

Bephratelloides Girault, 1913 (Hymenoptera, Eurytomidae): a new species from Brazil and two new host plants

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Abstract. In this study, we documented two species of *Bephratelloides* Girault, 1913 (Hymenoptera, Eurytomidae) collected in Brazilian savanna areas in the state of São Paulo. *Bephratelloides duguetiarum* Perito & Lara **sp. nov.** is described and illustrated based on specimens that emerged from the seeds of *Duguetia furfuracea* (St. Hil.) Benth. & Hook (Annonaceae). *Bephratelloides petiolatus* Grissell & Schauff, 1990 is associated with seeds of *Xylopia aromatica* (Lam.) Mart. (Annonaceae). The name *Bephratelloides duguetiphagus* Chang, 1998 must be regarded as unavailable because it fails to satisfy the availability criteria of the International Code of Zoological Nomenclature.

Keywords. Brazilian savanna; Chalcidoidea; *Duguetia furfuracea*; Phytophagy; *Xylopia aromatica*.

INTRODUCTION

Bephratelloides Girault, 1913 (Hymenoptera, Eurytomidae) are Neotropical wasps easily identified by their antenna with six long funicular segments, club almost or quite solid, and no wider than funicle; gaster strongly compressed, wide dorso-ventrally; propodeum broadly concave on meson; forewing usually shaded with brown or yellow, stigmal and postmarginal veins subequal in length (Burks, 1971).

Until the early 2010s, it was believed that during their larval stage, *Bephratelloides* fed exclusively on seeds of the Annonaceae (Magnoliales) (Grissell & Schauff, 1990; DiGiulio, 1997; Grissell & Foster, 1996). However, Castañeda-Vildózola *et al.* (2011) reported the rearing of *B. ablusus* Grissell & Foster, 1996 from fruits of *Diospyros digyna* (Ericales: Ebenaceae) in Mexico, suggesting that species of *Bephratelloides* may have hosts outside the Annonaceae family.

After consuming the seeds' tissues, the larvae of *Bephratelloides* pupate inside them, give rise to adults that emerge by chewing a hole with their mandibles, and tunneling through the fruit tissue to reach outside environment. These perforations in the fruit's epithelium can serve as entry points for microorganisms that cause rot, rendering the fruit unmarketable for human consumption (Pereira *et al.*, 1997; Souza *et al.*, 2004).

Grissell & Schauff (1990) recognized *B. pomorum* (Fabricius, 1804) (= *B. maculicollis* Cameron, 1913), *B. cubensis* (Ashmead, 1894), *B. paraguayensis* (Crawford, 1911), and *B. petiolatus* Grissell & Schauff, 1990 as valid species of *Bephratelloides*. Until then, it was known that the first three species are seed-feeders in *Annona* (Annonaceae), while the host of *B. petiolatus* remained unknown.

Grissell & Foster (1996) described *B. ablusus*, which develops in seeds of *Cymbopetalum mayanum* Lundell (Annonaceae), representing the first record of a host of *Bephratelloides* not belonging to *Annona* L. (Annonaceae). These authors predicted a high probability of discovering new species of *Bephratelloides*, considering the existence of other diverse genera related to *Annona*, such as *Xylopia* L., *Rollinia* A. St. Hil. and *Porcelia* Ruiz & Pav.

Bephratelloides duguetiphagus Chang was initially mentioned in Chang's (1998) master's thesis as a seed-feeding wasp associated with *Duguetia panamensis* Standl. (Annonaceae) in Costa Rica. However, as a thesis does not qualify as published work under Article 9 of the International Code of Zoological Nomenclature (ICZN), this designation remains invalid. Despite this, the specific epithet was later cited by Castañeda-Vildózola *et al.* (2011) but also did not satisfy the ICZN's availability crite-

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ria. Consequently, *B. dugetiphagus* must be regarded as an unavailable name, necessitating formal proposition. According to Chang (personal communication), the original material he examined has been lost.

In Brazil, Annonaceae are represented by about 30 genera and approximately 390 species (Lobão *et al.*, 2020) distributed across the Amazon Rainforest, Caatinga, Brazilian savanna, Atlantic Rainforest, Pampa and Pantanal phytophysiognomies (Flora e Função do Brasil, 2024a).

Duguetia A. St. Hil. (Annonaceae) has a primarily Neotropical distribution with about 90 species, approximately 70 of which occur in Brazil (Maas *et al.*, 2003). *Duguetia furfuracea* (A. St. Hil.) Saff. is a shrub that can grow up to two meters tall, with solitary red flowers and globose syncarpous fruits about eight cm in diameter when mature; these plants are widely distributed in Brazil in areas of Brazilian savanna and Caatinga from Ceará to Paraná states (Pot & Pot, 1994; Durigan *et al.*, 2004; Lobão & Bazzante, 2024).

Xylopia L. (Annonaceae) has pantropical distribution with about 150 described species (WFO, 2024), around 30 of which occur in Brazil (Flora e Função do Brasil, 2024b). *Xylopia aromatica* (Lam.) Mart. is a small tree, ranging from three to ten meters in height, with multiple dehiscent fruits, and is the most widely distributed species of all American *Xylopia*, spanning a large area from Central America and the West Indies to southern Brazil and Paraguay (Pot & Pot, 1994; Oliveira-Filho & Ratter, 1995; Castellani *et al.*, 2001; Durigan *et al.*, 2004; WFO, 2024).

The aims of this study are to describe and illustrate *Bephratelloides dugetiarum* Perioto & Lara **sp. nov.** based on specimens that emerged from seeds of *Duguetia furfuracea* (St. Hil.) Benth. & Hook (Annonaceae), to associate *Bephratelloides petiolatus* Grissell & Schauff, 1990 with its host plant *Xylopia aromatica* (Lam.) Mart. (Annonaceae), and to provide data on the geographic distribution of the *Bephratelloides* species studied.

MATERIAL AND METHODS

Fruits of *D. furfuracea* were collected in the Brazilian savanna areas of Luiz Antônio (21°33'18"S, 47°42'16"W) and in São Simão (21°29'36"S, 47°30'53"W), both in São Paulo State, while fruits of *X. aromatica* were collected at the latter locality. In the laboratory, the fruits were kept in plastic containers (20 cm in diameter, 25 cm in height) covered with synthetic gauze and observed daily until putrefaction. The emerging wasps were killed in 70% ethanol, dried in a Leica EM CPD030 critical point dryer and subsequently mounted on point or card on entomological pins.

Images and measurements were taken using a Leica MC170 HD digital camera attached to a Leica M205C APO automated research stereomicroscope. The measurements were taken using the "Distance Line Tool" and serial images from different layers were captured using Leica Application Suite software (LAS version 4.12.0). The specimens under study were illuminated using a Leica

LED5000 HDI high diffuse dome of illumination system (Kerr *et al.*, 2008). Partially focused images were combined using Helicon Focus software (v. 5.3). The photomicrographs of the uncoated specimens were taken with a high-resolution FEI QUANTA 250 scanning electron microscope in the low vacuum mode at the Departamento de Ecologia e Biologia Evolutiva, Universidade Federal de São Carlos, São Carlos, SP, Brazil. The figures were prepared using Adobe Photoshop version 11.0.

The key provided by Grissell & Foster (1996) was used for identification of species. The morphological terminology follows Gibson (1997) and the surface sculpture Harris (1979).

Species distributions were assembled in a dataset and incorporated into distribution maps. The distribution maps were generated using the web software SimpleMappr (Shorthouse, 2010).

Used abbreviations are: *Fn*, flagellomeres (*n* = number of the flagellomere); *OOL*, ocular ocellar line; *POL*, posterior ocellar line; *Mtn*, metasomal tergum (*n* = number of the metasomal tergum).

Information on specimen labels is given *ad litteram*.

The specimens studied herein are deposited in the Coleção Entomológica do Laboratório de Sistemática e Bioecologia de Predadores e Parasitoides of the Instituto Biológico (LRRP), Ribeirão Preto, SP, Brazil, N.W. Perioto, curator.

TAXONOMY

Bephratelloides dugetiarum Perioto & Lara **sp. nov.** (Figs. 1-3)

Type material: **Holotype**, female labeled "BRASIL/SP/Luiz Antônio, Estação Ecol. de Jataí, ex. frutos *Duguetia furfuracea* (Annonaceae), 15.X.2009, N.W. Perioto, col.", "♀ HOLOTYPE, *Bephratelloides dugetiarum* **sp. nov.**, Perioto & Lara" [LRRP #23286]. **Paratypes**: same data as holotype except: 5 females [LRRP #23287-23291]; same data except: 27.X.2009, 2 males [LRRP #23292-23293]. "BRASIL/SP/São Simão, Sítio Flor do Ipê – Rod. SP-253, ex. frutos *Duguetia furfuracea* (Annonaceae), 01.X.2001, N.W. Perioto, col.", 2 females and 1 male [LRRP #23294-23296]. The holotype glued on card and paratypes, glued on cards or triangles, are in good condition.

Geographical distribution: BRAZIL, São Paulo state (Fig. 1).

Etymology: The specific epithet refers to the generic name of the host plant.

Diagnosis: Females of *B. dugetiarum* **sp. nov.** (Figs. 2A-2B) can be distinguished by the following set of characters: forewing speculum absent (Figs. 2D); median panel of propodeum with median longitudinal carina vaguely indicated and transverse carinae irregular and interrupted, and basal constriction of F1 asymmetrical (Fig. 2C).

Description: Body length 7.5 mm (holotype) (Figs. 2A-2B). **Color:** Head and mesosoma predominantly dark orange brown; black to dark brown on frontovertex, scrobal depression, apex of the mandibles, occiput, ventral $\frac{3}{4}$ of mesopleuron and propodeum; dark brown on dorsal pronotum except by two dark orange-brown elliptical spots. Antenna with scape dorsally black on $\frac{3}{4}$ apical, pedicel black and the remaining segments dark brown. Legs predominantly pale yellow; black on coxae and $\frac{3}{4}$ basal of pro, meso and metafeur. Metasoma predominantly dark brown. Forewing hyaline, shaded beneath the apical portion of submarginal, marginal and stigmal veins; veins brown with a break between apex of parastigma and base of marginal vein; setae brown. Body setation white. **Head** rectangular, $0.7\times$ as high as wide (Fig. 2E), predominantly densely foveolate, areolate between the inner margin of the eye and dorsal margin of scrobal depression; POL/OOL = 0.6; eye height $0.9\times$ malar space; scrobal depression smooth, dorsally finely imbricate and carinate, with small interantennal prominence; malar space with coriarius sculpture, without setigerous punctures (Fig. 2F); genal carina well developed; supraclipeal sculpture with striae converging toward clypeus; ventral margin of clypeus bilobed (Fig. 2E). Antenna (Fig. 2C): scape $3.4\times$ and pedicel $1.0\times$ as long as wide; F1 $1.9\times$ (tapering towards base), F2-F4 $1.5\times$, F5 $1.3\times$, F6 $1.4\times$ and clava $3.1\times$ as long as wide. **Mesosoma** (Figs. 2G, 2H, 3A) $1.6\times$ as long as wide, densely foveolate except lateral panel of propodeum with fine transversal striation, prepectus and acropleuron smooth, and femoral depression transversely carinate on medial portion. Medial interruption of the anterior carina of pronotum $ca. 4.0\times$ as long as POL. Propodeum broadly concave on meson, median panel

with longitudinal carina interrupted, vaguely indicated, with transverse irregular carinae; callus with coarse areolate-rugose sculpture with long white setae (Fig. 3B). Mesoscutum $2.2\times$ as long as pronotum and $1.5\times$ as long as mesoscutellum measured medially, notauli complete. Mesoscutellum $0.8\times$ as long as wide, arched in lateral view, with apical margin slightly excised in dorsal view (Fig. 2H), scarcely projecting beyond the metanotum. Forewing (Fig. 2D) $2.6\times$ as long as wide, speculum absent; cubital setal line present; submarginal vein $4.7\times$ and $5.6\times$ as long as marginal and postmarginal veins, respectively; postmarginal vein $1.4\times$ as long as stigmal vein. **Metasoma** (Fig. 3C) Mt1 dorsally transverse, very short, $4.7\times$ wider than long. Gaster strongly compressed, wide dorso-ventrally, $2.5\times$ as long as high and $1.4\times$ as long as head+mesosoma, smooth and shine, with fine coriarius sculpture. Mt5-Mt7 laterally and Mt8 dorso apically and ventrally with long white setae.

Variation: The studied specimens showed a striking degree of intraspecific variation in color pattern. In most of them the body is predominantly brown or dark orange; black on vertex, scrobal depression, occiput, dorsal portion of pronotum (in some specimens with a pair of orange spots medially), ventral portion of meso and metapleuron and propodeum; pale yellow on upper and lower face and gena (in some specimens with black or dark brown spots high on lower face and gena), lateral panel of pronotum, prepectum, and dorsal portion of meso and metapleuron; dark brown metasoma (in some specimens with pale yellow marks of different patterns ventrally), shine. In darker specimens, the body is predominantly brown with black markings

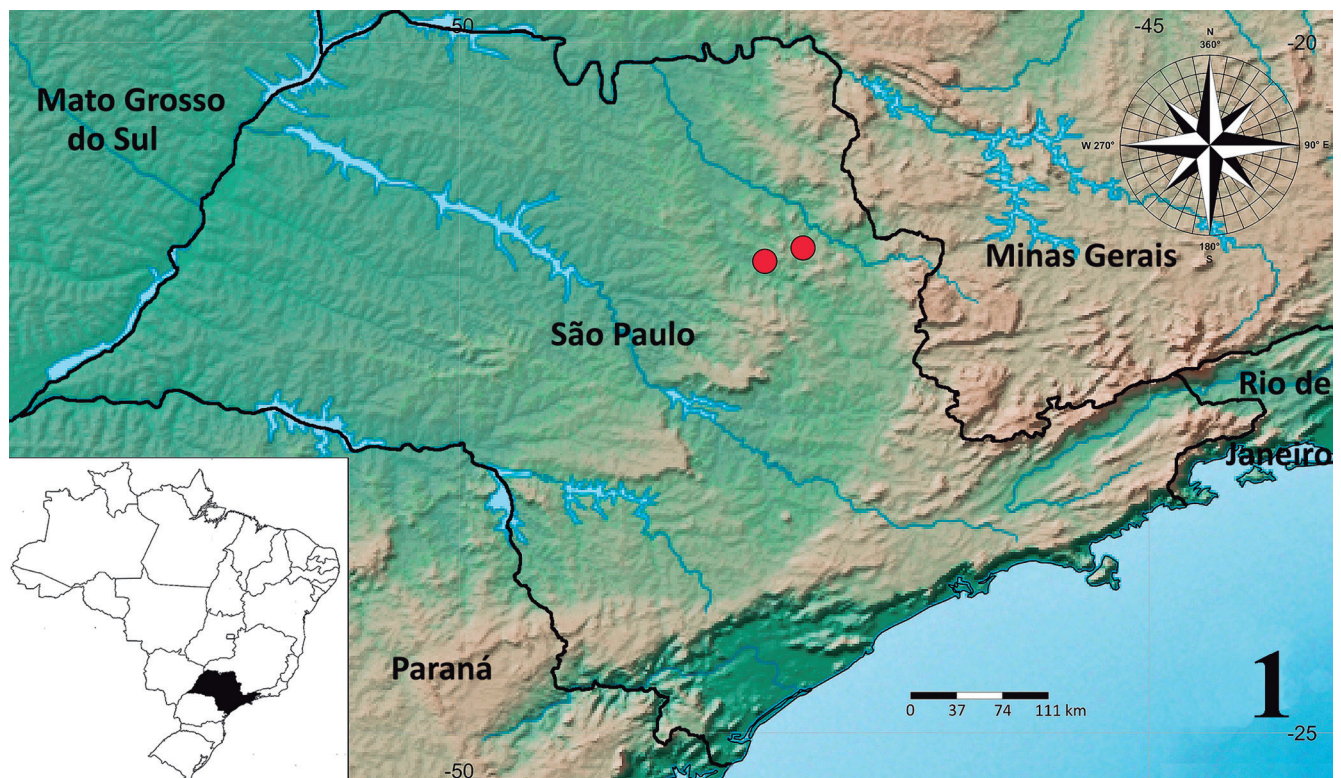


Figure 1. Map of Brazil and in detail the São Paulo state, showing the geographic distribution of *Bephratelloides duquetiarum* Perioto & Lara **sp. nov.** (red dots).

on vertex, scrobal depression, occiput, dorsal portion of pronotum, propodeum and ventral portion of meso and metapleuron. Body length 6.6-7.9 mm. Head 0.6-0.7× as high as wide; POL/OOL = 0.5-0.7; eye height 0.8-1.1× malar space; scape 2.9-3.2× and pedicel 1.0-1.3× as long as wide; F1 1.9-2.1× (tapering towards base), F2-F3 1.5-1.8×, F4 1.4-1.8×, F5 1.4-1.9×, F6 1.3-1.8× and clava 2.6-3.5× as

long as wide. Mesosoma 1.4-1.7× as long as wide, mesoscutum 1.9-2.5× as long as pronotum and 1.2-1.3× as long as mesoscutellum measured medially. Forewing 2.5-3.0× as long as wide, submarginal vein 3.5-4.8× and 5.4-6.4× as long as marginal and postmarginal veins, respectively; postmarginal vein 1.2-1.5× as long as stigmal vein. Mt1 dorsally 5.7-6.0× wider than long. Metasoma

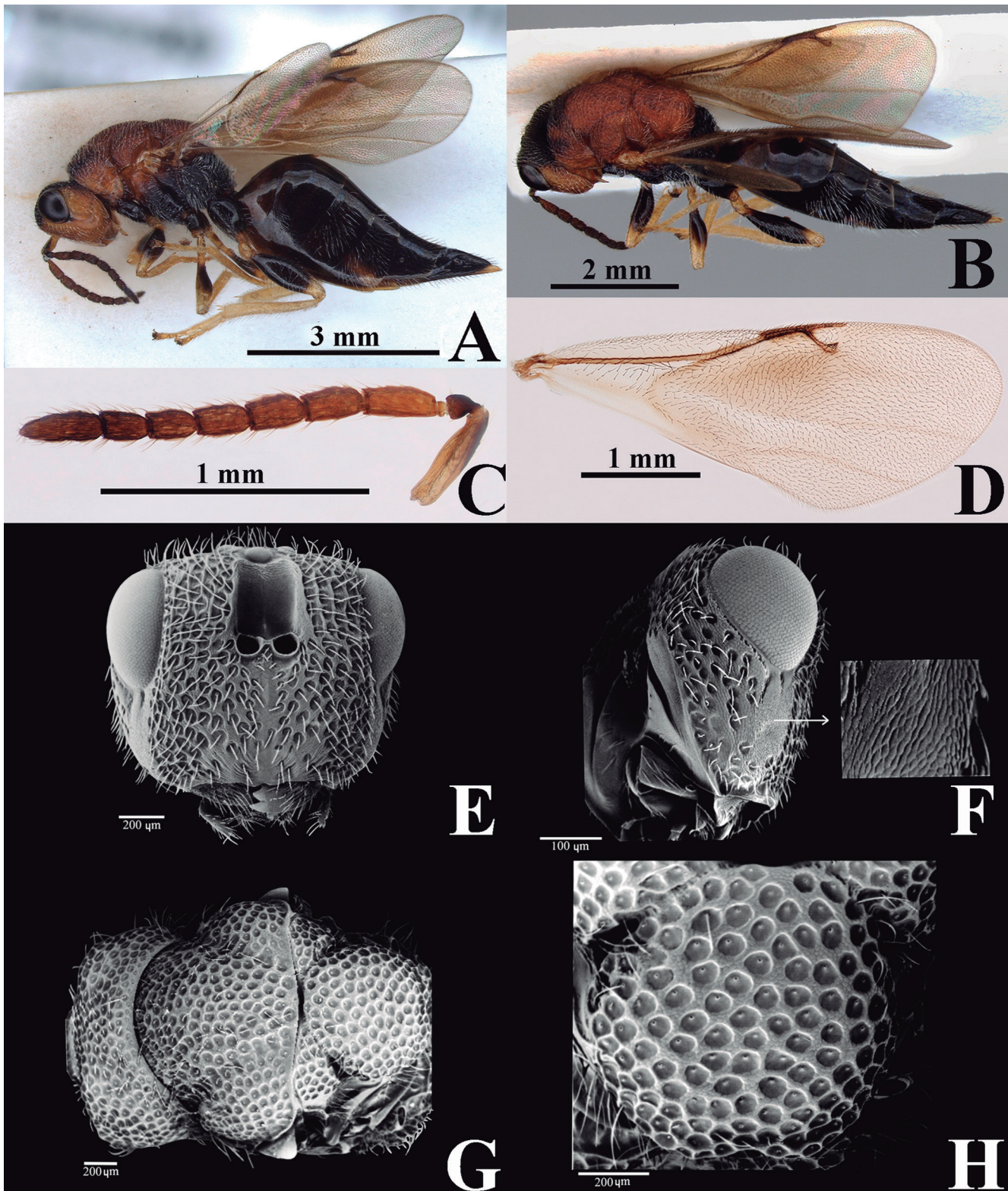


Figure 2. *Bephratelloides duquetiarum* Perioto & Lara **sp. nov.** (A) Habitus, female, lateral view. (B) Habitus, female, dorsolateral view. (C) Antenna, female. (D) Fore wing, female. (E) Head, anterior view. (F) Head, lateral view and malar space, detail of sculpture. (G) Mesosoma, dorsal view. (H) Mesoscutellum, dorsal view.

ma 2.1-2.8× as long as high and 1.4-1.6× as long as head+mesosoma.

Male (Fig. 3E): As in females, the studied male specimens showed a striking degree of intraspecific variation in the color pattern. Most of them presented body predominantly pale yellow with dark brown or black coloration on vertex (in some specimens the darker coloration is restricted to the median region), dorsal portions of scrobal depression and occiput, dorso-apically portion of scape, pedicel, dorsal portion of pronotum (in some specimens restricted to small marks on median region), propodeum (in a few specimens pale yellow with dark brown spots dorso-apically), petiole and dorso-lateral portion of metasoma. The darker specimens presented body

predominantly brown or dark orange with black or dark brown markings on upper and lower mesepisternum, metapleuron and dorsoapical region of hind coxae and femurs infuscated at medial region. Males have a longer petiole, apically with a pair of long setae dorso-laterally (Fig. 3D) and smaller gaster (Fig. 3E) than females. Length = 2.8-5.7 mm; head 1.2-1.3× as wide as high; POL/OOL = 0.5-0.6; eye height 1.0-1.1× malar space. Antenna with scape and pedicel 3.2-3.9× and 1.0× as long as wide, respectively; F1 3.1-3.7×, F2 3.2-3.9×, F3 3.2-3.8×, F4 3.6-3.8×, F5 3.3-3.5×, F6 3.0-3.3× and clava 4.1-4.4× as long as wide. Flagellomeres cylindrical, longer than wide (Fig. 3E), with erect setae. Mesosoma 1.5-1.8× as long as wide; mesoscutum 1.5-2.0× as long as pronotum. Forewing (Fig. 3F) 2.6-3.0× as long as wide, submarginal vein

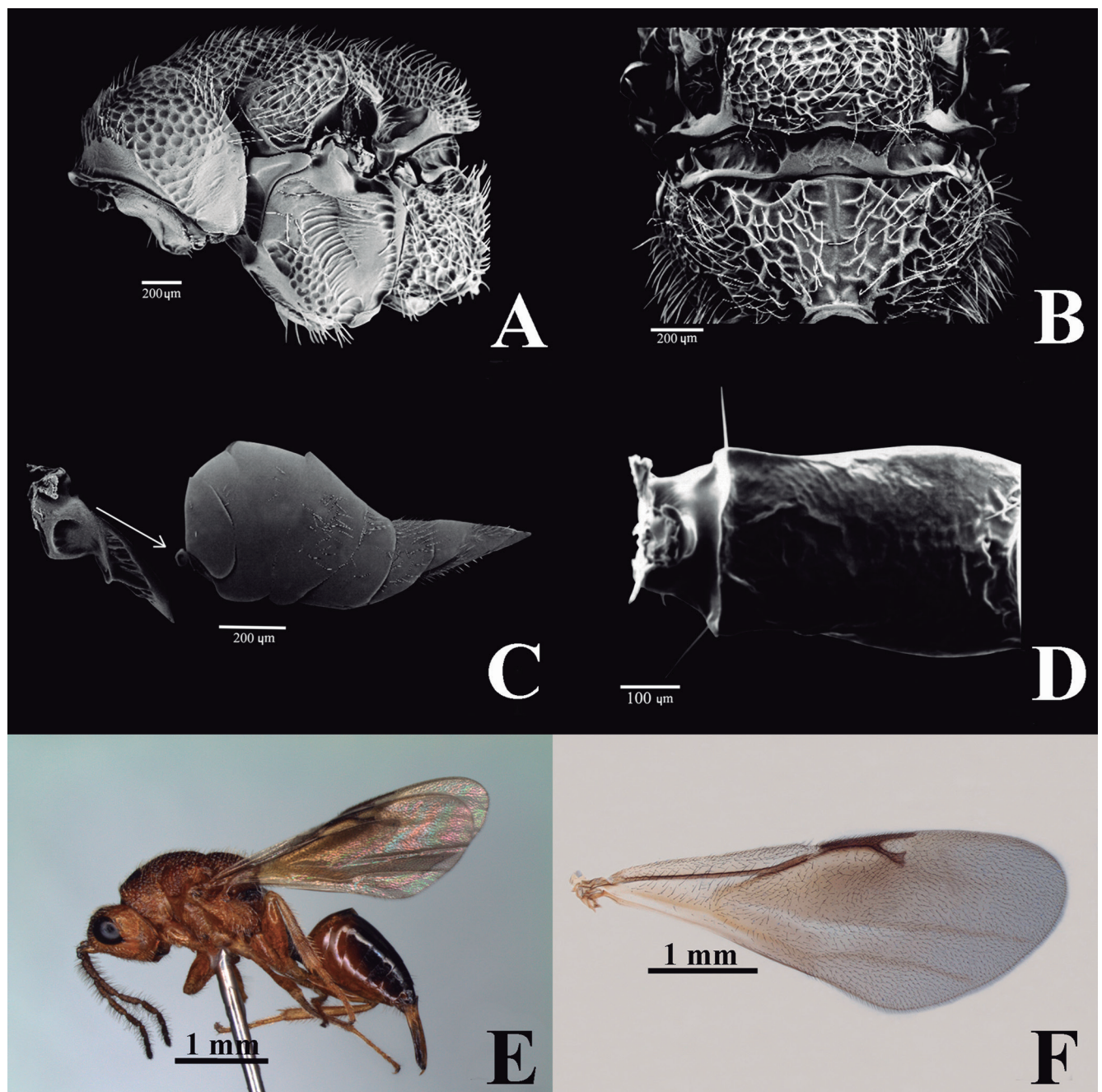


Figure 3. *Bephratelloides duquetiarum* Perioto & Lara **sp. nov.** (A) Mesosoma, lateral view. (B) Dorsellum and propodeum, dorsal view. (C) Metasoma, lateral view and petiole, detail. (D) Petiole, male, dorsal view. (E) Habitus, male, lateral view. (F) Fore wing, male.

3.8-4.4× length of marginal vein and 4.6-5.9× length of postmarginal vein; postmarginal vein 1.1-1.3× length of stigmal vein. Metasoma 1.7-2.1× as long as high and 1.0-1.2× as long as head+mesosoma; petiole 1.7-2.1× as long as wide (Fig. 3E).

Species identification: In the key provided by Grissell & Foster (1996) *B. duquetiarum* **sp. nov.** runs to couplet 4' and can be separated by an additional couplet as follows:

- Both sexes: forewing speculum present, relatively small; median panel of propodeum with single transverse cells. Females: basal constriction of F1 essentially symmetric [see fig. 4 in Grissell & Foster (1996)]
.....*B. ablusus* Grissell & Foster
- Both sexes: forewing speculum absent (Figs. 4, 14); median panel of propodeum with median longitudinal carina vaguely indicated and transverse carinae irregular and interrupted (Fig. 10). Females: basal constriction of F1 asymmetrical (Fig. 3)
.....*B. duquetiarum* Perioto & Lara **sp. nov.**

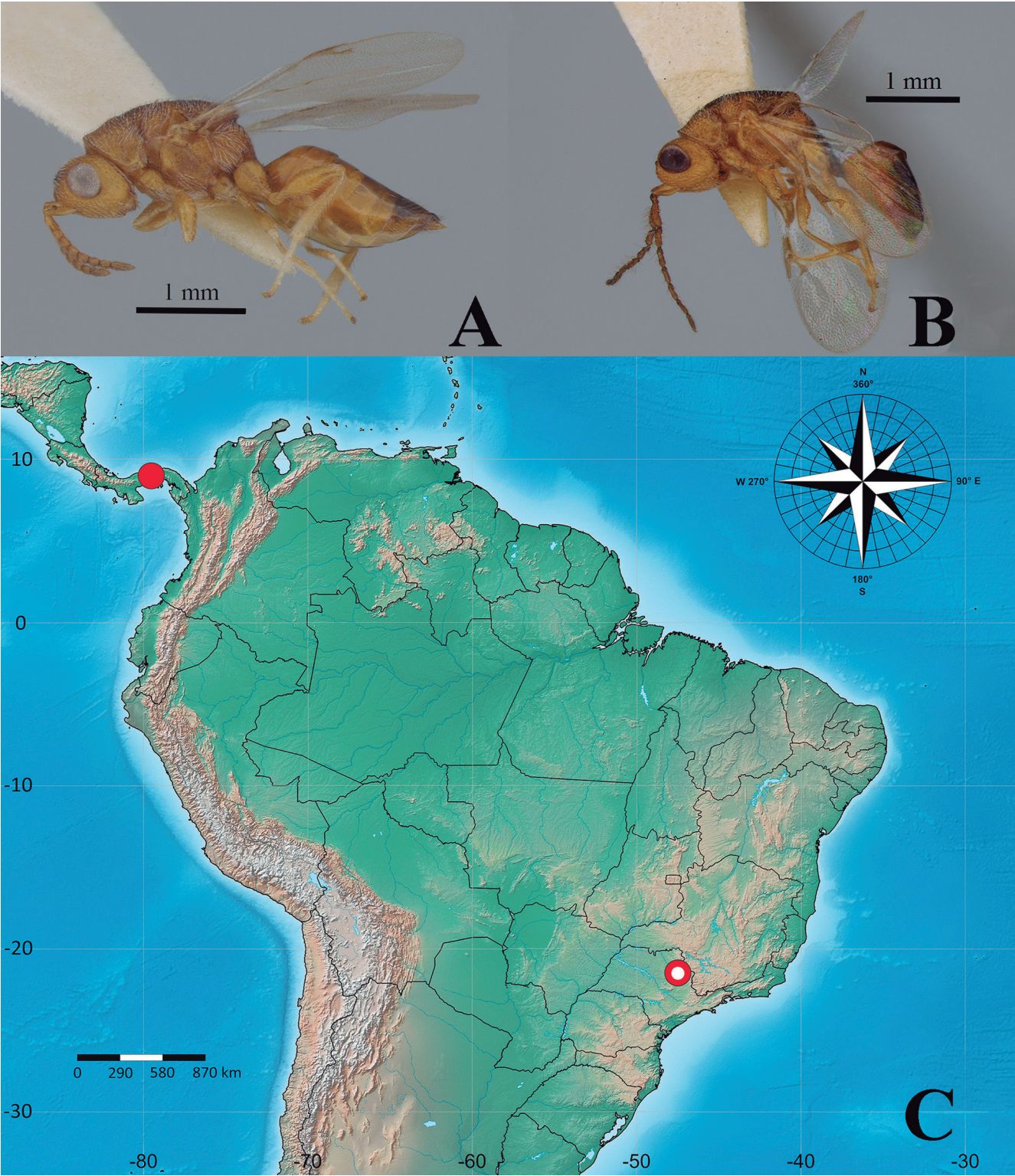


Figure 4. *Bephratelloides petiolatus* Grissell & Schauff, 1990. (A) Habitus, female, lateral view. (B) Habitus, male, lateral view. (C) Map of part of Central and South Americas showing the type-locality and the geographical distribution of *B. petiolatus* (red dot = previous record; red dot with white point = new record).

Comments: In the key provided by Grissell & Foster (1996) *B. duquetiarum* Perioto & Lara **sp. nov.** keys close to *B. ablusus* Grissell & Foster, 1996, and is easily differentiated from it by presenting: a. speculum absent (vs. speculum present, relatively small in *B. ablusus*), b. median panel of propodeum with median longitudinal carina vaguely indicated and transverse carinae irregular and interrupted (vs. median panel of propodeum with single line of transverse cells), c. head and mesosoma predominantly dark orange-brown (vs. predominantly black) and, d. female body length 6.6-7.9 mm (vs. 4.0-5.8 mm).

Biology: All infested seeds of *D. furfuracea* that were dissected contained only one larva, pupa, or adult of *B. duquetiarum* **sp. nov.**, leading us to believe that these insects develop in isolation within the seeds. Seeds containing larvae, pupae, and/or adults of *B. duquetiarum* **sp. nov.** do not differ externally in appearance from uninfested seeds. This observation contrasts with those of Grissell & Foster (1996) for seeds of *C. mayanum* infested with larvae of *B. ablusus*, where they reported that healthy seeds were black while infested seeds were brown. After feeding on the interior tissues of the seeds, the larvae pupate within the seeds, eventually developing into adults. To reach the external environment, the adults use their mandibles to create a hole in the seed coat and then dig a tunnel through the fruit tissues until they emerge outside.

***Bephratelloides petiolatus* Grissell & Schauff, 1990 (Fig. 4)**

Material examined: "BRASIL/SP/São Simão, Sítio Flor do Ipê – Rod. SP 253, ex. fruto *Xylopia aromatica* (Annonaceae), 12/XI/1994, N.W. Perioto, col.", 1 female [LRRP #20844]; same data except: 05/XI/1994, 3 females and 1 male [LRRP #23297-23298, 23300-23301]; 12/11/1994, 1 female and 3 males [LRRP #23299, 23303-23304, 23306]; 27/11/1994, 3 females [LRRP #23302, 23305, 23307].

Geographical distribution: BRAZIL, state of São Paulo (new record) (Fig. 4C), PANAMA (Grissell & Schauff, 1990).

Diagnosis: Length 3.3-3.6 mm; POL subequal or shorter than OOL; mesoscutellum slightly depressed, protruding slightly over metanotum in lateral view, with apex slightly truncated in dorsal view; median panel of propodeum with median carina irregular present only in anterior third and with many irregular, transverse carinae.

Biology: *B. petiolatus* (Figs. 4A, 4B) is associated for the first time with *Xylopia aromatica*. All dissected infested seeds of *X. aromatica* contained only one larva, pupa or adult, leading us to believe that these insects develop individually within them. Additionally, the observations made for *B. duquetiarum* are also applicable to this species.

AUTHORS' CONTRIBUTIONS: NWP, RIRL: Conceptualization, investigation, writing original draft, review & editing. The authors were actively involved

in discussing the results, and they reviewed and approved the final version of the manuscript.

CONFLICT OF INTEREST: Authors declare there are no conflicts of interest.

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