ENTOMOLOGICAL Communications

Entomological Communications, 6, 2024: ec06039
doi: 10.37486/2675-1305.ec06039
e-ISSN: 2675-1305
Open Access Full Text Article

Scientific Note

New records of the flower fly *Lejops barbiellinii* (Ceresa, 1934) (Diptera, Syrphidae) in the Atlantic Forest: integrating collection and citizen science data

Danilo P. Cordeiro[1,2], Cássio Zocca[1,3], Natalia P. Ghilardi-Lopes[1,4]

[1]Instituto Nacional da Mata Atlântica – INMA, Santa Teresa, ES, Brazil. [2]Universidade Federal de Minas Gerais, Belo Horizonte, MG, Brazil. [3]Universidade Federal do Espírito Santo, Vitória, ES, Brazil. [4]Universidade Federal do ABC, São Bernardo do Campo, SP, Brazil.
Corresponding author: d.pacheco.c@gmail.com

Edited by: Daniell R. R. Fernandes

Received: December 07, 2024. Accepted: December 17, 2024. Published: December 30, 2024.

Abstract. Citizen science provides valuable data on species diversity worldwide. In this note, we discuss how a scientist's opportunistic observations of biodiversity, recorded on a citizen science platform, have enriched our understanding of the geographic distribution of *Lejops barbiellinii* (Ceresa, 1934) (Diptera, Syrphidae), a flower fly native to Brazil's Atlantic Forest. We also compared the number and specificity of iNaturalist records for the five most species rich families of flies in Brazil, demonstrating the potential of this platform for data acquisition of species with external morphological diagnostic characters, as for many flower fly species. This type of contribution from voluntary citizens contributes to increasing the knowledge about geographical distribution and our collective knowledge about *L. barbiellinii* and other flies in the Atlantic Forest.

Keywords: Bromeliad, phytotelmata, hoverfly, Eristalinae, Wallacean shortfall.

Online citizen science platforms enable the large-scale compilation of biodiversity data, potentially mitigating sampling gaps by providing open access to data concerning the distribution and richness of species, as well as information on rare and endangered species (Theobald et al. 2015; Pocock et al. 2018; Rowley et al. 2019; Fontaine et al. 2022). One major way of gathering such data is via public contributions of geo-located photographs of observed wildlife from around the world (iNaturalist 2024).

The citizen science platform iNaturalist boasts a substantial user community that contributes to the taxonomic identification of the records (Chandler et al. 2017). Since 2008, the platform has received over 48 million observations of more than 190,294 insect species from over 1,490,305 collaborators (iNaturalist 2024, by June 13th). Even so, megadiverse insect orders such as Coleoptera and Diptera remain highly underrepresented in Citizen Science Projects (Theobald et al. 2015). For insects of the Order Diptera, recent studies employing citizen science approaches have played a key role in revealing the current distribution of non-native species (Goossen-Lebrón et al. 2023; Kvifte 2023; Kondo et al. 2024), and, in conjunction with data from scientific collections, they are helping to investigate changes in species distribution and their conservation importance (Clem et al. 2023).

Syrphidae are better known as flower flies, given their behavior of visiting flowers to feed. Several species of Syrphidae are known to breed in the phytotelm of bromeliads in the Neotropical region (Rotheray et al. 2007; 2009; Ricarte et al. 2012), but in Brazil, data on the biology and occurrence of these species is scarce (Echeverry et al. 2021). The flower fly *Lejops barbiellinii* (Ceresa, 1934) (Syrphidae, Eristalinae) is one of these species which breeds in bromeliads (Morales & Marinoni 2008). This species is known to occur in lowlands of coastal areas of the States of Espírito Santo (ES), São Paulo (SP) and Paraná (PR) in Brazil, and is easily recognized by the swollen metafemur and by the characteristic pilosity pattern, mainly the triangular macule of yellow tomentose pile anterior to the scutellum (Fig. 1A) [see Morales & Marinoni 2008 for the species redescription]. A the distinctive diagnostic characteristics in the external morphology of this species make it a good candidate for data collection using citizen science approaches. Here we expand the known distribution of *L. barbiellinii* both latitudinally and altitudinally, using collected specimens from by municipalities of Conselheiro Pena, Minas Gerais - MG, and Santa Teresa, ES, and data from iNaturalist.

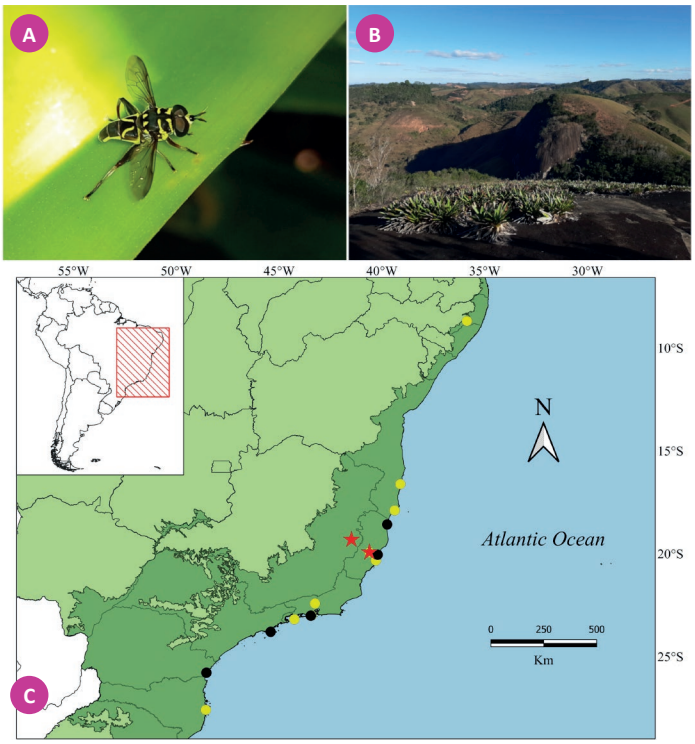

Figure 1. A. Living male specimen of *Lejops barbiellinii* (Ceresa, 1934), photographed in the state of Pernambuco by iNaturalist user Carlos Otávio Gussoni, available at https://www.inaturalist.org/observations/147029581. B. Collection site of *L. barbiellinii* in east Minas Gerais. Photo: Danilo P. Cordeiro. C. Records of *L. barbiellinii* in Atlantic Forest, Brazil. Black circles= Collection data; Yellow circles= iNaturalist Research grade data; Red star= new records from collected specimens.

This study started in April 2023, when the entomologist DPC (first author) observed a syrphid fly on the leaves of a bromeliad (*Neoregelia gigas* Leme & L.Kollmann) in an urban park at Santa Teresa municipality (ES), a mountainous region in southeastern Brazil. DPC photographed and registered this opportunistic observation of the fly on iNaturalist. Two months later, in the same bromeliad, *L. barbiellinii* was observed again, photographed and collected. Since then, more records were found both from collections and iNaturalist observations.

To complement the previously described geographic distribution available in the scientific literature, we have searched for collection records on GBIF (GBIF 2023) and SpeciesLink (https://specieslink.net/) online platforms, using the species name and synonyms as the searching terms (Ceresa 1934; Morales & Marinoni 2008).

To find additional records of the species shared by iNaturalist users, we searched the platform for all records with photos, until November 24th 2024, identified at least at the family level as 'Syrphidae' in all states that possess the Atlantic Forest biome. This approach was designed to ensure that even non-research-grade observations could be found and their identification status improved. Also, we established a collection project on the platform (https://www.inaturalist.org/projects/registros-de-lejops-barbiellinii) to enable filtering and downloading of record information and the identification of new records. The project accepts all records at research grade of the species, without geographical restriction.

Two voucher specimens are deposited at the Museu de Biologia Prof. Mello Leitão (MBML) invertebrate collection, of the National Institute of the Atlantic Forest (*Instituto Nacional da Mata Atlântica* - INMA). One specimen, from Santa Teresa, ES, was photographed and submitted to iNaturalist (available at https://www.inaturalist.org/observations/166425324). The second specimen was an undetermined fly deposited at MBML, collected from tank bromeliads (*Alcantarea* sp., Fig. 1B) during an expedition to the mountains in eastern Minas Gerais State, 115 km from Santa Teresa.

On iNaturalist, 22 records of *L. barbiellinii* were retrieved (Tab. 1), located in the states of Pernambuco, Bahia, Espírito Santo, Rio de Janeiro and Santa Catarina. Interestingly, apart from only one, all photos show *L. barbiellinii* on bromeliad leaves, which may indicate a strong ecological relationship between these organisms. Only three of the iNaturalist records were not identified at species level before this work. This high level of identification may be a result of the engagement of amateur enthusiasts of Syrphidae on the platform. When compared to other highly diverse families of flies (Diptera: Brachycera) in Brazil, Syrphidae is only the fourth in number of described species (Rafael et al. 2024), but presents the highest number of observers, identifiers and records, irrespective of whether they are classified as research grade or not (Tab. 2).

Table 1. Records of *Lejops barbiellinii* (Ceresa, 1934) retrieved from literature, collected specimens and the online platforms GBIF (2023) and iNaturalist (2024). *Coordinates inferred from the locality described on specimen label. Abbreviations: MSNG – Museo Civico di Storia Naturale "Giacomo Doria", DZUP – Coleção Entomológica Padre Jesus Santiago Moure, MBML – Museu de Biologia Professor Mello Leitão, CEIOC – Coleção Entomológica do Instituto Oswaldo Cruz.

Record Source	Collection Code	Event Date	State Province	Decimal Latitude	Decimal Longitude
https://www.inaturalist.org/observations/252893027	Human Observation	2024-11-24	RJ	-23.13630	-44.17029
https://www.inaturalist.org/observations/252589000	Human Observation	2024-11-22	BA	-16.62132	-39.09456
https://www.inaturalist.org/observations/251433761	Human Observation	2024-10-22	RJ	-22.50883	-43.17568
https://www.inaturalist.org/observations/196940596	Human Observation	2024-01-15	RJ	-22.42431993	-43.24619237
https://www.inaturalist.org/observations/193392690	Human Observation	2023-12-08	ES	-19.93570442	-40.59954978
https://www.inaturalist.org/observations/192722399	Human Observation	2023-12-01	ES	-19.93583995	-40.59958599
https://www.inaturalist.org/observations/192455750	Human Observation	2023-11-28	ES	-19.93584720	-40.59955917
https://www.inaturalist.org/observations/191280950	Human Observation	2023-11-17	ES	-19.93589763	-40.59983912
https://www.inaturalist.org/observations/190591934	Human Observation	2023-11-10	ES	-19.93569465	-40.59958297
https://www.inaturalist.org/observations/179711927	Human Observation	2023-08-22	ES	-19.93567763	-40.59965640
https://www.inaturalist.org/observations/166425324	Human Observation/MBML	2023-06-09	ES	-19.9357186	-40.59957962
https://www.inaturalist.org/observations/154127568	Human Observation	2023-04-09	ES	-19.9358708	-40.59960041
https://www.inaturalist.org/observations/147202688	Human Observation	2023-01-23	PE	-8.69404666	-35.85613
https://www.inaturalist.org/observations/147029581	Human Observation	2023-01-21	PE	-8.69422719	-35.85620877
https://www.inaturalist.org/observations/147043031	Human Observation	2023-01-21	PE	-8.6941017	-35.8562572
https://www.inaturalist.org/observations/138178268	Human Observation	2022-10-08	RJ	-23.0045054	-43.42147549
https://www.inaturalist.org/observations/136029910	Human Observation	2022-09-17	RJ	-23.0033546	-43.42095040
https://www.inaturalist.org/observations/104189693	Human Observation	2022-01-01	BA	-17.9007956	-39.37170222
https://www.inaturalist.org/observations/102475593	Human Observation	2021-12-04	RJ	-23.0042207	-43.42099942
https://www.inaturalist.org/observations/100008851	Human Observation	2021-11-01	SC	-27.5948036	-48.5569286
https://www.inaturalist.org/observations/71576822	Human Observation	2021-03-18	ES	-20.3292781	-40.28673112
Present paper	MBML	2020-08-24	MG	-19.321	-41.473
https://www.inaturalist.org/observations/81252896	Human Observation	2017-03-20	RJ	-23.1920116	-44.25017135
gbifID4092333841	DZUP_Diptera	2007-12-09	PR	-25.789271*	-48.527849*
gbifID4092333842	DZUP_Diptera	2007-10-04	PR	-25.789271*	-48.527849*
gbifID4092333840	DZUP_Diptera	2007-04-09	PR	-25.789271*	-48.527849*
gbifID4092333839	DZUP_Diptera	2007-04-09	PR	-25.789271*	-48.527849*
gbifID4092333774	DZUP_Diptera	1969-06-26	ES	-18.583005*	-39.734907*
gbifID4092333838	DZUP_Diptera	1967-02-25	ES	-20.053878*	-40.197300*
gbifID1457256319	CEIOC	1937-04-24	RJ	-23.017327*	-43.450432*
gbifID1457256278	CEIOC	1937-04-01	RJ	-23.017327*	-43.450432*
Ceresa (1934)	MSNG	1906-11	SP	-23.802039*	-45.403673*

Table 2. Representativeness and quality of data on iNaturalist of the five most diverse families of flies (Diptera: Brachycera) in Brazil. All data restricted to Brazil and collected on November 24th, 2024. *according to *Catálogo Taxonômico da Fauna do Brasil*, available at http://fauna.jbrj.gov.br/. Abbreviations: RG – Research Grade.

Family	Number of species in Brazil*	Number of species with RG records on iNaturalist	Number of RG records at species level	Number of identifiers of RG records at species level	Total of records (including non-RG levels)	Number of identifiers/observers of all records in Brazil
Muscidae	965	6	199	95	2013	226/851
Phoridae	908	5	14	13	190	49/109
Tachinidae	835	27	135	41	4420	317/1054
Syrphidae	710	73	1565	264	9986	698/2474
Asilidae	661	29	196	63	4183	372/1227

In citizen science, taxonomic bias can often skew which organisms are studied, primarily driven by factors such as the charisma of the species, ease of identification, and accessibility (Ward 2014; Steger et al. 2017; Callaghan et al. 2021). It is likely that syrphid flies attract more attention due to their bright colors and patterns, making them both visible and popular among amateur naturalists. Additionally, many species within this group can be identified with basic field guides or visually, without the need for specialized equipment. This ease of identification may be the cause of their prevalence, as it allows even those with limited entomological training to contribute valuable observations effectively.

Regarding specimens from collections, on GBIF (2023) we have found two specimens collected in 1937 in Rio de Janeiro (RJ), housed at CEIOC collection but not previously mentioned in the literature. SpeciesLink platform did not add any record to the previous searches. The specimens deposited in the MBML collection contribute with the first record of the species in Minas Gerais (MG) State and by providing a voucher specimen for one of the iNaturalist observations (Tab. 1).

The records reported here extend the known distribution of the species into the Atlantic Forest regions of the states of Santa Catarina, Minas Gerais, Bahia and Pernambuco, the latter being more than 1,000 km north of the previous known distribution of the species (Fig. 1C). Furthermore, in the states of Pernambuco, Espírito Santo, Minas Gerais and Rio de Janeiro this species was found only in mountainous areas, at elevations up to 1,000 m above sea level. This demonstrates that this species is not confined to lowlands in the Atlantic Forest. These records, most of which come from citizen volunteers, are important to provide accurate geographical data that can be used for many studies, such as ecological niche modeling and conservation.

Acknowledgments

Thanks to iNaturalist users Anderson Rabello Pereira (userlogin: anderson62), Antonio Leite (rogerleite), Carlos Otávio Gussoni (gussoni), Franciely Vitoria (franciely), Gui Durante (guidurante), João Pedro Aguilar (jpaguilar), José Antonio Vicente Filho (zezitofilho), Luana Teixeira (luanateixeira), Marco Antônio Zamith (marcozamith), Matheus Jordão Machado (matheus_jordao_machado) and Rogerio Dias (rogerriodias) who voluntarily submitted their observations and to all users who contributed to the research grade identification level of the records. Special thanks to Carlos Gussoni who kindly provided the photo of a living specimen. Thanks also to the expedition team of the project "*Drosera magnifica* (Droseraceae): a flagship species for the conservation of an unexplored mountain complex" and to the reviewers who contributed to the quality of the final version of the manuscript.

Funding information

The project "*Drosera magnifica* (Droseraceae): a flagship species for the conservation of an unexplored mountain complex" is supported by The Mohamed bin Zayed Species Conservation Fund (projects 192522325 and 212527281). The National Institute of the Atlantic Forest (INMA) provided infrastructure for the study. DPC had a research grant from the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq - PCI Program 300405/2023-5). NPGL is supported by CNPq (406712/2022-0).

Authors' contributions

DPC: Conceptualization, Data curation, Investigation, Visualization, Writing – original draft, Writing – review & editing. CZ: Conceptualization, Visualization, Writing – review & editing. NPGL: Conceptualization, Supervision, Writing – review & editing.

Conflict of Interest Statement

The authors declare there is no conflict of interest.

References

Callaghan, C. T.; Poore, A. G. B.; Mesaglio, T.; Moles, A. T.; Nakagawa, S.; Roberts, C.; Rowley, J. J. L.; Vergés, A.; Wilshire, J. H.; Cornwell, W. K. (2021) Three Frontiers for the Future of Biodiversity Research Using Citizen Science Data. *BioScience*, 71(1): 55-63. doi: 10.1093/biosci/biaa131

Ceresa, L. (1934) Tre nuove specie de *Quichuana* Knab (Diptera: Syrphidae). *Atti della Societá Italiana di Scienze Naturali,* 73: 383-392.

Chandler, M.; See, L.; Copas, K.; Bonde, A. M. Z.; López, B. C.; Danielsen, F.; Legind, J. K.; Masinde, S.; Miller-Rushing, A. J.; Newman, G. (2017) Contribution of citizen science towards international biodiversity monitoring. *Biological Conservation,* 213: 280-294. doi: 10.1016/j.biocon.2016.09.004

Clem, C. S.; Hart, L. V.; McElrath, T. C. (2023) A century of Illinois hover flies (Diptera: Syrphidae): museum and citizen science data reveal recent range expansions, contractions, and species of potential conservation significance. *Journal of Insect Science*, 23(4): 1-25. doi: 10.1093/jisesa/iead051

Echeverry, A.; Souza, D. de S.; Marinoni, L. (2021) Description of the immature stages, biology and DNA-barcoding of *Quichuana pogonosa* (Diptera: Syrphidae) collected in Bromeliaceae in Paraná, Brazil. *Zoologia*, 38: e 21004. doi: 10.1590/S1984-4689.v38.e21004

Fontaine, A.; Simard, A.; Brunet, N.; Elliott, K. H. (2022) The scientific contributions of citizen science applied to rare or threatened animals. *Conservation Biology*, 36(6): e13976. doi: 10.1111/cobi.13976

Goossen-Lebrón, T.; Garcete-Barrett, B.; Martínez, N.; Espíndola, V. (2023) New records and distribution of the tiger fly *Eristalinus* (*Eristalodes*) *taeniops* (Wiedemann, 1818) (Diptera: Syrphidae) in Paraguay. *Revista Chilena de Entomología*, 49 (2): 331-336. doi: 10.35249/rche.49.2.23.14

GBIF (2023) Global Biodiversity Information Facility. https://www.gbif.org/pt/. Access on: 28.vii.2023. 10.15468/dl.hjq5zy

iNaturalist (2024) A Community for Naturalists – iNaturalist. https://www.inaturalist.org. Access on: 24.xi.2024.

Kondo, T.; Rosero, R.; Garivia, J. (2024) *Eristalinus taeniops* (Wiedemann, 1818) (Diptera: Syrphidae), an exotic flower fly rapidly spreading in South America: A review. *Revista Chilena de Entomología*, 50(3): 589-599. doi: 10.35249/rche.50.3.24.17

Kvifte, G. M. (2023) Citizen science reveals the establishment of the invasive container breeder *Clogmia albipunctata* in Sweden and Denmark (Diptera: Psychodidae). *Management of Biological Invasions,* 14(2): 239-244. doi: 10.3391/mbi.2023.14.2.04

Morales, M. N.; Marinoni, L. (2008) Immature stages and redescription of *Lejops barbiellinii* (Ceresa) (Diptera: Syrphidae) found in bromeliads in Brazil. *Zootaxa*, 1830(1): 37-46. doi: 10.11646/zootaxa.1830.1.3

Pocock, M. J.; Chandler, M.; Bonney, R.; Thornhill, I.; Albin, A.; August, T.; Bachman, S.; Brown, P. M. J.; Gasparini, D.; Cunha, F., et al. (2018) A vision for global biodiversity monitoring with citizen science. *Advances in Ecological Research,* 59: 169-223. doi: 10.1016/bs.aecr.2018.06.003

Rafael, J. A.; Calhau, J.; Alvarez-Garcia, D. M.; Ament, D. C.; Amorim, D. S.; Andrade, A. J.; Câmara, J. T.; Capellari, R. S.; Carvalho, C. J. B.; Carvalho-Filho, F., et al. (2024) Diptera. *In: Catálogo Taxonômico da Fauna do Brasil*. PNUD. http://fauna.jbrj.gov.br/fauna/faunadobrasil/252. Access on: 14.v.2024.

Ricarte, A.; Marcos-García, M. A.; Hancock, E. G.; Rotheray, G. E. (2012) Revision of the New World genus *Quichuana* Knab, 1913 (Diptera: Syrphidae), including descriptions of 24 new species. *Zoological Journal of the Linnean Society*, 166: 72-131. doi: 10.1111/j.1096-3642.2012.00842.x

Rotheray, G. E.; Hancock, E. G.; Marcos-García, M. A. (2007) Neotropical *Copestylum* (Diptera, Syrphidae) breeding in bromeliads (Bromeliaceae) including 22 new species. *Zoological Journal of the Linnean Society*, 150: 267-317. doi: 10.1111/j.1096-3642.2007.00288.x

Rotheray, G. E.; Marcos-García, M. A.; Hancock, G., Pérez-Bañón, C.; Maier, C. T. (2009) Neotropical *Copestylum* (Diptera, Syrphidae) breeding in Agavaceae and Cactaceae including seven new species. *Zoological Journal of the Linnean Society*, 156: 697-749. doi: 10.1111/j.1096-3642.2008.00503.x

Rowley, J. J. L.; Callaghan, C. T.; Cutajar, T.; Portway, C.; Potter, K.; Mahony, S.; Trembath, D. F.; Flemons, P.; Woods, A. (2019) FrogID: citizen scientists provide validated biodiversity data on frogs of Australia. *Herpetological Conservation and Biology,* 14: 155-170.

Steger, C.; Butt, B.; Hooten, M. B. (2017) Safari Science: assessing the reliability of citizen science data for wildlife surveys. *Journal of Applied Ecology*, 54(6): 2053-2062. doi: 10.1111/1365-2664.12921

Theobald, E. J.; Ettinger, A. K.; Burgess, H. K.; DeBey, L. B.; Schmidt, N. R.; Froehlich, H. E.; Wagner, C.; HilleRisLambers, J.; Tewksbury, J.; Harsch, M. A., et al. (2015) Global change and local solutions: tapping the unrealized potential of citizen science for biodiversity research. *Biological Conservation,* 181: 236-244. doi: 10.1016/j.biocon.2014.10.021

Ward, D. F. (2014) Understanding sampling and taxonomic biases recorded by citizen scientists. *Journal of Insect Conservation*, 18: 753-756. doi: 10.1007/s10841-014-9676-y