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Hidden under darkened wings: the identity of *Doryctobracon fluminensis* (Lima, 1938) (Hymenoptera: Braconidae) and a new species of the genus from Brazil

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Abstract

Doryctobracon fluminensis (Lima) is one of several species of braconid parasitoids of fruit flies occurring in Brazil. Nearly 60 years passed after the original description by Lima (1938) until the publication of new records of *D. fluminensis* in several Brazilian states. Species identifications in these records were generally based on the darkened (infumate) fore wings, which has become the main character used in identification keys for recognizing *D. fluminensis*. After examination of the holotype of *D. fluminensis*, and comparison with several Brazilian specimens, we concluded that infumate fore wing alone is insufficient for separating species in the genus, as other *Doryctobracon* species also possess this feature. Here, we describe a new species, *Doryctobracon simulatus* Marinho **sp. nov.**, based on specimens previously identified as *D. fluminensis*; redescribe *D. fluminensis* (Lima); and redefine the limits of *D. maculatus* Marinho. The misidentification discovered in the only two voucher specimens available indicates that other records of *D. fluminensis* in Brazil may also be incorrect, although those identifications cannot be verified. Our results demonstrate the importance of preserving voucher specimens in collections for future studies. An updated key to the species of *Doryctobracon* attacking fruit-infesting tephritids in Brazil is presented.

Keywords: Opiinae, parasitoid, illustrated key, fruit fly, *Anastrepha pickeli*, *Manihot esculenta*, cassava

Introduction

Species of *Doryctobracon* Enderlein are parasitoids of larval Tephritidae (Diptera) occurring in the Nearctic and Neotropical regions. Of the 16 known species, 13 are parasitoids of fruit-infesting flies (Wharton 1997; Ovruski *et al*. 2000; Yu *et al*. 2012; Marinho & Zucchi 2023), one species is associated with tephritids on flowers (Wharton & Norrbom 2013), and no hosts are known for the remaining two species (Yu *et al.* 2012; Wharton & Yoder 2012). The genus is divided into two groups: group 1, defined by the areolate propodeum; and group 2, defined by the propodeum with two apical carinae (Wharton & Yoder 2012). Seven species are recorded in Brazil, all parasitoids of fruit flies: *Doryctobracon areolatus* (Szépligeti), *D. adaimei* Marinho & Penteado-Dias, *D. brasiliensis* (Szépligeti), *D. crawfordi* (Viereck), *D. fluminensis* (Lima), *D. maculatus* Marinho, and *D. whartoni* Marinho & Penteado-Dias (Marinho *et al.* 2018; Marinho & Zucchi 2023).

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Doryctobracon fluminensis was one of the first species of braconid attacking fruit-infesting tephritids described in Brazil, reared from *Anastrepha fraterculus* (Wiedemann) in the municipality of Guaratiba, Rio de Janeiro, in 1934 (Lima 1938). However, according to their labels, the holotype and allotype of *D. fluminensis* were obtained from *A. pseudoparallela* (Loew) (Figs 1–4, 24–33). In that same year, Gonçalves (1938) recorded *D. fluminensis* reared in *A. pseudoparallela* (Loew) in passion fruit (*Passiflora* sp., Passifloraceae) in Rio de Janeiro; subsequently, Lima (1948) recorded *D. fluminensis* in *A. parallela* (Wiedmann). Approximately 60 years passed after the original description until new records for *D. fluminensis* were published (Canal *et al*. 1996). All of these more recent records resulted from surveys of fruit flies in fruits or shoots of cassava (*Manihot esculenta* Crantz, Euphorbiaceae), where the parasitoids were obtained from three *Anastrepha* species: *A. montei* Lima (Canal *et al.* 1996; Uchôa-Fernandes *et al.* 1996); *A. pickeli* Lima (Uchôa-Fernandes *et al.* 2003); and *A. montei*, *A. pickeli*, and *A. hadropickeli* Canal, Uramoto & Zucchi (Alvarenga *et al.* 2009). Two male specimens collected by Alvarenga *et al.* (2009), reared from *A. pickeli*, are the only known voucher specimens of *D. fluminensis* (nec Lima), which are being here described as *D. simulatus* **sp. nov.**

The identifications of *D. fluminensis* after its rediscovery were based on Canal *et al.* (1996), who used only the infumate fore wings to separate it from *D. areolatus* (Szépligeti), as well as the areolate propodeum and yellowish head to separate it from *D. brasiliensis*. Other authors of records of *D. fluminensis* in Brazil, from 1996 onwards, carried out joint studies on fruit fly parasitoids and used these same characters to recognize *D. fluminensis.* These characters were also used in illustrated keys (Marinho *et al*. 2018, 2021). On the other hand, certain morphological characters described by Lima (1938) were not discussed by other authors (Muesebeck 1958; Fischer 1964, 1965; Wharton & Marsh 1978; Wharton & Yoder 2012). The description of *D. maculatus* Marinho made it evident that the fore wings alone are not sufficient to identify *D. fluminensis* and separate it from *D. maculatus* (Marinho *et al.* 2021). Therefore, it is likely that some of the records in Brazil represent erroneous identifications of *D. fluminensis*.

The objective of this paper is to highlight the morphological characters of *D. fluminensis* that have been neglected in previous studies, resulting in probable erroneous identifications of this species, and discuss the limits of three morphologically similar species that share the same character state of infumate wings. Aiming to improve future identifications, an updated, illustrated identification key to species of *Doryctobracon,* parasitoids of fruit-infesting tephritids in Brazil, is also presented.

Material and Methods

Specimens examined

Holotype of *D. fluminensis* (Lima, 1938) (CEIOC 77185), deposited in the Entomological Collection of the Instituto Oswaldo Cruz (CEIOC/FIOCRUZ).

Allotype of *D. fluminensis* (Lima, 1938) (CEIOC 3159), deposited in the Entomological Collection of the Instituto Oswaldo Cruz (CEIOC/FIOCRUZ).

Holotype of *D. maculatus* Marinho, 2021 (ESALQENT0264), deposited in the Entomological Museum "Luiz de Queiroz" (MELQ/ESALQ).

Voucher specimens. Two males, previously identified as *D. fluminensis* (nec Lima), reared from larvae of *Anastrepha pickeli* Lima in fruit of *Manihot esculenta* (Euphorbiaceae) (Unimontes, sample 915), collected in the municipality of Jaíba (S 15° 08' 26.4" W 44° 02' 4.7"), state of Minas Gerais (MG), Brazil. The voucher specimens (in 70% ethanol) were deposited in the collection of the Department of Agricultural Sciences, State University of Montes Claros, Janaúba, MG.

Images

The images of the *D. fluminensis* holotype and allotype (CEIOC/FIOCRUZ) were taken by the curator of the entomological collection, Dr Márcio Félix, using a Leica M 205 C microscope with a self-assembly system and an attached Leica DMC 2900 camera. Digital images of the holotype of *D. maculatus* Marinho and *Doryctobracon simulatus* Marinho **sp. nov.** were taken with a Motic® 2000 2.0MP digital camera, coupled to a Nikon® E200

stereoscopic light microscope. Measurements were carried out with the Motic Image Plus 2.0 software, coupled to a light microscope (Nikon® E200).

Terminology

The terminology for body morphology and wing veins broadly follows Sharkey & Wharton (1997) and Wharton (1997). The terms for anatomical structures are based on Yoder *et al.* (2010) and the description of Opiinae by Karlsson & Ronquist (2012). For clarity, the first metasomal tergum, referred to as the petiole, is termed T1, and the following median tergites are termed T2, T3, and successively (Walker & Wharton 2011). The measurements broadly follow Wharton (1977), Ovruski (2003) and Walker & Wharton (2011).

Wing measurements: The lengths of veins were taken from the centers of the junctions that delineate the veins (Quicke *et al*. 1987). The length of the antenna excludes the scape and pedicel.

Results

Taxonomy

Doryctobracon Enderlein

See http://species-id.net/wiki/Doryctobracon
Doryctobracon Enderlein, 1920: 144. Type species: *Doryctobracon conjungens* Enderlein, 1920 [junior subjective synonym of *Doryctobracon crawfordi* (Viereck, 1911)]. Original designation.

Doryctobracon fluminensis (Lima, 1938)

Opius fluminensis Lima, 1938:69.
(Figs 1–3, 5–10, 24–32)

Redescription. Body length, 6 mm; antenna with 58 flagellomeres; dorsal head wide (1.5 mm), almost twice the height, polished, and covered with relatively long, pale setae (0.5 mm) (Figs 7a, 28a); vertex straight and elevated in ocellar region (Figs 24, 27). Eye almost circular (Figs 6, 27); temple almost as wide as anteroposterior width of eye (Figs 6, 27); center of face with strong carina that arises immediately above clypeus and ends shortly after torulus (Fig. 26a). Ventral clypeus weakly sinuous, with median lobe slightly protruding and distinctly angular on sides; malar space slightly longer than width of base of mandible; mesosome with few setae, absent on mesoscutum (Figs 8, 30) and mesopleuron (Figs 6, 27), but abundant on propodeum (Figs 9, 31); notaulices complete, smooth and deep (Figs 8, 30); mesopleuron with smooth depression (Figs 6, 27); propodeum with short anterior mid-longitudinal carina, and complete posterior areola, pentagonal, elongated, and relatively narrow from middle, reaching lower edge of propodeum. Anterior end of areola angular, where long straight anterior transverse carina begins and reaches strong lateral longitudinal carina (Figs 9, 31). Transverse carina arises from upper edge of propodeum, and runs downward and outward, bifurcating inferiorly before reaching posterior edge of propodeum. Center of areola smooth, metapleuron setose (Figs 9, 31); metasoma completely smooth and polished (Figs 10, 29). Ovipositor approximately 6 mm long.

Wings. Fore wing with stigma 4.2× longer than wide; with vein r projecting from its midpoint; (RS+M)a sinuous anteriorly and 1.2× longer than 3RSa; 2RS 0.9× longer than 3RSa, 1.2× longer than 1m-cu, and 2.2× longer than r-m; 1m-cu directly in line with 2RS; 3RSa 2.2× longer than r vein; 2M 1.6× longer than 3Rsa (Figs 3, 32). Hind wing with m-cu, distinctly pigmented (Fig. 32).

Color. Distinctly reddish orange, but black on head [antenna (Figs 5, 24, 25), apex of mandible (Fig. 26), and vertex (ocellar triangle) (Figs 7b, 28b)], on mesosoma [wide area of median and lateral lobes of mesoscutum (Figs 8, 30), anterior region of mesopleuron (Figs 6a, 27), mesosternum (Fig. 26b), and posterior leg except apical half of femur and last segment of anterior and middle tarsi (Figs 5, 24)]; metasoma with black bands from segments T4 to T7 (Figs 10, 29) and on ovipositor sheath (Fig. 5). Fore wing darkened (infumate), veins and stigma dark brown (Figs 5, 25, 32).

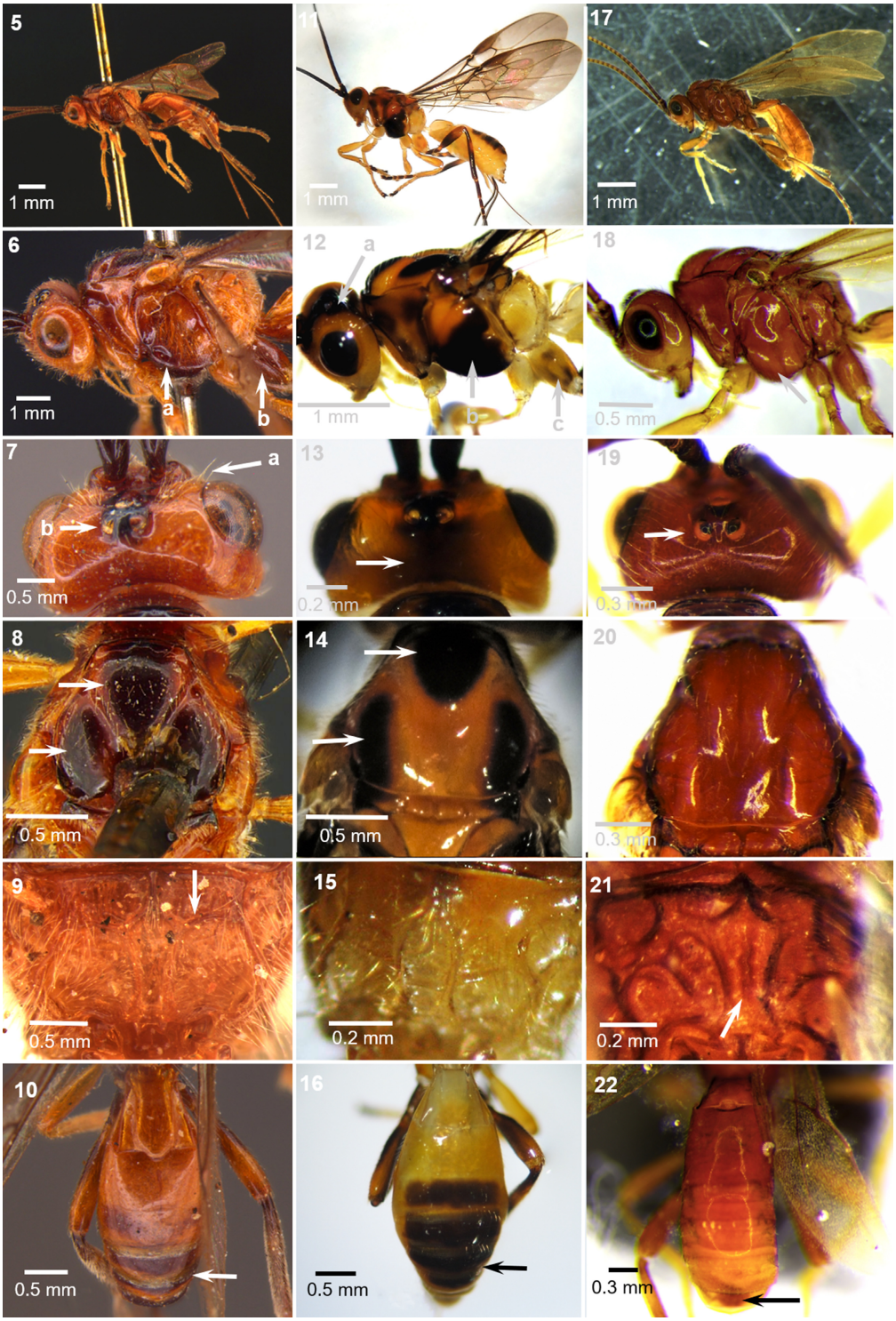
Distribution. Guaratiba, Rio de Janeiro State, Brazil.

Fruit fly and associated plant. Lima (1938) mentioned that *D. fluminensis* was described from specimens obtained from *Anastrepha fraterculus*; however, in the Fiocruz file and on the holotype and allotype labels, the host is given as *A. pseudoparallela* (Figs 2, 4, 33). Lima (1948) recorded *D. fluminensis* as a parasitoid of *A. parallela* in his compilation of South American entomophagous insects, but he did not mention his own record (Lima 1938) nor that of Gonçalves (1938) (see discussion section for additional information on host records).

FIGURES 1–4. *Doryctobracon fluminensis* (Lima) (holotype). 1. Habitus, lateral; 2. pinned and labelled specimen; 3. Fore wing; 4. file card (Photos: M. Félix and C. F. Marinho).

Specimens examined. Holotype (female) (CEIOC 77185), Allotype (male) (CEIOC 3159).

Comments. The original description was based on the holotype, allotype, and paratype (male, CEIOC No. 2682; not examined). Only the type material is known. Although Lima (1938) described *D. fluminensis* with black spots on the lobes of the mesoscutum (Figs 8, 30) and the anterior region of the mesopleuron (Figs 6, 27), these spots were neither characterized in detail nor mentioned in the subsequent literature and taxonomic keys. These spots easily separate *D. fluminensis* from other species of *Doryctobracon*, except from *D. maculatus*, which shares the same characteristics, as discussed below. However, the appearance of these black spots is quite particular, and this difference can be used to separate these two species. Examination of the holotype and allotype of *D. fluminensis* reveals extensive black spots that completely cover the mesoscutal lobes (median and lateral), and their limits, or the intersection of these spots, almost reach the notauli (Figs 8, 30). In *D. maculatus*, the spots are pitch black, well defined, and are located at the ends of the lobes of the mesoscutum, being widely separated by the orange color of the mesosoma; on the median lobe, the spot is semi-oval, and the lateral lobes have wide black bands that reach the anterolateral region of the scutellum (Marinho *et al*. 2021) (Fig. 14). In *D. fluminensis*, the anterior region of the mesopleuron, defined by Lima (1938) as "sternopleuron" (Figs 6a, 27), and mesosternum are black (Fig. 26b). In *D. maculatus*, the mesopleuron is almost completely black, mainly posteriorly, which continues, covering the mesosternum (Fig. 12b), except for the longitudinal groove on the ventral surface of the mesothorax, which is orange (mesodiscrimen).



FIGURES 5–22. *Doryctobracon fluminensis* (Lima). (5–10) [5. Female; arrows: 6. (a. mesopleuron, black anteriorly; b. hind coxa, black) 7. (a. long pale setae; b. black vertex), 8. median and lateral lobes of mesoscutum with black spots; 9. anterior transverse carina of propodeum; 10. black dorsal abdominal bands]. *Doryctobracon maculatus*. (11–16) [11. Female; arrows: 12. (a. uninterrupted spot or stripe, black or dark reddish brown, on frons, vertex (ocellar triangle), and occiput; b. mesopleuron, almost completely black; c. hind coxa, yellow with three small dark brown spots); 13. uninterrupted spot or stripe, black or dark reddish brown, on frons, vertex (ocellar triangle), and occiput; 14. median lobe with semi-oval black spot and lateral lobes with broad black bands; 15. propodeum with short carinae, radiate and weakening anteriorly on areola, and weak carinae within the areola; 16. metasoma with dark brown to black crossbands]. *Doryctobracon simulatus* Marinho **sp. nov.** (17–22) [17. Male; arrows: 18. smooth mesopleuron; 19. reddish orange vertex; 20. reddish orange mesoscutum; 21. longitudinal carina in center of areola; 22. circular brown spot at T7]. Photos: M. Félix, *D. fluminensis*; C.F. Marinho, *D. maculatus* and *D. simulatus*.

Other characteristics can be used to separate these species, such as the color of the head (dorsal) and the structure of the propodeum. The head in *D. fluminensis* is completely orange, and only the vertex (ocellar triangle) is black (Figs 7b, 28b). *D. maculatus* also has an orange head; however, an uninterrupted black or dark reddish brown spot or stripe occurs on the frons and vertex (ocellar triangle), ending on the occiput (Figs 12a, 13). In *D. fluminensis*, the hind coxa is black (Fig. 6b). In *D. maculatus*, the hind coxa is yellow with three small dark-brown smoky spots arranged circularly (Fig. 12c). Although both these species have an areolate propodeum, they differ in the shape of the areola and the presence of carinae within them. *Doryctobracon fluminensis* has a propodeum with a short anterior mid-longitudinal carina and a complete posterior areola, pentagonal, elongated, and relatively narrow from the middle, which reaches the lower edge of the propodeum (Figs 9, 31). The anterior end of the areola is angular, where a long straight anterior transverse carina begins and reaches a strong lateral longitudinal carina; the center of the areola is smooth, and many bristles cover the metapleuron (Figs 9, 31). In *D. maculatus,* the propodeum also has a short mid-anterior longitudinal carina, followed by a complete posterior areola (Figs 15, 34a). However, the areola has anteriorly rounded edges, where two to three short carinae radiate on each side, weakening without reaching the lateral longitudinal carina (Figs 15, 34b); only one, the posterior transverse carina of the areola, reaches the lateral longitudinal carina (Figs 15, 34c). Within the areola are two very weak longitudinal carinae, bending posteriorly (Fig 15, 34d), and another transverse carina at the base (Figs 15, 34e).

Although the spots on the lobes of the mesoscutum and anterior region of the mesopleuron are described as black in *D. fluminensis* (Lima, 1938) the analysis of the holotype and allotype showed a less-intense color, close to dark brown, particularly in the anterior region of the mesopleuron, mesosternum, and antenna, indicating that the color may have faded with time due to preservation issues. The black dorsal abdominal bands in females, reported by many authors (Muesebeck 1958; Fischer 1964, 1965; Wharton & Marsh 1978) can also be found in males, as observed in the allotype (Figs 10, 29). Furthermore, the vertex of females was defined as lighter than that of males (Wharton & Marsh 1978), but these differences were not observed in the type material examined (holotype and allotype), which have a black vertex (ocellar triangle) (Figs 7b, 28b).

According to the original description (Lima, 1938), *D. fluminensis* was reared in *A. fraterculus* (Wiedemann), collected by Aristóteles Silva, with no information on host fruit. However, on the labels of the type material, the host is *A. pseudoparallela* (Loew) reared in *Passiflora* sp. (passion fruit) (Figs 2, 4, 33). Information on *A. pseudoparallela* as host of *D. fluminensis* was published by Gonçalves (1938), who also reported that this record was obtained by Aristóteles Silva, who collected the specimens described by Lima (1938). Gonçalves (1938)'s record went practically unnoticed, but Lima's information (1938) was released by other authors (e. g., Zucchi 2000; Aguiar-Menezes & Menezes 2023). Anyway, *A. pseudoparallela* should be considered host of *D. fluminensis* and not *A. fraterculus* as stated in Lima (1938). Furthermore, passion fruit is the most common host of *A. pseudoparallela* in Brazil (Zucchi & Moraes 2024).

Doryctobracon maculatus **Marinho, 2021**

(Figs 11–16, 34)

Description. Body length (female), excluding ovipositor, 5.7–6.7 mm. Antenna with 58–60 flagellomeres. Head orange, with uninterrupted black or dark reddish brown spot or stripe that occurs on frons and vertex (ocellar triangle) and ends on occiput (Figs 12a, 13); lobes of mesoscutum with well-defined pitch-black spots, located at ends of lobes, being widely separated by orange color of mesosome; spot on median lobe is semi-oval, and lateral lobes are wide black bands that reach anterolateral region of scutellum (Marinho *et al*. 2021) (Fig. 14). Mesopleuron almost completely black, mainly posteriorly, black color extending over mesosternum (Fig. 12b) except for longitudinal groove on ventral surface of mesothorax (mesodiscrimen), which is orange. Hind coxa yellow with three small dark-brown smoky spots, arranged circularly (Fig. 12c). Propodeum with a short mid-anterior longitudinal carina followed by complete posterior areola (Figs 15, 34a). Areola with rounded edges anteriorly, where two to three short carinae radiate on each side, weakening without reaching lateral longitudinal carina (Figs 15, 34b); only one carina, posterior transverse carina of areola, reaches lateral longitudinal carina (Figs 15, 34c). Within areola are two very weak longitudinal carinae, bending posteriorly (Figs 15, 34d), and another transverse carina at base (Figs 15, 34e). Metasoma with dark-brown to black crossbands (T3–T6) (Fig. 16). Fore wing 5.9–6.6 mm long, darkened (infumate); stigma, veins and bristles all dark brown (Fig. 11). Hind wing 3.8–4.8 mm long; ovipositor about 5.6–6.4 mm (Fig. 11) (details in Marinho *et al.* 2021).

Distribution. Piracicaba and São Roque, São Paulo State, Brazil (Marinho *et al.* 2021).

Fruit fly and associated plant. *Anastrepha pseudoparallela* (Loew) in passion fruit (*Passiflora alata* Curtis, Passifloraceae) (Marinho *et al.* 2021).

Specimens examined. Holotype (female) (ESALQENT0261) and paratypes (3 females) (ESALQENT0262–263 and 581).

Comments. Only the type material is known. *Doryctobracon maculatus* is easily separated from other species of *Doryctobracon* by the black spots on the median and lateral lobes of the mesoscutum (Fig. 14). Despite this species having been described as the first of the genus to have this characteristic, *D. fluminensis* was previously characterized by Lima (1938) as having similar black spots (Figs 8, 30). However, the shape of these spots in the two species separates them, as discussed above. Other characters in *D. maculatus* and *D. fluminensis* that easily separate the two species are the mesopleuron, head, hind coxa, and propodeum (detail in notes, *D. fluminensis*). In general, *D. maculatus* is characterized by having many black spots on the body, such as on the vertex, pronotum, hind legs, and dorsal bands of the metasoma (T3 to T6) (Figs 11–16). In the illustrated key (Marinho & Zucchi 2023), the image of *D. fluminensis* actually corresponds to *D. maculatus*.

Doryctobracon simulatus Marinho sp. nov.

http://zoobank.org/1C84E190-22E3-4507-AEDC-00F59D0988B2

(Figs 17–22, 23)

Diagnosis. *Doryctobracon simulatus* **sp. nov.** is similar to *D. fluminensis* (Lima). However, *D. simulatus* **sp. nov.** is distinguished by the complete absence of black spots on the body, except at the apex of the mandibles (Figs 17–22, 23), whereas in *D. fluminensis* black areas are present on the head [antenna, apex of the mandibles, and vertex (ocellar triangle)] and mesosoma (median and lateral lobes of the mesoscutum, anterior region of the mesopleuron, mesosternum, and hind leg, except the apical half of the femur) (Figs 5–10, 24–30). *Doryctobracon simulatus* **sp. nov.** also differs from *D. maculatus* in the large number of black spots present on *D. maculatus* (Figs 11, 17). *Doryctobracon simulatus* **sp. nov.** can be further distinguished from *D. fluminensis* and *D. maculatus* by the propodeum, which, although areolate, has a sinuous longitudinal carina in the center of areola, continuing from the anterior mid-longitudinal carina, which may be more or less strongly impressed (Fig. 21). In comparison, the center of the areola is smooth in *D. fluminensis* (Fig. 9), while in *D. maculatus* within the areola are two very weak longitudinal carinae that bend posteriorly (Figs 15, 34d) and another transverse carina at the base (Figs 15, 34e). *Doryctobracon simulatus* **sp. nov.** is also distinguished from *D. fluminensis* and *D. maculatus* by the dorsal surface of the petiole (T1) of *D. simulatus*, which has small punctures of various sizes on the inner margins of the

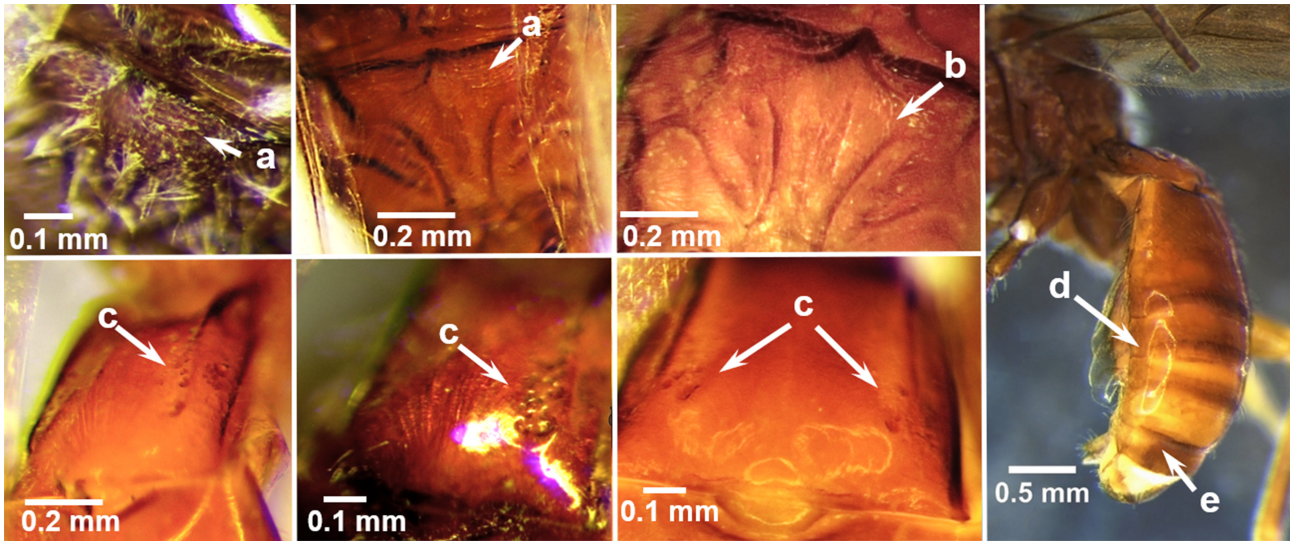
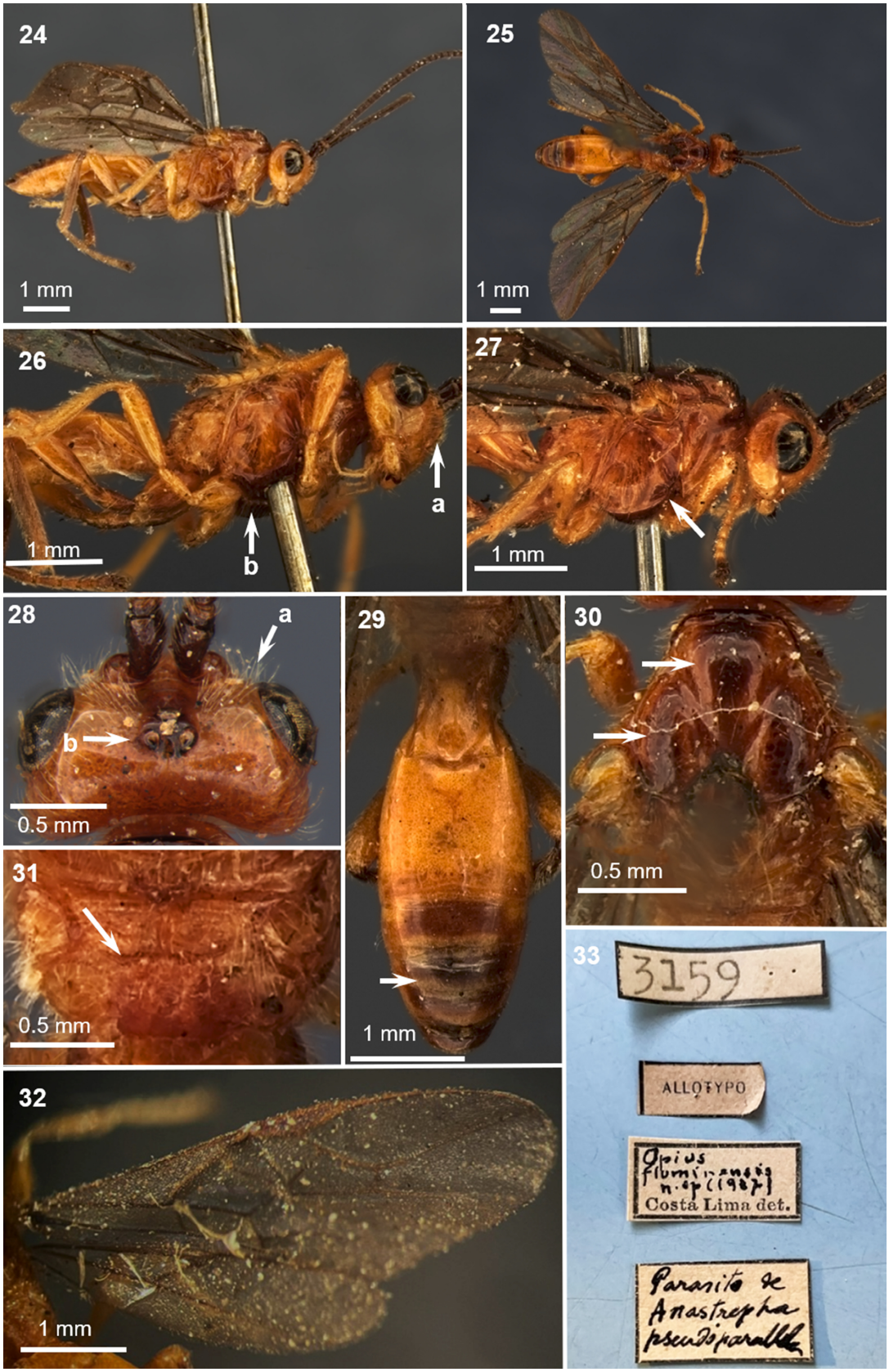


FIGURE 23. *Doryctobracon simulatus* Marinho **sp. nov.** Propodeum (arrows: a. lateral striations; b. carina of pentagonal areola); metasoma (arrows: c. punctures near dorsal carina on petiole—T1; d. light-brown transverse bands; e. circular brown spot at T7). Photos: C.F. Marinho.



FIGURES 24–33. *Doryctobracon fluminensis* (Lima). Allotype (male). 24. Habitus, lateral; 25. habitus, dorsal; 26. head and mesosoma, lateral (arrows: a. center of face with carina; b. black mesosternum); 27. head and mesosoma, lateral (arrows: mesopleuron, black anteriorly); 28. head, dorsal (arrow: a. long pale setae; b. black vertex); 29. metasoma, dorsal (arrows: dorsal black abdominal bands); 30. mesoscutum, dorsal (arrow: black spots on median and lateral lobes of mesoscutum); 31. propodeum, arrow: transverse longitudinal carina; 32. Fore wing and hind wing; 33. labels of holotype. Photos: M. Félix.

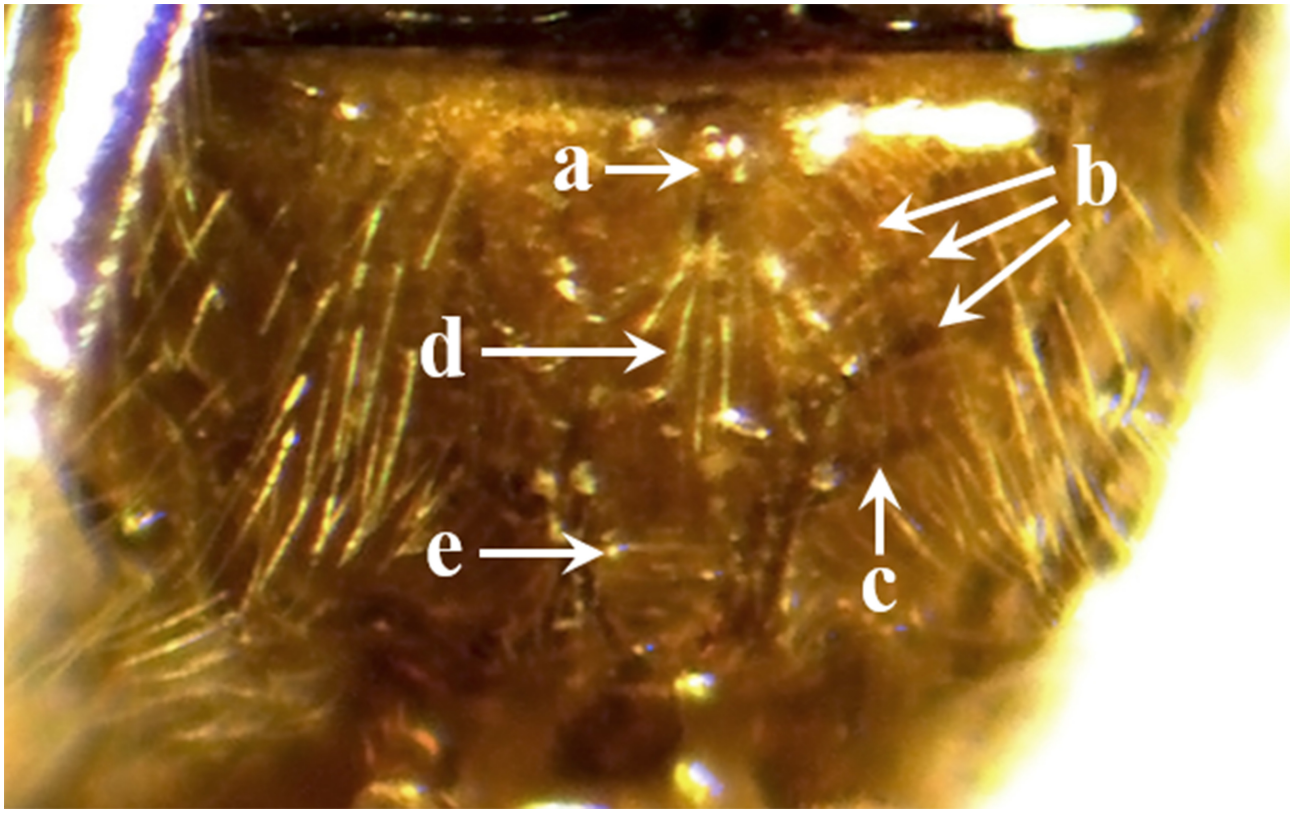


FIGURE 34a–d. *Doryctobracon maculatus* Marinho. Propodeum (arrows: a. mid-anterior longitudinal carina; b. short weak radiate carinae, anteriorly on areola; c. posterior transverse carina of areola; d. two very weak longitudinal carinae, bending posteriorly; e. transverse carina on base of areola). Photos: C.F. Marinho.

dorsal carina, located subapically in a very shallow groove (Fig 23c). Wharton (1997) described the petiole of *Doryctobracon* as smooth, and in all other *Doryctobracon* species, this characteristic was not mentioned; therefore, this character is described herein for the first time in *D. simulatus* **sp. nov.** and may be useful in the characterization of other *Doryctobracon* species.

Type material. Holotype: male (ESALQENT001773), Brazil, Minas Gerais, Jaíba, 20-I-2000, reared in larva/pupa of *Anastrepha pickeli* Lima in cassava *Manihot esculenta* Crantz, coll. Clarice D. Alvarenga. Paratype, 1 male (ESALQENT001774), same data as holotype. Both deposited in the collection of the Entomological Museum "Luiz de Queiroz", Department of Entomology and Acarology, Luiz de Queiroz College of Agriculture (MELQ/ESALQ).

Male. Body length 5.4 mm.

Head. 1.3–1.4× wider than high; 1.3× wider than width of mesoscutum; face polished and shiny, with smooth, slightly developed median crest that originates between toruli and slightly exceeds mid-length of clypeus; antenna longer than body, 5.8–6.4 mm long, excluding scape and pedicel; with 43 to 45 flagellomeres, first and second flagellomeres of equal length and width. Eyes large, 1.25× higher than wide (Fig 18); in lateral view, eye 1.66× longer than temple length; malar space 0.5× eye height. Malar space approximately equal to basal width of mandible (0.2 mm). Clypeus 2.5–3.0× wider than high, slightly sinuous on ventral margin, with setae two to three times longer than setae on face.

*Mesosoma.*1.26–1.28× longer than high; 1.9–2.0× longer than wide; 1.5× higher than wide. Pronotum not visible dorsally; mesoscutum polished, shiny, with few bristles; notaulices smooth, complete, deep anteriorly, slightly shallower posteriorly, converging into large impression without midpoint (Fig. 20); scutellar groove divided into two large pits by median longitudinal carina; scutellum smooth with small punctures; mesopleuron shiny, smooth, with slight longitudinal impression (Fig. 18). Propodeum with short anterior mid-longitudinal carina (0.1 mm long) with long setae, followed by posterior areola, this carina having inconspicuous striae laterally (Fig. 23a). Pentagonal propodeal areola imperfectly closed by anterior transverse carinae and median longitudinal carina of

areola, which appear to be separate but are closed by narrow carina (Fig. 23b). Sinuate carina present in center of areola and similar to continuation of anterior median longitudinal carina, which may be quite distinct (Fig. 21). Anterior transverse carina of areola disappears toward lateral longitudinal carina (Fig. 21). Median longitudinal carina of areola and lateral longitudinal carina are united by posterior transverse carina, forming two posterolateral loops (Fig. 21) that may have a very noticeable carina or protuberance in center of each loop (Fig. 21).

Metasoma. 2.0–2.4× longer than wide and 1.3–1.5× wider than high; T1 length 1.0–1.1× greater than width at apex; apex T1 about 1.5× wide at base; T1 with two parallel dorsal carinae, just above spiracles, well developed at base but indistinct posteriorly; T1 smooth and polished, but with small punctures of varying size that follow inner margins of carinae from posterior half, sitting in very shallow groove (Fig. 23c); spiracles at midpoint of T1. Remaining terga completely smooth, polished and shiny (Fig. 22).

Wings. Fore wing 4.3–4.9 mm long; stigma 3.0–3.3× longer than wide, (RS+M)a 1.5–2.0× longer than 3RSa; 2RS 1.2–1.63× longer than 3RSa, 1.6× longer than 1m-cu and 2.5× longer than r-m; 1m-cu directly in line with 2RS; 3RSa 1.9–3.0× longer than r vein; 2M 1.7–2.3× longer than 3RSa; 1cu-a straight line separated from 1M by 0.1 mm. Hind wing 3.4–3.5 mm long, m-cu distinctly pigmented. Fore and hind wings darkened (infumate), stigma and veins brown (Fig. 17).

General coloration. Reddish orange, head and mesosoma darker, lower half of head and metasoma slightly lighter (Figs 17, 18). Scape and pedicel dark brown (Figs 17, 18); flagellomeres brown at base and lighter toward apex (Fig. 17); apex of mandible black; vertex, mesoscutum and tegula same reddish orange color as body (Figs 17–20). Foreleg completely orange, median leg with orange reddish coxa and trochanter, and other parts orange, hind leg same color as body, completely reddish orange except for orange anterior half of tibia (Fig. 17). Metasoma lighter, sometimes with light brown transverse bands (Fig. 23d); T7 with circular brown dorsal spot (Figs 22, 23e).

Female. Unknown.

Etymology. From Latin, *simulatus* (adjective), meaning false, copy, referring to the morphological similarity with *D. fluminensis*.

Fruit fly and associated plant. The two specimens were reared from larvae of *Anastrepha pickeli* Lima in fruits of *Manihot esculenta* Crantz (Euphorbiaceae) (Alvarenga *et al.* 2009).

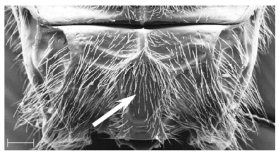
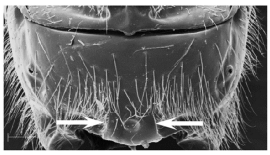
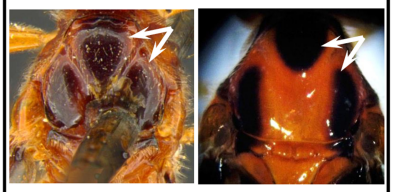
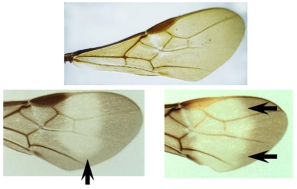
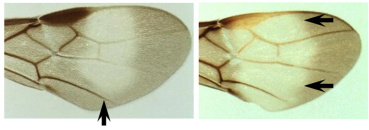
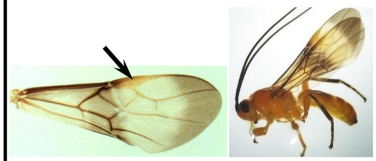
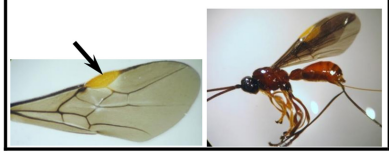
Comments. The majority of the specimens identified as *D. fluminensis* have the tritrophic association *Manihot*/*Anastrepha*/*Doryctobracon* (see Marinho & Zucchi 2023). With the description of *D. simulatus* **sp. nov.**, 14 species of *Doryctobracon*, eight of which occur in Brazil, are known to parasitize fruit-infesting tephritids.

Discussion

Lima (1938) described *D. fluminensis* as having, among other characters, black mesoscutal lobes and sternopleuron, an areolate propodeum, and darkened (infumate) fore wing. The first author to discuss the characters of *D. fluminensis*, after the description by Lima (1938), was Muesebeck (1958). In his description of *D. capsicola* (Muesebeck) (as *Opius*), Muesebeck considered *D. capsicola* to be very similar to *D. fluminensis,* although he stated that "It can be distinguished from *D. fluminensis* by the more or less extensive black spots on the vertex, forehead and face, by the visibly yellow apex of the stigma and by the absence of black spots on the apical abdominal segments of the female". Muesebeck (1958) did not comment on the black spots on the lobes of the mesoscutum, sternopleuron, and ocellar region, or on the infumate fore wings of *D. fluminensis*. Also, these characteristics were not used in identification keys for species of *Doryctobracon* (Fischer 1964, 1965) and tephritid braconid parasitoids (Wharton & Marsh 1978; Wharton & Yoder 2012). Fischer (1964, 1965), in two similar keys, included *D. capsicola* and *D. fluminensis* in the same couplet, separating them by the color of the head, stigma, and/or apical abdominal segments of females. In other keys, *D. fluminensis* was coupled with *D. areolatus*, differing only in the infumate fore wings (Wharton & Yoder 2012; Marinho *et al.* 2018, 2021).

Since the rediscovery of *D. fluminensis* in Brazil (Canal *et al.* 1996), identifications have been based exclusively on the general color of the body (reddish orange), areolate propodeum, and infumate fore wings, because at the time this species was the only one in group 1 (areolate propodeum) known to exhibit these characteristics. However, with the discovery of *D. maculatus* Marinho and *D. simulatus* **sp. nov.**, these characters are insufficient to recognize *D. fluminensis*, because all these species share the same characteristics. Therefore, to identify *D. fluminensis*, it is also necessary to examine the extent of the black spots present on the lobes of the mesoscutum, anterior region of the mesopleuron and mesosternum, and dorsal region of the head, in addition to the sculpturing of the propodeum.

Illustrated key to the species of *Doryctobracon* from Brazil

1 Propodeum areolate…….....2 	1’ Propodeal sculpture reduced to two apical ridges…….7 
2(1) Mesoscutum with dark spots…….....3 	2’ Mesoscutum without dark spots……..……...4 
3(2) Mesopleuron covered with a large dark spot…… ……..***Doryctobracon maculatus*** **Marinho** 	3’ Mesopleuron with dark spot anteriorly……..…… ……..***Doryctobracon fluminensis*** **(Lima)** 
4(2’) Fore wing uniformly clear (hyaline), stigma brown…. ……....***Doryctobracon areolatus*** **(Szépligeti)** 	4’ Fore wing uniformly darkened (infumate) or partially darkened with rounded hyaline area or hyaline band……..5 
5 Fore wing uniformly darkened (infumate); petiole with small punctures at rear end of carinae…….. ……***Doryctobracon simulatus*** **Marinho** 	5’ Fore wing partially darkened with rounded hyaline area or hyaline band.....6 
6(5’) Stigma dark brown; fore wing darkened with rounded hyaline area after stigma ……. ….....***Doryctobracon adaimei*** **Marinho & Penteado-Dias** 	6’ Stigma yellow; fore wing darkened with broad hyaline band on apical half of wing……..…… …....***Doryctobracon whartoni*** **Marinho & Penteado-Dias** 
7(1’) Stigma yellow; fore wing darkened (infumate)…… .....***Doryctobracon brasiliensis*** **(Szépligeti)** 	7’ Stigma brown; fore wing darkened (infumate)…… ……..***Doryctobracon crawfordi*** **(Viereck)** 

The two male voucher specimens collected in the municipality of Jaíba, Minas Gerais (Brazil), which had earlier been identified as *D. fluminensis* (nec Lima) (Alvarenga *et al.* 2009) based on the infumate fore wings and general body color (reddish orange), also do not fit the original description of *D. fluminensis* (Lima, 1938). Based on the original description and examination of the holotype of *D. fluminensis*, one of us (CFM) verified that the voucher specimens belong to a new species, which is described herein. This discovery reveals that the specimens previously identified as *D. fluminensis* in Brazil may not actually correspond to this species, but unfortunately there are no voucher specimens to confirm this.

Outside Brazil, *D. fluminensis* (as *Opius*) was recorded in Venezuela by Fischer (1963). A few years later, Guagliumi (1966) also recorded *D. fluminensis* (as *Opius*) in Venezuela parasitizing *Anastrepha striata* Schiner in *Psidium guajava*, *M. esculenta* [sic], and *Spondias* sp. However, the specimens recorded by Guagliumi (1966) are apparently lost (Quirós *et al*. 2007). Subsequent information on this parasitoid in Venezuela (Katiyar *et al*. 1995; Boscán & Godoy 1996) was based exclusively on Guagliumi (1966), who stated that the species listed in his extensive work were identified by several taxonomists. Probably the record of Guagliumi (1966) was based on parasitoids identified by Maximilian Fischer, who carried out taxonomic studies on Braconidae (Opiinae) from the Neotropical Region (Fischer 1963, 1964, 1965).

The taxonomic clarifications presented here were made possible by the careful preservation of types and voucher specimens in collections. Conversely, the lack of voucher specimens from many studies hindered further conclusions on the identity, distribution, and host range of the parasitoid species treated here. Taken together, these results exemplify the importance of preservation and access to specimens, as well as the essential role of biological collections.

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