

# Redescription of the male golden ghost moth *Phassus aurigenus* PFITZNER, 1914 from Costa Rica with taxonomical note (Lepidoptera: Hepialidae)

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**Abstract:** Details of the external morphology and genitalia of the male of *Phassus aurigenus* PFITZNER, 1914 are described for the first time, including illustration of the male holotype. Features of the basal forewing pattern and male genitalia show similarities to several other species of *Phassus* WALKER, 1856 from Mexico and Central America. A lectotype for *Phassus triangularis* EDWARDS, 1885 is designated.

**Keywords:** *Phassus triangularis*, Neotropical, species, taxonomy.

## Beschreibung des Männchens von *Phassus aurigenus* PFITZNER, 1914 aus Costa Rica mit taxonomischen Anmerkungen (Lepidoptera: Hepialidae)

**Zusammenfassung:** Details der äußeren Morphologie und der Genitalien des Männchens von *Phassus aurigenus* PFITZNER, 1914 werden erstmals beschrieben, und der männliche Holotypus wird abgebildet. Merkmale des basalen Vorderflügel-musters und der männlichen Genitalien weisen Ähnlichkeiten mit einigen anderen Arten von *Phassus* WALKER, 1856 aus Mexiko und Zentralamerika auf. Ein Lectotypus für *Phassus triangularis* EDWARDS, 1885 wird designiert.

## Introduction

The genus *Phassus* WALKER, 1856 is a group of poorly known callus-feeding stem borers with a distribution encompassing Mexico and Central America (C. MIELKE & GREHAN 2017). This range includes at least 13 species, including three that cannot be verified at this time because the primary types have not been located (see Table 1) (C. MIELKE & GREHAN 2012, 2016). A further four species from Central and South America do not show any characteristics to support their inclusion (C. MIELKE & GREHAN 2012), but rather appear to be members of the cibyrene clade (*sensu* GREHAN 2012), although there is also at least one genus, *Phthius* C. MIELKE & GREHAN, 2017, that may represent a sister clade to *Phassus* and *Schausiana* VIETTE, 1950 (C. MIELKE & GREHAN 2017).

Several *Phassus* species comprise large moths that easily attract attention when attracted to light, but their species characteristics and taxonomic boundaries are still not well understood. It is anticipated that there are additional species to be discovered, as indicated by the recent description of *Phassus violetteae* C. MIELKE & GREHAN, 2016 from the same general locality as *P. aurigenus* (C. MIELKE & GREHAN 2017).

One of the 13 species, *Phassus aurigenus* PFITZNER, 1914, was described based on a single male from Orosi, 1200 m, Costa Rica and recently some more specimens

became known allowing for its redescription. The external appearance of *P. aurigenus* is made distinctive by the silvery white and yellowish gold markings of the forewing. Apart from a subsequent listing by PFITZNER (1938), there has been no additional publication on its morphology or distribution. The purpose of this redescription is to characterize some of the external morphology of this species in anticipation of future work on *Phassus*, which remains poorly resolved both taxonomically and systematically (C. MIELKE & GREHAN 2016). We also comment briefly on some characters of *P. aurigenus* that may be indicative of its relationships with other *Phassus* species.

## Materials and methods

The abdomen was removed and treated in a cold solution of 5% KOH. The abdominal skin was opened by a right lateral cut from the tergo-sternal bar to the genitalia which were removed and stained in Chlorazol black. Terminology follows that of MIELKE & CASAGRANDE (2013). Wing venation diagrams were drawn over photographic image supplemented with examination of specimens. The labium was removed and prepared following the methodology described in GREHAN & C. MIELKE (in press).

## Abbreviations

### Collections

- |        |  |
|--------|--|
| AMNH   | American Museum of Natural History, New York, New York, USA.                                 |
| CGCM   | Collection Carlos G. C. MIELKE, Curitiba, Paraná, Brazil.                                    |
| CMNH   | Carnegie Museum of Natural History, Pittsburgh, Pennsylvania, USA.                           |
| JRG    | Collection John R. GREHAN, Evans, New York, USA.   |
| MNCR-A | Museo Nacional de Costa Rica, Sede de Santo Domingo de Heredia (former collection of INBio). |
| NHMUK  | The Natural History Museum, London, United Kingdom.  |
| SMFL   | Senckenbergmuseum, Lepidoptera collection, Frankfurt am Main, Germany.                       |
| USNM   | National Museum of Natural History, Washington D.C., USA.                                    |

### Other abbreviations used

- FW = forewing; HT = holotype;  
HW = hindwing; LT = lectotype.

## Taxonomic section

### *Phassus aurigenus* PFITZNER, 1914

Figs. 1, 2, 3a, 3b, 5, 6, 7a, 7b, 8, 9, 10, 11.

#### Redescription

♂ (Figs. 1–3, 5–10). Wingspan 64–110 mm; FW length: 31–55 mm, width: 18–20 mm, ratio 2.8: 1; HW length: 40–45 mm, width: 16–17 mm, ratio about 2.6:1.

Head covered with short, dark brown piliform scales. Antenna black, filiform, ca. 25 flagellomeres, annuli slightly laterally compressed, covered with numerous sensilla chaetica, dorsal surface of basal seven annuli with some piliform scales; scape barrel shaped, covered with short piliform scales. Interocular-antenna scales absent. Labium short, pentagonal, distally extended to triangular point ventrally; labial palps slightly asymmetrical in orientation and size, short, three segmented, subequal in length, basal palpomere strongly sclerotized basally, central and distal palpomeres mostly sclerotized, distal palpomere subcylindrical with VOM RATH's organ apically (Fig. 5). Other mouthparts rudimentary, anterior-lateral lobe stalked (possible maxillary palp), central lateral bilobed structure (possible maxilla), and postero-lateral sclerotized knob (possible mandible).

Pro- and mesonotum dorsally covered with dark reddish brown piliform scales, laterally with pale yellowish orange; metascutum, dark chocolate brown, covered with rows of microtrichia and free of scales other than posterior edges where pale yellowish orange scales merge with similar dorsal scales of first and second abdominal segments; ventral thorax yellowish golden brown.

Legs with yellowish golden brown coxae, other pro- and mesoleg segments greyish to dark reddish brown, epiphysis present (Fig. 6); metafemur and basal half of tibia with long golden brown piliform scales (Fig. 7a), androconial scales piliform along most of dorsal surface, not noticeably differentiated by color or form from other scales, scent gland only indicated by soft, pliable

dorsal surface of metatibia (Fig. 7b); tarsi greyish brown, ventral tarsal scales very short.

Dorsal FW ground color pale greyish brown over posterior and costal regions; central area pale golden brown from base to near apex, predominantly between veins R and  $M_1$  in the outer wing, and extending posteriorly to  $CuA_1$  near base; white scales scattered across wing; base of wing with short brown piliform scales, dark brown patch edged with pale golden brown in central region of cell between  $CuA_2$  and A and near wing margin; silvery white markings edged with dark brown in the basal, central, and outer areas.

Dorsal HW greyish brown with pale yellowish brown between Sc and costal margin. Ventral HW translucent, dorsal tints; veins and band of piliform scales along Sc pale yellowish brown. Wing venation hepialine (DUMBLETON 1966), Sc1 absent, R–Sc separation narrows in distal outer half of wing, FW  $CuP$  extending half distance to margin, HW with two anal veins (Text Fig. 8).

Tergosternal connection (Fig. 9) with elongate tergosternal bar, posterior edge curving to meet anterior edge of sternum II; lateral and dorsal tergal brace short, not fused to anterior margin of tergum II, anterior margin of central zone with non-sclerotized break, tergal knob absent.

First abdominal tergum with long, with thin golden orange hair-like scales; second tergum anteriorly with short orange scales, posteriorly dark brown to black; third to eighth tergites with short black scales except for brown sclerotized region free of scales before anterior dorsal tubercular plates and narrow posterior pale yellowish white band; sternum II golden orange, following sternum dark chocolate brown; sternites golden orange on all segments; sternum VII with postero-lateral scale tufts.

Tergites and sternites moderately sclerotized (Fig. 10); tergum II with thick lateral ridge, extending anteromedially to anterior ridge; sternum II sub-rectangular, lateral margins convex to base of anterior lateral arms, anterior lateral arms prominent, strongly sclerotized

Table 1: *Phassus* spp. and distributions.

Species	Type locality	Type in collection	Distribution
<i>Phassus aurigenus</i> PFITZNER, 1914	Costa Rica: Cartago, Orosi, 1200 m	SMFL	Costa Rica
<i>Phassus basirei</i> SCHAUS, 1890	Mexico: Veracruz, Coatepec	USNM	SE Mexico
<i>Phassus championi</i> DRUCE, 188	Guatemala: Baja Verapaz, Purulhá, 1200 m	NHMUK	Costa Rica, Guatemala
<i>Phassus chrysodidyma</i> DYAR, 1915	Mexico: Zacualpan	USNM	SW Mexico
<i>Phassus exclamationis</i> PFITZNER, 1938	unknown	unknown	unknown
<i>Phassus huebneri</i> (GEYER, 1838)	Mexico	NHMUK	S Mexico to Central America
<i>Phassus marcius</i> DRUCE, 1892	Mexico: Durango, near Durango City	NHMUK	SW Mexico
<i>Phassus n-signatus</i> WEYMER, 1907	Guatemala	unknown	S Mexico to Central America
<i>Phassus phalerus</i> DRUCE, 1887	Mexico: Veracruz, Jalapa	NHMUK	SE Mexico to Central America
<i>Phassus pharus</i> (DRUCE, 1887)	Guatemala: Las Mercedes, 900 m	NHMUK	SE Mexico to Central America
<i>Phassus rosulentus</i> WEYMER, 1907	Mexico: Veracruz, Jalapa	unknown	SE Mexico
<i>Phassus triangularis</i> EDWARDS, 1885	Mexico: Veracruz, Jalapa	AMNH	SE Mexico to Central America
<i>Phassus violetteae</i> C. MIELKE & GREHAN, 2016	Costa Rica: Cartago, Tapantí, 1600 m	MNCR-A	Costa Rica

along lateral and distal anterior margins, posterior margin straight; tergum VIII subrectangular, longer than wide with wider anterior margin; sternum VII triangular, narrowing to posterior apex; sclerotization of sternum VIII reduced to narrow elbowed ridge anteriorly and small, posterior elongate ovoid shape.

♂ **genitalia** (Fig. 11). Tegumen strongly sclerotized, fused to pseudotegumen. Saccus wider than long, with central apodemal suture curving in parallel with anterior margin, posterior margin of saccus forming a centrally raised ridge. Tergal lobes absent. Pseudotegumen strongly sclerotized, postero-ventral apex narrowly fused at the median, smooth edged along base of membranous phallus. Fultura superior U-shaped; fultura inferior rectangular, about twice as long as wide with a strongly sclerotized anterior margin with central longitudinal sclerotized band narrowing towards the posterior margin. Valve lobate, slightly elbowed, broad and covered with short setae, anterior sacculus with short tooth. Phallus membranous without cornutus.

♀ unknown.

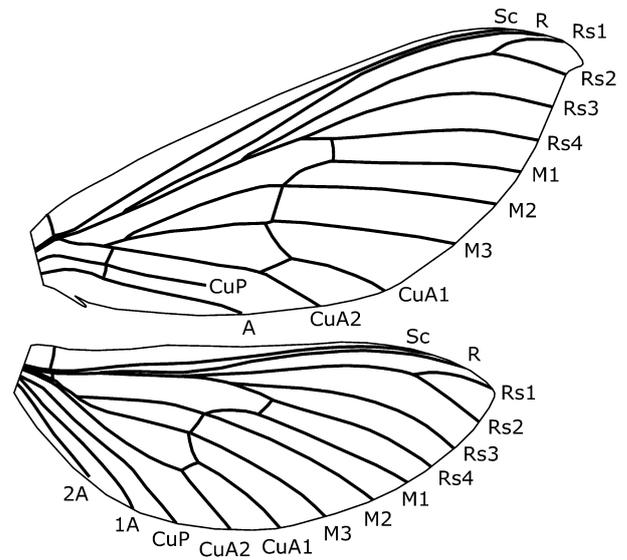
**Etymology.** PFITZNER (1914) did not refer to the etymology, however, it is obvious that he named for its golden appearance: gold-begotten.

**Diagnosis.** This species is easily distinguished from all other *Phassus* by the orange-gold ground color of the forewings. FW has a unique distribution of silvery white spots in the basal, central, and outer areas of the FW, and golden brown shading interspersed with darker grayish brown markings.

**Distribution and habitat.** Known only from Orosi region of Cartago Province in central Costa Rica (Fig. 12). Published records of *Phassus* distributions in Costa Rica are extremely limited and so there is no wider context to anticipate whether *P. aurigenus* is geographically restricted to forests of the Tapantí area (Fig. 13) or is more widespread.

The habitat of *P. aurigenus* comprises mid-elevation tropical rain/cloud forest (Fig. 14) where trunks and branches of trees are extensively covered with mosses and epiphytes (Fig. 15). The climate of Costa Rica comprises a pronounced wet and dry season (BRABY & NISHIDA 2010). The climate of the nearby municipality of Orosi has a short dry season between January and April with the remaining months subject to more than twice as much rainfall (EN.CLIMATE-DATA.ORG, OROSI 2018). The mean annual average rainfall in the Tapantí sector of the Park (where the specimens were collected) is 6550 mm and permanent clouds and mist are regularly in contact with the forest vegetation (BERNARD et al. 2009). The collection records between April and August are all well within the wet season.

Eggs of Hepialidae are dropped to the ground when females are at rest or flying (GREHAN 1989, SIMONSEN 2018). The eggs require near 100% humidity to complete



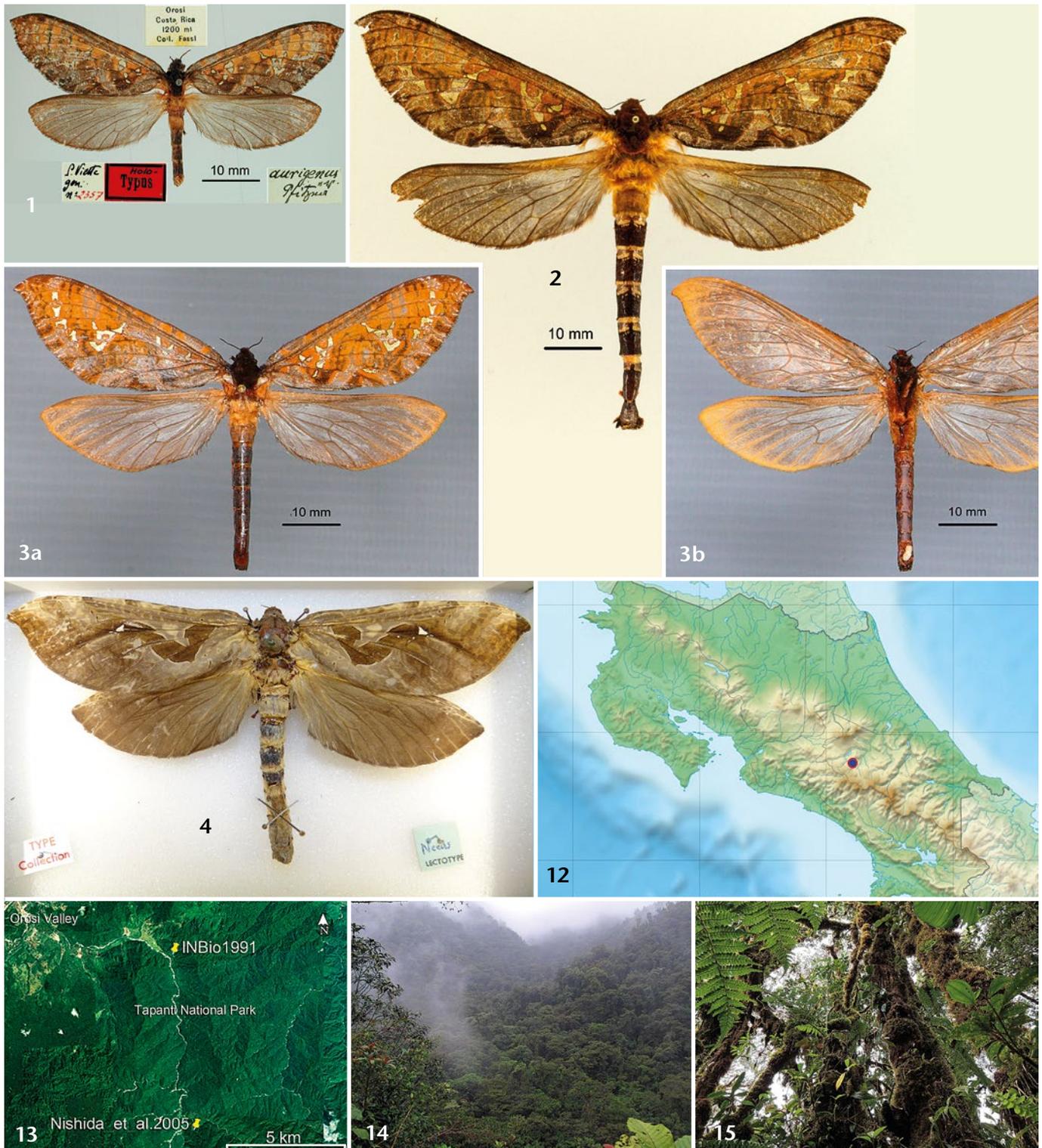
**Text Fig. 8:** *Phassus aurigenus*, wing venation.

development although excessive ground surface water may result in drowning. This moisture regime would also apply to first and early instars where there is an initial detrital feeding phase prior to boring into plant stems (cf. GREHAN 1989). While many species of South American Hepialidae appear to emerge at the beginning or end of wet season (GREHAN & RAWLINS 2016), a more extended emergence during the wet season is not precluded, particularly where it characterizes such a majority of the year as in Costa Rica. Details of early larval development of *P. aurigenus* under these climatic conditions would be valuable contribution to the characterization of hepialid larval development in general.

**Examined specimens.** In total 6 ♂♂. All from Costa Rica, Cartago: 1 ♂, Orosi, Tapantí National Park, 1300 m, 9°41' 39.29" N, 83°46' 36.99" W, 28. iv. 2005, lights at night, K. NISHIDA, M. HOSHI, K. Hotta leg., JRG Dissection M267 (CMNH). 1 ♂, Tapantí, 1200–1700 m, 20. viii.–15. ix. 1999, V. O. BECKER leg. (CGCM 14.005). 1 ♂, Tapantí, 1600 m, 21. iv. 2012, CAMPOSECO & MONZÓN leg. (CGCM 24.846). 1 ♂, Ref. Nac. Fauna Silv., Tapantí, 1250 m, G. MORA leg., viii. 1991, L-N-194000, 559800 (MNCR-A CR1000 360378). 1 ♂ (HT), Orosi, 1200 m, ex coll. FASSL (SMFL). 1 ♂ (NHMUK).

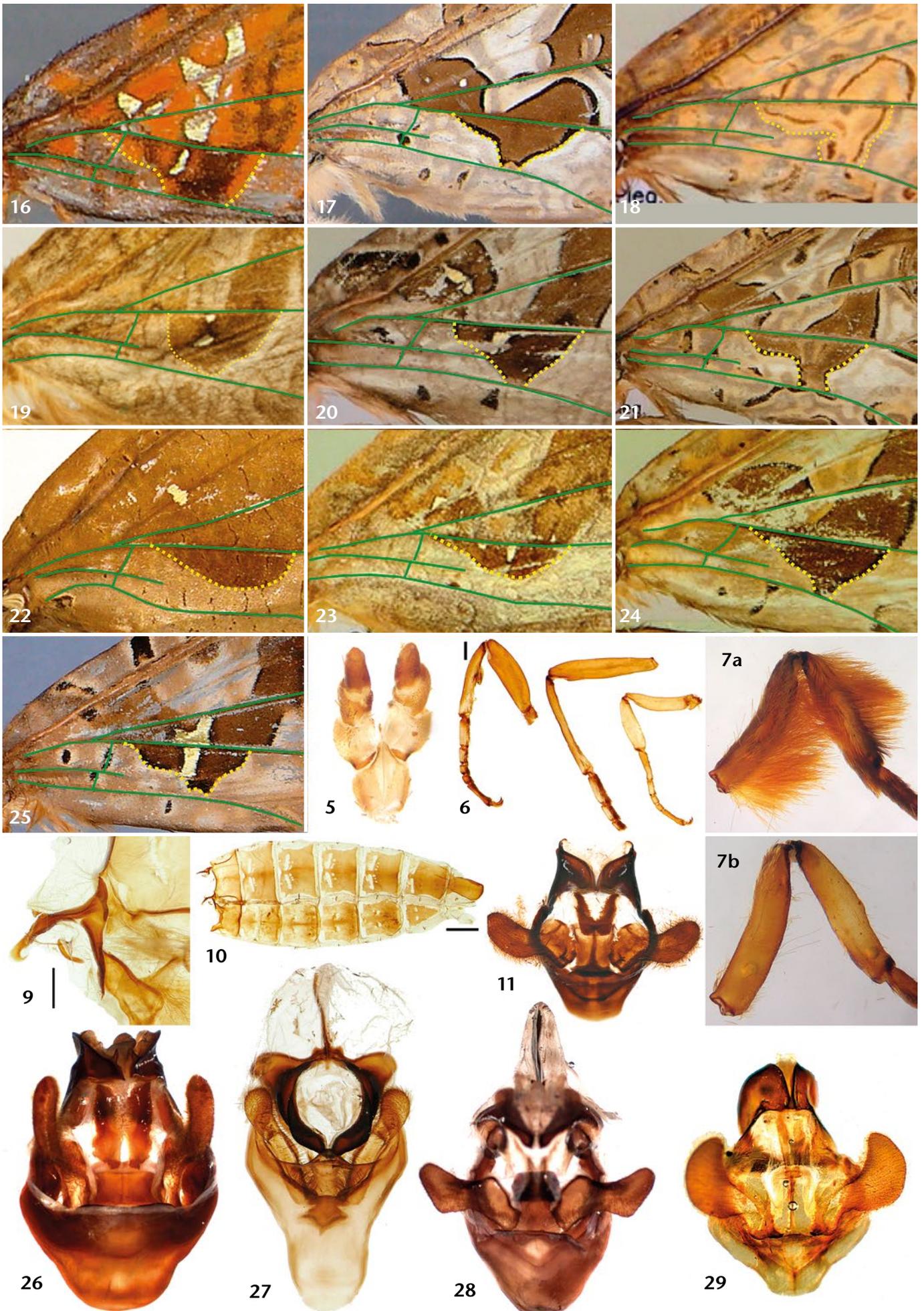
#### Remarks

The monophyly of *Phassus* has yet to be determined, and this will not be possible until most or all species have been characterized. Although the golden orange color is distinctive for *P. aurigenus* (Figs. 1, 2, 3a, 16), the FW pattern shows general similarities to other *Phassus* species. In particular, the presence of a shaded patch extending between  $CuA_2$  and A is a consistent feature shared among all the larger species of *Phassus* (Figs. 17–21, 24, 25) except *P. phalerus* DRUCE, 1887 (Fig. 22) and *P. pharus* (DRUCE, 1887) (Fig. 23) where the patch forms a semi-circle and extends only half way to CuP.



**Figs. 1–3:** *Phassus aurigenus*, ♂. **Fig. 1:** HT, dorsal. **Fig. 2:** MNCR-A CR1000 360378, dorsal. **Fig. 3a, b:** CGCM 24.846 (CGCM); dorsal (3a), ventral (3b). — **Fig. 4:** *Phassus triangularis*, LT ♀, dorsal. — **Figs. 12–13:** Geographical distribution of *Phassus aurigenus* within Costa Rica (12) and collecting sites (13) (©: Google Earth, CNES/Airbus, Landsat/Copernicus, and DigitalGlobe). — **Figs. 14–15:** Habitat of *Phassus aurigenus* in the collecting site in Tapantí National Park.

**Figs. 16–25:** Position of cubital patch (bordered by yellow dotted lines; veins in green) in different *Phassus* spp.: **Fig. 16:** *P. aurigenus*, ♂ (CGCM 14.005, CGCM). **Fig. 17:** *P. basirei*, ♂, Mexico, Veracruz, Sierra de los Tuxlas (CGCM 32.282, CGCM). **Fig. 18:** *P. championi*, ♂, Guatemala, Zacapa, El Naranjo (CGCM 24.115, CGCM). **Fig. 19:** *P. chrysodidyma*, ♀, Mexico, Arcos (AMNH). **Fig. 20:** *P. huebneri*, ♀, Guatemala, Suchitepéquez, Patulul (CGCM 23.300, CGCM). **Fig. 21:** *P. n-signatus*, ♀, Guatemala, Zacapa, El Naranjo (CGCM 24.307, CGCM). **Fig. 22:** *P. phalerus*, ♂, Mexico, Vera Cruz, Jalapa (NHMUK). **Fig. 23:** *P. pharus*, ♂, Guatemala, Zacapa, La Unión (CGCM 7.110, CGCM). **Fig. 24:** *P. triangularis*, ♂, Guatemala, Huehuetenango (CGCM 25.180, CGCM). **Fig. 25:** *P. violetteae*, ♀, Costa Rica, Cartago, Tapantí (MNCR-A). — **Figs. 5–7:** *Phassus aurigenus* ♂, details of morphology. **Fig. 5:** Labial palpi, ventral view (unscaled). **Fig. 6:** Legs, lateral view. **Fig. 7:** Metaleg with scales (7a); metaleg without scales (7b), (M267, CMNH). Scale bars 1 mm. — **Figs. 9–11:** *Phassus aurigenus*, Abdominal morphology and ♂ genitalia. **Fig. 9:** Tergosternal connection (M267, CMNH). Scale bar 1 mm. **Fig. 10:** Abdominal sclerites (M267, CMNH). Scale bar 5 mm. **Fig. 11:** ♂ genitalia: ventral view (M267, CMNH). — **Figs. 26–29:** Different *Phassus* species, ♂ genitalia, ventral view. **Fig. 26:** *P. huebneri*, Mexico, Sinaloa, Choix (JRG M228, CMNH). **Fig. 27:** *P. violetteae*, Costa Rica, Cartago, Tapantí (CGCM 25.440, CGCM). **Fig. 28:** *P. triangularis*, Guatemala, Baja Verapaz, Biotopo del Quetzal (JRG M159, JRG). **Fig. 29:** *P. pharus*, Guatemala (JRG M213, CMNH). All unscaled.



Genitalic characterization of *Phassus* is much more limited. The shape of the pseudotegumen in *P. aurigenus* (Fig. 11) is similar to that of *P. huebneri* (Fig. 26) and *P. pharus* (Fig. 29), and in these three species, the fulcrum superior is bifurcated and dorsally elongate. They also differ from *P. violetteae* (Fig. 27) and *P. triangularis* (Fig. 28) where the ventral pseudotegumen is narrow and there is a central posterior-dorsal strut (medially fused tergal lobes) that extends along the ventral surface of tergum VIII.

### *Phassus triangularis* EDWARDS, 1885

Fig. 4, 24, 28.

EDWARDS (1885) described *Phassus triangularis* based on an uncertain number of specimens. One syntype ♀, figured here for the first time (Fig. 4), deposited in AMNH, bears the label "type". This specimen is here designated as lectotype. It has the following labels: / *Phassus triangularis* Hy. EDW. Type/ Jalapa Mexico/ Type, No., A.M.N.H./ No. 8689, Collection Hy. EDWARDS/ Lectotype, *Phassus triangularis* EDWARDS, 1885, GREHAN & MIELKE des. 2018.

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We thank John NOYES (NHMUK) for climatic information, Ernst BROCKMANN (Lich) for imaging the holotype of *Phassus aurigenus*, and Diego DOLIBAINA (Curitiba) for locating the syntypes of *Phassus triangularis* in the AMNH.

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