611, E133.066083 (KUM5), 87 m.a.s.l., forêt sur pente en amont de la rivière [forest on slope upstream of the river], 16–17.xi.2014, nuit [night], molecular sample P2, T. Robillard (MZB).

Paratype: 1 male (LEN2014-TR631), same locality and details as holotype, call recording on video 203 (MNHN-EO-ENSIF\*\*\*\*\*)

**Type locality.** New Guinea, **Indonesia**, West Papua, Kumawa

**Etymology.** The species name refers to the similarity of this new species with the preceding new species, *P. dischidia* sp. nov.

**Diagnosis.** This new species is unique among congeners by genitalia: pseudepiphallic lobes slender and tapering before enlarging into rhomboidal–roundish apex; pseudepiphallic parameres with a rectangular basal inner lobe and a stout and curved hook-like apical outer process; ectophallic apodeme inner apical arm pointing posteriorly before bending at the apex towards one another and outer apical arm straight with apex obliquely enlarged and truncated.

This new species is most similar to *P. beybienkoi* from Supiori Island (north of West Papua) in habitus, colour patterns and male genitalia. It differs by pseudepiphallic parameres with inner basal lobe more rectangular and forming two angular lobules (instead of rounded) and pseudepiphallic lobes more angular rather than rounded. It is also similar to *P. similis* and *P. parasimilis* from New Guinea by pseudepiphallic parameres with rectangular lobe but differs by hook-like process not positioned basally and pseudepiphallic lobes with apex enlarged.

**Subgeneric status.** This species should belong to the subgenus *Papuloria* based on the pseudepiphallos with a pair of lateral lophi and endophallic sclerite without large unpaired apodeme directed anteriorly.

**Description.** Very similar to *P. dischidia* sp. nov. in habitus, size and colour patterns (Figs. 1B, 2B, 3B). Male. FW dorsal and lateral fields and hind wings very similar to *P. dischidia* sp. nov. except: FWs 1.7 times longer than wide, mirror with distal dividing vein roundly curved, instead of slightly sinuous (Fig. 4B). Mirror 0.8 times as long as wide, apical field about 0.5 times shorter than length of mirror.

Male genitalia also similar to *P. dischidia* sp. nov. (Figs. 5C, 5D) except for: Pseudepiphallos narrower, with posterior margin with a deep, rounded indentation in the middle. Pseudepiphallic lobe enlarged into rhomboidal–roundish apex. Pseudepiphallic parameres with basal inner lobe not distinctly indented. Ectophallic apodemes fork-shaped, with basal end broad; inner apical arm pointing posteriorly before bending at the apex towards one another; outer apical arm straight, with apex obliquely enlarged and truncated.

Female. Unknown.

Measurements (in mm). Male holotype PronL = 2.6, PronW = 4.2, FWL = 10.4, FWW = 6.0, FIIL = 8.3, FIIW = 2.6, TIIL = 7.0.

**Calling song (Fig. 7).** At 26°C, the calling song with call duration of  $0.12 \pm 0.03$  s (0.1–0.19 s) consists of two (and rarely, three) isolated pulses. Each pulse has a duration of  $17.3 \pm 1.8$  ms (14.0–21.0 ms). The pulses within each call are separated by a down time of  $68.6 \pm 2.7$  ms (64.0–75.0 ms). The pulse has a dominant frequency of  $4.83 \pm 0.02$  kHz (4.82–4.91 kHz).

***Phaloria tukul* Tan & Robillard, sp. nov.**

(Figs. 1C, 2C, 3C, 4C, 5E, 5F, 6D)

**Material examined. Holotype** (male, LEN2014-TR144), New Guinea, **Indonesia**, West Papua, Lobo, S3.706417, E134.072139 (LOBO4), 189 m.a.s.l., forêt proche PK8/ route Lobo-Kaimana camp à 200 m, forêt primaire [forest near PK8 / Lobo-Kaimana camp road 200 m away, primary forest], 21–30.x.2014, nuit [night], sur plante basse [on low plant], molecular sample P3, T. Robillard (MZB).

**Type locality.** New Guinea, **Indonesia**, West Papua, Lobo

**Etymology.** The species name refers to the hammer-shaped pseudepiphallic parameres, unique among congeners; tukul = hammer in Bahasa Malay.

**Diagnosis.** This new species is unique among congeners by male genitalia: pseudepiphallic parameres inverted hammer-shaped, with a rectangular lobe before middle along inner margin (resembling the head of a hammer), with apical half slender and produced with small apical lobule along inner margin (resembling the handle of the hammer).

This new species is most similar to *P. beybienkoi* from Supiori Island (north of West Papua) in habitus and genitalia (particularly pseudepiphallic parameres), but differs by pseudepiphallic lobes not enlarged at the apex and pseudepiphallic parameres with outer apical process not acute apically. This species is also similar to *P. similis* and *P. parasimilis* from New Guinea by pseudepiphallic lobes and pseudepiphallic parameres with rectangular lobe, but differs by long apical process of pseudepiphallic parameres.

**Subgeneric status.** This species should belong to the subgenus *Papuloria* based on the pseudepiphallus with a pair of lateral lophi and endophallic sclerite without large unpaired apodeme directed anteriorly.

**Description.** Very similar to *P. dischidia* sp. nov. from Lobo in habitus and size (Fig. 1C). Head dorsum yellow brown with 5 very faint brown longitudinal bands at posterior end; vertex with a T-shaped brown pattern (Fig. 2C). Fastigium darker brown. Scapes yellow brown. Antennae yellow brown. Fastigium verticis and frons dark brown; clypeus and mouthparts yellow brown (Fig. 3C). Maxillary palpi pale coloured, apices of segments slightly brownish. Lateral part of head yellow brown without darker patterns. Pronotal disk unicolourous brown with distinctly darkened posterior and anterior margins; posterior margin straight (Fig. 2C). Lateral lobes also generally brown with dark margins. Legs generally unicolourous yellow brown. Inner and outer tympana similar in size and shape: relatively small and oval. FIIs with a faint incomplete ring near knees. TIIs with very faint brown rings. FIILs yellow brown without bands or spots, slightly darker in colouration near knees, knees brown. TIILs brown with dark spots near bases of spurs. Tergites brown.

Male. FWs 1.7 times longer than wide, surpassing abdominal apex, mostly yellow brown and some parts hyalinous (Fig. 4C). FW venation typical of genus, 8 fairly straight veins in harp; mirror 0.8 times as long as wide, very large and transverse, separated by two dividing veins: basal one mostly straight, distal one obliquely sinuous. Apical field short, 0.9 times shorter than length of mirror. Lateral field with R and M diverging posteriorly, with 6 faint cross-veins. Hind wings reaching apex of FW, not exceeding FWs.

Male genitalia (Figs. 5E, 5F). Pseudepiphallus with lateral margins slightly converging posteriorly; with posterior margin roundly, deeply and broadly incised in the middle. Pseudepiphallic lobe elongated, tapering into a slender process that bends inwards slightly, apex obtuse. Rami short, only slightly longer than half of pseudepiphallus length, not bent apically. Pseudepiphallic parameres sclerotized, inverted hammer-shaped, basal margin truncated (resembling the mallet of a hammer), external margin concave, inner margin with a rectangular lobe before middle (resembling the head of the hammer); apical half slender (resembling the handle of the hammer), with a small apical lobule along inner margin, apical end tapering into an obtuse apex. Ectophallic apodemes fork-shaped; with apical inner and outer arms long and somewhat pointing posteriorly and obliquely. Ectophallic fold with a pair of obtuse lobes at posterior margin.

Female. Unknown.

Measurements (in mm). Male holotype PronL = 2.2, PronW = 3.8, FWL = 9.7, FWW = 5.7, FIIL = 9.3, FIIW = 2.6, TIIL = 9.2.

***Phaloria brevis* Tan & Robillard, sp. nov.**

(Figs. 1D, 1E, 2D, 3D, 4D, 4E, 5G, 5H)

**Material examined. Holotype** (male, LEN2014-TR343), New Guinea, **Indonesia**, West Papua, Lobo, S3.7033056, E134.071444 (LOBO6), 221 m.a.s.l., forêt proche PK8/ route Lobo-Kaimana, crête prox. camp, forêt primaire [forest near PK8 / Lobo-Kaimana road, ridge prox. camp, primary forest], 21–30.x.2014, nuit [night], T. Robillard (MZB)

Paratypes. 2 females (LEN2014-TR344, TR345), same locality and details as holotype, molecular sample P4 (MNHN-EO-ENSIF1744, MZB).

**Type locality.** New Guinea, **Indonesia**, West Papua, Kumawa

**Etymology.** The species name refers to the diagnostically shorter apical processes of the ectophallic fold; *brevis* = short in Latin.

**Diagnosis.** This new species is unique among congeners by genitalia: pseudepiphallic lobes stout and strongly sclerotized with obtuse apex; pseudepiphallic parameres basal end with small inner tooth and distal third with two stout lobules pointing posteriorly; and shape of endophallic sclerite.

This new species is most similar to *P. pararava* Gorochov, 1999 from Kokoda (Papua New Guinea) and *P. rava* Gorochov, 1996 from Malu? (New Guinea) in habitus, colour patterns and male genitalia. This species is more similar to *P. pararava* in the ectophallic apodemes than in *P. rava*. It differs from both species most distinctly in the male genitalia by ectophallic fold with apical processes shorter and barely surpassing pseudepiphallic lobes (rather than surpassing well beyond pseudepiphallic lobes). The new species also differs from the two species by the shape of pseudepiphallic parameres. This species is also similar to *P. neorava* Gorochov, 2014 from Faowi in West Papua by shape of pseudepiphallic lobes, but differs by ectophallic fold with apical processes and shape of pseudepiphallic parameres.

**Subgeneric status.** This species should belong to the subgenus *Papuloria* based on the pseudepiphallus with a pair of lateral lophi and endophallic sclerite without large unpaired apodeme directed anteriorly.

**Description.** Slender and relatively large among congeners (Fig. 1D). Head dorsum and fastigium brown (Fig. 2D). Scapes yellow brown. Antennae yellow brown. Fastigium verticis brown, frons, clypeus and mouthparts pale yellow brown (Fig. 3D). Maxillary palpi pale coloured, apices of segments faintly brownish. Lateral part of head, including genae, pale yellow brown; with a broad brown (darker than head dorsum) horizontal band at posterior of eye. Pronotal disk generally unicolourous brown, slightly darker posteriorly; posterior margin straight (Fig. 2D). Lateral lobes with dorsal half brown, ventral half pale yellow brown. Legs pale yellow brown with sparse brown spots and bands. Inner tympanum large and oblong, with distal end tapering into acute apex; outer tympanum oval and smaller. FIs and FIIs with few small brown spots and one incomplete ring near knees (more distinct in FIIs), basally with some brown spots on the dorsal and inner surface. TIs with an indistinct brown ring around tympanum. FIIs yellow brown with some brown spots, with a brown ring near knee; knees brown. TIIs yellow brown with faint brown rings. Tergites brown.

Male. FWs slenderer, about 2.6 times longer than wide, surpassing abdominal apex, mostly yellow brown and some parts hyalinous (Fig. 4D). FW venation typical of genus, 8 fairly straight veins in harp; mirror as long as wide, very large and separated by two dividing veins: basal one mostly straight, distal one obliquely curved (appearing slightly sinuous). Apical field long, 1.2 times longer than length of mirror. Lateral field with R and M diverging before converging at apical third, with 5 cross veins between R and M; with 25 projections of Sc. Hind wings reaching apex of FW, not exceeding FWs.

Male genitalia (Figs. 5G, 5H). Pseudepiphallus with lateral margins slightly diverging; with posterior margin broadly incised in the middle. Pseudepiphallic lobe stout and strongly sclerotized at the apex, external margin faintly curving inwards, inner margin slightly sinuous; apex obtuse. Rami relatively long, longer than half the pseudepiphallus length, curved inwards apically, but not connected. Pseudepiphallic parameres strongly sclerotized, somewhat obliquely transverse and curved; basal end narrow and truncated, with inner tooth (less sclerotized and fairly slender); slightly widened after basal third, distal third with two stout lobules pointing posteriorly. Ectophallic apodemes fork-shaped, with basal end broad and short; inner and outer apical arm pointing posteriorly, but outer longer than inner arm. Ectophallic fold separated into two elongated plate-like structures with apex producing into an elongated lobe with obtuse apex. Endophallic sclerite small with two lateral plate-like structures connected together.

Female. Similar to males in colour patterns (Fig. 1E). FW venation typical of genus, with 11 oblique veins on dorsal field (Fig. 4E). Lateral field with 13 cross veins between R and M; with 15 projections of Sc. Ovipositor barely surpassing hind wings; apex obtuse, with 4–5 ventral teeth.

Measurements (in mm). Male holotype PronL = 3.1, PronW = 4.4, FWL = 14.7, FWW = 5.7, FIIL = 12.7, FIIW = 3.4, TIIL = 12.6; female paratypes PronL = 3.4–3.5, PronW = 4.2–4.4, FWL = 17.5–17.8, FWW = 4.7, FIIL = 12.9–13.1, FIIW = 3.5–3.6, TIIL = 12.3–12.4, OL = 10.0–10.2.

***Phaloria berbeda* Tan & Robillard, sp. nov.**

(Figs. 1F, 2E, 3E, 4F, 5I, 5J, 8)

**Material examined. Holotype** (male, LEN2014-TR142). New Guinea, **Indonesia**, West Papua, Lobo, S3.706417, E134.072139 (LOBO4), 189 m.a.s.l., forêt proche PK8/ route Lobo-Kaimana camp à 200 m, forêt primaire [forest near PK8 / Lobo-Kaimana camp road 200 m away, primary forest], 21–30.x.2014, nuit [night], sur plante [on plant], T. Robillard (MZB).

Paratypes. 1 male (LEN2014-TR167), same locality and details as holotype, call recording on video 075 (MNHN-EO-ENSIF1718). 1 male (LEN2014-TR242), same locality, S3.7141944, E134.069333 (LOBO7), 377 m.a.s.l., forêt proche PK8/ route Lobo-Kaimana, forêt primaire entre camp et falaise [forest near PK8 / Lobo-Kaimana road, primary forest between camp and cliff], 21–30.x.2014, nuit [night], molecular sample P5, sur plante [on plant], T. Robillard (MZB).

**Type locality.** New Guinea, **Indonesia**, West Papua, Lobo

**Etymology.** The species name refers to the distinctly unique shapes of pseudepiphallic lobes and parameres and endophallic sclerite; berbeda = different in Bahasa Indo.

**Diagnosis.** This new species is unique among congeners by genitalia: pseudepiphallic lobes with a folded ventral lobe also with truncated apex; pseudepiphallic parameres with basal end narrow and apical half with stout inner tooth-like process; ectophallic fold with apex producing into pair of short slender lateral process with acute apex; endophallic sclerite very small with a pair of stout check-mark structures.

This species similar to *P. vulgata* Gorochov, 1996 from New Guinea by habitus, colour patterns and genitalia (presence of stout nodules in the middle of pseudepiphallus, pseudepiphallic lobes with apical lobe produced inwards); but differs by pseudepiphallic lobes more broad and obtuse at apex, pseudepiphallic parameres with very different shape, apical spines of ectophallic fold slenderer with acute apices and inner arm of ectophallic apodemes broader. This species is also similar to *P. manifesta* Gorochov, 2014 from Faowi (West Papua) by shape of ectophallic fold, but differs by shapes of pseudepiphallic lobes and pseudepiphallic parameres. Habitus and pseudepiphallic lobes of the new species somewhat resembles that of *P. chopardi* (Willemse, 1951) from Carolina Islands but differs by pseudepiphallic lobes not bent inwards and pointing one another, apical spines of ectophallic fold much shorter, rami much longer, surpassing ectophallic apodemes. This species is also vaguely similar to *P. aspersa* Gorochov, 1996 from New Guinea by shapes of pseudepiphallic parameres and pseudepiphallic lobes, but differs drastically in size and colour patterns, shapes of ectophallic fold and ectophallic apodemes.

**Subgeneric status.** This species should belong to the subgenus *Papuloria* based on the pseudepiphallus with a pair of lateral lophi and endophallic sclerite without large unpaired apodeme directed anteriorly.

**Description.** Habitus similar to *Phaloria brevis* Tan & Robillard, **sp. nov.** from Kumawa, but smaller in size and wings slightly broader (Fig. 1F). Head dorsum yellow brown with four longitudinal brown bands at posterior end (Fig. 2F). Fastigium brown. Scapes yellow brown, ventrally dark brown. Antennae unicolourous yellow brown. Fastigium verticis yellow brown with  $\Omega$  omega-shaped dark brown pattern. Frons, clypeus and mouthparts pale yellow brown; frons with four brown vertical bands that continue to clypeus (Fig. 3E). Maxillary palpi pale coloured; apices of segments faintly brownish. Lateral part of head, including genae, pale yellow brown; gena with a vertical brown band ventral to eye; with a broad brown (darker than head dorsum) horizontal band at posterior of eye. Pronotal disk generally brown; posterior margin slightly sinuous (Fig. 2F). Lateral lobes brown (slightly darker than pronotal disk), with a few pale brown spots. Legs pale yellow brown with brown patterns and spots. Inner tympanum oblong, with distal end more acute; outer tympanum similarly sized and oval. FIs and FIIs with large brown spots on inner and outer surface at the base, followed by two brown rings near knees (one in the middle and another near the knee), basally with some brown spots on the dorsal and inner surface. TIs with a broad brown ring around tympanum and two other rings (one in middle and one at apex). FIIIs yellow brown basally with some brown spots, distal third and knees brown, with a pale ring near knees. TIIIs yellow brown with brown rings. Tergites yellow brown.

Male. FWs slenderer, about 2.8 times longer than wide, surpassing abdominal apex, mostly yellow brown and some parts hyalinous (Fig. 4F). FW venation typical of genus, 8 fairly straight veins in harp; mirror 1.0–1.1 times as long as wide, very large and separated by two dividing veins: basal one mostly straight, distal one angularly bent. Apical field long, 1.0–1.1 times longer than length of mirror. Lateral field with R and M diverging before converging strongly at apical third, with 8 cross veins between R and M; with 22 projections of Sc. Hind wings reaching apex of FW, not exceeding FWs.

Male genitalia (Figs. 5I, 5J). Pseudepiphallus with lateral margins slightly converging posterior; its posterior margin with a deep round indentation in the middle, with a pair of small stout nodular lobules. Pseudepiphallic lobe stout, dorsally obliquely truncated at the apex, with a folded ventral lobe also with truncated apex. Rami long, much longer than half of pseudepiphallus length, faintly curved inwards at the basal end, but not connected. Pseudepiphallic parameres strongly sclerotized, somewhat obliquely transverse; basal end narrow with rounded apex, apical third with stout dorso-inner tooth-like process; apex obtuse, pointing posteriorly. Ectophallic apodemes fork-shaped, with basal end short; inner apical arm pointing obliquely and towards each other, outer apical arm pointing posteriorly with apex strongly widened and truncated. Ectophallic fold separated into two

elongated plate-like structures with inner margin concave, with apex producing into a short slender process at the external margin, process with apex acute and pointing obliquely towards each other. Endophallic sclerite very small with a pair of check-mark structures, with basal lobule pointing externally and dorsad with obtuse apex and posterior end also with obtuse apex.

Female. Unknown.

Measurements (in mm). Male holotype PronL = 2.1, PronW = 3.9, FWL = 15.1, FWW = 5.4, FIIL = 7.6, FIIW = 2.5, TIIL = 8.8; male paratypes PronL = 2.0–2.4, PronW = 3.8, FWL = 13.9–14.6, FWW = 5.5–5.7, FIIL = 7.7–7.9, FIIW = 2.1–2.5, TIIL = 8.1–8.4.

**Calling song (Fig. 8).** The calling song consists of a series of echemes with echeme duration of  $54.4 \pm 9.7$  ms (43.1–70.6 ms) and echeme period of  $0.11 \pm 0.01$  s (0.10–0.12 s). Down time between echemes is  $53.4 \pm 7.2$  ms (35.0–61.0 ms). Each echeme consists of 4 to 6 closely-packed pulses. Each pulse has a duration of  $11.0 \pm 0.5$  ms (10.2–11.8 ms). The pulse has a dominant frequency of  $4.96 \pm 0.02$  kHz (4.89–4.97 kHz).

***Phaloria lobulata* Tan & Robillard, sp. nov.**

(Figs. 1G, 2F, 3F, 4G, 5K, 5L)

**Material examined. Holotype** (male, LEN2014-TR542), New Guinea, **Indonesia**, West Papua, Kumawa, S4.0688333, E133.036444 (KUM2), 27 m.a.s.l., forêt littorale karstique sur pente [karst coastal forest on slope], 11–17.xi.2014, jour [day], litière [leaf litter], T. Robillard (MZB).

**Type locality.** New Guinea, **Indonesia**, West Papua, Kumawa

**Etymology.** The species name refers to the median lobe present in the ectophallic fold and the lobule at the apical third external margin of the pseudepiphallus that distinguish this species from other similar congeners; lobulata = lobulated in Latin.

**Diagnosis.** This new species is unique among congeners by pseudepiphallus lobes forming pincer-like paired processes, dorsal process bends inward, with setose lobule at apical third along external margin; ectophallic fold with lateral arms pointing postero-externally and with a narrow median lobe tapering into a narrow obtuse apex.

This species is most similar to *P. pareximia* Gorochov, 1999 from Cyclops Mountains (north-eastern West Papua) and then *P. eximia* Gorochov, 1996 from New Guinea in pseudepiphallus lobes, pseudepiphallus parameres and endophallic sclerite; but differs by pseudepiphallus lobes with setose nodule at apical third, shape of pseudepiphallus parameres and ectophallic fold with median lobe and with lateral arms pointing slightly externally. It also differs from *P. pareximia* by basal process of pseudepiphallus lobes pointing interno-anteriorly (instead of interno-posteriorly). It differs from *P. eximia* by basal lobe of pseudepiphallus lobes acute (rather than stout) and pseudepiphallus parameres without long acute process. This species is also vaguely similar in pseudepiphallus lobes as *P. aleximia* Gorochov, 2005 from Supiori Island (north of West Papua) but differs by shape of pseudepiphallus parameres without long acute external process.

**Subgeneric status.** This species should belong to the subgenus *Papuloria* based on the pseudepiphallus with a pair of lateral lophi and endophallic sclerite without large unpaired apodeme directed anteriorly.

**Description.** Similar to *Phaloria brevis* Tan & Robillard, **sp. nov.** in habitus, size and colour patterns (more contrasting but could be due to artefact of preservation) (Fig. 1G). Head dorsum yellow brown with irregular brown bands at posterior end (Fig. 2G). Fastigium darker brown. Scapes yellow brown, ventrally dark brown. Antennae yellow brown. Fastigium verticis brown. Frons, clypeus and mouthparts pale brown; frons with a horizontal dark brown stripe ventral to eye; clypeus with another horizontal dark brown stripe (Fig. 3F). Maxillary palpi pale coloured, apices of segments faintly brownish. Lateral part of head, including genae, pale yellow brown; gena with a vertical brown band ventral to eye; with a brown horizontal band at posterior of eye; posterior margin of head dark brown. Pronotal disk generally dark brown with median carina pale brown and two pairs of lateral oval pale brown spots; posterior margin slightly sinuous (Fig. 2G). Lateral lobes also dark brown, with two pale brown spots near ventro-anterior angle. Legs pale yellow brown with brown patterns and spots. Inner tympanum oblong; outer tympanum smaller and oval. FIs and FIIs with two brown oblong spots on inner and outer surfaces at the base (sometimes forming an incomplete ring), followed by brown rings near knees. TIs with three brown rings (one around tympana, one in middle and one at apex). FIIs yellow brown basally with some brown spots and mottled patterns on the dorsal surface, distal third with a brown ring and knee area brown. TIIs yellow brown with brown rings, particularly around bases of spurs. Tergites yellow brown.

Male. FWs slenderer, about 2.9 times longer than wide, surpassing abdominal apex, mostly yellow brown and some parts hyalinous (Fig. 4G). FW venation typical of genus, 8 fairly straight veins in harp; mirror as long as wide, very large and separated by two dividing veins: basal one mostly straight, distal one angularly bent. Apical field long, 1.1 times longer than length of mirror. Lateral field with R and M diverging before converging strongly at apical third, with 6 cross veins between R and M. Hind wings reaching apex of FW, not exceeding FWs.

Male genitalia (Figs. 5K, 5L). Pseudepiphallus with lateral margins slightly converging posterior; with posterior margin deeply, roundly and broadly incised in the middle, in the middle with a pair of small stout

triangular lobules. Pseudepiphallic lobe forming pincer-like paired processes; both processes pointing internally, slender and with acute apex; dorsal process anterior of ventral process; dorsal process bends inward, with setose lobule at apical third along external margin; ventral process more gently curved. Rami long, longer than the pseudepiphallus length, curved inwards apically, but not connected. Pseudepiphallic parameres strongly sclerotized, obliquely transverse and curved, with two posterior lobes, one dorsal and one ventral; dorsal lobe basal of ventral lobe, triangular; ventral lobe tongue-shaped, pointing interno-posteriorly. Ectophallic apodemes fork-shaped, with basal end straight and fairly long; inner apical arm pointing interno-posteriorly, apex rounded; outer apical arm longer, pointing posteriorly, apex enlarged. Ectophallic fold broad, laterally with lateral arms pointing postero-externally; posterior margin concave with a narrow median lobe tapering into a narrow obtuse apex. Endophallic sclerite small with two lateral plate-like structures, star-shaped; with a pair of stout and obtuse basal lobes.

Measurements (in mm). Male holotype PronL = 2.4, PronW = 4.3, FWL = 17.3, FWW = 5.9, FIIL = 10.9, FIIW = 2.1, TIIL = 10.0.

### ***Phaloria* nr. *aspersa* Gorochov, 1996**

(Figs. 1H–K, 2G, 3G, 4H, 4I, 5M, 5N)

*Phaloria aspersa* Gorochov, 1996: 68 (original description)

*Phaloria (Papuloria) aspersa*—Gorochov, 2005: 34 (new locality record in Supiori Island, West Papua); Gorochov, 2018: 62 (new locality record in Faowi and Nabire in Papua New Guinea); Cigliano *et al.* 2021 (Orthoptera species file Online)

**Material examined (photographs from OSF).** **Holotype** (male, DORSA BG00040S01), “Holl. N. Guinea, Pauwi-Samberi”, 17–20.vi.1910, coll. Moszkowski, S. G. (MfN)

**New material examined.** 1 male (LEN2014-TR609), New Guinea, **Indonesia**, West Papua, Kumawa, S4.0646111, E133.0371111 (KUM3), 82 m.a.s.l., forêt littorale sur karst, ligne de crête [littoral forest on karst, ridge line], 13–15.xi.2014, jour [day], B. Framento (MNHN); 1 female (LEN2014-TR620), Kumawa, S4.0555, E133.0663333 (KUM4), 47 m.a.s.l., forêt littorale karstique sur pente [karst coastal forest on slope], 16.xi.2014, nuit [night] (MNHN); 1 female (LEN2014-TR235), Lobo, S3.7141944, E134.0693333 (LOBO7), 377 m.a.s.l., forêt proche PK8/ route Lobo-Kaimana, forêt primaire entre camp et falaise [forest near PK8 / Lobo-Kaimana road, primary forest between camp and cliff], 21–30.x.2014, nuit [night], molecular sample P6, T. Robillard (MZB).

**Remarks.** This species has a very unique habitus among congeners, distinct from most species by larger size and slender habitus (with distinctly elongated FWs), pale coloured with distinct dark patterns on head, pronotum and legs (Figs. 1H–K, 2G, 3G, 4H, 4I). Our specimens from Kumawa and Lobo show similarity in the male genitalia as the holotype (Figs. 5M, 5N), but differ slightly in shape of ectophallic apodemes and pseudepiphallic parameres as well as colouration of the pronotum and face: pronotum dark-coloured only in apical third, anterior margin with some dark patterns and spots (instead of more dark parts with some light patterns); lateral lobe with dorsal, posterior and ventral areas dark, pale coloured in the centre (instead of more dark parts). Since this species is widely distributed across New Guinea, we should examine the conspecific variations more closely before considering the differences observed in our specimens as species differences.

### **Acknowledgments**

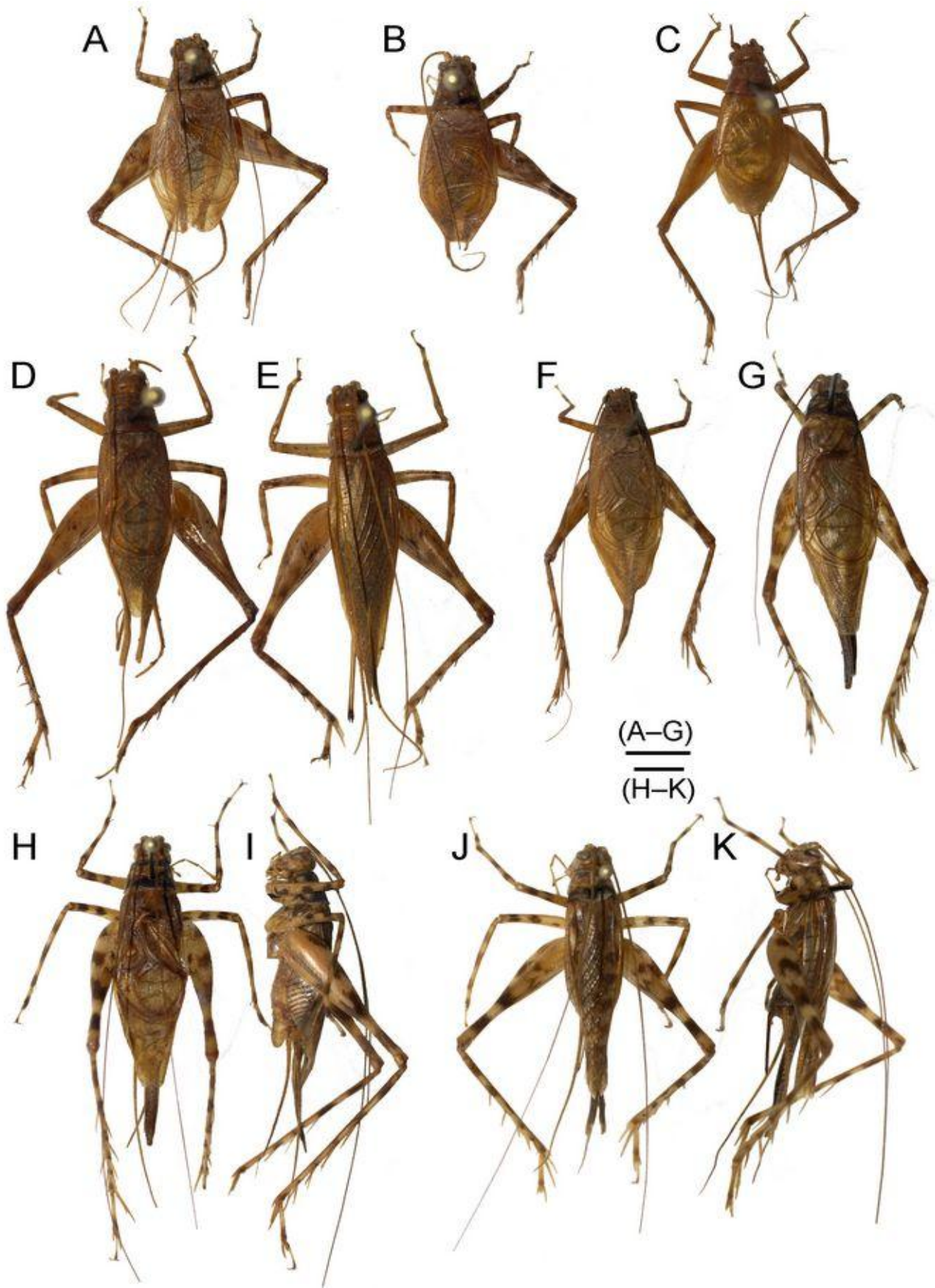
Fieldwork was supported by the Project Lengguru 2014 ([www.lengguru.org](http://www.lengguru.org)), conducted by the French Institut de Recherche pour le Développement (IRD), the Indonesian Institute of Sciences (LIPI), the University of Papua (UNIPA), the University of Cendrawasih (UNCEN), the University of Musamus (UNMUS) and the Sorong Fisheries Academy (APSOR) with corporate sponsorship from COLAS Group, Veolia Water and the Total Foundation. The work of MKT was supported by the Fyssen Foundation Postdoctoral Fellowship.

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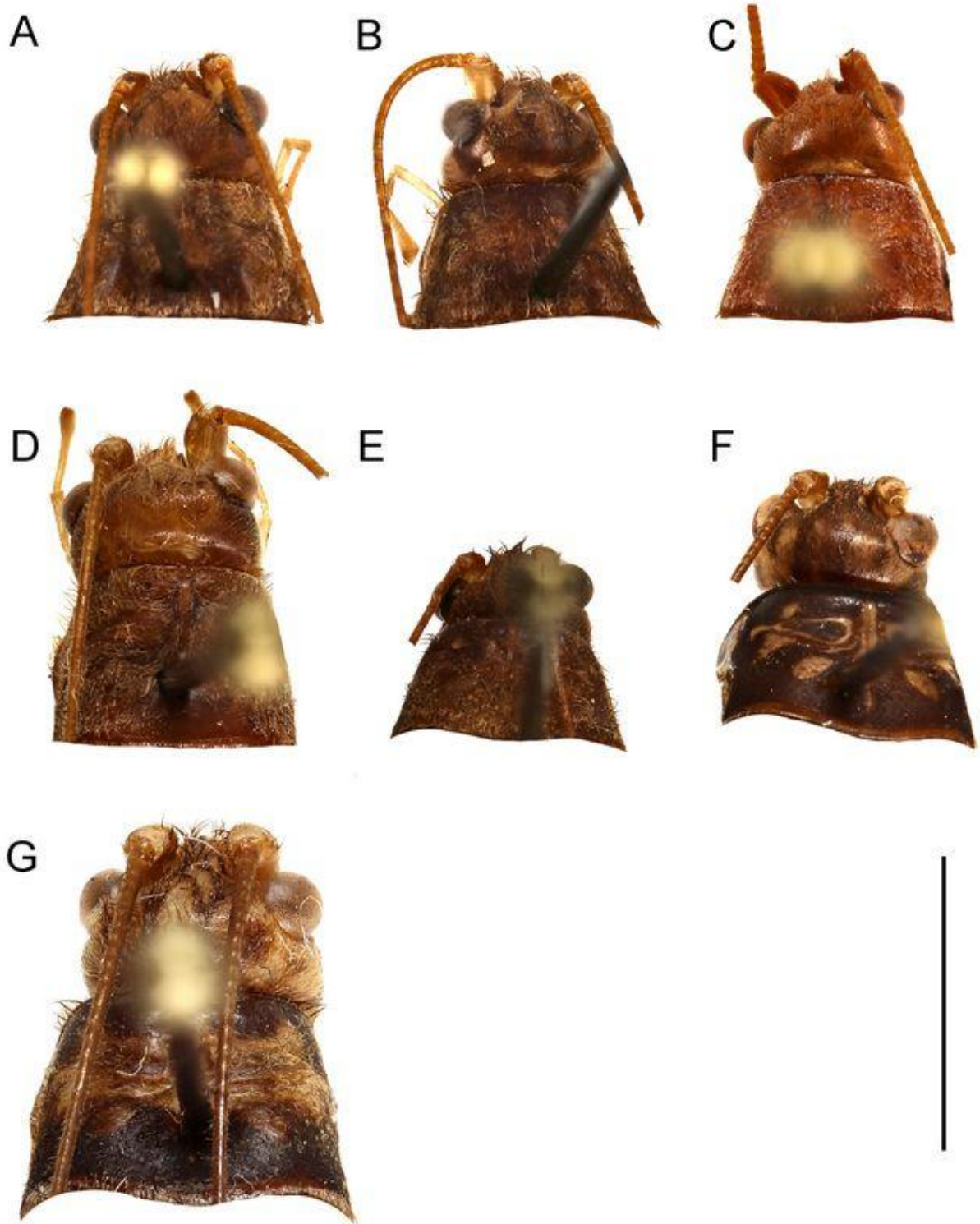
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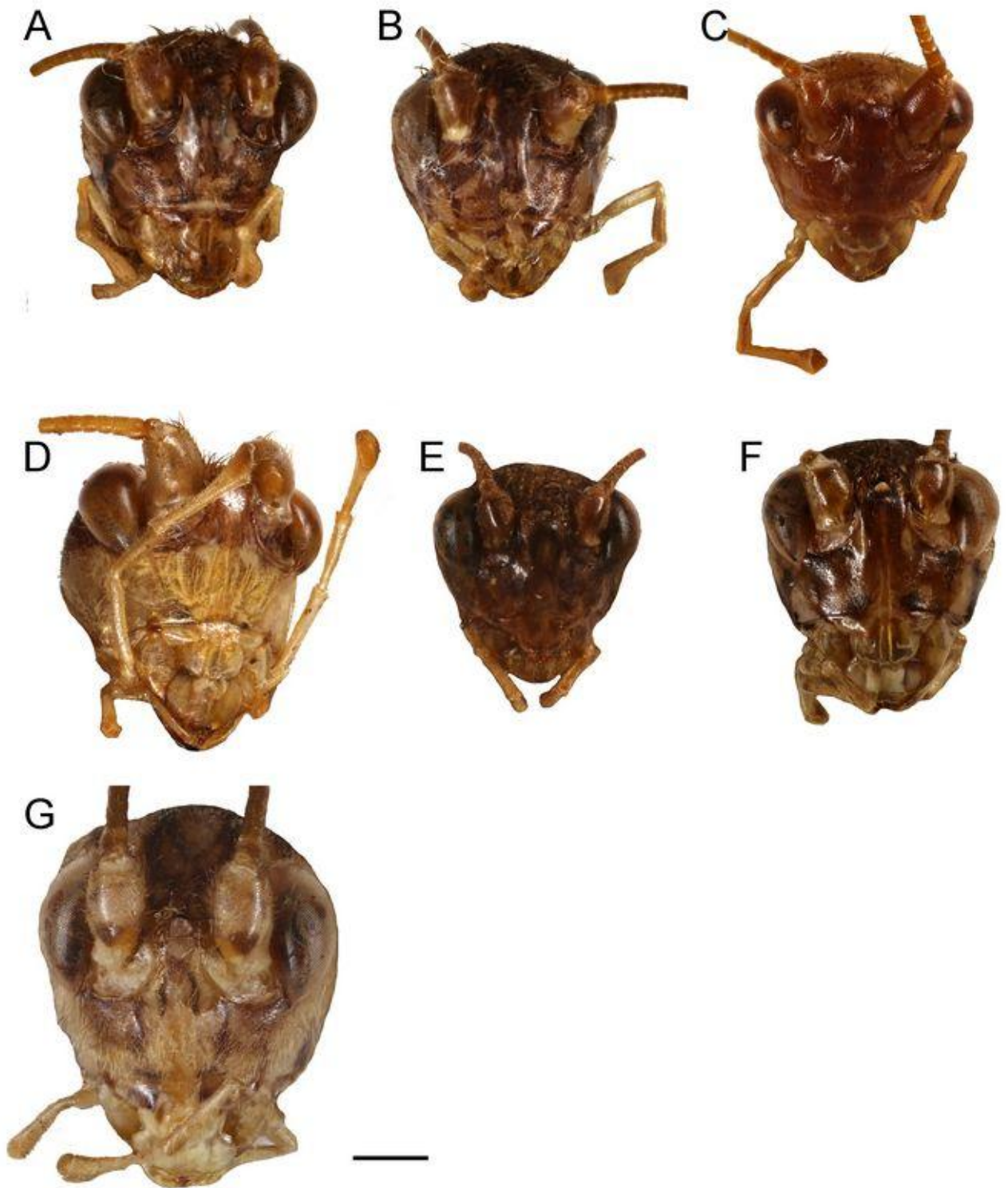
## Figure captions



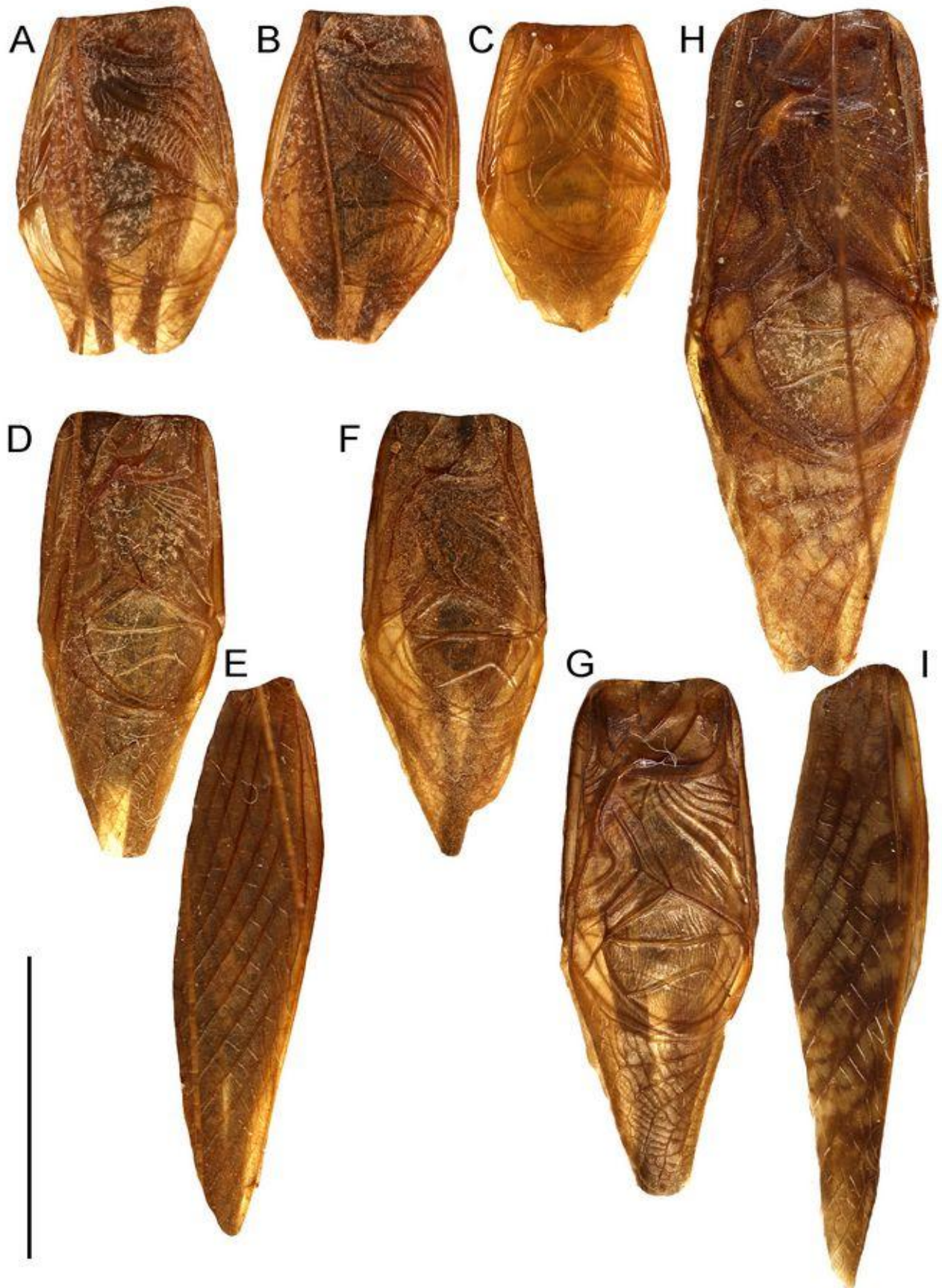
**FIGURE 1.** Habitus of *Phaloria* males (A–D, F–I) and females (E, J, K) from Lobo and Kumawa in dorsal (A–H, J) and lateral (I, K) views: *P. dischidia* sp. nov. (A), *P. paradischidia* sp. nov. (B), *P. tukul* sp. nov. (C), *P. brevis* sp. nov. (D, E), *P. berbeda* sp. nov. (F), *P. lobulata* sp. nov. (G), *P. nr. aspersa* (H–K). Scale bars: 5 mm.



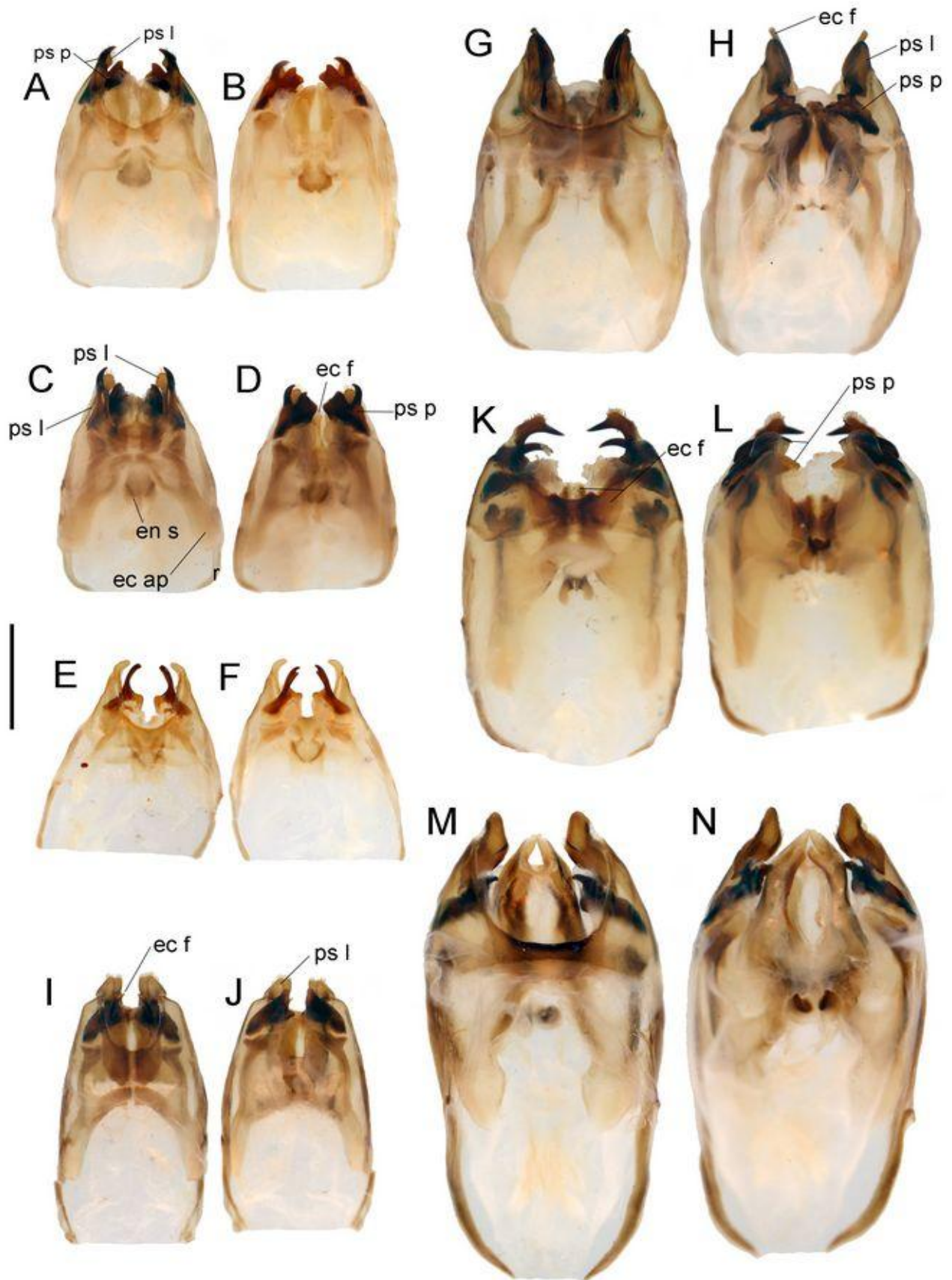
**FIGURE 2.** Head and pronotum of *P. dischidia* **sp. nov.** (A), *P. paradischidia* **sp. nov.** (B), *P. tukul* **sp. nov.** (C), *P. brevis* **sp. nov.** (D), *P. berbeda* **sp. nov.** (E), *P. lobulata* **sp. nov.** (F), *P. nr. aspersa* (G) in dorsal view. Scale bar: 5 mm.



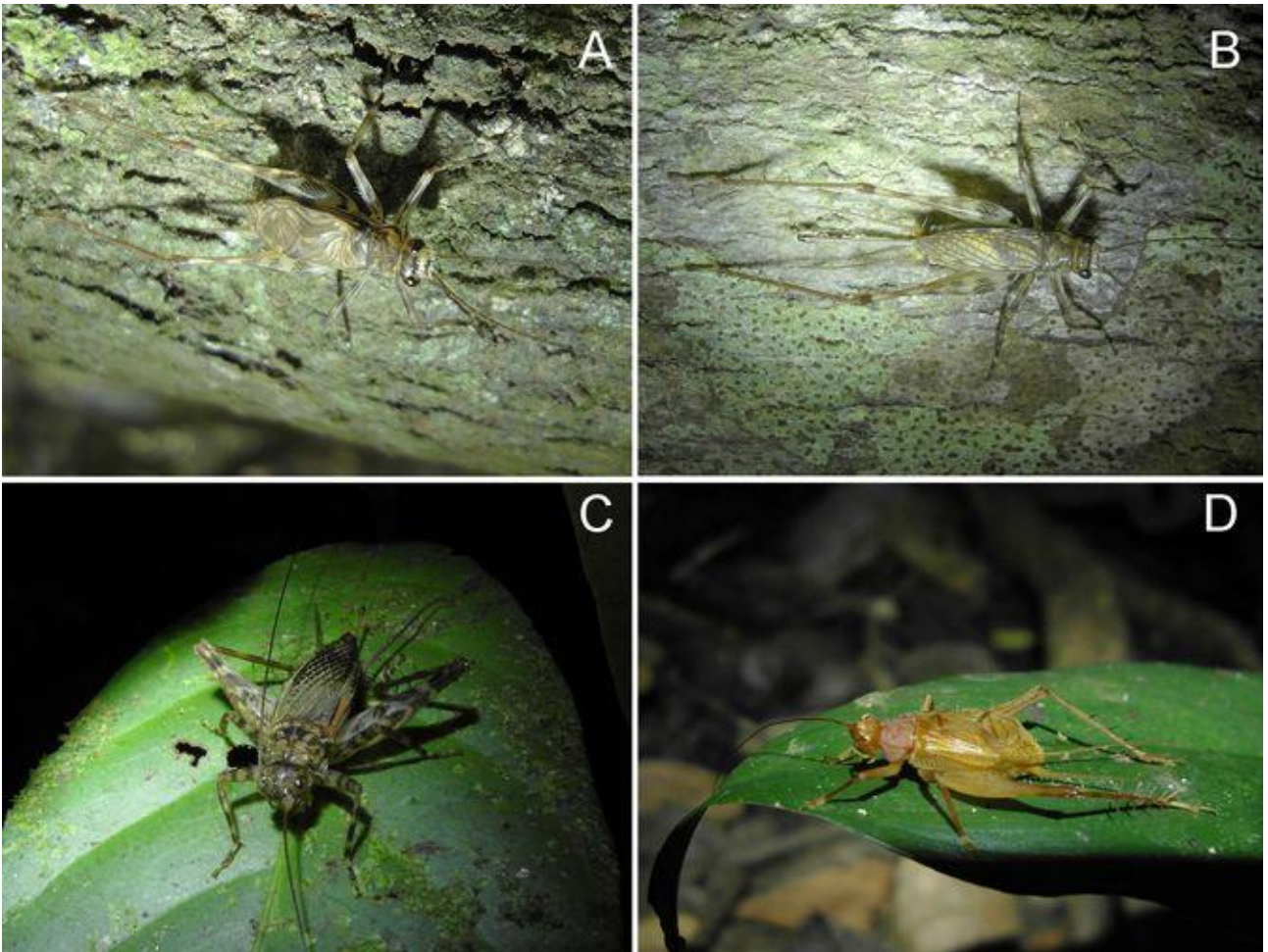
**FIGURE 3.** Faces of *P. dischidia* **sp. nov.** (A), *P. paradischidia* **sp. nov.** (B), *P. tukul* **sp. nov.** (C), *P. brevis* **sp. nov.** (D), *P. berbeda* **sp. nov.** (E), *P. lobulata* **sp. nov.** (F), *P. nr. aspersa* (G) in anterior views. Scale bar: 1 mm.



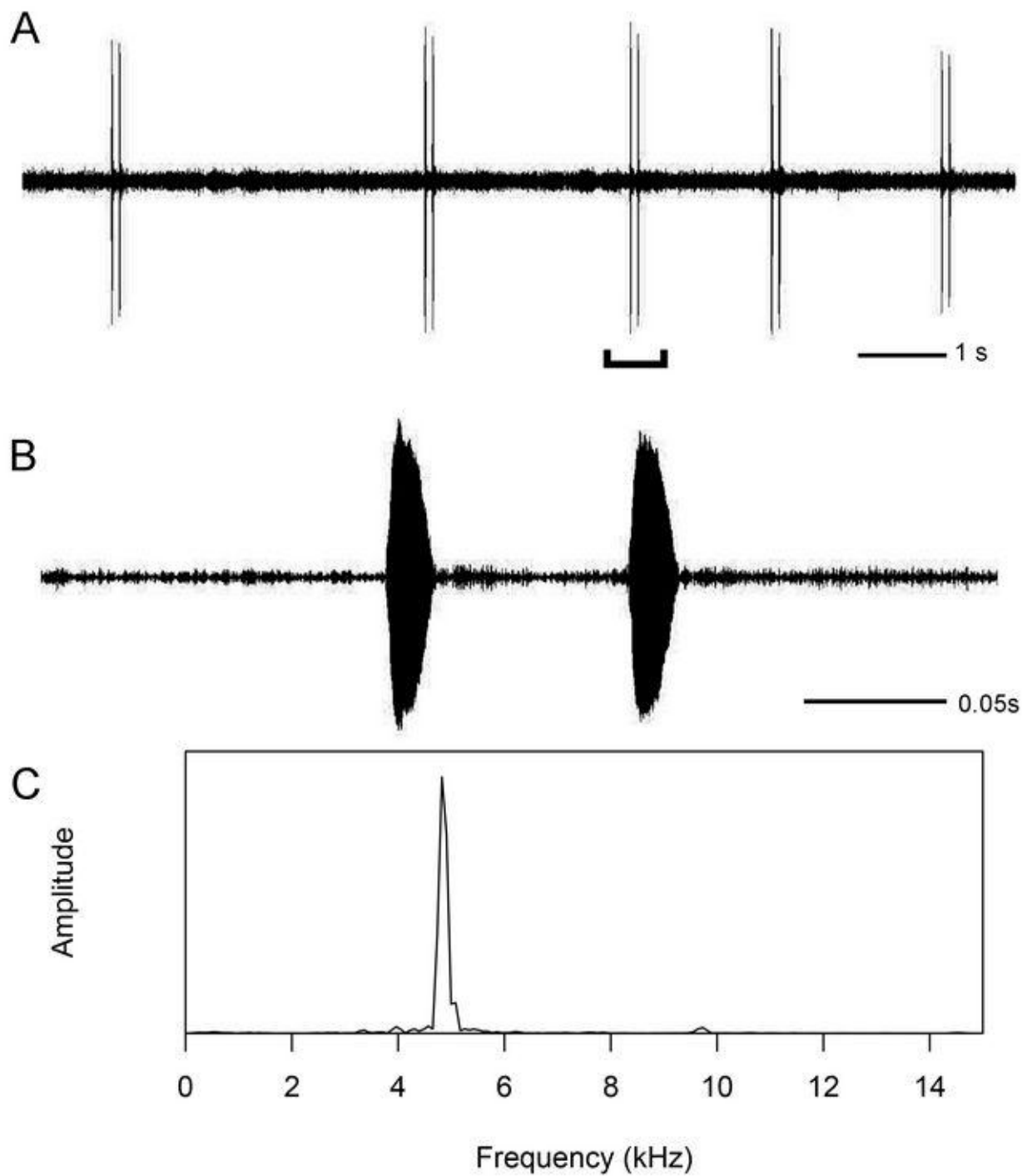
**FIGURE 4.** Male FWs of *P. dischidia* **sp. nov.** (A), *P. paradischidia* **sp. nov.** (B), *P. tukul* **sp. nov.** (C), *P. brevis* **sp. nov.** (D), *P. berbeda* **sp. nov.** (F), *P. lobulata* **sp. nov.** (G), *P. nr. aspersa* (H) and female FWs of *P. brevis* **sp. nov.** (E) and *P. nr. aspersa* (I) in dorsal views. Scale bar: 10 mm.



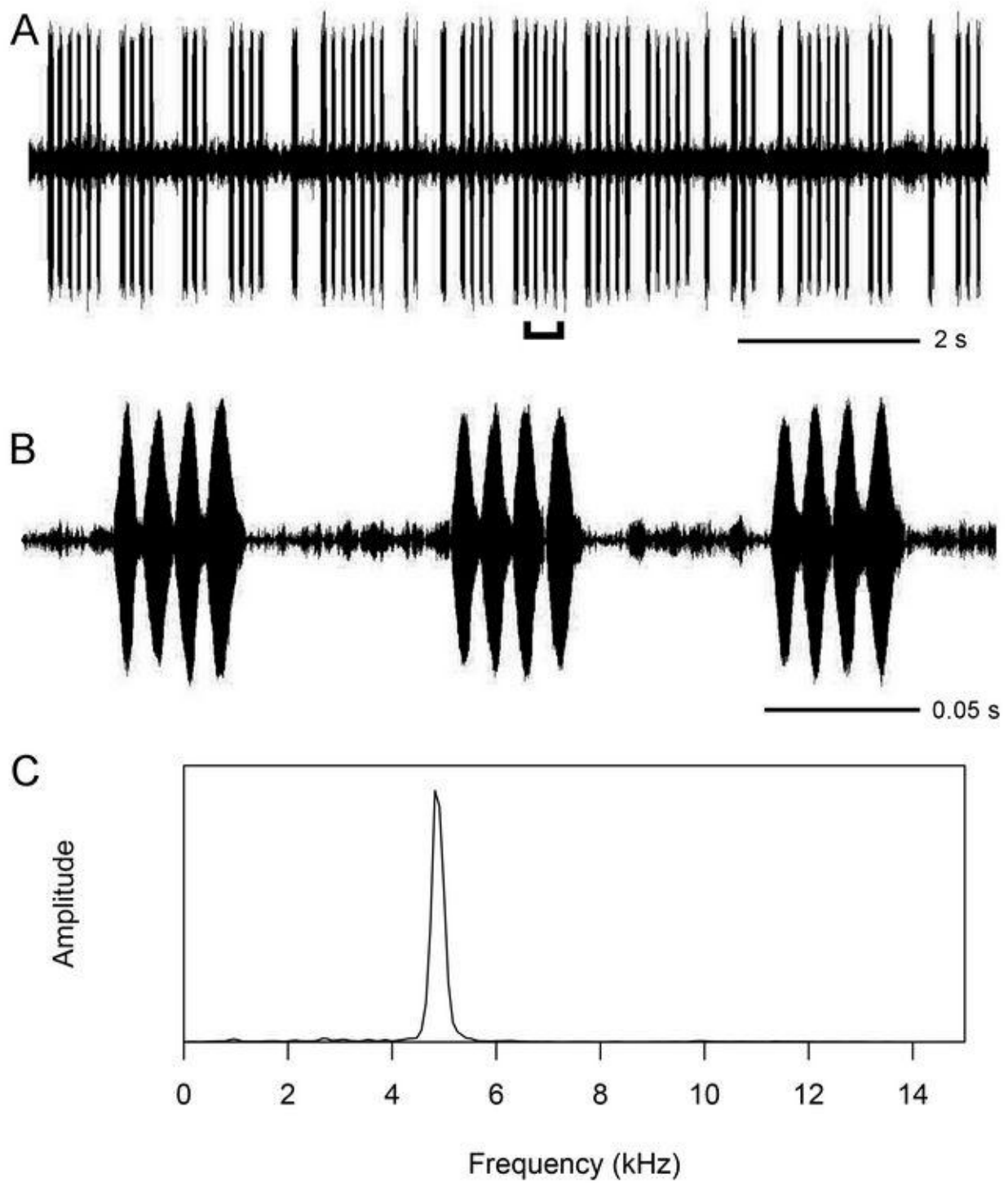
**FIGURE 5.** Male genitalia of *Phaloria* in dorsal (A, C, E, G, I, K, M) and ventral (B, D, F, H, J, L, N) views: *P. dischidia* sp. nov. (A, B), *P. paradischidia* sp. nov. (C, D), *P. tukul* sp. nov. (E, F), *P. brevis* sp. nov. (G, H), *P. berbeda* sp. nov. (I, J), *P. lobulata* sp. nov. (K, L), *P. nr. aspersa* (M, N). Scale bar: 1 mm.



**FIGURE 6.** *Phaloria* in the natural environment: probably *P. dischidia* **sp. nov.** male (A) and female (B) in Lobo; *P. paradischidia* **sp. nov.** from Kumawa (C); *P. tukul* **sp. nov.** in Lobo (D).



**FIGURE 7.** Calling song of *Phaloria paradischidia* **sp. nov.**: a sequence of five calling songs (A); a single calling song consisting of two pulses (B); spectral plot of a pulse (C).



**FIGURE 8.** Calling song of *Phaloria berbeda* sp. nov.: a series of echemes (A); a sequence of three echemes, each consisting of four pulses (B); spectral plot of a pulse (C).