

First record of *Nausigaster meridionalis* Townsend (Diptera: Syrphidae) from Colombia

Primer registro de *Nausigaster meridionalis* Townsend (Diptera: Syrphidae) en Colombia

Henry Mauricio Parada-Marin ^{1*}, Ximo Mengual ^{2,3}, Yardany Ramos-Pastrana ¹

- Received: 09/Feb/2024
- Accepted: 30/May/2024
- Online Publishing: 28/Aug/2024

Citation: Parada-Marin HM, Mengual X, Ramos-Pastrana Y. 2024. First record of *Nausigaster meridionalis* Townsend (Diptera: Syrphidae) from Colombia. *Caldasia* 46(3):685-693. doi: <https://doi.org/10.15446/caldasia.v46n3.112651>

ABSTRACT

Syrphidae has 6,700 described species worldwide, distributed in 290 genera. *Nausigaster* Williston is a genus of flower flies endemic to the New World. *Nausigaster meridionalis* Townsend is currently known from Brazil, Mexico, and Venezuela. Here we report *N. meridionalis* from Colombia based on a female collected with a Malaise trap in a tropical dry forest in the Ecoreserva La Tribuna at an altitude of 481 m above sea level. This finding is the first record of a *Nausigaster* species from Colombia with accurate geographical data, contributing to the knowledge of the distribution of flower flies in the Neotropics and the Colombian Andean region.

Keywords: flower flies, geographic record, hover flies, Neotropics, tropical dry forest.

RESUMEN

Syrphidae cuenta con 6700 especies descritas en todo el mundo, distribuidas en 290 géneros. *Nausigaster* Williston es un género de moscas de las flores endémico del Nuevo Mundo. *Nausigaster meridionalis* Townsend se conoce actualmente de Brasil, México y Venezuela. Aquí se reporta *N. meridionalis* para Colombia con base en una hembra colectada con trampa malaise en un bosque seco tropical en la Ecoreserva La Tribuna a una altitud de 481 m s.n.m. Este hallazgo es el primer registro de una especie de *Nausigaster* de Colombia con datos geográficos precisos, contribuyendo al conocimiento de la distribución de las moscas de las flores en el Neotrópico y región Andina colombiana.

Palabras Clave: bosque seco tropical, moscas cernícalo, moscas de las flores, Neotrópico, registro geográfico.

¹ Universidad de la Amazonia, Grupo de Investigación en Entomología Universidad de la Amazonia -GIEU-, Laboratorio de Entomología, Florencia, Caquetá, Colombia h.parada@udla.edu.co; ya.ramos@udla.edu.co;

² Museum Koenig Bonn, Leibniz-Institut zur Analyse des Biodiversitätswandels, Adenauerallee 127, D-53113 Bonn, Germany

³ División de Entomología, Instituto Nacional de Biodiversidad (INABIO), Quito, Ecuador x.mengual@leibniz-lib.de;

* Corresponding author



INTRODUCTION

Members of the family Syrphidae (Insecta, Diptera), also known as hover or flower flies, inhabit almost all biographical regions except Antarctica and certain oceanic islands (Thompson *et al.* 2010). There are about 6,700 described species worldwide, distributed in 290 genera (Dunn *et al.* 2020), with the Neotropical Region housing having about 1/3 of the known diversity of flower flies (Thompson *et al.* 2010, Reemer and Ståhls 2013, Morales *et al.* 2013, Miranda *et al.* 2014, 2020, Skevington *et al.* 2019). The phylogenetic relationships of *Nausigaster* are still unclear (Hippa and Ståhls 2005), Rotheray *et al.* (2000) considered *Nausigaster* related to *Criorhina* Meigen, 1822 based on their larval morphology, although Moran *et al.* 2021 recovered *Nausigaster* as sister group to Cerioidini. Adults are important pollinators in natural environments and crops, whilst their larvae are used as biological pest controllers and are important in the recycling of organic matter (Mengual and López García 2015, Mengual *et al.* 2023). Because of these attributes, flower flies are recognized as biological bioindicators of environmental quality, which gives them great relevance in the dynamics of the ecosystems they inhabit (Sommaggio 1999). Nevertheless, the number of flower fly species continues to increase due to the constant description of new species for science (e.g., Ricarte *et al.* 2015, Montoya *et al.* 2017, Reemer 2017, Carvalho-Filho *et al.* 2019, Miranda *et al.* 2020, Montoya *et al.* 2022, Montoya and Wolff 2023).

Nausigaster Williston, 1883 is a genus endemic to the New World, distributed from the southern United States to Argentina, but absent in the Chilean subregion (Thompson *et al.* 2010, Mengual and López García 2015, Barahona-Segovia *et al.* 2021), whose adults mimic cuckoo wasps (Hymenoptera, Chrysididae) (Hull 1949). *Nausigaster* species are characterized by their small size, well-demarcated facial tubercle, with the entire body densely punctate, anepisternum flat without a clear differentiation between anterior and posterior parts, and rounded abdomen (Shannon 1922, Curran 1941, Thompson *et al.* 2010, Mengual and López García 2015). Its larvae are saprotrophs of moist tissues, having been found on decaying cacti, bromeliads, and rotting trunks of papaya (Hunter *et al.* 1912, Carrera *et al.* 1947, Rotheray *et al.* 2000), but they can also be found in other plant groups inhabiting arid and open areas (Thompson *et al.* 2010). All known records are from lowlands, below 600 m above sea level

(Townsend 1897a, Curran 1941, Carrera *et al.* 1947, Montoya *et al.* 2012, Morales *et al.* 2014).

Currently there are fifteen described *Nausigaster* species, of which ten occur in the Neotropical Region, namely *N. bonariensis* Lynch-Arribáizaga, 1892 (Argentina and Brazil) (Lynch-Arribáizaga 1892, Carrera *et al.* 1947, Bachmann 2012); *N. chrysidiformis* Shannon, 1922 (Peru) (Shannon 1922); *N. flukei* Curran, 1941 (Argentina, Brazil, Paraguay and Venezuela) (Curran 1941, Carrera *et al.* 1947, Mengual and López García 2015, Arcaya and Mengual 2016); *N. geminata* Townsend, 1897 (Mexico) (Sarmiento-Cordero *et al.* 2010); *N. meridionalis* Townsend, 1897 (Mexico, Costa Rica, Venezuela, and Brazil?) (Townsend 1897a, Ramírez-García 1997, Sarmiento-Cordero *et al.* 2010, Morales *et al.* 2014, Vargas 2016); *N. peruviana* Shannon, 1922 (Peru) (Shannon 1922); *N. punctulata* Williston, 1883 (Mexico) (Thompson *et al.* 1976, GBIF 2024); *N. tuberculata* Carrera, Lopes and Lane, 1947 (Brazil) (Carrera *et al.* 1947, Thompson *et al.* 1976); *N. unimaculata* Townsend, 1897 (Rotheray *et al.* 2000) and *N. vanzolinii* d'Andretta and Carrera, 1952 (Brazil) (d'Andretta and Carrera 1952).

The diversity of flower flies in Colombia currently consists of 354 species belonging to 59 genera (Montoya *et al.* 2012, 2022, Montoya 2016, Montoya and Wolff 2020, 2023, Parada-Marin *et al.* 2021), but *Nausigaster* is not listed in the last checklist for the country (Montoya 2016). Earlier, Gutierrez *et al.* (2005) listed the genus *Nausigaster* for Colombia based on specimen(s) collected in the Parque Nacional Natural El Tuparro, located in the department of Vichada, but they did not provide any detailed geographic information, nor the number of examined specimens and the species involved. This lack of information makes this record uncertain.

In this manuscript, we confirm the presence of the genus *Nausigaster* from Colombia, report a new record of the species *N. meridionalis*, and provide the sampling and locality information.

MATERIAL AND METHODS

The specimen of *Nausigaster meridionalis* was collected with a Malaise trap, which was active from 5th May to 29th December 2021, in the Ecoreserva La Tribuna, located in Vereda Tamarindo, municipality of Neiva-Huila, in

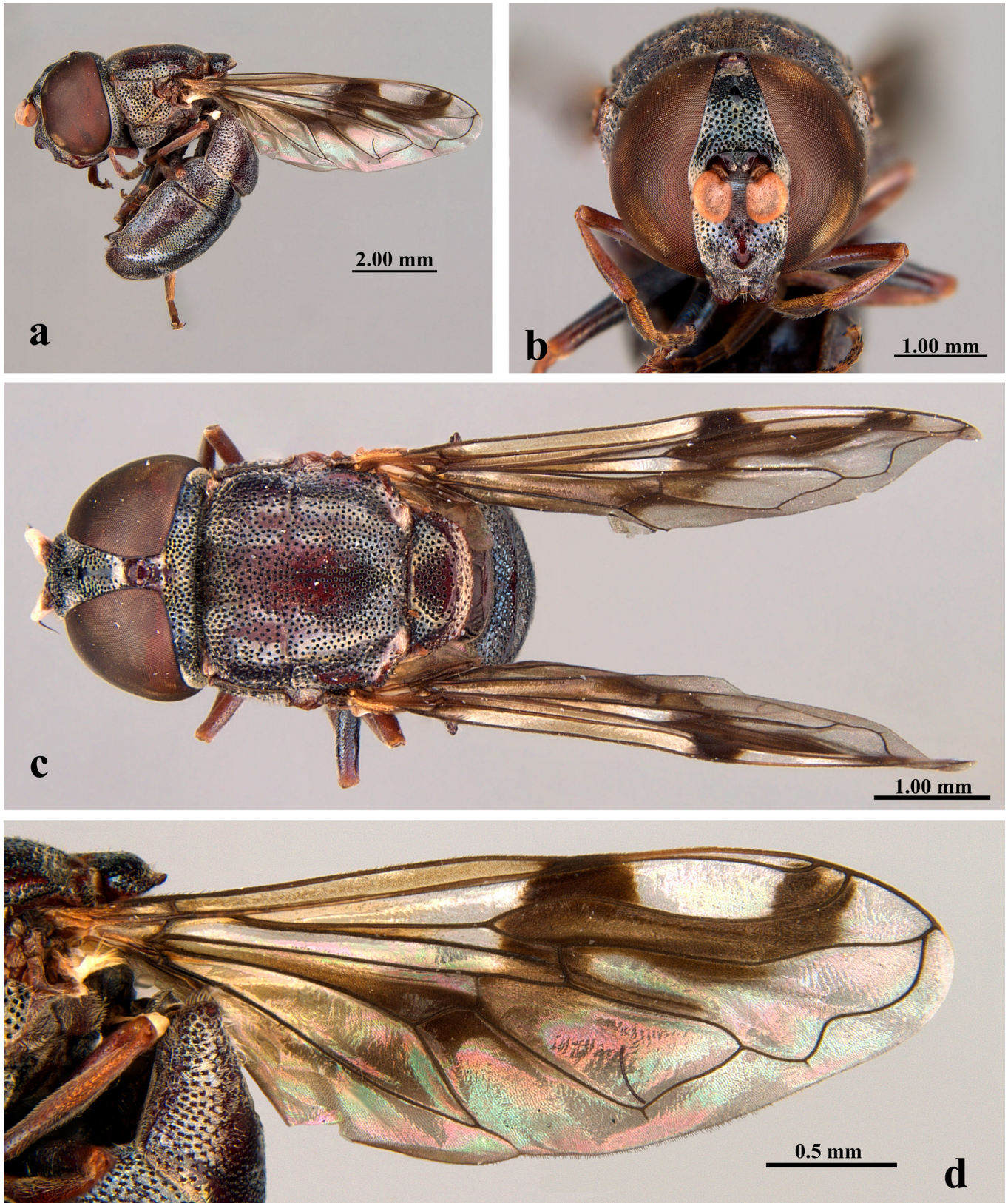


Figure 1. Adult female of *Nausigaster meridionalis* (LEUA-63890). a: Habitus left lateral view; b: Head frontal view; c: dorsal view; d: Wing.

the Colombian Andean region (3°04'02" North, 75°22'32" West) (Fig. 2). The area is a protected area of tropical dry forest, with an average annual rainfall of 1350 mm. The rainy season is bimodal, with a dry season from June to September and a rainy season from October to March. The average annual temperature is 27 °C and the relative humidity is 67 % (IDEAM 2010).

The specimen was identified to genus level using the keys proposed by Miranda (2017) Thompson *et al.* (2010), and Curran (1941) was used to identify the species, together with the original descriptions of the described species, and comparison with material in our collections. We consider that in Syrphidae the female genitalia are not frequently described because it seems not to be diagnostic at the species level, as shown by Miranda and Moran (2017). Therefore, the female genitalia of the species were not dissected. The specimen was imaged using a LEICA DFC450 camera coupled to a Leica M205A stereomicroscope, following the methodology employed by Parada-Marin *et al.* (2021) and Montoya *et al.* (2022). The distribution map was made in SimpleMapp (Shorthouse 2010). The morphological terms follow Cumming and Wood (2017) and van Steenis *et al.* (2023). The studied material was deposited in the collection of the Laboratorio de Entomología Universidad de la Amazonia (LEUA) (Registro Nacional de Colecciones No. 270).

RESULTS

Taxonomy

Syrphidae Latreille, 1802

Eristalinae Newman, 1838

Nausigaster Williston, 1883

Nausigaster meridionalis Townsend, 1897

Nausigaster meridionalis Townsend, 1897a: 20 (original designation); Townsend, 1897b: 24 (Brazil, records from Williston (1886)), 25 (key); Aldrich 1905: 350 (cat. cit.); Kertész 1910: 13 (cat. cit.); Curran 1941: 255 (key); Fluke 1957: 43 (cat. cit.); Thompson *et al.* 1976: 92 (cat. cit., doubt about the report from Brazil by Curran); Ramírez-García and Sarmiento-Cordero 2004: 185 (list, visited plants, Mexico); Sarmiento-Cordero *et al.* 2010: 203 (list,

visited plants, Mexico); Morales *et al.* 2014: 65 (list, Venezuela); Morales and Marinoni 2023 (cat. cit.).

Differential diagnosis. *Nausigaster meridionalis* is most similar to *Nausigaster geminata* Townsend, 1897 as they both have wings with an extensive infusate, dark area, with the cell r_{2+3} darkened connecting the medial and the apical dark maculae, that is, the cell r_{2+3} has not a medial hyaline area (Fig. 1d). Both species differ in the lateral margin of the second abdominal tergite (with a distinct basolateral spur in *N. meridionalis*, but the spur is absent in *N. geminata*) and the extension of the medial dark macula on the wing. *Nausigaster meridionalis* has a more extensive dark macula covering most of the cell bm and basal parts of cells dm and m_4 , whereas *N. geminata* has cells bm , dm , and m_4 almost entirely hyaline with dark areas restricted to the veins separating these cells (Fig. 1) (Townsend 1897b, Curran 1941).

Description. *Female.* Length body: 10.8 mm; wing 7.39 mm (Fig. 1a).

Head. Face dark reddish brown, white pilose, densely white pruinose except for the facial tubercle and some parts of the gene, which are shiny; gena reddish brown, sparsely white pilose; frons densely white pruinose on the lateral margins and dorsally, right before the anterior ocellus; vertex dark reddish, bronze pruinose; eyes bare, without pile; ocelli reddish. Antenna short; scape and pedicel reddish brown, postpedicel orange, lightly white pruinose (Fig. 1b). **Thorax.** Reddish brown, densely white pruinose; Scutum with four shiny, greenish vittae; scutellum reddish, with a distinct posterior margin covered with yellowish pruinosity and without tubercles. Anepisternum, anepimeron, and katepimeron densely white pilose. Calypter and halter white (Figs. 1b, 1c). Legs reddish brown to black; profemur and mesofemur reddish brown, except for the 1/4 basal black, sparsely white pilose; metafemur black, except for the apical 1/3 reddish; yellow pilose; pro and mesotibia reddish brown, yellow pilose; metatibia reddish brown, thickened medially, yellow pilose; tarsomeres reddish brown, yellow pilose (Figs. 1a, 1b). Wing hyaline with extensive dark areas: cell r_1 with a medial and distal macula placed posterior to the pterostigma and at the apex, joined through the cell r_{2+3} , which is entirely infusate except for the apical 1/5; the dark area continues posteriorly covering the apical 1/5 of the cell br and basal part of cell r_{4+5} , most of cell bm , basal 1/3–1/2 of cell

dm and basal part of cell m_4 (Fig. 1d). **Abdomen.** Dark reddish brown, sparsely white pilose, with sublateral and medial areas with irregular white pruinosity; 1st and 3rd tergites shorter than 2nd and 4th tergites; 2nd tergite produced basolaterally into a distinct spur (Figs. 1a, c).

Examined material. COLOMBIA. **Huila:** 1 female, Neiva, Vereda Tamarindo, Ecoreserva La Tribuna, bosque seco tropical, 03°04'02" North, 75°22'06" West, 544 m, trampa Malaise MAL0075, 20-27 oct. 2021, grupo biomonitores (LEUA-63890).

Habitat. *Nausigaster meridionalis* occurs in the dry forest ecoregions of Jalisco and the humid forests of Veracruz between 20–100 m above sea level. In Brazil, it has been reported in the Madeira-Tapajós humid forest, and in Venezuela in a dry xerophytic scrub forest of Paraguaná at 500 m above sea level (Fig. 2). The Colombian specimen was collected in a tropical dry forest in the Andean region.

Geographical distribution. Brazil? (see comments below), Colombia (Huila; new record), Mexico (Jalisco, Ramírez-García and Sarmiento-Cordero 2004; Sonora,

Ramírez-García 2010; Veracruz, Townsend 1897a), and Venezuela (Lara, Morales et al. 2014, Arcaya and Mengual 2016). *Nausigaster meridionalis* has published records from Mexico, Venezuela and now Colombia, but there is confusion about the records for this species from Brazil.

Williston (1886) mentions five male specimens from California and a female from New Mexico identified as *Nausigaster punctulata* Williston, 1883. He also mentions a male from the Isthmus of Tehuantepec (Mexico), which he also lists under *Nausigaster punctulata*, but with morphological differences (two spots in the wing “connected through nearly the whole length of the submarginal cell”) that make it difficult to be conspecific with *N. punctulata*, as we know now. Two years later, Williston (1888) identifies three specimens from Chapada, Brazil, as *N. punctulata* with the following original sentence: “Three specimens from Chapada agree with the one mentioned by me from Tehuantepec. Whether they belong to a distinct species or not I cannot say.” Williston (1888: 243) mentions that Chapada is a small village near Cuyabá (likely Cuiabá, the capital of Mato Grosso), which would coincide with the town of Chapada dos Guimarães (at approx. 810 m above



Figure 2. Geographical distribution of *Nausigaster meridionalis*.

sea level, but the surrounding areas range from 220 to 820 m above sea level). Later, Williston (1891) mentions that those specimens from Tehuantepec (Mexico) and Chapada (Brazil) are similar and suggests that they belong to another species, not to *N. punctulata*.

Townsend (1897a) describes *N. meridionalis* based on a female from San Rafael (Veracruz, Mexico), collected on flowers of *Cordia* sp. (Boraginaceae) (holotype deposited at the Natural History Museum, London, UK; not studied). He agrees with Williston (1891) that specimens mentioned by Williston (1886) from the Isthmus of Tehuantepec (Mexico) and those from Chapada in Brazil cited by Williston (1888) do not belong to *N. punctulata*, and he considers them conspecific with his new species, *N. meridionalis*, even though he did not study them (Townsend 1897b: 24). Townsend (1897b) explains the differences between *N. punctulata* and the Californian specimens studied by Williston (1886), gives the new name *N. unimaculata* Townsend, 1897 to the specimens from California, and also states that the male from Isthmus of Tehuantepec belongs to *N. meridionalis*, but without studying the specimen.

Those Brazilian specimens from Chapada are referred to later on by Curran (1941) and Thompson *et al.* (1976), who put a question mark on these Brazilian records. Morales and Marinoni (2023) list *N. meridionalis* from Rondônia and refer to Townsend (1897a), who has no mention of Rondônia. We can only find two reasons to indicate Rondônia in the geographic distribution for *N. meridionalis*: 1) that Morales and Marinoni (2023) have seen specimens from Rondônia which belong to this species, but these records are not published; or 2) that Morales and Marinoni (2023) indicate Rondônia because there is a town named Chapada dos Parecis. We do not know the odds of the first option, but the second option would be incorrect, as the Chapada that Townsend (1897a) mentions is likely located in Mato Grosso as Williston (1888: 243) explains. As a clarifying note, the word Chapada in Brazil refers to a highland plateau with table mountains. In summary, nobody has studied specimens from Brazil and identified them as *N. meridionalis*.

DISCUSSION

Nausigaster is mentioned for the first time from Colombia by Gutierrez *et al.* (2005), who listed the genus based on an unknown number of specimens collected in the Parque

Nacional Natural (PNN) El Tuparro, located in the department of Vichada. However, they did not provide any specific locality information (PNN El Tuparro has an area of 548 000 hectares) nor an identification of the species. Here we report for the first time *N. meridionalis* from Colombia and provide accurate data for the record

Nausigaster is a genus in serious need of taxonomical revision. Curran (1941) provided the last identification key to the species of this genus, although Carrera *et al.* (1947) suggested that the key couplets do not fully agree with the species descriptions. The lack of revisionary work for the genus including all known species and the little knowledge about its natural history and distribution (Mengual and López García 2015) urge to work on the taxonomy of *Nausigaster*. Thus, new records, with locality information and clear morphological descriptions, together with photographs, are important to help make the genus revision shortly.

Knowledge of Neotropical Syrphidae is poor compared to other regions of the world (Montoya *et al.* 2012); thus, there are still many species pending to be described and new geographic records for the described ones (Parada-Marin *et al.* 2021). The diversity of Syrphidae in Colombia and the Andean-Amazon region is poorly studied (Montoya, 2016, Parada-Marin *et al.* 2021, Montoya *et al.* 2021) due to infrastructure limitations and political instability (Montoya *et al.* 2012). Our record increases the knowledge of the syrphid fauna in Colombia to 60 genera and 355 species and highlights the importance of continuing sampling and focusing our efforts on field expeditions looking for rare taxa, such as *Nausigaster*, to learn more about the biology, ecology, distribution, and abundance of tropical dry forest species.

AUTHORS PARTICIPATION

HMPM taxonomic identification, photographs, structure, design and writing the manuscript; XM taxonomic identification, structure, design and writing the manuscript; YRP taxonomic identification, photographs, structure, design and writing the manuscript.

ACKNOWLEDGEMENTS

We thank Ecopetrol, Instituto de Investigación de Recursos Biológicos Alexander von Humboldt, Universidad de

la Amazonia and Ministerio de Ciencia Tecnología e Innovación for the FIBRAS projects (agreement no. 3025877), “Taxonomía de Pipunculidae (Diptera: Insecta) de Colombia” (code 1131712497-49-2015), and “Fortalecimiento de vocaciones científicas en jóvenes mediante becas-pasantías en la Región centro Sur, Caquetá, Amazonas, Putumayo, Huila y Tolima” (BPIN 2022000100076) for the financial support.

COMPETING INTERESTS

The authors have no competing interests to declare that are relevant to the content of this article.

REFERENCES

- Aldrich JM. 1905. A catalogue of North American Diptera (or two-winged flies). Smithsonian Miscellaneous Collections. 46(1444):1–680. doi: <https://doi.org/10.5962/bhl.title.1681>
- Arcaya E, Mengual X. 2016. Nuevos registros de especies de Eristalinae (Diptera: Syrphidae) para Venezuela, con larvas asociadas a cactáceas. *Entomotropica*. 31(2): 14–22.
- Bachmann AO. 2012. A catalog of the types of Stratiomyidae, Tabanidae, Asilidae sensu lato, and Syrphidae (Insecta, Diptera) deposited in the Museo Argentino de Ciencias Naturales, Buenos Aires (MACN): with an appendix on types of Tabanidae deposited in the Instituto “Dr. Carlos G. Malbrán”, Buenos Aires (ANLIS). *Revista del Museo Argentino de Ciencias Naturales*. 14(1):97–123. doi: <https://doi.org/10.22179/REVMACN.14.211>
- Barahona-Segovia RM, Riera P, Pañinao-Monsálvez L, Valdéz Guzmán V, Henríquez-Piskulich P. 2021. Updating the knowledge of the flower flies (Diptera: Syrphidae) from Chile: Illustrated catalog, extinction risk and biological notes. *Zootaxa*. 4959(1):1–178. doi: <https://doi.org/10.11646/zootaxa.4959.1.1>
- Carrera M, de Souza Lopes H, Lane J. 1947. Contribuição ao conhecimento dos “Microdontinae” neotrópicos e descrição de duas novas espécies de “*Nausigaster*” Williston (Diptera, Syrphidae). *Revista Brasileira de Biología*. 7:471–486.
- Carvalho-Filho FDS, Martins MB, De Souza MT, Reemer M. 2019. Revision of the Neotropical genus *Domodon* Reemer (Diptera: Syrphidae), with description of three new species. *Zootaxa*. 4648(3):523–536. doi: <https://doi.org/10.11646/zootaxa.4648.3.7>
- Cumming JM, Wood DM. 2017. Adult morphology and terminology. In: KirkSpriggs AH. and Sinclair BJ. (eds). *Manual of Afrotropical Diptera*. Volume 1. Introductory chapters and keys to Diptera families. Suricata 4. Pretoria, South African National Biodiversity Institute. p. 89–134.
- Curran CH. 1941. New American Syrphidae. *Bulletin of the American Museum of Natural History*. 78:243–304. <http://digitallibrary.amnh.org/dspace/handle/2246/377>
- Dunn L, Lequerica M, Reid CR, Latty, T. 2020. Dual ecosystem services of syrphid flies (Diptera: Syrphidae): pollinators and biological control agents. *Pest Management Science*. 76(6):1973–1979. doi: <https://doi.org/10.1002/ps.5807>
- d’Andretta MA, Carrera M. 1952. Resultados de uma expedição científica ao território do Acre. — DIPTERA. Papéis Avulsos de Zoología. 10(17):293–306. doi: <https://doi.org/10.11606/0031-1049.1952.10p293-306>
- GBIF. 2024. GBIF Occurrence Download [Last accessed: 19 June 2024] <https://doi.org/10.15468/dl.fjvzbz>
- Gutierrez C, Carrejo NS, Ruiz C. 2005. Listado de los géneros de Syrphidae (Diptera: Syrphoidea) de Colombia. *Biota Colombiana*. 6(2):173–180.
- Hippa H, Ståhls G. 2005. Morphological characters of adult Syrphidae: descriptions and phylogenetic utility. *Acta Zoologica Fennica*. (215):1–72.
- Hull FM. 1949. The morphology and inter-relationship of the genera of syrphid flies, recent and fossil. *Transactions of the Zoological Society of London*. 26(4):257–408. doi: <https://doi.org/10.1111/j.1096-3642.1949.tb00224.x>
- Hunter WD, Pratt FC, Mitchell JD. 1912. The principal cactus insects of the United States. U.S. Department of Agriculture Entomological Bulletin. 113:1–71. doi: <https://doi.org/10.5962/bhl.title.64983>
- IDEAM. 2010. Atlas climatológico de Colombia. Instituto de Hidrología, Meteorología y Estudios Ambientales, Bogotá D.C.
- Kertész K. 1910. *Catalogus Dipteriorum hucusque descriptorum*. Volumen VII. Syrphidae, Dorylaidae, Phoridae, Clythiidae. *Museum Nationale Hungaricum, Budapestini [= Budapest]* pp. 470. doi: <https://doi.org/10.5962/bhl.title.5147>
- Latreille PA. 1802. *Histoire Naturelle, Générale et Particulière des Crustacés et des Insectes*. Tome troisième. Familles Naturelles des Genres. F Dufart, Paris. pp. 13–467. doi: <https://doi.org/10.5962/bhl.title.15764>
- Lynch-Arribázcaga F. 1892. *Dipterología Argentina, Syrphidae*. *Anales de la Sociedad Científica Argentina*. 34:33–46, 173–192, 242–280.
- Mengual X, Mayer C, Burt TO, Moran KM, Dietz L, Nottebrock G, Pauli T, Young AD, Brasseur MV, Kukowka S, Kelso S, Etzbauer C, Bot S, Hauser M, Jordaens K, Miranda GFG, Ståhls G, van Steenis W, Peters RS, Skevington JH. 2023. Systematics and evolution of predatory flower flies (Diptera: Syrphidae) based on exon-capture sequencing. *Systematic Entomology*. 48(2):250–277. doi: <https://doi.org/10.1111/syen.12573>
- Mengual X, López García GP. 2015. First records of *Nausigaster flukei* (Diptera, Syrphidae) from Argentina. *Check List*. 11(6):1816. doi: <https://doi.org/10.15560/11.6.1816>
- Miranda GFG, Marshall SA, Skevington JH. 2014. Revision of the genus *Pelecinobaccha* Shannon, description of *Relictanum* gen. nov., and redescription of *Atylobaccha flukiella* (Curran, 1941) (Diptera: Syrphidae). *Zootaxa*. 3819(1):001–154. doi: <https://doi.org/10.11646/zootaxa.3819.1.1>

- Miranda GFG. 2017. Identification key for the genera of Syrphidae (Diptera) from the Brazilian Amazon and new taxon records. *Acta Amazonica*. 47(1):53–62. doi: <https://doi.org/10.1590/1809-4392201601022>
- Miranda GFG, Moran K. 2017. The female abdomen and genitalia of Syrphidae (Diptera). *Insect Systematics & Evolution*. 48(2):157–201. doi: <https://doi.org/10.1163/1876312x-48022153>
- Miranda GFG, Skevington JH, Marshall SA. 2020. New generic concepts for orphaned lineages formerly treated as part of the genus *Ocyptamus* Macquart, 1834 (Diptera, Syrphidae). *Zootaxa*. 4822:151–174. doi: <https://doi.org/10.11646/zootaxa.4822.2.1>
- Montoya AL, Pérez SP, Wolff M. 2012. The diversity of flower flies (Diptera: Syrphidae) in Colombia and their Neotropical distribution. *Neotropical Entomology*. 41(1):46–56. doi: <https://doi.org/10.1007/s13744-012-0018-z>
- Montoya AL, Wolff M. 2020. Description of six new large species of *Argentinomyia* Lynch-Arribáizaga, 1891 and redescription of *Talahua fervida* (Fluke, 1945) (Diptera, Syrphidae, Syrphinae). *ZooKeys*. 929:19–51. doi: <https://doi.org/10.3897/zookeys.929.37666>
- Montoya AL. 2016. Family Syrphidae. *Zootaxa*. 4122(1):457–537. doi: <https://doi.org/10.11646/8700taxa.4122.1.39>
- Montoya AL, Parada-Marín HM, Ramos-Pastrana Y. 2022. Description of a new flower fly species of the *Copestylum vagum* group (Diptera: Syrphidae) from pristine Amazonian rainforests of Colombia and Suriname. *Zootaxa*. 5091(3):9–23. doi: <https://doi.org/10.11646/zootaxa.5091.3.1>
- Montoya AL, Ricarte A, Wolff M. 2017. Two new species of *Quichuana* Knab (Diptera: Syrphidae) from the paramo ecosystems in Colombia. *Zootaxa*. 4244(3):390–402. doi: <https://doi.org/10.11646/zootaxa.4244.3.7>
- Montoya AL, Wolff M. 2023. Taxonomic revision of the Neotropical genus *Argentinomyia* Lynch-Arribáizaga, 1891 (Diptera: Syrphidae), with description of 16 new species. *Zootaxa*. 5234(1):1–157. doi: <https://doi.org/10.11646/zootaxa.5234.1.1>
- Morales J, González R, Arcaya E. 2014. Especies de Eristalinae (Diptera: Syrphidae) presentes en estados del Centro-Occidente de Venezuela. *Bioagro*. 26(1):63–68.
- Morales MN, Marinoni L. 2023. Syrphidae in Catálogo Taxonômico da Fauna do Brasil. PNUD. Last accessed: 04 dec 2023] <http://fauna.jbrj.gov.br/fauna/faunadobrasil/62316>
- Morales MN, Stahls G, Hippha H. 2013. Two new species of *Meropidia* Hippha & Thompson, 1983 (Diptera, Syrphidae) from the Andes Mountains. *ZooKeys*. 338:55–65. doi: <https://doi.org/10.3897/zookeys.338.6093>
- Moran KM, Skevington JH, Kelso S, Mengual X, Jordaens K, Young AD, Ståhls G, Mutin V, Bot S, Van Zuijlen M, Ichige K, van Steenis J, Hauser M, Steenis W. 2021. A multigene phylogeny of the Eristaline flower flies (Diptera: Syrphidae), with emphasis on the subtribe Criorhinina. *Zoological Journal of the Linnean Society*. 194(1):120–135. doi: <https://doi.org/10.1093/zoolinnean/zlab006>
- Parada-Marin HM, Montoya AL, Ramos-Pastrana Y. 2021. New record of *Cepa apeca* (Diptera, Syrphidae, Eristalinae, Mero-dontini) in the Andean-Amazonian region of Colombia and expansion of its geographic range. *Acta Amazonica*. 51(2):162–165. doi: <https://doi.org/10.1590/1809-4392202003841>
- Newman E. 1838. *Entomological Notes*. *Entomological Magazine* 5: 372–402.
- Ramírez-García E. 2010. Instituto de Biología, Universidad Nacional Autónoma de México, Ciudad Universitaria, México D.F. <http://unibio.unam.mx/irekani/handle/123456789/25940?proyecto=Irekani>
- Ramírez-García E, Sarmiento-Cordero MA. 2004. Syrphidae (Diptera) de la Estación de Biología Chamela. 181–191. In: García-Aldrete AN, Ayala-Barajas R (Eds). *Artrópodos de Chamela*. 1. Instituto de Biología, UNAM. Distrito Federal, México. pp. 227.
- Ramírez-García E. 1997. Syrphidae. In: González Soriano E, Dirzo R, Vogt RC (Ed.). *Historia natural de los Tuxtlas*. Instituto de Biología, Instituto de Ecología, UNAM y CONABIO. p. 371–373.
- Reemer M. 2017. *Ubristes rex* sp. n., a new Microdontinae hoverfly from northern Brazil (Diptera: Syrphidae: Microdontinae). *Zootaxa*. 4362(2):280–286. doi: <https://doi.org/10.11646/Zootaxa.4362.2.7>
- Reemer M, Ståhls G. 2013. Generic revision and species classification of the Microdontinae (Diptera, Syrphidae). *ZooKeys*. 288:1–213. doi: <https://doi.org/10.3897/zookeys.288.4095>
- Ricarte A, Marcos-García MÁ, Hancock EG, Rotheray GE. 2015. Neotropical *Copestylum* Macquart (Diptera: Syrphidae) Breeding in Fruits and Flowers, Including 7 New Species. *PLoS ONE*. 10(11):e0142441. doi: <https://doi.org/10.1371/journal.pone.0142441>
- Rotheray GE, Marcos-García MA, Hancock EG, Gilbert FS. 2000. The systematic position of *Alipumilio* and *Nausigaster* based on early stages (Diptera, Syrphidae). *Studia dipterologica* 7(1):133–144.
- Sarmiento-Cordero MA, Ramírez-García E, Contreras-Ramos A. 2010. Diversidad de la familia Syrphidae (Diptera) en la Estación de Biología “Chamela”, Jalisco, México. *Dugesiana*. 17(2):197–207.
- Shannon RC. 1922. A reclassification of the subfamilies and genera of North American Syrphidae (Diptera). *Bulletin of the Brooklyn Entomological Society*. 17:30–42.

- Shorthouse, DP. 2010. SimpleMapp, an online tool to produce publication-quality point maps. [Last accessed: 19 June 2024] <https://www.simplemapp.net>
- Skevington JH, Locke MM, Young AD, Moran K, Crins WJ, Marshall SA. 2019. Field Guide to the Flower Flies of Northeastern North America. Princeton University Press. doi: <https://doi.org/10.2307/j.ctv7xbrvz>
- Sommaggio D. 1999. Syrphidae: Can they be used as environmental bioindicators? *Agriculture, Ecosystems and Environment*. 74(1-3):343-356. doi: [https://doi.org/10.1016/S0167-8809\(99\)00042-0](https://doi.org/10.1016/S0167-8809(99)00042-0)
- Thompson FC, Vockeroth JR, Sedman YS. 1976. Family Syrphidae. In: A catalogue of the Diptera of the Americas south of the United States. Museu de Zoologia, Universidade de Sao Paulo, Sao Paulo. 46:195 pp. <https://repository.si.edu/handle/10088/17070>
- Thompson FC, Rotheray GE, Zumbado MA. 2010. Syrphidae (Flower Flies). In: Brown BV, Borkent A, Cumming JM, Wood DM, Woodley NE, Zumbado MA. (Ed.). *Manual of Central American Diptera*. v.2. NRC Research Press, Ottawa, p.763-792.
- Townsend CHT. 1897a. Contributions from the New Mexico Biological Station. No.2. On a collection of Diptera from the lowlands of the Rio Nautla, in the state of Vera Cruz. I. *Annals and Magazine of Natural History*. 6(19):16-34. doi: <https://doi.org/10.1080/0022293970868>
- Townsend CHT. 1897b. Contributions from the New Mexico Biological Station. No. II (continued). On a collection of Diptera from the lowlands of the Rio Nautla, in the state of Vera Cruz. II. *Annals and Magazine of Natural History*. (6)20:19-33, 272-291. doi: <https://doi.org/10.1080/00222939708680625>
- van Steenis J, Miranda GFG, Tot T, Mengual X, Skevington JH. 2023. Glossary of morphological terminology of adult Syrphidae (Diptera): an update and extension. *Journaal van Syrphidae*. 2(4):1-99. doi: <https://doi.org/10.55710/1.AIMS1978>
- Vargas M. 2016. *Insecta of Costa Rica (INBio)*. Version 1.7. Instituto Nacional de Biodiversidad (INBio), Costa Rica. Occurrence dataset <https://doi.org/10.15468/myknou>. [Last accessed: 19 June 2024] <https://www.gbif.org/occurrence/1256007172>
- Williston SW. 1883. On North American Asilidae (Dasyopogoninae, Laphrinae), with a new genus of Syrphidae. *Transactions American Entomology Society*. 11:1-35. doi: <https://doi.org/10.5962/bhl.title.40953>
- Williston SW. 1886. Synopsis of the North American Syrphidae. *Bulletin of the United States National Museum*. 31:1-335. 12 pls. doi: <https://doi.org/10.5479/si.03629236.31.i>
- Williston SW. 1888. Diptera Brasiliana, Ab H.H. Smith collecta. Part I - Stratiomyidae, Syrphidae. *Transactions of the American Entomological Society and Proceedings of the Entomological Section of the Academy of Natural Sciences*. 15:243-292. doi: <https://doi.org/10.2307/25076505>
- Williston SW. 1891. Fam. Syrphidae. *Biologia Centrali-Americana. Insecta. Diptera*. Vol. 3. p. 1-56.