ZooKeys 1244: 159–184 (2025)
DOI: 10.3897/zookeys.1244.150382

Research Article

Not so deep in the rainforest: two new species of *Anastrepha* (Diptera, Tephritidae) and a pictorial key to species from Amazonas state, Brazil

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Abstract

Two new species, *Anastrepha dorsidentata* Uramoto, Zucchi, Araújo & Savaris and *A. norrbomi* Uramoto, Zucchi, Araújo & Savaris, from a fragment of the Amazon Rainforest in the city of Manaus, state of Amazonas, Brazil, are described and illustrated. Both species were collected in McPhail-type traps hanging from trees on the campus of Federal University of Amazon. A pictorial key to 47 species of *Anastrepha* recorded in Amazonas state is provided.

Key words: Brazilian Amazon, diversity, fruit flies, geographical distribution, taxonomy

OPEN ACCESS

Academic editor: Teresa Vera
Received: 15 February 2025
Accepted: 11 May 2025
Published: 10 July 2025

ZooBank: https://zoobank.org/98F9BBA7-6655-4E3B-B117-1951D06E2C7A

Citation: Uramoto K, Araújo AS, Costa-Silva FC, Silva NM, Savaris M, Zucchi RA (2025) Not so deep in the rainforest: two new species of *Anastrepha* (Diptera, Tephritidae) and a pictorial key to species from Amazonas state, Brazil. ZooKeys 1244: 159–184. https://doi.org/10.3897/zookeys.1244.150382

Introduction

Amazon forest, as legally defined, encompasses approximately 5 million km^2 of the territory of Brazil, comprising 59% of the country and including part or all of nine states. Of these states, Amazonas is the largest (about 1.5 million km^2) and borders on five other states (Acre, Mato Grosso, Pará, Rondônia, and Roraima) and three countries (Colombia, Peru and Venezuela).

In general, records of *Anastrepha* species in the state of Amazonas have been sporadic or restricted to the vicinity of urban centers (see Silva et al. 2023). This limitation is primarily due to the difficulty of accessing the diverse ecosystems of the Amazon. The characteristics of the region and the state's vast territorial expanse pose challenges for collecting, which impede our understanding of the local diversity of species.

A more comprehensive understanding of diversity requires a coordinated effort to collect specimens across the diverse ecosystems that comprise the Amazon biome. This effort involves the implementation of continuous surveys, such as those undertaken in the state of Amapá (see Adaime et al. 2023) or those resulting in the publications by Norrbom et al. (2015, 2021), using traps and fruit sampling, taking into consideration the seasonal occurrence of rainforest fruits. Nevertheless, sporadic collections have revealed

the considerable diversity of *Anastrepha* species in Amazonas, which has the largest number of known species. Thus, it is not always necessary to venture deeply into the rainforest to ascertain the diversity of fruit flies. It is crucial that collections be methodical and continuous, as evidenced by the diversity of species, including two new to science, collected on the campus of the Federal University of Amazonas (UFAM) (Costa-Silva 2012), situated approximately 10 km from the Manaus city center.

In the present contribution, we describe two new species, review published distribution records, and provide a pictorial key to the 47 species known to occur in the state of Amazonas, Brazil.

Materials and methods

Identification

Females were identified with reference to the taxonomic keys provided by Zucchi (2000), Zucchi et al. (2011) and Norrbom et al. (2012), complemented by taxonomic works published after 2012 (Norrbom et al. 2015, 2021; Troya et al. 2020; Rodriguez and Norrbom 2021).

Morphological study

Morphological terminology is based on White et al. (1999), wing venation on Cumming and Wood (2017), and wing bands on Stone (1942). Wing length was measured from the base of the costa to the wing apex in cell r_{4+5}; wing width was measured from the apex of vein R_1 to the posterior margin of cell m_4. The width of cell r_{4+5} at the level of dm-m was measured on a line from the junction of dm-m and M_1. The maximum width of cell r_{4+5} was measured perpendicular to vein M_1 at the widest subapical part. The apical width of cell r_{4+5} was measured from the apex of vein R_{4+5} to the junction of M_1 and the costa. The width of the distal part of the S-band was measured from the outer (anteroapical) margin of the costa to the inner (posterobasal) margin of the band perpendicular to the band at the apex of vein R_{2+3}. The width of cell r_{2+3} was measured on the same straight perpendicular line from the apex of vein R_{2+3} to R_{4+5}. Oviscape length was measured medially on the ventral side, from the ventromedial indentation to the apex. The aculeus tip length was measured ventrally from the sclerotized margin distal to the cloacal opening to the extreme apex. Illustrations of these measurements and the morphological characters described here can be seen in Norrbom et al. (2012). Type material is deposited at Museum of Entomology "Luiz de Queiroz" (MELQ), Department of Entomology and Acarology, Luiz de Queiroz College of Agriculture (ESALQ/USP).

Images and measurements

The wings and aculei were photographed using a Leica DFC 450 camera coupled to an M205C stereomicroscope. The aculeus tip was photographed using a Zeiss Axio Imager 2 microscope. Measurements were taken using a Leica Wild M10 stereomicroscope. The images were enhanced using Corel Draw 2020 to adjust the color and implement minor corrections.

Study site

The survey was conducted in an urban fragment of the Amazon Forest (3°05'87"S, 59°58'82"W), situated on the campus of the Federal University of Amazonas (UFAM) in Manaus, Amazonas, Brazil. This area encompasses 700 ha, with a perimeter of 12 km, elevation 46 m, and a predominant vegetation cover of dense ombrophilous forest. The campus is surrounded by urban infrastructure with dense human occupation and situated approximately 10 km from the city center of Manaus. The specimens were captured using McPhail traps baited with a 10% sugar cane solution and borax, hanged from trees at a height of 1.80 m above ground, from September 2010 to September 2011 (Costa-Silva 2012).

License

The study was conducted with the approval of IBAMA (permit number 44295131) and focused on the identification of fruit flies captured in the Brazilian Amazon.

Results

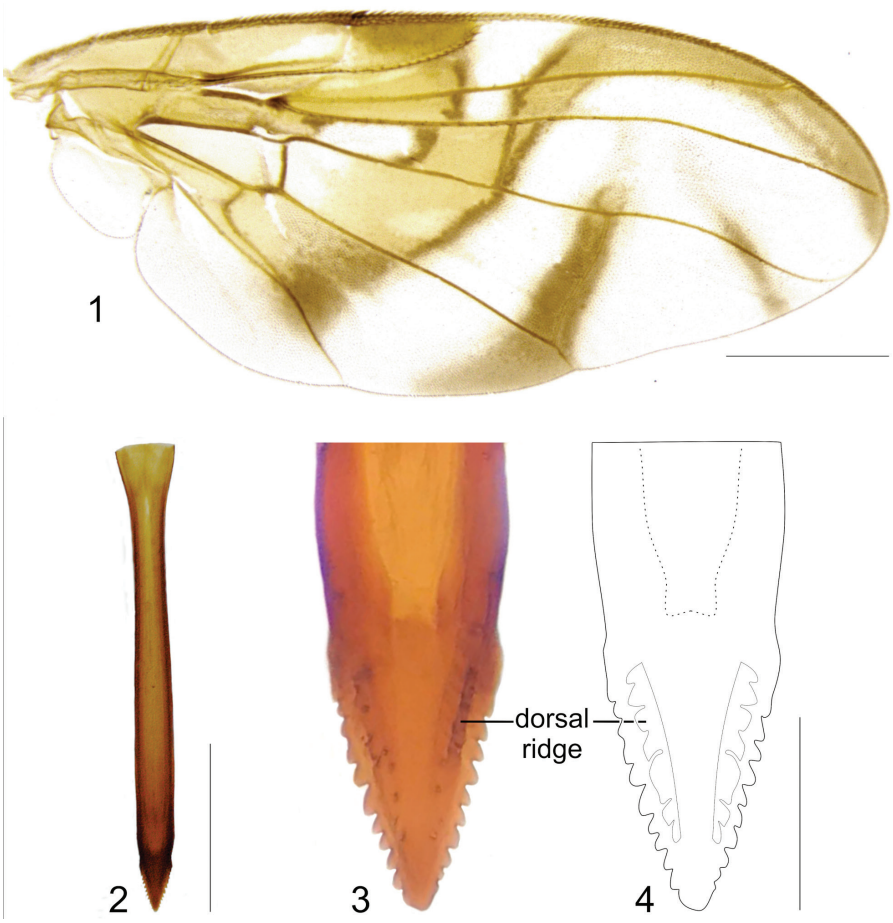
The description of the two new species brings the total number of *Anastrepha* species known in the state of Amazonas to 47, and in Brazil to 131 species. The *Anastrepha* species key for the state of Amazonas (Silva et al. 2023) has been amended and updated.

Order Diptera Linnaeus, 1758
Family Tephritidae Newman, 1834

***Anastrepha dorsidentata* Uramoto, Zucchi, Araújo & Savaris, sp. nov.**
https://zoobank.org/4867598B-F136-4162-82B7-713C016942AA
Figs 1–4

Type material. ***Holotype*** Brazil • 1 ♀; Amazonas, Manaus, campus of Federal University of Amazonas; 03°06'08.3"S, 59°58'31.6"W, 92 m elev.; collected on 15 July 2011, McPhail-type trap, food attractant, F.C. Costa-Silva leg. (MELQ ESALQENT001840).

Diagnosis. *Anastrepha dorsidentata* sp. nov. can be distinguished from other species of *Anastrepha* by the following combination of characters: scutum posteriorly without brown markings, subscutellum and mediotergite yellow to orange medially, dark brown laterally; wing pattern with C, S and V-bands complete; S-band middle section predominantly or entirely orange, with brown margins, V-band distal arm not connected to proximal arm of V-band along vein R_{4+5} and to S-band along vein R_{2+3}; oviscape 1.63 mm long, aculeus 1.43 mm long, tip 0.18 mm long, gradually tapered with medial constriction, serrated part 0.84 length of tip, with serrations extending onto dorsal side basally. In the key of Zucchi (2000), *A. dorsidentata* sp. nov. runs to *A. sororcula* Zucchi, from which it differs in having the serrated part 0.84 times length of tip (0.45–0.70 in *A. sororcula*) and serrations extending onto the dorsal side basally. In the interactive key of Norrbom et al. (2012), *A. dorsidentata* sp. nov. runs to *A. canalis* Stone, from which it differs in having serrations displaced dorsally, forming ridge separate from lateral margins.



Figures 1–4. *Anastrepha dorsidentata* sp. nov. **1.** Wing; **2.** Aculeus (ventral view); **3.** Aculeus tip (dorsal view); **4.** Aculeus tip showing dorsal ridge (dorsal view). Photographs by Alexandre S. (wing), Keiko Uramoto (aculeus and aculeus tip); illustration by M. Savaris. Scale bars: 1.0 mm (wing and aculeus); 0.1 mm (aculeus tip).

Anastrepha dorsidentata sp. nov. differs from *A. compressa* Stone, which also has the aculeus tip with dorsal ridge, by having lateral margins of aculeus tip near straight (slightly convex in *A. compressa*), triangular and distal arm of V-band not connected to proximal arm. *Anastrepha reichardti* Zucchi also has an aculeus tip similar to that of *A. dorsidentata* sp. nov., but without a dorsal ridge.

Description. Mostly orange. Setae dark red-brown.

***Head*.** Yellow to orange except brown ocellar tubercle. 3 frontal setae; 2 orbital setae. Ocellar seta weak, at most 1.5 times as long as ocellar tubercle. Facial carina, in profile, straight on dorsal two-thirds. Antenna not extended to ventral facial margin. Palpus in lateral view dorsally curved, evenly setulose. Face with ventral part gradually tapering laterally.

***Thorax*.** Mostly orange; without brown markings, scuto–scutellar suture without brown spot; with following areas white to pale yellow: postpronotal lobe and lateral margin of scutum bordering it; sublateral scutal vitta from transverse suture to posterior margin, including base of intra-alar seta; medial scutal vitta present with posterior end ovoid; scutellum, dorsal margins of anepisternum and katepisternum; katepimeron, most of anatergite and katatergite. Subscutellum and mediotergite dark brown laterally, yellow to orange medially. Mesonotum 2.38 mm long. Postpronotal lobe, notopleuron, scutum, and scutellum entirely microtrichose; scutal setulae golden yellow to orange. Chaetotaxy

typical for genus. Katepisternal seta orange-brown, much weaker than and less than half as long as anepisternal seta.

***Legs*.** Entirely yellow to orange.

***Wing*.** Length 6.45 mm, width 2.61 mm, ratio 2.47. Apex of vein R_1 at 3.27 wing length, proximal to level of anterior end of crossvein r-m. Cell c 1.18 times as long as pterostigma; pterostigma 1.45 times as long as wide. Vein R_{2+3} not sinuous. Crossvein r-m at 0.65 distance from bm-m to dm-m on vein M_1. Vein M_1 moderately curved apically; cell r_{4+5} at apex 1.05 times as wide as at level of dm-m, 0.81 times as wide as maximum subapical width. Cell cua with distal lobe relatively short, cua 1.5 times as long as anterior margin, lobe 0.58 times as long as vein CuA+CuP. Wing pattern (Fig. 1) mostly orange and moderate brown. C-band mostly orange, most of cell c sometimes paler but without subapical hyaline area, most of pterostigma orange-brown, distal margin in cells r_1 and r_{2+3} narrowly brown, fork of vein Rs with ovoid brown spot, junction of costa and crossvein h without brown spot, and cell br with brown mark anterior to proximal end of cell bm and small brown mark on apical margin of band bordering vein R_{4+5}. C-band and S-band connected along vein R_{4+5}. Basal hyaline area in cell dm relatively small, occupying less than one-third of cell. Cell bm hyaline, microtrichose only on subapical fold. Basal half of S-band mostly orange, anterobasal margin narrowly brown except in cell dm, posterodistal margin narrowly brown, more broadly in cell m_4, but at most extending to apex of lobe of cell cua, margin with a small incision in cell m_4; distal section narrowly brown on most of posterior margin and in cell r_{4+5}; moderately broad, at apex of vein R_{2+3}, 0.53 times width of cell r_{2+3}, without marginal hyaline areas; hyaline area proximal to apex of band extending nearly to vein R_{2+3}. V-band with proximal arm brown in cell m_4 and on most proximal and distal margins; separated from S-band along vein R_{4+5}; on posterior margin extending two-thirds of distance to vein CuA+CuP; distal arm mostly brown, not connected to proximal arm.

***Abdomen*.** Mostly orange, without brown markings.

***Female terminalia*.** Oviscape 1.63 mm long, 0.68 times as long as mesonotum, straight in lateral view; entirely orange to pale brown; spiracle at basal 0.34. Eversible membrane not dissected, pattern of dorsobasal denticles not visible. Aculeus slightly ventrally curved in lateral view, 1.43 mm long, 0.87 times oviscape length; in ventral view base expanded, triangular, 0.22 mm wide, shaft 0.12 mm wide at midlength (Fig. 2); tip 0.18 mm long, 0.12 times aculeus length, 0.09 mm wide at base, 0.11 mm wide preapically, 1.62 times as long as preapical width; in ventral view (Figs 3, 4) gradually tapered, moderately constricted before serrated part, serrate part triangular, 0.84 times tip length, with serrations extending to dorsal side basally. Spermathecae not dissected.

Male. Unknown.

Distribution. *Anastrepha dorsidentata* sp. nov. is known only from Manaus, Amazonas, Brazil.

Biology. The host plants and other aspects of the biology of this species are unknown.

Etymology. The species epithet is a Latin adjective formed by *dorsum* (dorsal) and *dentatus* (toothed), with reference to the dorsal position of some teeth at the aculeus tip.

Comments. *Anastrepha dorsidentata* sp. nov. belongs to the *fraterculus* group, on the basis of its aculeus tip and the brown lateral markings on the subscutellum and mediotergite.

***Anastrepha norrbomi* Uramoto, Zucchi, Araújo & Savaris sp. nov.**
https://zoobank.org/B8602B9B-207F-468D-B039-EFFA19109C1E
Figs 5–7

Type material. ***Holotype*** Brazil • 1 ♀; Amazonas, Manaus, campus of Federal University of Amazonas; 03°05'51.1"S, 59°58'23.8"W; 92 m elev.; collected on 15 July 2011, McPhail-type trap, food attractant, F.C. Costa-Silva leg. (MELQ ESALQENT001841).

Diagnosis. *Anastrepha norrbomi* sp. nov. can be recognized by the following combination of characters: face with ventral part gradually tapered laterally; scutal and scutellar setae well developed, dark brown to black, mediotergite and subscutellum entirely yellow, without brown marks; wing pattern with C- and S-bands complete, distal arm of V-band absent; oviscape 4.72 mm long, 1.18 as long as mesonotum; aculeus tip short (0.07 mm), 0.01 times aculeus length, subquadrate (0.83 times as long as preapical width), nonserrate and blunt. In the key of Zucchi (2000), *A. norrbomi* sp. nov. runs to *A. quararibae* Lima, from which it differs in having the aculeus tip much shorter (0.25–0.33 mm in *A. quararibae*) and the distal arm of the V-band absent. In the key of Steyskal (1977), it runs to *A. panamensis* Greene, but that species has the distal arm of the V-band connected to the proximal arm and a shorter aculeus (2.65–3.35 mm) with a tapered, triangular tip.

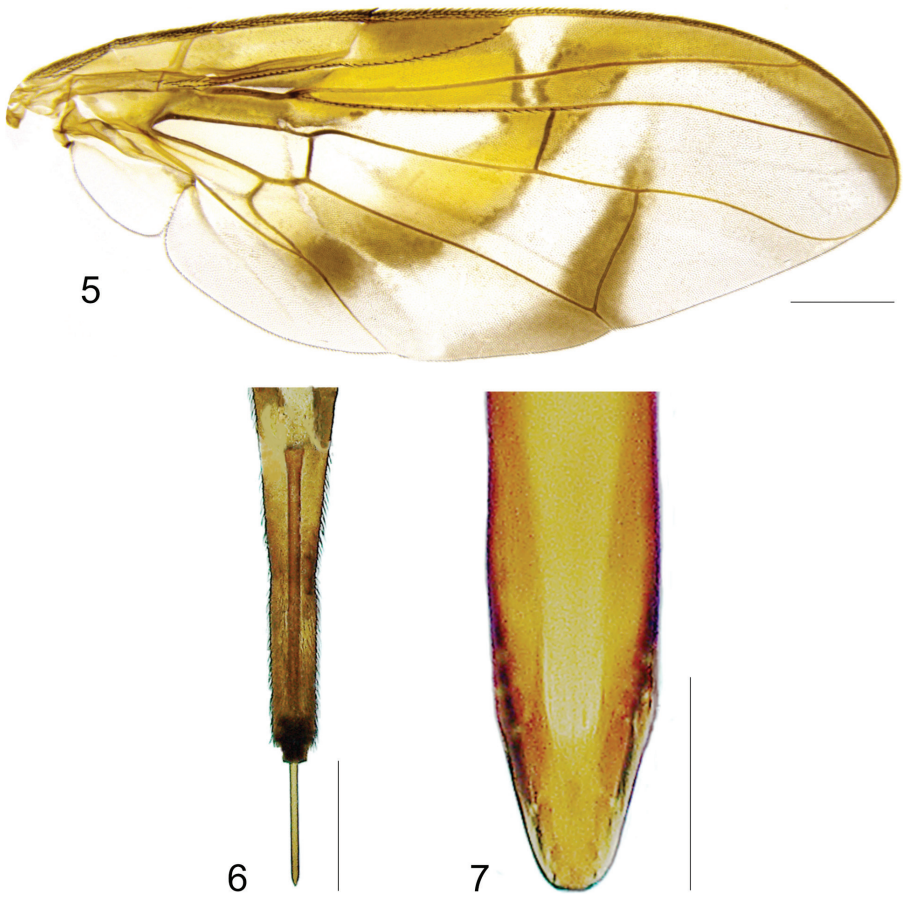
Description. Mostly orange. Setae dark brown to black.

***Head*.** Yellow to orange except brown ocellar tubercle. 4 frontal setae; 2 orbital setae. Ocellar seta weak, at most 1.5 times as long as ocellar tubercle. Facial carina, in profile, straight on dorsal two-thirds. Antenna not extending to ventral facial margin. Palpus in lateral view dorsally curved, evenly setulose. Face with ventral part gradually tapering laterally.

***Thorax*.** Mostly orange; without brown marking, scuto–scutellar suture without brown spot; with following areas white to pale yellow: postpronotal lobe and lateral margin of scutum bordering it; medial scutal vitta present with posterior end ovoid; sublateral scutal vitta from transverse suture to posterior margin, including base of intra-alar seta; scutellum, dorsal margins of anepisternum and katepisternum; katepimeron, most of anatergite and katatergite. Subscutellum and mediotergite entirely orange. Mesonotum 3.98 mm long. Postpronotal lobe, notopleuron, scutum, and scutellum entirely microtrichose; scutal setulae yellow to orange. Chaetotaxy typical for genus. Katepisternal seta orange, much weaker than and less than half as long as anepisternal seta.

***Legs*.** Entirely yellow to orange.

***Wing*.** Length 8.45 mm, width 3.36 mm, ratio 2.51. Apex of vein R_1 at 0.55 wing length, proximal to level of anterior end of crossvein r-m. Cell c 1.27 times as long as pterostigma; pterostigma 3.60 times as long as wide. Vein R_{2+3} not sinuous. Crossvein r-m at 0.69 distance from bm-m to dm-m on vein M_1. Vein M_1 moderately curved apically; cell r_{4+5} at apex 0.82 times as wide as at level of dm-m, 0.73 times as wide as maximum subapical width. Cell cua with distal lobe relatively short, length of cua 1.50 times as long as anterior margin, lobe 0.52 times as long as vein CuA+CuP. Wing pattern (Fig. 5) mostly orange and moderate brown. C-band mostly orange, most of cell c sometimes paler but without subapical hyaline area, most of pterostigma orange-brown, distal margin in cells r_1 and r_{2+3} narrowly brown, fork of vein Rs with ovoid brown spot, junction of costa and crossvein h with brown spot, and cell br with small ovoid brown mark on apical margin of band bordering vein



Figures 5–7. *Anastrepha norrbomi* sp. nov. **5.** Wing; **6.** Oviscape and aculeus (ventral view); **7.** Aculeus tip (ventral view). Photographs by Alexandre S. Araújo (Wing), Keiko Uramoto (Aculeus and aculeus tip). Scale bars: 1.0 mm (wing and aculeus); 0.1 mm (aculeus tip).

R_{4+5}. C-band and S-band connected along vein R_{4+5}. Basal hyaline area in cell dm relatively small, occupying less than one-third of the cell. Cell bm hyaline, microtrichose only on subapical fold. Basal half of S-band mostly orange, anterobasal margin narrowly brown except in cell dm, posterodistal margin narrowly brown, more broadly in cell m_4, but at most extending to apex of lobe of cell cua, margin with incision in cell m_4; distal section narrowly brown on most of posterior margin and in cell r_{4+5}; moderately broad, at apex of vein R_{2+3}, 0.57 times width of cell r_{2+3}, without marginal hyaline areas; hyaline area proximal to apex of band extending nearly to vein R_{2+3}. V-band with proximal arm brown in cell m_4 and on most of proximal and distal margins; separated from S-band along vein R_{4+5}; on posterior margin extending two-thirds of distance to vein CuA+CuP; distal arm absent.

***Abdomen*.** Mostly orange, without brown markings.

***Female terminalia*.** Oviscape 4.72 mm long, 1.18 times as long as mesonotum, straight in lateral view; entirely orange to pale brown; spiracle at basal 0.26. Eversible membrane not dissected, pattern of dorsobasal denticles not visible. Aculeus slightly ventrally curved in lateral view, 4.27 mm long, 0.90 times oviscape length; in ventral view base expanded, triangular, 0.21 mm wide, shaft 0.08 mm wide at midlength (Fig. 6); tip 0.07 mm long, 0.01 times aculeus length, 0.07 mm wide at base, 0.08 mm wide preapically, 0.83 times as long as preapical width; in ventral view slightly tapered, non-serrate, lateral margin straight, tip truncated (Fig. 7). Spermathecae not dissected.

***Male terminalia*.** Unknown.

Distribution. *Anastrepha norrbomi* sp. nov. is known only from Manaus, Amazonas, Brazil.

Biology. The host plants and other aspects of the biology of this species are unknown.

Etymology. The species epithet pays tribute to Allen L. Norrbom, for his notable contributions to knowledge of the diversity of the genus *Anastrepha*, describing numerous species, and for revealing several morphological characters that allowed the standardization of species descriptions, leading to the development of an interactive illustrated key for hundreds of *Anastrepha* species.

Comments. This species has not been placed in a species group.

Discussion

The records of *Anastrepha* species in the state of Amazonas were obtained by multiple researchers over approximately 90 years (see Zucchi and Moraes 2025). The first record of the genus in the state (*A. fenestrata* Lutz & Lima) was published in the 1910s (Lutz and Lima 1918), while the most recent record (*A. caballeroi* Norrbom) was reported by Uramoto et al. (2024). Descriptions of new species from the state of Amazonas have been published intermittently (Lima 1934; Stone 1942; Norrbom 1991; Norrbom and Korytkowski 2009, 2011, 2012; Norrbom et al. 2012, 2015, 2021).

The first key for identifying *Anastrepha* species from the Brazilian Amazon included 32 species and data from five states of the North region: Amapá (3 species), Amazonas (25), Pará (15), Rondônia (5), and Roraima (8) (Silva and Ronchi-Teles 2000). At that time, no records were available for the northern states of Acre and Tocantins. Approximately a decade later, an illustrated key was produced for 54 species of *Anastrepha* from the Amazon region, including records from all nine states of the region (Zucchi et al. 2011). A key was recently published exclusively for species native to the state of Amazonas (Silva et al. 2023). This key is currently being amended and updated, with the inclusion of *A. caballeroi* Norrbom, *A. cruzi* Lima, *A. dorsidentata* sp. nov., and *A. norrbomi* sp. nov.

The state of Amazonas comprises 62 municipalities, yet only 17 of these have documented records of *Anastrepha* species. About 80% (37) of the species were recorded in Manaus. In contrast, records of *Anastrepha* species in municipalities in the southern part of the state, in the region of the deforestation arc, are scarce (Silva et al. 2023) (Fig. 8). *Anastrepha striata* Schiner appears to be the most widely distributed species in the state, having been recorded in 16 municipalities, followed by *A. distincta* Greene and *A. obliqua* (Macquart) (both in 12). Nevertheless, 22 species were documented in a single municipality (Table 1). The considerable number of municipalities with only a single recorded species suggests that collections in the state have been sporadic or occasional. Four species (*A. amazonensis* Norrbom, *A. cruzi* Lima, *A. megacantha* Zucchi, and *A. trivittata* Norrbom) are known only from the state of Amazonas. *Anastrepha caudata* Stone, originally described from the Amazon, is likely to occur in Colombia as well (Norrbom 2025). For four species (*Anastrepha hamata* (Loew), *A. hastata* Stone, *A. obscura* Aldrich, and *A. shannoni* Stone) recorded from Amazonas the municipality is unknown, the sites of occurrence were given only as Amazonas. Conversely, *A. grandicula* Norrbom and *A. macracantha* Norrbom & Korytkowski

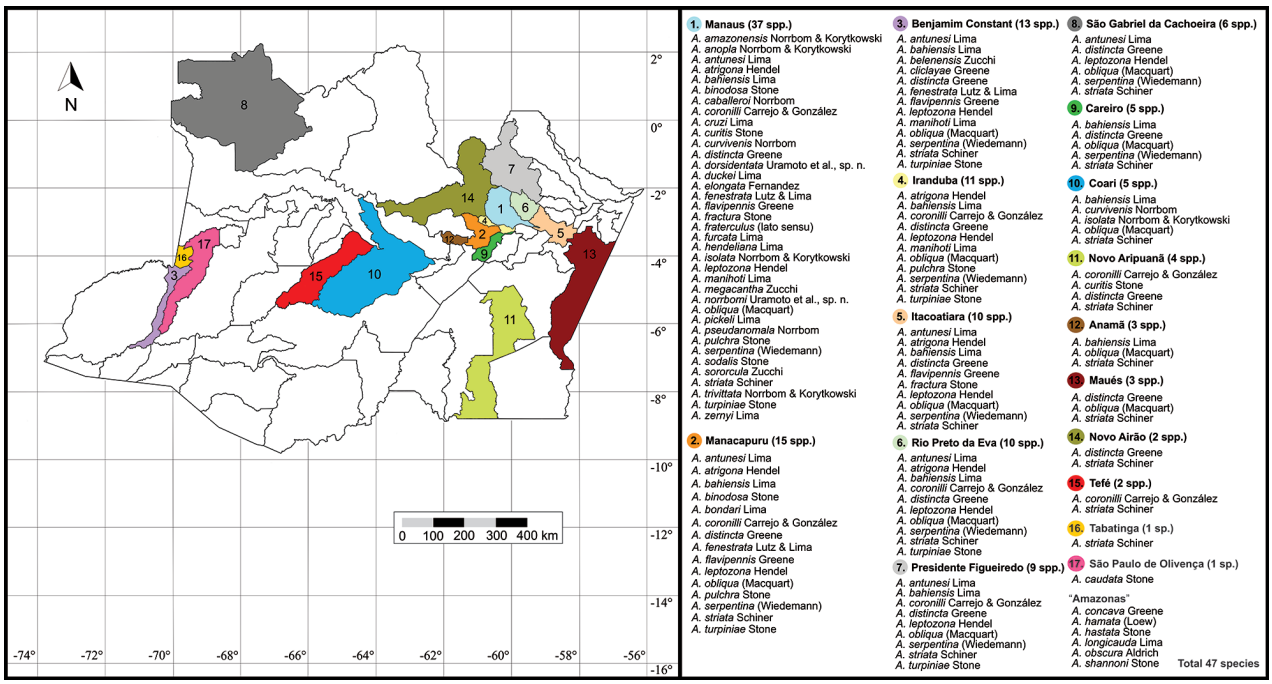


Figure 8. Distribution of *Anastrepha* species in the municipalities of the state of Amazonas, Brazil. Illustration by M. Savaris.

were erroneously recorded in the state of Amazonas (Zucchi 2007; Silva et al. 2023, respectively). *Anastrepha grandicula* has been recorded only from Colombia (Amazon Basin, Rio Putumayo, Puerto Arica) and Peru (Junín) (Norrbom 1991; Mengual et al. 2017), and *A. macracantha* occurs in eastern Ecuador (Orellana, Sucumbíos) (Norrbom and Korytkowski 2012). On the other hand, *A. concava* Greene was collected in the city of São Paulo de Olivença, state of Amazonas (Norrbom and Caraballo 2003), but was incorrectly recorded for the state of São Paulo (Stone 1942). In addition to Brazil (Amazonas and Pará), *A. concava* also occurs in Bolivia, Costa Rica, Ecuador, Panama, and Peru (Norrbom 2025). Host plants are unknown for about 80% of the *Anastrepha* species from Amazonas (Table 1) (see Zucchi and Moraes 2025).

A compilation of the records, which encompass a wide temporal and geographic scope, indicates that collections of *Anastrepha* species in the state of Amazonas have been sporadic and concentrated mostly in the vicinity of urban centers. The factors that may explain this limited collection effort are the same as for the entire Brazilian Amazon, namely the vast territorial extent, inaccessible locations, and a scarcity of human resources for conducting entomological studies (Sousa et al. 2021).

Notwithstanding these constraints, Amazonas is the Brazilian state with the most records of *Anastrepha* species. However, knowledge of the diversity of fruit flies in Amazonas remains at a very incipient level. This reasoning is supported by data collected on the UFAM campus (fragment of urban rainforest), where 18 species of *Anastrepha* were collected in McPhail traps over a 13-month period, in addition to other unidentified species (Costa-Silva 2012). These species were subsequently identified, resulting in new records for the state of Amazonas (Costa-Silva et al. 2020), including the rediscovery of *A. cruzi* Lima, 80 years after its original description (Uramoto et al. 2024), and the discovery of two new species (*A. dorsidentata* sp. nov. and *A. norrbomi* sp. nov.) described here.

Table 1. Distribution of *Anastrepha* species in the state of Amazonas, Brazil.

Species of *Anastrepha*	Municipalities (for numbers see Fig. 8)																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
A. amazonensis[1]	X																
A. anopla	X																
A. antunesi[2]	X	X	X		X	X	X	X									
A. atrigona[2]	X	X		X	X	X											
A. bahiensis[2]	X	X	X	X	X	X	X		X	X		X					
A. belenensis			X														
A. binodosa	X	X															
A. bondari[2]		X															
A. caballeroi	X																
A. caudata																	X
A. chiclayae			X														
A. concava[3]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
A. coronilli[2]	X	X		X		X	X				X				X		
A. cruzi[1]	X																
A. curitis[2]	X										X						
A. curvivenis[1]	X									X							
A. distincta[2]	X	X	X	X	X	X	X	X	X		X		X	X			
A. dorsidentata[1]	X																
A. duckei[2]	X																
A. elongata	X																
A. fenestrata	X	X	X														
A. flavipennis[2]	X	X	X		X												
A. fractura[2]	X				X												
A. fraterculus	X																
A. furcata	X																
A. hamata[3]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
A. hastata[3]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
A. hendeliana	X																
A. isolata	X									X							
A. leptozona[2]	X	X	X	X	X	X	X	X									
A. longicauda[3]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
A. manihoti[2]	X		X	X													
A. megacantha[1]	X																
A. norrbomi[1]	X																
A. obliqua[2]	X	X	X	X	X	X	X	X	X	X		X	X				
A. obscura[1, 3]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
A. pickeli[2]	X																
A. pseudanomala	X																
A. pulchra[2]	X	X		X													
A. serpentina[2]	X	X	X	X	X	X	X	X	X								
A. shannoni[3]	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
A. sodalis	X																
A. sororcula	X																
A. striata[2]	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
A. trivittata[1]	X																
A. turpiniae[2]	X	X	X	X		X	X										
A. zernyi	X																

[1]Recorded only from Amazonas state; [2]Known hosts in Amazonas state; [3]Unknown locality.

In this rainforest fragment, where numerous fruit species typical of the Amazon region are present, nearly half of the species so far recorded in the state of Amazonas were collected. This finding underscores the importance and necessity of continuous and frequent surveys to assess the diversity of fruit flies in the Amazon. Such surveys would increase the probability of collecting more species of fruit flies, given the seasonality of fruits in the Amazon region, which is home to a vast array of native fruit species (Cavalcante 2010). Consequently, in view of the logistical challenges associated with collecting in remote locations, continuous sampling (utilizing traps and/or collecting fruits), even in forest fragments situated near urban centers, can be of great value in understanding the diversity of *Anastrepha* fruit flies in the Amazon biome. On the other hand, the enormous biodiversity of the rainforest reminds us of the words of Isaac Newton, broadly paraphrased: "...we collect one species or another, while the enormous diversity of species in the Amazon Rainforest remains unknown to us".

Illustrated key to the species of *Anastrepha* (female) recorded in the state of Amazonas, Brazil

1 C-band and S-band fused, covering anterior margin of wing **2**

1' C-band and S-band at least partially separated by hyaline area distal to apex of vein R_1 ..... **4**

Photo: A.S. Araújo

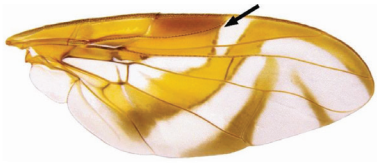


Photo: A.S. Araújo

2(1) Cell br with hyaline area extending at least one third of cell length .... ***A. trivittata*** **Norrbom & Korytkowski**

2' Cell br without hyaline area **3**

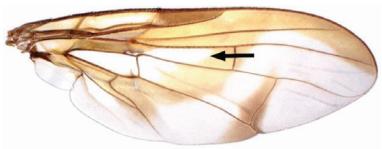


Photo: Norrbom and Korytkowski 2011: fig. 17

Photo: A.L. Norrbom

3(2') Cell r_{2+3} with subapical hyaline area extending to vein R_{2+3}; V-band with proximal arm often partially joined to S-band in cell dm; aculeus tip not serrated..... ***A. atrigona*** **Hendel**

3' Cell r_{2+3} entirely infuscated; V-band with proximal arm separated from S-band in cell dm; aculeus tip serrated..... ***A. shannoni*** **Stone**

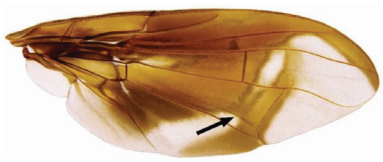


Photo: A. S. Araújo

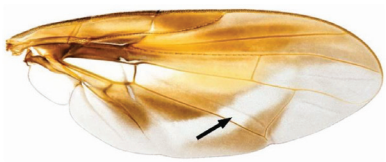
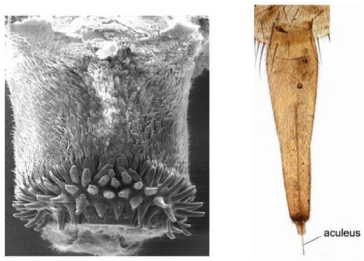


Photo: A.L. Norrbom

4(1') Eversible membrane with dorsobasal denticles all small and weakly developed; aculeus width less than 0.05 mm **5**

4' Eversible membrane with dorsobasal denticles all sclerotized; aculeus width more than 0.05 mm **8**



Photos: K. Uramoto; Uramoto et al. 2016, fig. 1E

Photo: A.L. Norrbom

5(4) C, S and V-bands broadly fused ..... ***A. obscura* Aldrich**

5' C-, S- and V-bands at least partially separated **6**

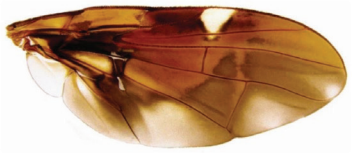


Photo: A. S. Araújo

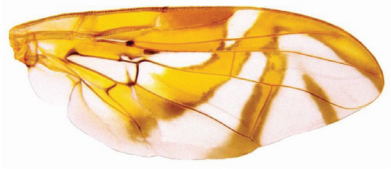


Photo: A. S. Araújo

6(5') Aculeus 6–8 mm long; tip nonserrate ..... ***A. longicauda* Lima**

6' Aculeus less than 5 mm long; tip serrate **7**

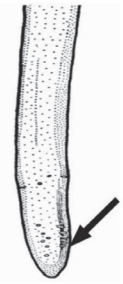


Illustration: Lima 1934: fig. 23

Photo: K. Uramoto

7(6') Aculeus tip with triangular, acute apex..... ***A. hamata* Loew**

7' Aculeus tip with blunt apex ..... ***A. zernyi* Lima**

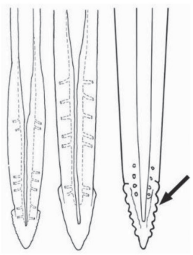


Illustration: Norrbom 1985: fig. 36C, E; Stone 1939: fig. 6

Photo: K. Uramoto

8(4') Eversible membrane with one very large slender medial hook-like denticle much larger than others; C-, S- and V-bands separated; oviscape 10 mm long ..... ***A. megacantha* Zucchi**

8' Eversible membrane with multiple large equal to subequal hook-like denticles **9**

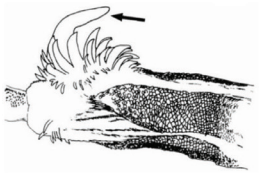


Illustration: Zucchi 1984: fig. 2b

Photo: K. Uramoto

9(8') Mesonotum, excluding white to yellow vittae, mostly dark brown **10**

9' Mesonotum, excluding vittae, mostly yellowish to orange **12**

Photo: A.L. Norrbom

Photo: A.C.L. Silva

10(9) Basal hyaline area between C-band and S-band absent ..... ***A. pulchra* Stone**

10' Basal hyaline area between C-band and S-band extending into cell br but not touching vein R_{4+5} **11**

Photo: A.L. Norrbom

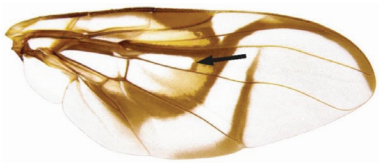


Photo: A.S. Araújo

11(10') Abdominal tergites brown with T-shaped yellow or white mark; aculeus length 2.55–3.85 mm ..... ***A. serpentina* (Wiedemann)**

11' Abdominal tergites with brown vittae; aculeus length 3.95–4.35 mm... ..... ***A. pseudanomala* Norrbom**

Photo: A.L. Norrbom

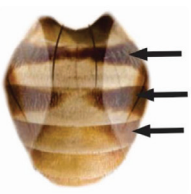


Photo: A.L. Norrbom

12(9') Oviscape spiracle near base (at basal 0.06–0.15 of length); aculeus tip with constriction, more than apical half serrate ..... ***A. curitis* Stone**

12' Oviscape spiracle far from base (distal to basal 0.15)..... **13**

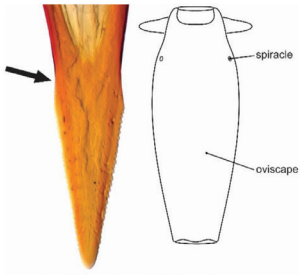


Photo: A.S. Araújo; illustration: M. Savaris

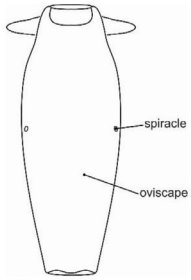


Illustration: M. Savaris

13(12') Scutum with U-shaped dark brown mark interrupted at transverse suture; aculeus length 1.95–2.3 mm..... ***A. striata* Schiner**

13' Scutum without longitudinal dark vittae..... **14**

Photo: Amaral et al. 2023: fig. 1D

Photo: A.C.L. Silva

14(13') Wing bands mostly dark brown..... **15**

14' Wing bands predominantly light brown and/or orange..... **21**

Photo: A.L. Norrbom

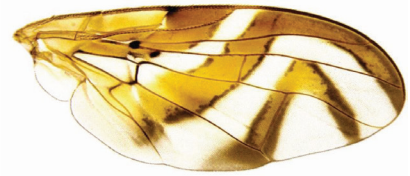


Photo: A. Araújo

15(14) Cell br entirely infuscate, without hyaline areas..... ..... ***A. amazonensis* Norrbom & Korytkowski**

15' Cell br not entirely infuscate, with subapical hyaline area **16**

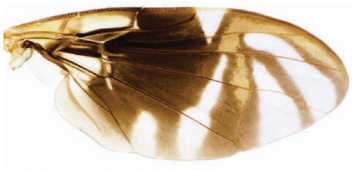


Photo: Norrbom and Korytkowski 2009: fig. 19

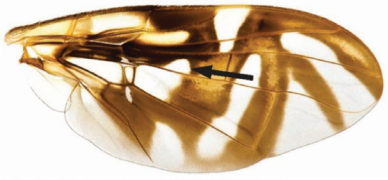


Photo: Norrbom and Korytkowski 2009: fig. 41

16(15') S-band with width of basal portion less than half length of CuA+CuP ... **17**

16' S-band with width of basal portion more than half length of CuA+CuP **18**

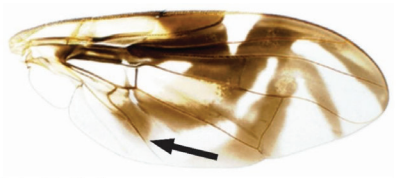


Photo: A.L. Norrbom

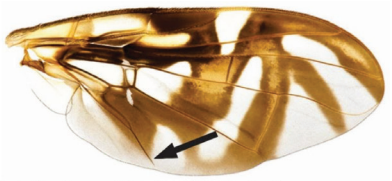


Photo: Norrbom and Korytkowski 2009: fig. 41

17(16) Aculeus length: 5–6 mm; aculeus tip 0.1–0.11 mm wide..... ..... ***A. hendeliana* Lima**

17' Aculeus length: 3.3–3.8 mm; aculeus tip 0.14–0.16 mm wide .... ***A. caudata* Stone**

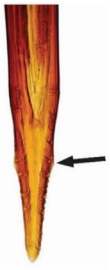


Photo: A.L. Norrbom

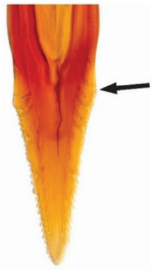


Photo: A.L. Norrbom

18(16') V-band connected to S-band at two points .... ***A. isolata* Norrbom & Korytkowski**

18' V-band connected to S-band at a single point **19**

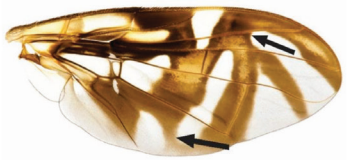


Photo: Norrbom and Korytkowski 2009: fig. 41

Photo: A.L. Norrbom

19(18') Base of S-band with posterior extension to almost to wing margin in middle of cell m_4; aculeus tip with medium-sized serrations..... ..... ***A. fenestrata* Lutz & Lima**

19' Base of S-band without posterior extension in middle of cell m_4 ..... **20**

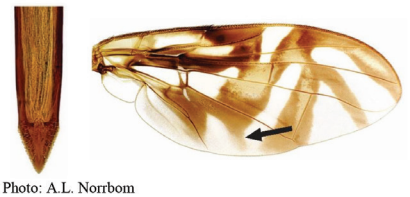


Photo: A.L. Norrbom

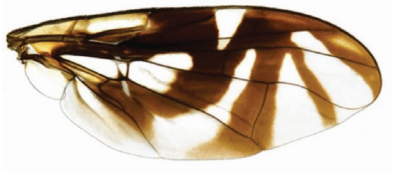
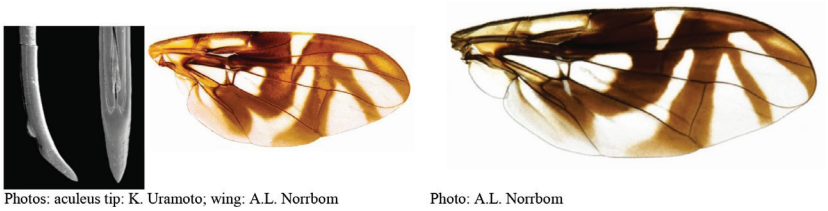


Photo: A.L. Norrbom

20(19') Vein M_1 very strongly curved apically; aculeus strongly curved in lateral view, 1.19–2.27 mm long ..... ***A. furcata* Lima**

20' Vein M_1 slightly curved apically; aculeus straight in lateral view, 6.4–9.20 mm long ..... ***A. concava* Greene**



Photos: aculeus tip: K. Uramoto; wing: A.L. Norrbom

Photo: A.L. Norrbom

21(14') Mediotergite not darkened laterally **22**

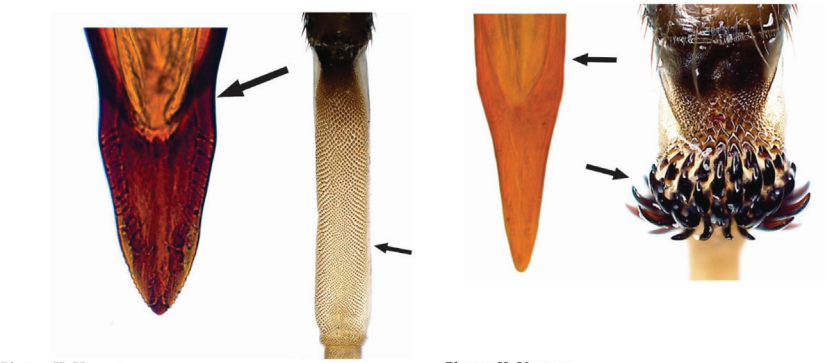
21' Mediotergite dark brown laterally **40**

Photo: A.S. Araújo

Photo: A.C.L. Silva

22(21') Aculeus tip with preapical constriction; eversible membrane with very long pattern of small denticles, platelike, not hook-like .... ***A. anopla* Norrbom & Korytkowski**

22' Aculeus tip without preapical constriction; eversible membrane with hook-like denticles **23**



Photos: K. Uramoto

Photos: K. Uramoto

23(22') Aculeus tip not serrate.....**24**
23' Aculeus tip serrate.....**28**

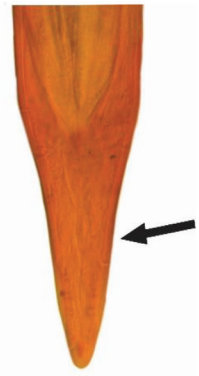


Photo: A.S. Araújo

Photo: A.S. Araújo

24(23) Aculeus tip with lateral projections on basal half.....***A. hastata* Stone**
24' Aculeus tip without lateral projection.....**25**

Photo: A.L. Norrbom

Photo: A.S. Araújo

25(24') Vein M_1 strongly curved apically.....***A. curvivenis* Norrbom**
25' Vein M_1 slightly curved apically.....**26**

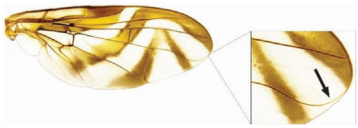


Photo: A.S. Araújo

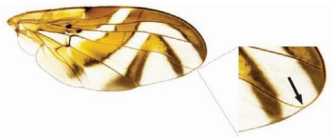


Photo: K. Uramoto

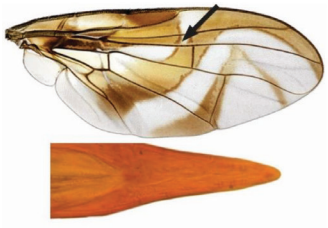
26(25') Aculeus tip very short (0.07 mm long) .....
.....***A. norrbomi* Uramoto et al. sp. nov.**
26' Aculeus tip long (0.20–0.37 mm).....**27**

Photo: K. Uramoto

Photo: K. Uramoto

27(26') C- and S-bands connected; aculeus 0.12–0.14 mm wide..... ..... ***A. bondari* Lima**

27' C- and S-bands disconnected; aculeus tip 0.05–0.09 mm wide..... .....***A. caballeroi* Norrbom**



Photos: wing: A.L. Norrbom; aculeus tip: A.S. Araújo

Photos: K. Uramoto

28(23') Aculeus tip with a constriction basal to serrate part and with medium-sized widely spaced serrations .....***A. cruzi* Lima**

28' Aculeus tip without constriction basal to serrate part and with minute, closely spaced serrations.....**29**

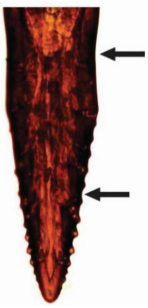


Photo: Uramoto et al. 2024: fig. 7

Photo: A.S. Araújo

29(28') Aculeus tip with serrations on less than apical half.....**30**

29' Aculeus tip with serrations on at least apical half.....**31**

Photo: A.S. Araújo

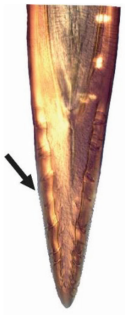


Photo: A.S. Araújo

30(29) Aculeus 9.25–12.25 mm long; aculeus tip without lateral projections.. ..... ***A. elongata*** **Fernandez**

30' Aculeus 4.10–5.20 mm long; aculeus tip with lateral projections..... ..... ***A. binodosa*** **Stone**

Photo: M. Savaris

Photo: A.S. Araújo

31(29') C- and S-bands separate **32**

31' C- and S-bands connected **33**

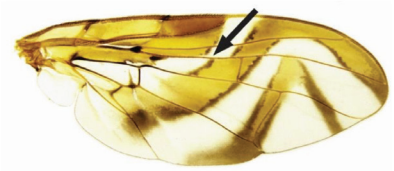


Photo: A.S. Araújo

Photo: A.L. Norrbom

32(31) Vein M_1 slightly curved apically..... ***A. chiclayae*** **Greene**

32' Vein M_1 strongly curved apically ..... ***A. leptozona*** **Hendel**

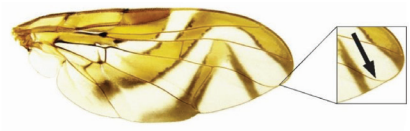


Photo: A.S. Araújo

Photo: A.S. Araújo

33(31') Aculeus tip tapering abruptly ..... ***A. fractura*** **Stone**

33' Aculeus tip not tapering abruptly..... **34**

Photo: A.L. Norrbom

Photo: A.S. Araújo

34(33') Aculeus tip serrate **35**
34' Aculeus tip not serrate **39**

Photo: A.S. Araújo

Photo: A.L. Norrbom

35(34) Aculeus tip with serrations beyond level of cloacal opening **36**
35' Aculeus tip with serrations not reaching cloacal opening **37**

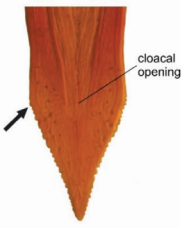


Photo: A.S. Araújo

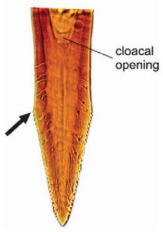


Photo: A.S. Araújo

36(35) Aculeus tip with a slight constriction before serration ..... ***A. manihoti*** **Lima**
36' Aculeus tip with no constriction before serration ..... ***A. pickeli*** **Lima**

Photo: A.S. Araújo

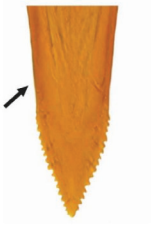


Photo: A.S. Araújo

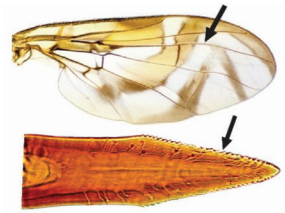
37(35') Aculeus tip with few large serrations ..... ***A. antunesi*** **Lima**
37' Aculeus tip with many small to tiny serrations **38**

Photo: A.S. Araújo

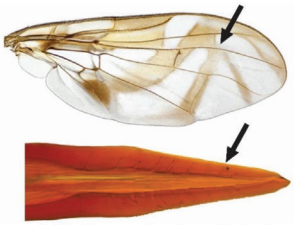
Photo: A.S. Araújo

38(37') S- and V-bands not connected; aculeus tip with distinct serrations.....
.....***A. duckei* Lima**

38' S- and V-bands connected; aculeus tip with fine serrations .....
.....***A. sodalis* Stone**



Photos: wing: A.L. Norrbom; aculeus tip: A.S. Araújo



Photos: wing: A.L. Norrbom; aculeus tip: A.S. Araújo

39(34') Cell bm yellowish; aculeus tip without constriction.....
.....***A. flavipennis* Greene**

39' Cell bm hyaline; aculeus tip with constriction.....***A. belenensis* Zucchi**

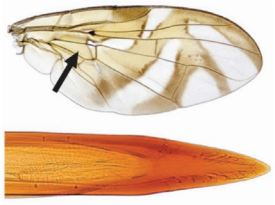


Photo: A.L. Norrbom

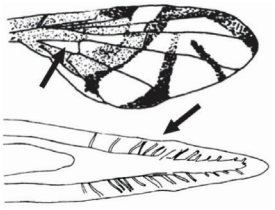


Illustration: Zucchi 1979: figs 3, 14

40(21') Aculeus tip with serrations extending at least to half tip length.....**41**

40' Aculeus tip with serrations along less than half tip length **45**

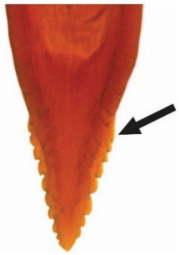


Photo: A.S. Araújo

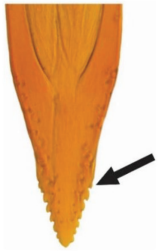


Photo: A.S. Araújo

41(40) Aculeus tip with distinct constriction before serrations.....**42**

41' Aculeus tip with slight constriction or with no constriction before serrations.....**44**

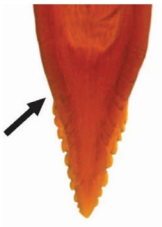


Photo: A.S. Araújo

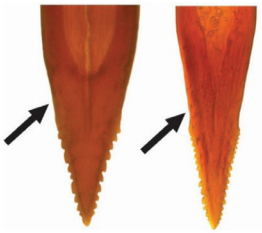


Photo: A.S. Araújo

42(41) Aculeus tip with dorsal ridge.... ***A. dorsidentata* Uramoto et al. sp. nov.**
42' Aculeus tip without dorsal serrations.....**43**

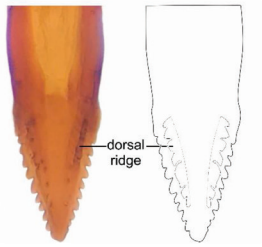


Photo: K. Uramoto; illustration: M. Savaris


Photo: A.S. Araújo

43(42') Aculeus tip long (tip length/tip width at base about 1.9 .... ***A. fraterculus* (Wiedemann)**
43' Aculeus tip short (tip length/ tip width at base about 1.4..... ..... ***A. sororcula* Zucchi**


Photo: A.S. Araújo


Photo: A.S. Araújo

44(41') Aculeus tip about 0.20 mm long; serrations acute..... ..... ***A. obliqua* (Macquart)**
44' Aculeus tip 0.27–0.30 mm long; serrations rounded..... ***A. turpinae* Stone**

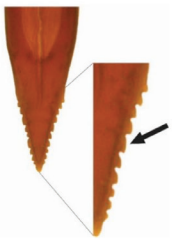


Photo: A.S. Araújo

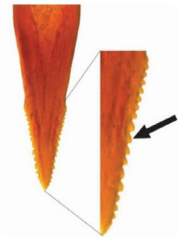


Photo: A.S. Araújo

45(40') Aculeus length less than 2.00 mm ..... ***A. bahiensis* Lima**
45' Aculeus length at least 2.00 mm **46**


Photo: A.S. Araújo


Photo: A.S. Araújo

46(45') Aculeus tip with prominent and acute serrations ..... ***A. coronilli* Carrejo & González**

46' Aculeus tip with slightly prominent and rounded serrations..... ***A. distincta* Greene**

Photo: A.S. Araújo

Photo: A.S. Araújo

Acknowledgements

We thank to Allen L. Norrbom for permission to use his images in the pictorial key. We are deeply grateful to anonymous reviewers for their careful review of the manuscript.

Additional information

Conflict of interest

The authors have declared that no competing interests exist.

Ethical statement

No ethical statement was reported.

Use of AI

No use of AI was reported.

Funding

Alexandre S. Araújo received financial support from the "Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP)". Roberto A. Zucchi and Marcoandre Savaris receive financial support from the "Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq)".

Author contributions

R.A. Zucchi and K. Uramoto drafted the first version of the manuscript. A.S. Araújo and M. Savaris imaged the new species and the figures for the pictorial key. K. Uramoto, R. A. Zucchi, A.S. Araújo, and M. Savaris developed the key. A.S. Araújo composed the pictorial key. N.M. Silva and F.C. Costa-Silva oversaw the fieldwork and processing of specimens. M. Savaris composed the map of the state of Amazonas. All authors critically revised the text and approved the final manuscript.

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Data availability

All of the data that support the findings of this study are available in the main text.

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