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Trichothurgus bolithophilus sp. n. (Hymenoptera, Megachilidae) a bee nesting in horse manure pads in Patagonia, Argentina

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Abstract

A new species of *Trichothurgus,* described herein, *T. bolitophilus* **sp. n.**, nests in dry horse manure pads in Chubut, Patagonia, Argentina. The simplest nests consisted of one main tunnel ending in a series of 2 cells without partitions between them. In the more complex ones up to 6 cells were connected laterally to the main tunnel. Nests showed signs of reutilization. The behavior of nesting in horse manure is described for the first time in bees.

Keywords

Trichothurgus bolitophilus sp. n., nests, horse manure, Patagonia, Argentina

Introduction

The Lithurgini is a small basal group of the Megachilidae distributed in tropical to temperate and semi-arid regions worldwide (Michener 2000; Litman et al. 2011). The tribe consists of only three genera (*Lithurgus*, *Microthurge* and *Trichothurgus*) with 61-

64 species, with the genus *Trichothurgus* comprising 13 species (Michener 2000) until now. The biology of the group is relatively well known and the nesting behavior of some of its species has been described in some detail. The members of Lithurgini excavate galleries in dead, soft or relative hard and dry wood (Roberts 1978; Kitamura et al. 2001; Rust et al. 2004; Hannan and Maeta 2007). The nesting behavior of *Lithurgus* species from North America (Parker and Potter 1973; Brach 1978; Roberts 1978), Europe (Malyshev 1930; Cros 1939; Rust et al. 2004), Japan (Kitamura et al. 2001; Hannan and Maeta 2007), Brazil (Camillo et al. 1983) and Australia (Houston 1971) has been studied with different degrees of detail whereas the biology of *Microthurge corumbae* has been studied in detail (Garófalo et al. 1981; Garófalo et al. 1992). In contrast, the nesting behavior of *Trichothurgus* species is poorly known. There are two mentions about the nests of *T. dubius* from Chile that were barely described by Claude-Joseph (1926) and redescribed later by Rozen (1973). The only reference about the use of dung pads by bees is by Michener (2000, pag. 427 and pers. com.), who mentioned the use of cow manure as nesting substrate by lithurgines without reference to a particular genus or species.

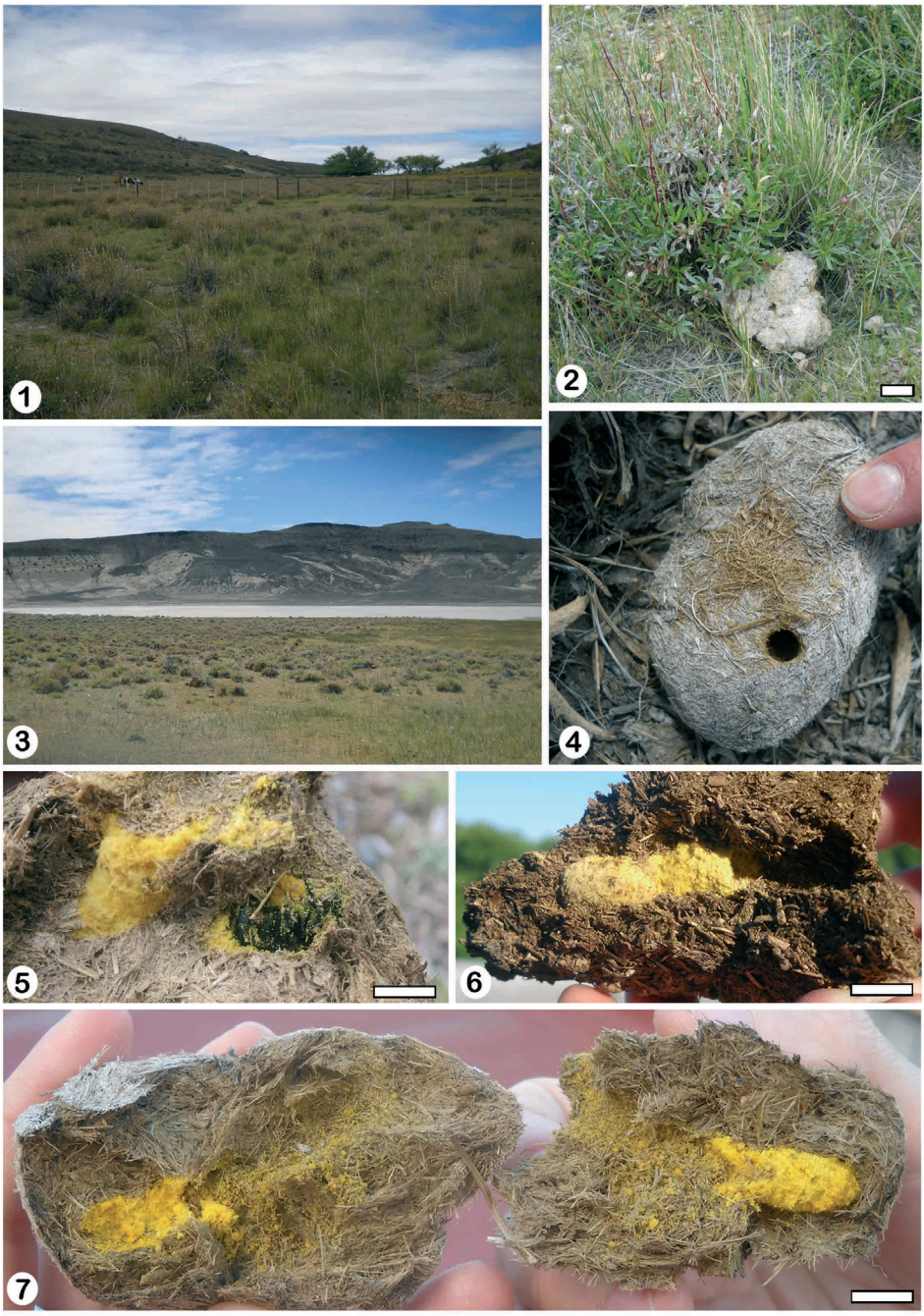
This contribution describes the nests of the new species *Trichothurgus bolitophilus*, in horse dung pads. It represents the first description of the use of dung pads for nesting by bees.

Study area

A total of 6 nests of *Trichothurgus bolitophilus* were found inside dry horse manure at two localities in Chubut Province (Patagonia, Argentina). Five nests were found at the Estancia Las Mellizas (locality 1) (45°04. 91'S, 68°02.7'W; 589 m (Fig. 1) and one nest in "Laguna de los Flamencos" (locality 2) (44°37.58'S, 69°07.5'W; 526 m) (Fig. 3). Both localities are included in the driest zone of Chubut, where the annual rainfall ranges between 100 to 150 mm and the mean annual temperatures range between 8 and 11° C (Burry et al. 2005). The vegetation comprises bush steppes of very low coverage with short cushion shrubs, sparse grasses, and *Nassauvia glomerulosa* (Asteraceae) as dominant. In lower areas also are extensive halophytic communities including *Chuquiraga aure*a (Asteraceae), *Atriplex* sp. (Amaranthaceae), and *Frankenia patagonica* (Frankeniaceae) (Burry et al. 2005). At Locality 1 the vegetation included abundant specimens of the introduced *Grindelia chiloensis* (Asteraceae), and secondarily *Senecio filaginoides* (Asteraceae). At locality 2 plants of *Azorella monantha* (Araliaceae) were abundant.

Description of nests

The nests were studied and collected in the field during 10 to 14 December 2010. At locality 1, dung pads with nests 1 to 5 were found within a fenced grassy area for



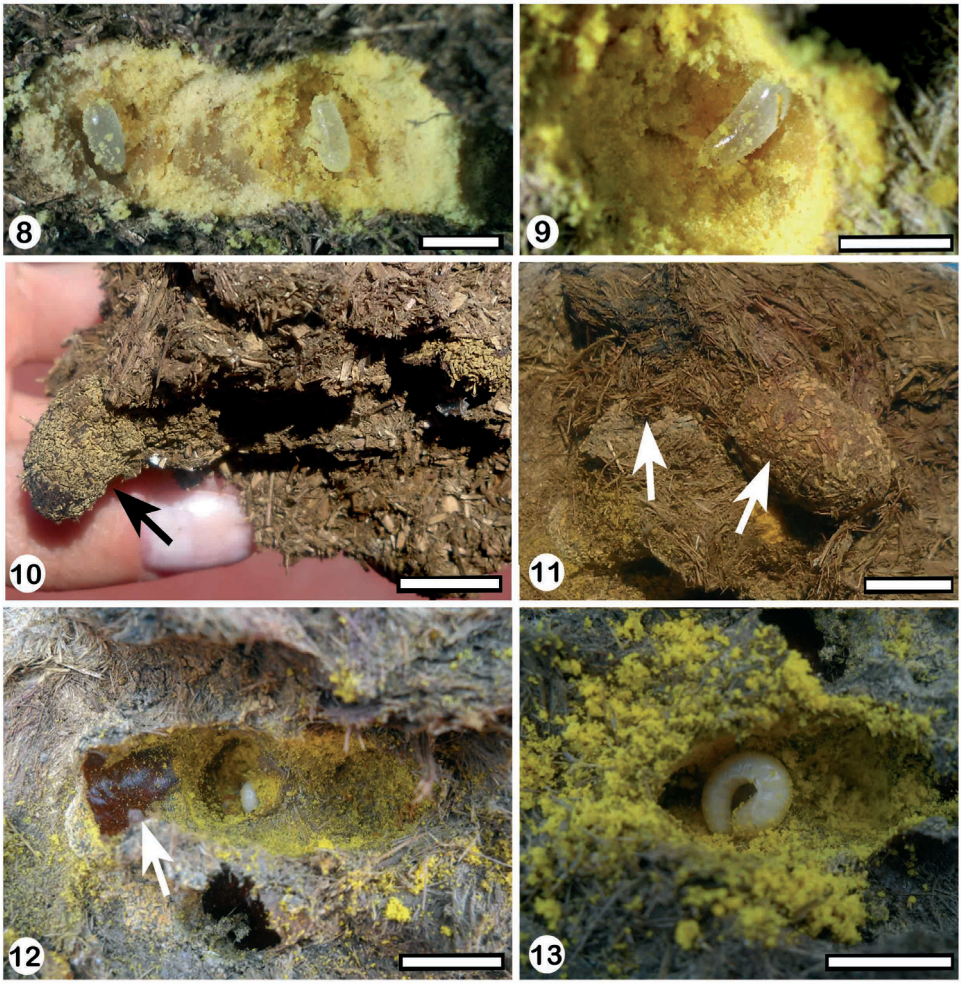
Figures 1–7. 1 general view of locality 1 Estancia Las Mellizas **2** nest 1 at Estancias Las Mellizas **3** general view of locality 2 "Laguna de los Flamencos" **4** nest 6 showing the open entrance hole and dung fibers **5** nest 5 showing the third cell with an alive and immobile female **6** nest 2 showing the provisioned cells with yellow packed pollen **7** unlined tunnels and cells with pollen of nest 6. Scale lines: **Fig 2**: 10 cm, **Figs 5–7**: 1 cm.

horse grazing (Fig. 1). At locality 2, nest 6 was found in a pad near a small saline pond (Figs 3 and 4). The simplest nests consisted of one main tunnel ending in a series of 2 cells without partitions between them. Two of them also showed one short, empty, and blind tunnel. In the more complex ones up to 6 cells were connected also laterally to the main tunnel (Figs 6 and 7). Entrances of the nests were rounded and usually open (Fig. 4). The tunnels and cells were unlined, although they had a smooth surface (Fig. 7). The provisioned cells contained pollen of Asteraceae and Amaranthaceae in roughly equal proportions, and eggs or larvae. In some cases cells also contained remains of old cocoons, indicating reutilization of nests. Beyond these common features, each nest showed different morphologies that need to be described individually.

Nest 1 (Fig. 14): it was excavated in a piece of dung composed of two parts, a bigger one below (L: 11 cm, W: 15 cm, H: 9 cm) and a smaller part on top (L: 10 cm, W: 6 cm, H: 9 cm) (Fig. 2). The entrance was open and located in the middle of the upper part. The main tunnel was 6 cm long and 1 cm in diameter. Its first portion, located entirely in the upper piece of dung, was 4 cm long, vertical, and almost straight (Fig. 14). It continued into the other piece of dung in a short and horizontal portion, 2 cm long. At 5 cm from the entrance there were two opposite series of two cells, without partitions, directly connected to the tunnel (Fig. 14). The cells were vertical, with rounded ends, and closed by a dung disk that was concave outside. These two cells were 2.4 cm long and 1 cm in diameter. The cells were completely filled with yellow packed pollen that was moist, probably because of the mixture with nectar. The provision contained two eggs, each one was inside an ellipsoidal chamber slightly larger than the egg (Figs 8 and 9). The first and anterior egg was at 1.5 cm (N: 2) from the top of the packed provision. The distance between egg chambers was 10 mm (N: 2). The eggs were whitish translucent, 0.5 cm long and 0.15 cm wide, and cylindrical with rounded ends, and were located horizontally inside the chambers (Figs 8 and 9). The main tunnel ended in an open, incomplete, vertical third cell that had an alive, immobile female (Figs 5 and 14).

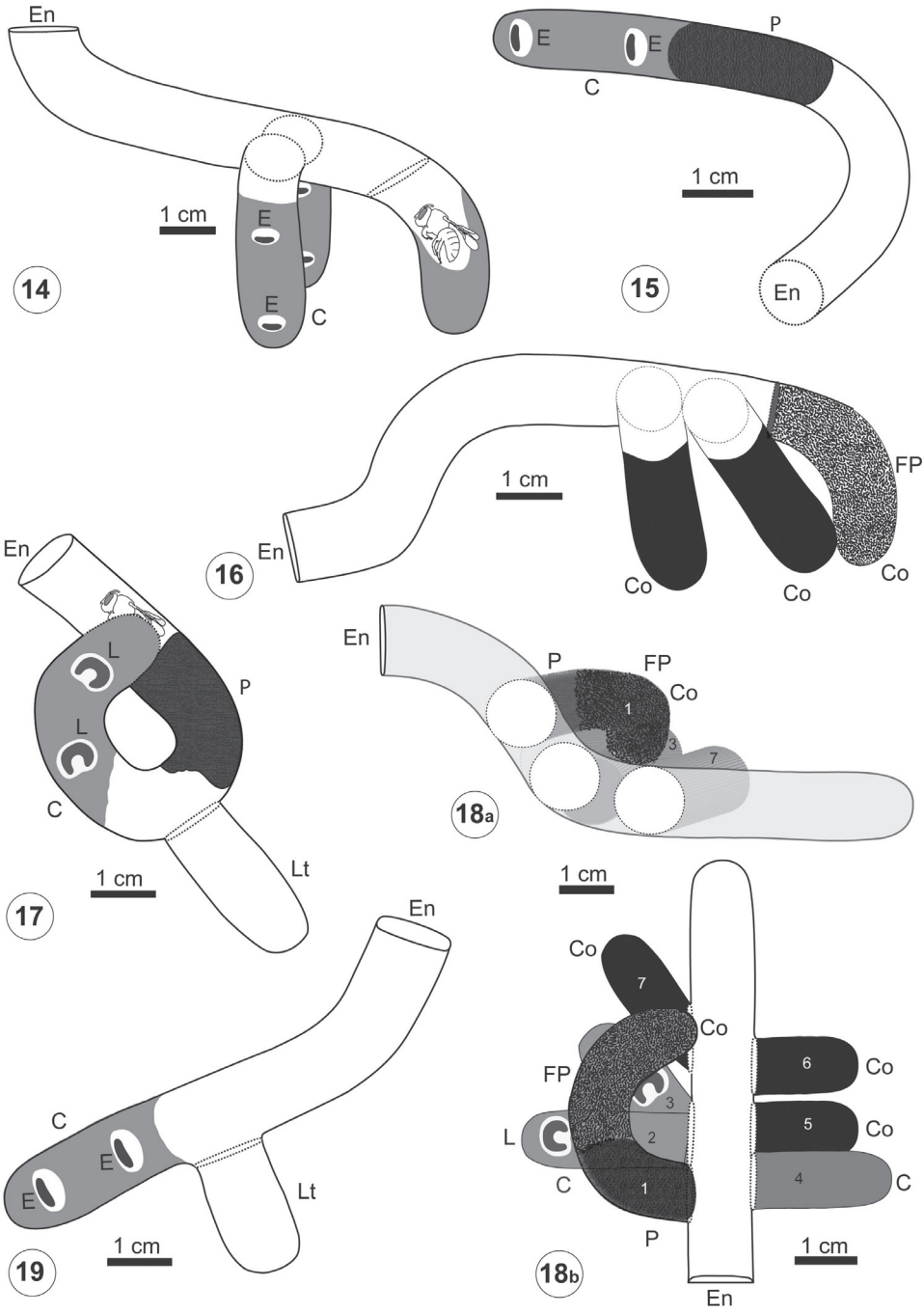
Nest 2 (Fig. 15): it was constructed in one piece of dung 8 cm long, 9 cm wide, and 5.5 cm high (Fig. 6). The entrance was open and located in one side of the pad. The nest showed one curved and horizontal main tunnel, 4.5 cm long and 1 cm in diameter that ended in a series of two cells without a partition between them (Fig. 15). The series of two cells was also horizontal, 2.9 cm long and 1 cm in maximum diameter and closed with a plug of dung fibers of 2.5 cm thick (Figs 8 and 15). The series of cells was provisioned with yellow packed pollen and contained two eggs which were included in individual chambers separated by 0.7 cm from each other. The dung pad also contained old cocoon remains without apparent connections with the tunnels. The cocoons were composed of a thin coriaceous layer of dark brown silk with a varnish-like substance on the smooth inner surface.

Nest 3 (Fig. 16): it was located in one piece of dung 11.2 cm long, 6.6 cm wide, and 4 cm high. The entrance, located laterally in the dung pad, was closed with a thin plug of dung fibers. The main tunnel, 6 cm long and 1 cm in diameter, was sinuous and ended in a cell containing cocoon remains (Fig. 16). The nest had



Figures 8–13. 8 the provisioned cells of nest 6 showing the eggs inside cavities **9** one egg inside the cavity of nest 6 **10** third cell of nest 3 showing the fecal pellets attached to the walls **11** cell 1 of nest 5 showing the plug of dung fibers (left arrow) and the random distribution of fecal pellets in cocoon walls (right arrow) **12** old cocoon remains inside cell 2 of nest 5 indicating reutilization of cells **13** cell 2 of nest 5 showing young larvae. Scale lines: **Figs 8–9**: 0.5 cm, **Figs 10–13**: 1 cm.

two other old open cells with emerged cocoons inside. The cells were 2.5 cm long and 1 cm in maximum diameter. The cocoons were shorter than cells (2 cm long) and their walls were similar to those from nest 2 (Fig. 10). The first cell was located in the main tunnel at 6 cm from the entrance and it was vertical, with its bottom pointing downwards. The second cell was located beside the first one, with their bottom pointing laterally. The third, curved cell was located at the end of the main tunnel. The cocoons from the second and third cells had old fecal pellets attached to their walls. The fecal pellets were elliptical yellow-brown, and oval in cross sec-



Figures 14–19. Architecture of *Trichothurgus bolitophilus* nests **14** nest 1 **15** nest 2 **16** nest 3 **17** nest 4 **18a–18b** nest 5, the numbers 1 to 7 indicate the cells and cocoons **19** nest 6. **C**: provisioned cell, **Co**: cocoon, **E**: egg, **En**: entrance, **FP**: fecal pellets, **L**: larva, **P**: plug of dung fibers. Scale lines: **Figs 14–19**: 1 cm.

tion, with rounded ends. They were 0.9 mm long, 0.4 mm wide, and distributed randomly (Fig. 10, arrow).

Nest 4 (Fig. 17): it was located in a piece of dung 24.5 cm long, 18.4 cm wide, and 7 cm high. The entrance was located up and laterally in the pad. At 1 cm from the entrance there was a dead female inside the main tunnel. The main tunnel was coiled, 4.6 cm long and 1 cm in diameter that was partially filled with dung fibers. At 4.5 cm from the entrance, it was an empty, short lateral tunnel. The main tunnel ended in an open and curved series of two cells without a partition between them. The series of cells, 2.5 cm long and 1.0 cm in diameter, contained yellow packed pollen and two young larvae.

Nest 5 (Fig. 18): it was located in a piece of dung 14.3 cm long, 8.4 cm wide, and 7 cm high. The main tunnel was horizonal, sinuous in vertical section, 6.7 cm long and 1 cm in diameter. At 2.5 cm from the entrance arose a C-shaped secondary tunnel, whose final portion rested over the main tunnel. The secondary tunnel was 4.4 cm long and 1 cm in diameter and contained remains of a cocoon (cell 1). The cocoon showed fecal pellets attached to its walls (Fig. 11, right arrow). The tunnel was closed with a plug of dung fibers (Fig. 11, left arrow). Adjacent to the secondary tunnel were located three more cells (cells 2-4). Cells 2 and 3 branched from the same point of the tunnel. Cell 2 was perpendicular to the main tunnel, whereas cell 3 was oriented in an acute angle to it. Cells 2 and 3 were 2.6 cm long and 0.8 cm in diameter. Both cells were located inside old cocoons (Fig. 12) and contained yellow packed pollen and a larva in each one. The larva from cell 2 was younger than that from cell 3 (Fig. 13). In addition, at 2.5 cm from the entrance and in front of the secondary tunnel was located a fourth cell (cell 4), inside an old cocoon. The cell 4 was 2.5 cm long, 0.8 cm in diameter, and contained packed pollen that seemed to be old because of its dryness and decoloration. At the sinuous, middle part of the main tunnel, were located three more cells (cells 5-7). Two of them (cells 5 and 6) at one side were straight and perpendicular to the main tunnel. Both cells were 1.5 long, 0.8 cm in diameter, and were empty, containing only old emerged cocoon. Cell 7, at the other side, was oriented at an angle to the main tunnel and was 2.5 long and 0.8 mm in diameter. It was also empty and contained only emerged old cocoon.

Nest 6 (Fig. 19): it was located in a piece of dung 8 cm long, 5.6 cm wide, and 4 cm high (Figs 4 and 7). The entrance was open and located on top. There were dung fibers and pollen grains on the dung around the entrance (Fig. 4). The main tunnel, slightly curved and inclined downwards, was 5.9 cm long and 1 cm wide finishing in an open series of two cells without partitions. The wall of the main tunnel had pollen grains adhering that gave it a yellow appearance. At 3.2 cm from the entrance arose an open and empty lateral tunnel. It was 1.9 cm long and 1 cm wide, with a rounded end (Fig. 19). At the end of the main tunnel was a series of two cells of 2.5 cm long and 1cm in diameter. The series of cells had packed pollen and two eggs, located in individual chambers 1.5 cm apart.

Discussion

Trichothurgus bolitophilus shares with most Lithurgini several behavioral characters. However, one important difference is striking: the substrate used for nesting. Typically, members of *Lithurgus* nest in dead, soft to relative hard dry wood or cactus (Rozen 1973; Roberts 1978; Kitamura et al. 2001; Rust et al. 2004). The first mention of the nesting biology of a member of *Trichothurgus* was by Claude-Joseph (1926), who found cells of *T. dubius* inside an old nest of *Odynerus humeralis* (Vespidae: Eumeninae). Later, in the only other report on nests of *Trichothurgus*, Rozen (1973) described cells and cocoons of the same species in dead cactus.

Trichothurgus bolitophilus excavates its nests in horse dung. It is difficult to understand the advantages to nest in dung pads on Patagonian plateaus. Cows are absent at this altitude so the only providers of this type of dung are horses, which are scarce and restricted to house surroundings. They were introduced in this continent in historical times, all of which suggest that *T. bolitophilus* must have had, and still has, alternative nesting substrates, which probably are similar in texture to dung. Other plant substrates used by Lithurgini are strong candidates. Cactaceae are present in the region, although these plants are also scarce and small. Dry cushions of *Azorella monantha* (Araliaceae) form a structure similar in aspect and texture to dung pads. Also wood from houses and fence posts may be alternative substrates in historical times. However, we failed to find nests in these substrates. Beside scarcity, exposed dung is subject to harsh environmental conditions. Strong winds are very common in Patagonia, which can blow easily dung pieces such as where nest 6 was found. In winter, these plateaus are covered with snow and the cold would seem to be too intense for the overwintering imagos or post-defecating larvae to be protected only by a centimetric layer of dung on the soil surface.

Typically, members of Lithurgini are considered to be oligolectic bees (Michener 2000), although *Lithurgus collaris* was observed to collect pollen from different families of plants (Kitamura et al. 2001; Hannan and Maeta 2007). Other species of *Lithurgus* gather pollen from Cactaceae, Malvaceae, Asteraceae and Convolvulaceae (Houston 1971; Rust et al. 2004). The only reference for *Trichothurgus* indicates that at least some species forage in cactus (Claude-Joseph 1926; Ruiz 1940; Toro et al. 1996; Michener 2000). The pollen analysis from cell contents in *T. bolitophilus* revealed the presence of Asteraceae, which was abundant at locality 1. Pollen of Amaranthaceae was also present in roughly same proportions as Asteraceae. In many other behavioral characteristics, such as the presence of several eggs in the same provision, unlined cells, and reutilization of nests by subsequent generations, *Trichothurgus bolitophilus* is similar to other Lithurgini. There are some architectural characters that show some differences. In nests of *T. bolitophilus,* cells were connected directly to the main tunnel, whereas in those of other species, such as *Microthurge corumbae* (Garófalo et al. 1981), *L. chrysurus* (Roberts 1978) and *L. collaris* (Kitamura et al. 2001), nests are composed of several secondary tunnels leading to numerous cells. The secondary tunnel of nest 5 was not actively used suggesting the

possibility that it was not a true branching of the present nest but a remnant of an old nest. Two nests of *T. bolitophilus* had an empty, blind, secondary tunnel (nests 4 and 6), whose function was not clear. They may be excavations for future cells. *Lithurgus huberi* (Camillo et al. 1983) and *M. corumbae* (Garófalo et al. 1981; Hannan and Maeta 2007) had blind tunnels near the entrance. Garófalo et al. (1981) called them "chambers" suggesting that they may be used as resting or guarding places, whereas Hannan and Maeta (2007) indicated that those structures may be used for facilitating movements inside the nest.

In most Lithurgini the cells are arranged in series (Roberts 1978; Rust et al. 2004), which may be separated by transverse partitions of wood-dust (Roberts 1978). In nests of some species, such as *Lithurgus chrysurus* (Roberts 2004), *L. atratiformis* (Houston 1971), and *L. fuscipennis* (Malyshev 1930) these partitions may be facultatively absent. Partitions between cells were absent in all cases in *Trichothurgus bolitophilus*, as well as in all nests observed of *Microthurge corumbae* (Garófalo et al. 1981) and *L. collaris* (Litman et al. 2001, Hannan and Maeta 2007). The tunnels and cells of *T. bolitophilus* were unlined as in the rest of lithurgines (Litman et al. 2011). The absence of a lining in lithurgine nests was originally attributed to a behavioral loss associated with above-ground nesting (Malyshev 1930). However, a recent phylogentic analysis of the Megachilidae by Litman et al. (2011) suggested, since the lithurgines are a basal group of the family, this character may represent an ancestral trait in this clade.

Lithurgus chrysurus, L. collaris, *L. huberi* and *Microthurge corumbae* all, at least occasionally, reutilize their nests (Roberts 1978; Kitamura et al. 2001; Garófalo et al. 1992; Hannan and Maeta 2007; Camillo et al. 1983). In *Trichothurgus bolitophilus,* nests 2 and 5 had recently provisioned cells that contained remains of old cocoons against the walls, indicating a nest reutilization for this species as well. The reuse of the same substratum was proposed as a primitive social strategy shown by certain bees and wasps (Camillo and Garófalo 1989). However, in *T. bolitophilus* the reutilization of the same nest is probably more related to the exploitation of scarce substrata. In fact, the utilization of dung horse pads as nest sites probably represents an alternative strategy for when the plant substrates commonly used by lithurgines are scarce.

Taxonomy

Trichothurgus bolitophilus **Durante & Roig Alsina, sp. n.**
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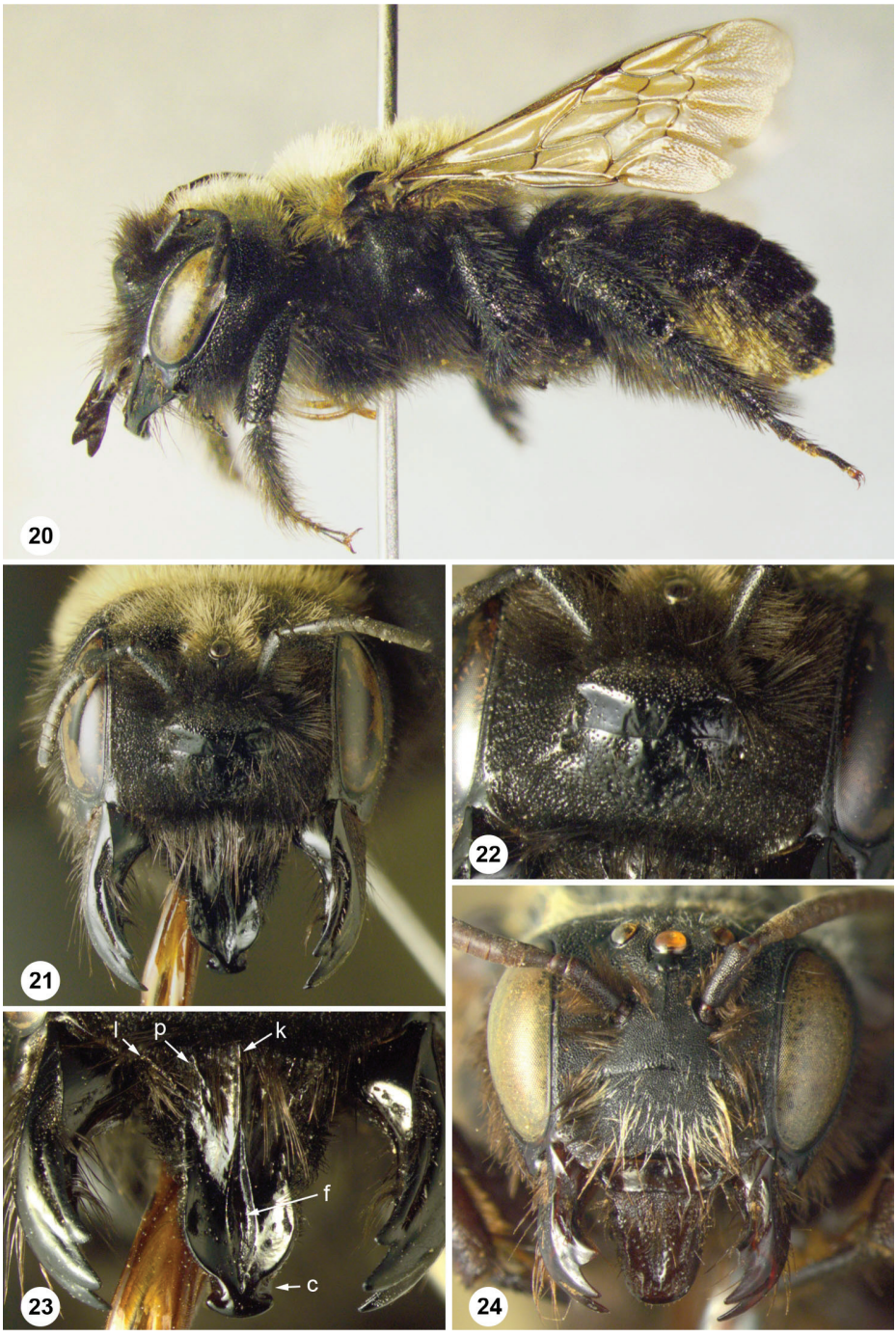
http://species-id.net/wiki/Trichothurgus_bolitophilus
Figs 20, 24

Description. *Female holotype.* Body length 13.6 mm (paratypes, 13.0-16.0 mm), length of forewing 9.2 mm, maximum width of head 5.9 mm, maximum length of head 4.5 mm. *Coloration.* Integument black except under surface of flagellum and tibial spurs dark bseriesn; front tibial spur and claws dark ferruginous (later black api-



Figures 20–24. *Trichothurgus bolitophilus* Durante & Roig Alsina, sp. n. **20** female holotype, habitus **21** female paratype Pampa Pelada, face **22** female paratype Pampa Pelada, detail of clypeus and facial prominence **23** female paratype Pampa Pelada, labrum: k, median longitudinal keel; p, paramedian carina; l, lateral carina; f, longitudinal furrow; c, preapical constriction **24** male, face.

cally). Wings evenly weakly infuscate, with apex appearing darker, due to black papillae; veins and pterostigma blackish.

Pubescence. Black, with yellowish hairs as follows: on vertex, between ocelli, dorsal portion of pronotum including pronotal lobe, scutum, scutellum, axilae and metanotum. Hairs on T1-T4 black at sides and dark brown medially, on T2-T5 forming black apical bands; T6 with dense covering of coarse, black hairs. Scopa black.

Punctation. Integument generally coriaceous, except smooth and shiny on labrum, clypeus, mandible, supraclypeal area below protuberance, around lateral ocellus, malar area, and on center of scutum. Clypeus with punctation sparse and irregular on basal medial area; punctures becoming smaller and denser toward apical and lateral margins. Supraclypeal area with few, scattered punctures below protuberance. Rest of head with small and dense punctures, except around ocelli. Mandibles unpunctured except on outer interspace. Scutum on mid-posterior region with large punctures separated by 0.3-1 times their diameter; punctures becoming smaller and denser on rest of surface; anteriorly with dense, poorly defined punctures. Scutellum and axilla with punctures separated basally, and denser toward posterior margin. Metapostnotum microsculptured. T1 with sparse, shallow punctures apically, separated by twice their diameter; punctures on T2-T5 becoming denser toward apex of metasoma.

Structure. Inner margins of eyes straight, subparallel, slightly divergent below (upper to lower interocular distance 0.97; paratypes 0.95-1.01); paraocular carina present. Lengths of scape, 1.20; pedicel, 0.24; flagellomeres 1 to 3, 0.42: 0.22: 0.22; flagellomere 10, 0.30; first flagellomere shorter than combined lengths of flagellomeres 2+3. Interantennal distance longer than distance from antennal insertion to median ocellus (1.10-0.50), shorter than antennocular distance (1.10-1.35), and subequall to antennoclypeal distance (1.10-1.00). Labrum 1.07 times as long as basal width (paratypes 1.03-1.35); base of labrum with median longitudinal keel (0.11 times length of labrum; variable in paratypes, 0.08-0.28, Fig. 23, k) short paramedian carina (Fig. 23, p) and strong lateral carina (Fig. 23, l); median keel continued apically by deep longitudinal furseries (Fig. 23, f) reaching preapical constriction (Fig. 23, c) (width of furseries 0.60 times median ocellar diameter; paratypes 0.74-0.88); median part of labrum broadened, with convex lateral margins (maximum width of median part 3.7 times median ocellar diameter; paratypes, 3.57-3.94); apex beyond constriction laterally pointed, and apically rounded to weakly pointed (some paratypes) (constriction as wide as median ocellar diameter; paratypes, 0.79-1.11). Clypeus flat, 0.73 times as long as basal width (paratypes 0.62-0.68); apical margin medially straight (Fig. 22). Supraclypeal area with facial protuberance prominent, convex in dorsal view, not carinate, laterally with conical projections (these projections are more developed in larger specimens) (Figs 21-22). Median ocellus located below supraorbital line; proportion of interocellar distance to ocellocular distance 0.64 (paratypes, 0.54-0.55); proportion of interocellar distance to ocelloccipital distance, 0.54 (paratypes, 0.46-0.50). Gena broader than eye in lateral view (1.17; paratypes, 1.25-2.66).

Observations. This species is closely related to *Trichothurgus laticeps* (Friese) and *T. dubius* (Sichel) by the shape of the labrum, with a preapical constriction, and the

similar shape of the facial prominence, with short lateral conical projections. It is intermediate in the color pattern of the vestiture, being *T. laticeps* entirely black, and *T. dubius* extensively white. The base of the labrum and the shape of the apical portion are different in the three species. The apex beyond the constriction is rounded in *T. laticeps* and *T. dubius*, without lateral conical projections. The base of the labrum in *T. dubius* bears a bifid projection, while in *T. laticeps* it bears a spiniform projection and several rugae between the median keel and the paramedian carinae.

A single male with the same labels as the female from Patagonia, San Jorge, is tentatively associated. Diagnostic structures of the labrum and the face in *Trichothurgus* are different in females and males, making sex association very difficult. This male has a similar color pattern, except that it bears white hairs on the face and on the first tergum. It completely lacks a facial protuberance, being the supraclypeal area slightly convex. Both the supraclypeal area and the clypeus are densely micropunctate, with the punctures coalescent, giving a dull appearance (Fig. 24). The labrum has a basal transverse depression delimited by a carina, the apex is rounded, and the median longitudinal depression is shallow (Fig. 24). The base of the labrum in *T. laticeps* and *T. dubius* is depressed laterally only, bearing medially a rounded protuberance which is not carinate apically. Males of *T. laticeps* are further differentiated by the sparser punctures with shiny interspaces on the clypeus and supraclypeal area.

Etymology. The name refers to the habits of this species, which makes its nests in dung pads (*boliton*, greek).

Distribution. Argentina, provinces of Santa Cruz, Chubut and Mendoza.

Material examined. Argentina. Holotype ♀: Chubut, ruta 24 entre Sarmiento y Paso de Indios, 44°37'35.20S, 69°7'30.10W, 529 m s.n.m., XII-2010, Genise col. (MACN); 2 ♀ paratypes, Chubut, Pampa Pelada, 45°4'54.89S, 68°2'48.68W, 20-XII-2010, Genise col. (MACN); 1 ♀ paratype, Patagonia, San Jorge (the San Jorge Gulf occupies the southern part of the province of Chubut and the northern part of the province of Santa Cruz) (MACN); 1 ♂ (tentatively associated) Patagonia, San Jorge (MACN); 1 ♀ paratype, Santa Cruz, ruta 3, El Salado, 22-II-1980, Willink, Fidalgo, Dominguez & Claps col. (IFML); 1 ♀ paratype, Mendoza, Ruta Termas Sosneado km 42, 11-I-1980, Willink, Fidalgo, Dominguez & Claps col. (IFML).

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SHORT COMMUNICATION

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Nest construction behavior by the orchid bee *Euglossa hyacinthina*

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Orchid bees (Euglossini) are a diverse and widespread Neotropical taxon comprised of five genera and nearly 200 species (Dressler 1982; Ramírez et al. 2002; Roubik and Hanson 2004; Cameron 2004). Nests are generally dispersed or otherwise difficult to locate, so the nesting biology of most species is unknown, and knowledge of euglossine nest architecture is fragmentary (*op. cit.*). Some species construct nests made of mud or resin within natural or man-made cavities, while others construct free-standing nests made of resin (*op. cit.*). *Euglossa* is the most speciose genus with 129 described species (Nemésio and Rasmussen 2011), but nest architecture has been described for only 24 species (< 20%), including both free-standing and cavity nests (reviewed by Ramírez et al. 2002).

Aerial nests of *Euglossa* are either built on the undersides of leaves, or are top-shaped and attached to plant stems (e.g., Young 1985; Eberhard 1988; Riveros et al. 2009). An example of the latter is the nest of *Euglossa hyancinthina*, which is attached to the side of secondary-growth plant stems. Gross nest architecture, general natural history and social behavior of *E. hyacinthina* have been described (Eberhard 1988; Soucy et al. 2003; Capaldi et al. 2007), but nest construction behavior has not been described for any aerial nester. During the course of other studies, we made observations on *E. hyacinthina* nest construction behavior, which, although preliminary, are worth summarizing here given the dearth of information about nest construction behavior in orchid bees.

Materials and methods

We studied *Euglossa hyacinthina* at the species' type locality in cloud forest near Fortuna, Panamá (Chiriqui Province) (elevation, ~ 1400 m). Nests were relatively abundant on small composites, mainly *Baccharis pedunculata*, between the Edwin Fabrega Hydroelectric Dam and about 2 km S of the Smithsonian Tropical Research Institute's Jorge L. Arauz Center for Tropical Investigations, along the side of the road running from Los Planes to Chiriqui Grande.

Nest construction behavior was recorded with a GoPro HD Hero2 video camera mounted on a support approximately 25 cm from the nest. A partially constructed nest was discovered on 30 August 2012, and video recordings were made from approximately 9:00 AM to 12:00 PM and 2:00 PM to 4:30 PM on 31 August, with additional photos taken on 2 September. Additional observations on cell construction were made intermittently between May 2011 and January 2012 from nests in which viewing windows were cut into the envelope. Estimates of the amount of work completed were taken from digital photos. Nests were collected very late in the afternoon, presumably when most bees were home. Nest measurements were made with a Mitutoyo digital caliper. Means are given $\pm$ one standard deviation. Statistical tests were done using PASW Statistics v 18.0. A voucher specimen is deposited in the Museo de los Invertebrados, Universidad de Panamá, and the STRI Dry Reference Collection.

Results and discussion

Two of 18 nests were presumably recently constructed, as inferred from the light orange color of the resin and the relatively pliable wall of the envelopes, and most (17) were relatively young, in contrast to an older nest that was dark brown, and brittle, as are abandoned nests (also Eberhard 1988). Fifteen nests contained a single female, and the other three nests had 0, 2 and 4 females, respectively. Nests contained from 1 to 17 cells ($\overline{x}$ = 4.17 $\pm$ 3.96); the nest with the latter had 4 females. Nests collected at other times of the year at the same or a different site also included both newly constructed nests and older ones (Eberhard 1988; Soucy et al. 2003; Capaldi et al. 2007). One nest was yellowish in color and the resin presumably came from a different tree, but the sources of resin are unknown. Nests of *E. nigropilosa* are constructed from *Clusia* resin (Otero et al. 2008). Completed nests were approximately 6.25 $\pm$ 0.6 cm long and 4.09 $\pm$ 0.25 cm wide near the top, with walls of equal thickness near the top of the next ($\overline{x}$ = 0.93 $\pm$ 0.23 mm) and at the bottom ($\overline{x}$ = 0.92 $\pm$ 0.37 mm), contrary to nests from a Costa Rican population (Eberhard 1988). Externally, nest envelopes were characterized by vertical bands of slightly different colored resin (which may reflect differences in age), and by fine ridges (also Eberhard 1988). Internally the surface of the envelope was smooth, except for a number of small mounds of resin (Figure 1A). At least some of these mounds were caches of resin that were used in construction, but it is not known if they have any architectural significance.

When first discovered, the nest envelope was approximately 1/3 completed (Figure 1A) and grew slowly each day (Figure 1B). Only a single female worked on constructing the new nest. This female made repeated foraging trips for resin lasting from 7 min 43 sec to 14 min 19 sec ($\bar{x}$ = 619 $\pm$ 138 sec, N = 7), returning to the nest with large masses of resin on the hind corbiculae, which she deposited in a small pile on the inner surface of the envelope as a temporary cache. These trips

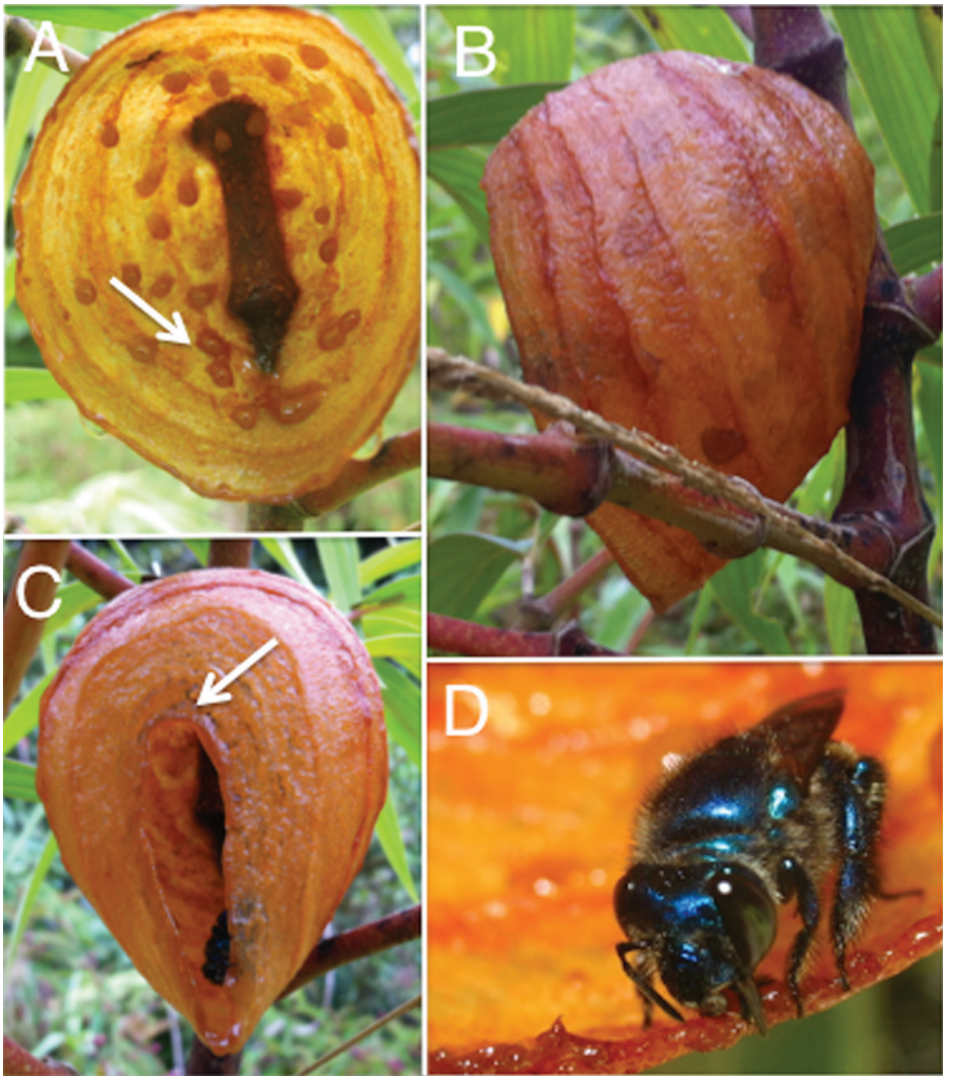

Figure 1. A Interior view of a nest of *Euglossa hyacinthina* under construction. The dark area in the center is where the nest envelope is attached to the plant stem. The numerous droplets are caches of resin (white arrow). **B** The same nest the next day. **C** The same nest nearly completed, 3 working days after the photo in A. The white arrow points to the eave over what will become the entrance hole. **D** A female orchid bee shaping resin along the rim of the growing nest envelope.

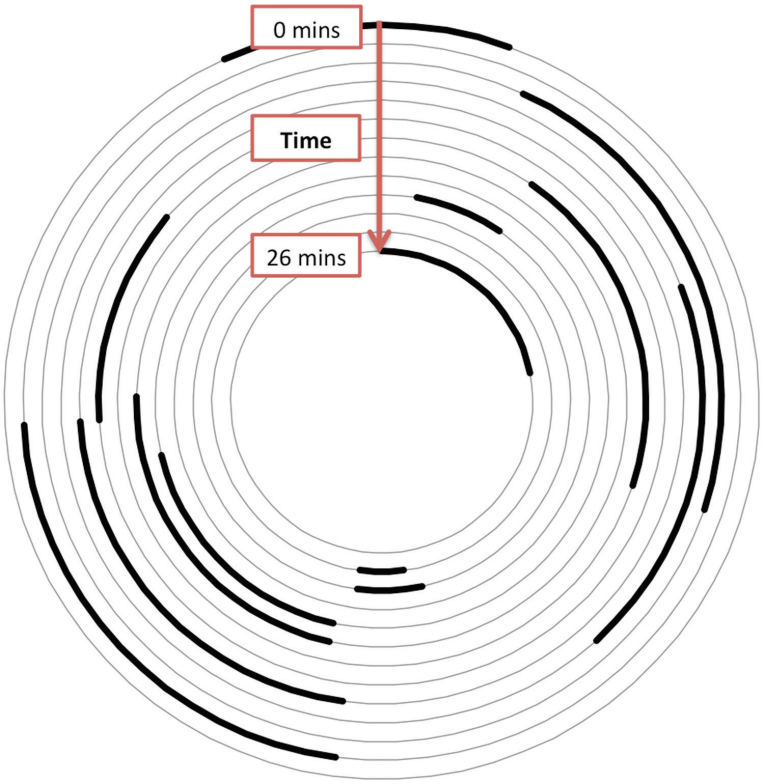

Figure 2. Graphical representation of work effort showing how the bee moves from one side of the nest to another while constructing the envelope. Each arc represents the area the bee worked in a given work session, each lasting approximately from 1 to 2 min. The concentric arcs represent 13 sequential work bouts during a 26 min session of construction; the outer-most arc is the starting position at the beginning of the session and the inner-most one is the ending position.

were faster than resin foraging in other *Euglossa* [means of 24.3 min and 18.2 min, respectively, for *Euglossa atroveneta* (Ramírez-Arriaga et al. 1996) and *E. nigropilosa* (Otero et al. 2008)] or a larger bee, *Eulaema meriana* (mean = 32 min) (Cameron and Ramírez 2001), but whether or not these differences are related to relative abundance of resin is not known. The bee made other trips away from the nest and returned without any building materials (range: 4 min 30 sec to 8 min 51 sec; ($\overline{x}$ = 435 ± 94 sec, N = 6); these were shorter than resin foraging trips (Mann-Whitney U, P = 0.015). Following each resin foraging trip, the bee worked on nest construction for 9 min 49 sec to 21 min 59 sec (x = 939 ± 252 sec, N = 6) before leaving the nest again, roughly similar to *Eu. meriana* (mean, 21 min) (Cameron and Ramírez 2001). Following non-resin foraging trips each construction session lasted equally long as those following resin-foraging trips, from 10 min 21 sec to 26 min 12 sec ($\overline{x}$ = 957 ± 393 sec, N = 5) (Mann-Whitney U, NS).

During construction the bee walked to the cache of resin and removed a small piece with her mandibles, and then went to the edge of the nest envelope, where she

applied the resin. She then formed it by keeping the inner surface of one mandible in contact with the edge of the envelope while the other mandible was repeatedly closed; along with subtle head movements this action apparently pushed resin against the concave inner surface of the other mandible (Figure 1D). Although sticky to human hands, the resin did not stick to the bee. Within a given session of construction, the bee did not extend the envelope only at a single spot, or extend the envelope in a continuous manner, but moved about the envelope between visits to the resin cache, from one side to the other with short bouts of resin-shaping (Figure 2). When females added new material to the previous work there was a thin band of slightly thicker resin that was visible externally as a ridge, which was then extended to a thinner layer by squeezing the resin with the mandibles (a video clip of nest construction behavior is given in the Supplemental Materials). Early on the 4th day after the nest was discovered the envelope was nearly completed, including a small roof defining the top of the entrance hole (Figure 1C); we infer that nest envelope construction takes approximately 6 days. Intermittent observations show that cell construction is completed in less than 2 (1 cell) or 3 days (4 cells).

Much of the very limited information available on orchid bee nest construction comes from studies of cavity nesters in artificial observation boxes, so few comparisons are possible. *Euglossa hyacinthina* offers an excellent opportunity for detailed studies of building behavior in corbiculate bees with relatively simple architecture, for comparisons with *Apis*, for which architecture reaches its zenith in the perfect geometric structure of honey bee comb (Gould and Gould 2007)**.**

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Appendix

A Quicktime video of a female *Euglossa hyacinthina* working on the construction of her nest envelope. doi: 10.3897/JHR.29.4067.app

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RESEARCH ARTICLE

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New records of *Elasmus* (Hymenoptera, Eulophidae) species from Barrow Island, Western Australia

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Abstract

Eleven species of *Elasmus* are recorded from Barrow Island in northern Western Australia, including nine not previously recorded for Western Australia. *Elasmus curticornis* **sp. n.** is described as new to science.

Keywords

north-western Australia, parasitic wasps, range extension, Chalcidoidea, Eulophinae

Introduction

The Chalcidoidea fauna of north-western Australia remains poorly-known and few species have been previously recorded from the area. *Elasmus* Westwood 1833 is a very distinctive genus of Chalcidoidea with over 200 species described worldwide (Noyes 2012; Verma et al. 2002; Yefremova and Strakhova 2010). *Elasmus* species are readily distinguished from most other Chalcidoidea by their enlarged discus-like hind coxae. Because of their morphological distinctiveness, many authors have placed *Elasmus* in its own monogeneric family within the Chalcidoidea. However, Gauthier et al. (2000) demonstrated that it is better placed within the subfamily Eulophinae of the Eulophidae.

Fifty-eight species of *Elasmus* were recognised in Australia by Riek (1967), including five species attributed to the genus *Austelasmus* Riek 1967. However, the latter were synonymised with *Elasmus* by Burks in Krombein et al. (1979). A further species was subsequently described by Naumann and Sands (1984). All species treated by Riek (1967) were recorded only from eastern Australia, from Queensland to Victoria, with three exceptions. These were *Elasmus ero* Girault 1920 and *Elasmus lividus* Girault 1913 from southern Western Australia and *Elasmus cyaneus* Girault 1912 from South Australia. Naumann and Sands (1984) reared *Elasmus bellicaput* Girault 1923 and *Elasmus broomensis* Naumann & Sands 1984 from specimens of cotton bollworm *Pectinophora gossypiella* (Saunders 1843). These were collected in Broome and are the only published records to date of *Elasmus* from northern Western Australia.

In general, northern Western Australia is poorly studied in terms of terrestrial invertebrates. However, since 2005, terrestrial invertebrates from over 20 orders have been surveyed regularly and recorded in detail on Barrow Island, an island off the coast of northern Western Australia (Callan et al. 2011). Barrow Island has been the subject of a long history of conservation and industrial custodianship as it is a Class 'A' nature reserve as well as Australia's longest running and largest onshore oil field. Currently, it is being utilised as a hub for the development and processing of Australia's offshore gas reserves by Chevron and its associates within the Gorgon Project (see acknowledgements). As a result of rigorous environmental impact assessment requirements, extensive surveys of flora and fauna have been carried out on the island. The surveys on Barrow Island possibly represent one of the most comprehensive records of terrestrial invertebrates in north-western Australia.

A large percentage of the invertebrate fauna recorded for the island represents undescribed species and many will remain so for years to come. A number of publications have described new species from specimens from Barrow Island (Fletcher 2008; Framenau 2011; Mound and Minaei 2007; Zhang et al. 2009) and it is hoped that species descriptions will continue to occur. Herewith, we present data from Barrow Island on this charismatic genus of chalcidoid wasp.

Methods

Barrow Island is approximately 234 km^2 in extent and is located about 60 km off the coast of Western Australia. The island is within the subtropical region of Australia and is characterised by wet summers (December to March) and cool dry winters (May to September). Annual rainfall is not consistent and in a given year, the island can receive no rainfall at all. Its flora is affiliated with the arid zones of the Carnarvon Basin and the Pilbara Bioregions and is dominated by hummock grasses (*Triodia* spp.) (Buckley 1983). Surveys were undertaken in two seasons in 2006 in native vegetation sites and in 2006 and 2007 at disturbed sites throughout the island. The results have been reported in Callan et al. (2011). A further study was commenced in 2009 and continues today targeting a different complement of sites.

A variety of collection methods were used as all terrestrial invertebrates were to be sampled. However, the majority of *Elasmus* specimens were collected mechanically using a modified leaf blower machine in suction mode. Species collected were identified using the key given in Riek (1967). Specimens were photographed mounted on points or in ethanol using a Leica M205C microscope and DFC500 camera, or Nikon SMZ1500 microscope and DS-Fi1 camera. Measurements were taken using the NIS-Elements D 4.00.03 programme for the Nikon SMZ1500 microscope.

Morphological terms used herein differ from Riek (1967) but conform with Bouček (1988) in that the anellus is not counted as part of the funicle. Abbreviations used below include: OC: minimum distance between posterior ocellus and the occipital carina; OD: ocellus diameter; OOL: minimum distance between posterior ocellus and adjoining compound eye; POL: distance between posterior ocelli.

Specimens are currently held by J. Majer, Curtin University; the type specimens of *Elasmus curticornis* sp. n. will be deposited in the Western Australian Museum, Perth, Australia.

Results

All species listed below were identified from female specimens collected on Barrow Island. The GPS coordinates of the localities where specimens were collected are listed in Table 1. Numerous male *Elasmus* specimens, representing several species, were also among the material collected. Unfortunately, our knowledge of the Australian *Elasmus* fauna is currently inadequate for males to be associated with their corresponding females (Riek 1967), unless collected in direct association. Because of the largely mechanical nature of the collection methods used in the current survey, such association could not generally be assumed, and many samples contained females of multiple species.

For convenience, species collected from Barrow Island are here organised into an identification key to emphasise distinguishing features, with figures provided for each species at the appropriate position in the key. Further notes on individual species have been provided after the key. A more extensive key to Australian *Elasmus* species can be found in Riek (1967).

Key to Barrow Island species of *Elasmus* (based on females)

1 Scutellum mostly light-coloured **2**
– Scutellum dark..... **4**
2 Mesoscutum mostly light-coloured ..... ***formosus nakomara* Girault**
– Mesoscutum extensively dark..... **3**
3 Mesoscutum dark medially, light-coloured laterally.... ***arumburinga* Girault**
– Mesoscutum entirely dark..... ***auratiscutellum* Girault**
4 Antennae with at least one funicle segment as broad as or broader than long... **5**

– Antennae with all funicle segments distinctly longer than broad **7**
5 Fore coxae entirely dark; gaster without extensive red markings .... ***neofunereus*** **Riek**
– Fore coxae pale at least in distal half; gaster with extensive red coloration ... **6**
6 Fore coxa entirely pale; hind coxa pale in distal half; hind femur entirely pale ..... ***flavipropleurum*** **Girault**
– Fore coxa basally dark; hind coxa almost entirely dark; hind femur extensively dark ..... ***curticornis*** **sp. n.**
7 Head mostly bright yellow ..... ***bellicaput*** **Girault**
– Head entirely dark **8**
8 Posterior pair of scutellar bristles much larger than anterior pair, extending well past end of metanotum; gaster extensively red with at least segments 2–3 entirely red in dorsal view ..... ***ero emma*** **(Girault)**
– Posterior pair of scutellar bristles little longer than anterior pair, not or only just extending past end of metanotum; gaster entirely dark or almost entirely dark in dorsal view **9**
9 Fore coxae pale in distal half ..... ***broomensis*** **Naumann & Sands**
– Fore coxae entirely dark **10**
10 Apex of hind femur narrowly pale ..... ***tenebrosus*** **Riek**
– Hind femur entirely dark ..... ***funereus*** **Riek**

Table 1. Collection data for female *Elasmus* specimens on Barrow Island. Specimens from 2006 were collected by S. Callan and R. Graham; those from 2007 were collected by S. Callan and K. Edwards; subsequent specimens were collected by N. Gunawardene and C. Taylor. Most *Elasmus* species on Barrow Island were collected from multiple localities. Only *Elasmus arumburinga* and *Elasmus broomensis* were collected from only one locality on the island.

Species	Locality	Easting	Northing	Date	No. of specimens
E. arumburinga	Gas Plant Site	115°27'10"E	20°47'33"S	19–29 September 2011	1
E. auratiscutellum	Accommodation Camp	115°26'39"E	20°49'35"S	6 May 2006	1
E. auratiscutellum	Airport	115°24'26"E	20°51'55"S	6 May 2006	1
E. auratiscutellum	Airport	115°24'25"E	20°51'54"S	19–29 September 2011	1
E. auratiscutellum	Gas Plant Site	115°27'10"E	20°47'33"S	19–29 September 2011	6
E. auratiscutellum	Near Gas Plant Site GP9	115°26'59"E	20°47'59"S	25 September 2006	1
E. bellicaput	Gas Plant Site	115°27'10"E	20°47'33"S	19–29 September 2011	1
E. bellicaput	Near Gas Plant Site CC2	115°26'24"E	20°49'3"S	25 September 2006	1
E. bellicaput	Northern Sector HDD	115°25'13"E	20°41'34"S	14–24 March 2011	2

Species	Locality	Easting	Northing	Date	No. of specimens
E. broomensis	Barge Landing	115°28'20"E	20°43'29"S	6 May 2006	1
E. curticornis	Barge Landing	115°28'19"E	20°43'29"S	14–24 March 2011	1
E. curticornis	Northern Sector HDD	115°25'13"E	20°41'34"S	14–24 March 2011	1
E. ero emma	Accommodation Camp	115°26'39"E	20°49'35"S	14–24 March 2011	1
E. ero emma	Gas Plant Site	115°27'10"E	20°47'33"S	19–29 September 2011	1
E. ero emma	Northern Sector X81	115°25'19"E	20°44'22"S	9–23 November 2009	1
E. flavipropleurum	Accommodation Camp	115°26'39"E	20°49'35"S	25 September 2006	4
E. flavipropleurum	Accommodation Camp	115°26'15"E	20°49'2"S	19–29 September 2011	2
E. flavipropleurum	Airport	115°24'26"E	20°51'55"S	1–8 March 2010	1
E. flavipropleurum	Gas Plant Site	115°27'10"E	20°47'33"S	8–17 November 2010	1
E. flavipropleurum	Gas Plant Site	115°27'10"E	20°47'33"S	14–24 March 2011	1
E. flavipropleurum	Gas Plant Site	115°27'10"E	20°47'33"S	19–29 September 2011	7
E. flavipropleurum	Near Gas Plant Site GP2	115°27'27"E	20°47'38"S	25 September 2006	5
E. formosus nakomara	Accommodation Camp	115°26'39"E	20°49'35"S	19–29 September 2011	1
E. formosus nakomara	Central Eastern Sector	115°25'55"E	20°47'47"S	9–23 November 2009	2
E. formosus nakomara	Gas Plant Site	115°27'10"E	20°47'33"S	19–29 September 2011	1
E. formosus nakomara	Near Gas Plant Site GP3	115°27'25"E	20°47'9"S	15 March 2006	1
E. formosus nakomara	Near Gas Plant Site GP4	115°27'33"E	20°47'3"S	25 September 2006	1
E. formosus nakomara	Northern Sector 72M	115°26'24"E	20°42'30"S	9–23 November 2009	1
E. formosus nakomara	Northern Sector HDD	115°25'13"E	20°41'34"S	19–29 September 2011	2
E. funereus	Barge Landing	115°26'39"E	20°49'35"S	1–8 March 2010	1
E. funereus	Barge Landing	115°28'19"E	20°43'29"S	14–24 March 2011	1
E. funereus	Barge Landing	115°28'19"E	20°43'29"S	19–29 September 2011	1
E. funereus	Central Eastern Sector	115°25'58"E	20°46'51"S	6 May 2006	1
E. funereus	Central Eastern Sector	115°25'55"E	20°47'47"S	9–23 November 2009	1
E. funereus	Central Sector	115°23'37"E	20°47'5"S	6 May 2006	1
E. funereus	Gas Plant Site	115°27'10"E	20°47'33"S	19–29 September 2011	4
E. neofunereus	Barge Landing	115°28'20"E	20°43'29"S	6 May 2006	2
E. neofunereus	Near Accommodation Camp	115°26'34"E	20°49'26"S	25 November 2006	1

Species	Locality	Easting	Northing	Date	No. of specimens
E. neofunereus	Near Gas Plant Site CC2	115°26'24"E	20°49'3"S	25 November 2006	1
E. tenebrosus	Barge Landing	115°28'19"E	20°43'29"S	14–24 March 2011	1
E. tenebrosus	Central Eastern Sector	115°25'58"E	20°46'51"S	6 May 2006	1
E. tenebrosus	Gas Plant Site	115°27'10"E	20°47'33"S	19–29 September 2011	2
E. tenebrosus	Near Accommodation Camp	115°26'34"E	20°49'26"S	6 May 2006	3
E. tenebrosus	South-eastern Sector	115°25'13"E	20°49'55"S	1 May 2007	2

Elasmus arumburinga Girault, 1920

Fig. 1

Comments. This species has previously been recorded from Queensland and Victoria (Riek 1967).

Figure 1. *E. arumburinga*, female, September 2011. Lateral view **A** dorsal view **B** antenna **C**.

Elasmus auratiscutellum Girault, 1915

Fig. 2

Comments. This species was previously described from Gordonvale in Queensland (Riek 1967). Riek's (1967) treatment of this species is contradictory as the species key states that the mesoscutum is dark while the species description indicates that it is light. Girault's (1915) original description implies that the mesoscutum is dark. *Elasmus auratiscutellum* has a similar colour pattern to *E. splendidus* Girault 1912, but has the scutellum almost entirely yellow while *E. splendidus* has the scutellum dark with yellow margins. The pedicel of *E. splendidus* is less than half the length of the first funicular segment while that of *E. auratiscutellum* is nearly as long as the first funicular segment. Some variation in coloration is visible among the specimens available: most specimens have the pronotum entirely dark, but two specimens have the lateral panels of the pronotum yellow.

Figure 2. *E. auratiscutellum*, airport, May 2006. Lateral view **A** dorsal view **B** antenna **C**.

Elasmus bellicaput Girault, 1923

Comments. This species was previously recorded from Broome in northern Western Australia by Naumann and Sands (1984). A specimen of this species was included by Stevens et al. (2007) among the figured examples of Eulophidae.

Elasmus broomensis Naumann & Sands, 1984

Fig. 3

Comments. This species was described from Broome in northern Western Australia by Naumann and Sands (1984).

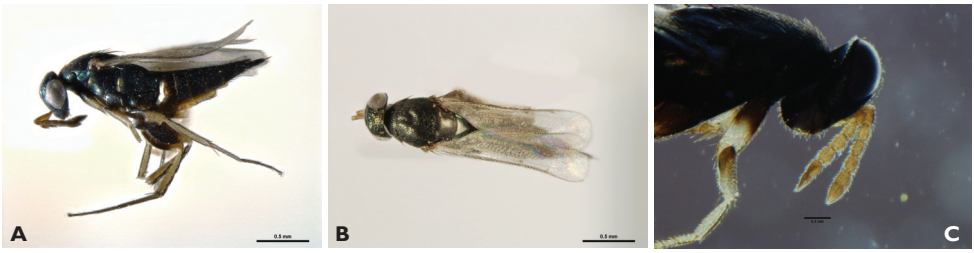

Figure 3. *E. broomensis*, May 2006. Lateral view **A** dorsal view **B** antenna **C**.

Elasmus curticornis sp. n.

urn:lsid:zoobank.org:act:B14EC723-18E2-4AFA-B69F-F4B6B957B96B
http://species-id.net/wiki/Elasmus_curticornis
Fig. 4

Holotype. 1 ♀, Barrow Island, northern sector HDD, N. Gunawardene, C. Taylor, 14–24 March 2011, sticky trap.

Paratype. 1 ♀, barge landing, N. Gunawardene, C. Taylor, 14–24 March 2011, suction.

Etymology. From the Latin *curtus*, shortened, and *cornu*, a horn, in reference to the short antennae of this species, as well as by analogy to the similar species *E. brevicornis* Gahan 1922.

Description. *Body length*. 1.48–2.13 mm.

Coloration. Head and mesosoma blackish with green sheen, except antenna, mandibles and base of tegula cream, dorsellum translucent. Gaster primarily orange, except T1 black, T4 with or without posterolateral dark spots meeting medially, posterior part of T5 to end of gaster black or T5 with transverse dark stripe and T6 to end of gaster dark, S6 to end of gaster black. Leg 1 with base of coxa black, remainder yellow except basal infuscation on femur; legs 2 and 3 each with coxae black except distal ends yellow, trochanters yellow, femora mostly brown except proximal and distal ends yellow, tibiae and tarsi yellow.

Head. Slightly narrower than mesosoma; in dorsal view 2.0 times wider than long; in frontal view slightly (1.1 times) wider than high. Vertex and frons with dense piliferous punctures, with interspaces on frons subequal to diameter of punctures. Ocellar triangle about twice as long as wide, POL:OOL 2.3–2.5:1, OD:OOL 0.3–0.4:1, OC:OD 0.8–0.9:1. Compound eye 1.5–2.1 times as high as wide in lateral view; inner margins of compound eyes straight to slightly concave, frons minimum width 0.7 times total head width. Malar space 0.4–0.5 times eye height; lower margin of toruli 2.1–2.5 times their diameter from lower margin of face, about in line with lower margin of eyes. Each mandible with seven teeth.

Antenna (Figure 4B, C). Scape 0.5 times as long as pedicel and flagellum combined, lengths of scape and of pedicel and flagellum combined 0.6–0.7 times and 1.0–1.2 times compound eye height; pedicel 1.4–1.8 times as long as wide, 1.3 times length of funicle 1; funicle 1 subtriangular, 0.9–1.0 times as long as wide; funicle 2 and 3 each shorter than (0.8 times and 0.8–0.9 times length of, respectively) funicle 1, funicle 2 0.6–0.7 times and funicle 3 0.6 times as long as wide; clava 1.4–1.5 times as long as wide, 2.3–2.8 times as long as and 1.3 times as wide as funicle 3, clava 3 triangular.

Mesosoma (Fig. 4D, E). 1.5–1.7 times longer than wide. Mesoscutum 0.9 times as long as wide, densely covered with piliferous punctures; posterior margin of mesoscutum concave. Scutellum 0.9 times as long as wide, finely reticulate, setae absent except elongate setae at anterolateral and posterolateral corners, anterior and posterior pairs of setae of similar length, posterior setae not extending beyond apex of dorsellum. Dorsellum length 0.7 times basal width.

Wings. Hyaline. Forewing (Fig. 4F, G) 1.4–1.5 times length of head and mesosoma combined, 3.3–3.6 times as long as wide; isolated subcubital line of setae present; postmarginal vein subequal in length to stigmal vein. Hind wing 0.9 times length of forewing, 5.1 times as long as wide.

Legs. Mid femur with stout apical posterolateral seta 0.2–0.3 times length of tibia. Hind tibia with dorsal pattern of black setae demarking four diamonds anterolaterally and three diamonds posterolaterally.

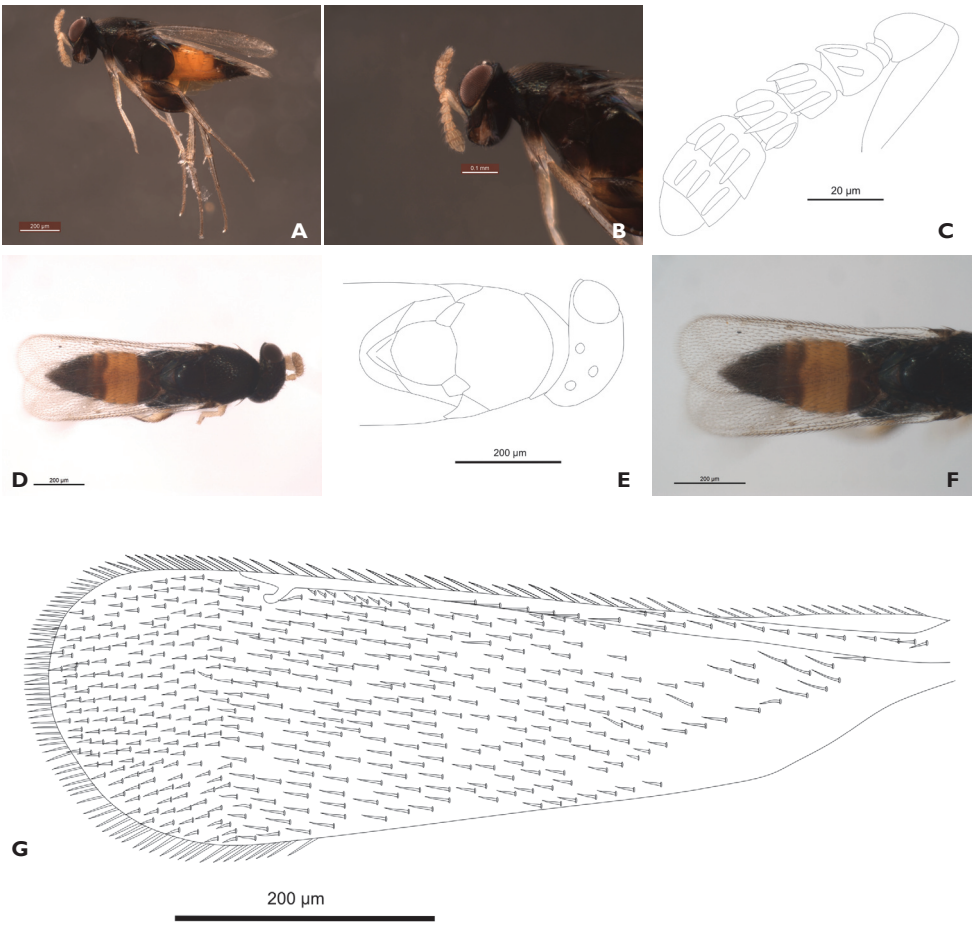

Figure 4. *Elasmus curticornis*, holotype. Lateral view **A** close-up of head **B** antenna, diagram (setae omitted) **C** dorsal view **D** dorsal view, diagram (E) forewing **F** forewing diagram showing setal pattern **G**.

Gaster. Gaster 0.8–1.1 times length of head and thorax combined, 2.1–2.3 times as long as wide, not produced; posterior margin of T6 straight.

Comments. The distinctive quadrate antennae of this species, with all funicular segments broader than long, distinguish it from most other species of *Elasmus* except the Asian species *Elasmus brevicornis* Gahan 1922 and *Elasmus philippinensis* Ashmead 1904 and the Australian *Elasmus concinnus* Riek 1967. *Elasmus philippinensis* has a brown-black flagellum, with only the scape yellowish (Ashmead 1904). *Elasmus brevicornis* and *E. concinnus* both have notably less extensive light coloration on the gaster. The gaster of *E. concinnus* is dorsally almost entirely dark except for a light cross-band at the apex of T2 (Riek 1967), while that of *E. brevicornis* is light dorsally at the apex of T1, T2 and sometimes T3 (Mani and Saraswat 1972; Verma et al. 2002; Yefremova

and Strakhova 2010) and may sometimes be entirely dark brown to black (Verma et al. 2002). In contrast, the gaster of *E. curticornis* is light from the apex of T1 to T4 or T5. Laterally, the gasters of *E. brevicornis* and *E. concinnus* are light over at most a third (Mani and Saraswat 1972; Riek 1967) while that of *E. curticornis* is light over at least two-thirds. Also, *E. brevicornis* has POL 1.5 times OOL (Yefremova and Strakhova 2010), as opposed to about 2.5 times in *E. curticornis*. *Elasmus concinnus* has the flagellum dark above and the first claval segment distinctly shorter than the third funicle (Riek 1967); *E. curticornis* has the flagellum more evenly pale, and the first claval segment and third funicle are subequal in length.

Elasmus ero emma (Girault, 1940)

Fig. 5

Comments. *Elasmus ero emma* was previously only known from Capella in central Queensland, but the type subspecies *Elasmus ero ero* has previously been recorded from Bunbury in southern Western Australia (Riek 1967). Some minor variation in colour pattern is visible in the available specimens: the specimen collected in November 2009 has the fore coxae almost entirely dark, as well as more extensive dark coloration of the dorsum of the gaster, with transverse dark stripes on the posterior margins of segments 4 on.

Figure 5. *E. ero emma*, March 2011. Lateral view **A** dorsal view **B** antenna **C**.

Elasmus flavipropleurum Girault, 1940

Fig. 6

Comments. This species was originally described from Gordonvale in northern Queensland (Riek 1967). Specimens may vary in the degree of dark coloration on the gaster; several specimens are almost entirely dark dorsally except for the posterior margins of most segments, while remaining predominantly orange laterally.

Figure 6. *E. flavipropleurum*, March 2010. Lateral view **A** dorsal view **B** antenna **C**.

Elasmus formosus nakomara Girault, 1920

Fig. 7

Comments. This species has been recorded from a number of localities in eastern Queensland (Riek 1967).

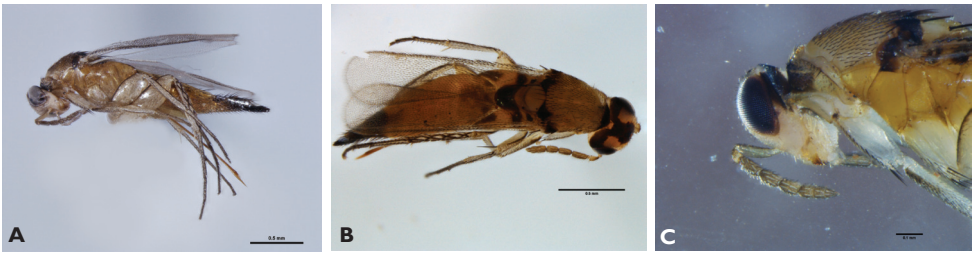

Figure 7. *E. formosus nakomara*, November 2009. Lateral view **A** dorsal view **B** antenna **C**.

Elasmus funereus Riek, 1967

Fig. 8

Comments. This species was originally described from a number of localities in Queensland, New South Wales and the Australian Capital Territory (Riek 1967).

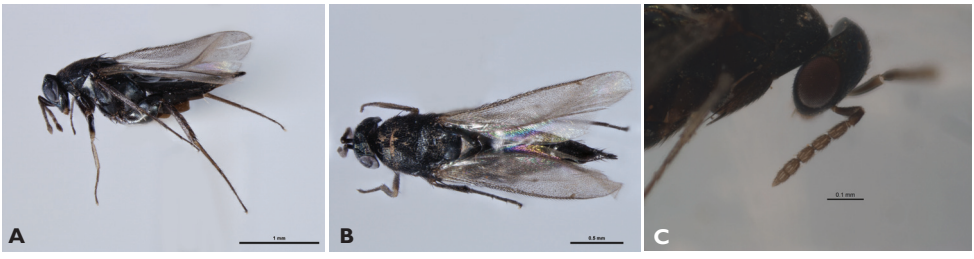

Figure 8. *E. funereus*, March 2010. Lateral view **A** dorsal view **B** antenna **C**.

***Elasmus neofunereus* Riek, 1967**
Fig. 9

Comments. This species was described from Griffith in New South Wales (Riek 1967).

Figure 9. *E. neofunereus*, May 2006. Lateral view **A** dorsal view **B** antenna **C**.

***Elasmus tenebrosus* Riek, 1967**
Fig. 10

Comments. This species was described from near Bourke in New South Wales. Riek (1967) described this species as having the gaster entirely dark; however, specimens from Barrow Island are reddish laterally on segments 2–5. This reddish coloration is more marked in some specimens than others, and may be little more than a reddish shading. In other features, specimens correlate with Riek's (1967) description, and we feel confident in assigning them to Riek's species.

Figure 10. *E. tenebrosus*, May 2007. Lateral view **A** dorsal view **B** antenna **C**.

Discussion

To date, eleven species of *Elasmus* have been recorded for the island and for eight of the species, the current records represent notable range extensions. Many chalcid species are known to have broad, even cosmopolitan, distributions (Bouček 1988). The fact that many of the *Elasmus* species now listed for Barrow Island occur on the other side of the continent demonstrates the large gap in collection effort for the north-west of Australia. Much of Barrow Island's invertebrate fauna is most likely shared with the mainland, especially in terms of more motile groups. Ants have

been well collected for the region and taxonomic expertise is available for this family of wasp relatives. The ant species from Barrow Island are all found on mainland Western Australia. However, comparisons of other invertebrate taxa from Barrow at a regional or continental scale are impeded by the lack of surveys carried out in the north-western part of the state. Its remoteness and the lack of resources for biological surveys in this part of the world mean that much of the fauna in the north-west still remains unknown. The other issue is the lack of current taxonomic work being carried out on these groups. Out of the 363 wasp morphospecies listed for Barrow Island, only *Elasmus* has been successfully taken to species with the help of Riek (1967). The majority of the remaining wasps have been identified only to family. Currently, a few other families are being analysed further and will hopefully yield species identifications or new species descriptions.

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RESEARCH ARTICLE

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Seven new species of *Notiospathius* (Hymenoptera, Braconidae, Doryctinae) from Northwest Venezuela

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Abstract

We describe seven new species of the doryctine wasp genus *Notiospathius* Matthews & Marsh from Northwest Venezuela: *N. araguae* **sp. n.**, *N. bolivari* **sp. n.**, *N. curvilineatus* **sp. n.**, *N. dantei* **sp. n.**, *N. estradae* **sp. n.**, *N. larensis* **sp. n.**, and *N. venezuelae* **sp. n.** These represent the first described species of the genus

reported for this country. Species boundaries for the above taxa were confirmed using the General mixed Yule-coalescent method with 441 DNA barcode sequences from specimens assigned to *Notiospathius* and other closely related genera collected in different countries along the Neotropics.

Abstract

Se describen siete especies nuevas del género *Notiospathius* Matthews & Marsh para el noroeste de Venezuela: *N. araguae* **sp. n.**, *N. bolivari* **sp. n.**, *N. curvilineatus* **sp. n.**, *N. dantei* **sp. n.**, *N. estradae* **sp. n.**, *N. larensis* **sp. n.**, y *N. venezuelae* **sp. n.** Estas representan las primeras especies descritas del género registradas para Venezuela. La validez de estas especies fue confirmada empleando el método 'General mixed Yule-coalescent' con 441 secuencias del código de barras de especímenes asignados a *Notiospathius* y otros géneros cercanamente relacionados provenientes de varios países del Neotrópico.

Keywords

Barcoding, GMYC model, integrative taxonomy, Neotropical region, parasitoid wasp

Palabras clave

Barcoding, modelo GMYC, taxonomía integral, Neotrópico, avispa parasitoide.

Introduction

The wasp family Braconidae is a group mainly composed of parasitoids that attack a wide range of insect larvae from different orders, but mostly Coleoptera, Diptera and Lepidoptera (Shaw and Huddleston 1991; Marsh 1997). One of the most speciose braconid subfamilies is Doryctinae, with around 200 currently recognised genera and over 1,300 described species (but minimum estimate of 3,000 undescribed species; Jones et al. 2009). Within this subfamily, *Notiospathius* Matthews & Marsh is probably the most speciose genus in the Neotropics after *Heterospilus* Haliday (Ceccarelli et al. 2012). *Notiospathius* was erected to contain 14 species previously placed within the cosmopolitan *Spathius* Nees (Matthews & Marsh, 1973). Currently, the genus comprises 34 Neotropical species (Zaldívar-Riverón and De Jesús-Bonilla 2010; De Jesús-Bonilla et al. 2011), though a considerable, undetermined number of undescribed species remains to be described (Ceccarelli et al. 2012). *Notiospathius* is principally characterised by a considerably enlarged and tubular first metasomal tergite, although this feature is also shared by members of other doryctine genera that are either closely (*Tarasco* Marsh, *Masonius* Marsh) or distantly related (e.g. *Spathius*) to it (Zaldívar-Riverón et al. 2007, 2008; Ceccarelli and Zaldívar-Riverón submitted).

Recently, a number of specimens assigned to *Notiospathius*, *Tarasco* and *Masonius* were collected by three of the authors (AZR, HC, RB) in different localities along northwest Venezuela. In this work, we describe seven new species of *Notiospathius* from this region following an integrative taxonomic approach (Schlick-Steiner et al. 2010; Padial and De la Riva 2010), where both morphological and DNA barcoding (Hebert et al. 2003) data consistently support our species limits. These represent the first described species of the genus recorded for Venezuela.

Methods

Examined specimens

A total of 243 specimens originally assigned to the genera *Notiospathius*, *Masonius* and *Tarasco* were obtained from several localities along four northwest Venezuelan states (Lara, Yaracuy, Carabobo and Aragua). All specimens were collected with yellow pan traps or sweeping nets and preserved in 100% ethanol until they were prepared for DNA extraction. Specimens are deposited in the following collections: Colección Nacional de Insectos, Instituto de Biología, Universidad Nacional Autónoma de México (IB-UNAM CNIN), Museo Entomológico "José M. Osorio", Decanato de Agronomía, Universidad Centroccidental "Lisandro Alvarado", Cabudare, Lara, Venezuela (UCOB), and Departamento de Ecologia e Biologia Evolutiva, Universidade Federal de São Carlos, São Carlos, SP, Brazil (DCBU). The wing venation and sculpture terminologies employed followed Marsh (2002). Digital SEM photographs were taken with a FEI Quanta™ 250 SEM in a low vacuum mode. Colour digital photographs were taken with a Leica® Z16 APO-A stereoscopic microscope and a Leica® DFC295/ DFC290 HD camera, and edited with the Leica application Suite® program.

Species boundaries based on DNA barcodes

We assessed species boundaries among the above Venezuelan specimens by obtaining DNA sequences from the standard animal DNA barcoding locus [cytochrome *c* oxidase I mitochondrial DNA gene (COI)]. DNA extraction, amplification and sequencing for these specimens was carried out at the University of Guelph, Ontario, Canada (see laboratory procedures in Smith et al. 2009). The above sequences are deposited in GenBank (see accession numbers in Table 1) and are also available in the project file "Doryctinae of the world" (DORYC project) of the Barcode of Life Data Systems (BOLD; www.barcodinglife.org). Fourteen sequences of specimens belonging to *Notiospathius* and *Masonius* were also obtained from the BOLD project file "Parasitoid Wasps (Braconidae: Doryctinae) of Chamela–Cuixmala Biosphere Reserve" (ASDOR project; GenBank accession numbers HM434312, 324, 544, 1013-15, 1292, 1293, HQ548183, HQ926041, JF912317-20).

Moreover, we obtained 12 additional sequences of specimens collected in various Neotropical countries (GenBank accession numbers JX870412-23). These sequences were generated at the Instituto de Biología UNAM following the lab procedures described in Ceccarelli et al. (2012). All these sequences were pooled together with a previously published COI data set (Ceccarelli et al. 2012) containing 171 sequences of specimens assigned to *Notiospathius*, *Masonius* and *Tarasco* that were collected in different regions along the Neotropics, and a sequence of *Spathius* that was employed to root the tree.

Species boundaries based on the 441 gathered COI sequences were assessed using the general mixed Yule-coalescent (GMYC) model (Pons et al. 2006; Fontaneto et al. 2007).

Table 1. List of the species delimited in this study, the Venezuelan states* where they were collected, number of representative specimens and GenBank accession numbers.

Species	Venezuelan state	No. specimens	GenBank accession nos
N. araguae sp. n.	Aragua	2	JN266962, 65
N. bolivari sp. n.	Aragua	1	JN266967
N. curvilineatus sp. n.	Lara	2	JN266984-85
N. dantei sp. n.	Yaracuy	1	JN267024
N. estradae sp. n.	Lara	4	JN267030-32, JN870425
N. larensis sp. n.	Lara	3	JN266987, 91, JN870424
N. venezuelae sp. n.	Carabobo, Yaracuy, Heredia*	5	JN266961, 63, 68, JN870300, 400
N. sp. 1	Yaracuy	1	JN267027
N. sp. 2	Aragua, Lara	4	JN266832, 864, 869, 983
N. sp. 3	Lara	2	JN266971, 82
N. sp. 4	Falcón	99	JN266796, 6798, 6799, 6801, 6802, 6879, 6881-6887, 6892-6901, 6904-6907, 6910, 6913-6922, 6924-6930, 6932, 6933, 6935-6938, 6940-6950, 6953-6957, 6992-6998, 7000, 7001, 7003-7016, 7018, JX571911, 12, 14, 18, JN870288, 413, 415, 450
N. sp. 5	Falcón	3	JN266952, 90, JN870414
N. sp. 6	Falcón	15	JN266888-6890, 6891, 6902, 6903, 6908, 6909, 6912, 6931, 6934, 6951, 6999, 7019, JN870416
N. sp. 7	Falcón	7	JN266911, 6923, 6939, 7002, 7017, JN870287, 418
N. sp. 8	Aragua	5	JN266815, 18, 23, 58, 63
N. sp. 9	Aragua, Lara	48	JN266791, 6794, 6806, 6808, 6810-6813, 6816, 6817, 6819, 6826-6830, 6833, 6835, 6841-6844, 6847, 6848, 6850, 6852, 6854, 6861, 6865, 6870-6873, 6960, 6972, 6976, 7035-7041, JX571917, JN870420, JN870292
N. sp. 10	Aragua	34	JN266790, 6792, 6793, 6795, 6809, 6814, 6824, 6825, 6834, 6836, 6840, 6845, 6846, 6849, 6851, 6853, 6855-6860, 6862, 6866, 6867, 6874, 6875, 6877, 6878, 6890, 6974, 7033, 7034, JN870289, 297, 422
N. sp. 11	Aragua	8	JN266805, 838, 969, 970, 978, JN870284, 299, 419
N. sp. 12	Aragua, Falcón	5	JN266822, 39, 80, JN870293, 417
N. sp. 13	Aragua	1	JN266966
N. sp. 14	Yaracuy	3	JN267025, 26, 29
Masonius sp.	Lara	1	JN266973
Tarasco sp. 1	Lara	1	JN266975
Tarasco sp. 2	Yaracuy, Carabobo, Lara	4	JN266789, 7022, 7028, JN870426
Tarasco sp. 3	Aragua	1	JN870423

Species	Venezuelan state	No. specimens	GenBank accession nos
Tarasco sp. 4	Lara	1	JX571925
Tarasco sp. 5	Aragua	2	JN266807, 76
New genus sp. 1	Aragua	3	JN266958, 59, 64
New genus sp. 2	Yaracuy	1	JX870417

* = Costa Rica.

We reconstructed the Bayesian topology required for the above method with the program BEAST version 1.5.3 (Drummond and Rambaut 2007), using a relaxed clock, a coalescent prior for estimating branch lengths and a GTR + I + G model of evolution (Lanave et al. 1984; Yang 1994). We ran the analysis for 20 million generations, sampling trees every 1,000 generations and discarding the first 10,000 sampled trees to ensure that the remaining sampled trees reached stationarity. We built a maximum clade credibility tree with our post-burn-in trees with TreeAnnotator version 1.5.3 (Rambaut and Drummond 2008). The ultrametric tree generated was employed for species delimitation using the SPLITS package for the R statistical environment (http://r-forge.r-project.org/projects/splits) and running the single threshold optimisation (Pons et al. 2006; Monaghan et al. 2009).

Results

Species boundaries analysis

The GMYC analysis based on the ultrametric tree reconstructed with the lognormal coalescent prior is shown in the Supplementary material. The analysis yielded 112 "GMYC" species (confidence interval 100–112; -lnL of null model = 3392.3; -lnL of GMYC model = 3415.7; threshold time = -0.03), 52 of which were recovered as sequence clusters and 60 as singletons. The 267 Venezuelan specimens examined were segregated into 29 GMYC species, of which only one contained specimens from a different country (Costa Rica; *N. venezuelae* sp. n.). Two of these species actually belong to an undescribed genus that is morphologically similar but is distantly related to *Notiospathius* according to a recent multilocus phylogenetic study (Ceccarelli and Zaldívar-Riverón, submitted). Moreover, two separate clades contained most of the examined Venezuelan specimens (232 sequences), one comprising nine (spp. 2-10 in Supplementary Material) and the other one two (spp. 11 and 12) GMYC species, respectively. Species within each of these two clades were morphologically indistinguishable according to our examined features and therefore they will not be described until more evidence is gathered. Other three Venezuelan GMYC species assigned to *Notiospathius* were only represented by males or single, damaged, females, whereas five belong to *Tarasco* and one to *Masonius*. Below we describe the remaining seven GMYC species represented by Venezuelan specimens that also were delimited morphologically. A list with the species delimited in this study, the Venezuelan states where they were collected, number of representative specimens and their GenBank accession numbers is provided in Table 1.

Descriptions

***Notiospathius araguae* López-Estrada & Zaldívar-Riverón, sp. n.**
urn:lsid:zoobank.org:act:BA858D04-A756-4F01-8100-63A34BBFF1A9
http://species-id.net/wiki/Notiospathius_araguae
Figs 1A–E

Diagnosis. This species runs to *N. platycorsus* Marsh in Marsh´s (2002) key to Costa Rican species and its Zaldívar-Riverón and De Jesús-Bonilla's (2010, 2011) extension; however it differs from the latter species by having the propodeum, metapleuron and first metasomal tergite black (mesosoma dark brown, metasoma honey yellow or light brown in *N. platycorsus*); and frons striate (rugose to rugose-costate in *N. platycorsus*).

Description. Female. *Colour*: Head light brown; scape light brown to honey yellow; flagellomeres brown turning dark brown, the last 10 white; palpi pale yellow to white. Mesonotum brown; propodeum, metapleuron and first metasomal tergite black; second and third metasomal tergites brown; remaining metasomal tergites dark brown except two last metasomal tergite, which are honey yellow; ovipositor and sheaths brown. Fore and middle coxae, trochanter and trochantellus pale yellow; femora and tibiae light brown; tarsi dark brown; hind coxa black; trochanter and trochantellus pale yellow; femur, tibia and tarsi ligth brown to brown. Wings dusky; veins and stigma brown; tegula pale yellow. *Body length:* 3.2 mm (lateral view); ovipositor 1.5 mm. *Head:* Clypeus rugose; face, frons and vertex striate, temple and gena smooth; eye about 1.6 times higher than wide (lateral view); malar space 0.1 times eye height (lateral view); temple 0.4 times eye width (dorsal view); hypoclypeal depression elliptic; ocular-ocellar distance four times diameter of lateral ocellus; length of scape twice its width (frontal view); antenna with 26 flagellomeres. *Mesosoma:* Length of mesosoma two times its maximum height; pronotum rugose, lateral area of pronotum coriaceous; pronotal groove wide and scrobiculate; propleuron slightly striate; mesoscutal lobes coriaceous; notauli wide and scrobiculate, meeting in scutellum in a costate area; scutellar disc coriaceous; mesopleural and subalar sulcus continuous, both wide, deep and scrobiculate; mesopleuron porcate dorsally, coriaceous medially and ventrally; precoxal sulcus wide, deep and scrobiculated, as long as mesopleuron; venter of mesosoma slightly coriaceous; metapleuron and propodeum strongly rugose; apical lateral corners without distinct tubercles; spines over hind coxa indistinct. *Wings:* Fore wing length 4.4 times its maximum width; length of pterostigma 3.3 times its maximum width; vein r 0.4 length of vein 3RSa; vein m-cu antefurcal to vein 2RS; vein 1cu-a interstitial to vein 1M; hind wing vein M+CU about 0.3 times length of vein 1M. *Legs:* hind coxa rugose, without basoventral tubercle; middle and hind femora smooth. *Metasoma:* First metasomal tergite rugose, length five times its apical width (dorsal view); basal sternal plate (acrosternite) about 0.7 times length of tergum; second metasomal tergite mostly smooth, only indistinctly costate near basal suture; suture between second and third metasomal tergites indistinct; third metasomal tergite and remaining metasomal tergites smooth and polished; ovipositor about 0.9 times length of metasoma.

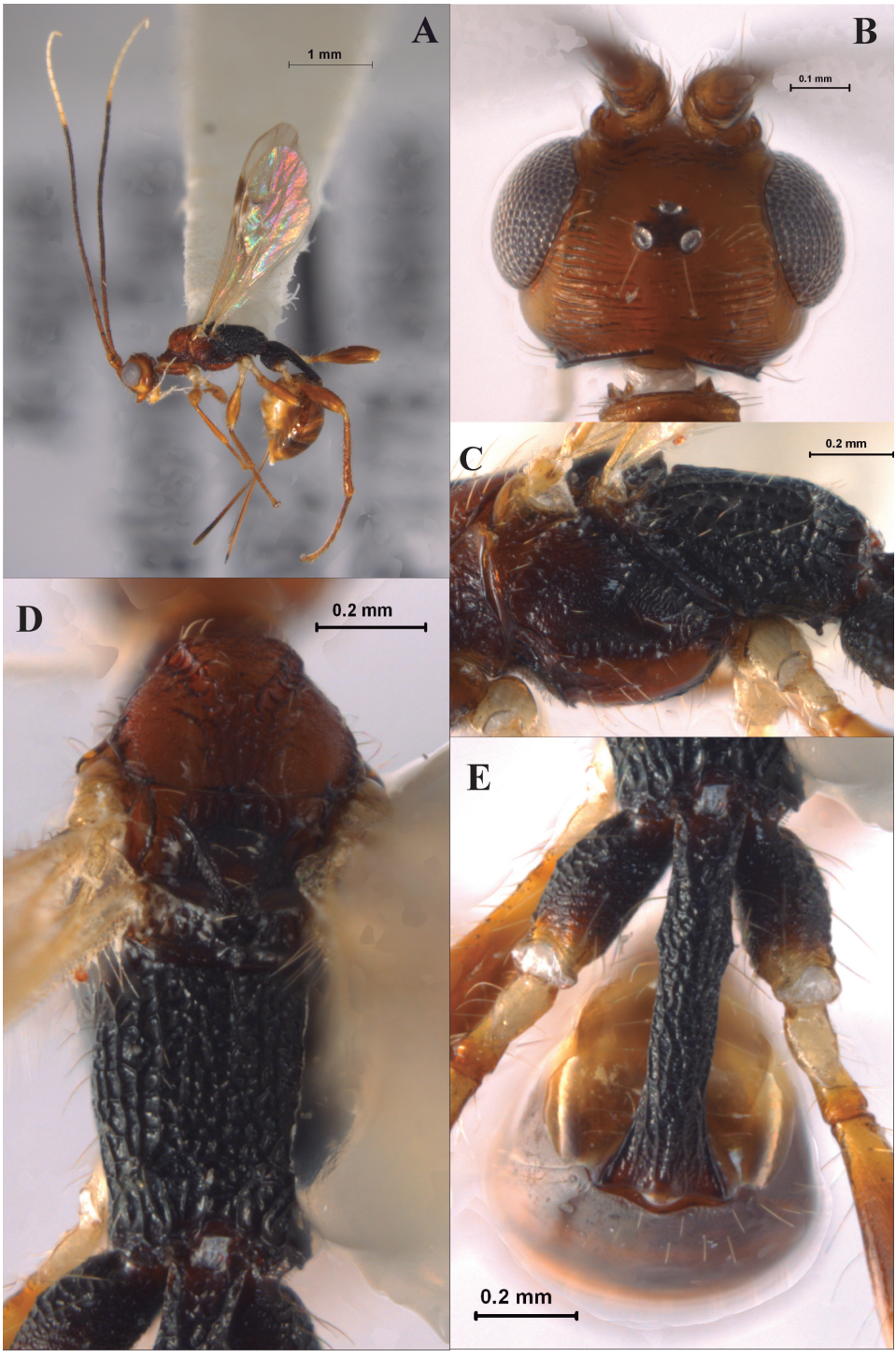

Figure 1. *Notiospathius araguae* sp. n. Female. Holotype: **A** habitus, lateral view **B** head, dorsal view **C** mesosoma, lateral view **D** mesosoma, dorsal view **E** first and second metasomal tergites, dorsal view.

Male. Smaller than female; body length 3 mm; head brown, orbit surrounding eyes yellow; antenna with 23 flagellomeres; second and third metasomal tergites light brown.

Holotype. Female (IB-UNAM CNIN). Venezuela, Aragua, Henri Pittier National Park, 10.37428N, -67.59279W, 1070m, montane cloud forest/riparian, H. Clebsch, 7–11.x.08. DNA voucher no. (BOLD system) DORYC207-11, GenBank accession no. JN266962.

Paratypes. One specimen, male (DCBU). Same data as holotype, DNA voucher no. (BOLD system) DORYC210-11; GenBank accession no. JN266965.

Biology. Unknown.

Etymology. The name of this species refers to the Venezuelan state where both type specimens were collected.

Notiospathius bolivari López-Estrada & Zaldívar-Riverón, sp. n.

urn:lsid:zoobank.org:act:6276E940-C7D2-4177-AEBF-1A9160A570A6
http://species-id.net/wiki/Notiospathius_bolivari
Figs 2A–E

Diagnosis. This new species is morphologically similar to *N. janzeni* Marsh; however, it differs from the latter species by having a basoventral tubercle in the hind coxa (absent in *N. janzeni*) and mesopleuron porcate-coriaceous dorsally, coriaceous ventrally (porcate-rugose dorsally, weakly coriaceous to smooth ventrally in *N. janzeni*). *Notiospathius bolivari* is genetically similar to two species described below, *N. larensis* sp. n. and *N. dantei* sp. n., though it differs from them by having the third metasomal tergite finely striate; and fourth and fifth metasomal tergites finely granulose (third, fourth and remaining metasomal tergites smooth and polished in *N. dantei* sp. n. and *N. larensis* sp. n.).

Description. Female. *Colour:* Head brown; orbit surrounding eye honey yellow; pedicel and scape honey yellow; flagellomeres brown, apical 9 white (one antenna broken); palpi white. Mesonotum brown, venter of mesopleuron and propodeum black; first metasomal tergite black turning brown apically; second metasomal tergite dark brown with two sublateral light brown stripes; third metasomal tergite dark brown; fourth and fifth metasomal tergites dark brown with a semicircular basal area light brown; remaining metasomal tergites dark brown; ovipositor brown, apex strongly sclerotised; sheaths brown, turning dark brown to apex. Fore and middle coxae, trochanter and trochantellus white; femora brown on basal edge, remaining area white with a longitudinal dark brown stripe; tibiae dark brown dorsally, white ventrally; tarsi light brown; hind coxa brown dorsally, dark brown to black ventrally, apical edge white; trochanter and trochantellus white, femur brown on basal edge, basal third white, apical two thirds dark brown with a white irregular area medially; tibia dark brown dorsally, white ventrally; tarsi dark brown. Wings dusky; veins dark brown; stigma dark brown to black, white laterally; tegula honey yellow. *Body length:* 4.2 mm (lateral view), ovipositor 3 mm. *Head:* Clypeus rugose; face, frons and vertex striate-rugose; temple slightly striate; gena smooth; eye 0.8 times higher than wide (lateral view); malar space 0.5 times eye height (lateral view); temple 0.25 times

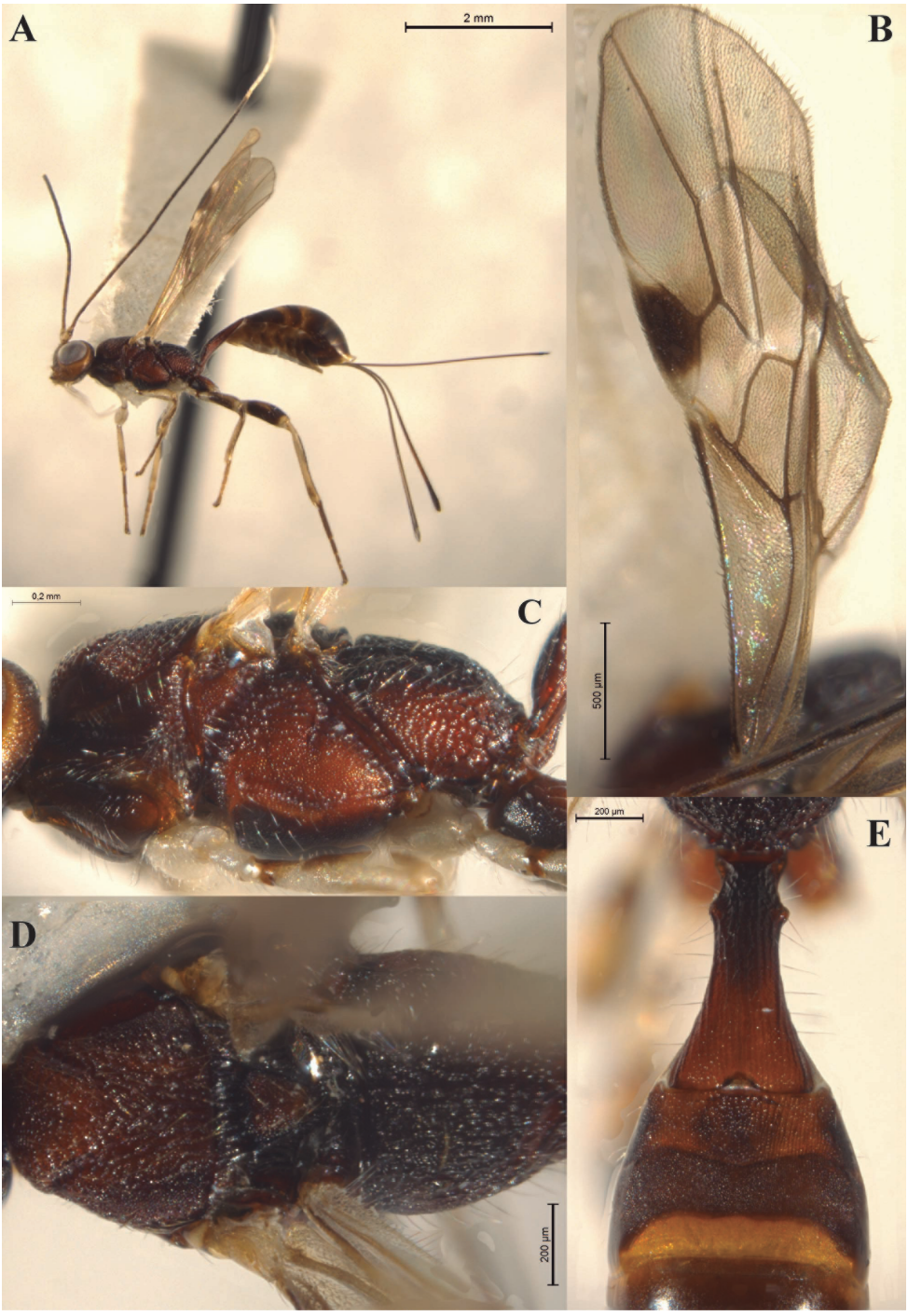

Figure 2. *Notiospathius bolivari* sp. n. Female. Holotype: **A** habitus, lateral view **B** fore wing **C** mesosoma, lateral view **D** metasoma, dorsal view **E** metasoma, dorsal view.

eye width (dorsal view); ocular-ocellar distance 4 times diameter of lateral ocellus; length of scape 2 times its width (frontal view); antenna with 29 flagellomeres (one antenna broken). *Mesosoma:* Length of mesosoma 1.8 times its maximum height; pronotum slightly striate-rugose; pronotal groove wide and scrobiculate; propleuron slightly striate; median mesoscutal lobe striate rugose; lateral mesoscutal lobes striate-rugose, coriaceous medially; notauli wide, deep and scrobiculate, not joining and obscured at middle of mesoscutum in a longitudinally striate-rugose area; scutellar disc coriaceous; subalar and mesopleural sulcus continuous, joining at middle of mesopleuron, the first one wide, deep and scrobiculate, the second one narrow, deep and slightly scrobiculate; mesopleuron porcate-coriaceous dorsally, coriaceous ventrally; precoxal sulcus wide, anterior half shallow and slightly scrobiculated, posterior half deep and scrobiculate, 0.85 as long as mesopleuron; venter of mesosoma coriaceous; metapleuron rugose- areolate, slightly coriaceous anteriorly; propodeum rugose-areolate; apical lateral corners without tubercles; spines over hind coxa absent. *Wings:* Fore wing length 3.3 times its maximum width; length of pterostigma 3.2 times its maximum width; vein r 0.3 length of vein 3RSa; vein m-cu distinctly antefurcal to vein 2RS; vein 1cu-a postfurcal to vein 1M; hind wing vein M+CU 0.7 times length of vein 1M. *Legs:* hind coxa striate dorsally, coriaceous ventrally, with a distinct basoventral tubercle; middle and hind femora coriaceous. *Metasoma:* First metasomal tergite costate with carinate microsculpture, with lateral spine-like projections at basal third of tergite; length 1.6 times its apical width (dorsal view); basal sternal plate (acrosternite) about 0.6 times length of tergum; second metasomal tergite striate with carinate microsculpture; suture between second and third metasomal tergites distinct and sinuate; third metasomal tergite finely striate; fourth and fifth metasomal tergites finely granulose, remaining metasomal tergites smooth and polished; ovipositor about 1.3 times length of metasoma.

Male. Unknown.

Distribution. Northwest Venezuela, state of Aragua.

Holotype. Female (IB-UNAM CNIN). Venezuela, Aragua, Henri Pittier National Park, 10.37428-67.59279, 11-12.ix.07 YPT/78 plates, 1070m Montane cloud forest/riparian, H. Clebsch, DNA voucher no. (BOLD system) DORYC212-11, GenBank accession no. JN266967.

Biology. Unknown.

Etymology. This species is named in honour to Simón Bolívar, the South American military and political leader who led Venezuela, Colombia, Ecuador, Peru and Bolivia to independence.

Notiospathius curvilineatus López-Estrada & Zaldívar-Riverón, sp. n.

urn:lsid:zoobank.org:act:8975DEB8-F0E4-45D0-9A5C-76A12187C839
http://species-id.net/wiki/Notiospathius_curvilineatus
Figs 3A–D

Diagnosis. *Notiospathius curvilineatus* sp. n. is distinguished from the remaining described species of the genus by having a combination of the mesopleuron diagonally

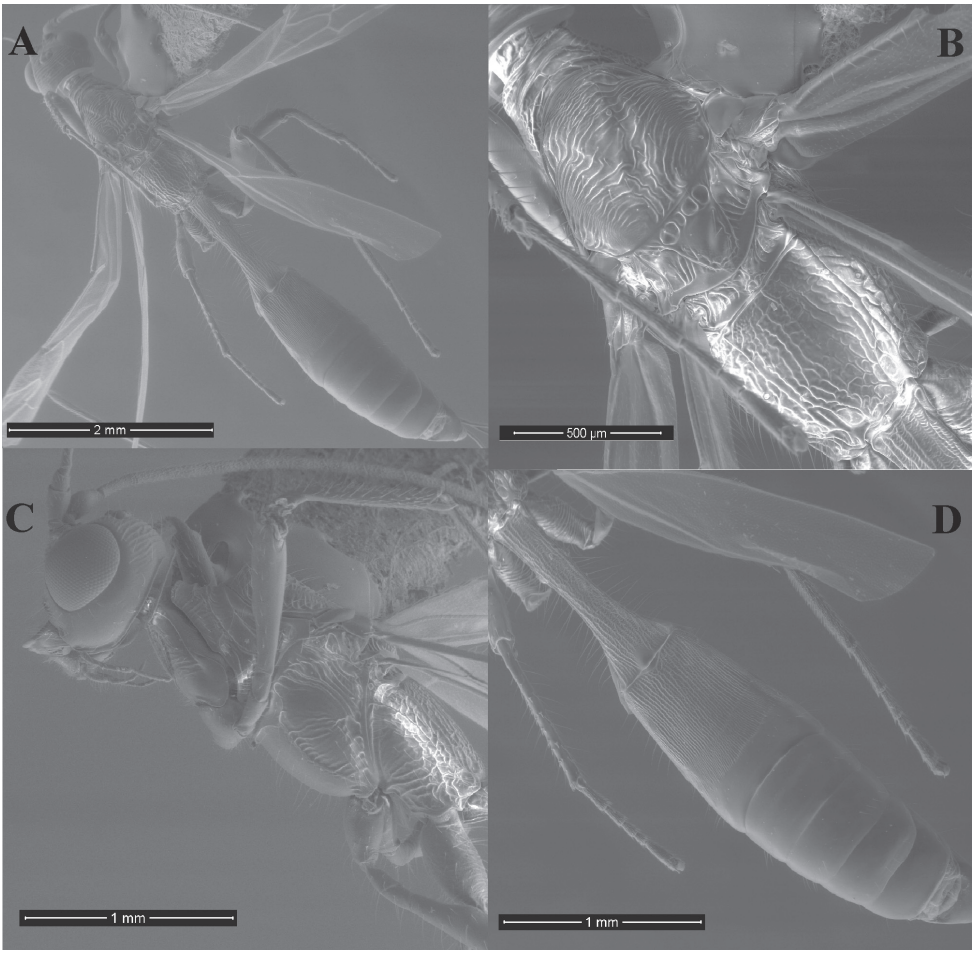

Figure 3. *Notiospathius curvilineatus* sp. n. Female. Paratype: **A** habitus, dorsal view **B** mesosoma, dorsal view **C** mesosoma, lateral view **D** metasoma, dorsal view.

costate from postero-median to medio-ventral region medially and ventrally, and the first three metasomal tergites sculptured. This species runs to *N. janzeni* in Marsh's (2002) key to Costa Rican species and its Zaldívar-Riverón and De Jesús-Bonilla's (2010, 2011) extension; however it differs by having the mesososma and first metasomal tergite reddish brown to brown (mesosoma and first metasomal tergite dark brown to black in *N. janzeni*); hind coxa pale yellow, brown apically (hind coxa dark brown or black in *N. janzeni*); and frons striate (frons rugose in *N. janzeni*).

Description. Female. *Colour*: Head brown to reddish brown; scape pale yellow with a brown longitudinal stripe laterally; flagellomeres dark brown turning black to apex, apical 9 white; palpi white. Mesosoma and first metasomal tergite reddish brown to brown; second metasomal tergite dark brown, yellow basolaterally; third metasomal tergite yellow, dark brown apically; remaining metasomal tergites brown except the last one which is yellow; ovipositor and sheaths brown to reddish brown. Fore and middle

coxae, trochanter and trochantellus pale yellow; femora pale yellow with a median and an apical dark brown transverse bands dorsally; tibiae pale yellow basally, light brown medially and apically, with a dark brown transverse band dorso-basally; tarsi light brown to brown; hind coxa pale yellow, brown apically; trochanter and trochantellus honey yellow; femur pale yellow on basal third, apical two thirds dark brown; tibia pale yellow basally, light brown medially and apically, with a dark brown transverse band dorso-basally; tarsi brown. Wings dusky; veins and stigma dark brown; tegula yellow. *Body length:* 5.8 mm (lateral view); ovipositor 6.8 mm. *Head:* Clypeus rugose; face straite; frons striate; vertex striate; temple and gena smooth; eye 1.5 times higher than wide (lateral view); malar space 0.4 times eye height (lateral view); temple 0.2 times eye width (dorsal view); hypoclypeal depression elliptic; ocular-ocellar distance 2.6 times diameter of lateral ocellus; length of scape 1.4 times its width (frontal view); antenna with 35 flagellomeres. *Mesosoma:* Length of mesosoma 1.9 times its maximum height; pronotum longitudinally costate-coriaceous; pronotal groove wide and slightly scrobiculate; propleuron slightly striate; lateral mesoscutal lobes coriaceous medially, transversally costate along notauli and edges; median mesocutal lobe transversally costate-rugose; notauli wide, deep and scrobiculate, meeting just before scutellum in a longitudinally costate-rugose area; scutellar disc smooth; mesopleural and subalar sulcus discontinuous, the first one deep and scrobiculate and the second one wide, deep and including the striate sculpture of mesopleuron; mesopleuron porcate-slightly coriaceous dorsally, slightly curved, diagonally costate from postero-median to medio-ventral region medially and ventrally; precoxal sulcus wide, deep and including the striate sculpture of mesopleuron, as long as mesopleuron; venter of mesosoma smooth and polished; metapleuron costate ventrally, rugose-aerolate dorsally, slightly coriaceous on anterior first third; propodeum rugose; apical lateral corners without distinct tubercles; spines over hind coxa indistinct. *Wings:* Fore wing length 4.3 times its maximum width; length of pterostigma 2.8 times its maximum width; vein r 0.2 length of vein 3RSa; vein m-cu antefurcal to vein 2RS; vein 1cu-a distinctly postfurcal to vein 1M; hind wing vein M+CU about 0.4 times length of vein 1M. *Legs:* hind coxa striate, indistinct tubercule at the base; middle and hind femora slightly coriaceous. *Metasoma:* First metasomal tergite strongly costate with rugose microsculpture, length 3.1 times its apical width (dorsal view); basal sternal plate (acrosternite) about 0.6 times length of tergum; second metasomal tergite costate with rugose microsculpture; suture between second and third metasomal tergites distinct and sinuate; third metasomal tergite coriaceous on basal half, smooth on apical half; remaining metasomal tergites smooth and polished; ovipositor about 1.8 times length of metasoma.

Male. Unknown.

Variation. Females: *Body length:* close to 5.8 mm; ovipositor about 5.8–6.8. *Head:* Eye 1.4–1.5 times higher than wide (lateral view); scutellar disc slightly coriaceous to smooth. Wings: Fore wing length 4.1–4.3 times its maximum width; length of pterostigma 2.8–3.7 times its maximum width. Metasoma: length of first metasomal tergite 3.1–3.7 times its apical width (dorsal view); ovipositor about 1.6–1.8 times length of metasoma.

Holotype. Female (UCOB). Venezuela, Lara, Parque Nacional Cerro Saroche, sector Cañaote #3, 10°11.83'N, -69°26.13'W, 929 m, 15–19.vii.08, DNA voucher no. (BOLD system) DORYC235-11, GenBank accession no. JN266985.

Paratypes. One female (DCBU). Venezuela, Lara, Parque Nacional Cerro Saroche, La Cimara # 3, 7–10.x.2008, 10°12.656'N, -69°25.339'W, YPT, R. Briceño col., DNA voucher no. (BOLD system) DORYC234-11, GenBank accession no. JN266984.

Biology. Unknown.

Etymology. The name of this species refers to the curved, diagonally costate sculpture on the median and ventral areas of mesopleuron.

***Notiospathius dantei* López-Estrada & Zaldívar-Riverón, sp. n.**
urn:lsid:zoobank.org:act:26384071-6B8F-4AC7-89FC-411C6046796A
http://species-id.net/wiki/Notiospathius_dantei
Figs 4A–D

Diagnosis. This new species is morphologically and genetically similar to one of the species described below, *N. larensis* sp. n., though it differs from the latter species by having the mesonotum reddish brown (brown to dark brown in *N. larensis* sp. n.); first metasomal tergite reddish brown at extreme base, black medially, turning reddish brown to apex (completely black in *N. larensis* sp. n.); and mesopleural and subalar sulcus continuous, joining at middle of mesopleuron (not joining in *N. larensis* sp. n.). *Notiospathius dantei* differs from the remaining described species of the genus with basoventral tubercle on hind coxa by having the following combination of features: first two metasomal tergites sculptured, remaining ones smooth; apical 10 flagellomeres lighter than remaining ones; mesopleuron porcate-sligthly coriacoeus dorsally and medially, coriaceous ventrally; lateral mesoscutal lobes coriaceous medially, striate-rugose laterally; median mesoscutal lobes coriaceous anteromedially.

Description. Female. *Colour:* Head dark brown; area near mandible and orbit surrounding eye honey-yellow; pedicel honey yellow, brown dorsally; flagellomeres brown, turning light brown to apex, apical 10 white (one antenna broken); palpi white. Mesonotum reddish brown to dark brown, first metasomal tergite reddish brown at extreme base, black medially and turning reddish brown to apex; second metasomal tergite dark brown with a semicircular basal area light brown; third and fourth metasomal tergites light brown basally and medially, dark brown apically; remaining metasomal tergites dark brown; ovipositor and sheaths reddish brown, ovipositor apex strongly sclerotized, black. Fore and middle coxae, trochanter and trochantellus white, femora brown at the base, following by white and turning brown to light brown to apex, tibiae and tarsi light brown; hind coxa light brown to brown, trochanter and trochantellus white, femur white at basal third, apical two thirds brown, tibia and tarsi brown. Wings dusky; veins dark brown; stigma pale yellow at extreme base, remaining area dark brown; tegula honey-yellow. *Body length:* 4.1 mm (lateral view), ovipositor

Figure 4. *Notiospathius dantei* sp. n. Female. Holotype: **A** habitus, lateral view **B** metasoma, dorsolateral view **C** mesosoma, lateral view **D** head, dorsal view.

3.7 mm. *Head:* Clypeus striate-rugose; face straite; frons striate-rugose; vertex striate-slightly rugose; temple slightly striate; gena smooth; eye 1.4 times higher than wide (lateral view); malar space 0.4 times eye height (lateral view); temple 0.5 times eye width (dorsal view); hypoclypeal depression elliptic; ocular-ocellar distance 6 times diameter of lateral ocellus; length of scape less than 1.2 times its width (frontal view); antenna with 29 flagellomeres (one antenna broken). *Mesosoma:* Length of mesosoma 1.9 times its maximum height; pronotum striate; pronotal groove wide and scrobiculate; propleuron laterally striate, remaining area slightly coriaceous; lateral mesoscutal lobes coriaceous medially, striate-rugose laterally; median mesoscutal lobes coriaceous anteromedially, remaining area transversally striate-rugose; notauli wide, deep and scrobiculate, not joining, obscuring at middle of mesoscutum in a longitudinally striate-rugose area; scutellar disc slightly coriaceous; mesopleural and subalar sulcus continuous, joining at middle of mesopleuron, the first one deep, narrow and scrobiculate, the second one wide, deep and including the porcate sculpture of mesopleuron; mesopleuron porcate-sligthly coriacoeus dorsally and medially, coriaceous ventrally; precoxal sulcus wide, deep and scrobiculate, as long as mesopleuron; venter of mesosoma slightly coriaceous; metapleuron longitudinally costate with rugose microsculpture;

propodeum longitudinally costate-rugose; apical lateral corners with tubercles; spines over hind coxa absent. *Wings:* Fore wing length 4.1 times its maximum width; length of pterostigma 3.2 times its maximum width; vein r 0.3 length of vein 3RSa; vein m-cu distinctly antefurcal to vein 2RS; vein 1cu-a slightly postfurcal to vein 1M; hind wing vein M+CU 0.4 times length of vein 1M. *Legs:* hind coxa striate, with an almost indistinct basoventral tubercle; middle and hind femora slightly coriaceous. *Metasoma:* First metasomal tergite costate with rugose microsculpture; length 2.3 times its apical width (dorsal view); basal sternal plate (acrosternite) about 0.7 times length of tergum; second tergite striate with rugose microsculpture; suture between second and third metasomal tergites distinct and slightly sinuate; remaining metasomal tergites smooth and polished; ovipositor about 1.7 times length of metasoma.

Male. Unknown.

Distribution. Northwest Venezuela, state of Yaracuy.

Holotype. Female (IB-UNAM CNIN). Venezuela, Yaracuy, Est. Biol. Guáquira, 10°17.84'N, -68°39.32'W, 107 m, sweep, selva trop., DNA voucher no. (BOLD system) DORYC278-11, GenBank accession no. JN267024.

Biology. Unknown.

Etymology. This species is named in honour of the first author's father.

Notiospathius estradae **López-Estrada & Zaldívar-Riverón, sp. n.**
urn:lsid:zoobank.org:act:52FF943B-8C41-4823-8DB3-F18BC9602BCC
http://species-id.net/wiki/Notiospathius_estradae
Figs 5A–D

Diagnosis. This species is similar to *N. shawi* Marsh, though it can be distinguished from the latter species by having the mesopleuron coriaceous-slightly rugose dorsally, coriaceous medially and ventrally (costate dorsally and coriaceous ventrally in *N. shawi*), and notauli obscuring before scutellum in a large porcate-rugose area (meeting before scutellum in a narrow rugose area in *N. shawi*).

Description. Female. *Colour*: Head light brown to honey yellow; scape honey yellow; flagellomeres honey yellow turning dark brown to apex; palpi pale yellow. Mesosoma and first metasomal tergite black, pronotum light brown on half basal half, black on apical half; second metasomal tergite dark brown; third metasomal tergite and remaining metasomal tergites brown to dark brown; last one pale yellow; ovipositor brown; sheaths honey yellow. Fore and middle coxae light brown to honey yellow; trochanter and trochantellus pale yellow; femora brown; tibiae pale yellow basally, honey yellow medially and apically; tarsi honey yellow; hind coxa black; trochanter and trochantellus pale yellow; femur dark brown; tibia pale yellow basally turning light to apex; tarsi light brown. Wings dusky, veins and stigma dark brown, tegula dark brown to black. *Body length:* 4.4 mm (lateral view); ovipositor 3.8 mm. *Head:* Clypeus rugose; face, frons and vertex striate; temple and gena smooth; eye about 0.9 times higher than wide (lateral view); malar space 0.6 times eye height (lateral view); temple 0.2 times

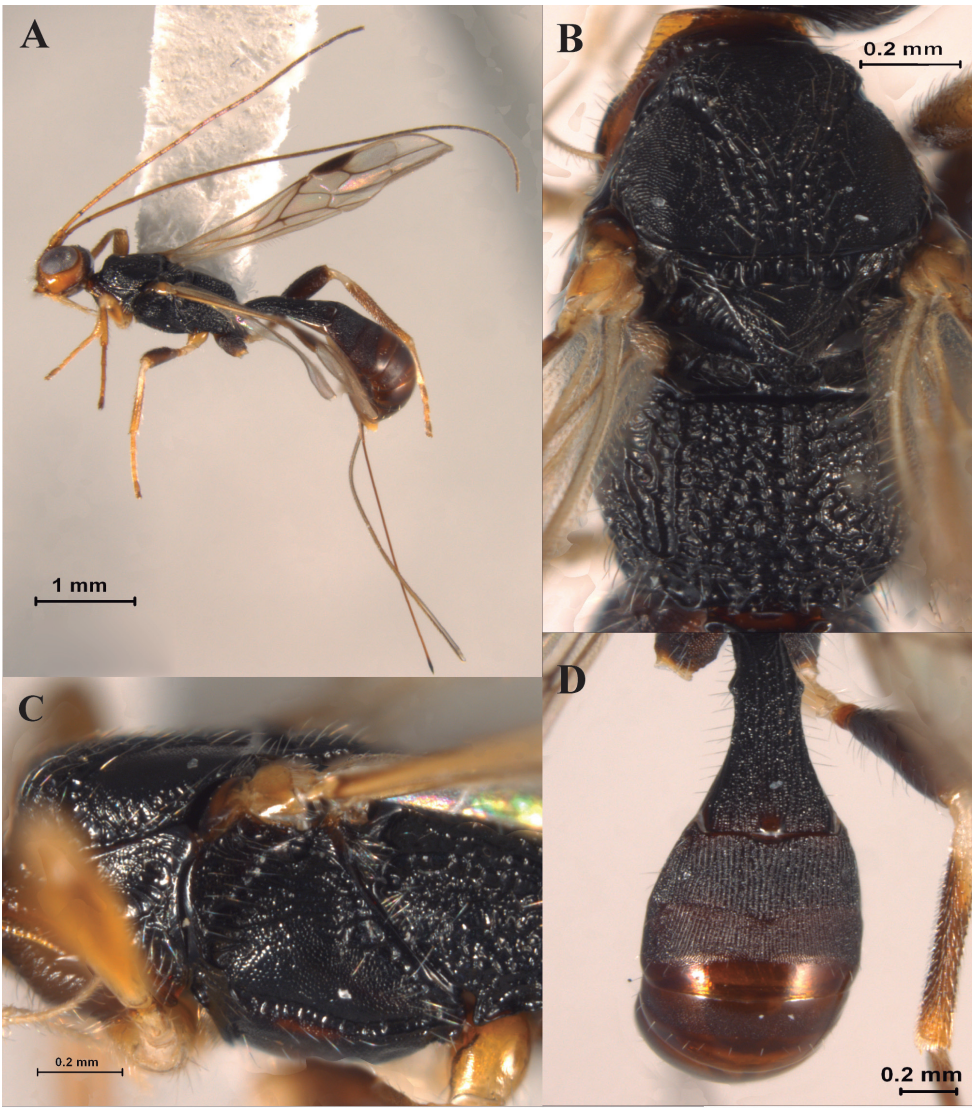

Figure 5. *Notiospathius estradae* sp. n. Female. Paratype: **A** habitus, lateral view **B** mesosoma, dorsal view **C** mesosoma, lateral view **D** metasoma, dorsal view.

eye width (dorsal view); hypoclypeal depression elliptic; ocular-ocellar distance 1.5 times diameter of lateral ocellus; length of scape twice its width (frontal view); antenna with 29 flagellomeres. *Mesosoma:* Length of mesosoma 1.9 times its maximum height; pronotum coriaceous; pronotal groove narrow and slightly scrobiculate; propleuron slightly striate; mesoscutal lobes coriaceous; notauli wide and scrobiculate, not joining, obscuring in a large porcate-rugose area; scutellar disc coriaceous; mesopleural and subalar sulcus continuous, both deep and scrobiculate; mesopleuron coriaceous-slightly rugose dorsally, coriaceous medially and ventrally; precoxal sulcus wide, deep

and scrobiculate, as long as mesopleuron; venter of mesosoma coriaceous; metapleuron and propodeum strongly rugose with coriaceous microsculpture; apical lateral corners without distinct tubercles; spines over hind coxa indistinct. *Wings:* Fore wing length 4.3 times its maximum width; length of pterostigma 3.6 times its maximum width; vein r 0.3 length of vein 3RSa; vein m-cu intersticial to vein 2RS; vein 1cu-a distinctly postfurcal to vein 1M; hind wing vein M+CU about 0.5 times length of vein 1M. *Legs:* hind coxa coriaceous, with a distinct basoventral tubercle; middle and hind femora smooth. *Metasoma*: First metasomal tergite strongly costate with rugose microsculpture, length twice its apical width (dorsal view); basal sternal plate (acrosternite) about 0.5 times length of tergum; second metasomal tergite costate with rugose microsculpture; suture between second and third metasomal tergites distinct and sinuate; third metasomal tergite costate on basal half, smooth on apical half; remaining metasomal tergites smooth and polished; ovipositor about 1.8 times length of metasoma.

Male. Unknown.

Variation. Females: *Colour:* head dark brown; orbit surrounding eyes yellow. *Body length:* 4.4–5.4 mm (lateral view); ovipositor 3.6–4.2 mm. *Head:* Eye 0.9–1.3 times higher than wide (lateral view). *Wings:* Fore wing length 4.2–4.6 times its maximum width; length of pterostigma 2.8–3.6 times its maximum width. *Metasoma:* length of first metasomal tergite 1.3–2.0 times its apical width (dorsal view); ovipositor 1.5–1.8 times length of metasoma.

Holotype. Female (UCOB). Venezuela, Lara, Parque Nacional Cerro Saroche, sector Batatal # 4, 10°09.15'N, -69°30.205'W, 809 m, 7–11.x.08, DNA voucher no. (BOLD system) DORYC286-11; GenBank accession no. JN267031.

Paratypes. Three females (IB-UNAM CNIN). Same data as holotype, DNA voucher nos (BOLD system) DORYC285-11, DORYC 287-11, IB-CNIN569, GenBank accession nos JN267030, JN267032, JN870425.

Biology. Unknown.

Etymology. We named this species in honour to the first author's mother, Margarita Estrada.

***Notiospathius larensis* López-Estrada & Zaldívar-Riverón, sp. n.**
urn:lsid:zoobank.org:act:90728947-9EBB-432D-B51C-8AAF57F3C73A
http://species-id.net/wiki/Notiospathius_larensis
Figs 6A–D

Diagnosis. This species is morphologically similar to *N. dantei*, but they differ by the morphological features mentioned in the diagnosis of the latter species. *Notiospathius larensis* differs from the remaining species of the genus with basoventral tubercle on the hind coxa by having the following combination of features: vertex rugose-striate; mesoscutal lobes coriaceous medially, striate-rugose laterally or anteromedially; mesopleuron porcate dorsally, rugose-coriaceous to coriaceous medially and ventrally; first two metasomal tergites scultpured, remaining ones smooth.

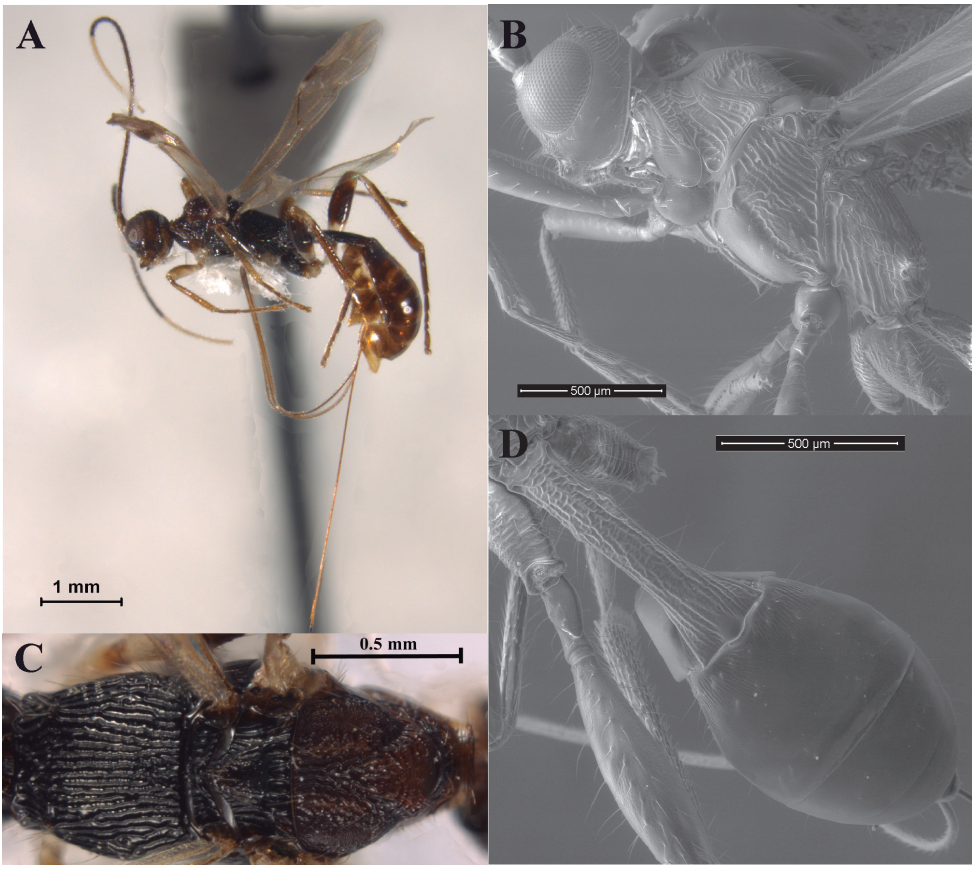

Figure 6. *Notiospathius larensis* sp. n. Female. Holotype: **A** habitus, lateral view **B** mesosoma, lateral view **C** mesosoma, dorsal view **D** metasoma, dorsal view.

Description. Female. *Colour:* Head brown; orbit surrounding eyes yellow; scape and pedicel light brown; flagellomeres brown, apical 10 white (broken); palpi white. Mesonotum brown to dark brown; propodeum, metapleuron and first metasomal tergite black, brown apically; second metasomal tergite dark brown with a light brown basal semicircular area; third and fourth metasomal tergites brown; remaining metasomal tergites brown to light brown, ovipositor and sheaths brown to honey yellow, ovipositor apex strongly sclerotized, black. Fore and middle coxae white; trochanter and trochantellus pale yellow; fore femur light brown; middle femur brown; fore and middle tibia and tarsi light brown; hind coxa dark brown; trochanter and trochantellus honey yellow; femur honey yellow at basal first third, apical two thirds dark brown; tibia brown; tarsi dark brown. Wings dusky, veins and tegula honey yellow; stigma yellow at basal third, dark brown apically. *Body length:* 4.2 mm (lateral view), ovipositor 3.3 mm. *Head:* Clypeus straite-rugose; face striate; frons rugose; vertex rugose-striate; temple weakly striate dorsally, gena smooth; eye 1.1 times higher than wide (lateral view); malar space almost 0.4 times eye height

(lateral view); temple 0.2 times eye width (dorsal view); hypoclypeal depression elliptic; ocular-ocellar distance 3 times diameter of lateral ocellus; length of scape less than 1.5 times its width (frontal view); antenna with 30 flagellomeres (broken). *Mesosoma:* Length of mesosoma 1.9 times its maximum height; pronotum striate dorsally, slightly rugose ventrally; pronotal groove, wide and scrobiculate; propleuron striate; lateral mesoscutal lobes coriaceous medially, striate-rugose laterally; median mesoscutal lobe coriaceous anteromedially, remaining area striate-rugose; notauli scrobiculate, not joining, obscuring in a longitudinally striate-rugose area; scutellar disc coriaceous; mesopleural and subalar sulcus discontinuous, both deep and narrow; mesopleuron porcate dorsally, including subalar area, rugose-coriaceous antero-ventrally, coriaceous ventrally; precoxal sulcus wide, deep and scrobiculate, as long as mesopleuron; venter of mesosoma slightly coriaceous; metapleuron striate; propodeum longitudinally striate; apical lateral corners with distinct tubercles; spines over hind coxa indistinct. *Wings:* Fore wing length 5.1 times its maximum width; length of pterostigma three times its maximum width; vein r 0.5 length of vein 3RSa; vein m-cu antefurcal to vein 2RS; vein 1cu-a distinctly postfurcal to vein 1M; hind wing vein M+CU 0.4 times length of vein 1M. *Legs:* fore tibia with a row of at least seven spines; hind coxa striate, with a distinct basoventral tubercle; middle and hind femora slightly striate. *Metasoma:* First metasomal tergite strongly rugose anteriorly, costate with rugose microsculpture medially and posteriorly, length three times its apical width (dorsal view); basal sternal plate (acrosternite) about 0.7 times length of tergum; second metasomal tergite striate; suture between second and third metasomal tergites distinct and straight; remaining metasomal tergites smooth and polished; ovipositor about 1.6 times length of metasoma.

Male. Unknown

Variation. Females: *Head*: scape and pedicel with a brown stripe laterally *Body length:* close to 4.0–4.2 mm; ovipositor about 3.3–3.8. *Head:* Eye 1.1–1.4 times higher than wide (lateral view). Wings: Fore wing length 3.8–4.1 times its maximum width; length of pterostigma 3.0–3.5 times its maximum width. *Metasoma*: length of first metasomal tergite 2.6–3.0 times its apical width (dorsal view).

Holotype. Female (UCOB). Venezuela, Lara, Parque Nacional Cerro Saroche, sector Batatal, 10°09.15'N, -69° 30.205'W, 809 m, 15–19.vii.2008, YTP, R. Briceño col., DNA voucher no. IB-CNIN567; GenBank accession no. JN870424.

Paratypes. Two females (IB-UNAM CNIN, DCBU). One female, Venezuela, Lara, Parque Nacional Cerro Saroche, La Cimara #5, 10°12.656'N, -69°25.339'W, 7-10.x.2009, R. Briceño col., DNA voucher no. (BOLD systems) DORYC241-11; GenBank accession no. JN266991; one female, Venezuela, Lara, Parque Nacional Cerro Saroche, Cañaote #3, 10°11.83'N, -69°26.13'W, 929 m, 15–19.vii.08, col. R. Briceño, DNA voucher no. (BOLD systems) DORYC237-11; GenBank accession no. JN266987.

Biology. Unknown.

Etymology. The name of this species refers to the Venezuelan state where the species was collected.

Notiospathius venezuelae **López-Estrada & Zaldívar-Riverón, sp. n.**
urn:lsid:zoobank.org:act:4C4BD7CE-586B-4142-BA7A-CC22284E094B
http://species-id.net/wiki/Notiospathius_venezuelae
Figs 7A–E

Diagnosis. This species runs to *N. leucacrocera* (Enderlein) in the extension (Zaldívar-Riverón and De Jesús-Bonilla 2010, 2011) to Marsh's (2002) key to Costa Rican species. However, it differs from the latter species by having the mesosoma and first metasomal tergite mostly black (mesosoma and first metasomal tergite dark brown in *N. leucacrocera*); fore and middle coxae white, femora pale yellow on basal third, brown on apical two thirds; (fore and middle legs completely yellow in *N. leucacrocera*), pronotum and propleuron coriaceous and striate, respectively (pronotum and propleuron costate in *N. leucacrocera*). *N. venezuelae* can be distinguished from the remaining described species of the genus by having the following combination of features: hind coxa black, pale yellow apically; pronotum coriaceous; mesoscutal lobes coriaceous; notauli not joining, obscuring in a large costate area; mesopleuron porcate-coriaceous dorsally, coriaceous medially and ventrally.

Description. Female. *Colour*: Head dark brown to black; orbit surrounding eyes yellow; scape light brown, with a brown stripe; flagellomeres dark brown, last 11 white; palpi white. Mesosoma and first metasomal tergite black except pronotum wich is brown; second metasomal tergite dark brown; third, fourth and fifth metasomal tergites brown with a light brown band at the middle; sixth metasomal tergite dark brown, pale yellow in apex; remaining metasomal tergites pale yellow; ovipositor brown; sheaths pale yellow turning dark brown. Fore and middle coxae and trochanter white, trochantellus brown, femora pale yellow on basal third, brown on apical two thirds, pale yellow apically, tibiae light brown, tarsi brown; hind coxa black, pale yellow apically; trochanter pale yellow; trochantellus brown; femur white to pale yellow on basal third, brown on apical two thirds, pale yellow at extreme apex; tibia pale yellow basally, turning light brown apically; tarsi brown. Wings dusky; veins and stigma brown; tegula light brown. *Body length:* 4.1 mm (lateral view), ovipositor 1.6 mm. *Head:* Clypeus rugose; face, frons and vertex striate; temple slightly striate; gena smooth; eye about 1.1 times higher than wide (lateral view); malar space 0.2 times eye height (lateral view); temple 0.2 times eye width (dorsal view); hypoclypeal depression elliptic; ocular-ocellar distance three times diameter of lateral ocellus; length of scape twice its width (frontal view); antenna with 28 flagellomeres. *Mesosoma:* Length of mesosoma 2.1 times its maximum height; pronotum coriaceous; pronotal groove wide and coriaceous; propleuron striate; mesoscutal lobes coriaceous; notauli narrow, scrobiculate and with coriaceous microsculpture, not joining, obscuring in a large costate area; scutellar disc coriaceous; mesopleural and subalar sulcus continuous, both scrobiculate; mesopleuron porcate-coriaceous dorsally, coriaceous medially and ventrally; precoxal sulcus narrow, deep and scrobiculated, as long as mesopleuron; venter of mesosoma coriaceous; metapleuron and propodeum costate with rugose microsculpture; apical lateral corners with distinct tubercles; spines over hind coxa distinct. *Wings:* Fore

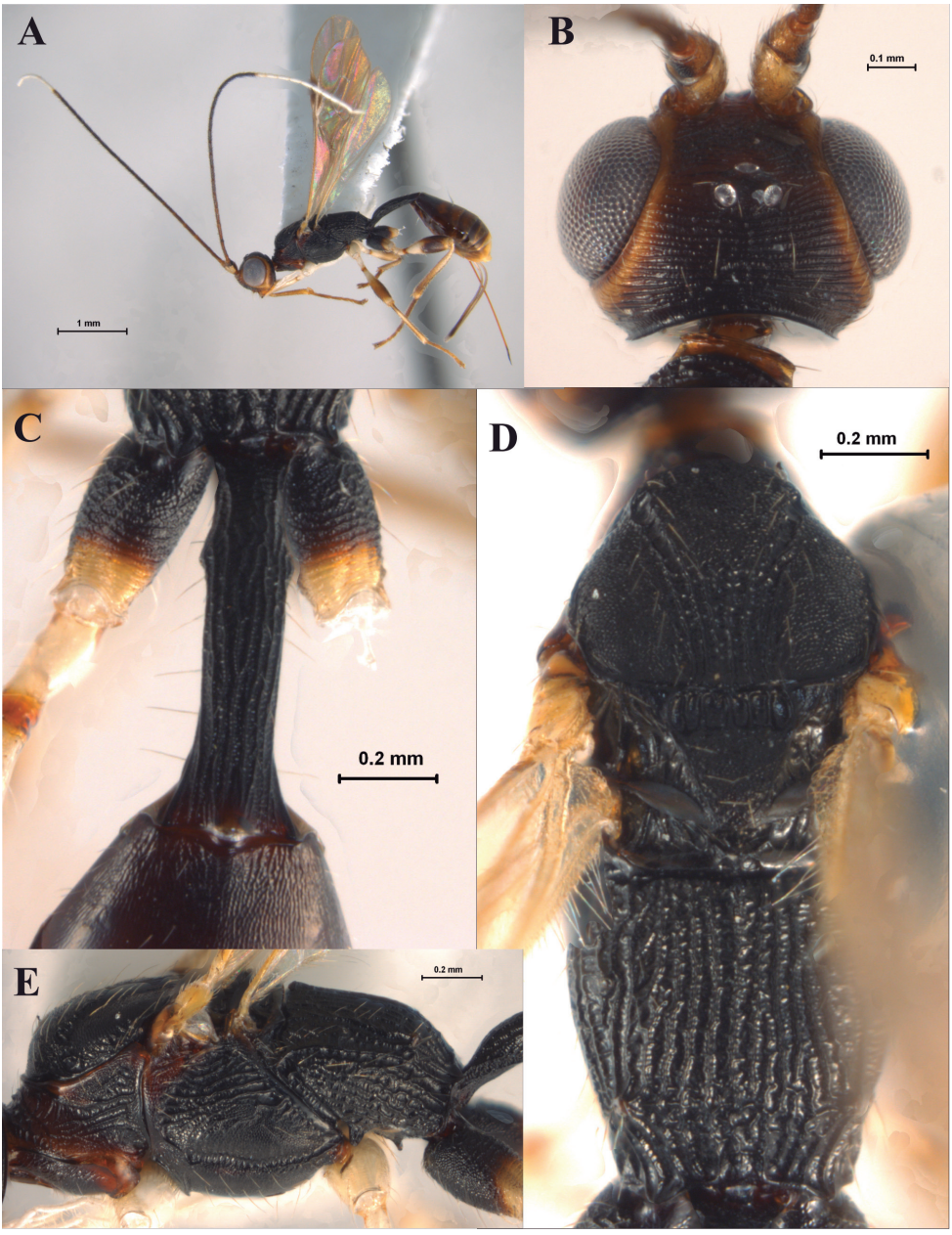

Figure 7. *Notiospathius venezuelae* sp. n. Female. Holotype: **A** habitus, lateral view **B** head, dorsal view **C** first and second metasomal tergites, dorsal view **D** mesosoma, dorsal view **E** mesosoma, lateral view.

wing length 5.1 times its maximum width; length of pterostigma 3.3 times its maximum width; vein r 0.3 length of vein 3RSa; vein m-cu antefurcal to vein 2RS; vein 1cu-a distinctly antefurcal to vein 1M; hind wing vein M+CU about 0.5 times length of vein 1M. *Legs:* hind coxa rugose at the base, striate posteriorly, indistinct tubercule

at the base; middle and hind femora coriaceous. *Metasoma:* First metasomal tergite strongly costate with rugose microsculpture, length 3.2 its apical width (dorsal view); basal sternal plate (acrosternite) about 0.7 times length of tergum; second metasomal tergite slightly costate; suture between second and third metasomal tergites distinct and sinuate; third metasomal tergite smooth; remaining metasomal tergites smooth and polished; ovipositor about 0.7 times length of metasoma.

Male. Essentially as female; pronotum light brown; third and fourth metasomal tergites light brown with a honey yellow band at the middle; antenna with 24 flagellomeres dark brown, only last three white.

Variation. Females: *Body length:* 2.8–4.1 mm (lateral view), ovipositor 1.0–1.6 mm. *Head:* Eye 1.1–1.2 times higher than wide (lateral view); malar space 3.3–4.5 mm *Wings:* Fore wing length 4.2–5.1 times its maximum width, length of pterostigma 2.8–3.6 times its maximum width. *Metasoma:* length of first metasomal tergite 3.2–3.6 times its apical width (dorsal view).

Holotype. Female (IB-UNAM CNIN). Venezuela, Carabobo, Palmichal, 10.28590N, -68.23993W, 93m, 30–3.viii.07, YTP/68 plates, shade coffee, orange grove, H. Clebsch, L. García col., DNA voucher no. (BOLD system) DORYC208-11; GenBank accession no. JN266963.

Paratypes. Four specimens, three males, one female (IB-UNAM CNIN, UCOB). One female and two male, same data as holotype, DNA voucher nos (BOLD system) DORYC206-11, DORYC213-11, GenBank accession nos JN266961, JN266968; one male, Venezuela Yaracuy Mpio. San Felipe, Est. Biol. Guáquira, 107 m, 10°17.84N, -68°39.32W, sweep, 11:00 am, selva tropical, DNA voucher no. IB-CNIN-396, GenBank accession no. JN870300; one male, Costa Rica, Heredia, 11 km ESE La Virgen, 10°21'N, -84°03'W, 20-II-2004, INBIO-OET transect, 250-350 m, DNA voucher no. IB-CNIN537, GenBank accession no. JN870400.

Biology. Unknown.

Etymology. We have named this species after the country where most of the specimens of this new species were collected.

Acknowledgments

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RBG, a grant given by the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), fundação de amparo à Pesquisa do Estado de São Paulo (FAPESP) to AMPD, a grant given by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (Capes) to JFN and AMPD, and a postdoctoral fellowship given by DGPA-PA-UNAM (Mexico) to FSC.

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Appendix

Species delimitation using the GMYC method. doi: 10.3897/JHR.29.3555.app

Explanation note: Ultrametric tree derived from the BEAST analysis showing the species boundaries recovered with the GMYC model and the SPLITS program for 441 DNA barcoding sequences belonging to specimens assigned to *Notiospathius*, *Tarasco* and *Masonius* that were collected in different localities along the Neotropics. Black terminal branches refer to species represented by a single specimen (singletons). Species represented by sequence clusters are coloured in red. Codes of terminal taxa: DORYC = BOLD process ID for Venezuelan specimens; Arg = Argentina; Bra = Brazil; Col = Colombia; Cri = Costa Rica; Cub = Cuba; Dom = Dominican Republic; Ecu = Ecuador; Fgu = French Guyana; Moa = Mexico, Oaxaca; Mve = Veracruz, Mexico; Tri = Trinidad and Tobago; Ven = Venezuela; Spat = *Spathius*.

Citation: López-Estrada KE, Briceño RG, Smith AM, Nunes JF, Penteado-Dias AM, Ceccarelli FS, Clebsch H, Zaldívar-Riverón A (2012) Seven new species of *Notiospathius* (Hymenoptera, Braconidae, Doryctinae) from Northwest Venezuela. Journal of Hymenoptera Research 29: 37–61. doi: 10.3897/JHR.29.3555.app

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RESEARCH ARTICLE

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Orientopius Fischer (Hymenoptera, Braconidae, Opiinae) new for continental China, with description of a new species

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Abstract

The genus *Orientopius* Fischer, 1966 (Hymenoptera: Braconidae: Opiinae) is reported for the first time from continental China and a new species (*O. punctatus* **sp. n.**) is described from Hunan. *Orientiopius tambourinus* Fischer, 1966, is transferred back to the genus *Orientopius*. A key to the Indo-Australian species is added.

Keywords

Braconidae, Opiinae, *Orientopius*, new species, Oriental, China, Hunan, key

Introduction

The genus *Orientopius* Fischer, 1966 (Braconidae: Opiinae) is a small genus with 15 described species from Palaearctic, Oriental and Australian regions. *Orientopius* is closely related to *Coleopius* Fischer, 1964 (Wharton 1988; van Achterberg et al. 2012); they could be treated as subgenera within the same genus, but the decision is postponed till more is known about the phylogeny of this group. Both have the female metasomal carapace covering the fourth and following tergites or largely so, the second metasomal tergite distinctly (1.3–2.1 times) longer than the third tergite, the third tergite with a sharp lateral crease and the second submarginal cell of the fore wing short (vein 3-SR up to 1.3 times as long as vein 2-SR). *Orientopius* can be separated from *Coleopius* as follows: malar suture complete and distinctly impressed (incomplete and obsolescent in *Coleopius*); medio-posterior depression of mesoscutum present (absent) and second metasomal suture distinctly crenulate, except in Australian species (finely sculptured, without distinct crenulae). Wharton (1988) included the Australian *O. tambourinus* Fischer, 1966, in *Coleopius*, because of similarities of the metasomal carapace. According to the differences listed above it agrees better with *Orientopius* and is, therefore, transferred back to *Orientopius*.

Its biology was unknown until recently van Achterberg et al. (2012) reported a new species of *Orientopius* from two species of the genus *Phytobia* Lioy, 1864 (Agromyzidae) mining near the cambium of trees and shrubs of *Crataegus monogyna* Linnaeus and *Prunus spinosa* Linnaeus in northern France. In general, Opiinae are solitary koinobiont endoparasitoids of larvae of cyclorrhaphous Diptera and may play an important role in the control ofdipterous pests such as fruit-infesting Tephritidae and mining Agromyzidae. Oviposition may take place in the egg of the host (ovo-larval parasitoids); the metasomal carapace of *Orientopius* spp. indicates that the oviposition is in a hard substrate. The parasitoid larva has its final development when the host larva has made its puparium and the adult parasitoid emerges from the host puparium. For the first time a key to the non-Palaearctic species of the genus *Orientopius* is supplied; a key to the Palaearctic species is given by van Achterberg et al. (2012).

Material and methods

The holotype was found in the collection of Hunan Agriculture University at Changsha and was re-prepared. The holotype is deposited in the Institute of Insect Sciences, Zhejiang University (ZJUH) at Hangzhou. For identification of the subfamily Opiinae, see van Achterberg (1990, 1993, and 1997), for identification of the genera, see Fischer (1972), Chen and Weng (2005), Wharton (1988) and van Achterberg (2004), for references to the Opiinae, see Yu et al. (2009) and for the terminology used in this paper, see van Achterberg (1988, 1993). Measurements are taken as indicated by van Achterberg (1988).

Taxonomy

***Orientopius* Fischer, 1966**
http://species-id.net/wiki/Orientopius
Figures 1–24

Orientopius Fischer, 1966: 147.

Type species. *Orientopius curiosigaster* Fischer, 1966 (original designation).

Diagnosis. Clypeus truncate medio-ventrally (Figs 8, 16); labrum exposed (Fig. 8); occipital carina present latero-dorsally and weakly or not protruding in lateral view (Figs 6, 23); head comparatively long in anterior view (Figs 8, 16) and malar space longer than basal width of mandible (Figs 9, 18); malar suture present (Figs 9, 16); inner sides of antennal sockets normal, not protruding (Fig. 20); around base of middle coxa no circular carina; medio-posterior depression of mesoscutum present (Figs 4, 17); notauli absent posteriorly (Figs 4, 17) or as row of punctures; postpectal carina variable, usually partly present medio-ventrally; vein 3-SR of fore wing 0.9–2.0 times as long as vein 2-SR (Figs 2, 13); metasoma with carapace (Fig. 1), but less developed in males (Figs 23, 24); second tergite sculptured and distinctly longer than third tergite (Figs 5, 23, 24); dorsal carinae of first tergite variable, separated basally (Fig. 24) or medially united in a median carina (Fig. 5); second metasomal suture distinct (Figs 4, 24); third tergite of female with a sharp lateral crease.

Notes. Fischer (1966, 1972, 1987) lists as a character of the genus that (translated) the second and third tergites are united and have no transverse furrow (= second metasomal suture). This is a misinterpretation of the carapace of the male holotype (Figs 23, 24); the holotype has a long second tergite, a distinctly crenulate second metasomal suture and a comparatively short third tergite. The fourth tergite is rather exposed and smooth, what is typical for males; females have the fourth tergite largely retracted (Figs 5, 10).

***Orientopius punctatus* van Achterberg & Li, sp. n.**
urn:lsid:zoobank.org:act:6368ECFD-581F-41F5-A566-6B03068C1373
http://species-id.net/wiki/Orientopius_punctatus
Figures 1–12

Type material. Holotype (ZJUH), ♀, "[S. China: Hunan], Nan Mt., meadow, 18.VII.1988, Fu-Xing Li".

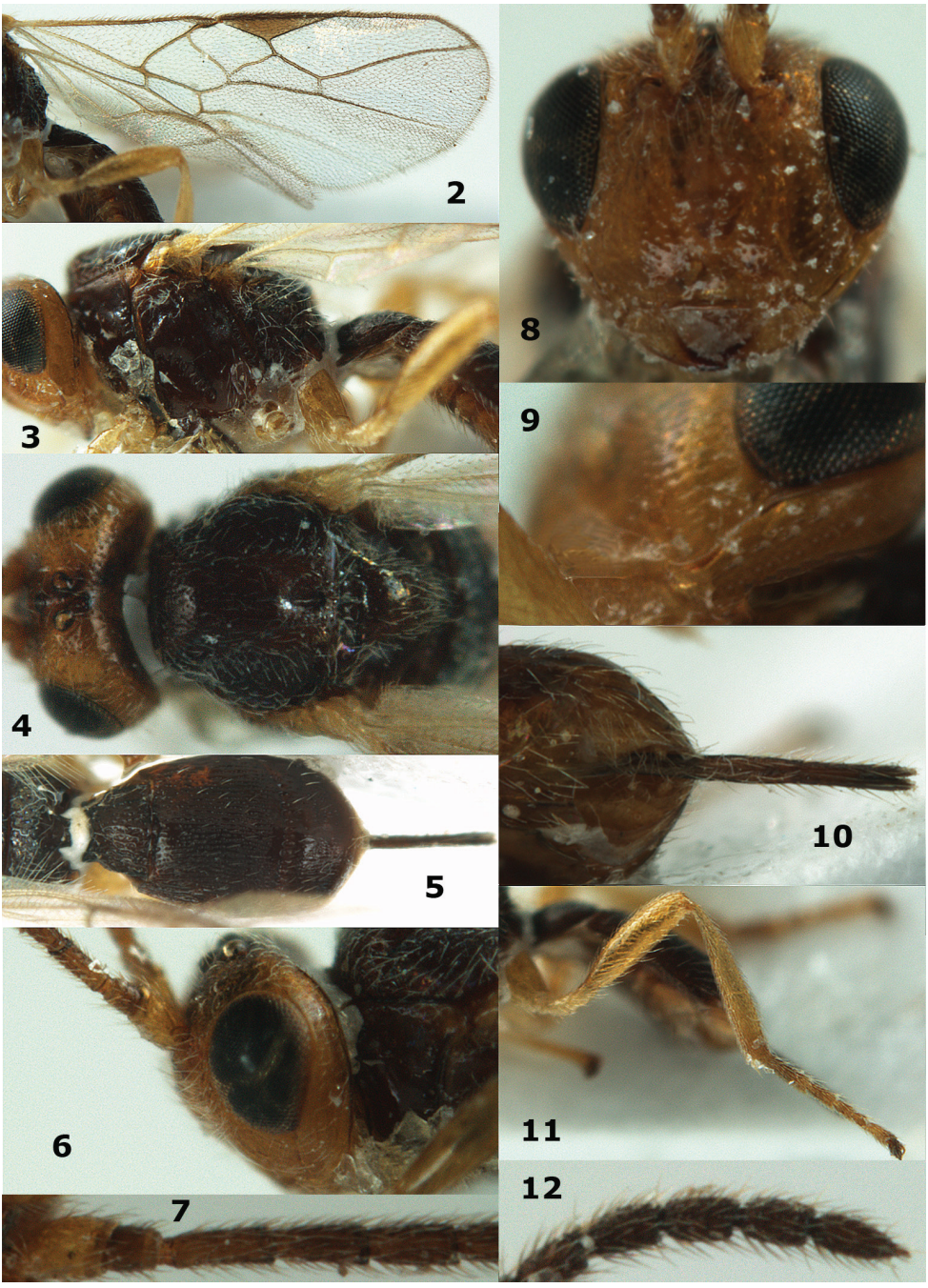
Diagnosis. Vein SR1 ends near apex of fore wing (Fig. 13); vertex moderately densely punctate, with interspaces mostly wider than diameter of punctures or wider (Fig. 4); antenna dark brown, except basally; malar space about 1.5 times as long as basal width of mandible and head less elongate in anterior view (Fig. 8); pterostigma dark brown; mesosoma dark brown or blackish (Figs 1, 3, 4); transverse carina of pro-

Figure 1. *Orientopius punctatus* sp. n., female, holotype. Habitus lateral.

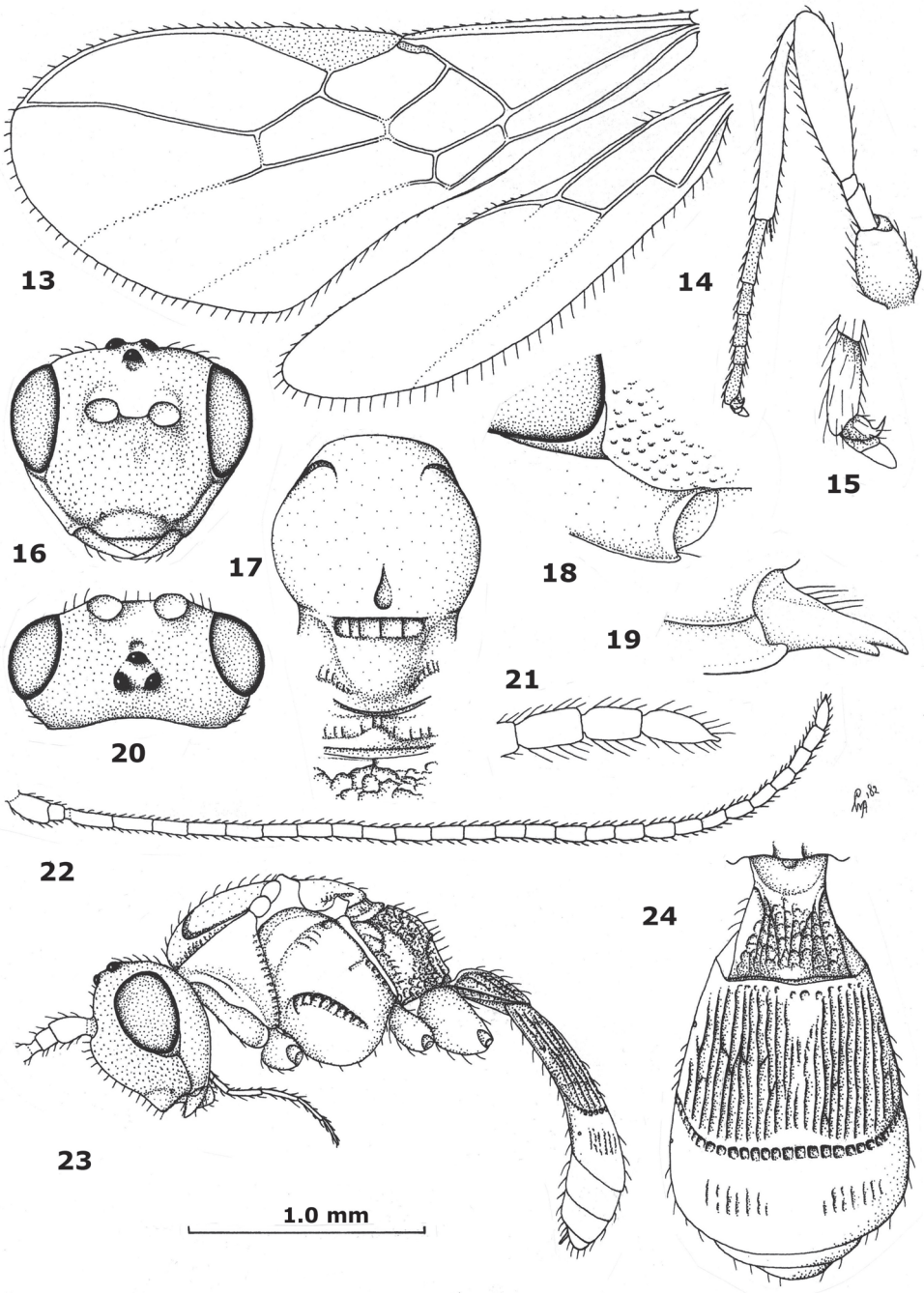
podeum distinctly in front of middle of propodeum; hind basitarsus about 3.7 times as long as wide (Fig. 11); dorsal carina of first tergite united subbasally; second tergite about twice as long as third tergite and with rows of punctures between striae (Fig. 5); third tergite 0.3 times longer than its basal width; third metasomal tergite semi-circular and partly distinctly punctate (Fig. 5); fourth tergite of female smooth and retracted (Fig. 1); setose part of ovipositor sheath 0.6 times as long as combined first-third metasomal tergites, 0.2 times as long as fore wing and 0.8 times as long as hind tibia (Fig. 1).

Description. Holotype, ♀, length of body 2.3 mm, of fore wing 2.5 mm.

Head. Antenna with 25 segments and 1.1 times as long as fore wing; third segment 1.1 times as long as fourth segment, length of third, fourth and penultimate segments 2.7, 2.5 and 1.8 times their width, respectively (Figs 7, 12); length of maxillary palp unknown, palp submerged in glue; occipital carina widely removed from hypostomal carina and dorsally absent; hypostomal carina narrow; length of eye in dorsal view 3.3 times temple; temples directly narrowed (Fig. 4) and largely smooth; vertex finely punctate, with interspaces mostly wider than punctures; frons slightly depressed behind antennal sockets and with some curved rugulae, remainder slightly convex and setose, largely finely punctate, with interspaces wider than punctures; face medio-dorsally elevated, coarsely punctate, with interspaces slightly wider than punctures and some striae latero-dorsally; width of clypeus 2.8 times its maximum height and 0.6 times width of face; clypeus flat, smooth and its ventral margin rather thin and medially straight; hypoclypeal depression wide and deep (Fig. 8); labrum flat (including ventral rim); malar suture complete; with punctures between malar suture and clypeus; length of malar space 1.5 times basal width of mandible (Fig. 9); mandible strongly constricted and twisted apically, without distinct ventral carina, second tooth medium-sized.



Figures 2–12. *Orientopius punctatus* sp. n., female, holotype. **2** wings **3** mesosoma lateral **4** mesosoma dorsal **5** metasoma dorsal **6** head lateral **7** base of antenna **8** head anterior **9** malar space **10** ovipositor sheath ventral **11** hind leg **12** apex of antenna.



Figures 13–24. *Orientopius curiosigaster* Fischer, male, holotype. **13** wings **14** hind leg **15** outer hind claw **16** head anterior **17** mesosoma dorsal **18** malar space **19** mandible and ventral part of occipital carina **20** head dorsal **21** apex of antenna **22** antenna **23** habitus lateral **24** metasoma dorsal. **13, 14, 22, 23**: scale-line (= 1 x); **15**: 5 ×; **16, 17, 20, 24**: 1.3 ×; **18, 19, 21**: 2.5 ×.

Mesosoma. Length of mesosoma 1.3 times its height; dorsal pronope absent, pronotum short and nearly vertical anteriorly; pronotal sides smooth but oblique groove anteriorly and posterior groove coarsely crenulate (Fig. 3); epicnemial area with few crenulae dorsally; precoxal sulcus distinctly impressed, but posterior 0.4 absent, and coarsely crenulate (Fig. 3); pleural sulcus distinctly crenulate; mesosternal sulcus and postpectal carina not visible because of glue; metapleuron coarsely reticulate ventrally and dorsally largely smooth (except some punctures); notauli impressed and with few crenulae anteriorly, and largely absent on disk; mesoscutum flattened, with large elliptical medio-posterior depression, setose and punctulate; scutellar sulcus wide and with 3 coarse crenulae (Fig. 4); scutellum rather flat and sparsely punctulate; metanotum with weak median carina; propodeum posteriorly largely smooth, with coarse curved transverse carina in front of middle and anteriorly rugose and with rather short median carina (Fig. 5).

Wings. Fore wing (Fig. 2): pterostigma triangular; 1-R1 ending close to wing apex and 1.3 times as long as pterostigma; r:3-SR:SR1 = 5:16:50; 2-SR:3-SR:r-m = 16:16:5; r slender; 1-M and SR1 slightly curved; m-cu just postfurcal; cu-a slightly postfurcal and 1-CU1 hardly widened; first subdiscal cell closed, CU1b medium-sized and shorter than 3-CU1; M+CU1 sclerotized. Hind wing: M+CU:1-M:1r-m = 25:18:12; cu-a straight; m-cu absent.

Legs. Length of femur, tibia and basitarsus of hind leg 3.8, 7.0 and 3.7 times as long as wide, respectively (Fig. 11); hind femur with long setae and tibia densely rather short setose; third and fourth segments of fore tarsus distinctly longer than wide and about as long as wide, respectively.

Metasoma. Length of first tergite 0.8 times its apical width, its surface smooth in front of united dorsal carinae and coarsely punctate-reticulate behind carinae, convex and no median carina posteriorly (Fig. 5); second suture coarsely crenulate, nearly straight, slightly widened medially and distinctly impressed; second tergite with row of punctures between longitudinal striae; median length of second tergite 2.1 times median length of third tergite; third tergite mainly with rows of punctures, but medially and posteriorly smooth; following tergites smooth and largely retracted below carapace; length of setose part of ovipositor sheath 0.22 times fore wing, 0.6 times first-third tergites combined and 0.8 times longer than hind tibia; hypopygium far retracted, truncate apically and about 0.2 times as long as metasomal carapace.

Colour. Dark brown, including pterostigma, veins and antenna (but scapus yellow); head and mandible yellow, but head medio-dorsally and posteriorly infuscate; ovipositor sheath blackish; wing membrane subhyaline.

Distribution. Oriental China (Hunan).

Biology. Unknown.

Etymology. Name "punctatus", because of the punctate second metasomal tergite.

Notes. The species can be separated from the other non-Palaearctic species as follows:

1 Vein SR1 of fore wing about 1.3 times as long as vein 3-SR; third metasomal tergite nearly as long as second tergite; fourth antennal segment of ♀ about

twice as long as wide; [ovipositor sheath about as long as first tergite]; East Malaysia..... ***O. malaysiae*** **Fischer, 1996**

– Vein SR1 of fore wing 2.5-3.3 times as long as vein 3-SR; third metasomal tergite distinctly shorter than second tergite; fourth antennal segment of ♀ about 3 times as long as wide (♀ unknown of *O. curiosigaster*)..... **2**

2 Wing membrane brown; third tergite more or less convex in lateral view; second metasomal suture smooth; metasoma yellowish-brown; [Australian region] **3**

– Wing membrane subhyaline; third tergite flat in lateral view; second metasomal suture crenulate (but narrowly so in *O. priminans* and *O. marianus*); metasoma black or dark brown **4**

3 Second metasomal tergite with longitudinal rows of punctures and third tergite largely smooth (except basal punctures); ovipositor sheath in lateral view about 0.8 times as long as second and third tergites combined and in dorsal view about 0.3 times as long as metasoma; Australia (Queensland) .... ***O. tambourinus*** **Fischer, 1966**

– Second tergite with longitudinal striae and third tergite entirely punctulate; ovipositor sheath in lateral view about as long as second and third tergites combined and in dorsal view about 0.5 times as long as metasoma; Papua New Guinea ..... ***O. bishopi*** **Fischer, 1996**

4 Notauli completely impressed and smooth; vein 1r-m of hind wing about as long as vein cu-a; medio-posterior depression of mesoscutum minute; [malar space about as long as basal width of mandible and without malar suture]; East Malaysia ..... ***O. priminans*** **Fischer, 1996**

– Notauli largely absent (except anteriorly); vein 1r-m of hind wing 1.5–2.0 times as long as vein cu-a; medio-posterior depression of mesoscutum large droplet-shaped or elliptical, but small in *O. marianus* **5**

5 Vein 3-SR of fore wing about as long as vein 2-SR; malar space about 1.7 times as long as basal width of mandible; mesoscutum punctulate; apical segments of antenna of ♀ (but ♀ unknown of *O. curiosigaster*) blackish or dark brown as other segments; [medio-posterior depression of mesoscutum large droplet-shaped; crenulate second metasomal suture moderately wide and parallel-sided medially] **6**

– Vein 3-SR of fore wing 1.6–2.0 times as long as vein 2-SR; malar space about as long as basal width of mandible; mesoscutum smooth; apical segments of antenna of ♀ white or yellow..... **7**

6 Second metasomal tergite without rows of punctures between longitudinal striae and third tergite only with some superficial striae (Fig. 24); mesosoma brownish-yellow; dorsal carina of first tergite remain separated subbasally (Fig. 24); malar space about 1.8 times as long as basal width of mandible and head more elongate in anterior view (Fig. 16); hind basitarsus about 5.0 times as long as wide (Fig. 14); transverse carina of propodeum near middle

of propodeum; second tergite about 1.8 times as long as third tergite medially; Philippines ..... ***O. curiosigaster*** **Fischer, 1966**

– Second tergite with rows of punctures between longitudinal striae and third tergite partly punctate (Fig. 5); mesosoma dark brown or blackish (Figs 1, 3, 4); dorsal carina of first tergite united subbasally; malar space about 1.5 times as long as basal width of mandible and head less elongate in anterior view (Fig. 8); hind basitarsus about 3.7 times as long as wide (Fig. 11); transverse carina of propodeum distinctly in front of middle of propodeum; second tergite about 2.1 times as long as third tergite medially; Oriental China (Hunan).... ***O. punctatus*** **sp. n.**

7 Crenulate second metasomal suture strongly widened medially; medio-posterior depression of mesoscutum large droplet-shaped; vein 3-SR of fore wing about 1.6 times as long as vein 2-SR; ovipositor sheath in lateral view about as long as first metasomal tergite and in dorsal view hardly protruding; 5 apical segments of antenna of ♀ yellow; China (Taiwan)..... ***O. formosanus*** **Fischer, 1966**

– Crenulate second metasomal suture narrow and parallel-sided medially; medio-posterior depression of mesoscutum small elliptical; vein 3-SR of fore wing about twice as long as vein 2-SR; ovipositor sheath in lateral view about 1.5 times as long as first metasomal tergite and in dorsal view about as long as second and third tergites combined; 4 apical segments of antenna of ♀ white; Papua New Guinea ..... ***O. marianus*** **Fischer, 1990**

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RESEARCH ARTICLE

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Psyttoma gen. n. (Hymenoptera, Braconidae, Opiinae) from Shandong and Hubei (China), with a key to the species

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Abstract

Psyttoma **gen. n.** (type species: *Opius latilabris* Chen & Weng, 2005) from Shandong and Hubei (China) is described and illustrated (Hymenoptera: Braconidae: Opiinae). *Psyttoma latilabris* (Chen & Weng, 2005) and *P. wachsmanni* (Szépligeti, 1898) are new combinations.

Keywords

Braconidae, Opiinae, *Psyttoma, Psyttalia*, new genus, Palaearctic, Oriental, China, Shandong, Hubei

Introduction

The large subfamily Opiinae (Braconidae), with 1,975 valid species according to Yu et al. (2009), is a common group containing generally small (2-5 mm) parasitoid wasps of mainly mining or fruit-infesting dipterous larvae. It has a worldwide distribution and the world fauna has been reviewed by Fischer (1972, 1977, 1986, 1987). Currently about 35 genera are used; Wharton (1988, 1997), van Achterberg (1997b, 2004a,

2004b), van Achterberg and Salvo (1997) and van Achterberg and Chen (2004) published updates or some additions for the existing keys to the genera of the Opiinae, but the number of genera and the limits of several genera are still matters of discussion.

The first author collected some Opiinae for her revision of the Opiinae of Hunan in her home town in the province of Shandong (Palaearctic China). One of the species resembles members of the genus *Psyttalia* Walker, 1860, but does not fit well in this genus. Also DNA analysis in the DNA lab of the Naturalis Biodiversity Center (Leiden) showed that also the molecular data disagree with inclusion in the genera *Psyttalia*, *Opius* or *Phaedrotoma.* A combined analysis of the 16S and 28S sequences of about 50 mainly Oriental Opiine taxa from China and Malaysia was made and the results corroborated the view that the new genus has a separate position among the Opiine genera. The results of this study will be published elsewhere (Li et al., in prep.). Therefore, we describe the species in a new genus below. The DNA sequences are deposited in GenBank and have been compared with unpublished sequences of *Psyttalia* species from Malaysia and with published sequences (Gimeno et al., 1997). Later it was discovered that the mutilated type of *Opius latilabris* Chen & Weng, 2005, from Hubei (Oriental China) belongs to this species.

Opiinae are solitary koinobiont endoparasitoids of larvae of cyclorraphous Diptera, but oviposition may take place in the egg of the host (ovo-larval parasitoid). They may play an important role in the control of such dipterous pests as fruit-infesting Tephritidae and mining Agromyzidae. The parasitoid larva completes its final development when the host larva has made its puparium and the adult emerges from this puparium.

Material and methods

The specimens were directly killed in 70% alcohol during collection. The redescribed specimens are deposited in the Naturalis collection (RMNH) at Leiden. For identification of the subfamily Opiinae, see van Achterberg (1990, 1993, and 1997a); for identification of the genera, see Chen and Weng (2005), Wharton (1988, 1997), van Achterberg (1997b, 2004a); for references to the Opiinae, see Yu et al. (2009); and for the terminology used in this paper, see van Achterberg (1988, 1993). Measurements are taken as indicated by van Achterberg (1988).

Taxonomy

***Psyttoma* van Achterberg & Li, gen. n.**
urn:lsid:zoobank.org:act:29FD6792-00E8-441F-9C72-E97458B50D3A
http://species-id.net/wiki/Psyttoma
Figures 1–13

Etymology. The name is a combination of the generic names *Psyttalia* Walker and *Phaedrotoma* Foerster, 1862, because it combines features of both genera. Gender: feminine.

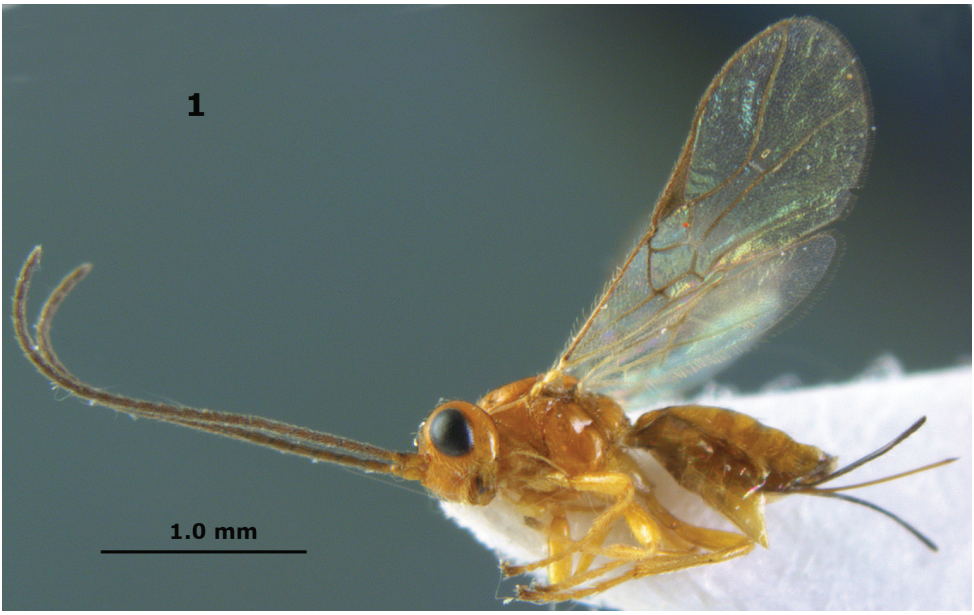


Figure 1. *Psyttoma latilabris* (Chen & Weng), female from Anqiu. Habitus lateral.

Type species. *Opius latilabris* Chen & Weng, 2005.

Diagnosis. Hypopygium of female distinctly acute apically and about 0.3 times as long as metasoma; labrum slanted backwards, leaving a large space below clypeus (Fig. 9); veins 2-SR+R and SC+R1 of hind wing of male strongly widened (Fig. 13); precoxal sulcus smooth; hind femur 2–3 times as long as wide (Fig. 11); hind tibia without carinula basally; scutellum convex medially and depressed medio-posteriorly, distinctly protruding above level of mesoscutum (Fig. 5); propodeum without median carina or areola; second metasomal segment 1.2 times longer than third tergite (Fig. 4); spiracle of second tergite distinctly removed from apex of first tergite (Fig. 4).

Notes. The genus will run in the key to world genera of Opiinae by Wharton (1997) to the genera *Psyttalia* Walker and *Opius* Wesmael (part with normal mandible; = *Phaedrotoma*). Because of the sharp pointed hypopygium it seems closer to *Psyttalia*, but it does not fit in any one of the genera and differs in having a medio-posterior depression of the mesoscutum, the second metasomal tergite longer than the third tergite, the precoxal sulcus smooth, the scutellum protruding dorsally, the hind wing narrowed and vein m-cu of the hind wing present as a faintly pigmented trace. The new genus can be separated from both genera as follows:

1 Scutellum distinctly protruding above level of mesoscutum (Fig. 5); hypopygium of ♀ distinctly acute apically and about 0.3 times as long as metasoma (Fig. 7) and hind wing comparatively narrow (Figs 12, 13); hind femur very robust, 2-3 times as long as wide (Fig. 11); labrum slanted backwards,

leaving a large space below clypeus (Fig. 9); medio-anterior veins of hind wing of male strongly widened (Fig. 13) ..... ***Psyttoma*** **gen. n.**

– Scutellum at level of mesoscutum; hypopygium of ♀ variable, if distinctly acute apically and about 0.3 times as long as metasoma then hind wing moderately wide and hind femur slender, 4–5 times as long as wide; labrum normal, without large space below clypeus; medio-anterior veins of hind wing of male narrow..... ***Psyttalia*** **Walker and** ***Phaedrotoma*** **Foerster**

Psyttoma latilabris **(Chen & Weng, 2005), comb. n.**
http://species-id.net/wiki/Psyttoma_latilabris
Figures 1–13

Opius latilabris Chen & Weng, 2005: 110 (Chinese key), 112–113 (description in Chinese; fig. 47), 180 (English key), 199 (description in English) (examined).

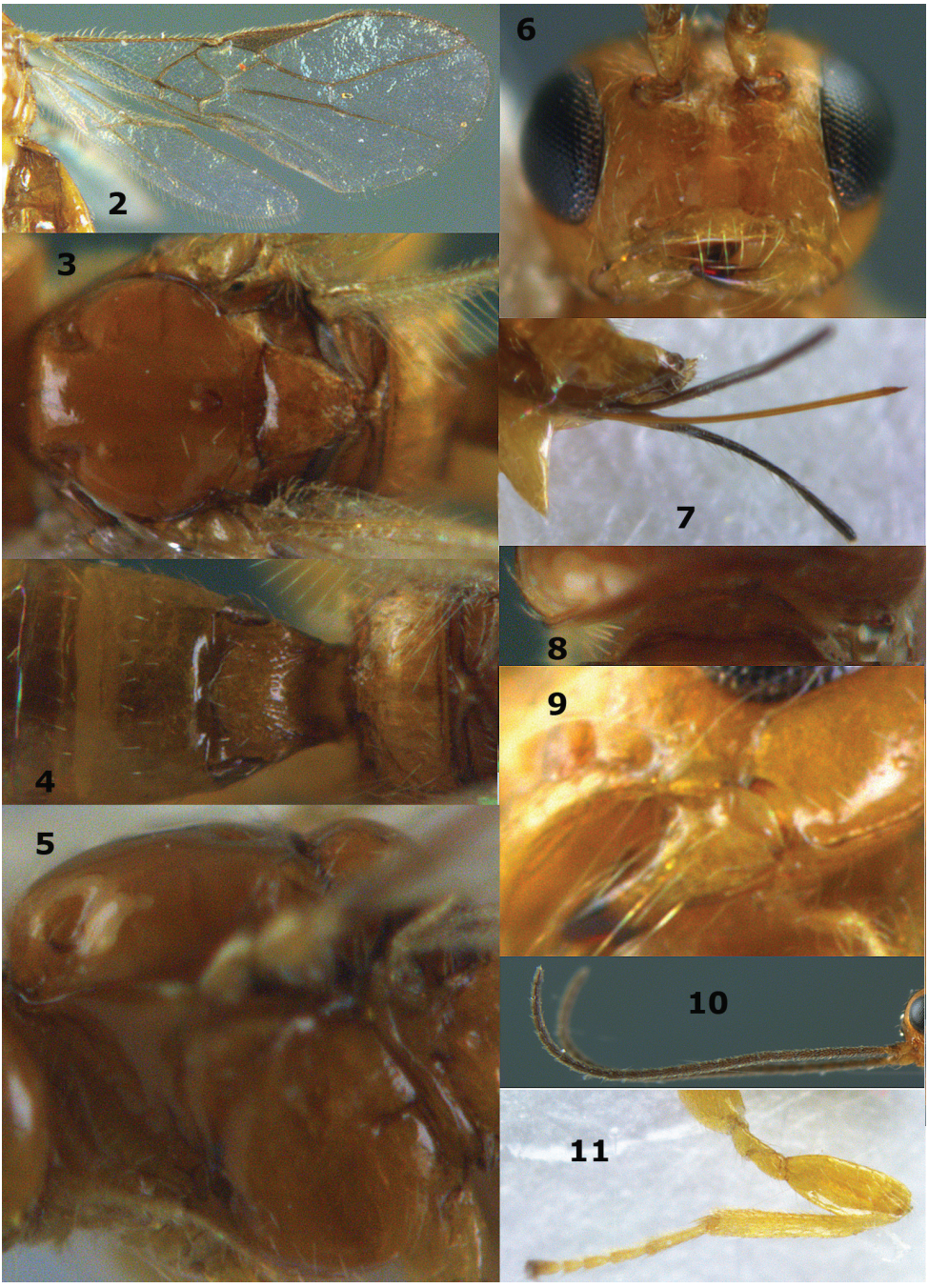
Type material. Holotype (Beneficial Insects Laboratory, Fujian Agriculture and Forestry University, Fuzhou), ♀, "[China:], Hubei, Shennongjia, Honghua, 2.vi.1988, Zhang Li-qin". Paratype: 1 ♂, "[China:], Hubei, Shennongjia, Yangriwan, 20.vi.1988, Yang Jian-quan". The holotype has the head missing and the wing venation is bleached.

Additional material. 1 ♀ (RMNH), "N. China: Shandong, Anqiu, Suotou Mt., 31.vii.2009, c. 120 m, Li Xi-Ying, RMNH'09", "CVA4245, sp. 11"; 1 ♂ (RMNH), same label data.

Diagnosis. Clypeus narrow, 5 times as wide as high and 0.7 times as wide as face and face distinctly transverse (Fig. 6); pronope rather large and round; medio-posterior depression of mesoscutum medium-sized and round (Fig. 5); precoxal sulcus slightly impressed and smooth; scutellum rugulose medio-posteriorly; body completely brownish-yellow (Fig. 1).

Description. Described from ♀ collected in Anqiu, length of body 2.0 mm, of fore wing 2.1 mm.

Head. Antenna with 25 segments and 1.2 times as long as fore wing; third segment 1.1 times as long as fourth segment, length of third, fourth and penultimate segments 3.5, 3.2 and 2.7 times their width, respectively; length of maxillary palp 0.9 times height of head; labial palp segments slender; labrum slanted backwards, leaving a large space below clypeus (Fig. 9); occipital carina widely removed from hypostomal carina and dorsally absent; hypostomal carina narrow; length of eye in dorsal view 2.1 times temple; frons slightly depressed behind antennal sockets, medially convex and glabrous, smooth; face smooth, medially weakly elevated; width of clypeus 5.0 times its maximum height and 0.7 times width of face; clypeus weakly convex, distinctly protruding forwards, punctate and its ventral margin thick and slightly concave; hypoclypeal depression wide and deep (Figs 6, 9); malar suture present; without punctures between malar suture and clypeus; mandible somewhat constricted medially and gradually widened baso-ventrally, with narrow ventral carina (Fig. 9), second tooth minute.



Figures 2–11. *Psyttoma latilabris* (Chen & Weng), female from Anqiu. **2** wings **3** mesosoma dorsal **4** propodeum and first-third metasomal tergites dorsal **5** mesoscutum and scutellum dorso-lateral **6** head anterior **7** ovipositor, sheath and hypopygium lateral **8** pronotum dorsal **9** mandible lateral **10** antenna **11** hind leg.

Mesosoma. Length of mesosoma 1.2 times its height; dorsal pronope large, round and pronotum oblique anteriorly (Fig. 8); pronotal sides smooth but oblique groove crenulate and posterior groove largely absent; epicnemial area smooth dorsally; precoxal sulcus medially superficially impressed, smooth as rest of mesopleuron; pleural sulcus smooth; mesosternal sulcus deep and narrow and very finely crenulate; notauli absent on disk, only anteriorly with pair of short smooth impressions; mesoscutum glabrous and strongly shiny; medio-posterior depression of mesoscutum medium-sized, deep, round; scutellar sulcus narrow and finely crenulate laterally, widened medially; scutellum convex medially, depressed and rugulose medio-posteriorly; surface of propodeum smooth, except for superficial rugulae posteriorly (Fig. 4).

Wings. Fore wing: pterostigma elongate triangular (Fig. 2); 1-R1 ending before wing apex and 1.4 times as long as pterostigma (Fig. 2); r:3-SR:SR1 = 3:27:55; 2-SR:3-SR:r-m = 15:27:7; r slender; 1-M slightly curved and SR1 straight; m-cu postfurcal; cu-a postfurcal and 1-CU1 widened; first subdiscal cell closed, CU1b short; apical third of M+CU1 sclerotized. Hind wing: M+CU:1-M:1r-m = 15:17:6; cu-a straight; m-cu present as faintly pigmented trace.

Legs. Length of femur, tibia and basitarsus of hind leg 2.3, 7.0 and 4.3 times as long as wide, respectively (Fig. 11); hind femur and tibia with medium-sized setae.

Metasoma. Length of first tergite equal to its apical width, its surface evenly moderately convex and rather densely longitudinally rugulose and dorsal carinae developed in basal 0.4 of tergite, straight (Fig. 4); second suture absent; second and following tergites smooth; length of setose part of ovipositor sheath 0.29 times fore wing, 2.7 times first tergite and equal to length of hind tibia; hypopygium distinctly acute apically and about 0.3 times as long as metasoma.

Colour. Brownish-yellow; antenna (but scapus yellowish), stemmaticum, ovipositor sheath, pterostigma and veins dark brown; palpi, mandible, tegulae and legs (but telotarsi darkened) pale yellow; wing membrane subhyaline.

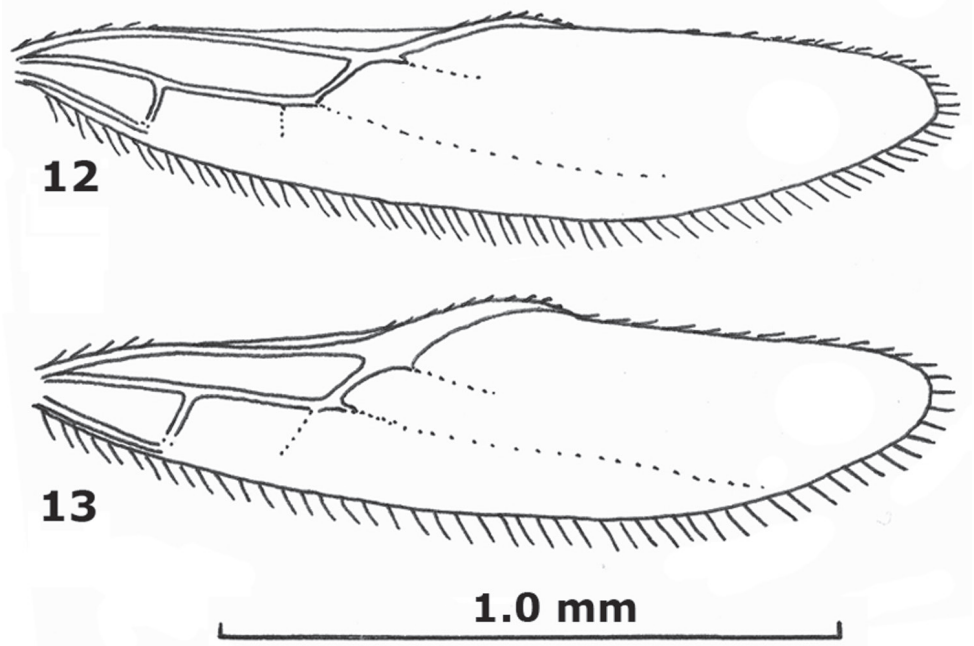
Variation. Male from Anqiu has length of fore wing 2.0 mm, antenna with 24 segments, hind femur 3.0 times as long as wide and medio-anterior veins of hind wing strongly widened (Fig. 13).

Molecular data. 16S and 28S (CVA4245); GenBank Accession numbers JQ736254 and JQ736282, respectively.

Distribution. China (Shandong, Hubei).

Biology. Unknown.

Notes. In the key by Chen and Weng (2005) to the Opiinae of China the type species runs to *Phaedrotoma louiseae* (Weng & Chen, 2005) comb. n., but this species has the propodeum with a pentagonal areola, the mesosoma brown, the first tergite 2.3 times longer than its apical width, the hind femur 6.0 times longer than wide, the antenna 1.6 times longer than body and the clypeus 1.7 times wider than high. Only by examining all Opiinae types in Beneficial Insects Lab., Fujian Agriculture and Forestry University (Fuzhou) it was found by the second author that the headless holotype of *Opius latilabris* Chen & Weng, 2005, from Hubei (Oriental China) is conspecific with the specimens from the Palaearctic Anqiu.



Figures 12–13. *Psyttoma latilabris* (Chen & Weng), female from Anqiu, but 13 male from Anqiu, hind wing. Scale-line: **12** 1.0 ×, **13** 1.1 ×.

In the key by Tobias (1998) to the East Palaearctic Opiinae it runs to *Opius wachsmanni* Szépligeti, 1898, described from Hungary (holotype examined by the second author). This species belongs to the same genus and can be separated as follows:

1 Eye in dorsal view about twice as long as temple; vein CU1b of fore wing much shorter than vein 3-CU1 (Fig. 1); first tergite rather densely longitudinally rugulose (Fig.); vein 1-R1 (= metacarp) about 1.4 times as long as pterostigma (Fig. 2); head dorsally, mesosternum, mesoscutal lobes medially, metanotum, propodeum, third and following metasomal tergites brownish-yellow (Fig. 1); East Palaearctic and North Oriental..... ..... ***P. latilabris*** **(Chen & Weng, 2005) comb. n.**

– Eye in dorsal view about as long as temple; vein CU1b of fore wing somewhat shorter than vein 3-CU1; first tergite mainly coriaceous-punctate; vein 1-R1 slightly longer than pterostigma; head dorsally, mesosternum, mesoscutal lobes medially, metanotum, propodeum, third and following metasomal tergites black; West Palaearctic .....***P. wachsmanni*** **(Szépligeti, 1898) comb. n.**

The specimens reported as *Opius wachsmanni* Szépligeti from the East Palaearctic region (Central Asia up to Korea) by Papp (1981), Tobias and Jakimavicius (1986) and Tobias (1998) need to be re-examined and most likely belong to *P. latilabris* (Chen & Weng, 2005).

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RESEARCH ARTICLE

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Western Amazonian Ateleutina (Hymenoptera, Ichneumonidae, Cryptinae)

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Abstract

Ateleutina is a small subtribe of Cryptinae (Ichneumonidae) composed of two genera: *Ateleute* Förster and *Tamaulipeca* Kasparyan. Neither of the genera includes species described from South America. In this article five new species of *Ateleute* (*A. ashaninka* **sp. n.** and *A. amarakaeri* from Peru, *A. shuar* **sp. n.** from Ecuador and Peru, and *A. huaorani* **sp. n.** and *A. kichua* **sp. n.** from Ecuador) and three new species of *Tamaulipeca* (*T. bora* **sp. n.** from Ecuador and Peru, *T. candoshi* **sp. n.** from Ecuador and *T. matses* **sp. n.** from Peru) are described and illustrated from Western Amazonia. Identification keys to the known South American species of the genera are provided.

Keywords

Amazonia, Andes, Ecuador, Parasitoid wasp, Peru, Taxonomy, Tropical

Introduction

Ateleutina is a small subtribe of Cryptini proposed by Townes (1970). It was originally based only on one genus, *Ateleute* Förster, 1869. Recently, another genus, *Tamaulipeca* Kasparyan, 2000, was described from Costa Rica and Mexico (Kasparyan and Hernández 2000).

Despite the fact that recent molecular studies discourage the use of the traditional Cryptinae subtribes of Townes (Laurenne et al. 2006), since the most part of them are not monophyletic groups, no new classification of genera has been proposed. In accordance, we consider Ateleutina *sensu* Townes as a framework for the present study.

Ateleute is a nearly cosmopolitan genus with 35 described species. A large part of the species are tropical in distribution: 24 are Ethiopian, 3 Palearctic, 1 Nearctic and Neotropical, 2 Neotropical and 5 Oriental (Yu et al. 2005, Sheng et al. 2011). *Tamaulipeca* comprises only two described species from Mexico and Costa Rica (Kasparyan and Hernández 2000).

The distribution of Ateleutina is interesting, as no species have been described from South America despite most of the *Ateleute* species being tropical in the Old World. However, already Townes (1967) mentioned having seen three undescribed species of *Ateleute* from Peru.

Almost nothing is known about the biology of Ateleutina. Townes (1967) reported that *A. carolina* Townes was reared several times from a psychid (Lepidoptera: Psychidae).

All species of Atelutina show a high degree of sexual dimorphism (Seyrig 1952, Townes 1967, Kasparyan and Hernández 2000).

In several sampling programs collecting parasitoid wasps, carried out in Western Amazonia, we have found eight new species of *Ateleute* and *Tamaulipeca*. The aim of the present paper is to describe and illustrate all of them and to provide an identification key for these South American species.

Material and methods

The Peruvian specimens were collected mainly in the course of two projects. The sampling program coordinated by S. Bordera and A. Rodríguez-Berrío was carried out from February 2008 to February 2009 in three Peruvian ecosystems: 1) the coastal valleys of Cañete (200–400 m) and Huaral (400-900 m), located in the central part of the coastal desert; 2) the central Andes in El Ingenio (Huancayo, 3,200 m); and 3) premontane tropical rain forest in the "Fundo Genova", Chanchamayo, Department of Junín (1,066–1,080 m). In this project Ateleutina were found only in Fundo Genova Trap 2. (11°05'44.8"S, 75°21'17.7"W, 1069 m) and Trap 4. (11°05'45.1"S, 75°21'21.8"W, 1075 m.). More information about the vegetation and climate of the area is given in Alvarado et al. (2011).

The second Peruvian sampling program was coordinated by I. Sääksjärvi in the 56,000 ha National Reserve of Allpahuayo-Mishana, approximately 3°57'S, 73°16'W (e.g. Sääksjärvi et al. 2004). The reserve is located about 25 km south of Iquitos in the Department of Loreto. The area is primarily moist tropical forest. General descriptions of the climate, geology and vegetation of the area are given in Kalliola and Flores Paitán (1998).

Specimens from Southern Peruvian Amazonia were also collected by Malaise trapping in Madre de Dios, by Isrrael Gómez (ZMUT). The study site is located near the Manu National Park.

Ecuadorian specimens were collected by canopy fogging in Onkone Gare, Department of Orellana, Ecuador, by Dr. Terry Erwin (USNM). The study site is located near the border of the Yasuní National Park.

The specimens are deposited in the following collections: Entomological Collection, University of Alicante, CIBIO, Spain (CEUA), Entomological Museum Klaus Raven Büller, Universidad Nacional Agraria la Molina, Lima, Peru (MEKRB), Smithsonian Institution, USA (USNM), University of San Marcos, Lima, Peru (UNSM) and The Zoological Museum, Section of Biodiversity and Environmental Research, Department of Biology, University of Turku, Finland (ZMUT). The specimens deposited at the USNM and UNSM are currently on loan to the ZMUT.

Observations were made using Olympus SZX10, Olympus SZX16, and Wild M3Z stereomicroscopes. Layer photos were taken in ZMUT using an Olympus SZX16 attached to an Olympus E520 digital camera. Digital photos were combined using the programs Deep Focus 3.1 and QuickPHOTO CAMERA 2.3. The SEM-images were taken using a Hitachi S-3000N scanning electron microscope (in low vacuum mode) in the University of Alicante, Spain. Morphological terminology follows Gauld (1991).

Results

Despite the large sampling effort (e.g. 300 Malaise trap months in different Peruvian ecosystems), only 16 females and 9 males belonging to Ateleutina were collected, all of them from moist tropical forests.

The females and males we have found in the field differ greatly from each other in all localities. The females of all species are coloured red, brown, black and white, while all males are uniformly brown or black in coloration (Figs 2A-E; 8A-D).

In *Ateleute* we have been able to put forward a proposal of sexual associations based on external morphological characters, but for *Tamaulipeca* we have not been able to link the only male to any of the females, therefore a description and illustration of this specimen is provided without assigning it to any of the species.

Taxonomic recognition of Ateleutina

Ateleutina are atypical Cryptini that can be recognized by the combination of the following characters: head and mesosoma usually granulate or coriaceous; clypeus convex, slightly truncate or pointed at apex; mandibles short, lower tooth as long as or slightly longer than upper tooth; occipital carina dorsally absent, ventrally joining hypostomal carina just before or at base of mandible; epomia absent; posterior transverse carina of mesosternum complete; mesopleural fovea absent or represented by a weak impression far in front of mesopleural suture; sternaulus weak and fairly short, sometimes inconspicuous; submetapleural carina strong and complete; areo-

let distinctively large when delimited by unpigmented 3*rs-m* vein, receiving 2*m-cu* basal of its middle, otherwise open; ramulus absent; hind wing vein *M+Cu* strongly arched; hind tibiae and tarsi with numerous stout bristles; spiracle of first tergite at mid-length or somewhat anterior; apex of ovipositor sheath usually truncate and tip of ovipositor conspicuously elongate.

Key to the genera of Ateleutina

1 Clypeus apically truncate (Fig. 1A, arrow). Areolet wide, closed by an unpigmented vein 3*rs-m* (open in some males). Abscissa of Rs between 2*rs-m* and 3*rs-m*, and abscissa of *M* between 2*m-cu* and 3*rs-m*, long and parallel (Fig. 1B). ..... ***Ateleute*** **Förster, 1869**

– Clypeus projecting strongly downward and pointed at apex (Fig. 1C, arrow). Areolet always open, without any trace of vein 3*rs-m*. Distal abscissa of Rs beyond 2*rs-m* and distal abscissa of *M* beyond 2*m-cu*, divergent (Fig. 1D).... ..... ***Tamaulipeca*** **Kasparyan, 2000**

Key to the South American species of *Ateleute*

Females

1 Ovipositor sheath black, widely truncate at apex (Fig. 3A). Head transverse, 0.43 times as long as wide. Metasoma and hind femur vividly red (Fig. 2A). Antenna (except for a white band) black, with 34–35 flagellomeres. Large species, body length 7.4–7.5 mm, fore wing length 5.9–6.1 mm (Fig. 2A) ... .***Ateleute ashaninka*** **sp. n.**

– Ovipositor sheath brown to light brown, moderately truncate or nearly pointed at apex (Figs 3B, C, D). Head less transverse, 0.48–0.51 times as long as wide. Metasoma and hind femur from yellow to orange or reddish brown (Figs 2B, C, D, E). Antenna (except for a white band) light brown to brown, with 28–32 flagellomeres. Smaller species than *A. ashaninka*, body length 3.8–5.9 mm, fore wing length 3.0–4.2 mm (Figs 2B, C, D, E)..... **2**

2 First tergite long, narrow, 2.16 times as long as wide posteriorly (Fig. 4A). Abscissa of Cu_1 between 1*m-cu* and Cu_{1a} strongly inclivous, 0.90 times the length of Cu_{1b} (Fig. 5A) .....***Ateleute huaorani*** **sp. n.**

– First tergite wider and shorter than in *A. huaorani*, 1.50–1.77 times as long as wide posteriorly (Figs 4B, C, D). Abscissa of Cu_1 between 1*m-cu* and Cu_{1a} moderately inclivous, 1.10–1.25 times the length of Cu_{1b} (Figs 5C, E, I).... **3**

3 Vein 2*rs-m* obliterated or 0.10 times length of abscissa of *M* between 2*rs-m* and 2*m-cu*. Vein 2*m-cu* vertical (Fig. 5C). Malar space about 0.65 times as long as basal width of mandible. .....***Ateleute kichua*** **sp. n.**

– Vein 2*rs-m* conspicuous, 0.40–0.55 times the length of abscissa of *M* between 2*rs-m* and 2*m-cu*. Vein 2*m-cu* inclivous (Figs 5E, I). Malar space about 0.80–0.86 times as long as basal width of mandible. **4**

4 Hind wing with distal abscissa of Cu_1 weak and unpigmented, Cu_1&*cu-a* fairly smoothly curved (Fig. 5G). Ovipositor sheath truncate at apex. First tergite about 1.50 times as long as maximum width (Fig. 4C). Small species, body length 3.8 mm, fore wing length 3 mm (Fig. 2D)... ***Ateleute amarakaeri* sp. n.**

– Hind wing with distal abscissa of Cu_1 strong and pigmented, Cu_1&*cu-a* strongly angled below middle (Fig. 5K). Ovipositor sheath very slightly truncate at apex, nearly pointed (Fig. 3D). First tergite about 1.70–1.77 times as long as maximum width (Fig. 4D). Body length 5.2–5.6 mm, fore wing length 3.7–4.1 mm (Fig. 2E). ..... ***Ateleute shuar* sp. n.**

Males (male of *A. ashaninka* is unknown)

1 Claspers transversely and widely truncate (Fig. 6A). Vein 2*rs-m* obliterated (Fig. 5D). Hind femur with numerous conspicuous stout bristles (Fig. 7A) .. .. ***Ateleute kichua* sp. n.**

– Claspers dorsally with an inwardly curved profile, so they are conspicuously pointed at apex (Figs 6B, C, D). Vein 2*rs-m* present (Figs 5B, F, J). Hind femur without or with sparse stout bristles (Figs 7B, C, D)..... **2**

2 Claspers very narrow and pointed (Fig. 6B). Abscissa of Cu_1 between 1*m-cu* and Cu_{1a}, 1.00-1.20 times the length of Cu_{1b} (Fig. 5J).. ***Ateleute shuar* sp. n.**

– Claspers moderately pointed (Figs 6C, D). Abscissa of Cu_1 between 1*m-cu* and Cu_{1a} clearly shorter than Cu_{1b} (Figs 5B, F)..... **3**

3 Hind wing with distal abscissa of Cu_1 present, Cu_1&*cu-a* angled below middle. Abscissa of Cu_1 between 1*m-cu* and Cu_{1a} extremely inclivous, 0.45 times length of Cu_{1b} (Fig. 5B). Hind femur without stout bristles (Fig. 7C). Hind tibia with sparse stout bristles (Fig. 7C). Occipital carina entirely absent .... ***Ateleute huaorani* sp. n.**

– Hind wing with distal abscissa of Cu_1 absent, so that Cu_1&*cu-a* is fairly smoothly curved (Fig. 5H). Abscissa of Cu_1 between 1*m-cu* and Cu_{1a} moderately inclivous, 0.77 times the length of Cu_{1b} (Fig. 5F). Hind femur with some stout bristles, principally on dorsal and ventral edge (Fig. 7D). Hind tibia with denser stout bristles (Fig. 7D). Occipital carina present ventrally .. .. ***Ateleute amarakaeri* sp. n.**

Key to the South American species of *Tamaulipeca* (females only)

1 Mesoscutum and scutellum brown, with white V-shaped marks (Fig. 9A). Hind wing vein *cu-a* of about same length as abscissa of *Cu* between *M* and Cu_1 (Fig. 9H)..... ***Tamaulipeca candoshi* sp. n.**

– Mesoscutum and scutellum reddish, without white V-shaped marks (Figs 9B, C). Hind wing vein *cu-a* shorter than abscissa of *Cu* between *M* and Cu_1 (Figs 9I, J) **2**

2 Face with broad white orbits (Fig. 9F). Metasoma with tergite 7 brown (Fig. 9B). ..... ***Tamaulipeca bora* sp. n.**

– Face without white orbits (Fig. 9G). Metasoma with tergite 7 white (Fig. 9C). ..... ***Tamaulipeca matses* sp. n.**

Descriptions of new species

Ateleute Förster, 1869

Ateleute Förster, 1869: 171. Type species: *Ateleute linearis* Förster
Talorga Cameron, 1911: 63 Type species: *Talorga spinipes* Cameron
Tsirirella Seyrig, 1952: 44 Type species: *Tsirirella tsiriria* Seyrig, designated by Townes and Gupta, 1961.
Psychostenus Uchida, 1955: 32. Type species: *Psychostenus minusculae* Uchida

Ateleute amarakaeri sp. n.

urn:lsid:zoobank.org:act:56072A09-2BC9-4FA4-A972-4B69F9A8C219
http://species-id.net/wiki/Ateleute_amarakaeri
Figs 2D, 4C, 5E–H, 6D, 7D, 8D

Material examined. Holotype: PERU, ♀, Dept. Madre de Dios, Los Amigos, 31-VII/7-VIII-2008, I. Gómez leg. a.s.l.: 233,4 m, Malaise T. 7, E: 381614.7, N:8610096.9 (UNSM). **Paratype: PERU,** 1 ♂, same locality, 5-12-VI-2008, I. Gómez leg. a.s.l.: 290m, Malaise T. 2, E: 380304.85, N: 8611305.81 (ZMUT).

Description. Female. Body length (without ovipositor) 3.8 mm, head length × width 0.4 × 0.9 mm, mesosoma length × width (mesoscutum) 1.3 × 0.5 mm, length of ovipositor sheath 0.8 mm, fore wing length 3.0 mm, flagellum 4.5 mm.

Head. Transverse, 0.48 times as long as wide, strongly narrowed behind eyes, gena at same level as hind rim of eye (dorsal view). Antenna with 28 flagellomeres; flagellum longer than body, 1.50 times as long as fore wing (Fig. 2D); its segments 1, 4, 7 and 12 about 9.50 (annellus excluded), 7.50, 2.57 and 1.42 times as long as wide, respectively; basal flagellar segments 1 to 4 slightly compressed, flagellomeres 5 to 9 cylindrical and from 10 to near apex depressed (flattened ventrally with short sensory setae in this area); maximum width of flagellum 2.33 times minimum width of first flagellomere; flagellum strongly tapered towards apex. Clypeus strongly convex, its margin sharp, slightly truncate in centre. Mandible short, 1.66 times as long as width at middle, teeth equal, base swollen. Malar space about 0.83 times as long as basal width of mandible. Occipital carina absent dorsally, ventrally joining hypostomal carina just be-

fore mandible. Ocellar-ocular distance and distance between hind ocelli 1.33 and 1.66 times maximum diameter of lateral ocellus, respectively. Face finely coriaceous, with silvery short hairs. Frons coriaceous. Vertex slightly coriaceous, with very sparse short hairs, lower vertex and occiput strongly concave centrally. Gena shiny, slightly coriaceous, hairless in upper half, with moderately long and dense silvery hairs in lower part.

Mesosoma. Upper margin of pronotum not swollen. Lateral part of collar bordered behind by weak carina. Pronotum coriaceous. Mesoscutum coriaceous, shiny. Notauli reaching tegula level, convergent, strongly impressed. Prescutellar groove without longitudinal wrinkles. Scutellum coriaceous, with complete lateral carinae. Mesopleuron coriaceous, with very fine and dense punctures and white hairs; these hairs usually absent in an antero-posterior diagonal band including speculum. Mesopleural fovea represented by a weak impression far in front of mesopleural suture. Sternaulus as a weak and short anterior depression. Metapleuron and propodeum finely and very densely punctate or rugulose-punctate on a coriaceous background, with very dense whitish hairs. Posterior transverse carina of mesosternum evanescent laterally. Propodeum 1.14 times as long as wide at spiracle level (dorsally measured), with a narrow longitudinal central depression; its spiracle rounded and very small, close to pleural carina. Anterior transverse carina absent. Posterior transverse carina present in centre and in area posteroexterna, absent laterally. Median longitudinal carinae faintly outlined; lateral longitudinal carina absent anterior to apical transverse carina, shortly present distad. Pleural carina strong. Area petiolaris confluent with areas posteroexterna. Vein 3*rs-m* unpigmented. Vein 2*rs-m* conspicuous, 0.40 times length of abscissa of *M* between 2*rs-m* and 2*m-cu*. Vein 2*m-cu* inclivous with one short bulla. *Cu-a* of fore wing a little distad of Rs&M, inclivous. Abscissa of Cu_1 between 1*m-cu* and Cu_{1a} inclivous, forming angle of 150° with Cu_1, 1.25 times length of Cu_{1b} (Fig. 5E). *M+Cu* of hind wing strongly arched. Hind wing vein *cu-a* clearly shorter than abscissa of *Cu* between *M* and Cu_1. Hind wing with distal abscissa of Cu_1 weak and unpigmented, so that Cu_1&*cu-a* is fairly smoothly curved (Fig. 5G). Distal abscissa of 1*A* of hind wing very short, nearly absent. Tip of axillus very close to anal margin. Tibiae and tarsi with sparse stout bristles, stronger and denser on hind leg. Hind femur with some isolated stout bristles on ventral and dorsal edge.

Metasoma. First tergite smooth and polished, about 1.50 times as long as maximum width (Fig. 4C); its maximum width at apex about 3.27 times minimum width (at base). Median dorsal and dorsolateral carinae of first tergite absent, ventrolateral carinae more or less distinct. Spiracle at anterior 0.42 of first tergite. Tergite 2 0.86 times as long as maximum width, smooth and shiny, with short and very sparse hairs; tergites 3-8 slightly coriaceous, rather densely pubescent. Thyridium transverse, as short, inconspicuous, impressed and granulate depression. Ovipositor sheath 0.52 times as long as hind tibia, truncate at apex. Ovipositor moderately slender and slightly down curved, its tip elongate lanceolate, nodus weak, its lower valve with three inconspicuous lateral ridges at apex.

Coloration (Fig. 2D). Head and mesosoma black; hind coxa, trochantellus, femur and tibia, metasoma and ovipositor, reddish-brown. Base of mandible and teeth,

flagellum, dorsal basal part of first tergite and distal tarsomeres, brown. Band on flagellomeres 5–11, palpi, front and mid coxa, trochanter and trochantellus and tegula, white. Central part of mandible scapus and pedicel below, fore and mid femora, tibiae and tarsi, and hind trochanter and tarsus (except distal tarsomere), yellow. Ovipositor sheath brownish.

Male. Body length 3.5 mm, head length × width 0.3 × 0.6 mm, mesosoma length × width (mesoscutum) 1.1 × 0.5 mm, fore wing length 2.9 mm, flagellum 4.0 mm.

Head. Transverse, 0.57 times as long as wide, strongly narrowed behind eyes, gena slightly rounded (dorsal view). Antenna with 26 flagellomeres; flagellum filiform, longer than body, 1.39 times as long as fore wing (Fig. 8D); basal half of flagellum slightly compressed. Mandible 1.83 times as long as its width at middle, teeth equal, base strongly swollen. Malar space about 0.44 times as long as basal width of mandible. Occipital carina absent dorsally, ventrally joining hypostomal carina just before mandible. Ocellar-ocular distance and distance between hind ocelli 1.00 and 1.37 times maximum diameter of lateral ocellus, respectively. Vertex slightly coriaceous, elevated above eye level, abruptly folded behind hind ocelli in a vertical lower vertex, lower vertex and occiput smooth and shiny, deeply concave centrally.

Mesosoma. Pronotum slightly coriaceous, shortly longitudinally strigose on lower hind corner. Prescutelar groove with weak longitudinal wrinkles. Whitish hairs of metapleuron and propodeum shorter. Mesopleural fovea represented by a weak impression far in front of mesopleural suture. Sternaulus virtually absent. Metapleuron punctate or rugulose-punctate on a slightly coriaceous background, with short whitish hairs. Median longitudinal carinae of propodeum absent, anterior to apical transverse carina replaced by a longitudinal narrow depression. Vein 2*rs-m* 0.30 times length of abscissa of *M* between 2*rs-m* and 2*m-cu*. *Cu-a* of fore wing clearly distal to *Rs*&*M*. Abscissa of Cu_1 between 1*m-cu* and Cu_{1a} inclivous, forming angle of 150° with Cu_1, 0.77 times length of Cu_{1b} (Fig. 5F). Hind wing with distal abscissa of Cu_1 absent so that Cu_1&*cu-a* is fairly smoothly curved (Fig. 5H). Distal abscissa of 1*A* of hind wing absent (Fig. 5H). Hind femur with some sparse stout bristles on dorsal and ventral edge (Fig. 7D). Hind tibia with dense stout bristles.

Metasoma. First tergite smooth and polished, about 2.39 times as long as maximum width, laterally with isolated short silvery hairs; maximum width at apex about 1.90 times minimum width (at base). Median dorsal carinae of first tergite absent, dorsolateral carinae shortly present at base, ventrolateral carinae slightly distinct posteriorly. Spiracle at anterior 0.30–0.40 of tergite. Tergite 2 shiny, coriaceous, with short and very sparse hairs laterally. Thyridium weak, as a granulate, small and transverse depression. Claspers with an inwardly curved profile dorsally, moderately pointed at apex (Fig. 6D).

Coloration (Fig. 8D). Head, mesosoma, first tergite and hind coxa, black; mandibles (except base and teeth), palpi, front and middle legs (except tarsi), yellow. Scapus, pedicel, fore and mid tarsi, light brown. Antenna, base and teeth of mandibles, metasoma from second tergite, hind trochanter and trochantellus, tibia and tarsus, dark brown. Hind femur orange.

Taxonomic discussion. Females differ from *A. carolina* Townes, 1967, *A. grossa* Kasparyan & Hernández, 2000 and *A. tinctoria* Kasparyan & Hernández, 2000 by their coloration: head and mesosoma black and metasoma mostly reddish-brown. They differ from other South American species by the head being 0.48 times as long as wide; ovipositor sheath brownish, truncate at apex; antenna (except white ring) brown, with 28 flagellomeres; first tergite about 1.50 times as long as maximum width; abscissa of Cu_1 between 1*m-cu* and Cu_{1a} inclivous, 1.25 times the length of Cu_{1b}; vein 2*rs-m* conspicuous, 0.40 times length of abscissa of *M* between 2*rs-m* and 2*m-cu*; vein 2*m-cu* inclivous; malar space about 0.83 times as long as basal width of mandible; hind wing with distal abscissa of Cu_1 weak and unpigmented, so that Cu_1&*cu-a* is fairly smoothly curved; and by their small body size, 3.8 mm. Males can be recognized by the claspers, which have an inward curved profile dorsally, moderately pointed at apex; hind femur with some sparse stout bristles, principally on dorsal and ventral edge; hind tibia with dense stout bristles; occipital carina present ventrally; abscissa of Cu_1 between 1*m-cu* and Cu_{1a} moderately inclivous, 0.77 times length of Cu_{1b} and hind wing with distal abscissa of Cu_1 absent, so that Cu_1&*cu-a* is fairly smoothly curved.

Remarks. We have linked males and females of this species using the following characters: vein 2*rs-m* conspicuous, 0.30–0.40 times the length of abscissa of *M* between 2*rs-m* and 2*m-cu*; abscissa of Cu_1 between 1*m-cu* and Cu_{1a} inclivous, forming an angle of about 150° with Cu_1, 1.25 and 0.77 times length of Cu_{1b}, in female (Fig. 5E) and male (Fig. 5F), respectively, and hind wing with distal abscissa of Cu_1 weak and unpigmented, so that Cu_1&*cu-a* is fairly smoothly curved (Figs 5G, H). These characters in combination differ from those of other South American species. Additionally, both male and female have been collected in the same locality, Los Amigos, Madre de Dios (Peru). The specimens were also collected during the same period of time.

Etymology. This species is dedicated to the Peruvian Amarakaeri people, who live in the Department of Madre de Dios, Peru.

Phenology. Adults fly in June-August.

Distribution. Peru.

Habitat. Madre de Dios. Tropical rain forest. The study site is located near the Manu National Park. The average annual precipitation at the site ranges from 2,700 to 3,000 mm and the mean annual temperature is around 23 C°. The species was found by Isrrael Gómez.

***Ateleute ashaninka* sp. n.**

urn:lsid:zoobank.org:act:8FE77420-0344-4B43-87C3-EDCD9460B05C
http://species-id.net/wiki/Ateleute_ashaninka
Figs 1A, 2A, 3A

Material examined. Holotype: PERU, ♀, Junín, Chanchamayo, Fundo Génova, 5–19.V.2008, Malaise Trap 2 (MEKRB, currently on loan in CEUA). **Paratypes: PERU,** 2 ♀♀, same locality, 05–19.IV.2008, Malaise Trap 4 (1 ♀, ZMUT; 1 ♀, CEUA).

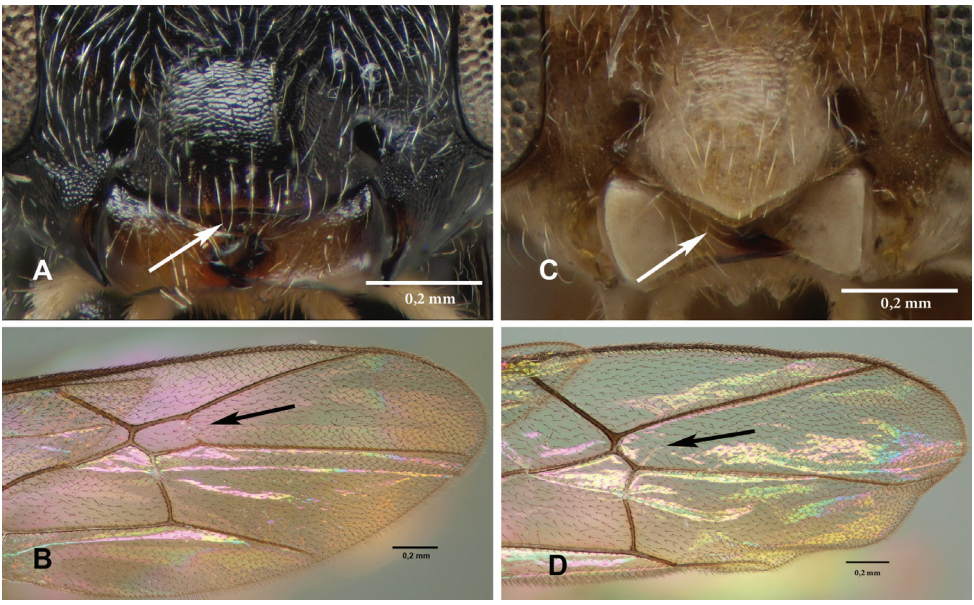

Figure 1. *Ateleute* (**A–B**): **A** clypeus (*A. ashaninka*) **B** fore wing of *A. shuar* showing areolet (arrow). *Tamaulipeca* (**C–D**) **C** clypeus (*T. bora*) **D** fore wing of *T. bora* showing areolet (arrow).

Description. Female. Body length (without ovipositor) 7.4–7.5 mm, head length × width 0.6–0.7 × 1.5–1.6 mm, mesosoma length × width (mesoscutum) 2.6 × 0.9–1.0 mm, length of ovipositor sheath 2.0–2.1 mm, fore wing length 5.9–6.1 mm, flagellum 9.2–9.3 mm.

Head. Transverse, 0.43 times as long as wide, strongly narrowed behind eyes, gena at same level as hind rim of eye (dorsal view). Antenna with 34–35 flagellomeres; flagellum longer than body, 1.47–1.55 times as long as fore wing (Fig. 2A); its segments 1, 4, 7 and 12 about 7.70, 5.00–5.60, 1.90–1.94 and 1.10 times as long as wide, respectively; basal flagellar segments 1 to 4 slightly compressed, flagellomeres 5 to 9–10 cylindrical, and from 11 to near apex depressed (flattened ventrally with short sensory setae in this area); maximum width of flagellum about 1.10 times the minimum width of segment 1; flagellum strongly tapered towards apex (Fig. 2A). Clypeus strongly convex, its margin sharp slightly truncate in centre (Fig. 1A). Mandible short, 2.30 as long as its width at middle, teeth equal or the lower tooth a little longer, base strongly swollen. Malar space about 0.80–0.90 times as long as basal width of mandible. Occipital carina absent dorsally, ventrally joining hypostomal carina just before mandible. Ocellar-ocular distance and distance between hind ocelli 1.16–1.25 and 1.40–1.50 times maximum diameter of lateral ocellus, respectively. Face coriaceous, with close, distinct but shallow punctures centrally and moderately long silvery hairs. Frons coriaceous. Vertex slightly coriaceous, with very sparse short hairs, lower vertex and occiput strongly concave; gena smooth and shiny, hairless in upper half, with moderately long and dense silvery hairs in lower part.

Mesosoma. Upper margin of pronotum not swollen. Lateral part of collar bordered behind by carina. Pronotum slightly coriaceous, laterally longitudinally strigose with

sparse silvery hairs. Mesoscutum coriaceous, shiny, longitudinally strigose in the area between posterior part of notauli. Notauli reaching tegula level, convergent, strongly impressed with tight transverse wrinkles along its length. Prescutelar groove with longitudinal wrinkles. Scutellum weakly coriaceous, with complete lateral carina. Mesopleuron coriaceous, with very dense punctures and white long hairs; these hairs absent in an antero-posterior diagonal band that includes speculum. Mesopleural fovea absent or represented by a weak impression far in front of mesopleural suture. Sternaulus nearly absent. Metapleuron and propodeum finely and densely punctate or rugose-punctate on a coriaceous background, with very dense and long whitish hairs. Posterior transverse carina of mesosternum complete (not interrupted in-front of each middle coxa). Propodeum long, its spiracle round and very small. Anterior transverse carina absent. Posterior transverse carina present in the centre and in area posteroexterna, absent laterally. Median longitudinal carinae of propodeum slightly distinct anterior to transverse carina; lateral longitudinal carina absent anterior to apical transverse carina, shortly present distad. Pleural carina strong, sometimes evanescent posteriorly. Area petiolaris confluent with areas posteroexterna. Vein 3*rs-m* un-pigmented. Vein 2*rs-m* 0.3 times length of abscissa of *M* between 2*rs-m* and 2*m-cu*. Vein 2*m-cu* vertical with one short bulla. *Cu-a* of fore wing a little distad of *Rs*&*M*. *M*+*Cu* of hind wing strongly arched. Hind wing with distal abscissa of Cu_1 strong and pigmented. Cu_1&*cu-a* strongly angled a little below middle. Distal abscissa of 1*A* of hind wing very short, nearly absent. Tip of axillus very close to-anal margin. Tibiae and tarsi with sparse stout bristle, stronger on hind leg. Hind femur with 3-4 stout bristles on ventral (1-2) and dorsal (2) edge.

Metasoma. First tergite smooth and polished about 1.70–1.80 times as long as maximum width; its maximum width at apex about 3.30 times minimum width (at base). Median dorsal and dorsolateral carinae of first tergite absent, ventrolateral carinae more or less distinct posteriorly. Spiracle at anterior 0.30–0.40 of tergite. Tergites 2 square, polished, slightly coriaceous, laterally with short, sparse hairs; tergites 3-8 rather densely pubescent. Thyridium absent. Ovipositor sheath 0.62–0.66 times as long as hind tibia, widely truncate at apex (Fig. 3A). Ovipositor moderately slender and slightly down curved (Fig. 2A), its tip elongate lanceolate, nodus weak, its lower valve with three weak lateral ridges at apex.

Coloration (Fig. 2A). Head and mesosoma black, metasoma entirely, hind coxa, trochanter, trochantellus and femur, and ovipositor, vividly red. Mandible except base and teeth and scapus below, reddish brown. Band on flagellomeres 5–11 and tegula white. Fore, mid leg, hind tibia and tarsus (except distal tarsomere), yellow. All distal tarsomeres brown. Palpi, fore coxa, fore and mid trochanter and tochantelli, light yellow. Ovipositor sheath black.

Male. Unknown.

Taxonomic discussion. This species differs from all other New World species by its coloration: head and mesosoma entirely black, and metasoma, hind coxa, trochanter, trochantellus, femur and tibia entirely red. The North American and Mesoamerican species *A. carolina*, *A. grossa* and *A. tinctoria* all have black and white patterns on the mesosoma and/or metasoma. *Ateleute ashaninka* also differs from other South Ameri-

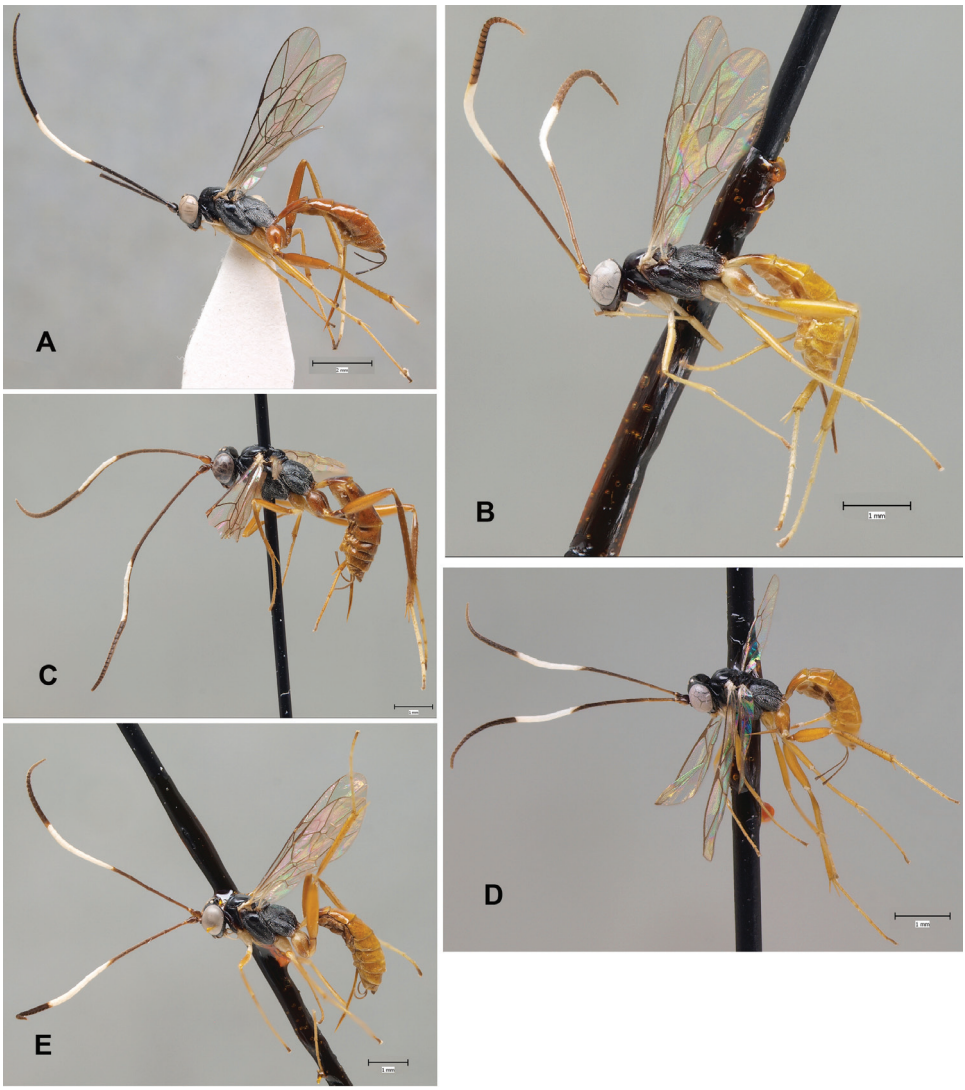

Figure 2. Female habitus, lateral: **A** *Ateleute ashaninka* sp. n. (paratype) **B** *Ateleute huaorani* sp. n. (holotype) **C** *Ateleute kichua* sp. n. (holotype) **D** *Ateleute amarakaeri* sp. n. (holotype) **E** *Ateleute shuar* sp. n. (holotype)

can species by its widely truncate black ovipositor sheath, more transverse head longer black antennae with 34–35 flagellomeres; and a larger body size.

Etymology. This species is dedicated to the Peruvian Amazonian Ashaninka people, who live in the province of Chanchamayo, where the specimens were collected.

Phenology. Adults fly in April-May.

Distribution. Peru.

Habitat. The species was collected in a premontane rain forest area strongly perturbed by traditional agricultural activities represented by small *Inga*-shaded coffee

plantations and maize and citrus cultivations. Large areas of the forest have been cut down, making way for the formation of secondary forest, grassland and degraded areas, but there are still some areas of primary forest left, due to their inaccessibility, selective extraction and policies of their owners. For more information on the vegetation and climate see Alvarado et al. (2011).

***Ateleute huaorani* sp. n.**
urn:lsid:zoobank.org:act:04425CF6-9D21-448A-B969-6391BC4CA653
http://species-id.net/wiki/Ateleute_huaorani
Figs 2B, 3B, 4A, 5A–B, 6C, 7C, 8C

Material examined. Holotype: **ECUADOR,** ♀, Dept. Orellana, Onkone Gare, 0°39'25.7"S, 76°27'10.8"W, Canopy fogging, 216.3 m., 1.X.1996, T. L. Erwin et al. Lot.1686 (USNM).

Paratypes: ECUADOR, 1 ♂, Dept. Orellana, Tiputini, 0°37'55.7"S, 76°8'39"W, Canopy fogging, 220–250 m., 6.II.1999, T. L. Erwin et al. Lot.2068 (ZMUT).

Description. Female. Body length (without ovipositor) 4.6 mm, head length × width 0.5 × 0.9 mm, mesosoma length × width (mesoscutum) 1.4 × 0.5 mm, length of ovipositor sheath 1.1 mm, fore wing length 3.3 mm, flagellum 5.6 mm.

Head. Transverse, 0.50 times as long as wide, strongly narrowed behind eyes, gena at same level as hind rim of eye (dorsal view). Antenna with 29 flagellomeres; flagellum longer than body, 1.70 times as long as fore wing (Fig. 2B); its segments 1, 4, 7 and 12 about 9.40, 7.20, 2.36 and 1.16 times as long as wide, respectively; basal flagellar segments 1 to 4 slightly compressed, flagellomeres 5 to 8 cylindrical and from 9 to near apex depressed (flattened ventrally with short sensory setae in this area); maximum width of flagellum about 1.10 times minimum width of segment 1; flagellum strongly tapered towards apex. Clypeus strongly convex, its margin sharp slightly truncate in centre. Mandible short, 2.50 times as long as its width at middle, its teeth equal, base strongly swollen. Malar space about 0.66 times as long as basal width of mandible. Occipital carina absent dorsally, ventrally joining hypostomal carina just little before mandible. Ocellar-ocular distance and distance between hind ocelli 0.90 times maximum diameter of lateral ocellus. Face coriaceous, with c1ose, but shallow punctures and moderately long silvery hairs. Frons coriaceous. Vertex slightly coriaceous, with very sparse short hairs, lower vertex and occiput strongly concave centrally; gena smooth and shiny, or slightly coriaceous, hairless in upper half, with sparse silvery hairs in lower part.

Mesosoma. Upper margin of pronotum not swollen. Lateral part of collar bordered behind by weak carina. Pronotum coriaceous, laterally shortly longitudinally strigose. Mesoscumum coriaceous, shiny. Notauli reaching tegula level, convergent, strongly impressed. Prescutelar groove with very weak longitudinal wrinkles. Scutellum coriaceous, with complete lateral carinae. Mesopleuron coriaceous, with very fine and dense punctures and white long hairs; these hairs absent in an antero-posterior diagonal band including speculum. Mesopleural fovea absent. Sternaulus evanescent.

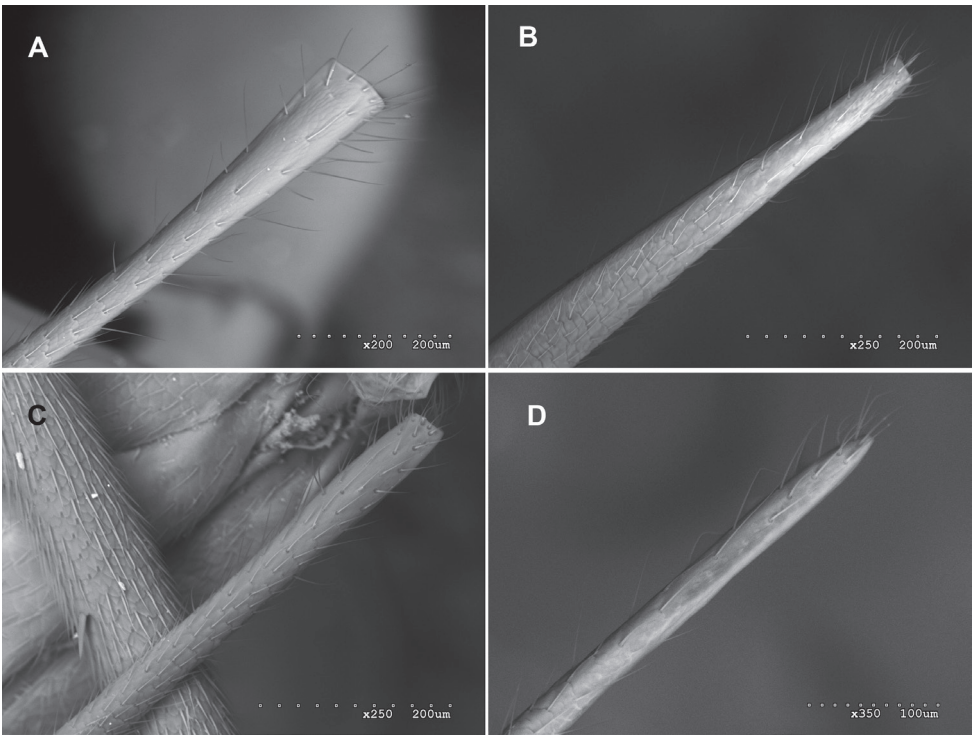

Figure 3. Ovipositor sheath: **A** *Ateleute ashaninka* sp. n. **B** *Ateleute huaorani* sp. n. **C** *Ateleute kichua* sp. n. **D** *Ateleute shuar* sp. n.

Metapleuron and propodeum fine and very densely punctate or rugulose-punctate on a coriaceous background, with very dense whitish hairs. Posterior transverse carina of mesosternum complete (not interrupted in-front of each middle coxa). Propodeum long, with a narrow longitudinal central depression; its spiracle rounded and very small, close to pleural carina. Anterior transverse carina absent. Posterior transverse carina present in the centre and in area posteroexterna, absent laterally. Median longitudinal carinae absent; lateral longitudinal carina absent anterior to apical transverse carina, shortly present distad. Pleural carina strong. Area petiolaris confluent with areas posteroexterna. Vein 3*rs-m* unpigmented. Vein 2*rs-m* conspicuous, 0.60 times the length of abscissa of *M* between 2*rs-m* and 2*m-cu*. Vein 2*m-cu* slightly inclivous with one bulla. *Cu-a* of fore wing a little distad of *Rs*&*M*, slightly inclivous. Abscissa of Cu_1 between 1*m-cu* and Cu_{1a} strongly inclivous, forming angle of 156° with Cu_1, 0.90 times length of Cu_{1b}. *M*+*Cu* of hind wing strongly arched (Fig. 5A). Hind wing with distal abscissa of Cu_1 pigmented. Cu_1&*cu-a* angled below middle. Distal abscissa of 1*A* of hind wing very short, nearly absent. Tip of axillus very close to anal margin. Tibiae and tarsi with sparse stout bristles, longer and denser on hind leg. Hind femur without stout bristles.

Metasoma. First tergite smooth and polished, about 2.16 times as long as maximum width (Fig. 4A); its maximum width at apex about 2.85 times minimum width

(at base). Median dorsal carina of first tergite absent, dorsolateral carinae slightly present at basal half, the ventrolateral carinae more or less distinct. Spiracle at anterior 0.43 of tergite. Tergite 2 0.90 times as long as maximum width, shiny, slightly coriaceous, laterally with short and sparse hairs; tergites 3-8 rather densely pubescent. Thyridium absent. Ovipositor sheath 0.58 times as long as hind tibia, narrowly truncate at apex (Fig. 3B). Ovipositor moderately slender and slightly down curved (Fig. 2B), its tip elongate lanceolate, nodus weak.

Coloration (Fig. 2B). Head and mesosoma black; central part of mandibles, scapus and pedicel below, front and mid femur, apex of hind trochanter, hind femur and tibia entirely, metasoma except 3/4 of first tergite yellowish. Base of mandible and teeth, flagellum and dorsal central part of first tergite, propleura, front lateral part of pronotum and mesopleura, apex of hind coxa and hind trochantellus dorsally and distal tarsomeres of all legs brown. Ovipositor sheath brownish. Band on flagellomeres 5–12, palpi, front and mid coxa, trochanter and trochantellus and tegula, white. Fore and mid femora ventrally, tibiae and tarsi, base of hind coxa and trochanter, tarsus and base of first tergite, light yellow.

Male. Body length 3.5 mm, head length × width 0.3 × 0.6 mm, mesosoma length × width (mesoscutum) 1.0 × 0.4 mm, fore wing length 2.5 mm, flagellum 3.6 mm.

Head. Transverse, 0.56 times as long as wide, strongly narrowed behind eyes, gena slightly rounded (dorsal view). Antenna thin, filiform with 23 flagellomeres; flagellum longer than body, 1.41 times as long as fore wing (Fig. 8C), measures of flagellomeres different; basal half of flagellum slightly compressed. Mandible 2.50 as long as its width at middle. Malar space about 0.44 times as long as basal width of mandible. Occipital carina absent. Ocellar-ocular distance and distance between hind ocelli 1.20 and 1.00 times maximum diameter of lateral ocellus, respectively. Vertex slightly coriaceous, elevated above the eye level, abruptly folded behind hind ocelli in a vertical lower vertex, lower vertex and occiput smooth and shiny, slightly concave in the centre.

Mesosoma. Pronotum coriaceous. Mesopleuron coriaceous with short and sparse white hairs. Sternaulus slightly impressed anteriorly. Metapleuron and propodeum coriaceous with very sparse short whitish hairs. Vein 2*rs-m* conspicuous, 0.50 times the length of abscissa of *M* between 2*rs-m* and 2*m-cu*. Abscissa of Cu_1 between 1*m-cu* and Cu_{1a} extremely inclivous, forming angle of 166° with Cu_1, 0.45 times length of Cu_{1b} (Fig. 5B). Hind wing with distal abscissa of Cu_1 pigmented. Cu_1&*cu-a* angled below middle. Distal abscissa of 1*A* of hind wing absent. Front and middle tibiae and tarsi, and hind femur (Fig. 7C) without conspicuous stout bristles. Hind tibia with sparse stout bristles.

Metasoma. First tergite coriaceous about 2.00 times as long as maximum width; maximum width at apex about 2.20 times minimum width (at base). Median dorsal carinae of first tergite absent, dorsolateral carina present anterior spiracle, the ventrolateral carinae more or less distinct posteriorly. Spiracle at anterior 0.45 of tergite. Thyridium weak, as a granulate, small and transverse depression. Claspers with an inwardly curved profile dorsally, moderately pointed at apex (Fig. 6C).

Coloration (Fig. 8C). Body brown; mandibles (except teeth), all legs except coxae, trochantelli and distal tarsomeres yellow. Scapus and pedicel light brown.

Figure 4. Metasomal first tergite, female, dorsal: **A** *Ateleute huaorani* sp. n. **B** *Ateleute kichua* sp. n. **C** *Ateleute amarakaeri* sp. n. **D** *Ateleute shuar* sp. n.

Taxonomic discussion. Females differ from *A. carolina, A. grossa* and *A. tinctoria* by their coloration: head and mesosoma entirely black or dark brown and metasoma mostly yellowish. They also differ from other South American species by their brownish ovipositor sheath which are narrowly truncate in the apex; head 0.50 times as long as wide; first tergite long and narrow, 2.16 times as long as wide posteriorly; antenna brown with 29 flagellomeres; and abscissa of Cu_1 between 1*m-cu* and Cu_{1a} strongly inclivous, about 0.90 times the length of Cu_{1b}. Males can be recognized by their claspers, which have an inwardly curved profile dorsally, moderately pointed at apex; hind femur without stout bristles; hind tibia with sparse stout bristles; abscissa of Cu_1 between 1*m-cu* and Cu_{1a}, extremely inclivous, 0.45 times length of Cu_{1b}; vein 2*rs-m* 0.50 times the length of abscissa of *M* between 2*rs-m* and 2*m-cu*; hind wing with distal abscissa of Cu_1 present; Cu_1&*cu-a* angled below middle; and the occipital carina absent.

Remarks. We have linked males and females of this species using the following characters: vein 2*rs-m* conspicuous, 0.60 times in female (Fig. 5A) and 0.50 times in male (Fig. 5B) the length of abscissa of *M* between 2*rs-m* and 2*m-cu*, and abscissa of Cu_1 between 1*m-cu* and Cu_{1a} strongly inclivous, 0.90 times in female (Fig. 5A) and 0.45 times in male (Fig. 5B) length of $Cu_{1b,}$ and forming an angle about 156°-166° with Cu_1 (Figs 5A, B). These characters in combination differ from those of other South American species.

Etymology. This species is dedicated to the Ecuadorian Huaorani people, who live in the Department of Orellana, Ecuador.

Phenology. Adults fly in October and February.

Distribution. Ecuador

Habitat. The holotype has been collected by canopy fogging in Onkone Gare, Department of Orellana, Ecuador (by Terry L. Erwin). The study site is located near the border of the Yasuní National Park. Vegetation at the site is old and diverse primary rain forest growing on relatively nutrient-rich soils.

***Ateleute kichua* sp. n.**

urn:lsid:zoobank.org:act:06492E74-195C-430A-8986-913E8F92ED2D
http://species-id.net/wiki/Ateleute_kichua
Figs 2C, 3C, 4B, 5C–D, 6A, 7A, 8A

Material examined. Holotype: **ECUADOR,** ♀, Dept. Orellana, Onkone Gare, 0°39'25.7"S, 76°27'10.8"W, Canopy fogging, 216.3 m., 30.IX.1996, T. L. Erwin et al. Lot.1677 (USNM).

Paratypes: ECUADOR, 1 ♂, same locality, 21-V-1994, T. L. Erwin et al. Lot.702; 1 ♂, same locality, 2-VI-1995, T. L. Erwin et al. Lot.1084; 1 ♂, same locality, 8-X-1995, T. L. Erwin et al. Lot.1268 (2 ♂ in USNM and 1 ♂ in ZMUT).

Description. Female. Body length (without ovipositor) 5.9 mm, head length × width 0.6 × 1.2 mm, mesosoma length × width (mesoscutum) 2.0 × 0.8 mm, length of ovipositor sheath 1.3 mm, fore wing length 4.2 mm, flagellum 6.2 mm.

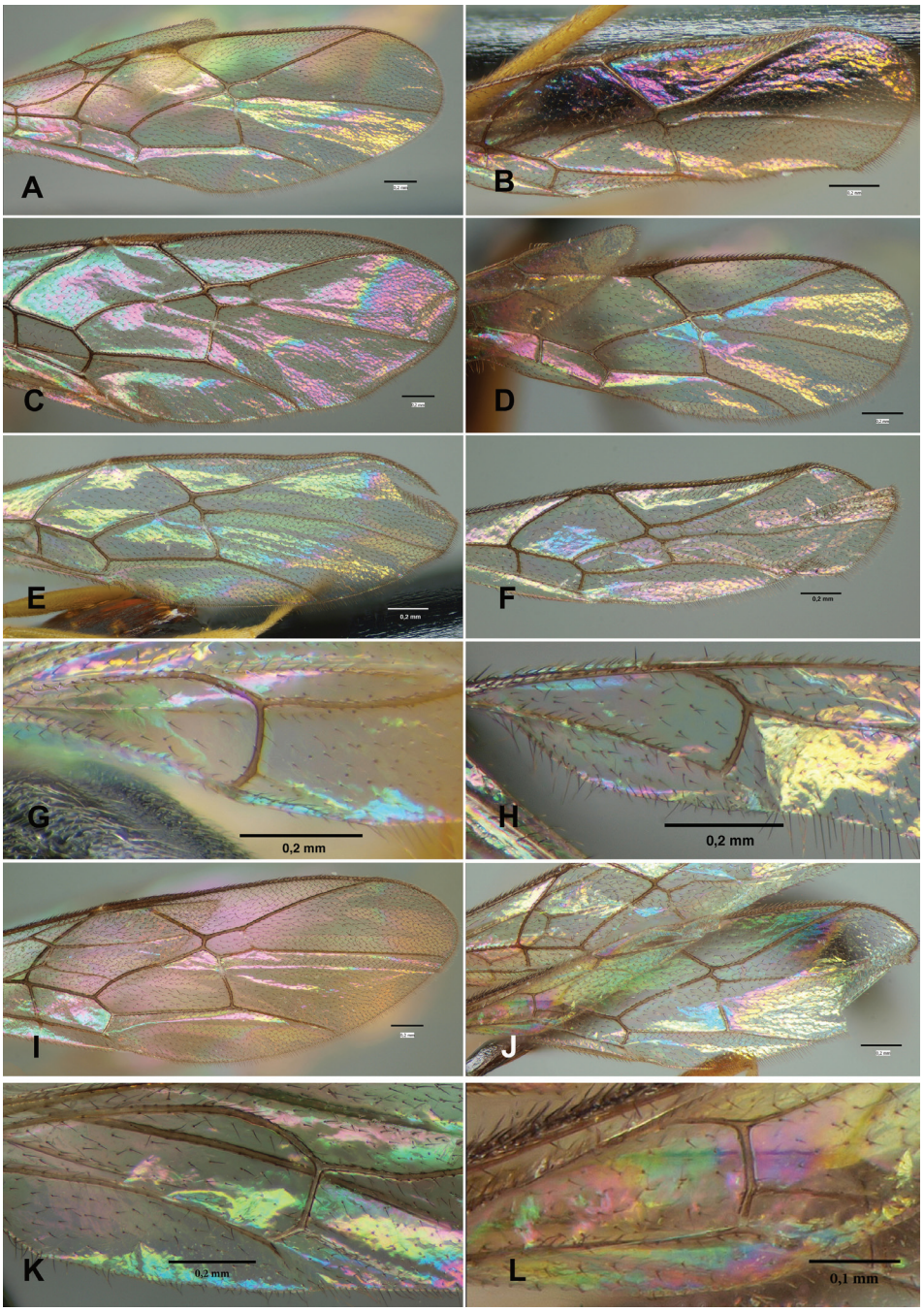

Figure 5. Wings: **A** *Ateleute huaorani* sp. n., fore wing, ♀ **B** *Ateleute huaorani* sp. n., fore wing, ♂ **C** *Ateleute kichua* sp. n., fore wing, ♀ **D** *Ateleute kichua* sp. n., fore wing, ♂ **E** *Ateleute amarakaeri* sp. n., fore wing, ♀ **F** *Ateleute amarakaeri* sp. n., fore wing, ♂ **G** *Ateleute amarakaeri* sp. n., hind wing, ♀ **H** *Ateleute amarakaeri* sp. n., hind wing, ♂ **I** *Ateleute shuar* sp. n., fore wing, ♀ **J** *Ateleute shuar* sp. n., fore wing, ♂ **K** *Ateleute shuar* sp. n., hind wing, ♀ **L** *Ateleute shuar* sp. n., hind wing, ♂.

Head. Transverse, 0.48 times as long as wide, strongly narrowed behind eyes, gena at same level as hind rim of eye (dorsal view). Antenna with 30 flagellomeres; flagellum longer than body, 1.49 times as long as fore wing (Fig. 2C); its segments 1, 4, 7 and 12 about 9.57, 6.25, 2.50 and 1.20 times as long as wide, respectively; basal flagellar segments 1 to 4 slightly compressed, flagellomeres 5 to 9 cylindrical and from 10 to near apex depressed (flattened ventrally with short sensory setae in this area); maximum width of flagellum about twice minimum width of first flagellomere; flagellum strongly tapered towards apex. Clypeus strongly convex, its margin sharp slightly truncate in centre. Mandible 2.27 times as long as width at middle, teeth equal or lower tooth little longer, base strongly swollen. Malar space about 0.65 times as long as basal width of mandible. Occipital carina absent dorsally, ventrally joining hypostomal carina just before mandible. Ocellar-ocular distance and distance between hind ocelli 1.10 and 1.30 times maximum diameter of lateral ocellus, respectively. Face finely coriaceous, dense and finely punctate, with silvery hairs. Frons and vertex coriaceous, with some isolated short hairs, lower vertex and occiput strongly concave centrally; gena shiny, slightly coriaceous, hairless in upper half, with moderately long silvery hairs in lower part.

Mesosoma. Upper margin of pronotum not swollen. Lateral part of collar bordered behind by weak carina. Pronotum strongly coriaceous-punctate, laterally longitudinally strigose with sparse silvery hairs. Mesoscumum coriaceous, shiny. Notauli reaching tegula level, convergent, strongly impressed with tight transverse wrinkles along its length. Prescutelar groove with longitudinal wrinkles. Scutellum coriaceous, with complete lateral carinae. Mesopleuron strongly coriaceous-punctate, with white long hairs; these hairs absent in an antero-posterior diagonal band that includes speculum. Mesopleural fovea absent or represented by a weak impression far in front of mesopleural suture. Sternaulus virtually absent. Metapleuron and propodeum densely punctate or rugulose-punctate on a strongly coriaceous background, with very dense and long whitish hairs. Posterior transverse carina of mesosternum complete (not interrupted in-front of each middle coxa). Propodeum long, its spiracle round and very small. Anterior transverse carina absent. Posterior transverse carina present in the centre and in area posteroexterna, obsolescent laterally. Median longitudinal carinae of propodeum slightly distinct anterior to apical transverse carina; lateral longitudinal carina absent anterior to apical transverse carina, shortly present distally. Pleural carina strong. Area petiolaris confluent with areas posteroexterna. Vein 3*rs-m* unpigmented. Vein 2*rs-m* obliterated or at most 0.10 times the length of abscissa of *M* between 2*rs-m* and 2*m-cu*. Vein 2*m-cu* vertical with one bulla. *Cu-a* of fore wing clearly distal of *Rs*&*M*. Abscissa of Cu_1 between 1*m-cu* and Cu_{1a} inclivous, forming angle of 150° with Cu_1, 1.25 times length of Cu_{1b} (Fig. 5C). *M*+*Cu* of hind wing strongly arched. Hind wing with distal abscissa of Cu_1 pigmented. Cu_1&*cu-a* angled clearly below middle. Distal abscissa of 1*A* of hind wing moderately long and strong. Tip of axillus very close to-anal margin. Tibiae and tarsi with sparse stout bristles, stronger and denser on hind leg. Hind femur with some stout bristles at distad part.

Metasoma. First tergite smooth and polished about 1.65 times as long as maximum width (Fig. 4B), laterally with isolated long silvery hairs; its maximum width

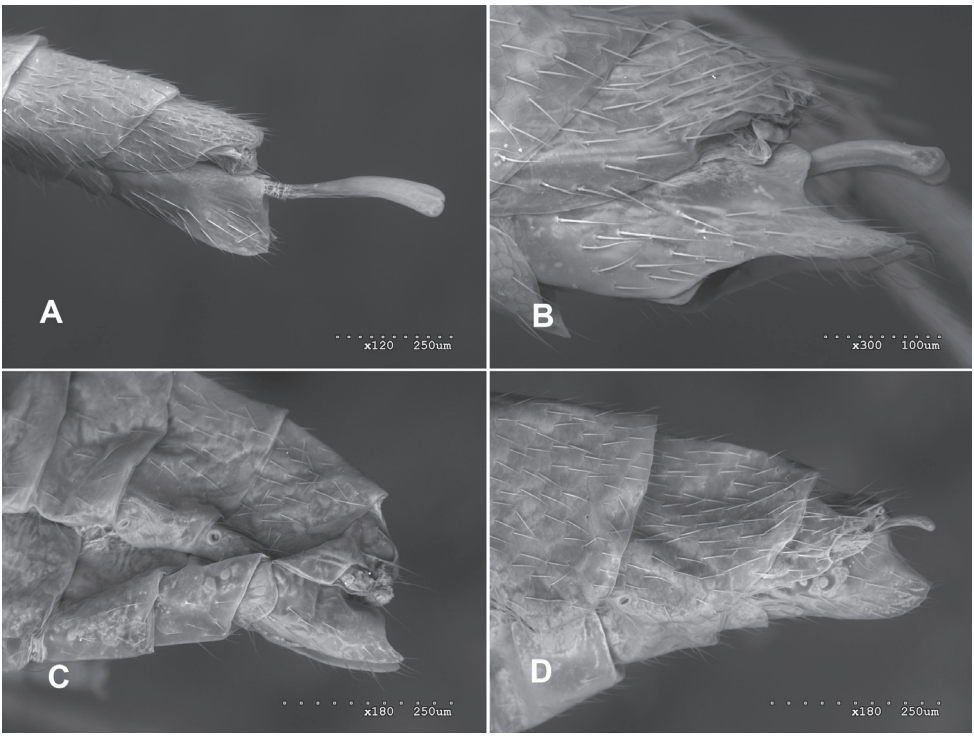

Figure 6. Male claspers: **A** *Ateleute kichua* sp. n. **B** *Ateleute shuar* sp. n. **C** *Ateleute huaorani* sp. n. **D** *Ateleute amarakaeri* sp. n.

at apex about 3.80 times minimum width (at base). Median dorsal carinae of first tergite absent, dorsolateral carinae shortly present at base, ventrolateral carinae slightly distinct posteriorly. Spiracle at anterior 0.30–0.40 of tergite. Tergite 2 1.04 times as long as maximum width, shiny, coriaceous, with short and very sparse hairs laterally; tergites 3-8 coriaceous, rather densely pubescent. Thyridium absent. Ovipositor sheath 0.60 times as long as hind tibia, truncate at apex (Fig. 3C). Ovipositor moderately slender and slightly down curved (Fig. 2C), its tip elongate lanceolate, nodus weak, its lower valve with three weak lateral ridges at apex.

Coloration (Fig. 2C). Head and mesosoma black; central part of mandibles, metasoma except first three tergites dorsally, all femora fore and mid tibiae, ovipositor, scapus and pedicel below and front and mid coxa, reddish-brown. Base of mandible and teeth, flagellum and dorsal central part of first tergite, second and third, hind coxa, trochanter, trochantellus, tibia and distal tarsomere, dark brown. Flagellomeres 5–10 above, palpi, front apex of coxa, trochanter and trochantellus and tegula, white. Hind tarsus (except distal tarsomere) light yellow. Base of first tergite and mid trochanter and part of trochantellus yellow. Ovipositor sheath brownish.

Male. Body length 4.0–4.3 mm, head length × width 0.3–0.4 × 0.6–0.8 mm, mesosoma length × width (mesoscutum) 1.2–1.3 × 0.4–0.5 mm, fore wing length 2.7–3.0 mm, flagellum 4.1–4.4 mm.

Head. Transverse, 0.49–0.57 times as long as wide, strongly narrowed behind eyes, gena slightly rounded (dorsal view). Antenna thin, filiform with 25–25 flagellomeres; flagellum longer than body, 1.50–1.60 times as long as fore wing (Fig. 8A), measures of flagellomeres different; basal half of flagellum slightly compressed. Mandible 2.14–2.28 as long as its width at middle. Malar space about 0.30 times as long as basal width of mandible. Ocellar-ocular distance and distance between hind ocelli 1.14–1.33 and 1.57–1.71 times maximum diameter of lateral ocellus, respectively. Vertex slightly coriaceous, elevated above the eye level, abruptly folded behind hind ocelli in a vertical lower vertex, lower vertex and occiput smooth and shiny, deeply concave centrally.

Mesosoma. Pronotum slightly coriaceous. Scutellum smooth. Mesopleuron coriaceous with short and sparse white hairs. Sternaulus slightly impressed anteriorly. Whitish hairs of metapleuron and propodeum shorter. Posterior transverse carina strong and complete. Median longitudinal and lateral longitudinal carina of propodeum absent anterior to apical transverse carina; lateral longitudinal carina, shortly present distally. Vein 2*rs-m* obliterated. Vein 2*m-cu* slightly inclivous, abscissa of Cu_1 between 1*m-cu* and Cu_{1a} inclivous, forming an angle of 140°–150° with Cu_1, 1.20–1.40 times length of Cu_{1b} (Fig. 5D). Hind wing with distal abscissa of Cu_1 pigmented. Cu_1&*cu-a* angled clearly below middle. Hind femur with numerous stout bristles (Fig. 7A).

Metasoma. First tergite coriaceous about 1.86–2.03 times as long as maximum width; maximum width at apex about 2.10–2.30 times minimum width (at base). Median dorsal carinae of first tergite absent, dorsolateral carina present anterior spiracle, ventrolateral carinae more or less distinct posteriorly. Spiracle in anterior 0.37–0.42 of tergite. Tergite 2 not measured. Thyridium weak, as a granulate, small and transverse depression. Claspers transversally and widely truncate (Fig. 6A).

Coloration (Fig. 8A). Body brown. Mandibles (except teeth), palpi, front and middle legs except base of coxa and distal tarsomere, yellow. Scapus and pedicel light brown. Hind trochanter, trochantellus, femur and anterior part of tibia, orange. Second and third tarsomeres of hind leg and sometimes the most part of first and fourth, whitish.

Taxonomic discussion. Females differ from *A. carolina, A. grossa* and *A. tinctoria* by their coloration: head and mesosoma entirely black and metasoma anteriorly dark brown and posteriorly reddish-brown. They differ from other South American species by their brownish ovipositor sheath, moderately truncate at the apex; head 0.48 times as long as wide; antenna (except white band) dark brown with 30 flagellomeres; first tergite 1.65 times as long as wide posteriorly; abscissa of Cu_1 between 1*m-cu* and Cu_{1a} 1.25 times the length of Cu_{1b}; vein 2*rs-m* obliterated or at most 0.10 times the length of abscissa of *M* between 2*rs-m* and 2*m-cu*; vein 2*m-cu* vertical; malar space about 0.65 times as long as basal width of mandible and body length 5.9 mm. Males differ from other species by their claspers being transversally and widely truncate; vein 2*rs-m* obliterated and hind femur with numerous conspicuous stout bristles.

Remarks. We have linked males and females of this species using the following characters: vein 2*rs-m* vein obliterated or at most 0.10 times the length of abscissa of *M* between 2*rs-m* and 2*m-cu* (Figs 5C, D) and the abscissa of Cu_1 between 1*m-cu*

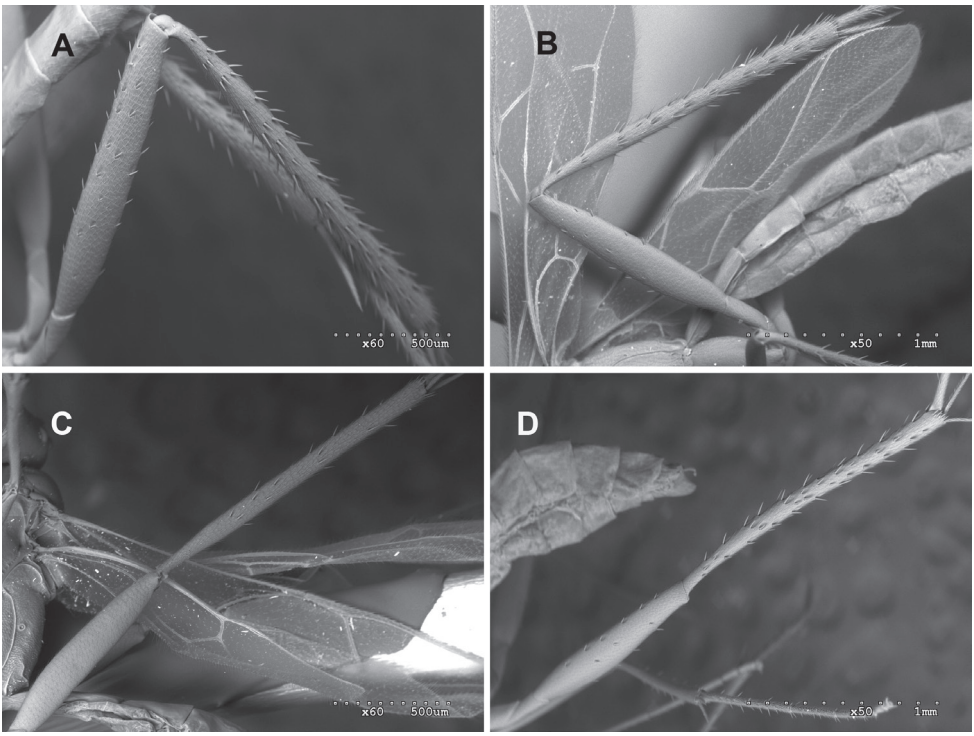

Figure 7. Male hind legs: **A** *Ateleute kichua* sp. n. **B** *Ateleute shuar* sp. n. **C** *Ateleute huaorani* sp. n. **D** *Ateleute amarakaeri* sp. n.

and Cu_{1a} inclivous, forming an angle of 140°–150° with Cu_1, 1.20–1.40 times the length of Cu_{1b} (Figs 5C, D). This combination of characters differs from those of other South American species.

Etymology. This species is dedicated to the Ecuadorian Kichwa people, who live in the Department of Orellana, Ecuador.

Phenology. Adults fly in May-June and September-October.

Distribution. Ecuador.

Habitat. The specimens have been collected by canopy fogging in Onkone Gare, Department of Orellana, Ecuador, in the same habitat as *A. huaorani*.

***Ateleute shuar* sp. n.**

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http://species-id.net/wiki/Ateleute_shuar
Figs 1B, 2E, 3D, 4D, 5I–L, 6B, 7B, 8B

Material examined. Holotype: **ECUADOR,** ♀, Dept. Orellana, Onkone Gare, 0°39'25.7"S, 76°27'10.8"W, Canopy fogging, 216.3 m., 2.VI.1995, T. L. Erwin et al. Lot.1086 (USNM).

Paratypes: ECUADOR, 1 ♂, same locality holotype, 21.V.1996, T. L. Erwin et al. Lot.1546; 1 ♂, same locality and date, T. L. Erwin et al. Lot.1086 (USNM). **PERU**, 1 ♀, Dept. Loreto, Iquitos area, Allpahuayo, 22.I-22.II.2000, clay, Sääksjärvi, I. E. et al. leg. Malaise Trap, APHI, F2/1 (ZMUT); 1 ♂, same locality, 17.X-8. XII.2000, clay, Sääksjärvi, I. E. et al. leg., Malaise Trap, APHI, H1/15 (UNSM).

Description. Female. Body length (without ovipositor) 5.2–5.6 mm, head length × width 0.5–0.7 × 1.1–1.3 mm, mesosoma length × width (mesoscutum) 1.7–1.9 × 0.6–0.8 mm, length of ovipositor sheath 1.1–1.2 mm, fore wing length 3.7–4.1 mm, flagellum 6.1 mm.

Head. Transverse, 0.48–0.51 times as long as wide, strongly narrowed behind eyes, gena at same level as hind rim of eye (dorsal view). Antenna with 29–32 flagellomeres; flagellum longer than body, 1.50–1.60 times as long as fore wing (Fig. 2E); its segments 1, 4, 7 and 12 about 7.86–8.00 (annellus excluded), 5.60–5.70, 2.20–2.30 and 1.00–1.10 times as long as wide, respectively; basal flagellar segments 1 to 4 slightly compressed, flagellomeres 5 to 8 cylindrical and from 9 to near apex depressed (flattened ventrally with short sensory setae in this area); maximum width of flagellum twice minimum width of first flagellomere; flagellum strongly tapered towards apex. Clypeus strongly convex, its margin sharp and truncate in centre. Mandible short, 1.70–2.00 as long as width at the middle, teeth equal, base strongly swollen. Malar space about 0.80–0.86 times as long as basal width of mandible. Occipital carina absent dorsally, ventrally joining hypostomal carina just before mandible. Ocellar-ocular distance and distance between hind ocelli 1.00–1.12 and 1.00–1.30 times maximum diameter of lateral ocellus, respectively. Face finely coriaceous, virtually impunctate, with silvery hairs. Frons coriaceous. Vertex slightly coriaceous, with very sparse short hairs, lower vertex and occiput strongly concave centrally. Gena shiny, slightly coriaceous, hairless in upper half, with moderately long and dense silvery hairs in lower part.

Mesosoma. Upper margin of pronotum not swollen. Lateral part of collar bordered behind by weak carina. Pronotum coriaceous, laterally shortly longitudinally strigose. Mesoscumum coriaceous, shiny. Notauli reaching tegula level, convergent, strongly impressed. Prescutelar groove with weak longitudinal wrinkles. Scutellum coriaceous, with complete lateral carinae. Mesopleuron coriaceous, with very fine and dense punctures and white long hairs; these hairs absent in an antero-posterior diagonal band including speculum. Mesopleural fovea absent or represented by a weak impression far in front of mesopleural suture. Sternaulus inconspicuous. Metapleuron and propodeum fine and very densely punctate or rugulose-punctate on a coriaceous background, with very dense whitish hairs. Posterior transverse carina of mesosternum complete (not interrupted in-front of each middle coxa). Propodeum 1.21–1.28 times as long as its width at spiracle level (dorsal view), with a narrow longitudinal central depression; its spiracle rounded and very small, close to pleural carina. Anterior transverse carina absent. Posterior transverse carina present in the centre and in area posteroexterna, absent laterally. Median longitudinal carinae absent; lateral longitudinal carina absent anterior to apical transverse carina, shortly present distad. Pleural carina strong. Area petiolaris confluent with areas posteroexterna. Vein 3*rs-m* unpigmented. Vein 2*rs-m*

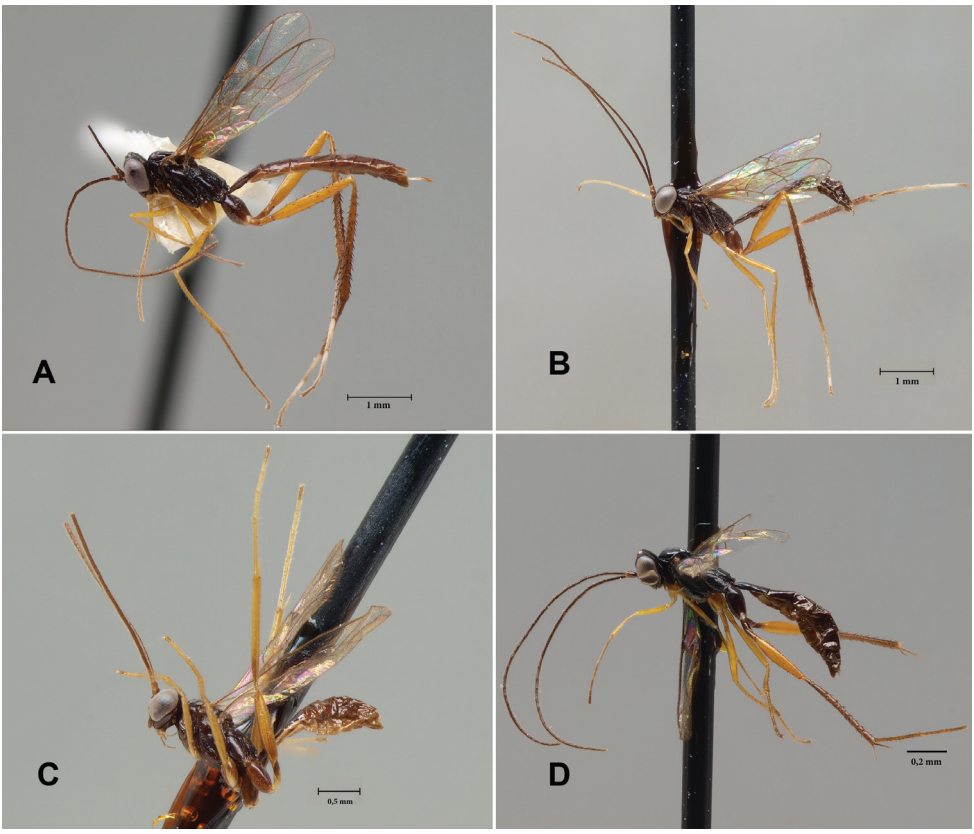

Figure 8. Male habitus, lateral: **A** *Ateleute kichua* sp. n. (paratype) **B** *Ateleute shuar* sp. n. (paratype) **C** *Ateleute huaorani* sp. n. (paratype) **D** *Ateleute amarakaeri* sp. n. (paratype).

conspicuous, 0.45–0.55 times length of abscissa of *M* between 2*rs-m* and 2*m-cu* (Fig. 1B). Vein 2*m-cu* slightly inclivous with one bulla. *Cu-a* of fore wing a little distad of *Rs&M*, inclivous. Abscissa of Cu_1 between 1*m-cu* and Cu_{1a} inclivous, forming angle of 151° with Cu_1, 1.10–1.17 times length of Cu_{1b} (Fig. 5I). *M+Cu* of hind wing strongly arched. Hind wing with distal abscissa of Cu_1 pigmented. Cu_1&*cu-a* angled clearly below middle (Fig. 5K). Distal abscissa of 1*A* of hind wing very short, nearly absent. Tip of axillus very close to anal margin. Tibiae and tarsi with sparse stout bristles, stronger and denser on hind leg. Hind femur without stout bristles.

Metasoma. First tergite smooth and polished about 1.70–1.77 times as long as maximum width (Fig. 4D); its maximum width at apex about 2.80–3.40 times minimum width (at base). Median dorsal and dorsolateral carinae of first tergite absent, ventrolateral carinae more or less distinct posteriorly. Spiracle at anterior 0.41–0.43 of tergite. Tergite 2 0.78–0.90 times as long as maximum width, shiny, slightly coriaceous, with short and very sparse hairs; tergites 3–8 rather more densely pubescent. Thyridium transverse as short inconspicuous impressed and granulate furrow. Ovipositor sheath 0.55–0.57 times as long as hind tibia, very narrowly

truncate at apex (Fig. 3D). Ovipositor moderately slender and slightly down curved (Fig. 2E), its tip elongate lanceolate, nodus weak, its lower valve with three weak lateral ridges at apex.

Coloration (Fig. 2E). Head and mesosoma black to dark brown; central part of mandibles, scapus and pedicel below, metasoma except first tergite, front and middle femora, apex of hind coxa and trochanter, trochantellus, femur and tibia entirely, and ovipositor, reddish-brown. Base of mandible and teeth, flagellum, and all distal tarsomeres, brownish. Band on flagellomeres 5–11(12), palpi, front and mid coxa, trochanter, trochantellus and tegula, white. Fore and mid femora ventrally, tibiae and tarsi (except distal tarsomeres), base of hind coxa and trochanter, tarsus and base of first tergite, yellow. Ovipositor sheath brownish.

Male. Body length 3.2–3.8 mm, head length × width 0.3–0.4 × 0.6–0.7 mm, mesosoma length × width (mesoscutum) 0.9–1.1 × 0.3–0.4 mm, fore wing length 2.4–2.9 mm, flagellum 3.4–4.1 mm.

Head. Transverse, 0.51 times as long as wide, strongly narrowed behind eyes, gena slightly rounded (dorsal view). Antenna thin, filiform with 24–25 flagellomeres; flagellum longer than body, 1.30–1.40 times as long as fore wing (Fig. 8B), measures of flagellomeres different; basal half of flagellum slightly compressed. Mandible short, 2.14–2.30 times as long as its width at middle. Malar space about 0.44–0.60 times as long as basal width of mandible. Ocellar-ocular distance and distance between hind ocelli 1.00–1.20 and 1.43–1.80 times maximum diameter of lateral ocellus, respectively. Vertex slightly coriaceous, elevated above the eye level, abruptly folded behind hind ocelli in a vertical lower vertex, lower vertex and occiput smooth and shiny, slightly concave centrally.

Mesosoma. Pronotum smooth and shiny, slightly coriaceous. Mesopleuron coriaceous with short and sparse white hairs. Vein 2*rs-m* conspicuous, 0.45–0.47 times length of abscissa of *M* between 2*rs-m* and 2*m-cu*. Abscissa of Cu_1 between 1*m-cu* and Cu_{1a} inclivous, forming angle of 153° with Cu_1, 1.00–1.20 times length of Cu_{1b} (Fig. 5J). Hind wing with distal abscissa of Cu_1 pigmented. Cu_1&*cu-a* angled clearly below middle (Fig. 5L). Hind femur with 3–6 stout bristles on dorsal and ventral edge (Fig. 7B).

Metasoma. First tergite coriaceous punctate about 2.30–2.50 times as long as maximum width; maximum width at apex about 1.80 times minimum width (at base). Median dorsal carinae of first tergite absent, dorsolateral carina present anterior spiracle, ventrolateral carinae more or less distinct. Spiracle at anterior 0.45 of tergite. Thyridium weak, as a granulate, small and rounded depression. Claspers very narrow and pointed (Fig. 6B).

Coloration (Fig. 8B). Body brown; mandibles (except teeth), scapus and pedicel below, front and middle leg, yellowish. Hind femur red. Palpi, front trochanter, trochantellus, and hind tarsus (except distal tarsomere), whitish.

Taxonomic discussion. Females differ from *A. carolina, A. grossa* and *A. tinctoria* by their coloration: head and mesosoma black or dark brown and metasoma mostly reddish-brown. They differ from other South American species by their brownish ovipositor sheath which is very narrowly truncate at apex, nearly pointed; head 0.48–0.51

times as long as wide; antenna (except white band) brownish with 29–32 flagellomeres; first tergite 1.70–1.77 times as long as maximum width; abscissa of Cu_1 between 1*m-cu* and Cu_{1a} moderately inclivous, 1.10–1.17 times the length of Cu_{1b}; vein 2*rs-m* conspicuous, 0.45–0.55 times length of abscissa of *M* between 2*rs-m* and 2*m-cu*; vein 2*m-cu* inclivous; malar space about 0.80–0.86 times as long as basal width of mandible; hind wing with distal abscissa of Cu_1 strong and pigmented; Cu_1&*cu-a* strongly angled below middle; and body length 5.2–5.6 mm. Males can be recognized by the claspers, which have an inwardly curved profile dorsally, very narrow and pointed; vein 2*rs-m* present; hind femur with 3–6 stout bristles on dorsal and ventral edge and abscissa of Cu_1 between 1*m-cu* and Cu_{1a} inclivous, 1.00–1.20 times the length of Cu_{1b}.

Remarks. We have linked males and females of this species using the following characters: vein 2*rs-m* conspicuous, 0.45–0.55 times the length of abscissa of *M* between 2*rs-m* and 2*m-cu* (Figs 5I, J) and abscissa of Cu_1 between 1*m-cu* and Cu_{1a} inclivous, forming an angle of 151–153° with Cu_1, 1.0–1.20 times the length of Cu_{1b} (Figs 5I, J), hind wing with distal abscissa of Cu_1 pigmented and Cu_1&*cu-a* angled clearly below middle (Figs 5K, L). These characters in combination differ from those of other South American species.

Etymology. This species is dedicated to the Ecuadorian Shuar people, who live in the Department of Orellana, Ecuador.

Phenology. Adults fly in May-June and October-November.

Distribution. Ecuador and Peru.

Habitat. The holotype has been collected by canopy fogging in Onkone Gare, Department of Orellana, Ecuador, in the same habitat as *A. huaorani*.

Tamaulipeca Kasparyan, 2000

Tamaulipeca Kasparyan, 2000: 231. Type species: *Tamaulipeca clypeator* Kasparyan & Hernández, 2000.

Tamaulipeca bora sp. n.

urn:lsid:zoobank.org:act:68A5D7F0-C1E3-4AC6-974A-765060032942
http://species-id.net/wiki/Tamaulipeca_bora
Figs 1C, 1D, 9B, 9F, 9I

Material examined. Holotype: **PERU,** ♀, Dept. of Loreto, Iquitos area, Allpahuayo, 21.XII.2000-23.I.2001, clay, Sääksjärvi, I.E. et al. leg., Malaise trap, APHI, H2/18 (UNSM). **Paratypes: PERU** 1 ♀, same locality, 16.VII-2.VIII.2000, clay, Sääksjärvi, I.E. et al. leg., Malaise trap, APHI, H1/10 (UNSM); 1 ♀, same locality, 2–24.III.2000, white sand, Sääksjärvi, I.E. et al. leg., Malaise trap, APHI, G1/3 (ZMUT); 1 ♀, same locality, 18.VIII-14.IX.2000, clay, Sääksjärvi, I.E. et al. leg., Malaise trap, APHI, H2/12 (CEUA). **ECUADOR**, 1 ♀, Dept. of Orellana, Onkone Gare, 0°39'25.7"S, 76°27'10.8"W, Canopy fog., 216.3m, 3.VII.1995, T.L.Erwin et al. leg., Lot#1094 (USNM).

Description. *Female.* Body length (without ovipositor) 6–7 mm, head length × width 0.8–0.9 × 1.2–1.4 mm, mesosoma length × width (mesoscutum) 2.0 × 0.8–1.0 mm, length of ovipositor sheath 1.4 mm, fore wing length 4–5 mm, flagellum 6.6–7.8 mm.

Head. Transverse, 0.70 times as long as wide, strongly narrowed behind eyes, gena at same level as hind rim of eye (dorsal view). Antenna with 28–29 flagellomeres; flagellum slightly longer than body, 1.55–1.65 times as long as fore wing (Fig. 9B); its segments 1, 4, 7 and 12 (and most of following segments) about 9, 7, 3 and 1.10 times as long as wide, respectively; basal flagellar segments 1 to 9 compressed or slightly cylindrical and flagellomeres 10–11 and following depressed (flattened ventrally and this flattened area covered with short sensory setae); maximum width of flagellum about twice minimum width of first flagellomere; flagellum strongly tapered towards apex (Fig. 9B). Clypeus convex, almost triangular, with apex produced into acute point, about once as long as distance between clypeal foveae (Figs 1C, 9F). Mandible short, about 2 times as long as width at the middle, teeth with the lower tooth slightly longer. Malar space about 0.80–0.90 times as long as basal width of mandible (Fig. 9F). Occipital carina absent dorsally, ventrally joining hypostomal carina just before mandible. Ocellar-ocular distance and distance between hind ocelli 1.00 and 1.20 times maximum diameter of lateral ocellus, respectively. Face coriaceous, matt and with moderately long silvery hairs (Fig. 9F). Frons matt, coriaceous. Vertex slightly coriaceous, with very sparse short hairs, lower vertex and occiput centrally concave; gena slightly coriaceous, occiput and gena with scattered silvery hairs.

Mesosoma. Upper margin of pronotum not swollen. Lateral part of collar without carina. Pronotum coriaceous, laterally longitudinally strigose with sparse silvery hairs. Mesoscumum coriaceous, shiny, slightly strigose in the area between posterior end of notauli. Notauli reaching tegula level, convergent, strongly impressed and without clear transverse wrinkles along its length. Prescutelar groove with longitudinal wrinkles. Scutellum weakly coriaceous, with lateral carinae present only at anterior end of the scutellum. Mesopleurum coriaceous, with very dense punctures and white long hairs. Mesopleural fovea present far in front of mesopleural suture. Sternaulus present and reaching approximately middle length of mesopleurum. Metapleurum and propodeum densely punctate or rugose-punctate on a coriaceous background, with dense and whitish hairs. Posterior transverse carina of mesosternum complete (not interrupted in front of each middle coxa). Propodeum long, its spiracle round and very small. Anterior transverse carina absent. Posterior transverse carina present in the centre and in area posteroexterna, absent laterally, slightly undulating along its length. Median longitudinal carinae of propodeum absent; lateral longitudinal carina absent anterior to apical transverse carina, present distad. Pleural carina strong. Area petiolaris confluent with areas posteroexterna. Vein 2*rs-m* very short, about 0.20 length of *M* (Fig. 1D). Vein 2*m-cu* almost vertical and with one short bulla. *M+Cu* of hind wing strongly arched. Hind wing with distal abscissa of Cu_1 pigmented. Vein *cu-a* clearly shorter than abscissa of *Cu* between *M* and Cu_1 (Fig. 9I). Distad abscissa of 1*A* of hind wing short. Base of hind coxa of moderate depth, with a short transverse shallow groove next to its attachment. Tibiae and tarsi with sparse and stout bristles, bristles stronger on hind leg.

Metasoma. First tergite smooth, polished, very slightly coriaceous and about twice as long as maximum wide; its maximum width at apex about 3 times minimum width

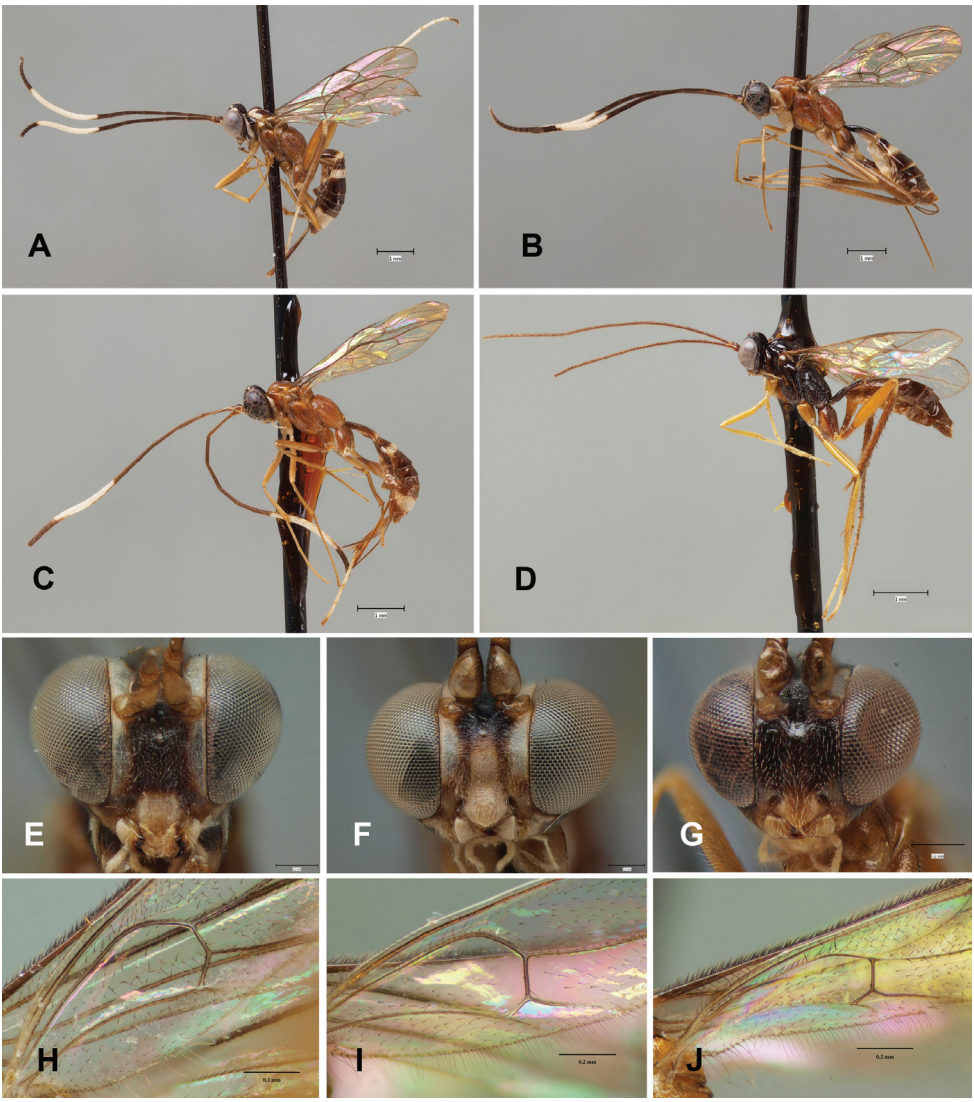

Figure 9. *Tamaulipeca* spp.: **A** *T. candoshi* sp. n., habitus, lateral, ♀ (holotype) **B** *T. bora* sp. n., habitus, lateral, ♀ (paratype) **C** *T. matses* sp. n., habitus, lateral, ♀ (holotype) **D** *Tamaulipeca* sp., habitus, lateral, ♂ **E** *T. candoshi* sp. n., face, frontal, ♀ **F** *T. bora* sp. n., face, frontal, ♀ **G** *T. matses* sp. n., face, frontal, ♀ **H** *T. candoshi* sp. n., hind wing, ♀ **I** *T. bora* sp. n., hind wing, ♀ **J** *T. matses* sp. n., hind wing, ♀.

(at base). Median dorsal and dorsolateral carinae of first tergite absent, ventrolateral carinae more or less distinct posteriorly. Spiracle at mid length of first tergite. Tergites 2-3 smooth and polished, laterally with short, sparse hairs; tergites 4-8 rather densely pubescent. Thyridium present as short impressed and granulate furrow. Ovipositor sheath about 0.50 times as long as hind tibia, truncate at apex. Ovipositor moderately slender and slightly down curved (Fig. 9B), its tip elongate lanceolate, nodus weak, its lower valve with a few weak and oblique ridges at apex.

Coloration (Fig. 9B). Head blackish with mandibles (except of brown teeth), palpi, clypeus, face, gena and orbits mostly white or creamy white. Antenna dark brown with scape whitish and broad white band on flagellar segments 7–16. Mesosoma reddish with whitish marks on anterior side of pronotum and subtegular area. Legs mostly creamy whitish to light brown with darker brown coloration in hind coxa, trochanter and trochantellus of mid and hind leg, and all distal tarsomeres. Metasoma dark brown with broad whitish bands on hind edges of tergites 1-3 and with a very narrow apical whitish band on other tergites, except the seventh, which is entirely brown. Ovipositor sheath dark brown, ovipositor yellowish.

Male. Unknown.

Taxonomic discussion. This species differs from all other species of the genus by the following characters in combination: mesoscutum and scutellum reddish, without white V-shaped marks; face with broad white orbits; metasoma dark brown with broad whitish bands on hind edges of tergites 1-3 and with a very narrow apical whitish band on other tergites except the seventh, which is entirely brown; and hind wing vein *cu-a* clearly shorter than abscissa of *Cu* between *M* and Cu_1.

Remarks. There is some variation especially in the coloration of the face (some specimens have a slightly darker face).

Etymology. This species is dedicated to the Peruvian Amazonian Bora people, who live in the vicinity of the type locality (Department of Loreto, Peru).

Phenology. Adults fly in July-August and December-January.

Distribution. Ecuador and Peru.

Habitat. The Peruvian type locality (the National Reserve of Allpahuayo-Mishana) of *T. bora* sp. n. is situated in a complex mosaic of different kinds of rain forest types (e.g. Sääksjärvi et al. 2004). In flat low-lying areas, soils are often clayey in texture, relatively rich in nutrients, and mainly brownish-grey in colour. Soils on hilltops are often composed of so-called white sand, which is of quartzitic mineralogy, very nutrient poor, and grey to white in colour. Also loamy soils of intermediate nutrient content occur in the area. *Tamaulipeca bora* has been collected by Malaise trapping in rain forests growing on both white sand (one paratype) and clayish soils (holotype and 2 paratypes). One paratype has been collected by canopy fogging in Onkone Gare, Department of Orellana, Ecuador, in the same habitat as *A. huaorani*.

***Tamaulipeca candoshi* sp. n.**
urn:lsid:zoobank.org:act:8E6F39B5-A7E5-4BE0-BCB4-BFCF94D9EDA4
http://species-id.net/wiki/Tamaulipeca_candoshi
Figs 9A, 9E, 9H

Material examined. Holotype: **ECUADOR,** ♀, Dept. of Orellana, Onkone Gare, 0°39'25.7"S, 76°27'10.8"W, Canopy fog., 216.3m, 29.VI.1994, T. L. Erwin et al. leg., Lot#757 (USNM).

Description. *Female.* Body length (without ovipositor) 5.0 mm, head length × width 0.8 × 1.2 mm, mesosoma length × width (mesoscutum) 2.4 × 0.7 mm, length of ovipositor sheath 1.8 mm, fore wing length 4.1 mm, antenna broken.

Head. Transverse, 0.40 times as long as wide, strongly narrowed behind eyes, gena at same level as hind rim of eye (dorsal view). Antenna broken; its segments 1, 4, 7 and 12 (and most of following segments) about 7.40, 5.00, 2.00 and 1.10 times as long as wide, respectively; basal flagellar segments 1 to 6 compressed or slightly cylindrical and flagellomere 7 and following depressed (flattened ventrally and this flattened area covered with short sensory setae); maximum width of flagellum about twice minimum width of first flagellomere; flagellum strongly tapered towards apex (Fig. 9A). Clypeus convex, almost triangular, with apex produced into acute point, about once as long as distance between c1ypeal foveae (Fig. 9E). Mandible short, about twice as long as width at middle, lower tooth slightly longer than upper tooth. Malar space about 0.70 times as long as basal width of mandible (Fig. 9E). Occipital carina absent dorsally, ventrally joining hypostomal carina just before mandible. Ocellar-ocular distance and distance between hind ocelli about once maximum diameter of lateral ocellus. Face coriaceous, matt and with moderately long silvery hairs (Fig. 9E). Frons matt, coriaceous. Vertex slightly coriaceous, with very sparse short hairs, lower vertex and occiput centrally concave; gena slightly coriaceous, occiput and gena with scattered silvery hairs.

Mesosoma. Upper margin of pronotum not swollen. Lateral part of collar without carina. Pronotum coriaceous, laterally slightly longitudinally strigose and with sparse silvery hairs. Mesoscumum coriaceous, slightly shiny, not strigose in the area between posterior end of notauli. Notauli reaching tegula level, convergent, strongly impressed and without clear transverse wrinkles along its length. Prescutelar groove with short longitudinal wrinkles. Scutellum weakly coriaceous, with lateral carinae present only at anterior end of the scutellum. Mesopleurum coriaceous, with very dense punctures and white long hairs. Mesopleural fovea present far in front of mesopleural suture. Sternaulus inconspicuous. Metapleurum and propodeum densely punctate or rugose-punctate on a coriaceous background, with dense whitish hairs. Posterior transverse carina of mesosternum complete (not interrupted in-front of each middle coxa). Propodeum long, its spiracle round and very small. Anterior transverse carina absent. Posterior transverse carina present in the centre and in area posteroexterna, absent laterally, very slightly undulating along its length. Propodeum with short transverse carinae just before mid-length of the propodeum. Median longitudinal carinae of propodeum absent; lateral longitudinal carina absent anterior to posterior transverse carina, present behind it. Pleural carina strong. Area petiolaris confluent with areas posteroexterna. Vein 2*rs-m* short, about 0.40 length of M. Vein 2*m-cu* almost vertical and with one short bulla. *M+Cu* of hind wing strongly arched. Hind wing with distal abscissa of Cu_1 strongly pigmented. Vein *cu-a* about same length as abscissa of *Cu* between *M* and Cu_1 (Fig. 9H). Distad abscissa of 1*A* of hind wing short. Base of hind coxa of moderate depth, with a short transverse shallow groove next to its attachment. Tibiae and tarsi with sparse and stout bristles, bristles stronger on hind leg.

Metasoma. First tergite smooth, polished and about 1.70 times as long as maximum width; its maximum width at apex about 3.00 times minimum width (at base). Median dorsal and dorsolateral carinae of first tergite absent, ventrolateral carinae more or less distinct posteriorly. Spiracle at mid length of first tergite. Tergites 2-3 smooth and polished, laterally with short, sparse hairs; tergites 4-8 rather densely pubescent. Thyridium present as short impressed and granulate furrow. Ovipositor sheath 0.74 times as long as hind tibia, truncate at apex. Ovipositor moderately slender and slightly down curved (Fig. 9A), its tip elongate lanceolate, nodus weak, its lower valve without oblique ridges at apex.

Coloration (Fig. 9A). Head dark brownish with mandibles (except of brown teeth), palpi, clypeus mostly white or creamy white; orbits broadly whitish and gena with whitish spots. Antenna dark brown with scape yellowish and broad white band on flagellar segments 7–18. Mesosoma reddish with pronotum, mesoscutum and scutellum brown; pronotum with anterior edge broadly white, mesoscutum with 2 broad V-shaped marks and scutellum with white V-shaped mark. Legs mostly light brown with darker lighter coloration mostly in trochanters and hind tarsi. Metasoma dark brown with broad whitish bands on hind edges of tergites 1-2 and with a very narrow apical whitish band on tergites 4-6; tergite 7 whitish. Ovipositor sheath dark brown, ovipositor yellowish.

Male. Unknown.

Taxonomic discussion. This species differs from all other species of the genus by the following characters in combination: mesoscutum and scutellum brown, with white V-shaped marks; metasoma dark brown with broad whitish bands on hind edges of tergites 1-2 and with a very narrow apical whitish band on tergites 4-6, tergite 7 whitish; and hind wing vein *cu-a* of about same length as abscissa of *Cu* between *M* and Cu_1.

Etymology. This species is dedicated to the Ecuadorian Candoshi people, who live in the Department of Orellana, Ecuador.

Phenology. Only one specimen is known, collected in June.

Distribution. Ecuador.

Habitat. The holotype was collected by canopy fogging in Onkone Gare, Department of Orellana, Ecuador, in the same habitat as *A. huaorani*.

***Tamaulipeca matses* sp. n.**
urn:lsid:zoobank.org:act:54BD46F5-E319-4254-87EC-15C87242E39A
http://species-id.net/wiki/Tamaulipeca_matses
Figs 9C, 9G, 9J

Material examined. Holotype: **PERU**, ♀, Dept. of Loreto, Iquitos area, Allpahuayo, 1.XII.2000-21.XII.2000, clay, Sääksjärvi, I.E. et al. leg., Malaise trap, APHI, H2/17 (USMN). **Paratype:** PERU, 1 ♀, same locality, 15.X.2000–8.XI.2000, clay, Sääksjärvi, I.E. et al. leg., Malaise trap, APHI, J2/15 (ZMUT).

Description. *Female.* Body length (without ovipositor) 4.3–4.5 mm, head length × width 0.6–0.8 × 0.9–1.1 mm, mesosoma length × width (mesoscutum) 1.8 × 0.5–

0.6 mm, length of ovipositor sheath 1.2–1.4 mm, fore wing length 3.0–3.7 mm, antenna broken.

Head. Transverse, 0.60–0.70 times as long as wide, strongly narrowed behind eyes, gena at same level as hind rim of eye (dorsal view). Antenna broken (in both holo- and paratype female); its segments 1, 4, 7 and 12 (and most of following segments) about 7.70, 6.60, 2.5 and 1.10 times as long as wide, respectively; basal flagellar segments 1 to 9 compressed or slightly cylindrical and flagellomeres 10–11 and following depressed (flattened ventrally and this flattened area covered with short sensory setae); maximum width of flagellum about twice minimum width of first flagellomere; flagellum strongly tapered towards apex (Fig. 9C). Clypeus convex, almost triangular, with apex produced into acute point, about once as long as distance between clypeal foveae (Fig. 9G). Mandible short, about 2 times as long as its width at the middle (Fig. 9G), lower tooth slightly longer than upper tooth. Malar space about 0.80 times as long as basal width of mandible (Fig. 9G). Occipital carina absent dorsally, ventrally joining hypostomal carina just beyond mandible. Ocellar-ocular distance and distace between hind ocelli about once maximum diameter of lateral ocellus. Face coriaceous, matt and with moderately long silvery hairs (Fig. 9G). Frons matt, coriaceous. Vertex slightly coriaceous, with very sparse short hairs, lower vertex and occiput centrally concave; gena slightly coriaceous, occiput and gena with scattered silvery hairs.

Mesosoma. Upper margin of pronotum not swollen. Lateral part of collar without carina. Pronotum granulate, laterally not longitudinally strigose and with sparse silvery hairs. Mesoscumum coriaceous, slightly shiny, not strigose in the area between posterior end of notauli. Notauli reaching tegula level, convergent, strongly impressed and without clear transverse wrinkles along its length. Prescutelar groove with short longitudinal wrinkles. Scutellum weakly coriaceous, with lateral carinae present only at anterior end of the scutellum. Mesopleurum granulate, with very dense punctures and white long hairs. Mesopleural fovea present far in front of mesopleural suture. Sternaulus inconspicuous. Metapleurum and propodeum densely punctate or rugose-punctate on a coriaceous background, with dense whitish hairs. Posterior transverse carina of mesosternum complete (not interrupted in-front of each middle coxa). Propodeum long, its spiracle round and very small. Anterior transverse carina absent. Posterior transverse carina present in centre and in area posteroexterna, absent laterally, very slightly undulating along its length. Propodeum with short transverse carinae just before mid-length. Median longitudinal carinae of propodeum absent; lateral longitudinal carina absent anterior to posterior transverse carina, present behind it. Pleural carina strong. Area petiolaris confluent with areas posteroexterna. Vein 2*rs-m* very short, about 0.20 length of *M*. Vein 2*m-cu* almost vertical and with one short bulla. *M+Cu* of hind wing strongly arched. Hind wing with distal abscissa of Cu_1 pigmented. Vein *cu-a* clearly shorter than abscissa of *Cu* between *M* and Cu_1 (Fig. 9J). Distad abscissa of 1*A* of hind wing short. Base of hind coxa of moderate depth, with a short transverse shallow groove next to its attachment. Tibiae and tarsi with sparse and stout bristles, bristles stronger on hind leg.

Metasoma. First tergite smooth, polished, very slightly coriaceous and about 1.70 times as long as maximum width; its maximum width at apex about 3.00 times mini-

mum width (at base). Median dorsal and dorsolateral carinae of first tergite absent, ventrolateral carinae more or less distinct posteriorly. Spiracle at mid length of first tergite. Tergites 2-4 smooth and polished, laterally with short, sparse hairs; tergites 5-8 rather densely pubescent. Thyridium present as short impressed and granulate furrow. Ovipositor sheath about 0.60 times as long as hind tibia, truncate at apex. Ovipositor moderately slender and slightly down curved (Fig. 9C), its tip elongate lanceolate, nodus weak, its lower valve without oblique ridges at apex.

Coloration (Fig. 9C). Head dark brownish with mandibles (except of brown teeth), palpi and clypeus mostly white or creamy white. Antenna dark brown with broad white band on flagellar segments 7-14. Mesosoma reddish with whitish marks on anterior side of pronotum and subtegular area. Legs mostly light brown with darker lighter coloration mostly in trochanters and hind femur, tibia and distal tarsomere. Metasoma dark brown with broad whitish bands on hind edges of tergites 1-2 and with a very narrow apical whitish band on tergites 4-6; tergite 7 whitish. Ovipositor sheath dark brown, ovipositor yellowish.

Male. Unknown.

Taxonomic discussion. This species differs from all other species of the genus by the following characters in combination: mesoscutum and scutellum reddish, without white V-shaped marks; face without white orbits; metasoma dark brown with broad whitish bands on hind edges of tergites 1-2 and with a very narrow apical whitish band on tergites 4-6, tergite 7 whitish; and hind wing vein *cu-a* shorter than abscissa of *Cu* between *M* and Cu_1.

Etymology. This species is dedicated to the Peruvian Matses people, who live in the Department of Loreto, Peru.

Phenology. Adults fly from October to December.

Distribution. Peru.

Habitat. This species occurs in the National Reserve of Allpahuayo-Mishana, in a rain forests growing on clayish soils (see habitat notes of *T. bora*).

***Tamaulipeca* sp.**

Fig. 9D

Material examined. ECUADOR, 1 ♂, Dept. Orellana, Tiputini, 0°37'55.7"S, 76°8'39"W, Canopy fogging, 220–250 m., 6.II.1999, T. L. Erwin et al. Lot.1802 (USNM).

Male. Body length about 3.4 mm, head length × width 0.6 × 0.9 mm, mesosoma length × width (mesoscutum) 1.4 × 0.5 mm, fore wing length 3.5 mm, flagellum 5.0 mm.

Head. Transverse, 0.70 times as long as wide, strongly narrowed behind eyes, gena slightly rounded (dorsal view). Antenna with 25 flagellomeres; flagellum longer than body, 1.40 times as long as fore wing (Fig. 9D). Clypeus convex, triangular, pointed at apex. Mandible about twice as long as width at middle, teeth equal (upper tooth slightly broken). Malar space about 0.40 times as long as basal width of mandible. Occipital carina absent dorsally, ventrally joining hypostomal carina before mandible.

Ocellar-ocular distance and distance between hind ocelli 1.0 and 1.40 times maximum diameter of lateral ocellus, respectively. Face finely coriaceous, with sparse setiferous punctures, the hairs short and silvery. Frons finely coriaceous and shiny. Vertex slightly coriaceous, elevated above the eye level, abruptly folded behind hind ocelli in a vertical lower vertex, lower vertex and occiput smooth and shiny, deeply concave in the centre; gena shiny, slightly coriaceous, hairless in upper half, with silvery hairs in lower part.

Mesosoma. Upper margin of pronotum not swollen. Lateral part of collar without carina. Pronotum slightly coriaceous, shortly longitudinally strigose on lower hind corner. Mesoscutum slightly coriaceous, shiny. Notauli reaching tegula level, convergent. Prescutelar groove almost smooth, at most with very weak longitudinal wrinkles. Scutellum slightly coriaceous, with lateral carinae present only at anterior end. Mesopleuron coriaceous with short and sparse white hairs. Sternaulus slightly impressed anteriorly. Mesopleural fovea represented by a weak impression far in front of mesopleural suture. Metapleuron punctate or rugulose-punctate on a slightly coriaceous background, with short whitish hairs. Propodeum long, granulate, its spiracle round and very small. Anterior transverse carina absent. Posterior transverse carina present in the centre, absent laterally. Median longitudinal carinae of propodeum absent, lateral longitudinal carina almost absent, only present prior to posterior transverse carina. Pleural carina strong. Areolet completely absent, without any trace of 3*rs-m* unpigmented. Hind wing with distal abscissa of Cu_1 pigmented. Vein *cu-a* shorter than abscissa of *Cu* between *M* and Cu_1. Distad abscissa of 1*A* of hind wing present but not complete. Tibiae and tarsi with sparse stout bristles, stronger and denser on hind leg. Hind femur with some stout bristles on dorsal and ventral edge.

Metasoma. First tergite smooth and polished, about 2.20 times as long as width, laterally with isolated short silvery hairs. Median dorsal carinae of first tergite absent, dorsolateral carinae present at base, ventrolateral carinae present at middle. Spiracle at anterior 0.4 of first tergite. Tergite 2 shiny and slightly coriaceous, with short and very sparse hairs laterally. Tergites 3-8 coriaceous, rather densely pubescent. Thyridium weak, present as a weak transverse and yellowish depression. Claspers slightly triangular at apex, however, apex widely, not narrowly, pointed.

Coloration (Fig. 9D). Blackish to dark brown. Mandibles, palpi, front and mid legs, hind femora and tarsi (except distal tarsomeres) from orange to light yellowish. Second and third tarsomeres of middle and hind tarsi whitish. Wings clear with veins and pterostigma dark brown.

Remarks. We have not been able to link this male with any of the *Tamaulipeca* females we have seen. It seems that the male is not *T. candoshi* as hind wing vein *cu-a* is shorter than the abscissa of *Cu* between *M* and Cu_1.

Habitat. The specimen was collected by canopy fogging in Tiputini, Department of Orellana, Ecuador. Vegetation at the site is old and diverse primary rain forest growing on relatively nutrient-rich soils.

Acknowledgements

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RESEARCH ARTICLE

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Hyperparasitoid wasps (Hymenoptera, Trigonalidae) reared from dry forest and rain forest caterpillars of Area de Conservación Guanacaste, Costa Rica

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Abstract

Five species of Trigonalidae, hyperparasitoids of Ichneumonidae (Hymenoptera) and Tachinidae (Diptera) that parasitize caterpillars (Lepidoptera), have been reared during the ongoing caterpillar inventory of Area de Conservación Guanacaste (ACG), Guanacaste Province, northwestern Costa Rica: *Lycogaster apicipennis* (Cameron), *Taeniogonalos woodorum* Smith**, sp. n.**, *Taeniogonalos fasciatipennis* (Cameron), *Trigonalys championi* Cameron, and *Trigonalys maculifrons* Sharp. Morphological and DNA barcoding data support species separation of these generalist hyperparasitoids. *Taeniogonalos gundlachii* (Cresson) is not a widespread, color-variable species as previously treated and is probably confined to eastern North America. The species previously considered as *T. gundlachii* in Costa Rica is regarded as *Taeniogonalos fasciatipennis*, a species found only in ACG dry forest. *Taeniogonalos woodorum* is a similar species but found only in the ACG rain forest. Habitat and host records are given for these five species of trigonalids.

Keywords
Central America, hyperparasitoid host specificity, Lepidoptera, Diptera, DNA barcoding, tropical trophic web

Introduction

Trigonalid wasps are usually hyperparasitoids, parasitizing Ichneumonidae (Hymenoptera) and Tachinidae (Diptera) larvae that parasitize Lepidoptera caterpillars, or they are parasitoids of the larvae of social or possibly solitary wasps (Weinstein and Austin 1991, Carmean 1991, Carmean and Kimsey 1998, Murphy et al. 2009). Some species also have been recorded as primary parasitoids of sawflies in Australia (Raff 1934, Carne 1969, Weinstein and Austin 1995). Trigonalids lay numerous eggs on foliage. For larval development, it is believed the eggs must be consumed by a caterpillar that is already parasitized. The egg hatches in the caterpillar gut, and the first-instar hyperparasitoid finds its way to the primary parasitoid larva inside the caterpillar, in turn developing inside the primary parasitoid larva (Carmean 1991).

Ten species in six genera of Trigonalidae have been recorded from Costa Rica (Carmean and Kimsey 1998). Little has been published on the hosts and biology of these species. Of the ten, five have been reared from parasitoids of caterpillars during the ongoing 34-year caterpillar inventory of Area de Conservación Guanacaste (ACG) in Guanacaste Province in northwestern Costa Rica (Janzen 2000, 2001; Janzen and Hallwachs 2001; Janzen et al. 2009). Although trigonalids are routinely captured in Malaise traps for flying insects, the only known method to obtain host records is through mass rearing of wild-caught caterpillars as is being done by the ACG caterpillar inventory (Janzen et al. 2009). As of 2010, the ACG caterpillar inventory has yielded 246 trigonalid rearings from 490,000 wild-caught caterpillars (0.05% hyperparasitization frequency).

The major identification problem among the reared species is that which appears morphologically to be the color-variable and widespread species *Taeniogonalos gundlachii* (Cresson). This has been considered to be a single species, known from southeastern Canada to Cuba and Central America, following the synonymy by Carmean and Kimsey (1998) of *Taeniogonalos costalis* (Cresson) (eastern Canada and USA) under *T. gundlachii* (described from Cuba). We show that specimens reared in Costa Rica are a distinct species, *Taeniogonalos fasciatipennis* (Cameron), and should not be synonymized with the species known in eastern North America.

Here, we present morphological and DNA analysis evidence for the distinctiveness of the five reared species, one of which is new, and offer rearing records and hosts.

Materials and methods

Images were obtained using an EntoVision Imaging Suite that included a firewire JVC KY-75 3CCD digital camera mounted to a Leica M16 zoom lens via a Leica z-step

microscope stand. Multiple focal planes were merged using Cartograph 5.6.0 (Microvision Instruments, France) software.

Acronyms used are: The Natural History Museum, London, UK (BMNH); Canadian National Collection of Insects, Ottawa (CNC); Instituto Nacional de Biodiversidad, Santo Domingo de Heredia, Costa Rica (INBio), National Museum of Natural History, Smithsonian Institution, Washington, D.C., USA (USNM). Other specimens examined in this study were kindly loaned from the Florida State Collection of Arthropods, Gainesville, FL, USA, and the collection of N. M. Schiff, Stoneville, MS, USA.

In the Costa Rican ACG inventory, each reared adult receives one voucher code, and often a second. The invariant voucher code of the form "99-SRNP-4597" (year-Santa Rosa National Park-unique rearing number) is unique for the event of finding and rearing the caterpillar, irrespective of what it produces. The entire rearing record may be obtained by searching with this code at http://janzen.bio.upenn.edu/caterpillars/database.lasso. If a hyperparasitoid wasp is DNA barcoded or otherwise treated as an individual (a "daughter specimen" of the SRNP rearing event) it is assigned a second unique voucher code of the form DHJPAR0034526 which applies only to that individual. This voucher code may be used to obtain the entire caterpillar (and wasp) rearing record from the same website and as described in Janzen (2000, 2001), Janzen et al. (2009), and Burns and Janzen (2001).

When rearing wild-caught caterpillars in the ACG inventory, wasp cocoons and tachinid fly puparia are routinely obtained and held for adult wasp and fly eclosion. There is no way to know if the wild-caught caterpillar has primary parasitoids in it, or if they in turn are hyperparasitized. Usually, primary parasitoids that are uninfected and emerge from a single caterpillar (or pupate in a caterpillar or pupal mummy) eclose during a 1–3 day period after 1–3 weeks (with a few exceptional univoltine species of primary parasitoids remaining dormant for 10–12 months). If the pupae inside these wasp cocoons or fly puparia contain a hyperparasitoid (Trigonalidae, Perilampidae, Eulophidae, or Ichneumonidae), this insect tends to eclose a few days to weeks after the eclosion of the primary parasitoid. This delay necessitates retaining and continuing to observe "dead" primary parasitoid wasp cocoons and tachinid puparia. This is especially the case if there are, for example, five tachinid puparia from one caterpillar and three of them produce tachinid flies; the remaining two are usually dead "of disease" but on rare occasions produce a trigonalid or other hyperparasitoids.

Eclosed trigonalids were killed by freezing, as are other ACG inventory insects, pinned, labeled with the above-described yy-SRNP-xxxxx label, stored frozen, and then oven-dried (40–55°C). In the University of Pennsylvania clearing center, one leg was removed and couriered to the Biodiversity Institute of Ontario (BIO) at the University of Guelph for DNA extraction, barcode amplification, and accessioning in the Barcode of Life Data System (www.boldsystems.org). At this time the leg and the corresponding specimen also received the second above-mentioned DHJPARxxxxxx voucher code, which was used in all DNA barcode analyses of ACG parasites and parasitoids. If the wasp is very small, it may be collected into 95% ethanol for refrigerated storage instead of pinned and oven-dried. This treatment of hyperparasitoids by the

inventory does not differ from that of primary parasitoids, except that more patience is required in waiting longer for hyperparasitoids to eclose.

Field identification (and later corroboration) of the host caterpillar is done by the inventory parataxonomists, later by DHJ and WH as inventory coordinators, using photographs, host remains, food plants, and microgeographic characters of caterpillars. Laboratory identification of the primary parasitoid remains was done by DHJ using intense familiarity and photographs and reference specimens with the parasitoids and their body parts (cocoons, pupae, puparia) as well as ecological information such as the identity of siblings that were not hyperparasitized. Nearly all reared parasitoids were also DNA barcoded to tease out cryptic species complexes (e.g., Smith et al 2006, 2007, 2008). Identification of the hyperparasitoid adults was achieved through all of these methods plus morphological and DNA barcode inspection of the adults by the inventory personnel and by collaborating taxonomists.

DNA extracts for 201 trigonalid specimens were prepared from single legs using a glass fibre protocol (Ivanova et al. 2006). After a re-suspension in 30 µl of dH_2O, a 658-bp region near the 5' terminus of the COI gene was amplified using primers (LepF1–LepR1) following standard (Ivanova et al. 2006) protocols. When initial amplification was not successful, composite sequences were generated using internal primers (300 bp near 5' of barcode region: LepF1/C_ANTMR1D, 400 bp near middle to 3' of barcode region: MLepF1/LepR1 and/or RonMWASPDeg_t1/LepR1). COI sequence divergences were calculated using the K2P distance model and a NJ tree of K2P distance was created to provide a graphic representation of the among-species divergences. Full details of methodology are as in (Smith et al. 2007, Smith et al. 2008). All sequence data are available on BOLD (www.boldsystems.org) in the projects called: "ACG Trigonalidae- in progress" (ASTR) and "ACG Hyperparasitoids compared to North America" (ASHYZ). All sample accessions (DHJPAR sample number, BOLD COI process ID and GenBank Accession) can be found in Supporting Information File 1.

Results

General

Five species of trigonalids are recognized from the ACG rearings. DNA barcoding suggests the existence of four entities (Figs 1, 2) of *Taeniogonalos* within the ACG. *Taeniogonalos woodorum*, occurring only in ACG rain forest, is clearly distinct genetically and morphologically from the others and is here described as new. We find *Taeniogonalos fasciatipennis* from the lowland dry forest to be distinct from the eastern North American *T. gundlachii*. Although there is genetic evidence for separation of T. *fasciatipennis* into two species, we treat them here as one, but suggest that further research will reveal that this single name covers two species, here called *T.* fasciatipennisDHJ001 from the driest parts of lowland dry forest and *T.* fasciatipennisDHJ002

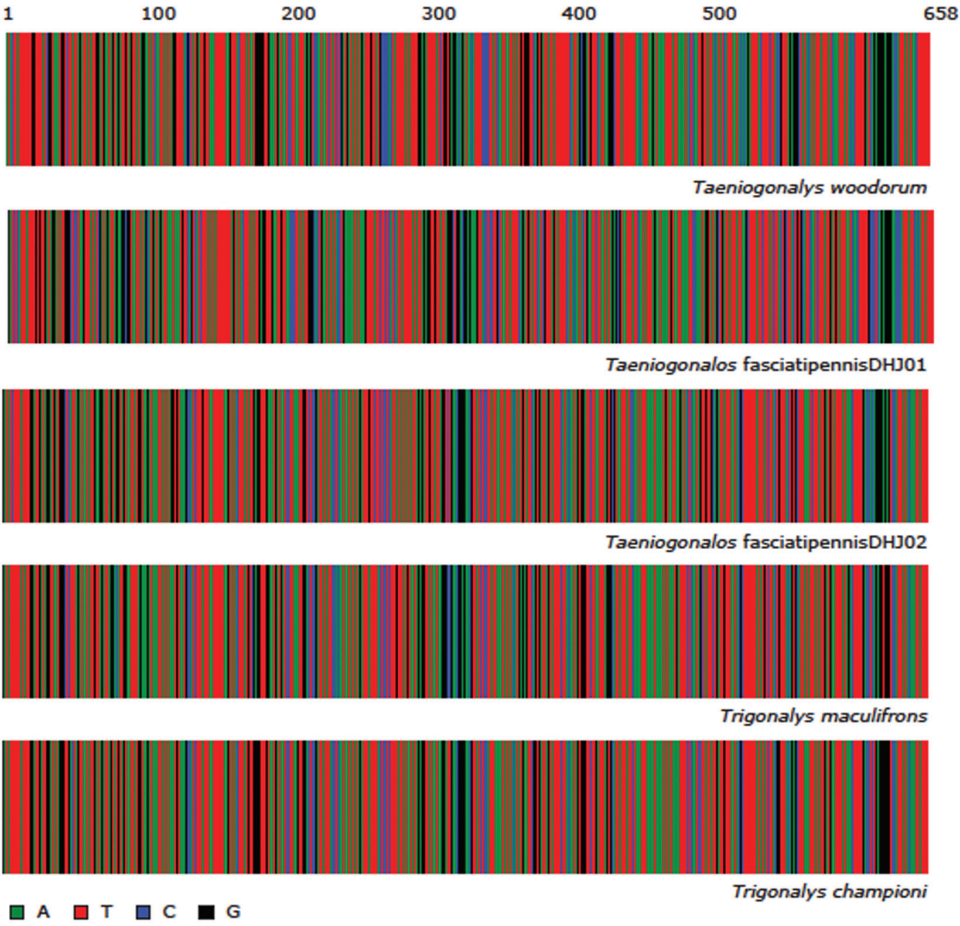

Figure 1. Color representation of the full length (658 base pairs (bp)) DNA barcodes for each of the 5 ACG trigonalid species. Intra-specific variation in the barcode region is represented by vertical bands in the color bar at that position.

from the upper, cooler, and more moist portion of the lowland dry forest (see discussion under *T. fasciatipennis*).

The very low percent yield (0.05%) of trigonalid wasps from wild-caught ACG caterpillars is partly generated by the natural history observation that trigonalids are usually not hyperparasitoids of primary parasitoids of leaf-rolling and leaf-tier caterpillars (Pyralidae, Thyrididae, Crambidae, Elachistidae, Tortricidae, etc.), which make up at least 20% of the caterpillars sampled and largely live their lives inside of leaf rolls. In other words, if just the more exposed caterpillars of the inventory are taken into account, the percent yield of trigonalids increases to (0.07%).

The inventory has to date logged about 47,000 parasitized caterpillars (9.6% parasitization frequency), and 0.59% of these yielded one or more trigonalid wasps. How-

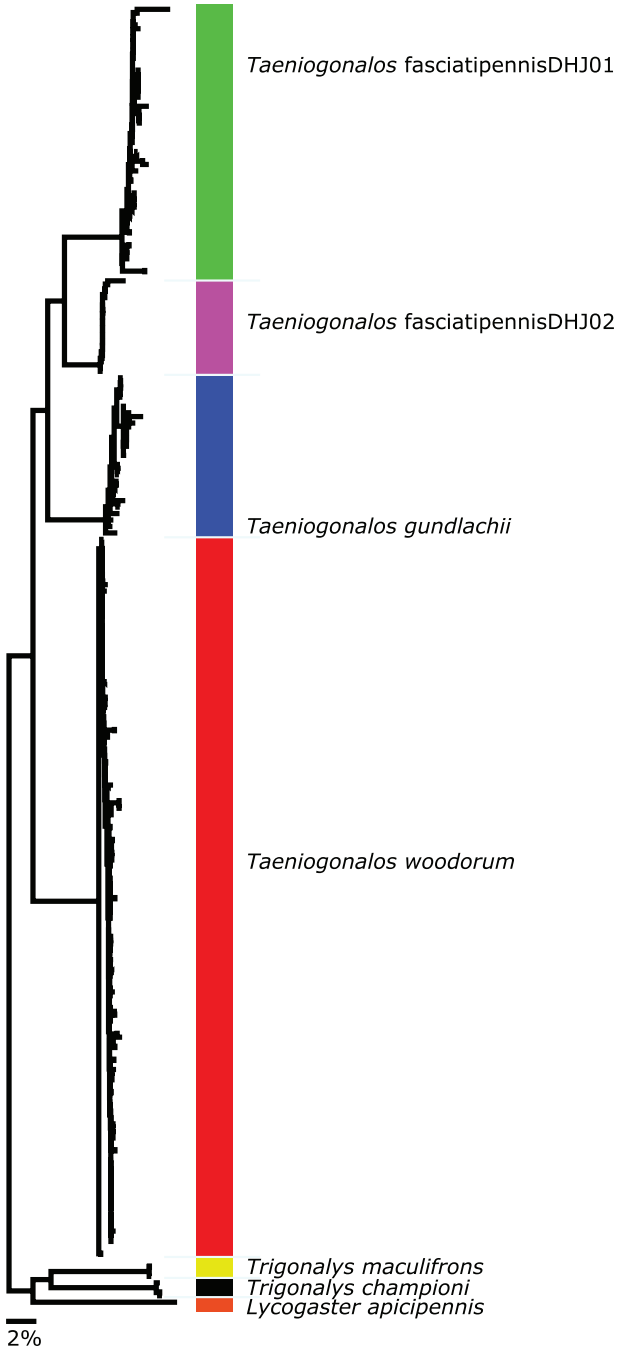

Figure 2. A neighbor-joining tree (NJ) built using Kimura 2 Parameter distance and including 201 sequenced trigonalid specimens from the ACG and North America that have COI sequence greater than 200 bp. Note the divergence between the ACG *Taeniogonalos* and the North American specimens – and within the dry forest *Taeniogonalos* fasciatipennisDHJ01 and *Taeniogonalos* fasciatipennisDHJ02 – all are clearly differentiated by mitochondrial DNA.

ever, 15,000 of these were attacked by Eulophidae and Microgastrinae Braconidae) generally too small to support the much larger trigonalid larva. For the remaining primary parasitoids (Diptera and Hymenoptera), the hyperparasitization frequency was 0.86%.

The Trigonalidae rearing experience to date shows almost no examples of sharing primary parasitoids hosts with other hyperparasitoids (Perilampidae, *Mesochorus* in the Ichneumonidae, Eulophidae, and Chalcididae). That is to say, when a clutch of tachinid puparia or microgastrine braconid cocoons produce a trigonalid wasp(s), that is the only hyperparasitoid that emerges from this clutch of primary parasitoids except in one case of sharing with a perilampid (83-SRNP-1127.2) and one case of sharing with a chalcidid (83-SRNP-1432).

Trigonalidae identification by morphology alone is made complicated by as much as 20 times variation in body weight of conspecifics, owing to the body size being determined in great part by the body size of the primary parasitoid host larva. DNA barcoding, however, of the ACG reared trigonalids has demonstrated unambiguously that specimens of this huge size range, from the same place in ACG, are the same species.

In the future, it may be possible to determine the primary parasitoid host of a wild-caught adult trigonalid through DNA barcoding of its gut content (e.g., Rougerie et al. 2011, Hrcek et al. 2011). In this case, specific primers can be designed that will ignore the DNA of the primary and secondary hosts of the hyperparasitoid and amplify the DNA of the hyperparasitoid.

The Costa Rican species of Trigonalidae

Keys to Central American and Neotropical genera of Trigonalidae were provided by Carmean (1995, 2006a, 2006b). The species recorded from Costa Rica are as follows (from Carmean and Kimsey 1998); an asterisk indicates that the species has been reared in ACG.

**Lycogaster apicipennis* (Cameron, 1897).

Nomadina smithii Westwood, 1868. Described from "Amaz." Recorded from Costa Rica by Carmean and Kimsey (1998).

Seminota depressa (DeGeer, 1773). Recorded from Brazil, Bolivia, Peru, Costa Rica by Carmean and Kimsey (1998).

Seminota laeviceps (Cresson, 1879). Described from Mexico. Recorded from Costa Rica, Panama by Carmean and Kimsey (1998).

**Taeniogonalos fasciatipennis* (Cameron, 1897).

**Taeniogonalos woodorum* (described below).

Taeniogonalos ornata (Smith, 1861). Recorded from Mexico and Costa Rica by Carmean and Kimsey (1998).

**Trigonalys championi* Cameron, 1897.

**Trigonalys maculifrons* Sharp, 1895.

Xanthogonalos robertibuyssoni Schulz, 1907. Described from Mexico. Recorded from Costa Rica by Carmean and Kimsey (1998).

Species reared

***Lycogaster apicipennis* (Cameron)**
http://species-id.net/wiki/Lycogaster_apicipennis
Figure 3

Trigonalys apicipennis Cameron, 1897: 269.

Discussion. This is the only species of *Lycogaster* known from Central America. It is distinguished by its spindle-shaped antennae, without tyloids, and with the basal 3 flagellomeres reddish brown (Fig. 3). The head and thorax are mostly black with only the tegula and spot on upper mesopleuron yellow, and the head and body are covered with golden-yellow hairs. The wings are yellowish, darker anteriorly and at apices, with the veins yellowish and stigma black.

Lycogaster apicipennis is between 16–18% different (K2P distance model) from other Trigonalidae in the ACG in the CO1 mtDNA barcode region.

Distribution. Costa Rica, Mexico (Carmean and Kimsey 1998).

Specimens examined. 10, 7 of which are barcoded. Deposited in USNM, INBio.

Hosts and biology. The ACG caterpillar inventory has reared *Lycogaster apicipennis* 10 times (between 1990 and 2008), and always in lowland dry forest. Six rearings have

Figure 3. *Lycogaster apicipennis* female, lateral view.

been from *Enicospilus* flavostigmusDHJ02 (Ichneumonidae) parasitizing *Boriza crossaea* Druce (Notodontidae), once from *Enicospilus flavostigma* Hooker parasitizing *Dicentria* rusticaDHJ05 (Notodontidae), two from *Cubus* validusDHJ03 (Ichneumonidae) parasitizing *Omiodes cuniculalis* Guenée (a large leaf-rolling Crambidae), respectively, and once from *Bassus brooksi* Sharkey (a large solitary Agathidinae Braconidae parasitizing *Epargyreus* in the Hesperiidae). If these primary parasitoid genera are viewed as the possible host universe, 2,377 caterpillars attacked by them yielded 10 *L. apicipennis* (0.42% frequency). Alternatively, if we use the genera of the host caterpillars (*Boriza, Dicentria, Omiodes, Epargyreus*) in the inventory as the available universe, 17,007 reared wild caught caterpillars yielded these ten *L. apicipennis* (0.059% frequency). This is a low density hyperparasitoid. The first six rearings (1990–1995) were all from *Enicospilus* flavostigmusDHJ02 parasitizing *Boriza crossaea* in ACG, and it would have been reasonable to label this wasp as a specialist to this host combination, but subsequent rearings makes it evident that it is at best a specialist on relatively large primary parasitoid wasps (and there is no suggestion that it is a hyperparasitoid of tachinid fly larvae, despite their being commonplace primary parasitoids of *Boriza crossaea*).

Taeniogonalos woodorum Smith, sp. n.

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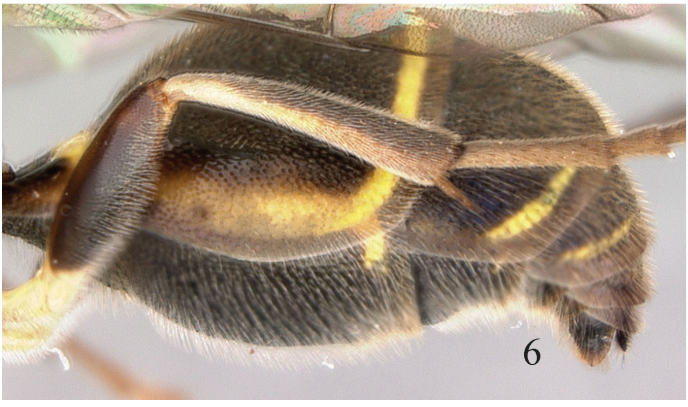
http://species-id.net/wiki/Taeniogonalos_woodorum
Figures 4–7

Diagnosis. Posterior postocellar area with two yellow oblique stripes; mandible mostly yellow, teeth reddish brown; gena mostly yellow, yellow extending dorsally and onto occiput; mesoscutellum with anterior third yellow; second metasomal tergum with narrow yellow band continuous along lateral and posterior margins. Female armature absent. Male with medial flattened area on sternum 2; genitalia with parameres about half as long as gonostipes.

Female. Length, 5.0–12.0 mm (holotype 8.0 mm). Antenna black. Head black, with following yellow (Figs 4. 5): Interantennal area, supraclypeal area, clypeus, labrum, mandible except reddish-brown apex, mouthparts, two oblique stripes at posterior or postocellar area, broad stripe on gena behind eyes extending dorsally onto occiput. Mesosoma black with following yellow markings (Figs 4, 5): anterolateral spot on mesoprescutum, axillae, anterior third of mesoscutellum, metascutellum, stripe on upper pronotum and lower pronotum, broad oblique stripe on mesopleuron, broad oblique stripe on metapleuron, large lateral spots on propodeum. Legs black with inner surfaces of coxae, trochanters, extreme bases of femora, and outer surfaces of tibiae and tarsi yellow. Metasoma black with following yellow markings (Figs 4–6): broad stripe on posterior margin of tergum 1, narrow continuous stripe on posterior and lateral margins of tergum 2; narrow stripe on posterolateral margins of terga 3 and 4, small spot on posterior lateral margin of sternum 2. Wings hyaline, black anterioapically, mostly in radial cell; veins and stigma black. Head and body covered with fine, short,



Figures 4–7. *Taeniogonalos woodorum*. **4** Lateral view, female **5** Dorsal view, female **6** Metasoma, lateral view, female **7** Male genitalia.

white hairs. *Head*: Covered with short, white hairs. Shiny, evenly punctate, punctures mostly separated by rounded ridges, interspaces less than puncture diameters; punctures on gena less dense, farther apart than those on vertex and frons, and with flat shiny

interspaces. Antenna with 24 flagellomeres, length about twice head width. Clypeus with median length about .3× width. Inner margins of eyes subparallel, lower interocular distance 0.7× eye length; malar space about 0.15× eye length. Distance between eye and margin of lateral ocellus about 3.0× distance between inner margins of hind ocelli. Area between torruli slightly concave (Fig.5). Antennal carinae low, sharp. Occipital carina complete. *Mesosoma*: Covered with short, white hairs. Shiny, evenly punctate with punctures similar to those on vertex and frons, most separated by rounded ridges, with interspaces less than puncture diameters; punctures on propleuron farther apart than those on mesonotum and separated by broader, flat interspaces; dorsoposterior section of mesepisternum, posterior downturned margin of mesoscutellum, and metapleuron, except lower margin, almost impunctate; punctures on propodeum small, denser than those on rest of mesosoma. Prescutum elevated above lateral lobes. Notaulus deep, with large punctures posteriorly; transverse row of large punctures anterior to mesoscutellum. Propodeal foramen shallowly concave at center. Hind coxa about as long as wide, with longitudinal carina on outer surface; hind basitarsomere subequal to length of remaining tarsomeres combined. *Metasoma*: Covered with fine, white hairs. Shiny, rather evenly punctate, punctures separated by rounded ridges mostly less than puncture diameters. Tergum 1 depressed at center. Armature absent from sternum 2 (Figs 4, 6). Sheath directed downward, rounded at apex in lateral view.

Male. Length, 4.0–7.5 mm. Color and structure similar to female. Tyloids present, long and narrow, middle tyloids longer than half length of flagellomeres. Male genitalia with parameres about half-length of gonostipes (Fig. 7); sternum 2 with medial flattened area on apical half.

Type material. Holotype female, "Voucher: D. H. Janzen & W. Hallwachs, DB: http://Janzen.sas.upenn.edu, Area de Conservation Guanacaste, Costa Rica," "10-SRNP-22162," "DHJPAR0041177." (USNM). Paratypes: Same data as for holotype except caterpillar rearing code (yy-SRNP-xxxx) and parasitoid individual code (DHJPARxxxxxxx); one specimen for each caterpillar collection and parasitoid rearing code. 98-SRNP-6785, DHJPAR0010613 (♂); 98-SRNP-7262, DHJPAR0016904 (♂); 98-SRNP-7361, DHJPAR0016911 (♀); 98-SRNP-15545, DHJPAR0016916 (♀); 98-SRNP-15545, DHJPAR0016899 (♀); 98-SRNP-15545, DHJPAR0016888 (♂); 99-SRNP-5503, DHJPAR0016895 (♀); 99-SRNP-5508, DHJPAR0016897 (♂); 99-SRNP-12098, DHJPAR0016891 (♀); 99-SRNP-12098, DHJPAR0016892 (♂); 99-SRNP-12098, DHJPAR0016896 (♀); 99-SRNP-12761, DHJPAR0010612 (♀); 99-SRNP-12852, DHJPAR0010604 (♂); 99-SRNP-13819, DHJPAR0010611 (♂); 99-SRNP-13823, DHJPAR0016909 (♀); 01-SRNP-3507, DHJPAR0010598 (♀); 01-SRNP-3507, DHJPAR0010599 (♀); 01-SRNP-5325, DHJPAR0010597 (♂); 01-SRNP-5932, DHJPAR0010605 (♀); 01-SRNP-9359, DHJPAR0010607 (♀); 01-SRNP-25186, DHJPAR0010600 (♂); 02-SRNP-7679, DHJPAR0010596 (♀); 02-SRNP-7978, DHJPAR0010595 (♀); 03-SRNP-6738, DHJPAR0010588 (♂); 03-SRNP-10070, DHJPAR0010585 (♀); 03-SRNP-11855, DHJPAR0010591 (♂); 03-SRNP-11855, DHJPAR0010592 (♂); 03-SRNP-11855, DHJPAR0010593 (♂); 03-SRNP-11855, DHJPAR0010594 (♂); 03-SRNP-20157, DHJPAR0010590

(♀); 03-SRNP-20236, DHJPAR0028047 (♀); 03-SRNP-21817, DHJPAR0010586 (♀); 04-SRNP-30072 [no barcode] (♀); 04-SRNP-41595, DHJPAR0010574 (♂); 04-SRNP-55214, DHJPAR0010571 (♀); 04-SRNP-55214.1, DJHPAR0010572 (♀); 04-SRNP-55215, DHJPAR0010573 (♀); 04-SRNP-56432, DJHPAR0010581 (♀); 04-SRNP-56458, DHJPAR0010582 (♀); 05-SRNP-4939, DHJPAR0010559 (♂); 05-SRNP-7881, DHJPAR0010551 (♂); 05-SRNP-33818, DHJPAR0010569 (♂); 05-SRNP-34358, DHJPAR0010562 (♂); 05-SRNP-42584, DHJPAR0010563 (♂); 05-SRNP-42827, DHJPAR0010570 (♂); 05-SRNP-70122, DHJPAR0010560 (♂); 05-SRNP-70325, DHJPAR0010561 (♀); 06-SRNP-6781, DHJPAR0016876 (♀); 06-SRNP-6781, DHJPAR0016877 (♀); 06-SRNP-6781, DHJPAR0016878 (♂); 06-SRNP-6781, DHJPAR0016884 (♀); 06-SRNP-30294, DHJPPAR0010443 (♂); 06-SRNP-30295, DHJPAR0010554 (♂); 06-SRNP-33412, DHJPAR0016873 (♀); 06-SRNP-34200, DHJPAR0016875 (♀); 06-SRNP-34577, DHJPAR0016886 (♀); 06-SRNP-34579, DHJPAR0016887 (♂); 06-SRNP-42284, DHJPAR0010555 (♀); 06-SRNP-42284, DHJPAR0010556 (♂); 06-SRNP-42284, DHJPAR0010557 (♂); 06-SRNP-42814, DHJPAR0016882 (♀); 06-SRNP-42819, DHJPAR0016883 (♀); 06-SRNP-43560, DHJPAR0016874 (♀); 06-SRNP-65304, DHJPAR0016885 (♂); 08-SRNP-2414, DHJPAR0027762 (♂); 08-SRNP-2414, DHJPAR0027763 (♂); 08-SRNP-6017, DHJPAR0030373 (♂); 08-SRNP-32269, DHJPAR0030377 (♀); 08-SRNP-41835 [no barcode] (♀); 08-SRNP-42172, DHJPAR0030374 (♀); 08-SRNP-42172, DHJPAR0030375 (♀); 08-SRNP-42172, DHJPAR0030376 (♀); 09-SRNP-2888, DHJPAR0036406 (♀); 09-SRNP-5008, DHJPAR0036682 (♀); 09-SRNP-32681, DHJPAR0038544 (♀); 09-SRNP-32752, DHJPAR0038545 (♀); 09-SRNP-32752, DHJPAR0038546 (♀); 09-SRNP-33385, DHJPAR0038543 (♂); 09-SRNP-69541, DHJPAR0036404 (♂); 09-SRNP-70610, DHJPAR0036405 (♀); 09-SRNP-73449, DHJPAR0037846 (♂); 09-SRNP-80526, DHJPAR0037847 (♂); 10-SRNP-1030, DHJPAR0039355 (♀); 10-SRNP-4609, DHJPAR0041181 (♀); 10-SRNP-22641, DHJPAR0041178 (♂); 10-SRNP-32041, DHJPAR0041179 (♂); 10-SRNP-42215, DHJPAR0041180 (♀); 10-SRNP-73124, DHJPAR0041176 (♀); 10-SRNP-73289, DHJPAR0041174 (♀); 10-SRNP-80666, DHJPAR0041175 (♂); 11-SRNP-2784, DHJPAR0045823 (♀); 11-SRNP-2784, DHJPAR0045824 (♂); 11-SRNP-2859, DHJPAR0044983 (♀); 11-SRNP-2911, DHJPAR0045822 (♂); 11-SRNP-71666, DHJPAR0045825 (♂); 11-SRNP-80954, DHJPAR0044984 (♀). Deposited in INBio, USNM, CNC, BMNH.

Other specimens. 03-SRNP-38118, DHJPAR0010587 (metasoma missing); 06-SRNP-6781, DHJPAR0016872 (metasoma missing); 09-SRNP-72860, DHJPAR0040090 (broken).

Specimens examined. 100; 98 submitted for DNA barcoding, 89 of which yielded complete DNA barcodes publically available from BOLD.

Etymology. *Taeniogonalos woodorum* is named in honor of Monty and Grace Wood of Ottawa, Canada in recognition of their three decades of intense and enthusiastic taxonomic and spiritual participation in the tachinid fly inventory of Area de Conservación Guanacaste and in INBio's inventory of the flies of Costa Rica.

Barcode. The DNA barcodes of the 89 *Taeniogonalos woodorum* specimens longer than 400 bp have less than 1% intraspecific divergence (0.702% avg, max 2.523%, min, 0%). They are 9% divergent from the DNA barcodes of *T.* fasciatipennisDHJ01 and *T*. fasciatipennisDHJ02.

Discussion. The mostly black color with yellow maculation, as described and illustrated, and lack of female armature on metasomal sternum 2 help distinguish this species from most other New World species of *Taeniogonalos*. The females of *T. fasciatipennis*, *T. gundlachii*, *T. lugubris* (Westwood), and *T. ornata* (Smith) have distinct armature on sternum 2, and the latter three are mostly yellow or reddish-brown with black maculation. The females of *T. enderleini* (De Santis) and *T. jucunda* (Westwood) from South America lack female armature. *Taeniogonalos enderleini* occurs in southeastern Brazil, is mostly black with some yellow maculation, but the posterior lower part of the mesopleuron and the metapleuron are reddish brown and the postocellar area lacks yellow marks. *Taeniogonalos jucunda* (Westwood) was described from "Amaz.", and the color was described as mostly reddish brown, head yellow, and the scutellum black, all of which differ from the color of *T. woodorum*.

Hosts and biology. *Taeniogonalos woodorum* is the most frequently reared of the ACG Trigonalidae, known only from ACG rain forest, and superficially resembles *Taeniogonalos fasciatipennis* and *Taeniogonalos gundlachii* (see below). It is the only species of trigonalid that has been reared from the sample of more than 220,000 wild-caught ACG rain forest caterpillars. This microgeographic and ecosystem separation from the parapatric and adjacent ACG dry forest of *Taeniogonalos fasciatipennis* (see below) allows first-pass species-level identification of *Taeniogonalos woodorum* even if key morphological traits are invisible and DNA barcodes have not been obtained from the specimen, such as when the reared wasp escapes or the abdomen is broken off and lost or consumed in analysis. This method of ecology-based identification cannot, however, be used for specimens from the narrow ecotone between ACG dry forest and rain forest, where both species of *Taeniogonalos* have been reared from caterpillars found in the same hectare. The presence of *Taeniogonalos woodorum* was first noticed in 2006 by its strikingly different (15%) DNA barcode from that of *Taeniogonalos fasciatipennis* (also called *Taeniogonalos gundlachii* at that time). Adult *Taeniogonalos woodorum*, as is the case with the other ACG *Taeniogonalos*, is a Batesian and Mullerian mimic of *Polybia* wasps (Vespidae; abundant in ACG) in body size, color pattern, and flight/walking behavior.

Taeniogonalos woodorum has been reared 97 times from 14 caterpillar families (Arctiidae, Crambidae, Elachistidae, Geometridae, Hesperiidae, Lasiocampidae, Noctuidae, Notodontidae, Nymphalidae, Pyralidae, Saturniidae, Sphingidae, Thyrididae, Uraniidae), parasitized by Braconidae (*Bassus, Dolichogenidea, Glyptapanteles, Meteorus, Stantonia, Zelomorpha*), Ichneumonidae (*Agrypon, Charops, Dusona, Eiphosoma, Hyposoter, Leurus, Microcharops, Xiphosomella, Zaglyptomorpha*) and Tachinidae (at least *Anoxynops, Agryrochaetona, Argyrophylax, Belvosia, Calolydella, Campylochaeta, Chrysotachina, Drino, Eucelatoria, Eujuriniodes, Eumea, Genea, Houghia, Hyphatrophaga, Lespesia, Patelloa, Phytomyptera, Winthemia*). The host caterpillars of these primary parasitoids may all be characterized as exposed leaf feeders (even these par-

ticular species of leaf rollers and tiers, Crambidae, Elachistidae, Pyralidae, Thyrididae, venture out of their leaf-silk nests to feed on fully exposed leaf blades), and no one species dominates this diverse list. While it is evident that *Taeniogonalos woodorum* can develop in a very wide variety of host caterpillars and primary parasitoids, experience with other apparent "generalists" in the ACG inventory warns that when much larger sample sizes have accumulated, it may become evident that certain taxa and ecologies are either being avoided by ovipositing wasps or the eggs/larvae do not survive their tour in the host or primary parasitoid.

It remains a mystery as to why this hyperparasitoid remains microgeographically restricted to ACG rain forest and does not venture into the extensive adjacent dry forest with its many thousands of species of potential caterpillar and primary parasitoid hosts only a few hundred meters away. Indeed, there is a single record of *Taeniogonalos woodorum* (DHJPAR0016846) well into the microgeographic distribution of *Taeniogonalos* fasciatipennisDHJ02 (see below), emphasizing the parapatric nature of the distribution of these two species of *Taeniogonalos.* However, in remaining restricted to rain forest, it is representative of the thousands of other species of ACG Lepidoptera, Hymenoptera, and Diptera which are faithful to their respective ecosystems, even at the time when the intense six month rainy season turns the adjacent dry forest in a very wet ecosystem.

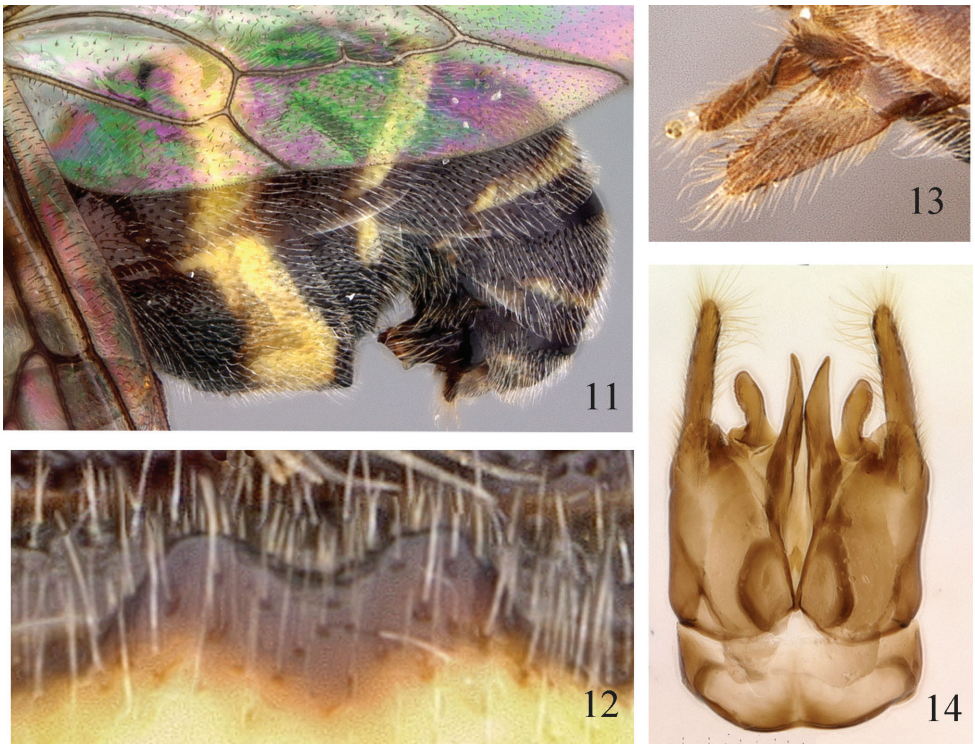
***Taeniogonalos fasciatipennis* (Cameron)**
http://species-id.net/wiki/Taeniogonalos_fasciatipennis
Figures 8–14

Trigonalys fasciatipennis Cameron, 1897: 271.
Taeniogonalos gundlachii (in part): Carmean and Kimsey 1998: 67.

Discussion. This species is distinguished as follows: vertex black; mandible outer surface black, upper surface yellow, teeth reddish brown; clypeus with large yellow spot on each side; narrow yellow line on gena on hind orbit (Figs 8, 10); mesoscutellum entirely yellow or with thin medial black stripe; second metasomal tergum with broad posterior transverse band, not extended laterally (Figs 8, 10). Female armature present, in ventral view with lobes short and with shallow central depression (Fig. 12), in lateral view, posterior and ventral sides perpendicular, not directed downward at apex (Figs 8, 11); male genitalia with paramere long, about three-quarters length of gonostipes (Fig. 14); paramere in lateral view with dorsal margin straight (Fig. 13), without slight depression.

Taeniogonalos fasciatipennis was described by Cameron (1897) from two Mexican specimens, a female from "Atoyac in Vera Cruz" and a male from "Venta de Zopilote in Guerrero." The male from the State of Guerrero was chosen as the lectotype by Carmean and Kimsey (1998). This lectotype (BMNH, examined) is morphologically identical to males reared as this species from ACG. It is noteworthy that the region around the type locality in Mexico is ecologically the same kind of tropical dry for-

Figures 8–10. *Taeniogonalos fasciatipennis,* female. **8** *T*. fasciatipennisDHJ01, lateral view **9** *T*. fasciatipennisDHH01, dorsal view **10** *T*. fasciatipennisDHJ02, lateral view.



Figures 11–14. *Taeniogonalos* fasciatipennis DHJ01. **11** Metasoma, lateral view, female **12** Female armature, sternum 2, ventral view **13** Male paramere, lateral view **14** Male genitalia.

est ecosystem as is the dry forest of ACG and shares a very large number of species of plants and insects with it.

The female syntype (not examined) from Veracruz was treated by Carmean and Kimsey (1998) as the "same" as *Taeniogonalos gundlachii*. It may not be the same species as the lectotype, and some of the specimens treated as *T. fasciatipennis* by Carmean and Kimsey (1998) are probably the species we here describe as *T. woodorum*.

This and the species from North America and Cuba have long been regarded as the "*gundlachii*" group, the members of which are distinguished from others by having similar color and the presence of distinctive female armature. However, *Taeniogonalos fasciatipennis* can be distinguished from North American *Taeniogonalos gundlachii* by the female armature and male parameres as described above. *Taeniogonalos fasciatipennis* is morphologically separable from *Taeniogonalos woodorum* by the former having the female armature present and the male paramere short in relation to the gonostipes.

The DNA barcodes of *Taeniogonalos fasciatipennis*DHJ01 and *T. fasciatipennis*-DHJ02 are 5.66% divergent from each other in the COI barcode region and both are 9% divergent from *T. woodorum.*

Distribution. Mexico and Costa Rica.

Specimens examined. *T.* fasciatipennisDHJ01 53, 42 barcoded; *T.* fasciatipennisDHJ02 15, 13 barcoded. Deposited in USNM, INBio, CNC, BMNH.

Hosts and biology. In the absence of genetic information, *Taeniogonalos fasciatipennis* appears to be one morphologically distinctive species that occurs throughout ACG dry forest (85 m to about 1300 m elevation) and does not occur in adjacent ACG rain forest or cloud forest. It is a hyperparasitoid of a wide variety of caterpillar and primary host species (see below). However, DNA barcoding has revealed that this morphologically-distinct species is divided into two distinct mitochondrial types in the ACG dry forest. One, baptized here as *Taeniogonalos* fasciatipennisDHJ01 (Figs 8, 9, 11–14) is an interim name in the inventory website database (http://janzen.bio.upenn.edu/caterpillars/database.lasso) and occurs throughout the ACG dry forest (85 to 700 m elevation). The other, interim name *Taeniogonalos* fasciatipennisDHJ02 (Fig. 10), has a very distinctive microgeographic distribution. Twelve of the 13 records are from the intermediate elevation southwest facing slope of the volcanic massif of Rincon de la Vieja (325–1276 m elevation in Sector Mundo Nuevo of ACG). The single other rearing record (two individuals from tachinid fly puparia from the same caterpillar) is from a site that is an ecogeographic analogue in biota, elevation, and climate to the Sector Mundo Nuevo site (600 m on the southwest facing slope of Volcan Cacao in Sector Cacao of ACG). *Taeniogonalos* fasciatipennisDHJ01 is probably the same as the lectotype from western (dry forest) Mexico, but since there is no present way to know for certain, both *T.* fasciatipennisDHJ01 and *T.* fasciatipennisDHJ02 have to be treated as interim names, and are therefore not italicized (and see below).

In general terms, *T.* fasciatipennisDHJ01 conspicuously ranges from the driest parts of ACG dry forest to its intermediate-elevation intersection with cloud forest and rain forest, and *T.* fasciatipennisDHJ02 is restricted to the upper, cooler, moister portion of this range. To emphasize the cooler and moister aspect of this very small range, there is even a single specimen (DHJPAR0016846) of the rain forest specialist, *Taeniogonalos woodorum,* from the very center of the range of *T.* fasciatipennisDHJ02. While *T.* fasciatipennisDHJ01 has not been found in the Sector Mundo Nuevo exact site occupied by *T.* fasciatipennisDHJ02, and thus they are parapatric, *T.* fasciatipennisDHJ01 is absolutely sympatric with the single record of *T. fasciatipennis*DHJ02 on the southwestern slopes of Volcan Cacao.

This situation creates two different taxonomic problems. First, since the two apparent ACG species within what appears morphologically to be *Taeniogonalos fasciatipennis* currently cannot be distinguished by any morphological trait, there is no way to know which of the two matches the lectotype from the State of Guerrero, Mexico. It is also possible that neither does. Second, the presence of two sympatric/parapatric species of "*Taeniogonalos fasciatipennis*" in the small area of ACG raises the spectre that this species of wasp may be a complex of sibling (cryptic) species. In contrast to parallel cases with extremely host-specific Microgastrinae Braconidae (e.g., Smith et al. 2008)

or Tachinidae (Smith et al. 2007), the unambiguously generalist host-selection and/or larval-survival ability of *Taeniogonalos fasciatipennis* excludes the use of host records as a way to verify or predict the presence of cryptic species.

If *T.* fasciatipennisDHJ02 were not distinctive by barcode from *T.* fasciatipennisDHJ01 (Fig. 2), it would not have been noticed. *Taeniogonalos* fasciatipennisDHJ01 and *T.* fasciatipennisDHJ02 have the same extremely varied lists of caterpillar and primary parasitoid hosts. In brief, *T.* fasciatipennisDHJ01 has been reared and barcoded 48 times from nine Lepidoptera families: Crambidae, Hesperiidae, Megalopygidae, Noctuidae, Nymphalidae, Papilionidae, Saturniidae, Sphingidae, and Uraniidae. While 53 more specimens of *T. fasciatipennis* have been raised, until (and if) those specimens are successfully barcoded, we cannot categorize them as *T.* fasciatipennisDHJ01 or *T.* fasciatipennisDHJ02.

In all cases, the primary parasitoid host was Tachinidae: *Acantholespesia, Belvosia, Blepharipa, Calolydella, Carcelia, Chetogena, Drino, Eucelatoria, Hemisturmia, Houghia, Hyphantrophaga, Leschenaultia, Lespesia, Patelloa, Winthemia,* and *Zizyphomyia.* If we add to this the other specimens of "*T. fasciatipennis*" that were not successfully barcoded but occupy the ACG ecosystem occupied by *T.* fasciatipennisDHJ01 a few more Lepidoptera families and tachinid genera are added to these lists, as well as three large-bodied genera in the Ichneumonidae (*Enicospilus, Pedinopelte, Trogus)*.

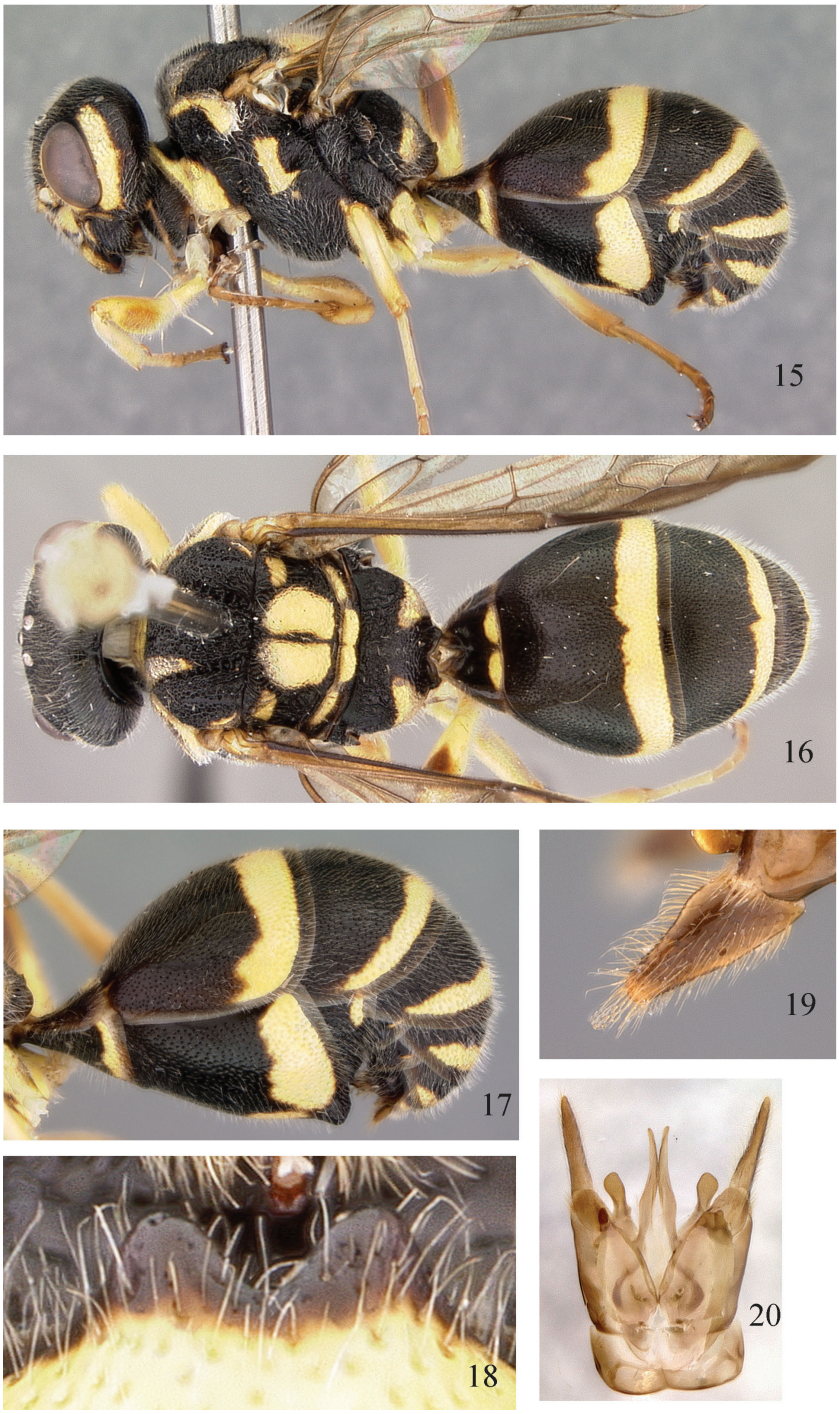
Taeniogonalos fasciatipennisDHJ02 has been reared 13 times from parasitoids of Crambidae, Hesperiidae, Noctuidae, Notodontidae, Nymphalidae, Riodinidae, Saturniidae, and Sphingidae. The primary host genera are Tachinidae (*Blepharipa, Drino, Houghia, Lespesia, Patelloa*), Ichneumonidae (*Enicospilus*) and Braconidae (Macrocentrinae).

***Taeniogonalos gundlachii* (Cresson)**
http://species-id.net/wiki/Taeniogonalos_gundlachii
Figs 15–20

Trigonalys Gundlachii Cresson, 1865: 10.
Trigonalys (*Lycogaster*) *costalis* Cresson, 1867: 352.
Trigonalis sulcatus Davis, 1898: 349

Discussion. This species is noted here because Costa Rican specimens of *Taeniogonalos* have been previously identified as belonging to this species. Carmean and Kimsey (1998) regarded *T. gundlachii* as a widespread, color-variable species occurring from Canada to Central America. They stated that "Specimens of '*T. costalis*' from North and Central America have less extensive yellow markings than *T. gundlachii* from Cuba, but specimens from Florida are intermediate." All specimens we have seen from Costa Rica are *Taeniogonalos woodorum* and *Taeniogonalos fasciatipennis*, both of which are separated from *T. gundlachii* of North America by morphology and DNA barcoding.

The color of *T. gundlachii* (Figs 15–17) is very similar to *T. fasciatipennis* (Figs 8–10) from Costa Rica, but we noted several morphological differences which appear



Figures 15–20. *Taeniogonalos gundlachii*. **15** Lateral view, female **16** Dorsal view, female **17** Metasoma, lateral view, female **18** Female armature, sternum 2, ventral view **19** Male paramere, lateral view **20** Male genitalia.

consistent in specimens examined: lobes on female armature on sternum 2 in ventral view much longer and central emargination deeper (Fig. 18) than in *T. fasciatipennis* (Fig. 12); female armature in lateral view more rounded, and slightly protruding ventrally (Fig. 17) than the squared appearance in *T. fasciatipennis* (Fig. 11); male paramere slightly indented dorsally (Fig. 19) rather than straight in *T. fasciatipennis* (Fig. 13).

Specimens from the northern parts of the range of *T. gundlachii*, northeastern United States and Canada, are relatively uniform in color, black with yellow maculation as in Figs 15–17. Specimens from Cuba, Florida, Louisiana, and Texas have a broader yellow band on the inner and outer orbits; legs all yellow with only coxae black; male with one yellow band on the metasoma, and female with 3–4 yellow bands. We have not seen specimens from the area between Texas and Guerrero, Mexico, and have seen only the type of *T. fasciatipennis* from Mexico and one specimen from El Salvador which appears to be *T. fasciatipennis*.

It is not our intent here to resolve the entire taxonomic problem and there is not enough material available from Cuba and intermediate ranges. Therefore, we continue to apply the name *T. gundlachii* to the specimens from Canada to Cuba, while suspecting that those from Canada and eastern U. S. eventually will again be called *T. costalis*. Though we cannot deny the possible presence of *T. gundlachii* in Costa Rica, the ACG dry forest specimens reared in this study are different from those from North America, and thus we refer them to *T. fasciatipennis*.

The DNA barcode for specimens from Virginia, West Virginia, and Mississippi is 8.6% divergent from *T. woodorum* and 7.49–7.75% divergent from *T.* fasciatipennis-DHJ02 *and T.* fasciatipennisDHJ01, respectively.

Distribution. Canada to Cuba, and west to Wisconsin and Texas.

Specimens examined. 200+; 25 DNA barcoded. Deposited in USNM.

Hosts and biology. See Smith 1996, Carmean and Kimsey 1998, and Krauth and Williams 2006.

Key to *Taeniogonalos* species in Costa Rica

1 Predominately yellow with black maculations ..... ***T. ornata***

– Predominately black with yellow markings (as in Figs 4–6, 8–10)..... **2**

2 Vertex with two oblique yellow stripes; yellow on gena broad, extending dorsally to occiput (Figs 4, 5); anterior half or third of mesoscutellum yellow (Fig. 5); mandible mostly yellow; female armature absent (Fig. 6); male parameres short, about half length of gonostipes (Fig. 7); ACG rain forest ..... ***T. woodorum***

– Vertex black; yellow on gena confined to narrow stripe on hind orbit (Figs 8, 10); metascutellum mostly yellow; mandible mostly black; female armature present (Figs 11, 12); male parameres longer, about ¾ length of gonostipes (Fig. 14); ACG dry forest..... ..... ***T.* fasciatipennisDHJ01 and *T.* fasciatipennisDHJ02**

***Trigonalys championi* Cameron**
http://species-id.net/wiki/Trigonalys_championi
Figures 21, 22

Trigonalys championi Cameron, 1897: 273.

Discussion. This strikingly large species is mostly black, shiny, with the propodeum and first metasomal segment contrastingly white; the forewing is darkly infuscated with only the extreme apex and posterior margin somewhat lighter (Figs 21, 22).

The *Trigonalys championi* DNA barcode is 13–17 % different from other Trigonalidae in the ACG.

Distribution. Guatemala, Costa Rica (Carmean and Kimsey 1998).

Specimens examined. 5; 5 barcoded. Deposited in USNM, INBio.

Hosts and biology. This species has been reared just four times, always from ACG dry forest and its ecotone with rain forest, and always from the large primary parasitoid wasp *Enicospilus monticola* (Cameron) (Ichneumonidae, Ophioninae) parasitizing *Oraesia* and *Gonodonta* spp. (Noctuidae) feeding on *Piper* (Piperaceae), *Annona* (Annonaceae), or *Cissampelos* (Menispermaceae).

***Trigonalys maculifrons* Sharp**
http://species-id.net/wiki/Trigonalys_maculifrons
Figure 23

Trigonalys maculifrons Sharp, 1895: 564, fig. 371.

Discussion. This species is mostly yellow with various black maculations on the head and body (Fig. 23). The specimens reared from Costa Rica resemble this species with very similar black markings on the head and mesosoma. The black on the metasoma, however, differs. It is possible this is species-level variation, but we do not have enough specimens to evaluate this, and it does not seem to justify the description of a new species. *Trigonalys flavescens* Bischoff 1951, described from Mexico, is similar, but it differs by the more weakly striped metasoma and lack of a triangular mark at the top of the gena.

As explained by Carmean and Kimsey (1998), Sharp (1895) illustrated *Trigonalys maculifrons* with the caption "*Trigonalys maculifrons* Cam., i.l. Mexico" prior to Cameron's (1897) description of the species. The illustration clearly depicts the holotype specimen described in Cameron, and Sharp is therefore the author of the species.

The *Trigonalys maculifrons* DNA barcode is 13–17% different from other ACG Trigonalidae.

Distribution. Costa Rica, Guatemala, Honduras, Mexico (Carmean and Kimsey 1998).

Figures 21–22. *Trigonalys championi*, female. **21** Lateral view **22** Dorsal view.

Specimens examined. 4; 4 DNA barcoded. Deposited in USNM, INBio.

Hosts and biology. This striking species has been reared just three times, all in 2001 and in ACG dry forest (Sector Santa Rosa), from caterpillars of *Euscirrhopterus poeyi* Grote (Noctuidae) feeding on *Pisonia aculeata* L. (Nyctaginaceae) and primary parasitized by *Lespesia* posticaDHJ01 (Tachinidae).

Figure 23. *Trigonalys maculifrons*, female, dorsal view.

Key to *Trigonalys* species in Costa Rica

1 Black, propodeum and first metasomal tergum yellow (Figs 21, 22); forewing darkly infuscate, especially anteriorly; pronotal collar not raised... ***T. championi***

– Predominately yellow with black maculations on head and body (Fig. 23); wings uniformly hyaline; pronotal collar abruptly raised..... ***T. maculifrons***

Acknowledgments

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