

## Research Article / Artículo de Investigación

**Osmyliidae (Insecta: Neuroptera) from Atlantic rainforest in southeastern Brazil and new records for *Gumilla adpersus* Navás, 1912**

Osmyliidae (Insecta: Neuroptera) de la selva atlántica en el sureste de Brasil y nuevos registros de distribución para *Gumilla adpersus* Navás, 1912

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**Abstract.** Between October 2009 and December 2011, five Malaise traps/area were used to survey of the lance lacewings (Neuroptera: Osmyliidae) in five areas of the Atlantic rainforest in São Paulo state, Brazil. Were obtained 73 specimens of *Isostenosmylus pulverulentus* (Gerstaecker, 1894) (96.1% of the total collected), two of *Gumilla adpersus* Navás, 1912 (2.6%), and one of *Isostenosmylus* sp. (1.3%). The osmylids were more frequently observed in the Parque Estadual da Serra do Mar / Núcleo Santa Virgínia (59.2% of the total collected), Parque Estadual Intervalles (30.3%) and Parque Estadual Morro do Diabo (7.9%), inland collection sites in the state of São Paulo, Brazil. The geographic range of *G. adpersus* is expanded to include the states of São Paulo and Rio de Janeiro, Brazil, based on two studied specimens and one record in the citizen science website iNaturalist.

**Key words:** Gumillinae; *Isostenosmylus pulverulentus*; lance lacewings; Neotropical fauna; Stenosmylinae.

**Resumen.** Entre octubre de 2009 y diciembre de 2011, se utilizaron cinco trampas Malaise/área para realizar un estudio de los Osmyliidae (Neuroptera) en cinco áreas de la selva atlántica en el estado de São Paulo, Brasil. Se obtuvieron 73 ejemplares de *Isostenosmylus pulverulentus* (Gerstaecker, 1894) (96,1% del total recolectado), dos de *Gumilla adpersus* Navás, 1912 (2,6%), y uno de *Isostenosmylus* sp. (1,3%). Los Osmyliidae se observaron con mayor frecuencia en el Parque Estadual da Serra do Mar / Núcleo Santa Virgínia (59,2% del total recolectado), Parque Estadual Intervalles (30,3%) y Parque Estadual Morro do Diabo (7,9%), sitios de recolección en el interior del estado de São Paulo, Brasil. El rango geográfico de *G. adpersus* se amplía para incluir los estados de São Paulo y Río de Janeiro, Brasil, basados en dos especímenes estudiados y un registro en el sitio web de ciencia ciudadana iNaturalist.

**Palabras clave:** Crisopas de lanza; fauna neotropical; Gumillinae; *Isostenosmylus pulverulentus*; Stenosmylinae.

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## Introduction

The diversity, abundance and distribution of Neuroptera in forests can be affected by habitat types and forms, and the altitude of these environments can influence the fauna of some families (Bozdoğan 2020; Cancino-López *et al.* 2022). Osmylids can be found in

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humid habitats close to aquatic ecosystems (*e.g.*, Osmylinae and Kempyninae) or living in leaf litter and under bark (*e.g.*, Eidoporisminae, Porisminae, and Stenosmylinae) (New 1974; Cover and Resh 2008; Winterton *et al.* 2010, 2019).

Osmylidae (Neuroptera), commonly known as lance lacewings, are present in almost all biogeographical regions, except for the Nearctic, where fossil records indicate that the family has recently gone extinct there (Oswald 1994; Shepard and Contreras-Ramos 2009; Ardila-Camacho and Noriega 2014; Martins *et al.* 2016; Winterton and Wang 2016; Winterton *et al.* 2019). According to Shepard and Contreras-Ramos (2009), Osmylidae and other aquatic Neuroptera have no economic importance, not even as bioindicators, nevertheless, this still needs to be confirmed with further studies. The understanding of the behavior and biology of this group of insects, including Brazilian species, is still limited (Ardila-Camacho and Noriega 2014; Xu *et al.* 2016; Machado and Martins 2022). Larvae of some osmylids species (*e.g.*, Osmylinae and Kempyninae) have a semi-aquatic behavior and feed on a wide variety of soft-bodied insects, especially those that develop in water bodies, such as the larvae of Chironomidae (Diptera) (Tjeder 1957; Shepard and Contreras-Ramos 2009). Although osmylids adults predominantly act as predators, it has been reported the presence of pollen, fungal spores, algae, and other vegetal material in the gut contents of some species (Devetak and Duelli 2007).

There are about 280 described species of Osmylidae distributed in 25 living and 38 extinct genera (Winterton *et al.* 2019). Three of the eight subfamilies of Osmylidae have been reported in South America: Gumillinae, Kempyninae and Stenosmylinae (Oswald and Machado 2018; Martins 2019). The extant Neotropical fauna of osmylids includes 26 species in five genera, of which three species, *Isostenosmylus barbatus* Martins, Ardila-Camacho, Flint & Stange, 2019 and *I. pulverulentus* (Gerstaecker, 1894) (Stenosmylinae) and *Gumilla adpersus* Navás, 1912 (Gumillinae) are known from Brazil (Martins 2019; Martins *et al.* 2016, 2019; Machado and Martins 2022), all of them from the Atlantic rainforest biome in the South and Southeast regions of the country (Machado and Martins 2022). As large territorial extensions of the country remain little explored, the fauna of Osmylidae in many Brazilian biomes is certainly underrepresented, for example, a new species of *Isostenosmylus* is being described to northeast region of the country by the third author.

*Isostenosmylus* Krüger, 1913, the most species rich genus among the neotropical Osmylidae, has 18 described species that are distributed mainly in the Andean region (Venezuela, Peru, Bolivia and Argentina), Paraguay, and in southern and southeastern regions of Brazil (Martins *et al.* 2016, 2019; Ardila-Camacho *et al.* 2020).

*Gumilla* Navás, 1912 includes two species: *G. adpersus* Navás, 1912 from Brazil and *G. longicornis* (Walker, 1853) of an indetermined locality in northern South America (Martins *et al.* 2016). *Gumilla* is only one extant genus of Gumillinae, an interesting subfamily of Osmylidae characterized, among others, for presenting antennae much longer than forewings and wings with venational peculiarities (Menon and Makarkin 2008).

Osmylidae is a Neuroptera group that deserves to be prominent in future research because it is the least diverse family in Brazil with records of occurrence in only seven states, all within the Atlantic rainforest biome (Machado and Martins 2022, 2023).

The objective of this study was to analyze the diversity and temporal variation of Osmylidae collected from five Atlantic rainforest locations in the São Paulo state, Brazil. New records of geographic distribution also were added, images of the studied species and a map showing their geographical distribution is provided.

## Material and Methods

The sampling protocol used for collecting Osmylidae specimens from Atlantic rainforest areas in São Paulo state, Brazil, which is now being studied, is described by Lara *et al.* (2022).

The abbreviations used to refer to the locations are: PESM/NSV = Parque Estadual da Serra do Mar / Núcleo Santa Virgínia; PESM/NP = Parque Estadual da Serra do Mar / Núcleo Picinguaba; PEI = Parque Estadual Intervalas; PEMD = Parque Estadual Morro do Diabo; EEJI = Estação Ecológica Juréia-Itatins.

Additionally, a specimen of *G. adspersus* was studied based on a record from the citizen science website iNaturalist; the images were taken by Rogerio Dias in May 2018, in the city of Rio de Janeiro (22°57'13.4"S; 43°17'42.7"W), Rio de Janeiro state, Brazil (<https://www.inaturalist.org/people/rogerriodias>).

The specimens were identified by the third author dissecting the last abdominal segments, which were cleared following the standard procedure with 10% potassium hydroxide (KOH) solution, washed with distilled water, 10% acetic acid, and 70% ethyl alcohol; stored in microvials with glycerin and stored together with the respective specimen. The specimen of *G. adspersus* recorded in the iNaturalist was identified by the third author comparing its external morphology with the holotype of the species.

Specimens were examined under a Leica MZ9.5 stereomicroscope and a Leica DM500 optical microscope. Imaging and measurements of specimens was performed with a Leica DFC295 digital camera attached to a Leica M205C APO with a Leica LED5000 HDI high diffuse dome illumination system, as well as with a Leica DFC295 digital camera attached to a Leica DM500 optical microscope, using the Leica Application Suite (LAS version 4.12.0). Images were stacked using Helicon Focus (version 5.3) and plates prepared using Adobe Photoshop (version 11.0).

Species distributions were compiled in a dataset and incorporated into distribution maps. Geographic coordinates of the species records, if not present in labels, were taken from Google Earth software (<https://www.google.com/earth/>), and the map was generated using SimpleMappr (Shorthouse 2010).

The specimens studied from PESM/NSV, PESM/NP, PEI; PEMD and EEJI (voucher specimens LRRP LOTE #29) were deposited at Coleção Entomológica do Laboratório de Sistemática e Bioecologia de Predadores e Parasitoides of the Instituto Biológico (LRRP), Ribeirão Preto, SP, Brazil (N.W. Perioto, curator).

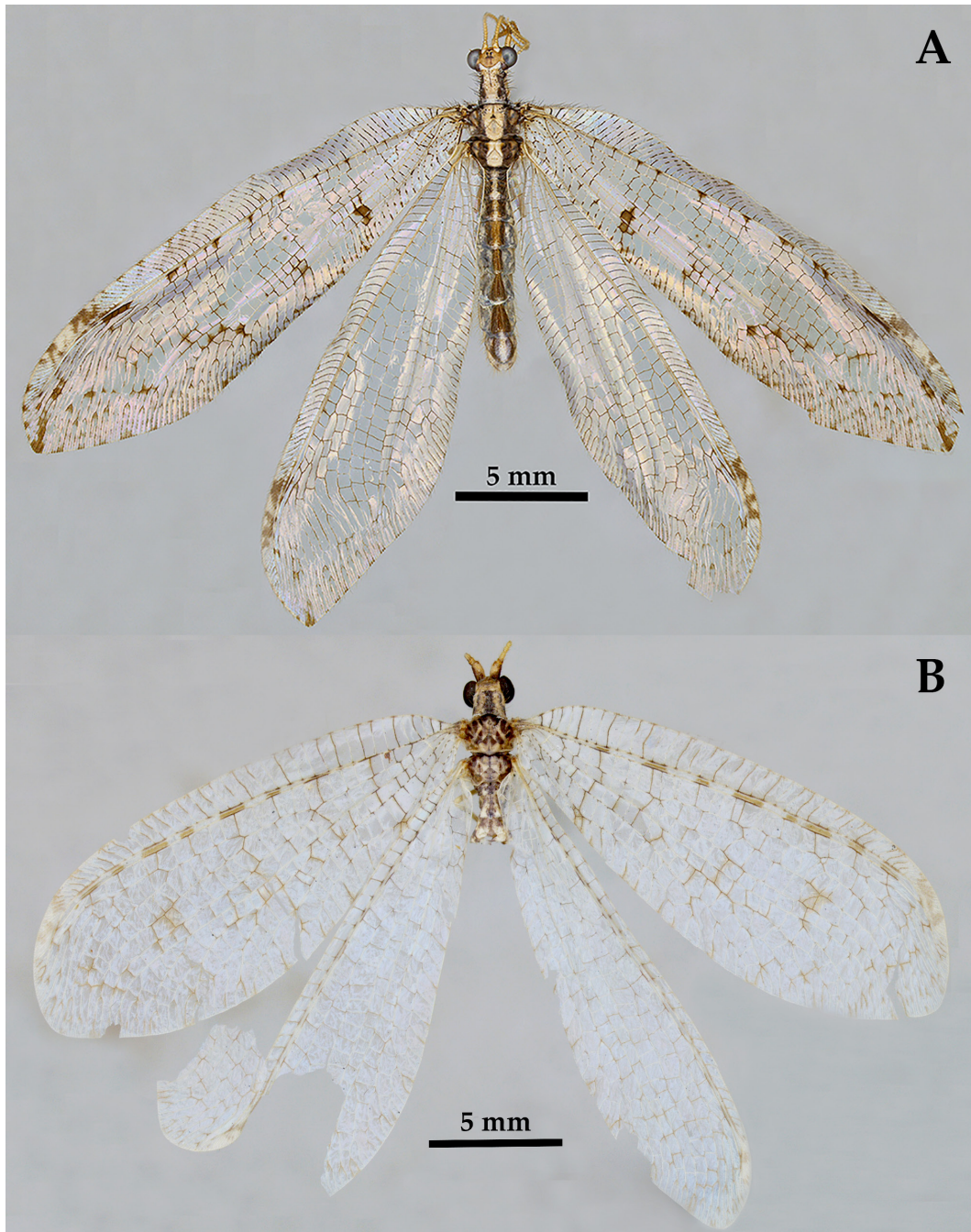
## Results and Discussion

A total of 76 adults of lance lacewings were obtained in this study (Tab. 1), among which 73 specimens of *I. pulverulentus* (Gerstaecker, 1894) (96.1% of the total collected) (Fig. 1A), one of *Isostenosmylus* sp. (1.3%) which is probably a new species, and two of *G. adspersus* Navás, 1912 (2.6%) (Fig. 1B).

The osmylids were more frequently observed in the PESM/NSV (59.2% of the total collected), PEI (30.3%), and PEMD (7.9%), inland collection sites in the state of São Paulo, with altitudes of 1,030 m, 880 m and 350 m above sea level (asl), respectively. Only 2.6% of the Osmylidae obtained were sampled at EEJI (16 m asl) and no specimens were collected at PESM/NP (215 m asl), areas located near the marine coast (Tab. 1, Fig. 2).

*Isostenosmylus pulverulentus*, the most abundant species captured, was recorded at PESM/NSV, PEMD and PEI, with highest abundances recorded in late summer and early autumn (57.5% of the total collected) and mid-spring (20.6% of the total collected). In this study, the presence of *I. pulverulentus* was restricted to environments with altitudes between 350 and 1,030 m asl. The geographical distribution of *I. pulverulentus* is limited to higher areas in the South and Southeast of Brazil and Paraguay (Martins *et al.* 2019; Machado and Martins 2022). In Brazil, this species has been recorded in Atlantic rainforest areas in the states of Minas Gerais, Espírito Santo, Rio de Janeiro, São Paulo, Paraná, Santa Catarina and Rio Grande do Sul, at altitudes ranging from 867 to 2,172 m asl. (Martins *et al.* 2016, 2018, 2019; Schuster and Machado 2021; Machado and Martins 2023). The results of this study are in accordance

with those of the authors mentioned before, as the highest incidence of *I. pulverulentus* was observed in areas with an altitude range between 880 to 1,030 m asl. The data obtained allowed to expand the knowledge about the temporal variation of this species, which was captured mainly between November and May, the hottest and wettest months of the year.



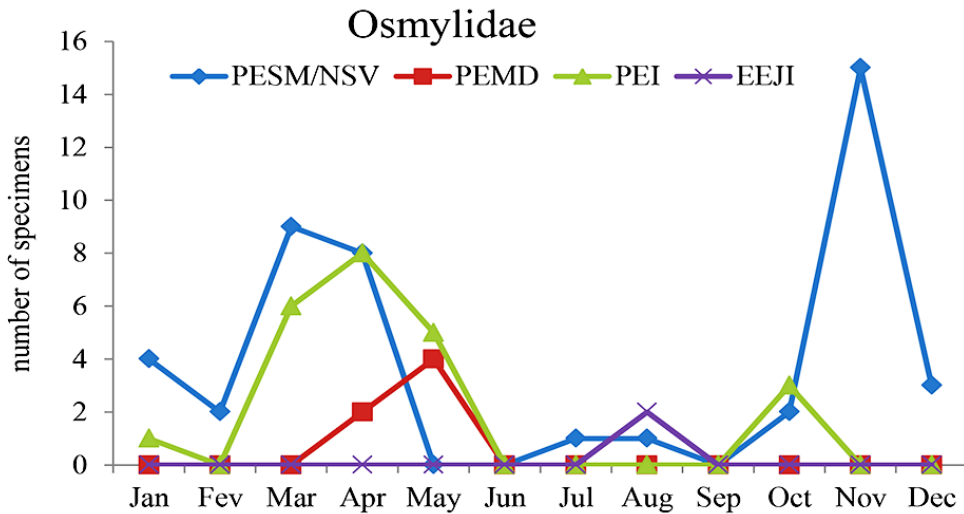
**Figure 1.** Dorsal *habitus* of the studied Osmylidae (Neuroptera) species. **A.** *Isostenosmylus pulverulentus* (Gerstaecker, 1894). **B.** *Gumilla adpersus* Navás, 1912. / **Figura 1.** Habito dorsal de las especies de Osmylidae (Neuroptera) estudiadas. **A.** *Isostenosmylus pulverulentus* (Gerstaecker, 1894). **B.** *Gumilla adpersus* Navás, 1912.

**Table 1.** Monthly abundance of the Osmylidae (Neuroptera) collected with Malaise traps in five areas of Atlantic rainforest at São Paulo State, Brazil, between October 2009 and December 2011. / **Table 1.** Abundancia mensual de Osmylidae (Neuroptera) recolectada con trampas Malaise en cinco áreas de la selva atlántica en el estado de São Paulo, Brasil, entre octubre de 2009 y diciembre de 2011.

Month-year	PESM/NSV		PEI	PEMD	EEJI	PESM/NP	Total
	<i>I. pulverulentus</i>	<i>Isostenosmylus</i> sp.	<i>I. pulverulentus</i>	<i>I. pulverulentus</i>	<i>G. adspersus</i>	Osmylidae	
Oct-09	-	-	2	-	0	-	2
Nov-09	14	0	0	0	0	0	14
Dec-09	1	0	0	0	0	0	1
Jan-10	4	0	0	0	0	0	4
Feb-10	2	0	0	0	0	0	2
Mar-10	9	0	5	0	0	0	14
Apr-10	6	0	8	2	0	0	16
May-10	0	0	5	4	0	0	9
Jun-10	0	0	0	0	0	0	0
Jul-10	0	1	0	0	0	0	1
Aug-10	1	0	0	0	2	0	3
Sep-10	0	0	0	0	0	0	0
Oct-10	0	0	1	0	0	0	1
Nov-10	1	0	0	0	0	0	1
Dec-10	0	0	0	0	0	0	0
Jan-11	0	0	1	0	0	-	1
Feb-11	0	0	0	0	0	-	0
Mar-11	0	0	1	-	0	-	1
Apr-11	2	0	-	-	-	-	2
May-11	0	0	-	-	-	-	0
Jun-11	0	0	-	-	-	-	0
Jul-11	0	0	-	-	-	-	0
Aug-11	0	0	-	-	-	-	0
Sep-11	0	0	-	-	-	-	0
Oct-11	2	0	-	-	-	-	2
Nov-11	0	0	-	-	-	-	0
Dec-11	2	0	-	-	-	-	2
Total	44	1	23	6	2	0	76
%	57.9	1.3	30.3	7.9	2.6	0	100.0

- = unrealized sample.

PESM/NSV = Parque Estadual da Serra do Mar / Núcleo Santa Virgínia; PESM/NP = Parque Estadual da Serra do Mar / Núcleo Picinguaba; PEI = Parque Estadual Intervales; PEMD = Parque Estadual Morro do Diabo; EEJI = Estação Ecológica Juréia-Itatins.



**Figure 2.** Population fluctuation of Osmylidae (Neuroptera) collected with Malaise traps in five areas of Atlantic rainforest of São Paulo state, Brazil, between October 2009 and December 2011. / **Figura 2.** Fluctuación poblacional de Osmylidae (Neuroptera) recolectada con trampas Malaise en cinco áreas de la selva atlántica del estado de São Paulo, Brasil, entre octubre de 2009 y diciembre de 2011. EEJI = Estação Ecológica Juréia-Itatins, PEI = Parque Estadual Intervales, PEMD = Parque Estadual Morro do Diabo and PESM/NSV = Parque Estadual da Serra do Mar - Núcleo Santa Virgínia.

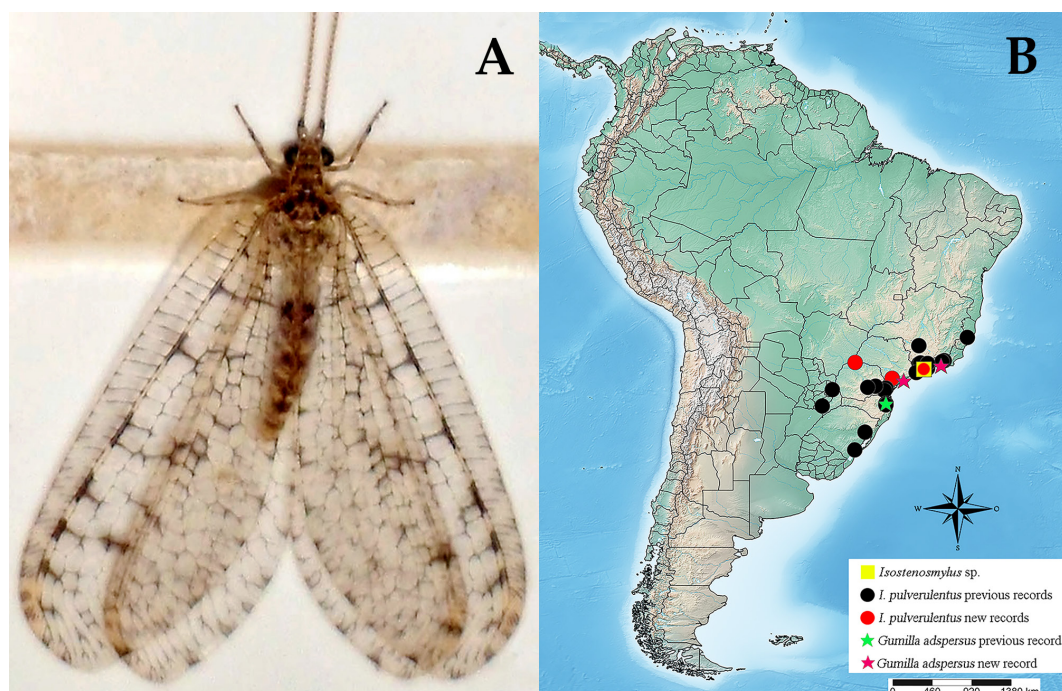
A single specimen of *Isostenosmylus* sp. was captured at PESM/NSV (1,030 m asl), in July, winter in the Southern hemisphere.

The two specimens of *G. adspersus* studied were caught in areas of Atlantic rainforest located close to the marine coast: a specimen at the EEJI (16 m asl) in mid-winter and another from the register of Rogério Dias on the iNaturalist website (Fig. 3A) for Rio de Janeiro (~550 m asl) in late autumn. Up to date, the geographical distribution of this species was limited to its type locality, the municipality of Blumenau (21 m asl), in the state of Santa Catarina, Brazil. About 110 years after its description by Navás (1912), these new records extend the geographical distribution of *G. adspersus* to the municipality of Iguape (state of São Paulo) and Rio de Janeiro (state of Rio de Janeiro), about 300 and 720 km to the northeast of the type locality, respectively (Fig. 3B). Based on the two records from São Paulo and Rio de Janeiro states, it can be inferred that this species is probably distributed in low altitude areas of the Atlantic rainforest.

This is the second long-term study in Brazil that investigates the fauna of Osmylidae in Atlantic rainforest areas. Schuster and Machado (2021), in their study on Neuroptera fauna in Atlantic rainforest areas in the state of Paraná, found only four specimens of *I. pulverulentus*. The use of different capture methods, such as Malaise traps in this study and light traps in Schuster and Machado (2021), was one of the factors that certainly contributed to the large difference in the amount of Osmylidae captured in the two studies. Different authors (Szentkirályi 1992, 1997; Ábrahám *et al.* 2003; Lara *et al.* 2008; Oliveira *et al.* 2013; Martins *et al.* 2019; Sarmiento-Cordero *et al.* 2021) studied Neuroptera sampling and concluded that, for certain groups, it is necessary to combine greater and longer sampling efforts with the use of different types of traps. Despite the difficulty in quantifying its importance, the climate of the studied locations should also be taken into account when dealing with the difference in the amount of osmylids captured in these two studies. In the localities studied by Schuster and Machado (2021) in the state of Paraná predominate the

climatic types Cfa (temperate climate, no dry season and hot summer) and Cfb (temperate climate, no dry season and cold summer) while in the localities sampled in the present study predominate the types Af (tropical equatorial), Am (tropical Monsoon) and Cfa, especially in the São Paulo state (Climate-Data.Org. 2023). Thus, the results obtained here are hardly compared due to methodological differences.

Gaps in knowledge about the bioecology of osmylids can be attributed to the lack of studies on their diversity, abundance and seasonality. Long-term investigations, using different types of traps in different biomes can contribute to a better understanding of their bioecology and distribution. The new record of *G. adspersus* to Rio de Janeiro state based on iNaturalist, is yet another example of the importance of citizen science for understanding Brazilian biodiversity, even rare species as in this case.



**Figure 3. A.** *Gumilla adspersus* Navás, 1912 (Neuroptera, Osmylidae), *habitus* dorsal (photo by Rogério Dias on the iNaturalist website). **B.** Distribution map of *Isostenosmylus pulverulentus* (Gerstaecker, 1894) and *Gumilla adspersus* Navás, 1912. (Neuroptera: Osmylidae) and their occurrence records to South America. / **Figura 3. A.** *Gumilla adspersus* Navás, 1912 (Neuroptera, Osmylidae), *habitus* dorsal (foto de Rogério Dias en el sitio iNaturalist). **B.** Mapa de distribución de *Isostenosmylus pulverulentus* (Gerstaecker, 1894) y *Gumilla adspersus* Navás, 1912 (Neuroptera: Osmylidae) y sus registros de presencia en Sudamérica.

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## Author Contributions

**RIRL:** Conceptualization, writing, edition, and revision of the final manuscript. **NWP:** Writing, preparation of distribution maps, edition, and revision of the final manuscript. **CCM:** Identification of specimens, writing, edition, and revision of the final manuscript.

## Literature Cited

- Ábrahám, L., Markó, V. and Vas, J. (2003)** Investigations on a neuropteroid community by using different methods. *Acta Phytopathologica et Entomologica Hungarica*, 38(1-2): 199-207. <https://doi.org/10.1556/aphyt.38.2003.1-2.21>
- Adams, P.A. (1977)** Taxonomy of United States *Leucochrysa* (Neuroptera: Chrysopidae). *Psyche*, 84: 92-102.
- Ardila-Camacho, A. and Noriega, J.A. (2014)** First record of Osmylidae (Neuroptera) from Colombia and description of two new species of *Isostenosmylus* Krüger, 1913. *Zootaxa*, 3826(2): 315-328. <http://dx.doi.org/10.11646/zootaxa.3826.2.2>
- Ardila-Camacho, A., Martins, C.C. and Noriega, J.A. (2020)** *Isostenosmylus ammirabilis* sp. nov., a remarkable new species of lance lacewing (Neuroptera: Osmylidae) from the Colombian Andes. *Zootaxa*, 4803: 561-575. <https://doi.org/10.11646/zootaxa.4803.3.10>
- Bozdoğan, H. (2020)** Diversity of lacewing assemblages (Neuropterida: Neuroptera) in different forest habitats and agricultural areas in the East Mediterranean area of Turkey. *Entomological Research*, 50: 163-173. <https://doi.org/10.1111/1748-5967.12426>
- Cancino-López, R.J., Moreno, C.E. and Contreras-Ramos, A. (2022)** Diversity of lacewings (Neuroptera) in an altitudinal gradient of the Tacaná Volcano, Southern Mexico. *Insects*, 13: 652. <https://doi.org/10.3390/insects13070652>
- Climate-Data.Org. (2023)** Clima, (various localities). Accessed on: 29 October 2023. Available from: <https://pt.climate-data.org/>
- Cover, M.R. and Resh, V.H. (2008)** Global diversity of dobsonflies, fishflies, and alderflies (Megaloptera; Insecta) and spongillaflyies, nevrorthids, and osmylids (Neuroptera; Insecta) in freshwater. *Hydrobiologia*, 595: 409-417. <http://dx.doi.org/10.1007/s10750-007-9035-z>
- Devetak, D. and Duelli, P. (2007)** Intestinal contents of adult *Osmylus fulvicephalus* (Scop.) (Neuroptera, Osmylidae). *Annals for Istrian and Mediterranean Studies, Series Historia Naturalis*, 17: 93-98.
- Lara, R.I.R., Freitas, S., Perioto, N.W. and Paz, C.C.P.D. (2008)** Amostragem, diversidade e sazonalidade de Hemerobiidae (Neuroptera) em *Coffea arabica* L. cv. Obatã (Rubiaceae). *Revista Brasileira de Entomologia*, 52: 117-123. <https://doi.org/10.1590/S0085-56262008000100020>
- Lara, R.I.R., Perioto, N.W. and Fernandes, D.R.R. (2022)** Diversity and temporal variation of brown lacewings (Neuroptera, Hemerobiidae) from Atlantic rainforest areas in southeastern Brazil. *Revista Brasileira de Entomologia*, 66: e20220076. <https://doi.org/10.1590/1806-9665-RBENT-2022-0076>
- Machado, R.J.P. and Martins, C.C. (2022)** The extant fauna of Neuroptera (Insecta) from Brazil: diversity, distribution and history. *Revista Brasileira de Entomologia*, 66: e20220083. <https://doi.org/10.1590/1806-9665-RBENT-2022-0083>
- Machado, R.J.P. and Martins, C.C. (2023)** Osmylidae *In*: Catálogo Taxonômico da Fauna do Brasil. PNUD. Accessed on: 23 October 2023. Available from: <http://fauna.jbrj.gov.br/fauna/faunadobrasil/31125>
- Martins, C.C. (2019)** Neuropterida from South America: large diversity, largely unknown *In*: XIII International Symposium of Neuropterology, 2019, Laufen. Proceedings. Wolnzach: Druckhaus Kastner A.G. Pp. 145-161. <http://doi.org/10.5281/zenodo.3569393>



- Martins, C.C., Ardila-Camacho, A. and Aspöck, U. (2016)** Neotropical osmylids (Neuroptera, Osmylidae): three new species of *Isostenosmylus* Krüger, 1913, new distributional records, redescriptions, checklist and key for the Neotropical species. *Zootaxa*, 4149: 1-66. <http://doi.org/10.11646/zootaxa.4149.1.1>
- Martins, C.C., Ardila-Camacho, A. and Courtney, G.W. (2018)** Neotropical Osmylidae larvae (Insecta, Neuroptera): description of habitats and morphology. *Aquatic Insects*, 39: 181-207. <https://doi.org/10.1080/01650424.2018.1436181>
- Martins, C.C., Ardila-Camacho, A., Machado, R.J.P., Flint, O.S. and Stange, L.A. (2019)** Unravelling the most diverse lance lacewing genus from the New World, *Isostenosmylus* Krüger (Neuroptera: Osmylidae). *Invertebrate Systematics*, 33: 849-891. <https://doi.org/10.1071/IS18079>
- Menon, F. and Makarkin, V.N. (2008)** New fossil lacewings and antlions (Insecta, Neuroptera) from the Lower Cretaceous Crato Formation of Brazil. *Palaeontology*, 51: 149-162. <https://doi.org/10.1111/j.1475-4983.2007.00740.x>
- Navás, L. (1912)** Insectos neurópteros nuevos o poco conocidos. *Memorias de la Real Academia de Ciencias y Artes de Barcelona*, 3(10): 135-202.
- New, T.R. (1974)** The egg and first instar larva of *Stenosmylus* (Neuroptera: Osmylidae). *Australian Entomological Magazine*, 2: 24-27. <https://search.informit.org/doi/10.3316/informit.146887842844122>
- Oliveira, R.C., Lara, R.I.R., Fonseca, A.R. and Perito, N.W. (2013)** Hemeroibiidae (Neuroptera) in the midwestern region of Minas Gerais State, Brazil. *Revista Colombiana de Entomología*, 39: 256-259. <https://doi.org/10.25100/socolen.v39i2.8247>
- Oswald, J.D. (1994)** Two new south American species of the genus *Kempynus* Navás (Neuroptera: Osmylidae: Kempyninae). *Proceedings of the Entomological Society of Washington*, 96: 367-372.
- Oswald, J.D. and Machado, R.J.P. (2018)** Biodiversity of the Neuropterida (Insecta: Neuroptera: Megaloptera, and Raphidioptera). Pp. 627-671. In: Footitt, R.G. and Adler, P.H. (Eds.), *Insect Biodiversity: Science and Society*, 2nd ed. Vol. 2. John Wiley & Sons, Oxford. <https://doi.org/10.1002/9781118945582.ch21>
- Sarmiento-Cordero, M.A., Rodríguez-Vélez, B., Huerta-Martínez, F.M., Uribe-Mú, C.A. and Contreras-Ramos, A. (2021)** Community structure of Neuroptera (Insecta) in a Mexican lime orchard in Colima, Mexico. *Revista Mexicana de Biodiversidad*, 92: e923399. <https://doi.org/10.22201/ib.20078706e.2021.92.3399>
- Shepard, W.D. and Contreras-Ramos, A. (2009)** Neuroptera y Mecoptera. Pp. 247-254. In: Domínguez, E. and Fernández, H.R. (Eds.), *Macroinvertebrados bentónicos sudamericanos. Sistemática y Biología*. Fundación Miguel Lillo, Tucumán, Argentina.
- Schuster, P.A. and Machado, R.J.P. (2021)** Unknown diversity: survey of Neuroptera (Insecta) in Paraná, southern Brazil, reveals 14 species newly recorded from the state and country. *Check List*, 17: 993-1005. <https://doi.org/10.15560/17.3.993>
- Shorthouse, D.P. (2010)** SimpleMappr, an online tool to produce publication-quality point maps. Accessed on: 15 November 2023. Available from: <https://www.simplemappr.net>
- Szentkirályi, F. (1992)** Spatio-temporal patterns of brown lacewings based on the Hungarian light trap network (Insecta: Neuroptera: Hemeroibiidae). Pp. 349-357. In: *Proceedings of the Fourth International Symposium on Neuropterology*, Toulouse, France.
- Szentkirályi, F. (1997)** Seasonal flight patterns of some common brown lacewing species (Neuroptera, Hemeroibiidae) in Hungarian agricultural regions. *Biologia (Bratislava)*, 52: 291-302.
- Tjeder, B. (1957)** Neuroptera-Planipennia. The lace-wings of Southern Africa. 1. Introduction and families Coniopterygidae, Sisyridae, and Osmylidae. Pp. 95-188. In: Hanström, B., Brinck, P. and Rudebec, G. (Eds.), *South African Animal Life*. Vol. 4. Swedish Natural Science Research Council, Stockholm.

- Winterton, S.L. and Wang, Y. (2016)** Revision of the genus *Gryposmylus* Krüger, 1913 (Neuroptera, Osmylidae) with a remarkable example of convergence in wing disruptive patterning. *ZooKeys*, 617: 31-45. <https://doi.org/10.3897/zookeys.617.10165>
- Winterton, S.L., Hardy, N.B. and Wiegmann, B.M. (2010)** On wings of lace: phylogeny and Bayesian divergence time estimates of Neuropterida (Insecta) based on morphological and molecular data. *Systematic Entomology*, 35: 349-378. <http://dx.doi.org/10.1111/j.1365-3113.2010.00521.x>
- Winterton, S.L., Martins, C.C., Makarkin, V., Ardila-Camacho, A. and Wang, Y. (2019)** Lance lacewings of the world (Neuroptera: Archeosmylidae, Osmylidae & Saucrosmylidae): a review of living and fossil genera. *Zootaxa*, 4581: 1-99. <https://doi.org/10.11646/zootaxa.4581.1.1>
- Xu, H., Wang, Y. and Liu, Z. (2016)** Three new species of *Osmylus* Latreille from China (Neuroptera, Osmylidae). *ZooKeys*, 589: 107-121. <https://doi.org/10.3897/zookeys.589.7320>