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Compiled records of butterfly species (Insecta: Lepidoptera) of Tocantins, Brazil

Registros compilados de espécies de borboletas (Insecta: Lepidoptera) do Tocantins, Brasil

Resumo. The aim of this paper is to provide the first checklist of butterfly species recorded in the State of Tocantins, Brazil. Butterfly species are reported here based on literature accounts and examined material from the Entomological Collection of the Universidade Federal do Norte do Tocantins. These baseline data intend to facilitate knowledge on the occurrence and distribution of butterflies in Cerrado. The checklist comprises a total of 91 butterfly species belonging to 6 families, 37 subfamilies, and 63 genera. The present study sheds light on the biodiversity of Lepidoptera fauna and represents a starting point for further research. Additionally, it consists an important approach to better understand and enhance knowledge of Lepidoptera in the Cerrado biome. **Palavras-chave:** Biodiversity, Cerrado, Citizen Science, Conservation, Hesperiiidae, Nymphalidae.

Abstract. O objetivo deste artigo é fornecer a primeira lista de verificação das espécies de borboletas registradas no Estado de Tocantins, Brasil. As espécies de borboletas são relatadas aqui com base em registros da literatura e material examinado na Coleção Entomológica da Universidade Federal do Norte do Tocantins. Esses dados iniciais têm a intenção de facilitar o conhecimento sobre a ocorrência e distribuição das borboletas no Cerrado. A lista de verificação inclui um total de 91 espécies de borboletas pertencentes a 6 famílias, 37 subfamílias e 63 gêneros. O presente estudo lança luz sobre a biodiversidade da fauna de Lepidoptera e representa um ponto de partida para pesquisas futuras. Além disso, abordagens importantes para compreender melhor o conhecimento de Lepidoptera no bioma Cerrado são discutidas aqui. **Keywords:** Biodiversidade, Cerrado, Ciência Cidadã, Conservação, Hesperiiidae, Nymphalidae.

Background

The order Lepidoptera Linnaeus, 1758 is diverse and widely distributed in the Neotropics, however the presence of these taxa in the environment is constantly threatened by the intense anthropization and the destruction of all biomes, especially in Brazil (BERTI FILHO & CERIGNONI, 2010). Therefore, it is urgent to unravel and document the knowledge of its real diversity. Further, it's clear how necessary identification and cataloging are not only for the purpose of preserving and conserving biodiversity for future generations, but also for scientists to have access to updated data and fresh material to test new hypotheses (FREITAS et al. 2006; ORLANDIN et al. 2020).

The known butterfly biodiversity in Brazil currently comprises by all the seven known families (Hesperiiidae Latreille, 1809, Hedyliidae Guenée, 1858, Lycaenidae Leach, 1815, Nymphalidae Rafinesque, 1815, Papilionidae Latreille, 1802, Pieridae Swainson, 1820 and Riodinidae Grote, 1895) and 3,570 species (SOUZA & GUILLERMO-FERREIRA, 2015; BERTINOTI et al. 2020; CASAGRANDE & DUARTE, 2021). The Atlantic Forest and the Amazon are the two well-sampled biomes regarding butterflies (UEHARA-PRADO et al., 2004), with almost two-thirds of all species reported in Brazil occurring in the former. In contrast, Cerrado areas remain under-sampled for most taxa, including butterflies, making it difficult to estimate the fauna and flora diversity in this ecoregion (CARNEIRO et al. 2008).

The Brazilian Cerrado is one of the most relevant threatened regions regarding its species richness, but unfortunately is also one of the least studied global biodiversity hotspots (MYERS et al. 2000). This large tropical savanna biome covers more than 20 percent of Brazil, predominantly extending through the States of Goiás, Tocantins, Federal District, and part of eight other States (RIBEIRO & WALTER, 1998).

Tocantins State is located in central Brazil and its vegetation comprises 88% of Cerrado biome and 12% of Amazon biome. Comprehensive and detailed faunistic studies in the State of Tocantins are scarce, and Lepidoptera surveys are still sparse. The lack of reliable information about the occurrence and distribution of moths and butterflies is almost absolute.

Updated checklists of butterflies are important for biodiversity conservation, taxonomy, scientific research, and citizen science. They provide a valuable resource for understanding the diversity of these insects and for informing efforts to protect them and their habitats. Therefore, this study aims to update the knowledge of butterfly species in Tocantins, Brazil, in order to improve the understanding of diversity and distribution of Lepidoptera in the Cerrado biome.

Material And Methods

The present annotated checklist of butterflies species includes reported species in previous checklist, taxonomic papers, dissertations, theses and overall published papers regarding the Lepidoptera fauna of the State of Tocantins. An extensive research on published information was conducted on Google Scholar, Scielo, Web of Science, Brazilian Biodiversity Information System (Sistema de Informação sobre a Biodiversidade Brasileira; SiBBR, 2022) and Global Biodiversity Information Facility (GBIF, 2022). Online zoological collections databases were also consulted during the research. Finally, data from the reference collection of butterflies housed by the Universidade Federal do Norte do Tocantins (UFNT) were also included. Other distributed information systems that integrate primary data from biological collections (SpeciesLink, iDigBio and Boldsystems) were analyzed, but no records of butterfly species for Tocantins were found.

The Entomological Collection of the Universidade Federal do Norte do Tocantins is affiliated to the Laboratório de Coleções Biológicas e Paleontológicas of the Biology course, Araguaína campus. In numbers, the estimate is that there are about a thousand specimens of invertebrates deposited in the dry way. However, a significant portion of the material lacks taxonomical identification. Additionally, some materials, such as butterflies, were not properly prepared and pinned. Despite this, as most of the vouchers are represented by a few individuals, and considering their damaged and fragile state, no attempt at restoration was made during this work. Figures of butterfly species from the UFNT collection are provided (Figures 1-2).

To include data from the Entomological Collection, butterfly specimens were first morphotyped and organized in proper entomological boxes. Then, the identification of species was carried out using specialized bibliography. Each specimen received a standardized label and updated tumble number. All butterflies were photographed in dorsal and ventral views.



Figure 1 A–H - A) *Urbanus dorantes*. B) *Euptoieta hegesia*. C) *Hamadryas* sp. 1. D) *Hamadryas* sp. 2. E) *Dione juno*. F) *Caligo illioneus*. Photos: Solandia Teixeira.

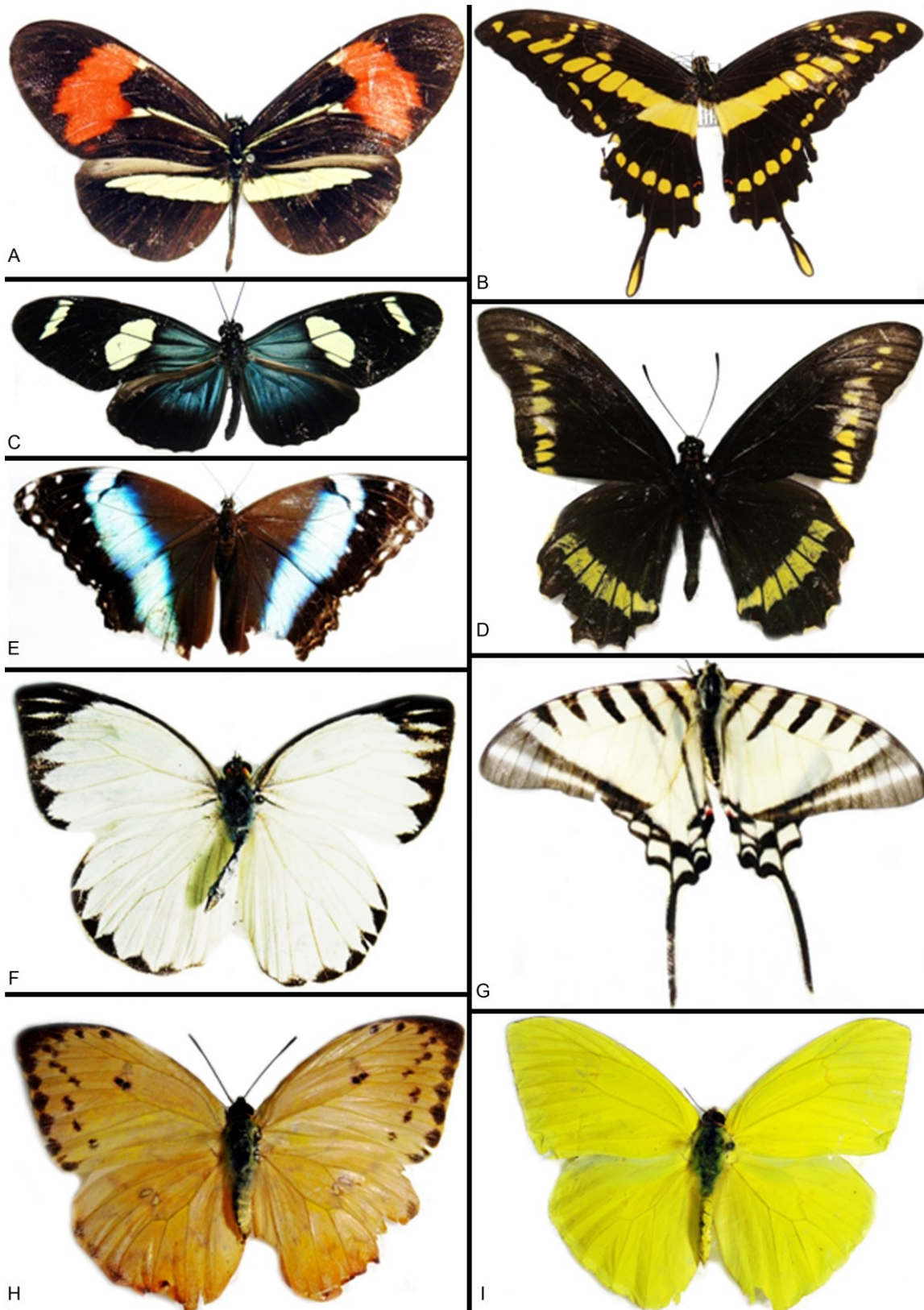


Figure 2 A-I - A) *Heliconius erato*. B) *Heraclides thoas*. C) *Heliconius sara*. D) *Battus polydamas*. E) *Morpho helenor*. F) *Ascia monuste*. G) *Protesilaus glaucolaus*. H) *Phoebis philea*. I) *Phoebis* sp. Photos: Solandia Teixeira.

Results

In total, we documented the presence of 90 butterfly species in Tocantins belonging to 62 genera, 33 tribes, 18 subfamilies and six families (Table 1; 2). The butterfly fauna reported here represents approximately 3% of the species already recorded for Brazil (CASAGRANDE & DUARTE, 2021).

Table 1 - Number of genera, tribes, species, and subspecies of butterflies per family from Tocantins, Brazil.

Family	Subfamily	Tribe	Genus	Species	Subspecies
Nymphalidae	10	20	42	67	6
Riodinidae	1	4	7	8	0
Papilionidae	1	3	3	4	1
Pieridae	2	2	3	4	0
Hesperiidae	3	3	4	4	0
Lycaenidae	1	1	3	3	0
Total	18	33	62	90	7

Table 2 - Checklist and taxonomy of butterflies reported for Tocantins, Brazil. Acronyms: FMNH, The Field Museum of Natural History; GBIF, Global biodiversity information facility; SIBBR, Sistema da Informação sobre a Biodiversidade Brasileira; UFNT, Universidade Federal do Norte do Tocantins, Brazil.

List of Species	Locality	References
HESPERIIDAE Latreille, 1809		
Eudaminae Mabille, 1877		
Eudamini Mabille, 1877		
<i>Proteides</i> Hübner, 1819		
<i>Proteides mercurius</i> Fabricius, 1787	Arraias	GBIF
<i>Urbanus</i> Hübner, 1807		
<i>Urbanus dorantes</i> (Stoll, 1790)	Araguaína	UFNT
Hesperiinae Latreille, 1809		
Moncini Warren, 2008		
<i>Rufocumbre</i> Dolibaina, Mielke & Casagrande, 2017		
<i>Rufocumbre schneideri</i> Dolibaina, Mielke & Casagrande, 2017	Ilha do Bananal	Dolibaina, Mielke & Casagrande, 2017
Pyrginae Burmeister, 1878		
Pyrgini Burmeister, 1878		
<i>Telemiades</i> Hübner, 1819		
<i>Telemiades amphion</i> (Geyer, 1832)	Ilha do Bananal	Siewert & Mielke, 2020
LYCAENIDAE Leach, 1815		

Theclinae Swainson, 1831		
Eumaeini Doubleday, 1847		
<i>Arcas</i> Swainson, 1832		
<i>Arcas imperialis</i> (Cramer, 1775)	Arraias	GBIF
<i>Panthiades</i> Hübner, 1819		
<i>Panthiades phaleros</i> (Linnaeus, 1767)	Arraias	GBIF
<i>Pseudolycaena</i> Wallengren, 1858		
<i>Pseudolycaena marsyas</i> (Linnaeus, 1758)	Lagoa da Serra (Rio da Conceição), Rio da Conceição	GBIF
NYMPHALIDAE Rafinesque, 1815		
Biblidinae Boisduval, 1833		
Ageroniini Doubleday, 1847		
<i>Ectima</i> Doubleday, 1848		
<i>Ectima iona</i> Hewitson, 1848	Pium	SIBBR
<i>Hamadryas</i> Hübner, [1806]		
<i>Hamadryas</i> sp. 1	Araguaína	UFNT
<i>Hamadryas</i> sp. 2	Araguaína	UFNT
<i>Hamadryas feronia</i> (Linnaeus, 1758)	Caseara, Pium	SIBBR, GBIF
<i>Hamadryas februa</i> (Hübner, 1823)	Caseara	SIBBR
<i>Hamadryas laodamia</i> (Cramer, 1777)	Arraias, Palmas	SIBBR, GBIF
<i>Hamadryas amphinome</i> Linnaeus, 1767	Caseara	GBIF
Biblidini Boisduval, 1833		
<i>Myscelia</i> Doubleday, 1844		
<i>Myscelia orsis</i> (Drury, 1782)	Palmas	SIBBR
<i>Paulogramma</i> Dillon, 1948		
<i>Paulogramma pyracmon</i> Godart, 1823	Arraias	GBIF
Catonephelini Orfila, 1952		
<i>Catonephele</i> Hübner, 1819		
<i>Catonephele acontius</i> Linnaeus, 1771	Pium	SIBBR
<i>Eunica</i> Hubner, 1819		
<i>Eunica cuvierii</i> (Godart, 1819)	Caseara	SIBBR
<i>Eunica marsolia</i> (Godart, 1823)	Palmas, Pium	SIBBR, GBIF

Charaxinae Guenée, 1865		
Anaeini Reuter, 1896		
<i>Zaretis</i> Hübner, 1819		
<i>Zaretis strigosus</i> (Gmelin, 1790)	Pedro Afonso	Dias et al. 2019
Preponini Rydon, 1971		
<i>Archaeoprepona</i> Fruhstorfer, 1915		
<i>Archaeoprepona demophon</i> (Linnaeus, 1758)	Pium	SIBBR
<i>Mesoprepona</i> Bonfanti, Casagrande & Mielke, 2017		
<i>Mesoprepona pheridamas</i> (Cramer, 1777)		Ortiz-Acevedo et al. 2017
<i>Prepona</i> Boisduval, 1836		
<i>Prepona pylene</i> Hewitson, 1854	Pium	SIBBR
Cyrestinae Guenée, 1865		
Cyrestini Guenée, 1865		
<i>Marpesia</i> Hübner, 1818		
<i>Marpesia chiron</i> (Fabricius, 1775)	Pium	SIBBR
Epiphilini Jenkins, 1987		
<i>Pyrrhogyra</i> Hübner, 1819		
<i>Pyrrhogyra crameri</i> Aurivillius, 1882	Pium	SIBBR
Danainae Boisduval, 1833		
Ithomiini Godman & Salvin, 1879 (1878)		
<i>Mechanitis</i> Fabricius, 1807		
<i>Mechanitis</i> sp. 1	Palmas	SIBBR
<i>Mechanitis polymnia</i> (Linnaeus, 1758)	Palmas	GBIF
<i>Sais</i> Hübner, 1816		
<i>Sais rosalia rosalinde</i> Weymer, 1890	Ilha do Bananal	Ríos Díaz et al. 2014
Heliconiinae Swainson, 1822		
Argynnini Swainson, 1833		
<i>Euptoieta</i> Doubleday, 1848		
<i>Euptoieta hegesia</i> (Cramer, 1779)	Araguaína	UFNT
Heliconiini Swainson, 1822		
<i>Dione</i> Hübner, 1819		
<i>Dione juno</i> (Cramer, 1779)	Araguaína	UFNT
<i>Dryas</i> Hübner, 1807		
<i>Dryas iulia</i> Fabricius, 1775	Arraias	GBIF
<i>Eueides</i> Hübner, 1816		

<i>Eueides vibilia</i> Latreille & Godart, 1819	Mateiros	GBIF
<i>Heliconius</i> Kluk, 1780		
<i>Heliconius antiochus</i> Linnaeus, 1767	Pium	SIBBR
<i>Heliconius erato</i> (Linnaeus, 1758)	Araguaína, Pindorama do Tocantins, Pium	UFNT, GBIF
<i>Heliconius sara</i> (Fabricius, 1793)	Araguaína, Arraias	UFNT, GBIF
<i>Heliconius wallacei araguaia</i> Brown, 1976	Ilha do Bananal	Brown, 2009
Ithomiinae Godman & Salvin, 1879		
Godryridini D' Almeida, 1941		
<i>Hypoleria</i> Godman & Salvin, 1879		
<i>Hypoleria lavinia</i> (Hewitson, 1855)	Palmas	SIBBR
Limenitidinae Behr, 1864		
Limenitidini Behr, 1864		
<i>Adelpha</i> Hübner, 1819		
<i>Adelpha</i> sp. 1	Palmas	SIBBR
Nymphalinae Rafinesque, 1815		
Coeini Scuder, 1893		
<i>Colobura</i> Billberg, 1820		
<i>Colobura dirce</i> Linnaeus, 1764	Pium	GBIF
Kallimini Doherty, 1886		
<i>Napeocles</i> Bates, 1864		
<i>Napeocles jucunda</i> Hübner, 1808		FMNH
Junoniini Reuter, 1896		
<i>Junonia</i> Hübner, 1819		
<i>Junonia evarete</i> Cramer, 1782	Arraias	GBIF
Victorinini Scudder, 1893		
<i>Anartia</i> Hübner, 1819		
<i>Anartia jatrophae</i> Linnaeus, 1763	Araguaína, Porto Nacional	GBIF
Morphinae Newman, 1834		
Brassolini Boisduval, 1836		
<i>Bia</i> Hübner, 1819		
<i>Bia rebeli tapajos</i> Penz & Simonsen, 2017	Ilha do Bananal	Penz et al. 2017
<i>Brassolis</i> Fabricius, 1807		
<i>Brassolis</i> sp. 1	Bom Jesus do Tocantins	SIBBR
<i>Caligo</i> Hübner, 1819		

<i>Caligo brasiliensis</i> (Felder, 1862)	Pium	SIBBR
<i>Caligo illioneus</i> (Cramer, 1775)	Araguaína	UFNT
<i>Catoblepia</i> Stichel, 1901		
<i>Catoblepia berecynthia</i> (Cramer, 1777)	Caseara, Pium	SIBBR
<i>Eryphanis</i> Boisduval, 1870		
<i>Eryphanis automedon</i> (Cramer, 1775)	Palmas, Pium	GBIF, SIBBR
Satyrinae Boisduval, 1833		
Haeterini Herrich-Schäffer, 1864		
<i>Pierella</i> Westwood, 1851		
<i>Pierella lamia</i> (Sulzer, 1776)	Plamas	
Satyrini Boisduval, 1833		
<i>Chloreuptychia</i> Forster, 1964		
<i>Chloreuptychia chlorimene</i> (Hübner, 1819)	Caseara, Pium	SIBBR
<i>Chloreuptychia herseis</i> (Godart, 1824)	Pium	SIBBR
<i>Cissia</i> Doubleday, 1848		
<i>Cissia penelope</i> (Fabricius, 1775)	Pium	SIBBR
<i>Cissia terrestris</i> (Butler, 1867)	Pium	SIBBR
<i>Emeryus</i> Zacca, Casagrande & Mielke, 2020		
<i>Emeryus difficilis</i> (Forster, 1964)	Xambioá	Zacca et al. 2020b
<i>Emeryus argulus argulus</i> (Godart, 1824)	Santa Fé do Araguaia, Barreira Branca (Aragominas)	Zacca et al. 2020b
<i>Hermeuptychia</i> Forster, 1964		
<i>Hermeuptychia atalanta</i> (Butler, 1867)	Araguatins, Ananás, Xambioá	Pereira, 2011, GBIF
<i>Hermeuptychia hermes</i> (Fabricius, 1775)	Araguatins, Xambioá	Pereira, 2011, GBIF
<i>Hermeuptychia maimoune</i> (Butler, 1870)	Ananás, Araguatins	Pereira, 2011, GBIF
<i>Pareuptychia</i> Forster, 1964		
<i>Pareuptychia ocirrhoe</i> (Fabricius, 1777)	Palmas	SIBBR
<i>Paryphthimoides</i> Forster, 1964		
<i>Paryphthimoides sp. 1</i>	Xambioá	Zacca et al. 2020a
<i>Paryphthimoides poltys poltys</i> (Prittwitz, 1865)	Ilha do Bananal	Zacca et al. 2020a
<i>Paryphthimoides terrestris araguaianus</i> Zacca, Casagrande & Mielke, 2020	Ilha do Bananal	Zacca et al. 2020a
<i>Paryphthimoides brixius brixius</i> (Godart, 1824)	Ilha do Bananal	Zacca et al. 2020a
<i>Posttaygetis</i> Forster, 1964		
<i>Posttaygetis penelea</i> Cramer, 1779	Natividade,	GBIF

<i>Pseudodebis</i> Forster, 1964	Palmas	
<i>Pseudodebis marpessa</i> (Hewitson, 1862)	Pium	SIBBR
<i>Splendeptychia</i> Forster, 1964		
<i>Splendeptychia</i> sp. 1	Pium	SIBBR
<i>Splendeptychia itonis</i> Hewitson, 1862	Pium	
<i>Taygetis</i> Hübner, 1819		
<i>Taygetis rufomarginata</i> Staudinger, 1888	Pium	GBIF
<i>Taygetis echo</i> Cramer, 1779	Palmas, Pium	GBIF
<i>Taygetis sosis</i> Hopffer, 1874	Palmas	
Morphini Newman, 1834		
<i>Morpho</i> Fabricius, 1807		
<i>Morpho achilles</i> Linnaeus, 1758	Palmas	GBIF
<i>Morpho helenor</i> (Cramer, 1776)	Araguaína, Caseara, Palmas, Pium	UFNT, SIBBR, GBIF
<i>Morpho menelaus</i> (Linnaeus, 1758)	Pium	SIBBR
<i>Morpho telemachus</i> (Linnaeus, 1758)	Pium	SIBBR
PAPILIONIDAE Latreille, 1802		
Papilioninae Latreille, 1802		
Leptocircini Smith & Vane-Wright, 2001		
<i>Protesilaus</i> Swainson, 1832		
<i>Protesilaus glaucolaus</i> (Bates, 1864)	Araguaína	UFNT
Papilionini Latreille, 1802		
<i>Heraclides</i> Hübner, 1819		
<i>Heraclides thoas</i> (Linnaeus, 1771)	Araguaína	UFNT
<i>Heraclides himeros baia</i> (Rothschild & Jordan, 1906)	Santa Maria do Tocantins	Kerpel et al. 2014
Troidini Talbot, 1939		
<i>Battus</i> Scopoli, 1777		
<i>Battus polydamas</i> (Linnaeus, 1758)	Araguaína	UFNT
PIERIDAE Swainson, 1820		
Coliadinæ Swainson, 1821		
Coliadini Swainson, 1827		
<i>Anteos</i> (Hübner, 1819)		
<i>Anteos clorinde</i> (Godart, 1824)	Pindorama do Tocantins	GBIF
<i>Phoebis</i> Hübner, 1819		

<i>Phoebis philea</i> (Linnaeus, 1763)	Araguaína	UFNT
<i>Phoebis</i> sp. 1	Araguaína	UFNT
Pierinae Swainson, 1820		
Pierini Swainson, 1820		
<i>Ascia</i> Scopoli, 1777		
<i>Ascia monuste</i> (Linnaeus, 1764)	Araguaína	UFNT
RIODINIDAE Grote, 1895		
Riodininae Grote, 1895		
Mesosemiini Bates, 1859		
<i>Hyphilaria</i> Hübner, 1819		
<i>Hyphilaria thasus</i> (Stoll, 1780)	Arraias	GBIF
Nymphidiini Bates, 1859		
<i>Juditha</i> Hemming, 1964		
<i>Juditha molpe</i> (Hübner, 1808)	Arraias	GBIF
<i>Nymphidium</i> Fabricius, 1807		
<i>Nymphidium</i> sp. 1	Pium	SIBBR
<i>Synargis</i> Hübner, 1819		
<i>Synargis galena</i> (Bates, 1868)	Araguaína	GBIF
Riodinini Grote, 1895		
<i>Isapis</i> Doubleday, 1847		
<i>Isapis agyrtus</i> (Cramer, 1777)	Caseara	SIBBR
<i>Lasaia</i> Bates, 1868		
<i>Lasaia agesilas</i> (Latreille, 1809)	Pium	SIBBR
Stalachtini Bates, 1861		
<i>Stalachtis</i> Hübner, 1818		
<i>Stalachtis phlegia</i> (Cramer, 1765)	Pium	GBIF
<i>Stalachtis calliope</i> (Linnaeus, 1758)	Palmas	

Considering the distributional records, knowledge of butterfly species in Tocantins is mainly based on occasional collections and studies carried out in twelve cities (of 139 municipalities) (Figure 3). Pium, Araguaína and Palmas recorded most of the species reported here with 29, 19 and 17 species, respectively.

Most species recorded in Tocantins have a wide geographic distribution in Brazil, especially in Other Cerrado areas (BROWN JR. & MIELKE, 1967a, b; MOTTA, 2002; SOUZA & GUILLERMO-FERREIRA, 2015; MARTINS et al. 2017) such as: *Ascia monuste* (LINNAEUS, 1764),

Heliconius erato (LINNAEUS, 1758), *Hamadryas februa* (HÜBNER, 1823), *Hamadryas feronia* (LINNAEUS, 1758), *Hamadryas amphinome* (LINNAEUS, 1767) and *Junonia evarete* (CRAMER, 1782).

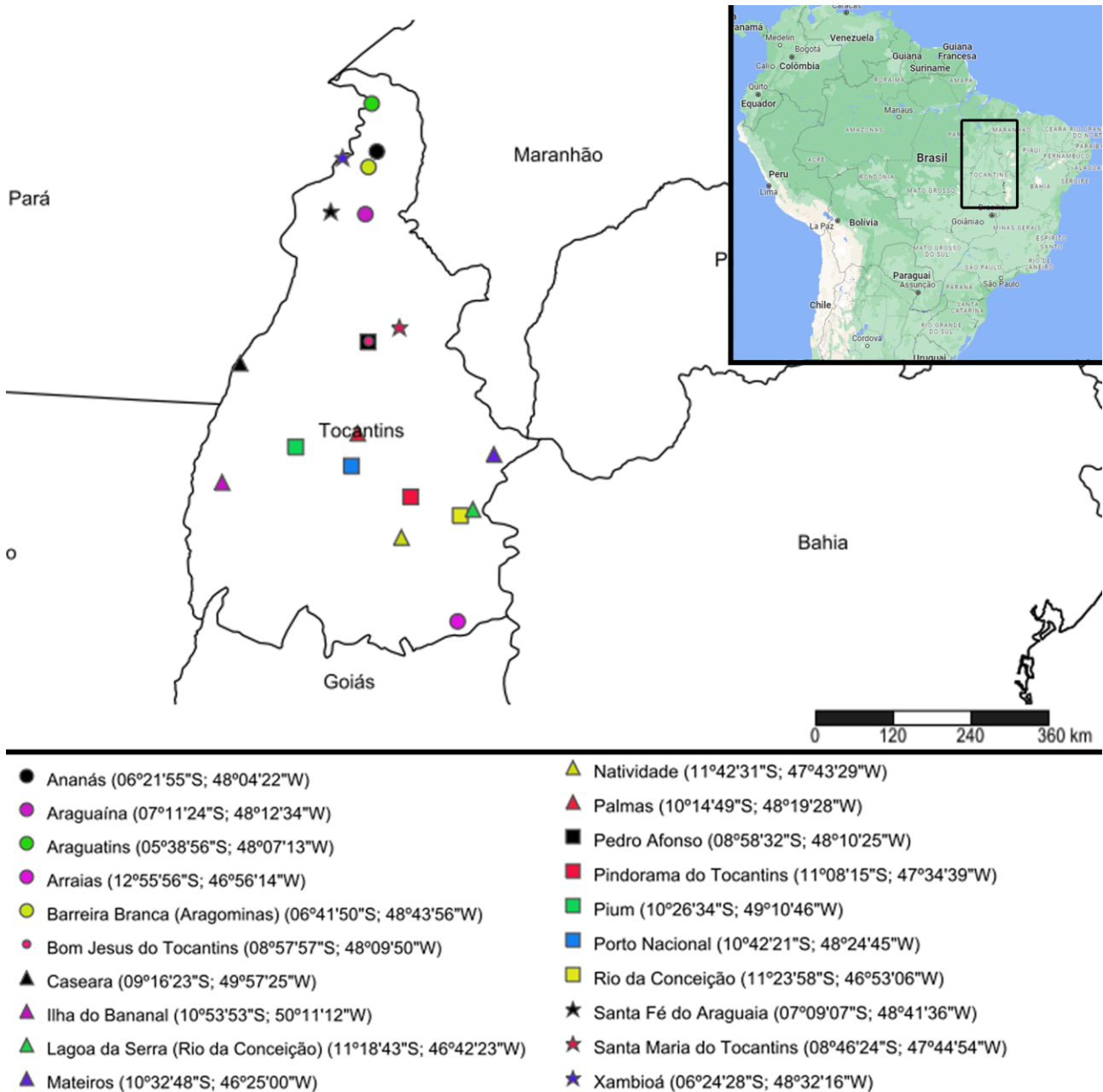


Figure 3 - Map of the collection locations in Tocantins, Brazil.

Among the six families recorded, Nymphalidae was the richest (42 genera and 67 species), followed by Riodinidae (seven genera and eight species), HesperIIDae (four genera and four

species), Papilionidae (three genera and 4 species), Pieridae (three genera and four species) and Lycaenidae (three genera and three species).

Among nymphalids, the subfamily Satyrinae Boisduval, 1833 is represented with the most number of tribes, a total of 21. The tribe Satyrini Boisduval, 1833 (Nymphalidae: Satyrinae) is reported with the most species, with 26 species, followed by the tribes Heliconiini Swainson, 1822 (Nymphalidae: Heliconiinae) and Brassolini Boisduval, 1836 (Nymphalidae: Morphinae), with eight and six, respectively.

The genus *Hamadryas* Hübner, (1806) (Nymphalidae: Biblidinae: Ageroniini) is the most representative, with six species, followed by *Morpho* Fabricius, 1807 (Nymphalidae: Morphinae: Morphini), *Heliconius* Kluk, 1780 (Nymphalidae: Heliconiinae: Heliconiini) and *Paryphthimoides* Forster, 1964 (Nymphalidae: Satyrinae: Satyrini), with four species each.

Of the species recorded, one has been given the status of endangered specie in Brazilian Red List (BRASIL, 2022): *Heraclides himeros* baia (Rothschild & Jordan, 1906).

In our study, we also found that *Zaretis itys* (CRAMER, 1777), *Zaretis isidora* (CRAMER, 1779) and *Zaretis falcis* (DIAS, CASAGRANDE & MIELKE, 2012) may occur further south and east in Brazil, which includes Tocantins, according to Dias et al. (2019); *Chlosyne lacinia saundersii* (DOUBLEDAY & HEWITSON, 1849) may also occur further in the state of Tocantins due to favorable climatic conditions (FORTES, 2009) and *Eunica bechina magnipunctata* (TALBOT, 1928) due to the presence of pequi trees (*Caryocar brasiliense* Cambess), which is its host plant (PINHEIRO et al. 2010).

Other important findings are related to the identification of potential pests to be monitored in order to evaluate the interference and to determine the level of economic damage (NDE) caused by larvae of some species, to the development of new and effective pest control strategies, and the assessment of the economic impact on crops. This knowledge can inform policymakers and agricultural stakeholders in making informed decisions about pest management and developing regulations to prevent the introduction of harmful pests into new areas in Tocantins. The following species are indicated by the Brazilian Agricultural Research Corporation and Other studies (EMBRAPA, 2017; LOVATTO et al. 2015; SCHEUNEMANN et al. 2020) as potential insect pests in Brazil: *Ascia monuste* (LINNAEUS, 1764), *Eryphanis automedon* (CRAMER, 1775), *Heraclides thoas* (Linnaeus, 1771), especially the subspecies *Heraclides thoas brasiliensis* (Rothschild & Jordan, 1906); and *Dione juno* (CRAMER, 1779).

Discussion

Sampling Efforts

The present study is an updated checklist of butterflies from Tocantins and the obtained results indicate a relatively rich butterfly community. However, this community only represents a fraction of the real butterfly species composition within the state. Compared to earlier studies in the region, the biodiversity in the current checklist was found to be greater.

Broad and integrated taxonomy studies, involving extensive sampling efforts, are notably absent in Regard to Lepidoptera in Tocantins. Most records were concentrating in easily

accessible collecting locations such as the capital surroundings and other major cities (Figure 1) And these records are characterized as sparse and sporadic sampling.

Along with the lack of sampling efforts, there are other factors (LEANDRO et al. 2017; REED et al. 2020) that contribute to minimize specimen knowledge of Lepidoptera in the Cerrado biome : a) sampling bias related to the size of specimens, medium and larger individuals tends to be collected more than small ones; b) sampling bias related to color, black, brown and dull color insects are not only less sampled but are also less consider for protection in conservation studies; c) lack of funding, which is still the major impediment to progress on biodiversity knowledge in developing countries; d) lack of taxonomist experts in local scientific institutions; d) rapid habitat loss and fragmentation altering butterfly habitats, disrupting their life cycles, changing their interactions with other species and leading to a fast pace of extinction.

Cerrado Anthropization Aggravation

Colli et al. (2020) outlined a comprehensive synopsis of the scientific community's concern regarding the biodiversity of the Cerrado in light of the resulting impact from the rapid advancement of agriculture, livestock and deforestation. The Cerrado is a highly heterogeneous landscape and the authors stressed that "any effort to address the biodiversity and conservation of a large region depends on a sound understanding of its boundaries and regionalization", therefore it is critical to comprehensively assess its ecological zones, delineate its distinct ecosystems, and develop targeted conservation strategies tailored to each unique biome.

Costa-Coutinho et al. (2022) assessed the potential impact of climate change on the diversity of plants in peripheral regions from the Northern Brazilian Cerrado. The findings of this study indicate that, even under the most optimistic climate change scenarios, climate conditions are likely to exert a significant influence on the composition of woody plants in the Brazilian Savanna in the near future (by 2050). The results also highlight that protected areas are inadequate for safeguarding both current and future rare plant species, underscoring the need for improved maintenance strategies in the Brazilian Savanna.

There is no similar study using the current distribution of Cerrado butterflies and future estimates of the impact of intensive anthropization and climate change. However, it is possible to extrapolate that the results of the previous study have significant implications for the region's fauna. A considerable number of plant species serve as habitats and food sources for butterflies and other animals. Consequently, the prospect that current protected areas are inadequate to safeguard their plant species also holds implications for the fauna, given that many animal species rely directly on these plants for their survival. Therefore, the imperative for enhanced monitoring and maintenance strategies in the Brazilian Cerrado is pivotal to ensure the continuous availability of habitats and resources for the local fauna, thereby contributing to the overall conservation of biodiversity within the region.

This strategy needs to be implemented in conjunction with the monitoring of anthropogenic processes, fire management, and the identification and expansion of more conservation areas. By simultaneously tracking human-induced changes, implementing controlled fire practices, optimizing of maintenance strategies, and designating specific

conservation zones, we can effectively safeguard the biodiversity of Cerrado while mitigating the adverse effects of agricultural expansion and deforestation.

Solution Approach

Addressing the problems given above to better understand the knowledge of Lepidoptera in the Cerrado biome will require a combination of approaches, including:

- a) Increasing sampling efforts, optimized inventories especially for smaller and less colorful species, to improve our understanding of the full diversity of Lepidoptera in the region.
- b) Raising awareness about the importance of conserving butterflies to ensure their presence and to maintain the ecological dynamics.
- c) Increasing funding for biodiversity research, conservation, and education in developing countries to promote more sampling, research, and conservation efforts.
- d) Training more taxonomic experts in Lepidoptera identification and using molecular tools for a rapid confirmation of species.
- e) Promoting habitat conservation and restoration efforts to mitigate the impacts of habitat loss and fragmentation.
- f) Integrating traditional knowledge, by promoting ethnobiology studies with indigenous and local communities to assess their valuable knowledge about the biodiversity in their area.
- g) Using technology and innovation, by the use of new tools to improve access to data, and to remote sensing that can also help to identify areas of high biodiversity that may be otherwise difficult to access.

A Call for Citizen Science

In order to fill some gaps of biodiversity knowledge immediately, citizen science might offer solutions to continually and constantly increase the records and reports of butterflies (CONSTANT et al. 2016; LIN et al. 2023). Citizen science can play a critical role in share collecting data about butterfly populations and distribution, also it is an easy and effective way of engaging the public in sciences by raising awareness about butterflies and their importance in the ecosystem and promoting a sense of ownership and stewardship of the natural world.

Citizen science projects can facilitate collaborations between scientists and community groups, including schools, local conservation organizations, and citizen science groups. These partnerships can help to build a sense of community around butterfly conservation and can lead to more effective conservation efforts.

As perspectives for future research, additional studies might aim to describe (1) the population dynamics and seasonal patterns of butterflies; (2) the interactions of butterflies with specific host-plants in Cerrado; (3) the potential impact that larval stage of some butterfly species

have on plants in Cerrado; and (4) the diversity of integrative taxonomic studies combining morphology and molecular tools.

Conclusions

The list of butterflies presented here is an important baseline for future entomological research in Tocantins and helps to fill a gap in our knowledge of the geographic distribution of these species in Brazil. It is evident that our list is incomplete due to the limited sampling effort in this region, and it is highly likely that Tocantins houses more species than those we have documented. This emphasizes the necessity of more research to elaborate a more comprehensive butterfly checklist of Tocantins.

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Authors' contributions

RCLO collected the data and performed the analysis. LS conceived and designed the analysis. RCLO and LS wrote the paper.

Competing interests

All authors declare that they have no conflict of interest.

Referências bibliográficas

- BENDER, A., MALGARIM, M., ANDRADE, S. B., SOUZA, A. L. K.; CALIARI, V. Perfil físico-químico e sensorial de sucos de uva brancos produzidos por extração a quente. *Revista Eletrônica Científica UERGS*, v. 4, n. 5, 743-751, 2018.
- BERTI FILHO, E.; CERIGNONI, J. A. *Borboletas*. Piracicaba: FEALQ, Piracicaba, São Paulo, Brasil, 2010.
- BERTINOTI, G. K. et al. Butterflies richness (Lepidoptera, Papilionoidea) from Ilha Grande National Park, Paraná, Brazil. *J. Entomol. Zool. Stud.*, n. 8, p. 835-840, 2020.
- BRASIL. *Portaria do Ministério do Meio Ambiente nº148*, de 7 de Junho de 2022. Ministério do Meio Ambiente, Gabinete do Ministro, Distrito Federal, Edição 108, seção 1, p.74, 2022.
- BROWN, K. S. Geographical patterns of evolution in Neotropical Lepidoptera. Systematics and derivation of known and new Heliconiini (Nymphalidae: Nymphalinae). *J. Entomol. Series B, Taxonomy*, v. 44, n. 3, p. 201-242, 2009. doi: 10.1111/j.1365-3113.1976.tb00014.x.

- BROWN, J. R. K. S.; MIELKE, O. H. H. Lepidoptera of the Central Brazil Plateau. I. Preliminary list of Rophalocera: Introduction, Nymphalidae and Libytheidae. *J. Lepid. Soc.*, n. 21, v. 2, p. 77–106, 1967a.
- BROWN, J. R. K. S.; MIELKE, O. H. H. Lepidoptera of the Central Brazil Plateau. I. Preliminary list of Rophalocera (continued): Lycaenidae, Pieridae, Papilionidae and Hesperidae. *J. Lepid. Soc.*, n. 21, v. 3, p. 145–168, 1967b.
- CARNEIRO, E.; MIELKE, O. H. H.; CASAGRANDE, M. M. Inventários de borboletas no Brasil: estado da arte e modelo de áreas prioritárias para pesquisa com vista à conservação. *Nat. Conserv.*, n. 6, v. 2, p. 68–90, 2008.
- CASAGRANDE, M. M.; DUARTE, M. Lepidoptera em Catálogo Taxonômico da Fauna do Brasil, PNUD, 2021. Available at <http://fauna.jbrj.gov.br/fauna/faunadobrasil/84>.
- COLLI, G. R.; VIEIRA, C. R.; DIANESE, J. C. Biodiversity and conservation of the Cerrado: recent advances and old challenges. *Biodivers Conserv.* 29, p. 1465–1475, 2020. doi: 10.1007/s10531-020-01967-x
- CONSTANT, J.; PHAUK, S.; BOURGOIN, T. Updating lanternflies biodiversity knowledge in Cambodia (Hemiptera: Fulgoromorpha: Fulgoridae) by optimizing field work surveys with citizen science involvement through Facebook networking and data access in FLOW website. *Belg. J. Entomol.*, n. 37, p. 1–16, 2016.
- COSTA-COUTINHO, J. M. D.; JARDIM, M. A. G.; MIRANDA, L. S.; CASTRO, A. A. J. F.. (2022). Climate change effects on marginal savannas from central-north. *Brazil. An. Acad. Bras. Ciênc.*, n. 94, v. 3, e20210191. doi:10.1590/0001-376520220210191
- DIAS, F. M. S. et. al. DNA barcodes uncover hidden taxonomic diversity behind the variable wing patterns in the Neotropical butterfly genus *Zaretis* (Lepidoptera: Nymphalidae: Charaxinae). *Zool. J. Linn. Soc.*, n. 85, v. 1, p.132–192, 2019. doi: 10.1093/zoolinnean/zly036.
- DOLIBAINA, D. R.; MIELKE, O. H. H.; CASAGRANDE, M. M. Taxonomy of *Rufocumbre* gen. nov., a new Moncini skipper genus (Lepidoptera: Hesperidae: Hesperinae). *Zootaxa*, n. 4365, v. 2, 2017. doi: 10.11646/zootaxa.4365.2.5
- EMBRAPA. Guia de identificação e controle de pragas na cultura do maracujazeiro. Brasília: *Embrapa*, 94 p, 2017.
- FMNH. The Field Museum of Natural History. *Zoological Collections*, 2022. Available at: <https://collections-zoology.fieldmuseum.org>.
- FORTES, J. C. *Potential distribution and climate change impact over the sunflower pest Chlosyne lacinia (Lepidoptera: Nymphalidae)*. 44 f. Dissertation (Master degree in Entomological Science) – Universidade Federal de Viçosa, Viçosa, 2009.
- FREITAS, A. V. L. et al. Insetos como indicadores de conservação da paisagem. In: ROCHA, C. F. D.; BERGALLO, H. G.; VAN SLUYS, M.; ALVES, M. A. S. (Eds.). *Biologia da Conservação*. Essências, RiMA Editora, São Carlos, 2006.
- GBIF. *Global biodiversity information facility*, 2022. Available at <https://www.gbif.org/>
- KERPEL, S. M.; JUNIOR, A. F.; FREITAS, A. V. L. New record of the Endangered Brazilian Swallowtail *Heraclides himeros* baia (Rothschild & Jordan, 1906). *J. Lepid. Soc.*, n. 68, v. 2, p. 145–146, 2014. doi:10.18473/lepi.v68i2.a9

- LEANDRO, C.; JAY-ROBERT, P.; VERGNES, A. Bias and perspectives in insect conservation: A European scale analysis. *Biological Conservation*, n. 215, p. 213–224, 2017. doi:10.1016/j.biocon.2017.07.033
- LIN YOU-SHENG, et al. 2023. Lanternflies (Hemiptera: Fulgoridae) of Taiwan. *Zool. Stud.*, n. 62, v. 07, p. 1-56.
- LOVATTO, P. B. et al.. Consumo foliar de *Ascia monuste orseis* (Latreille) (Lepidoptera: Pieridae) em couve orgânica tratada com extratos e óleo de *Tagetes minuta* L. In: *Anais do Congresso Brasileiro de Defensores Agrícolas Naturais*, 7, 2015 Pelotas: Embrapa Clima Temperado, Brasília, DF: Embrapa, 2015.
- MARTINS, L. P. et al. Butterflies of Amazon and Cerrado remnants of Maranhão, Northeast Brazil. *Biota Neotrop.*, n. 17, v. 3, 2017.
- MOTTA, P. C. Butterflies from the Uberlândia region, Central Brazil: species list and biological comments. *Braz. J. Biol.*, n. 62, v. 1, p. 151-163, 2002.
- MYERS, N. et al. Biodiversity hotspots for conservation priorities. *Nature*, n. 403, p. 853-858, 2000.
- ORLANDIN, E.; PIOVESAN, M.; CARNEIRO, E. *Borboletas do meio oeste de Santa Catarina: História natural e guia de identificação*, 1 ed., Joçaba, Edição Independente, 2020.
- ORTIZ-ACEVEDO, E. et al. Using molecules and morphology to unravel the systematics of neotropical preponine butterflies (Lepidoptera: Charaxinae: Preponini). *Insect Syst. Divers*, n. 1, v. 1, p. 48–56, 2017.
- PENZ, C. M. et al. Documenting diversity in the Amazonian butterfly genus *Bia* (Lepidoptera, Nymphalidae). *Zootaxa*, n. 4258, v. 3, 2017doi: 10.11646/zootaxa.4258.3.1
- PEREIRA, N. S. *Delimitando espécies: contribuição de marcadores morfológicos e moleculares para a compreensão do gênero *Hermeuptychia* Forster (Nymphalidae: Satyrinae: Euptychiina)*. 102 f. Dissertation (Master Degree in ecology) - Universidade Estadual de Campinas, 2011.
- PINHEIRO, C. E. G. et al. Endemismos e conservação de borboletas (Lepidoptera: Papilionoidea e Hesperioidea) no bioma Cerrado. In: DINIZ, I. R.; MARINHO-FILHO, J. R.; MACHADO, B.; CAVALCANTI, R. B. *Cerrado: Conhecimento científico quantitativo como subsídio para ações de conservação*, Universidade Federal de Brasília, Brasília, p. 225-238, 2010.
- RIBEIRO, J. F.; WALTER, B. M. T. Fitofitofisionomia do Bioma Cerrado. In: SANO, S. M. & ALMEIDA, S. P. *Cerrado: ambiente e flora*. Brasília: Embrapa, p. 89-166, 1998.
- REED, J. et al. 2020. The extent and distribution of joint conservation-development funding in the tropics. *One Earth*, n. 3, v. 6, p. 753–762. doi:10.1016/j.oneear.2020.11.008.
- RÍOS DÍAZ, S. D. et al. Notes on the geographic distribution and subspecific taxonomy of *Sais rosalia* (Cramer) (Lepidoptera, Nymphalidae, Ithomiini), including the first records in Paraguay. *Rev. Bras. Entomol.*, n. 58, v. 1, p. 11–18, 2014. doi: 10.1590/S0085-56262014000100003
- SCHEUNEMANN, T.; BERNARDI, D.; NAVA DE. Pragas da Oliveira. *Cultivar HF*, v. 119, p. 10-13, 2020.
- SIBBR. *Sistema da Informação sobre a Biodiversidade Brasileira*, 2022. Available at https://www.sibbr.gov.br/?lang=pt_BR.

SIEWERT, R. R.; MIELKE, O. H. H.; CASAGRANDE, M. M. Taxonomic revision of the Neotropical genus *Telemiades* Hübner, 1819 (Lepidoptera: Hesperiiidae: Eudaminae), with descriptions of fourteen new species. *Zootaxa*, v. 4721, n. 1, p. 1-1112020. doi: 10.11646/zootaxa.4721.1.1.

SOUZA, P. R. B.; GUILLERMO-FERREIRA, R. Butterflies of the Bodoquena Plateau in Brazil (Lepidoptera, Papilionoidea). *ZooKeys*, v. 546, p. 105-124, 2015. doi: <https://doi.org/10.3897/zookeys.546.6138>.

UEHARA-PRADO, M. et al. 2004. Guia de borboletas frugívoras da Reserva Estadual do Morro Grande e Região de Caucaia do Alto, Cotia (São Paulo). *Biota Neotrop.*, n. 4, 2004.

ZACCA, T. et al. Systematics of the Neotropical butterfly genus *Paryphthimoides* Forster, 1964 (Lepidoptera: Nymphalidae: Satyrinae), with descriptions of seven new taxa. *Insect Syst. Evol.*, v. 1, n. 52,, p. 42-96, 2020a. doi: 10.1163/1876312X-00001027

ZACCA, T. et al. Description of *Emeryus* Zacca, Mielke & Casagrande gen. nov. (Lepidoptera: Nymphalidae) to accommodate three species formerly placed in *Paryphthimoides* Forster, 1964. *Austral Entomol.*, n. 59, v. 3, p. 505–523, 2020b. doi: 10.1111/aen.12479.

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