



RESEARCH ARTICLE - WASPS

A checklist of social wasps (Vespidae: Polistinae) from Tocantins state, Brazil

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Abstract

Tocantins state has high biodiversity and a high degree of endemism, nevertheless, there are no studies on the diversity of social wasps. This study introduces a survey of social wasps actively collected using entomological nets and *Malaise* trap in addition to different light traps in sixteen sites in the Amazon and Cerrado biomes in Tocantins state, Brazil. We sampled a total of 1,013 social wasps distributed in 57 species of 13 genera. Fifty of these species and nine genera represent new distribution records for the state. Some species are not commonly found in collections and lists of species, and *Protopolybia picteti* (de Saussure, 1854) is newly recorded for Brazil. Such an increase of 714% may indicate that Polistinae richness is probably higher in the studied regions and that the state of Tocantins may well contain several additional (yet unrecorded) social wasp species. More comprehensive studies should be conducted to enhance the knowledge of wasp species in this state, contributing to our understanding on the biodiversity in Northern Brazil.

Introduction

Many areas in Brazil lack the most basic biodiversity studies, particularly in the case of invertebrates. For any effective conservation proposal to be established, the knowledge of species occurring in a particular area must be enhanced (Melo et al., 2012). In this context, such a taxonomic baseline is only achieved by conducting biodiversity surveys. The state of Tocantins is one of these undersampled areas, a large gap in the Brazilian territory regarding insect diversity. Only a few taxonomic works or faunal surveys have been developed, mostly over the last decade and including only a few taxa: Coleoptera (Fernandes et al., 2020; Polizei & Fernandes, 2020; Polizei et al., 2022), Diptera (Figueiro et al., 2012, 2014; Krolow & Vieira, 2016; Lima et al. 2015; Lima et al., 2018; Da Silva et al., 2022), Embioptera (Krolow & Valadares, 2016; Salvatierra, 2020), Ephemeroptera (Boldrini

& Krolow, 2017; Orlando et al., 2019, 2021), EPT (Andrade et al., 2020b), Hymenoptera (Andrade et al., 2021); Megaloptera (Andrade et al., 2020a), Neuroptera (Machado & Krolow, 2016; Alvim et al., 2019), Plecoptera (Rippel et al., 2019a, b), and Psocoptera (Lienhard et al., 2010).

Such a scenario is also the case for social wasps (Vespidae: Polistinae) - until 2009, there were no records of social wasps for the state. The first recorded species, *Synoeca surinama* (Linnaeus, 1767), is derived from a series of specimens examined in a phylogenetic proposal (Andena et al., 2009a). Souza et al. (2020) recorded six other species for Tocantins: *Apoica arborea* Saussure, 1854, *Apoica pallida* Olivier, 1792, *Apoica strigata* Richards, 1978, *Apoica thoracica* du Buysson, 1906, *Mischocyttarus flavicornis* Zikán, 1935, and *Polybia striata* Fabricius, 1787. In summary, only seven species and four genera of social wasps are recorded for Tocantins.



Brazil shelters the greatest richness of Polistinae worldwide, with 381 species recorded so far (Somavilla et al., 2021a; Hermes et al., 2022). Considering the richness and distribution of social wasps in other bordering states, like Pará, Maranhão, Mato Grosso, and Goiás (Santos et al., 2020; Somavilla et al., 2021a), these data are notoriously underestimated and show the lack of information about the richness of this taxon in Tocantins. Thereby, our goal was to perform a pioneer systematic work and present an update about the geographic records of the social wasp fauna in Tocantins.

Material and Methods

The state of Tocantins is located in the Northern region of Brazil and represents a transition area between the Amazon and Cerrado domains. Although the other states in the region have a large portion of their territories inserted in the Amazon domain, around 90% of the area of Tocantins is in the Cerrado domain (IBGE, 2004). The climate of the state is classified as Aw according to the Köppen system. It has a warm and dry winter from May to September, and a hot and rainy summer from October to April (Alvares et al., 2014). The mean annual rainfall in the state varies between 1,200 and 2,100 mm, and the mean annual temperature is between 26 °C and 29 °C (Miranda & Bognola, 1999).

Social wasps were sampled from 16 locations in Tocantins (Figure 1), two of them in the Amazon region

(Araguaína and Pium) and fourteen in the Cerrado (Arraias, Babaçulândia, Brejinho de Nazaré, Dianópolis, Lagoa da Confusão, Mateiros, Miracema, Monte do Carmo, Natividade, Palmas, Pedro Afonso, Porto Alegre do Tocantins, Porto Nacional, and Wanderlândia). These wasps were collected using different sampling methods, mainly *Malaise* flight interception traps, lighted sheet, lighted tray, and Pennsylvania light trap, in addition to the active collection with an entomological net. The material is derived from collections carried out over the last decade but without standardization of methods or sampling effort. All specimens/vouchers examined are deposited in the Entomology Collection of the Federal University of Tocantins (CEUFT).

We identified specimens to genus-level based on the keys proposed by Richards (1978) as well as Somavilla and Carpenter (2021b), in addition to further specific identification keys, in the case of the species *Agelaia* (Cooper, 2000), *Angiopolybia* (Barroso et al., 2022), *Apoica* (Pickett & Wenzel, 2007), *Brachygastra* (Andena & Carpenter, 2012), *Epipona* (Andena et al., 2009a), *Mischocyttarus* (Silveira, 2008), *Polistes* (Somavilla et al., 2021c), *Pseudopolybia* (Somavilla et al., 2021d), *Protopolybia* (Junior et al., 2018; 2020a; 2020b), and *Synoeca* (Andena et al., 2009b), for example. Dr. Orlando Tobias Silveira (Museu Paraense Emilio Goeldi) was responsible for verifying the *Mischocyttarus* species/morphospecies identifications.

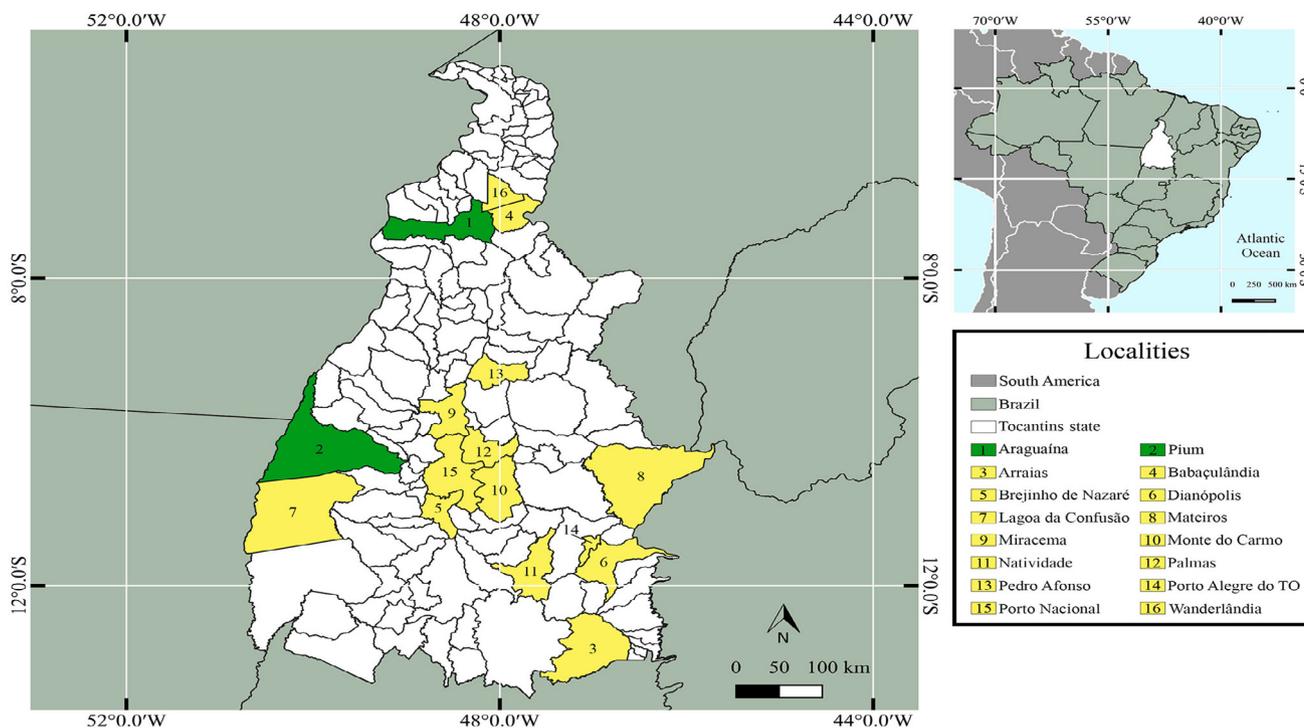


Fig 1. Map with 16 cities in the Tocantins state: The localities in green have phytophysiognomies predominantly from the Amazon biome, while the localities in yellow have phytophysiognomies from the Cerrado biome.

Results

We provide an updated list of Polistinae species for Tocantins, which shows an increase of 714% in the species richness of social wasps for the state, from seven to 57 species (Table 1). Regarding tribes, Epiponini was the most diverse with 41 species and 11 genera, followed by Mischocyttarini, with ten species, and Polistini, with four species. Thirteen genera of social wasps were recorded, corresponding to approximately 62% of the genera likely to be found in Brazil (21 genera). The other genera (*Angiopolybia* Araujo, 1946, *Asteloeca* Raw, 1985, *Charterginus* Fox, 1898, *Chartergus* Lepeletier, 1836, *Clypearia* de Saussure, 1854, *Leipomeles* Möbius, 1856, *Nectarinella* Bequaert, 1938, and *Protonectarina* Ducke, 1910) were not collected in the state of Tocantins so far, although they are likely to be registered in further collection efforts due to their confirmed distribution in other Northern states.

The genera *Polybia* (16 species), *Mischocyttarus* (ten species), *Apoica* (six species), and *Agelaia* (five species) presented the largest number of species. Together, these genera are responsible for 67% of the species recorded herein. *Agelaia pallipes* (Olivier, 1792) was the most representative of all species collected, with 282 specimens representing about 28% of all specimens examined. The species was followed by *Apoica pallida* (Olivier, 1792) and *Apoica thoracica* du Buysson, 1906, with 110 and 107 specimens collected, respectively. In contrast, most of the species were represented by a few individuals, like the 17 species with a single specimen collected, and other seven species with two individuals.

Among the known species for Tocantins, only two were not recorded in this survey, *Apoica strigata* Richards, 1978 and *Mischocyttarus flavicornis* Zikán, 1935 (listed in the table without the number of specimens collected (-)). The species in this survey include 50 new records for the state (Table1), and *Protopolybia picteti* (de Saussure, 1854) is a new record for Brazil.

Table 1. Species of social wasps (Vespidae: Polistinae) from the Tocantins state. Relationship between the wasp species recorded herein and the number of specimens collected in each sampling method. Fields with “-” mean that the particular species was not collected by the respective collection method. Species marked with “*” represent new records for the state of the Tocantins. The species marked with “***” represents a new record for Brazil.

Taxon / Collected methods	Active	Malaise	Illuminated tray	Light trap	Pennsylvania	Total
Polistini						
<i>Polistes canadensis</i> (Linnaeus, 1798)*	1	1	-	1	-	3
<i>Polistes cinerascens</i> de Saussure, 1854*	-	-	-	1	-	1
<i>Polistes occipitalis</i> Ducke, 1904*	-	1	-	-	-	1
<i>Polistes versicolor</i> (Olivier, 1792)*	-	1	-	1	-	2
Mischocyttarini						
<i>Mischocyttarus cerberus</i> Ducke, 1898*	-	1	-	-	-	1
<i>Mischocyttarus</i> cf. <i>tricolor</i> Richards, 1945*	-	3	-	-	-	3
<i>Mischocyttarus flavicornis</i> Zikán, 1935	-	-	-	-	-	-
<i>Mischocyttarus</i> gr. <i>injucundus</i> (de Saussure, 1854)*	-	-	1	-	-	1
<i>Mischocyttarus</i> gr. <i>surinamensis</i> de Saussure, 1854*	-	2	-	-	-	2
<i>Mischocyttarus labiatus</i> (Fabricius, 1804)*	-	10	-	-	-	10
<i>Mischocyttarus rotundicollis</i> (Cameron, 1912)*	-	7	-	-	-	7
<i>Mischocyttarus</i> sp.1*	-	1	-	-	-	1
<i>Mischocyttarus</i> sp.2*	-	-	1	-	-	1
<i>Mischocyttarus (Artifex)</i> sp.1*	-	1	-	-	-	1
<i>Mischocyttarus (Megacanthopus)</i> sp.1*	-	1	-	-	-	1
Epiponini						
<i>Agelaia cajemensis</i> (Fabricius, 1798)*	-	3	33	5	-	41
<i>Agelaia flavipennis</i> (Ducke, 1905)*	-	1	-	-	-	1
<i>Agelaia fulvofasciata</i> (de Geer, 1773)*	-	2	-	-	-	2
<i>Agelaia pallipes</i> (Olivier, 1792)*	9	270	3	-	-	282
<i>Agelaia testacea</i> (Fabricius, 1804)*	6	9	-	1	-	16
<i>Apoica arborea</i> de Saussure, 1854	1	-	39	-	-	40
<i>Apoica flavissima</i> van der Vecht, 1972*	3	2	29	11	2	47
<i>Apoica gelida</i> van der Vecht, 1972*	2	1	21	7	5	36

Table 1. Species of social wasps (Vespidae: Polistinae) from the Tocantins state. Relationship between the wasp species recorded herein and the number of specimens collected in each sampling method. Fields with “-” mean that the particular species was not collected by the respective collection method. Species marked with “*” represent new records for the state of the Tocantins. The species marked with “**” represents a new record for Brazil. (Continuation)

Taxon / Collected methods	Active	Malaise	Illuminated tray	Light trap	Pennsylvania	Total
Epiponini						
<i>Apoica pallens</i> (Fabricius, 1804)*	-	-	4	-	2	6
<i>Apoica pallida</i> (Olivier, 1792)	-	-	81	15	14	110
<i>Apoica strigata</i> Richards, 1978	-	-	-	-	-	-
<i>Apoica thoracica</i> du Buysson, 1906	2	-	64	21	20	107
<i>Brachygastra mouleae</i> Olivier, 1978*	-	2	2	5	-	9
<i>Chartergellus communis</i> Richards, 1978*	-	6	-	-	-	6
<i>Epipona tatus</i> (Cuvier, 1797)*	-	2	-	-	-	2
<i>Metapolybia docilis</i> Richards, 1978*	-	-	8	6	-	14
<i>Parachartergus fraternus</i> (Gribodo, 1892)*	-	1	-	-	-	1
<i>Parachartergus lenkoi</i> Richards, 1978*	-	-	-	1	-	1
<i>Parachartergus smithii</i> (de Saussure, 1854)*	-	1	-	-	-	1
<i>Polybia chrysothorax</i> (Lichtenstein, 1796)*	-	38	-	-	-	38
<i>Polybia dimidiata</i> (Olivier, 1792)*	1	1	-	-	-	2
<i>Polybia emaciata</i> Lucas, 1879*	-	34	4	1	-	39
<i>Polybia erythrothorax</i> Richards, 1978*	15	-	-	1	-	16
<i>Polybia ignobilis</i> (Haliday, 1836)*	1	12	1	-	-	14
<i>Polybia jurinei</i> de Saussure, 1854*	-	1	-	-	-	1
<i>Polybia liliacea</i> (Fabricius, 1804)*	-	7	2	2	1	12
<i>Polybia micans</i> Ducke, 1904*	1	10	-	-	-	11
<i>Polybia occidentalis</i> (Olivier, 1792)*	2	30	8	2	-	42
<i>Polybia platycephala</i> Richards, 1951*	-	5	2	-	-	7
<i>Polybia rejecta</i> (Fabricius, 1798)*	-	12	1	-	1	14
<i>Polybia ruficeps</i> Schrottky, 1902*	-	5	4	1	-	10
<i>Polybia scroballis</i> Richards, 1970*	1	-	-	-	-	1
<i>Polybia sericea</i> (Olivier, 1792)*	-	6	-	-	-	6
<i>Polybia singularis</i> Ducke, 1905*	-	2	-	-	-	2
<i>Polybia striata</i> (Fabricius, 1787)	-	2	-	-	-	2
<i>Protopolybia chartegoides</i> (Gribodo, 1892)*	-	-	-	1	-	1
<i>Protopolybia picteti</i> (de Saussure, 1854)**	-	-	1	-	-	1
<i>Protopolybia sedula</i> (de Saussure, 1854)*	-	5	2	-	-	7
<i>Pseudopolybia compressa</i> (de Saussure, 1854)*	-	-	6	-	1	7
<i>Pseudopolybia vespiceps</i> de Saussure, 1863*	-	3	-	-	-	3
<i>Synoecacyanea</i> (Fabricius, 1775)*	-	-	-	1	-	1
<i>Synoeca surinama</i> (Linnaeus, 1767)	4	14	-	1	-	19
Total	49	516	317	85	46	1.013

The *Malaise* trap was the most successful collection method, both in collected specimens (516) and in recorded species (40), followed by the lighted tray (317 specimens and 22 species), lighted sheet (85 and 20), and Pennsylvania light trap (46 and eight). Despite not being successful in collecting many specimens, the active search obtained a total of 49 individuals, represented by 14 species.

Discussion

Agelaia is a relatively abundant genus in surveys, possibly making *Agelaia pallipes* the most abundant species. *Agelaia* usually forms large colonies with millions of individuals (Zucchi et al., 1995). Consequently, it is more likely to be captured, probably also due to the habits of its generalist and

opportunistic behavior concerning food and resource choices (Somavilla et al., 2014). In contrast, *Apoica* species have a nocturnal foraging behavior (Pickett & Wenzel, 2007), therefore, since more than one light trap method was used, a larger number of specimens were collected. In turn, most species were represented by very few specimens collected.

Despite the effort to identify all social wasps, a few specimens, subjected to a thorough characterization and examination by a specialist, could not be determined with certainty, probably representing new species (*Mischocyttarus* sp.1 and *Mischocyttarus* sp.2). Other examined specimens belonging to the same genus were not identified at the species level, however, they were allocated to the respective subgenera or species groups.

The lack of local studies on social wasps – this is the first comprehensive survey – provides very little information to attribute the wasp species collected in Tocantins with the “endemic” or “threatened” conditions. However, most of the species have been registered for the first time in the state, therefore, their status should be regarded as insufficient information in terms of geographic distribution. They could also be assigned with the condition of rarity, therefore deserving special attention and further investigations.

Among the six states bordering Tocantins, only Piauí has a lower species richness than the one presented herein, with 21 species (Santos et al., 2020). However, as seen in Tocantins, until recently Piauí has not been the target of taxonomic studies involving social wasps. In contrast, Pará has one of the highest number of species of social wasps, with 190 species recorded (Somavilla et al., 2021a), followed by Mato Grosso with 137 species (Somavilla et al., 2021a). Both states have undergone comprehensive systematic studies over recent decades (Richards, 1978, Silveira, 2002; Silva & Silveira, 2009). The richness of the other border states is relatively close to that of Tocantins – Bahia, with 86 species (Santos et al., 2020), Maranhão, with 77 (Silva et al., 2011; Santos et al., 2020), and Goiás, with 74 (Somavilla et al., 2021a). The states of Maranhão and Mato Grosso have the closest phytophysionomies to that found in Tocantins, presenting fragments of Cerrado and Amazon within their territories and well-defined transition areas. Therefore, it was expected that the number of species was closer. Nonetheless, both states have been the object of studies involving the collection of social wasps, resulting in greater sampling efforts (Barbosa et al., 2016).

Different methods are used in the sampling of social wasps; however, few studies have attempted to propose standardization of these methods or to establish comparable and adequate protocols to survey the fauna of a given site. It is important to use different methods and traps when sampling social wasp richness in an area, since different species generally have varied foraging behaviors (Silveira, 2002; Somavilla et al., 2014). Active search with entomological nets is one of the best ways to collect polistines, but previous

collections have not focused on these taxa (Silveira, 2002; Somavilla et al., 2014). However, it was important to use indirect methods like interception and light traps for collecting certain wasp groups; for example, most species of different genera are always collected using a *Malaise* trap (Somavilla et al., 2014), and the light trap is used for nocturnal foraging wasps (*Apoica*) (Pickett & Wenzel, 2007).

This study introduces 50 new occurrences of social wasp species in the state of Tocantins. Our findings increase the number of species recorded in the state to 57, however, some taxa deserve special attention since they could not be determined at a specific level. Such an increase is significant, but it can be even greater by enhancing the sampling effort and carrying out further field expeditions in areas without surveys in the state. Therefore, further comprehensive studies should be conducted to enlarge the knowledge of wasp species in Tocantins. Our results also highlight the importance of continuing taxonomic studies on these insects to expand our knowledge on their distribution and determine priority areas for environmental preservation, especially in transitional environments between the Amazon and Cerrado biomes.

Authors' Contribution

LBF: Conceptualization, methodology, identification, formal analysis, writing.

AS: Conceptualization, identification, formal analysis, writing.

TKK: Supervision, conceptualization, methodology, formal analysis, writing.

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References

- Alvares, C.A., Stape, J.L., Sentelhas, P.C., Gonçalves, J.L.M. & Sparovek, G. (2014). Köppen's climate classification map for Brazil. *Meteorologische Zeitschrift*, 22: 711-728.
- Alvim, B.G.C., Machado, R.J.P. & Krolow, T.K. (2019). Mantidflies (Neuroptera, Mantispidae) from Tocantins state (Brazil): distribution and identification key. *Check List*, 15: 275-285.
- Andena, S.R., Carpenter, J.M. & Noll, F.B. (2009a). A phylogenetic analysis of *Synoeca* de Saussure, 1852, a neotropical genus of social wasps (Hymenoptera: Vespidae: Epiponini). *Entomologica Americana*, 115: 81-89.

- Andena, S.R., Carpenter, J.M. & Pickett, K.M. (2009b). Phylogenetic analysis of species of the neotropical social wasp *Epipona* Latreille, 1802 (Hymenoptera, Vespidae, Polistinae, Epiponini). *Zookeys*, 20: 385-398.
- Andena, S.R. & Carpenter, J.M. (2012). A phylogenetic analysis of the social wasps genus *Brachygastra* Perty, 1833, and description of a new species (Hymenoptera: Vespidae: Epiponini). *American Museum Novitates*, 3753: 1-38.
- Andrade, I.C.P., Fernandes, A.S. & Krolow, T.K. (2020a). The Megaloptera (Insecta) of Tocantins State, Brazil. *Zootaxa*, 4816: 144-148.
- Andrade, I.C.P., Krolow, T.K., Boldrini, R. & Pelicice, F.M. (2020b). Diversity of EPT (Ephemeroptera, Plecoptera, Trichoptera) Along Streams Fragmented by Waterfalls in the Brazilian Savanna. *Neotropical Entomology*, 49: 203-212.
- Andrade, N.G, Barros, S.S.O, Bragança, M.A.L., De Oliveira, F.F. & De Oliveira Júnior, W.P. (2021). The wild bees fauna in the Cangaçu Rppn – Pium – To (Hymenoptera, Anthophila): preliminary data i. *Brazilian Journal of Development*, 7: 73911-73924.
- Barroso P.C.S., Menezes R.S.T., Oliveira M.L., Somavilla A. (2022) A systematic review of the Neotropical social wasp genus *Angiopolybia* Araujo, 1946 (Hymenoptera: Vespidae): species delimitation, morphological diagnosis, and geographical distribution. *Arthropod Systematics and Phylogeny*, 80: 75-97. doi: 10.3897/asp.80.e71492
- Boldrini, R. & Krolow, T.K. (2017). New records of Ephemeroptera (Insecta) from Tocantins state, northern Brazil. *Check List*, 13: 2067.
- Cooper, M. (2000). Five new species of *Agelaia* Lepeletier (Hym., Vespidae, Polistinae) with a key to members of the genus, new synonymy and notes. *Entomologist's Monthly Magazine*, 136: 177-197.
- Da Silva, P.C., Capellari, R.S. & Oliveira, S.S. (2022). Three new species of the *Neurigona orbicularis* species group from Brazil (Diptera: Dolichopodidae). *Zootaxa*, 5093: 547-558. doi: 10.11646/zootaxa.5093.5.4
- Fernandes, A.S., Polizei, T.T.S. & Boldrini, R. (2020). Notes on *Stenhelmoides* and description of the true male genitalia of *S. strictifrons* Grouvelle, 1908 (Coleoptera: Elmidae). *Acta Amazonica*, 50: 317-326.
- Figueiro, R., Maia-Herzog, M., Gil-Azevedo, L.H., & Monteiro, R.F. (2014). Seasonal variation in black fly (Diptera: Simuliidae) taxocenoses from the Brazilian Savannah (Tocantins, Brazil). *Journal of Vector Ecology*, 39: 321-327. doi: 10.1111/jvec.12107
- Figueiro, R., Gil-Azevedo, L.H., Maia-Herzog, M. & Monteiro, R.F. (2012) Diversity and microdistribution of black fly (Diptera: Simuliidae) assemblages in the tropical savanna streams of the Brazilian cerrado. *Memórias do Instituto Oswaldo Cruz*, 107: 362-369. doi: 10.1590/S0074-02762012000300011
- Hermes, M.G., Somavilla, A. & Andena, S.R. (2022). Vespidae. <http://fauna.jbrj.gov.br/fauna/faunadobrasil/4019>. (Access date: May 10, 2022).
- IBGE (2004). Mapas de biomas e de vegetação. <http://www.ibge.gov.br/>. (Access date: May 10, 2022).
- Junior, J.N.A.S., Silveira, O.T. & Carpenter, J.M. (2018). Taxonomic revision of the *Protopolybia sedula* species-group (Hymenoptera, Vespidae, Polistinae), with a new identification key to species. *Zootaxa*, 4403: 87-98.
- Junior, J.N.A.S., Silveira, O.T. & Carpenter, J.M. (2020a). Taxonomic revision of the *Protopolybia picteti-emortualis* species-group (Richards, 1978), with descriptions of two new species (Hymenoptera: Vespidae, Polistinae). *Zootaxa*, 4729: 228-248.
- Junior, J.N.A.S., Silveira, O.T. & Carpenter, J.M. (2020b). Taxonomic revision of the *P. chartergoides* species-group of the genus *Protopolybia* Ducke, 1905 (Hymenoptera: Vespidae, Polistinae). *Zootaxa*, 4858: 542-554.
- Krolow, T.K. & Valadares, A.C.B. (2016). First record of order Embioptera (Insecta) for the State of Tocantins, Brazil, with description of a new species of *Clothoda* Enderlein. *Zootaxa*, 4193: 184-188.
- Krolow, T.K. & Vieira, R. (2016). New Records of Distribution for *Protomydas coeruleus* (Olivier) (Diptera: Mydidae). *EntomoBrasilis*, 9: 143-145.
- Lienhard, C., Do Carmo, T.O. & Ferreira, R.L. (2010). A new genus of Sensitibillini from Brazilian caves (Psocodea: 'Psocoptera': Prionoglarididae). *Revue Suisse De Zoologie*, 117: 611-635. doi: 10.5962/bhl.part.117600
- Lima, H.I.L., Krolow, T.K. & Henriques, A.L. (2018). A New Species of *Dichelacera* (*Dichelacera*) Macquart (Diptera, Tabanidae) from the Brazilian Savannah. *Neotropical Entomology*, 47: 380-384.
- Lima, H.I.; Krolow, T.K. & Henriques, A.L. (2015). Checklist of horse flies (Diptera: Tabanidae) from Taquaruçu, Tocantins, Brazil, with new records for the state. *Check List*, 11: 1596-1598.
- Machado, R.J.P. & Krolow, T.K. (2016). A new species of *Spiroberotha* Adams 1989 (Neuroptera: Bethidae) and first record of the genus in Brazil. *Zootaxa*, 4093: 127-134.
- Melo, G.A.R., Aguiar, A.P. & Garcete-Barrett, B.R. (2012). Hymenoptera. In J.A. Rafael, G.A.R. Melo, C.J.B. de Carvalho, S.A. Casari & R. Constantino (Eds.), *Insetos do Brasil* (pp. 554-612). *Ribeirão Preto, Holos Editora*.
- Miranda, E.E. & Bognola, I.A. (1999). Zoneamento Agroecológico do Estado do Tocantins. <http://www.zaeto.cnpm.embrapa.br/index.html>. (Access date: August 10, 2022).

- Orlando, T.Y.S., Krolow, T.K. & Boldrini, R. (2019). A new species of *Simothraulopsis* Demoulin, 1966 (Ephemeroptera: Leptophlebiidae) from Tocantins state, Brazil. *Zootaxa*, 4674: 363-368.
- Orlando, T.Y., Salles, F.F., Boldrini, R. & Krolow, T.K. (2021). Updated records for Leptophlebiidae (Ephemeroptera) and a new species of *Thraulodes* Ulmer, 1920 from Tocantins State, Northern Brazil. *Zootaxa*, 5076: 39-55.
- Pickett, K.M. & Wenzel, J.W. (2007). Revision and Cladistic Analysis of the Nocturnal Social Wasp Genus, *Apoica* Lepeletier (Hymenoptera: Vespidae; Polistinae, Epiponini). *American Museum Novitates*, 3562: 1-30.
- Polizei, T.S. & Fernandes, A.S. (2020). The Neotropical genus *Portelmis* Sanderson, 1953 (Coleoptera: Elmidae): three new species, new records and updated key. *Zootaxa*, 4810: 452-467.
- Polizei, T.S., Fernandes, A.S. & Hamada, N. (2022). "Out of the Shield": the Discovery of *Platyparnus* Shepard and Barr, 2018 (Coleoptera: Dryopidae) in Brazil with New Species. *Neotropical Entomology*, 51: 256-269. doi: 10.1007/s13744-022-00943-0
- Richards, O.W. (1978). The social wasps of the Americas excluding the Vespinae. London, British Museum (Natural History), 580p.
- Rippel, M.L.S., Novaes, M.C. & Krolow, T.K. (2019a). First records of the genus *Anacroneuria* (Plecoptera: Perlidae) from Tocantins State, Brazil and description of a new species. *Zootaxa*, 4560: 355-364.
- Rippel, M.L.S., Novaes, M.C. & Krolow, T.K. (2019b). First records of *Kempnyia* and *Macrogynoplax* (Plecoptera: Perlidae) from Tocantins State, Brazil with description of the immatures and the adult female. *Zootaxa*, 4700: 471-478.
- Salvatierra, L. (2020). New species of *Pararhagadochir* Davis, 1940 (Insecta: Embioptera: Scelembiidae) from Brazil. *Zootaxa*, 4816: 383-388. doi: 10.11646/zootaxa.4816.3.9
- Silva, S.S. & Silveira, O.T. (2009). Vespas sociais (Hymenoptera, Vespidae, Polistinae) de floresta pluvial Amazônica de terra firme em Caxiuanã, Melgaço, Pará. *Iheringia*, 99: 317-323.
- Silveira, O.T. (2002). Surveying Neotropical Social Wasps. An Evaluation of Methods in the "Ferreira Penna" Research Station (ECFPn), in Caxiuanã, PA, Brazil (Hymenoptera, Vespidae, Polistinae). *Papéis Avulsos de Zoologia*, 42: 299-323.
- Silveira, O.T. (2008). Phylogeny of wasps of the genus *Mischocyttarus* de Saussure (Hymenoptera, Vespidae, Polistinae). *Revista Brasileira de Entomologia*, 52: 510-549.
- Santos, L.V.B., Monteiro, D.P., Somavilla, A., Neto, J.R.A. & Silva, P.R.R. (2020). Social Wasps (Hymenoptera: Vespidae: Polistinae) from Northeastern Brazil: State of the Art. *Sociobiology*, 67: 481-491. doi: 10.13102/sociobiology.v67i4.5466
- Somavilla, A., Oliveira, M.L. & Silveira, O.T. (2014). Diversity and aspects of the ecology of social wasps (Vespidae, Polistinae) in Central Amazonian 'terra firme' forest. *Revista Brasileira de Entomologia*, 58: 349-355. doi: 10.1590/s0085-56262014005000007
- Somavilla, A., Barbosa, B.C., Souza, M.M. & Prezoto, F. (2021a). List of species of social wasps from Brazil. In Prezoto, F. Prezoto, F.S. Nascimento, B.C. Barbosa & A. Somavilla (Eds.), *Neotropical Social Wasps*, (pp. 293-316). Switzerland: Springer Nature Switzerland AG. doi: 10.1007/978-3-030-53510-0_16
- Somavilla, A. & Carpenter, J.M. (2021b). Key to the Genera of Social Wasps (Polistinae) Occurring in Neotropics. In Prezoto, F. Prezoto, F.S. Nascimento, B.C. Barbosa & A. Somavilla (Eds.), *Neotropical Social Wasps*, (pp. 327-336). Switzerland: Springer Nature Switzerland AG. doi: 10.1007/978-3-030-53510-0_18
- Somavilla, A., Santos, B.F., Andena, S.R., Carpenter, J.M. & Oliveira, M.L. (2021c). Total-Evidence Phylogeny of the New World *Polistes* Lepeletier, 1836, Paper Wasps (Vespidae, Polistinae, Polistini). *American Museum Novitates*, 3973: 1-42. doi: 10.1206/3973.1
- Somavilla, A., Barroso, P.C.S., Aragão, M., Mateus, S. & Menezes, R.S.T. (2021d). An integrative taxonomic and phylogenetic approach reveals a new Neotropical swarm-founding social wasp, *Pseudopolybia cryptica* sp. n. (Vespidae: Polistinae: Epiponini). *Arthropod Systematics and Phylogeny*, 79: 25-35. doi: 10.3897/asp.79.e64304
- Souza, M.M., Pires, E.P., Coelho, A.L., Clemente, M.A. & Bonfitto, P.P. (2020). Ampliação da distribuição de espécies de vespas sociais neotropicais no Brasil (Hymenoptera: Vespidae: Polistinae). *Nature and Conservation*, 13: 1-6.
- Zucchi, R., Sakagami, S.F., Noll, F.B., Mechi, M.R., Mateus, S., Baio, M.V. & Shima, S.N. (1995). *Agelata vicina*, a Swarm-Founding Polistine with the Largest Colony Size among Wasps and Bees (Hymenoptera: Vespidae). *Journal of the New York Entomological Society*, 103: 129-137.

