



## Annotated checklist and illustrated key to braconid parasitoids (Hymenoptera, Braconidae) of economically important fruit flies (Diptera, Tephritidae) in Brazil

CLÁUDIA F. MARINHO<sup>1</sup>, VALMIR A. COSTA<sup>2</sup> & ROBERTO A. ZUCCHI<sup>3,4</sup>

<sup>1</sup>Centro de Investigaciones y Transferencia de Catamarca—CITCA-CONICET-UNCA, Prado 366, K4700AAP. San Fernando del Valle de Catamarca, Catamarca, Argentina. E-mail: [cfmarinho@gmail.com](mailto:cfmarinho@gmail.com)

<sup>2</sup>Instituto Biológico, Centro Experimental Central do Instituto Biológico, Alameda dos Vidoeiros 1097, 13101-680 Campinas, SP, Brasil. E-mail: [valmir@biologico.sp.gov.br](mailto:valmir@biologico.sp.gov.br)

<sup>3</sup>Departamento de Entomologia e Acarologia, ESALQ, Universidade de São Paulo, 13418-900, Piracicaba, SP, Brasil. E-mail: [razucchi@usp.br](mailto:razucchi@usp.br)

<sup>4</sup>Corresponding author

### Abstract

The braconid parasitoids of fruit-infesting flies have been more intensively studied from the middle to late 1990s, when taxonomic research was restarted in Brazil. At the same time, efforts toward the biological control of fruit flies intensified, and an exotic species, *Diachasmimorpha longicaudata*, was introduced. In the decade 2010, another exotic species, *Fopius arisanus*, was introduced, and two new species of *Doryctobracon* were described. Currently, 12 species of braconids from the subfamilies Alysiniinae (two species) and Opiinae (10 species) are associated with fruit flies of economic importance in Brazil, two of which are introduced species. More than half of the species belong to the genus *Doryctobracon*, with *D. areolatus* (Szépligeti) the most widely distributed species in Brazil.

**Key words:** Alysiniinae, Opiinae, *Anastrepha*, *Ceratitis capitata*

### Introduction

Several species of *Anastrepha* and *Ceratitis capitata* (Wiedemann) (an exotic species) are the main pests of Brazilian fruit growing. Among the methods for the control of these pests, biological control has been investigated through the rearing techniques and field releases of fruit fly braconid parasitoids. In Brazil, the biological control of tephritids are mainly concentrated in two native species, *Doryctobracon areolatus* (Szépligeti) and *D. brasiliensis* (Szépligeti), and two introduced species, *Diachasmimorpha longicaudata* (Ashmead) and *Fopius arisanus* (Sonan). Braconids are mostly koinobiont endoparasitoids of cyclorrhaphous Diptera. Most of these braconids oviposit in the larval stage, however, *F. arisanus* oviposits in the egg of its host. The braconid adults emerge from the host's puparium.

Taxonomic studies on braconid parasitoids of fruit-infesting fruit flies in Brazil began in the late 1930s (Lima 1937; 1938). In the following decades, research on these parasitoids remained incipient. Studies restarted in the 1990s, when a MSc thesis on fruit fly braconid parasitoids recorded in Brazil was presented (Leonel Junior 1991). Later on, four species associated with fruit flies were recorded in the state of Amazonas (Canal & Zucchi 1994). In the next year, nine species were discussed, and the synonymies of the tephritid braconids in Brazil were listed (Leonel Junior *et al.* 1995). This study can be considered the starting point for the resumption of Brazilian research on braconids parasitizing fruit flies. Finally, two new species were described (Marinho *et al.* 2017), totalizing 12 species of braconids parasitizing fruit flies in Brazil.

The objective of this study was to gather information about the braconids associated with species of tephritid fruit flies of the genus *Anastrepha* Schiner and also *Ceratitis capitata* (Wiedemann) in Brazil. An illustrated key based on morphological characters was developed to aid non-taxonomists, mostly researchers involved with biological control, to identify braconid parasitoids of economically important fruit flies in Brazil.

## Material and methods

The specimens were collected in fruit fly surveys carried out in the last two decades by researchers from several Brazilian institutions, and sent to our laboratory for identification. The association of a braconid and a fruit fly was established when specimens of a single species of parasitoid and fruit fly emerged in a glass tube with a sample of fruit (Leonel Junior *et al.* 1995). Some of the specimens studied were deposited in the collection of the ESALQ (Piracicaba, São Paulo, Brazil), in the collection of the Department of Ecology and Evolutionary Biology at the Federal University of São Carlos (UFSCar) in São Carlos, São Paulo, Brazil (DCBU), and in the Oscar Monte Collection of Entomophagous Insects, at the Biological Institute (Campinas, São Paulo, Brazil).

Terminology for body morphology and wing veins broadly follows Sharkey & Wharton (1997) and Wharton (1997). The illustrated key is based on these articles and also on the on-line identification key of Wharton & Yoder (n.d.). Anatomical structures are based on the Hymenoptera Anatomy Ontology (HAO) (Yoder *et al.* 2010).

Electron microscopy images were obtained in Zeiss DSM940A and LEO 435VP scanning electron microscopes at the Research Support Center, Electron Microscopy Applied to Agricultural Research (NAP/MEPA), ESALQ/USP. Digital images were produced using a Motic® 2000 2.0MP digital camera coupled to a Nikon® E200 stereoscopic light microscope. In some cases, specimens were photographed with a Leica DFC 420 digital camera installed in a Leica M165C stereomicroscope; photographs were combined with the Leica Application Suite v3.8 to produce the final extended-focus images. Also, the SEM micrographs of *F. arisanus* (Sonan) were taken of an uncoated specimen in low vacuum, with a Quanta 250 scanning electron microscope (FEI Company, Hillsboro, USA) at the “Universidade Federal de São Carlos” in São Carlos, state of São Paulo, Brazil.

Information on associated hosts and distribution in the Brazilian states is derived from the databases of Zucchi & Moraes (2008, 2012).

## Discussion

The parasitoid braconids of fruit-infesting Tephritidae in Brazil belong to the subfamilies Opiinae (10 species) and Alysiniinae (two species). Opiines are more commonly collected in fruit fly surveys throughout Brazil. Among alysiines, *Asobara anastrephae* (Muesebeck) is occasionally collected, and *Microcrasis lonchaeae* Lima is rare within parasitoid surveys. Species of five genera of Opiinae are associated with species of *Anastrepha* and *C. capitata* in Brazil. *Doryctobracon* Enderlein has the most parasitoids of fruit flies (see checklist); each of the other genera has only one species that parasitizes fruit flies of economic importance in Brazil. Two braconid species have been introduced for controlling fruit flies in Brazil, *Diachasmimorpha longicaudata* in 1994 by “Embrapa Mandioca e Fruticultura” (Carvalho *et al.* 1995), and *Fopius arisanus*, in 2012 by “Embrapa Semiárido” (Paranhos *et al.* 2013; Sá & Pessoa 2015).

Some other opiines have been recorded associated with tephritids with no agricultural importance in Brazil. These species are not commonly collected and information on them is very meager, sometimes restricted only to original descriptions. For example, *Utetes itatiayensis* (Lima) and *U. tomoplagniae* (Lima) were found associated with *Tomoplagnia* sp. and *T. rudolphi* Lutz & Lima, respectively (Lima 1938). Both species were described originally in the genus *Opius*, but they were transferred to the genus *Utetes* by Wharton (1997). The record of *U. tomoplagniae* in the state of Santa Catarina (Nora *et al.* 2000) is a misidentification. The correct identification, according to Canal & Zucchi (2000), is *U. anastrephae* Viereck. These species belong to the species-group of *U. anastrephae*, which is characterized by the presence of a dorso-posterior carina on the hind tibia, and the head with no occipital carina (Wharton 1997).

*Opius bucki* Lima is another opiine known exclusively from its original description. Information on its host is contradictory, as Lima (1938) suggested that *O. bucki* could be reared from a tephritid, but according to Wharton & Yoder (n.d.), the host could be an agromyzid.

Two additional species of Alysiniinae, *Phaenocarpa pericarpa* Wharton & Carrejo and *Idiasta delicata* (Papp), have been recorded in Brazil, but these were not associated with species of *Anastrepha* or with *C. capitata*. However, *P. pericarpa* was associated with a lonchaeid species in the state of Amazonas, Brazil (Costa *et al.* 2009) and with *Anastrepha distincta* Greene in other countries (Trostle *et al.* 1999). *Idiasta delicata* occurs in five Brazilian states (Arouca & Pentead-Dias 2009), but no host is known for this parasitoid.

## List of braconid parasitoids of fruit flies (Diptera, Tephritidae)

### Subfamily Alysiinae

#### *Asobara anastrephae* (Muesebeck, 1958)

(Figure 1A)

**Diagnosis.** Mandibles exodont with three well-developed teeth, notauli incomplete, propodeum with short median carina anteriorly and areola posteriorly, wings hyaline, stigma brown, fore wing (RS+M)b present, 2<sup>nd</sup> submarginal cell long 4-sided, 1<sup>st</sup> subdiscal cell very weakly defined posteriorly and distally, hind wing with Cu-a and m-cu absent.

**Comments.** *Asobara anastrephae* is associated with 10 species of *Anastrepha* and *C. capitata* (see Zucchi & Moraes 2008, 2012) in Brazil, but it is not collected frequently.

#### *Microcrasis lonchaeae* (Lima, 1937)

(Figure 1B)

**Diagnosis.** Mandibles exodont with four teeth (three well-developed, one weakly developed along lower border of mandible); propodeum with long median carina anteriorly followed by areola posteriorly, where anteriorly from the areola, run two transverse keels; notauli smooth and restricted to anterior portion of mesoscutum; wings hyaline, fore wing with m-cu reaching 2<sup>nd</sup> submarginal cell, 2<sup>nd</sup> submarginal cell long 5-sided (2RS longer than 3RSa), r-m strongly sinuous, 1<sup>st</sup> subdiscal cell completely closed, hind wing with cu-a, 1A, r-m strongly pigmented and veins 2M, 1RSa, m-cu faintly pigmented but present.

**Comments.** *Microcrasis lonchaeae* is rarely found in surveys of fruit flies on fruit in Brazil. It was originally described as *Opius lonchaeae*, and later renamed *Alysia lonchaeae* by Lima (1938). Wharton (1980) transferred this species to the genus *Microcrasis*, based on the morphology of the fore wing. In Brazil, Lima (1937, 1938) associated *M. lonchaeae* with *Neosilba pendula* (Bezzi), as *Silba pendula* and *Lonchaea pendulans* [sic] in Rio de Janeiro and São Paulo (Fernandes 2009). In São Paulo, Fernandes (2009) obtained *M. lonchaeae* in the same sample where species of *Anastrepha* and *C. capitata* emerged, although it is not clear which host, or if both hosts were parasitized. This parasitoid is also found in Santa Catarina (Canal & Zucchi 2000).

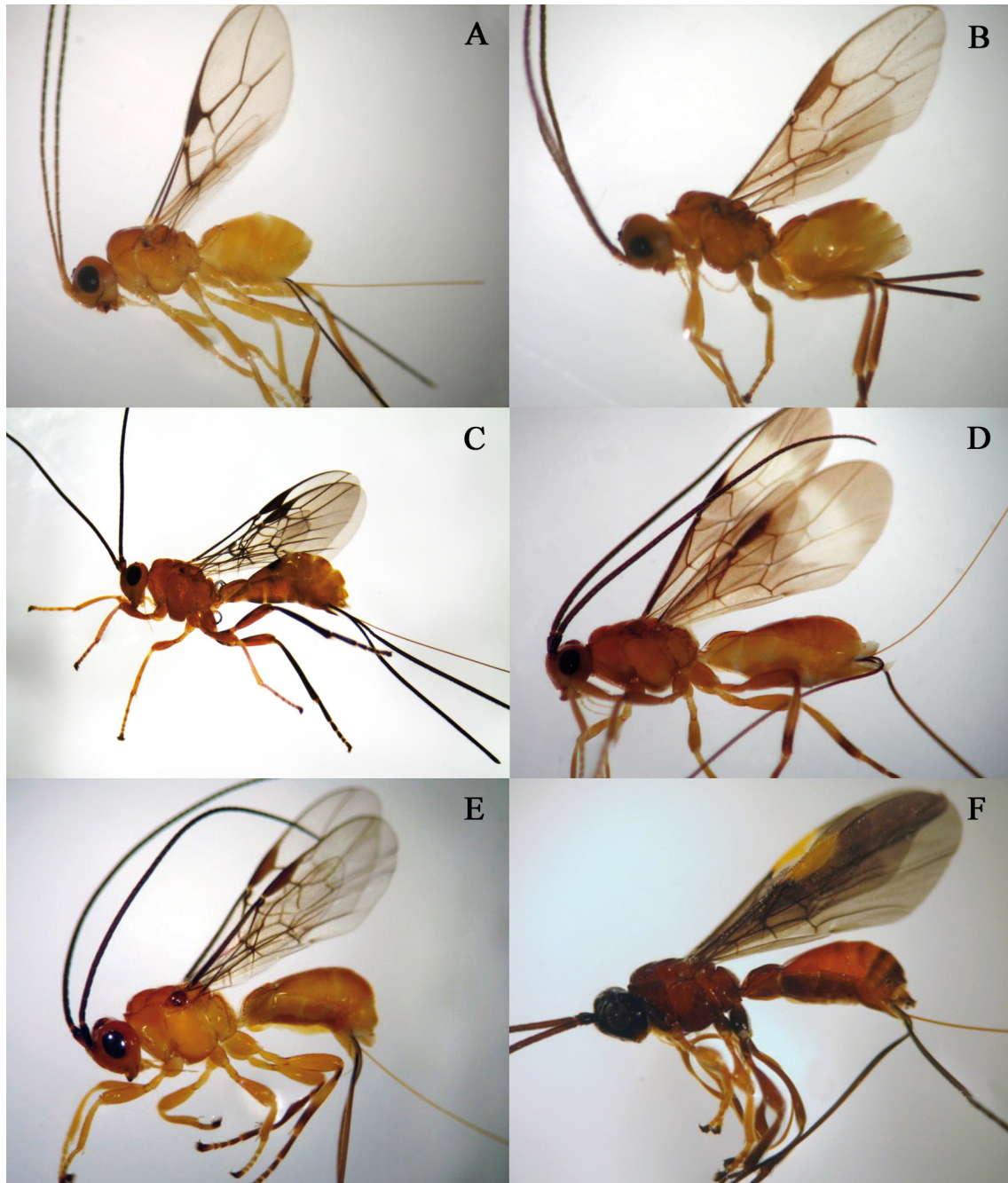
### Subfamily Opiinae

#### *Diachasmimorpha longicaudata* (Ashmead, 1905)

(Figure 1C)

**Diagnosis.** Occipital carina well-developed laterally, notauli deeply impressed and smooth, propodeum varying from extensively rugose to smooth with only trace of weak carinae, second metasomal tergum striate medially, fore wing m-cu arising from a shortened 2<sup>nd</sup> submarginal cell 5-sided, hind wing m-cu present.

**Comments.** This parasitoid can be separated from other species discussed here by the fore wing m-cu arising from a shortened 2<sup>nd</sup> submarginal cell 5-sided. It is originally from the Indo-Australian Region. *Diachasmimorpha longicaudata* has been used in several biological control programs in Latin America (Ovruski *et al.* 2000), because it adapts readily to several pest fruit flies. In Brazil, it was introduced in 1994 by “Embrapa Mandioca e Fruticultura” (Carvalho *et al.* 1995) and is present in 10 states. Some studies on *D. longicaudata*, such as the olfactory response (Silva *et al.* 2007), field dispersal, rates of parasitism and field survival when reared in two hosts (Camargos *et al.*, 2016, 2018), and learning behavior of the female related to two essential oils (Zadra *et al.* 2018) have been conducted in Brazil. *D. longicaudata* has recently been certified as a biological insecticide in Brazil, as it was published in the Federal Register, on September 3, 2018, edition 170, section 1, p. 127, based on Joint Normative Instruction nr. 2 on August 8, 2018.



**FIGURE 1.** Fruit fly braconid parasitoids. *Asobara anastrephae* (A); *Microcrasis lonchaeae* (B); *Diachasmimorpha longicaudata* (C); *Doryctobracon adamei* (D); *D. areolatus* (E); *D. brasiliensis* (F) (figures are not on the same scale).

***Doryctobracon adamei* Marinho & Pentead-Dias, 2017**

(Figure 1D)

**Diagnosis.** Fore wing infumate, with a broad rounded hyaline spot from stigma to middle of R1a but not reaching the posterior margin, stigma dark brown, propodeum areolate (details in Marinho *et al.* 2017).

**Comments.** It is close to *D. areolatus* and *D. whartoni* but is differentiated from both by morphometric and molecular data (Marinho *et al.* 2017), and also by wing color (see key). *Doryctobracon adamei* occurs in the states of Amapá (Deus *et al.* 2010; Silva *et al.* 2011; Adaime *et al.* 2018), Amazonas (Dutra *et al.* 2013), Goiás (Velooso *et al.* 1996; Braga-Filho *et al.* 2001), Roraima (Amorim 2003; Ronchi-Teles 2008; Marsaro Junior *et al.* 2008; 2009;

2010) and Tocantins (Bomfim *et al.* 2007), parasitizing larvae of *Anastrepha coronilli* Carrejo & González, *A. atrigona* Hendel, *A. fraterculus* (Wiedemann) and *A. striata* Schiner. For a long time, *D. adamei* was referred in the Brazilian literature as *Doryctobracon* sp. 2 (Marinho *et al.* 2017).

### ***Doryctobracon areolatus* (Szépligeti, 1911)**

(Figure 1E)

**Diagnosis.** Occipital carina absent, clypeus with sinuate margin, notauli unsculptured, propodeum areolate with median longitudinal carina anteriorly and areola posteriorly, wings clear, fore wing with 2<sup>nd</sup> submarginal cell short 4-sided, hind wing with m-cu present.

**Comments.** This is the most widespread fruit-fly parasitoid in the New World. In Brazil, *D. areolatus* is widely distributed, and it is the most common and abundant species parasitizing several *Anastrepha* species and *Ceratitis capitata* (Leonel Junior *et al.* 1995; Canal & Zucchi 2000; Zucchi & Moraes 2008, 2012). *Doryctobracon areolatus* comprises a complex of cryptic species, and recently two new species closely similar to this parasitoid, *D. adamei* and *D. whartoni*, were described (Marinho *et al.* 2017). Probably *D. areolatus* forages only on fruits still on the tree, as it did not forage on fallen fruits in a shade house (Silva *et al.* 2007). *Doryctobracon areolatus* is a parasitoid of the larva/pupa, but it can also parasitize eggs of *A. obliqua*, as reported in Mexico (Murillo *et al.* 2015). Studies on biological parameters and the potential use of *D. areolatus* as a biological agent for control of fruit flies are being carried out in Brazil (Nunes *et al.* 2011).

### ***Doryctobracon brasiliensis* (Szépligeti, 1911)**

(Figure 1 F)

**Diagnosis.** This species is readily distinguished by the infumate fore wing and yellow stigma, propodeal sculpture reduced to two apical ridges, notauli incomplete, fore wing with 2<sup>nd</sup> submarginal cell short with 4-sided, and hind wing with m-cu present.

**Comments.** *Doryctobracon brasiliensis* is distributed in northern, southwestern and southern Brazil, parasitizing nine *Anastrepha* species, including economically important species such as the South American fruit fly *Anastrepha fraterculus*, the West Indian fruit fly (*A. obliqua*), and also the Mediterranean fly (*C. capitata*) (Souza Filho 1999). For this reason, rearing techniques for *D. brasiliensis* are being studied in Brazil (Poncio *et al.* 2018).

### ***Doryctobracon crawfordi* (Viereck, 1911)**

(Figure 2A)

**Diagnosis.** Head dark and mandibles brownish, propodeal sculpture reduced to two apical ridges, wing evenly infumate, stigma blackish, 2<sup>nd</sup> submarginal cell short with 4-sided.

**Comments.** The dark head easily distinguishes *D. crawfordi* from the other braconids that parasitize fruit-infesting tephritids. This parasitoid was found recently in Amapá and Roraima states of northern Brazil (Zucchi *et al.* 2011). Its known hosts are *A. atrigona* Hendel, *A. coronilli* Carrejo & González and *A. serpentina* (Wiedemann).

### ***Doryctobracon fluminensis* (Lima, 1938)**

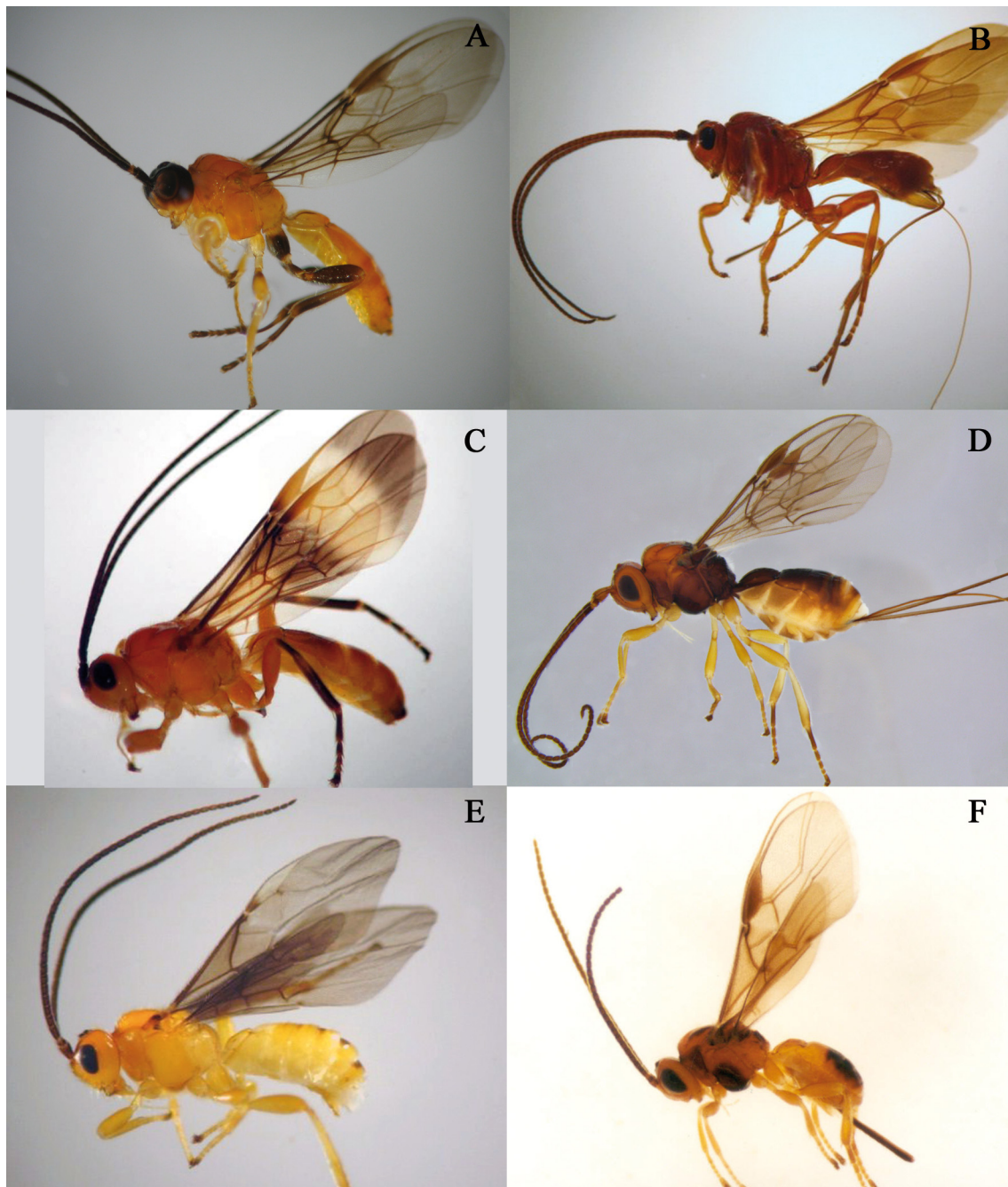
(Figure 2B)

**Diagnosis.** Propodeum areolate, fore wing evenly infumate, stigma brown, 2<sup>nd</sup> submarginal cell short with 4-sided.

**Comments.** This is not a common species in fruit-fly surveys, although it has been recorded in five Brazilian states. *Doryctobracon fluminensis* was described from larvae of *A. fraterculus* collected in the state of Rio de Janeiro; however, it attacks five others species of *Anastrepha* as well (Zucchi & Moraes 2008). Sixty-five years



after the original description, *D. fluminensis* was rediscovered from larvae of *Anastrepha monte* Lima in *Manihot esculenta* Crantz, in the municipality of Rochedo, state of Mato Grosso do Sul (Uchôa *et al.* 2003).



**FIGURE 2.** Fruit fly braconid parasitoids. *Doryctobracon crawfordi* (A); *D. fluminensis* (B); *D. whartoni* (C); *Fopius arisanus* (D); *Opius bellus* (E); *Utetes anastrephae* (F) (figures are not on the same scale).

***Doryctobracon whartoni* Marinho & Pentead-Dias, 2017**

(Figure 2C)

**Diagnosis.** Fore wing infumate with two hyaline bands, one near base and one on apical half of wing; stigma yellow; propodeum areolate; 2<sup>nd</sup> submarginal cell short 4-sided; hind wing m-cu present (details in Marinho *et al.* 2017).

**Comments.** *Doryctobracon whartoni* is closely related to *D. areolatus* and *D. adamei*, but differs from these species in morphometric and molecular data (Marinho *et al.* 2017). These three species can be differentiated by

wing color (see key). *Doryctobracon whartoni* occurs in Pedra Branca do Amapari, state of Amapá, parasitizing *Anastrepha atrigona* in fruits of *Geissospermum argenteum* Woodson (Deus *et al.* 2010). This species was previously mentioned in the Brazilian literature as *Doryctobracon* sp. 1 (Marinho *et al.* 2017).

### ***Fopius arisanus* (Sonan, 1932)**

(Figure 2D)

**Diagnosis.** Frons with large punctures (rugose appearance), occipital carina present, notauli crenulate, striate sculpturing on second metasomal tergum, fore wing hyaline with 2<sup>nd</sup> submarginal cell short (3RSa less than or equal to 2RS), m-cu arising directly in line with 2RS, hind wing RS absent and m-cu present.

**Comments.** *Fopius arisanus* is easily separated from the other species discussed here, by its strongly sculptured body and dark thoracic pleura and abdomen. It is native to the Indo-Pacific Region and is an egg-larval parasitoid of fruit flies. It was introduced from Florida to Brazil by “Embrapa Semiárido” in 2012 (Paranhos *et al.* 2013; Santos *et al.* 2014; Sá & Pessoa 2015). In Brazil, it is being studied to control *Anastrepha fraterculus* and *Ceratitis capitata* (Groth *et al.* 2016).

### ***Opius bellus* Gahan, 1930**

(Figure 2E)

**Diagnosis.** Occipital carina absent, labrum concealed by clypeus when mandibles closed, notauli and midpit absent, propodeum with strong median carina, hind tibia with no basal carina, apex and base of posterior tibiae black or yellow, wings infumate, stigma broad, fore wing with (RS+M)b present, 2<sup>nd</sup> submarginal cell long 4-sided, hind wing with m-cu absent.

**Comments.** *Opius bellus* belongs to the subgenus *Bellopius* Wharton, which is constituted of Neotropical species associated with tephritids, and it is characterized by the absence of the occipital carina and notauli (Wharton 1997). *Opius bellus* has dark-brown tibiae. In Brazil, some specimens have dark-brown tibiae and others have yellowish tibiae. These specimens were considered as *Opius* sp. aff. *bellus* for about two decades. However, based on geometric morphometry and molecular analyses, it was concluded that specimens with yellowish tibiae actually belong to *O. bellus* as well (Marinho *et al.* 2014). *Opius bellus* is quite common in several fruit-fly surveys, recorded in 22 Brazilian states, and is predominant in the state Amazonas (Canal *et al.* 1994, 1995) and Piauí (Araújo *et al.* 2014, Vilanova *et al.* 2016, Souza *et al.* 2017). It parasitizes 19 species of *Anastrepha*, including some of economic importance, and *C. capitata* (see Zucchi & Moraes 2008; 2012).

### ***Utetes anastrephae* (Viereck, 1913)**

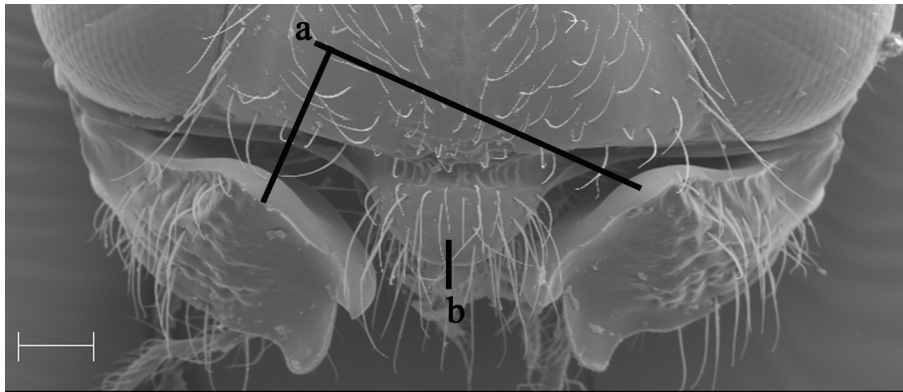
(Figure 2F)

**Diagnosis.** Clypeal margin truncate or concave, occipital carina absent, notauli short and not sculptured, propodeum rugose with irregular transverse carina on anterior half, hind tibia dorso-posteriorly with distinct basal carina, fore wing hyaline with 2<sup>nd</sup> submarginal cell long 5-sided, stigma brown.

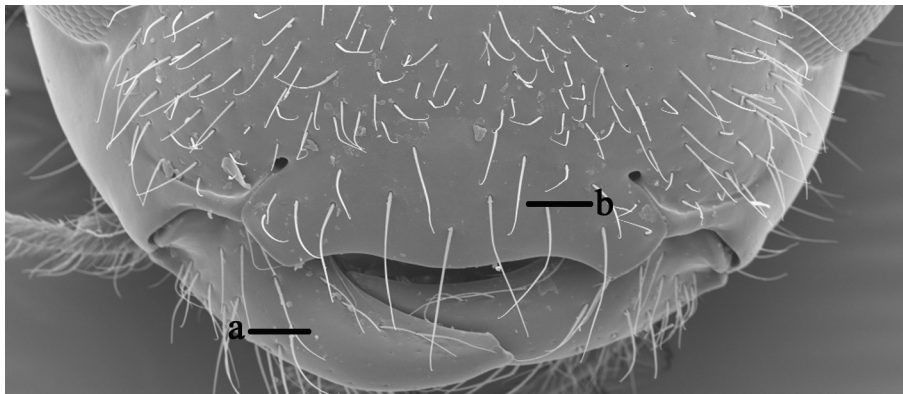
**Comments.** *Utetes anastrephae* was originally described as *Opius anastrephae* by Viereck in 1913, and was transferred by Fischer (1977) to the genus *Bracananastrepha*. Wharton (1988) retained *Bracananastrepha* as a subgenus of *Utetes*, where the species from the New World with a distinct carina at the base of the posterior tibia were placed. *Utetes anastrephae* is distributed throughout the Neotropical Region, and may be a complex of closely related species with subtle differences in ovipositor length, body sculpturing and host preference (Wharton 1997). It is the only species of *Utetes* recorded from species of *Anastrepha*. It occurs in 20 states in all five Brazilian regions, and has been found associated with 16 species of *Anastrepha* and with *C. capitata* (see Zucchi & Moraes 2008; 2012).

**Illustrated key**

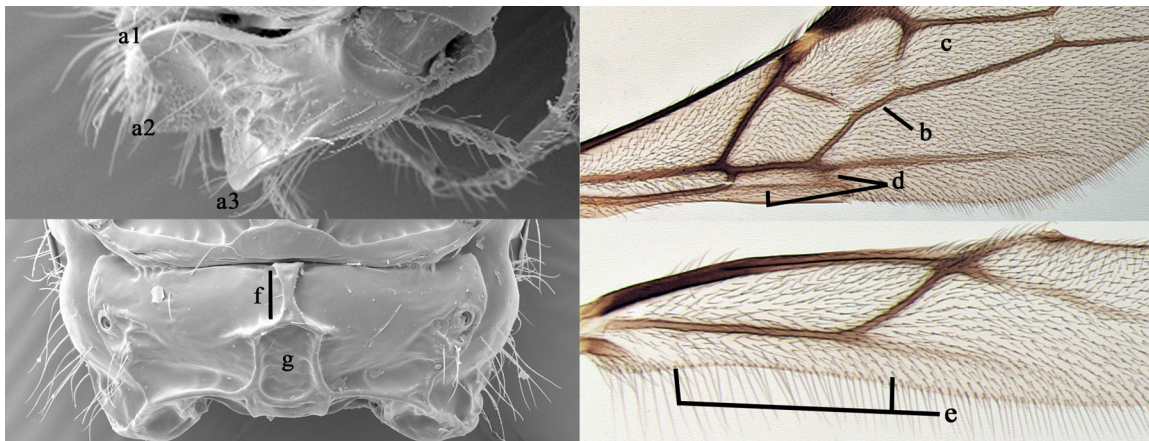
- 1 Mandibles not touching or overlapping when closed (exodont) (a); clypeus small (Alysiinae) (b).....2



- 1' Mandibles touching and usually overlapping when closed (endodont) (a); clypeus developed (Opiinae) (b).....3

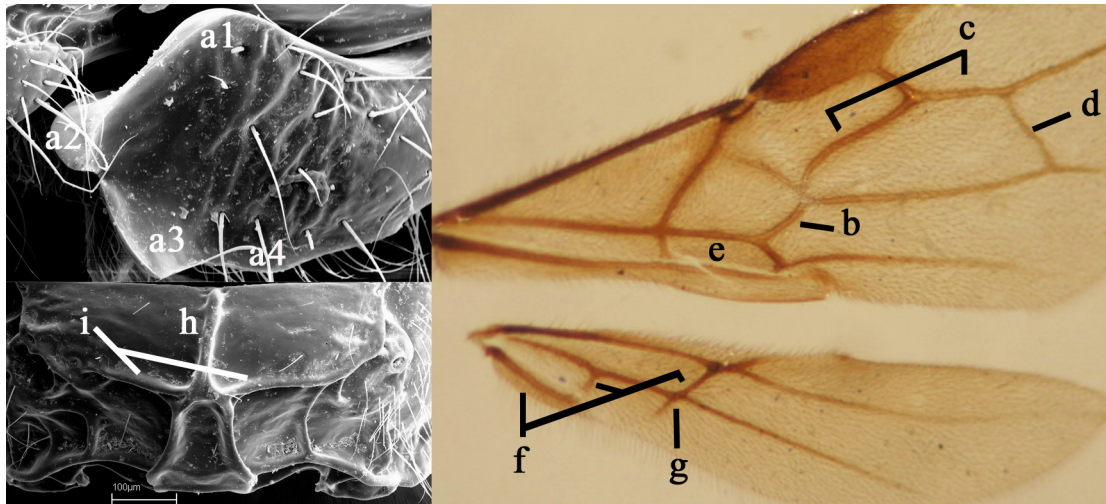


- 2(1) Mandibles with three teeth (a1-a3); fore wing (RS+M)b present (b); 2<sup>nd</sup> submarginal cell long 4-sided (c); 1<sup>st</sup> subdiscal cell very weakly defined posteriorly and distally (d); hind wing with Cu-a and m-cu absent (e); propodeum with short median carina anteriorly (f) and areola posteriorly (g)..... *Asobara anastrephae* (Muesebeck, 1958)

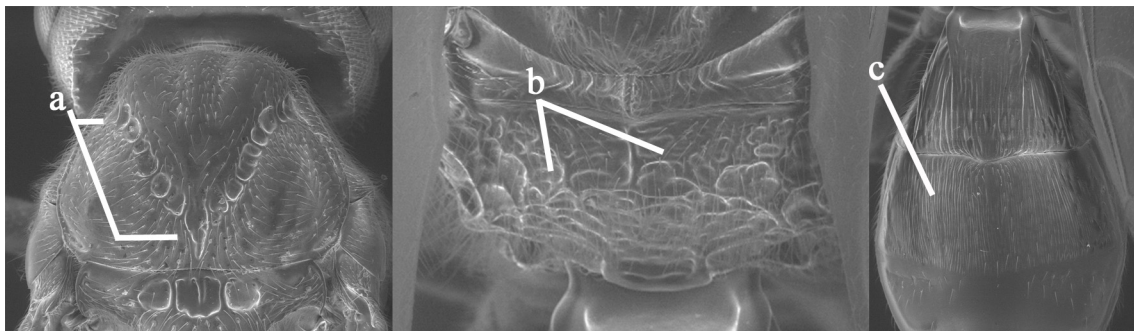




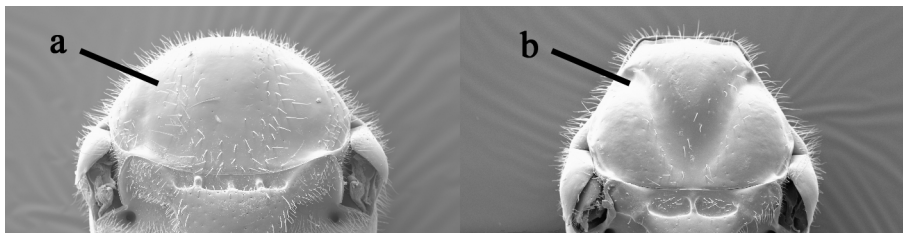
- 2' Mandibles with four teeth (a1-a4); fore wing m-cu reaching 2<sup>nd</sup> submarginal cell (b); 2RS longer than 3RSa (c); r-m strongly sinuous (d); 1<sup>st</sup> subdiscal cell completely closed (e); hind wing with cu-a, 1A and r-m well pigmented (f) and m-cu pigmented weakly but present (g); propodeum with long median carina anterior (h) followed by areola posterior, where previously, run two transverse keels (i) . . . . . *Microcrasis lonchaeae* (Lima, 1937)



- 3(1') Mesoscutum with notauli present and completely sculptured to midpit (a); propodeum densely rugose, without obvious pattern (b); second metasomal tergum with striate sculpturing (c) . . . . . *Fopius arisanus* (Sonan, 1932)



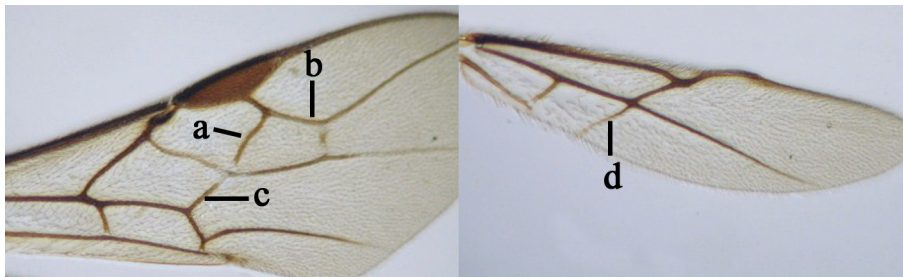
- 3' Mesoscutum with notauli absent (a) or present (b), but unsculptured . . . . . 4



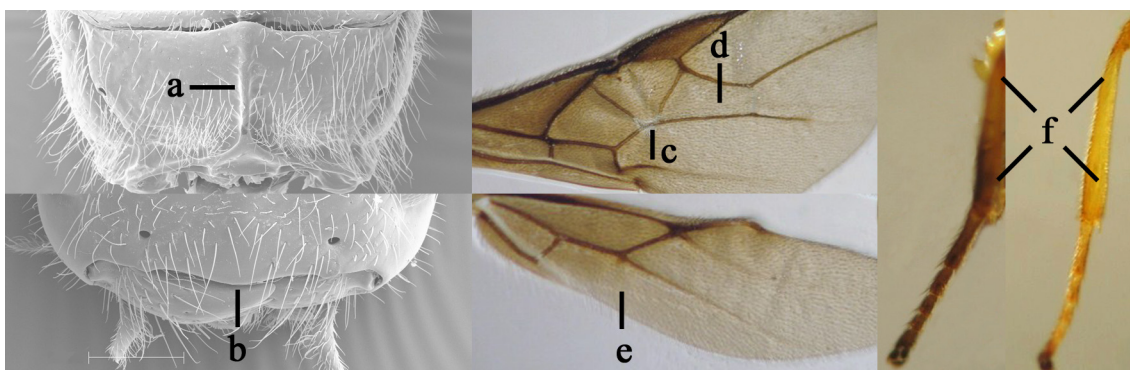
- 4 (3') Fore wing 2RS (a) distinctly shorter than 3RSa (b); hind wing m-cu absent (c) . . . . . 5



4' Fore wing with 2RS (a) equal to or longer than 3RSa (b); m-cu in direct line with 2RS (c); hind wing m-cu present (d) . . . . . 6



5(4) Propodeum unsculptured, with strong median carina (a); labrum completely concealed by clypeus when mandibles closed (b); fore wing (RS+M)b present (c) and 2<sup>nd</sup> submarginal cell long 4-sided (d); hind wing m-cu absent (e); apex and base of posterior tibiae black or yellow (f) . . . . . *Opius bellus* (Gahan, 1930)

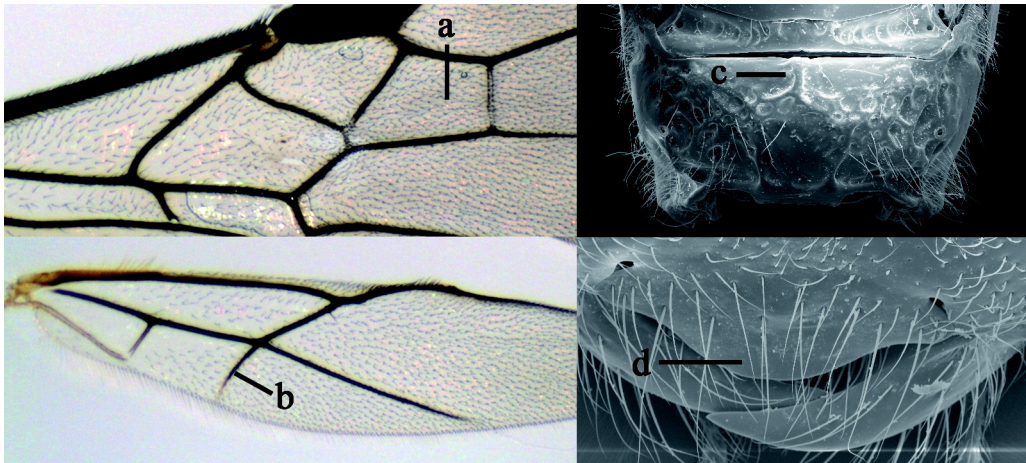


5' Propodeum rugose, usually without pattern (a); clypeal margin truncate to concave (b), thus forming a distinct opening between clypeus and mandibles when mandibles closed (c); fore wing with 2<sup>nd</sup> submarginal cell long 5-sided (d); hind wing m-cu absent (e) . . . . . *Uetetes anastrephae* (Viereck, 1913)

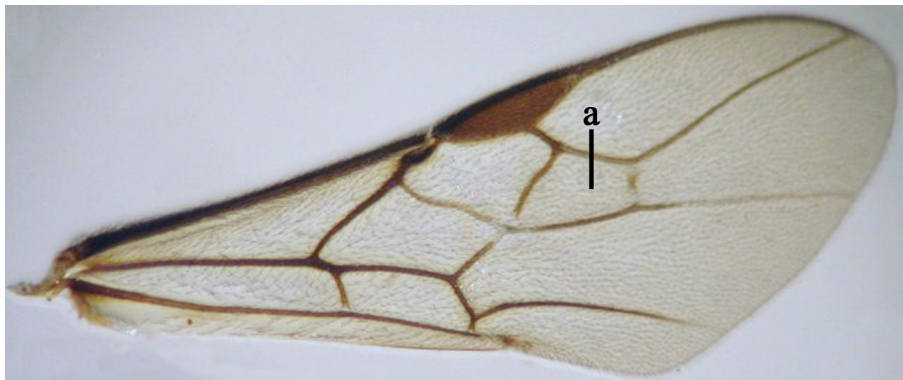




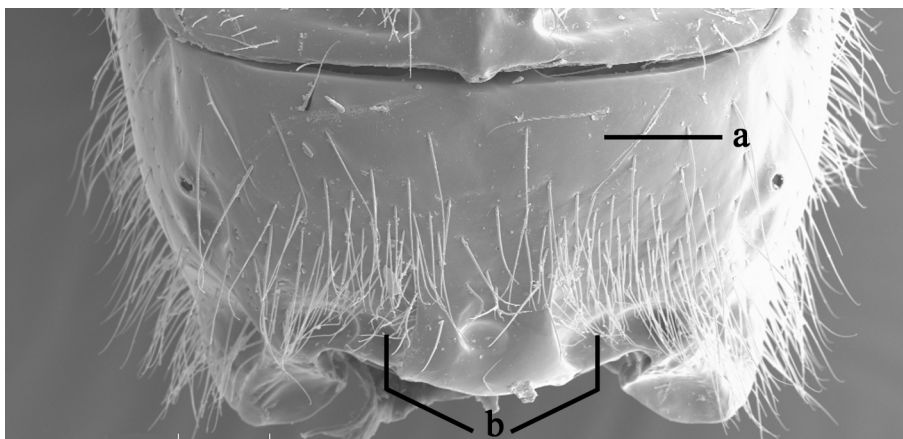
6 (4') Fore wing with 2<sup>nd</sup> submarginal cell short 5-sided (a); hind wing m-cu present (b); propodeum varying from extensively rugose to smooth, with only a trace of weak carinae (c); clypeus large, concealing labrum when mandibles closed (d).....  
*Diachasmimorpha longicaudata* (Ashmead, 1905)

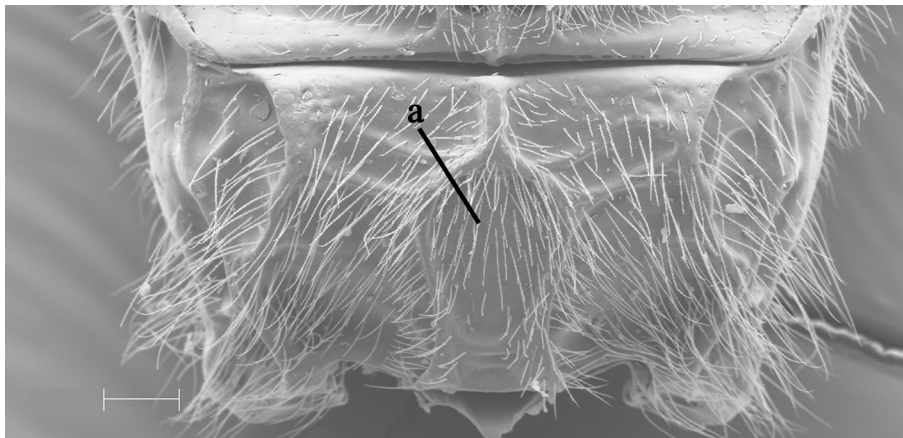


6' Fore wing with 2<sup>nd</sup> submarginal cell short 4-sided (a).....7

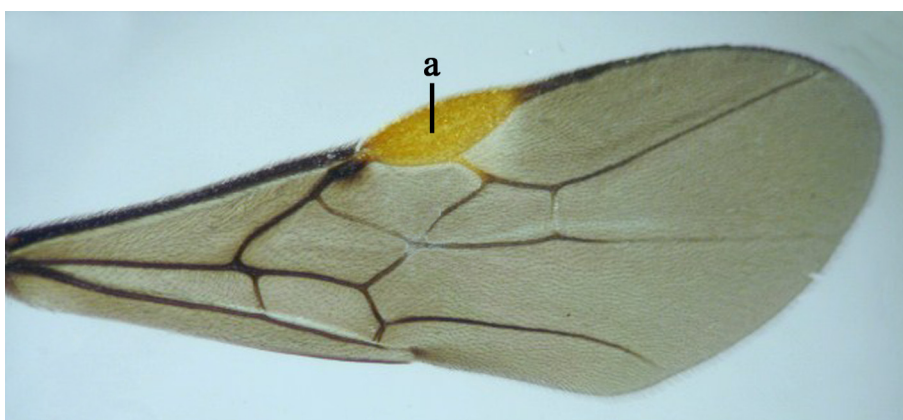


7 (6') Propodeum smooth anteriorly (a), with propodeal sculpturing reduced to two apical keels posteriorly (b) .....8





8 (7) Wings darkened (infumate) with stigma yellow (a) ..... *Doryctobracon brasiliensis* (Szépligeti, 1911)

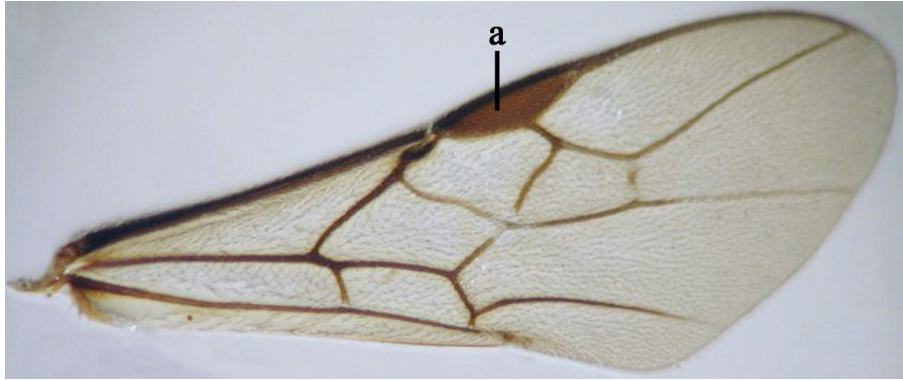


8' Wings darkened (infumate) with stigma brown (a); head black with mandibles brownish .....  
..... *Doryctobracon crawfordi* (Viereck, 1911)





9 (7') Wings clear (hyaline), stigma brown (a) ..... *Doryctobracon areolatus* (Szépligeti, 1911)



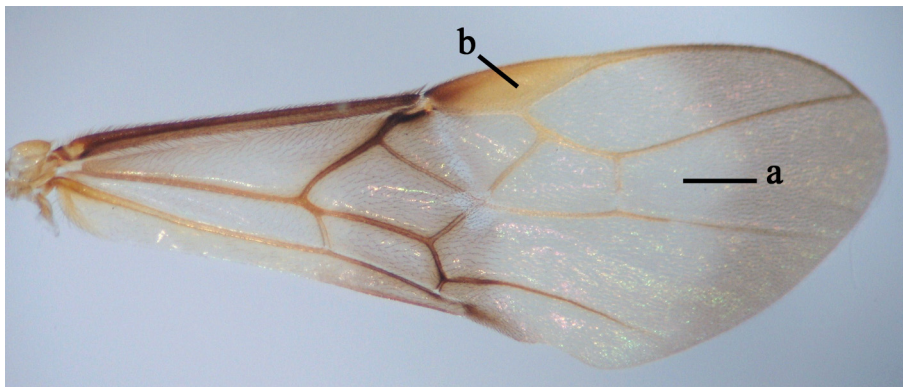
9' Wings darkened (infumate) ..... 10

10(9') Wings evenly darkened (infumate) ..... *Doryctobracon fluminensis* (Lima, 1938)

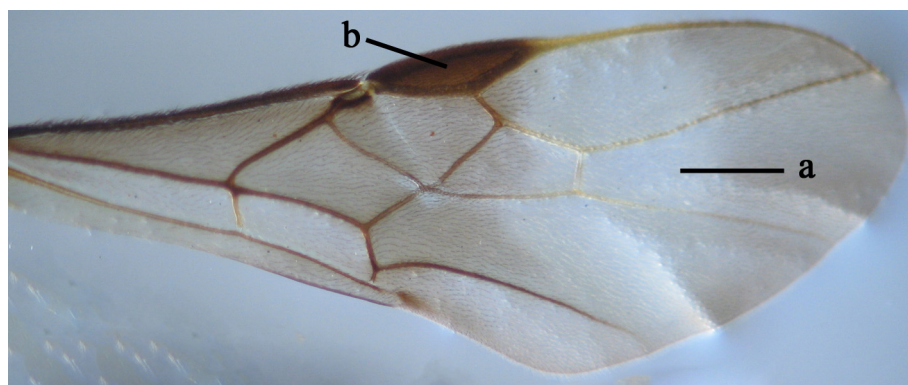


10' Fore wing darkened (infumate) with rounded hyaline area or transverse hyaline band ..... 11

11(10') Fore wing darkened (infumate) with broad transverse hyaline band on the apical half of the wing (a); stigma yellow (b) .....  
 ..... *Doryctobracon whartoni* Marinho & Pentead-Dias, 2017



- 11' Fore wing darkened (infumate) with rounded hyaline area after stigma till the middle of R1a and in the middle of the 2<sup>nd</sup> discal cell (a); stigma dark brown (b)..... *Doryctobracon adaime* Marinho & Pentead-Dias, 2017



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