Research Article

Brown-lacewings (Insecta: Neuroptera: Hemerobiidae) from Brazilian savannah in Central Brazil

Hemeróbidos (Insecta: Neuroptera: Hemerobiidae) de la sabana del centro de Brasil

Rogéria Inês Rosa Lara[1*] and Nelson Wanderley Perioto[1]

[1]*Instituto Biológico, Laboratório de Sistemática e Bioecologia de Predadores e Parasitoides, Ribeirão Preto, SP, Brazil.* **rirlara@yahoo.com.br*

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Abstract. In this study were documented the species of brown-lacewings (Neuroptera: Hemerobiidae) found at Parque Nacional da Chapada dos Veadeiros, in Alto Paraíso de Goiás, state of Goiás and at Parque Nacional Grande Sertão Veredas, in Chapada Gaúcha, state of Minas Gerais, both in Brazil, based on a survey carried out with Malaise traps between February 2018 and May 2019. During the samplings 60 specimens of hemerobiids were captured, being 26 of *Nusalala tessellata* (Gerstaecker, 1888), 13 of *Nomerobius argentinensis* González Olazo, 1990, eight of *Sympherobius amazonicus* Penny & Monserrat, 1985, six of *Megalomus impudicus* (Gerstaecker, 1888), five of *Hemerobius hernandezi* Monserrat, 1996, one *Nomerobius cuspidatus* Oswald, 1990 and one of *Notiobiella* sp. *Nomerobius argentinensis* and *Nom. cuspidatus* are reported by the first time to Brazil and *H. hernandezi*, *M. impudicus*, *Notiobiella* sp. and *S. amazonicus* to the state of Goiás, Brazil.

Key words: *Hemerobius*; *Megalomus*; *Nomerobius*; *Notiobiella*; *Sympherobius*.

Resumen. En este estudio se informan las especies de hemeróbidos (Neuroptera: Hemerobiidae) encontradas en el Parque Nacional da Chapada dos Veadeiros, Alto Paraíso de Goiás, Goiás y en el Parque Nacional Grande Sertão Veredas, Chapada Gaúcha, Minas Gerais, ambos en Brasil, recolectados con trampas Malaise entre febrero de 2018 y mayo de 2019. Se capturaron 60 ejemplares de hemeróbidos, con la siguiente composición de especies: 26 de *Nusalala tessellata* (Gerstaecker, 1888), 13 de *Nomerobius argentinensis* González Olazo, 1990, ocho de *Sympherobius amazonicus* Penny y Monserrat, 1985, seis de *Megalomus impudicus* (Gerstaecker, 1888), cinco de *Hemerobius hernandezi* Monserrat, 1996, uno de *Nomerobius cuspidatus* Oswald, 1990 y uno de *Notiobiella* sp. *Nomerobius argentinensis* y *Nom. cuspidatus* son reportadas por primera vez para Brasil y *H. hernandezi*, *M. impudicus*, *Notiobiella* sp. y *S. amazonicus* para el estado de Goiás, Brasil.

Palabras clave: *Hemerobius*; *Megalomus*; *Nomerobius*; *Notiobiella*; *Sympherobius*.

Introduction

Hemerobiidae (Neuroptera), commonly know as brown lacewings, include about 590 species described in 28 genera, and are found on all continents, except Antartica (Oswald 1993; Engel *et al*. 2018). For Brazil are known 24 species of hemerobiids distributed in six

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genera (Lara and Perioto 2016; Machado and Martins 2021).

Larvae and adults of hemerobiids act predominantly as arboreal generalist predators of phytophagous insects mainly aphids, coccids, psyllids, mites and other soft-bodied species (Carpenter 1940; Penny and Monserrat 1985; Tauber *et al*. 2007) and, due to this behavior, such insects are considered important to the biological control of pests in agricultural ecosystems (Stelzl and Devetak 1999). Most adult of hemerobiids species have a brown color, nocturnal habits and when disturbed will display a behavior known as thanatosis (New 1975; Oswald 1993).

This study aimed to characterize the diversity of Hemerobiidae collected in two areas of environmental protection of Brazilian savannah in Central Brazil: at Parque Nacional da Chapada dos Veadeiros (PNCV), in the municipality of Alto Paraíso de Goiás, Goiás state and at Parque Nacional Grande Sertão Veredas (PNGSV), in the municipality of Chapada Gaúcha, Minas Gerais state. Herein we treated seven species of hemerobiids, six of which had their geographic distribution expanded. Maps with the geographical distribution of the species are provided.

Material and Methods

The studied specimens were collected in samplings occurred between February 2018 and May 2019 in areas of Brazilian savannah at PNCV and at PNGSV, in Central Brazil. The climate in both localities is Köpen AW type (tropical with wet summers and dry winters); in PNCV the total annual rainfall is 1,792 mm concentrated between October and April, with mean annual temperature 21.7 °C and, in PNGSV the total annual rainfall is 1,217 mm also concentrated between October and April, with mean annual temperature 22.3 °C (Climate-Data.Org 2021a, 2021b).

In areas of Brazilian savannah at PNCV were installed two sets of five Townes' style Malaise traps (Townes 1972) with 96% ethanol solution as a preservative to collect continuously over the study period; in both sets the Malaise traps were separated one of the other by at least 50 m. The insects were removed every two weeks. The first set was located in an area without anthropic action (14°08'36" S, 47°46'0.4" W, ~1100 m above sea level [asl]) and the second one in an area that suffered a severe fire in November 2016 (14°07'44" S, 47°44'0.4" W, ~1100 m asl).

In the Brazilian savannah area without anthropic action at PNGSV was installed one set of five Malaise traps (15°10'30.6"S, 45°43'16.62"W, ~1100 m asl); the trap model used, the preservative solution, the conditions of installation and removal of insects were the same as PNCV. The collections were done under a Brazilian Biodiversity Information and Authorization System (SISBIO) license# 16473-1.

The collected material was transported to the laboratory, and the Hemerobiidae were separated from other insects and stored in labeled plastic vials with 96% ethanol solution. The terminalia were macerated in a 10% KOH hot solution for about 20 minutes and subsequently immersed, for one hour, in a 10% $C_2H_4O_2$ solution for neutralization. After its study, the genital structures were stored in glass micro vials with glycerin which were placed inside the same plastic vials of the respective specimens.

Observations were made under magnification using a Leica MZ9.5 APO stereomicroscope and a Leica DM500 optical microscope. The color images and measurements were taken using 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 , using the Leica Application Suite (LAS version 4.12.0) (Leica Microsystems, Germany). The images were focus-stacked using Helicon Focus version 5.3 (Helicon Soft, Kharkiv, Ukraine). The figures were prepared using Adobe Photoshop version 11.0 (Adobe Inc., California, USA).

The studied specimens were identified by the first author based on González Olazo (1990, 1992); Monserrat (1984, 1996, 1997, 2000); Penny and Monserrat (1985) and Oswald (1988, 1990, 1993). Collecting sites indicated on maps are based mainly on Lara and Perioto (2016); Machado and Martins (2021) and Oswald (2021), as well as in the new data obtained in the present study. The abbreviations related to the names of Brazilian states were: AM = Amazonas, BA = Bahia, DF = Distrito Federal, ES = Espírito Santo, GO = Goiás, MG = Minas Gerais, MT = Mato Grosso, PR = Paraná, RJ = Rio de Janeiro, RO = Rondônia, RS = Rio Grande do Sul, SC = Santa Catarina and SP = São Paulo.

All studied specimens 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 (voucher specimens LRRP lote #21).

Results and Discussion

In this study 60 specimens of hemerobiids were collected, 58 of which (96.7% of the total) captured at PNCV: 26 specimens of *Nusalala tessellata* (Gerstaecker, 1888) (16 in fired area), 12 of *Nomerobius argentinensis* González Olazo, 1990 (five in fired area), eight of *Sympherobius amazonicus* Penny & Monserrat, 1985 (five in fired area), six of *Megalomus impudicus* (Gerstaecker, 1888) (three in fired area), five of *Hemerobius hernandezi* Monserrat, 1996 (four in fired area) and one of *Notiobiella* sp. (in fired area) (Figs. 1-3, 5-7).

At PNCV 58.6% of the total of the hemerobiids were captured in an area of Brazilian savannah that suffered a severe fire about seven months before the beginning of the samplings and 41.4% in the Brazilian savanna area without anthropic action. Most specimens (32) of the fired area were obtained between February and October (when an average of 3.5 specimens / month were captured) (Fig. 9). These data contrast with those obtained in the area that has not been impacted by fire where more than 80% of the specimens were obtained between July and September 2018 with a population peak in August (13) (Fig. 9).

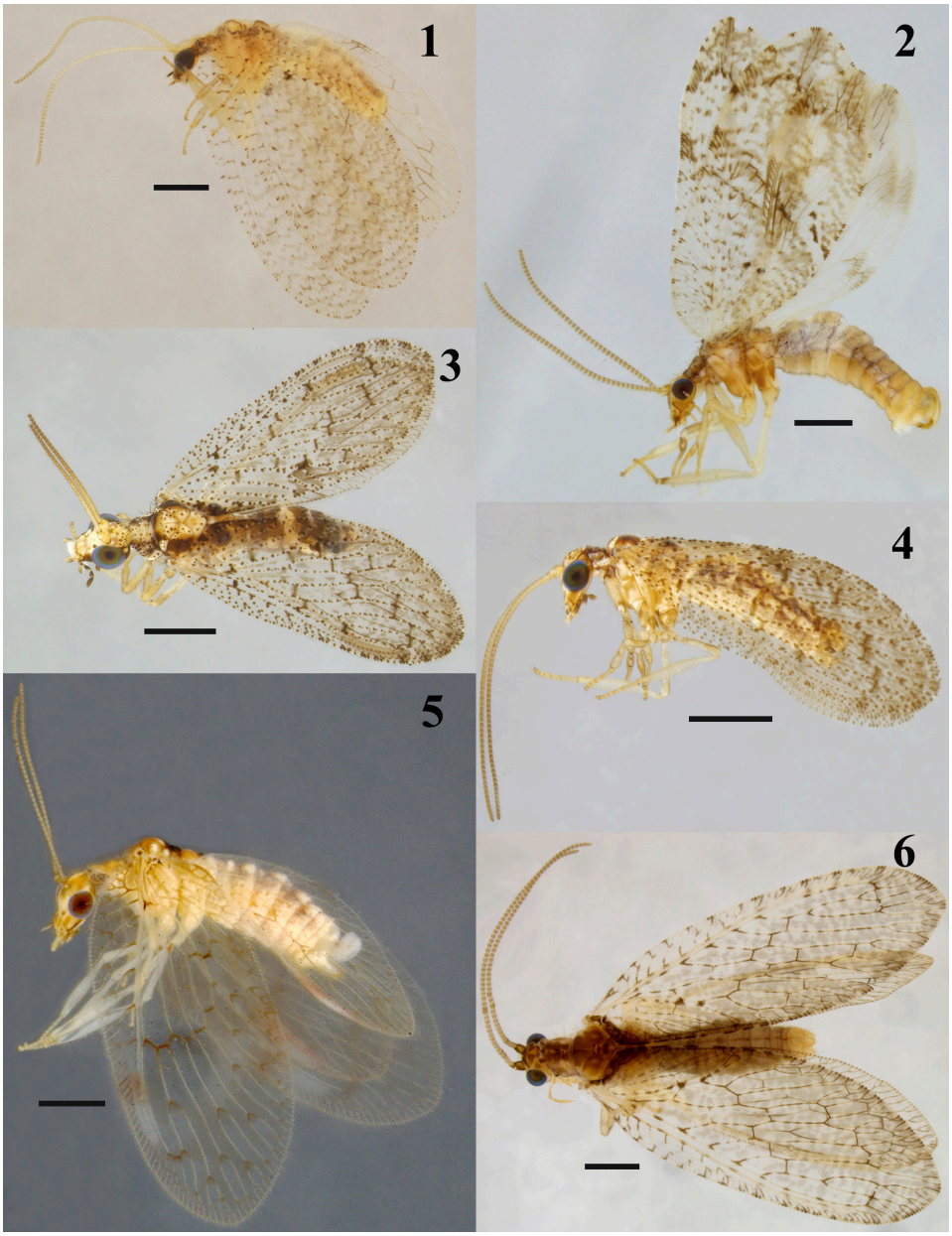
Coutinho (1976) and Fidelis *et al*. (2019) stated that the post-fire events in savanna vegetation are peculiar given that about 15 days after the fires it is possible to verify the regrowth of several species of plants, many of which producing flowers, regardless of the season of the year fire occurred. The intense post-fire regrowth increases the availability of food to phytophagous insects, whose populations tend to increase providing an increase in prey for the hemerobiids in the burned area, what probably favored and / or influenced the greater abundance of these predators.

Curiously, only two specimens of hemerobiids (3.3% of the total) were captured at PNGSV: one of *Nom. argentinensis* (Fig. 3) and one of *Nomerobius cuspidatus* Oswald, 1990 (Fig. 4) and the authors have no arguments to explain the low frequency of occurrence of this group of predators at PNGSV.

In the present study, a large sampling effort of 5,475 trap-days with Malaise traps was employed to capture the hemerobiids, divided into a 3,650 trap-days at PNCV (1,825 trap-days at each studied ambient) and 1,825 trap-days in area of Brazilian savannah without anthropic action at PNGSV. At PNGSV the sampling effort to catch each specimen was to 912.5 trap-days. At fired area in PNCV the sampling effort amounted to 53.7 trap-days/specimen while in area without anthropic action amounted to 76 trap-days/specimen.

The reasons that lead to this small catch rate of specimens of hemerobiids are unknown and factors such as their development in small populations and/or the low efficiency of the traps used should be taken into account. Despite of Silva *et al*. (2011) captured only 15 specimens of Neuroptera during one year of sampling using light trap in a Brazilian savannah area in Brazil (GO); the use of light trap and sweep net may be more efficient alternative for the Hemerobiidae sampling as shown by the reports of Szabó and Szentkirályi (1981), Szentkirályi (1997), Ábrahám *et al*. (2003) and (Lara *et al*. 2008). Similar

studies using Malaise traps were conducted by the authors in five areas of Atlantic Forest and in three savannah phytophysiognomies at Estação Ecológica de Jataí, both in Brazil (SP), where were collected specimens of the same six genera of Hemerobiidae reported here, with a sampling effort of 38.5 trap-days/specimen and 105.3 trap-days/specimen, respectively (Lara comm. pers. 2021).



Figures 1-6. Habitus of collected species of Hemerobiidae. 1. *Hemerobius hernandezi* Monserrat, lateral view. 2. *Megalomus impudicus* (Gerstaecker), lateral view. 3. *Nomerobius argentinensis* González Olazo, dorsal view. 4. *Nomerobius cuspidatus* Oswald, lateral view. 5. *Notiobiella* sp., lateral view 6. *Nusalala tessellata* (Gerstaecker), dorsal view. Scale bar: 1 mm. / Hábitos de las especies de Hemerobiidae recolectadas. 1. *Hemerobius hernandezi* Monserrat, vista lateral. 2. *Megalomus impudicus* (Gerstaecker), vista lateral. 3. *Nomerobius argentinensis* González Olazo, vista dorsal. 4. *Nomerobius cuspidatus* Oswald, vista lateral. 5. *Notiobiella* sp., vista lateral. 6. *Nusalala tessellata* (Gerstaecker), vista dorsal. Escala: 1 mm.

Figures 7-8. *Sympherobius amazonicus* Penny and Monserrat. 7. Habitus, lateral view. 8. Distribution records of *S. amazonicus* and *Sympherobius* Banks in Brazil and the Neotropics. / *Sympherobius amazonicus* Penny y Monserrat. / *Sympherobius amazonicus* Penny and Monserrat. 7. Hábito, vista lateral. 8. Registros de distribución de *S. amazonicus* y *Sympherobius* Banks en Brasil y el Neotrópico.

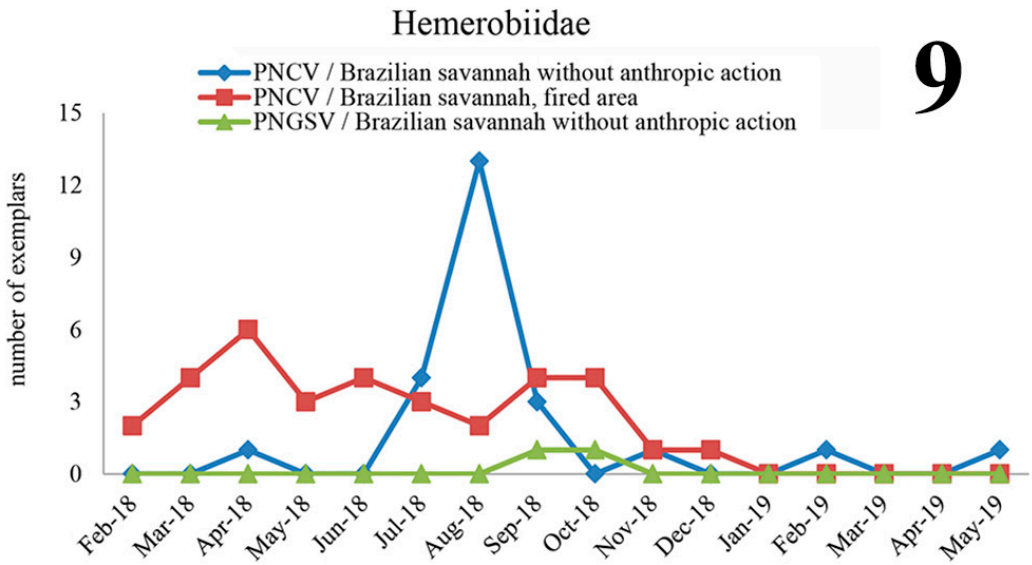


Figure 9. Population fluctuation of Hemerobiidae collected between February 2018 and May 2019 in areas of Brazilian savannah at the Parque Nacional da Chapada dos Veadeiros (PNVC), in Alto Paraíso de Goiás, Goiás state and Parque Nacional Grande Sertão Veredas (PNGSV), in Chapada Gaúcha, Minas Gerais state, both in Brazil. / Fluctuación poblacional de Hemerobiidae registrada entre febrero 2018 y mayo 2019 en áreas de la sabana brasileña en el Parque Nacional da Chapada dos Veadeiros (PNVC), en Alto Paraíso de Goiás, estado de Goiás y el Parque Nacional Grande Sertão Veredas (PNGSV), en Chapada Gaúcha, estado Minas Gerais, ambos en Brasil.

The five specimens of *H. hernandezi* were sporadically collected at PNCV between May and December, mid-autumn, winter and spring in southern hemisphere. Silva *et al*. (2015) reported the collecting of *H. hernandezi* between August and December in semideciduous forest and riparian forest areas in Brazil (MG), corroborating the data obtained. *Hemerobius hernandezi* have previously known recorded in Mexico, Guatemala, Nicaragua, Panama, Colombia, Venezuela, Brazil and Paraguay (Monserrat 1996, 1998, 2002; Silva *et al*. 2015; Lara and Perioto 2016; Machado and Martins 2021) (Fig. 10). This is the first record of geographical distribution of *H. hernandezi* to Goiás state, Brazil, about 4,900 km SE from Alajuela, Costa Rica, the type locality, and 900 km NO from Barroso (MG) and 1,800 km NE from RS, Brazilian localities with previously known records (Silva *et al*. 2015; Monserrat 1998) (Fig. 10).

Six specimens of *M. impudicus* also were sporadically collected between June and November at PNCV, winter and spring in southern hemisphere. Lara *et al*. (2010) studied the Hemerobiidae present in a coffee plantation in Cravinhos, São Paulo state, Brazil, where they found high frequencies of *M. impudicus* in the summer of 2005/2006. Melo *et al*. (2020) reported the occurrence of *M. impudicus* (2 specimens) and *Megalomus rafaeli* Penny and Monserrat, 1985 (11) in a fruit orchard in Avaré, Brazil (SP) and Comério *et al*. (2011) captured specimens of *M. rafaeli* from a coconut plantation in Linhares, Brazil (ES); in both studies, the highest capture rates occurred in the summer of the Southern Hemisphere, months of the rainy season.

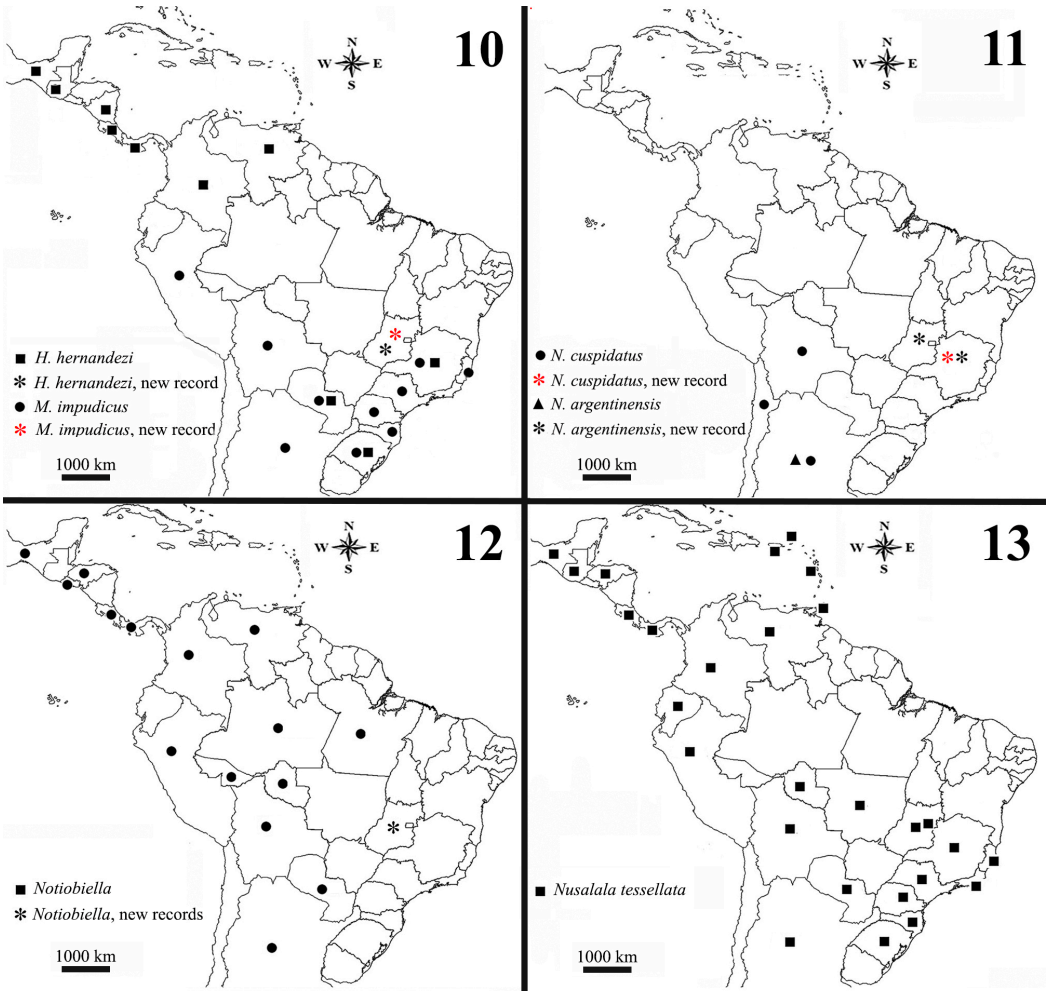
The distribution of *M. impudicus* have previously known recorded in Brazil (MG, ES, SP, PR, SC, RS), Peru, Bolivia, Argentina, Paraguay (Penny 1977; Monserrat 1990, 1997; Lara *et al*. 2010; Oliveira *et al*. 2013; Machado and Martins 2021) and, thus, this is a new record of the distribution range of this species to Goiás state, Brazil, about 1,800 km NE from Blumenau, Brazil (SC), the type locality and about 1,700 km NE from Gran Chaco, Entre Rios province, Argentina, its southernmost known distribution (Fig. 10).

Nomerobius cuspidatus and *Nom. argentinensis* are, for the first time, reported to Brazil. A single specimen of *Nom. cuspidatus* was obtained at PNGSV, in September; this species have previously known records to Argentina, Bolivia and Chile (Oswald 1990, 2021) and, thus, this is a new record of the distribution range to Chapada Gaúcha (MG) and to Alto Paraíso de Goiás (GO), both in Brazil, about 2,500 km NE from Berisso, Buenos Aires province, Argentina, the type locality (Fig. 11). Most of the specimens of *Nom. argentinensis* obtained in this study were collected at PNCV between July and October and a single specimen was collected at PNGSV, in September. About a hundred specimens of *Nom. argentinensis* were collected in Argentina between 1968 and 1987, most of them between September and March (González Olazo 1990), the hottest months of the year. Lara and Perioto (unpublished data) performed collections between 2008 and 2009 with light traps in an area of riparian forest in Luiz Antonio (SP), Brazil and obtained about 40 specimens of *Nom. argentinensis*, mainly between September and December, which corroborates the data compiled by González Olazo (1990). *Nomerobius argentinensis* is known only to Argentina (González Olazo 1990; Oswald 2021) and this findings extends its distribution to Alto Paraíso de Goiás (GO), and to Chapada Gaúcha (MG), Brazil, both about 2,300 km NE from San Miguel de Tucumán, Tucumán Province, Argentina, the type locality and, about 4,000 km SW from Rada Tilly, Chubut Province, Argentina, its southernmost known distribution (Fig. 11).

The single captured specimen of *Notiobiella*, a male obtained in August, had its genitalia damaged during the dissection process and was identified only at the generic level. Four species of *Notiobiella* are known to Brazil, all of them in the northern region of the country (Lara and Perioto 2016; Machado and Martins 2021) and this finding extends the distribution of *Notiobiella* to Goiás state, in Central Brazil (Fig. 12).

In both studied areas at PNCV, *Nus. tessellata* was the most abundant species of hemerobiids and represented more than 40% of the total of the specimens collected. Twenty

six specimens of *Nus. tessellata* were collected between February and August. Oliveira *et al*. (2013) studied the hemerobiids from a Brazilian savannah and gallery forest areas in Brazil (MG) and found that *Nus. tessellata*, followed by *M. impudicus*, were the most abundant species; the authors also stated that the highest capture frequencies occurred between June and October. Lara *et al*. (2008) and de Melo *et al*. (2020) studied the hemerobiids from a coffee crop in Cravinhos, and a fruit orchard in Avaré, respectively, both in São Paulo state, and reported that the higher capture frequencies occurred in the spring and summer. *Nusalala tessellata* has wide distribution in the Brazil (RO, BA, MT, GO, DF, MG, ES, SP, RJ, PR, SC, RS), and there are reports of its occurrence in Mexico, Guatemala, Dominica, Porto Rico, British Virgin Islands, Trinidad & Tobago, Honduras, Costa Rica, Panama, Colombia, Venezuela, Ecuador, Peru, Bolivia, Paraguay and Argentina (Penny 1977; Monserrat 1990, 2000, 2002, 2004; Penny and Monserrat 1985; Lara and Freitas 2002; Lara *et al*. 2010; Oliveira *et al*. 2013; Lara and Perioto 2016; Machado and Martins 2021) (Fig. 13).



Figures 10-13. Distribution of the studied Hemerobiidae species and their occurrence records to Brazil and Neotropics. 10. *Hemerobius hernandezi* Monserrat and *Megalomus impudicus* (Gerstaecker). 11. *Nomerobius argentinensis* González Olazo and *Nomerobius cuspidatus* Oswald. 12. *Notiobiella* Banks. 13. *Nusalala tessellata* (Gerstaecker). / Distribución de las especies de Hemerobiidae estudiadas y sus registros de ocurrencia en Brasil y el Neotrópico. 10. *Hemerobius hernandezi* Monserrat and *Megalomus impudicus* (Gerstaecker). 11. *Nomerobius argentinensis* González Olazo and *Nomerobius cuspidatus* Oswald. 12. *Notiobiella* Banks. 13. *Nusalala tessellata* (Gerstaecker).

Eight specimens of *S. amazonicus* also were sporadically collected in February (one specimen) and October (seven) at PNCV and its low frequency difficult the analysis of its annual distribution. Previous records indicate that its distribution was restricted to Amazonas state (Penny and Monserrat 1985; Monserrat 1990; Lara and Perioto 2016); this record extends the distribution range of *S. amazonicus* to the state of Goiás, about 1,800 km southeast of the type locality. There are reports of the occurrence of four species of *Sympherobius* in the North, Northeast, Southeast and South regions of the country (Lara and Perioto 2016) and this study extends the distribution range of the genus to Goiás state, in the Central West region of the country (Fig. 8).

Despite the limited data available, it is interesting to note that *Nus. tessellata* is the dominant species of most of the environments studied in Brazil, such as crops of citrus, coffee, corn, cotton, okra, soy and native and exotic fruits, as well as in areas of Brazilian savanna and Atlantic Forest (Lara com. pers. 2021), with the exception registered for the study by Comério *et al*. (2011), in coconut cultivation in Espírito Santo state, where *M. rafaeli* was predominant.

The knowledge about Neotropical Hemerobiidae is still incipient and indicates that a greater collection effort is necessary for a better representation of this Neuroptera group in Brazil.

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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*: 199-207.

Carpenter, F.M. (1940) A revision of the Neartic Hemerobiidae, Berothidae, Sisyridae, Polystoechotidae and Dilaridae (Neuroptera). *Proceedings of the American Academy of Arts and Sciences, 74*: 193-278.

Climate-Data.Org (2021a) Clima, Alto Paraíso de Goiás. Accessed August 10, 2021. Available at: https://pt.climate-data.org/search/?q=alto+para%C3%ADso+de+goi%C3%A1s

Climate-Data.Org (2021b) Clima, Chapada Gaúcha. Accessed August 10, 2021. Available at: https://pt.climate-data.org/search/?q=chapada+ga%C3%BAcha

Comério, E.F., Benassi, V.L.R.M., Oliveira, A.L.S., Lara, R.I.R. and Perioto, N.W. (2011) Hemerobiidae (Neuroptera) em cultura de coqueiro anão verde, com e sem vegetação invasora, em Linhares, ES. *In*: I Congresso Brasileiro de Fitossanidade, 2011, Jaboticabal, Brazil. pp. 31-34.

Coutinho, L.M. (1976) Contribuição ao conhecimento do papel ecológico das queimadas na floração de espécies do cerrado. Universidade de São Paulo, São Paulo, Brazil. Accessed July 5, 2021. Available at: https://teses.usp.br/teses/disponiveis/livredocencia/41/tde-04092014-095647/publico//LD_Coutinho_Leopoldo1.pdf

Engel, M.S., Winterton, S.L. and Breitkreuz, L.C.V. (2018) Phylogeny and evolution of Neuropterida: where have wings of lace taken us? *Annual Review of Entomology, 63*: 531-551.

Fidelis, A., Rosalem, P., Zanzarini, V., Camargos, L.S. and Martins, A.R. (2019) From ashes to flowers: a savanna sedge initiates flowers 24 h after fire. *Ecology, 100*(5): e02648. https://doi.org/10.1002/ecy.2648

González Olazo, E.V. (1987) Los neurópteros asociados con los cultivos cítricos de la provincia de Tucumán y descripción de una nueva especie de *Nomerobius* (Hemerobiidae). *CIRPON, Revista de Investigación, 5*: 37-54. **[1990]**

González Olazo, E.V. (1992) Una nueva especie de *Nomerobius* (Neuroptera, Hemerobiidae) de la Argentina. *Acta Zoológica Lilloana, 42*: 109-111.

Lara, R.I.R. and Freitas, S. (2002) Caracterização morfológica de adultos de *Nusalala tessellata* (Gerstaecker, 1888) (Neuroptera, Hemerobiidae). *Revista Brasileira de Entomologia, 46*(4): 523-530.

Lara, R.I.R. and Perioto, N.W. (2016) Updated checklist of Hemerobiidae (Neuroptera) from Brazil and new distributional records in the Neotropical Region. *Acta Amazônica, 46*(4): 425-432.

Lara, R.I.R., Freitas, S., Perioto, N.W. and Paz, C.C.P. (2008) Amostragem, diversidade e sazonalidade de Hemerobiidae (Neuroptera) em *Coffea arabica* L. cv. Obatã (Rubiaceae). *Revista Brasileira de Entomologia, 52*(1): 117-123.

Lara, R.I.R., Perioto, N.W. and Freitas, S. (2010) Diversidade de hemerobiídeos (Neuroptera) e suas associações com presas em cafeeiros. *Pesquisa Agropecuária Brasileira, 45*(2): 115-123.

Machado, R.J.C. and Martins, C.C. (2021) Hemerobiidae. *In*: Catálogo Taxonômico da Fauna do Brasil. PNUD. Accessed August 15, 2021. Available at: http://fauna.jbrj.gov.br/fauna/faunadobrasil/2022

Melo, M.A., Araújo, M.L.N.M. and Martins, C.C. (2020) Entomofauna de Hemerobiidae (Neuroptera) em sistema de cultivo orgânico e convencional de frutíferas no município de Avaré, SP, Brasil. *Revista de Biologia Neotropical*, *17*(2): 121-129.

Monserrat, V.J. (1984) Sobre las especies americanas del género *Notiobiella* Banks, 1909, I (Neuroptera, Planipennia, Hemerobiidae). *In*: Progress in World's Neuropterology, (ed. Gepp, J., Aspöck, H. and Hölzel, H.), 1984, Graz, Austria. pp. 85-97.

Monserrat, V.J. (1990) A systematic checklist of the Hemerobiidae of the world (Insecta: Neuroptera). *In*: Advances in Neuropterology, Proceedings of the Third International Symposium on Neuropterology South African, (ed. Mansell, M.W. and Aspöck H.), 1990, Pretoria, South African. pp. 215-262.

Monserrat, V.J. (1996) Revisión del género *Hemerobius* de Latinoamerica (Neuroptera, Hemerobiidae). *Fragmenta Entomologica, 27*: 399-523.

Monserrat, V.J. (1997) Revisión del género *Megalomus* de Latinoamerica (Neuroptera, Hemerobiidae). *Fragmenta Entomologica, 29*: 123-206.

Monserrat, V.J. (1998) Nuevos datos sobre los hemeróbidos de América (Neuroptera: Hemerobiidae). *Journal of Neuropterology, 1*: 109-153.

Monserrat, V.J. (2000) Revisión del género *Nusalala* (Neuroptera, Hemerobiidae). *Fragmenta Entomologica, 32:* 83-162.

Monserrat, V.J. (2002) Family Hemerobiidae. A guide to the lacewings (Neuroptera) of Costa Rica. (ed. Penny, N.D.), pp. 238-251. *Proceedings of the California Academy of Sciences, 53*(12): 161-457.

Monserrat, V.J. (2004) Nuevos datos sobre algunas especies de hemeróbidos (Insecta: Neuroptera: Hemerobiidae). *Heteropterus Revista de Entomología, 4*: 1-26.

New, T.R. (1975) The biology of Chrysopidae and Hemerobiidae (Neuroptera) with reference to their usage as biocontrol agents: a review. *Transactions of the Royal Entomological Society of London, 127*: 115-140.

Oliveira, R.C., Lara, R.I.R., Fonseca, A.R. and Perioto, N.W. (2013) Hemerobiidae (Neuroptera) in the midwestern region of Minas Gerais State, Brazil. *Revista Colombiana de Entomología, 39*: 256-259.

Oswald, J.D. (1988) A revision of the genus *Sympherobius* Banks (Neuroptera, Hemerobiidae) of America North of Mexico with a synonymical list of the world species. *Journal of the New York Entomological Society, 96*(4): 390-451.

Oswald, J.D. (1990) Revision of the Neotropical brown lacewing genus *Nomerobius* (Neuroptera, Hemerobiidae). *Annals of the Entomological Society of America, 83*: 18-29.

Oswald, J.D. (1993) Revision and cladistic analysis of the world genera of the family Hemerobiidae (Insecta: Neuroptera). *Journal of the New York Entomological Society, 101*: 143-299.

Oswald, J.D. (2021) Neuropterida Species of the World. Lacewing Digital Library, Research Publication No.1. Accessed August 08, 2021. Available at: http://lacewing.tamu.edu/SpeciesCatalog/Main

Penny, N.D. (1977) Lista de Megaloptera, Neuroptera e Raphidioptera do México, América Central, Ilhas Caraíbas e América do Sul. *Acta Amazonica, 7:* 5-61.

Penny, N.D. and Monserrat, V.J. (1983) Neuroptera of the Amazon basin Part 10-Hemerobiidae. *Acta Amazonica, 13*: 879-909. **[1985]**

Silva, N.A.P., Frizzas, M.R. and Oliveira, C.M. (2011) Seasonality in insect abundance in the "Cerrado" of Goiás State, Brazil. *Revista Brasileira de Entomologia, 55*(1): 79-87.

Silva, M., Lara, R.I.R. and Souza. B. (2015) Primeiro registro de ocorrência de *Hemerobius gaitoi* Monserrat, 1996 e *Hemerobius hernandezi* Monserrat, 1996 (Neuroptera: Hemerobiidae) para o estado de Minas Gerais, Brasil. *Arquivos do Instituto Biológico, 82*: 1-3.

Stelzl, M. and Devetak, D. (1999) Neuroptera in agricultural ecosystems. *Agriculture, Ecosystems and Environment, 74*(1-3): 305-321.

Szabó, S. and Szentkirályi, F. (1981) Communities of Chrysopidae and Hemerobiidae (Neuroptera) in some apple-orchards. *Acta Phytopathologica Academiae Scientiarum Hungaricae, 16*: 157-169.

Szentkirályi, F. (1997) Seasonal flight patterns of some common brown lacewing species (Neuroptera, Hemerobiidae) in Hungarian agricultural regions. *Biologia, 52*: 291-302.

Tauber, C.A., Tauber, M.J. and Giffin, J.G. (2007) Flightless Hawaiian Hemerobiidae (Neuroptera): comparative morphology and biology of a brachypterous species, its macropterous relative and intermediate forms. *European Journal of Entomology, 104*: 787-800.

Townes, H.A. (1972) A light-weight Malaise trap. *Entomological News, 83*: 239-247.