



Social Wasps (Hymenoptera: Vespidae) in the Atlantic Forest of the State of Paraná, Southern Brazil

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ABSTRACT – Social wasps are insects that provide different ecosystem services, which justifies the dedicated effort to better understand the distribution and occurrence of these insects in Brazil, intensified from the beginning of the 21st century, however, there are still under-sampled areas in some states, such as Paraná, without information for one of the largest conservation units for the protection of the Atlantic Forest in the interior of Brazil, the Iguaçu National Park. Considering that conservation units are the main tool for the conservation of biota in Brazil and that the Atlantic Forest biome is a *hotspot* of biodiversity, the objective of this study was to list the social wasp species occurring in the Atlantic Forest at the Iguaçu National Park, West of the state of Paraná, as well as to expand the information on the richness of these insects in the state. The study was conducted from September 2021 to May 2022, in the municipalities of Capanema, Céu Azul and Foz do Iguaçu, totaling 198 hours of sampling in 33 days. Twenty-nine species were recorded at PARNA Iguaçu, with six new records for the state of Paraná, Brazil. Therefore, this National Park is home to an important fauna of social wasps in the state of Paraná, which reaffirms the importance of this conservation unit as an instrument for protecting the Brazilian biota.

Keywords: Inventory; Polistinae; Semideciduous Seasonal Forest; social insects.

Vespas Sociais (Hymenoptera: Vespidae) na Mata Atlântica do Paraná, Sul do Brasil

RESUMO – As vespas sociais são insetos que desempenham diferentes serviços ecossistêmicos, o que justifica o esforço empenhado para conhecer melhor a distribuição e ocorrência desses insetos no Brasil, intensificando-se a partir do início do século XXI. Contudo, ainda existem áreas subamostradas em alguns estados como o Paraná, sem informações para uma das maiores unidades de conservação para proteção da Mata Atlântica de interior no Brasil, o Parque Nacional do Iguaçu. Considerando que as unidades de conservação constituem a principal ferramenta para a conservação da biota no Brasil, e que o bioma Mata Atlântica é um *hotspot* da biodiversidade, o objetivo deste trabalho foi listar as espécies de vespas sociais que ocorrem na Floresta Atlântica no Parque Nacional do Iguaçu, oeste do estado do Paraná, bem como ampliar as informações sobre a riqueza desses insetos no estado. O estudo foi conduzido no período de setembro de 2021 a maio de 2022, nos municípios de Capanema, Céu Azul e em Foz do Iguaçu, totalizando 198 horas em 33 dias. Foram registradas 29 espécies no PARNA Iguaçu, com seis novos registros para o estado do Paraná, Brasil. Logo, essa unidade de conservação abriga importante fauna de vespas sociais do estado do Paraná, o que reafirma a relevância dessa unidade de conservação como instrumento de proteção da biota brasileira.

Palavras-chave: Inventário; Polistinae; Floresta Estacional Semidecidual; insetos sociais.



Avispas sociales (Hymenoptera: Vespidae) en la Mata Atlántica de Paraná, Sur de Brasil

RESUMEN – Las avispas sociales son insectos que realizan diferentes servicios ecosistémicos, lo que justifica el esfuerzo dedicado a comprender mejor la distribución y ocurrencia de estos insectos en Brasil, que se intensificó desde principios del siglo XXI, sin embargo, todavía hay áreas submuestreadas en algunos estados, como Paraná, sin información para una de las mayores unidades de conservación para la protección de la Mata Atlántica interior de Brasil, el Parque Nacional Iguazú. Considerando que las unidades de conservación son la principal herramienta para la conservación de la biota en Brasil y que el bioma de la Mata Atlántica es un *hotspot* de biodiversidad, el objetivo de este trabajo fue catalogar las especies de avispas sociales que se dan en la Mata Atlántica en Iguazú Parque Nacional oeste del estado de Paraná, así como ampliar la información sobre la riqueza de estos insectos en el estado. El estudio se realizó de septiembre de 2021 a mayo de 2022, en los municipios de Capanema, Céu Azul y Foz do Iguaçu, totalizando 198 horas de muestreo en 33 días. Veintinueve especies fueron registradas en PARNA Iguazu, con seis nuevos registros del estado de Paraná, Brasil. Por lo tanto, este Parque Nacional alberga una importante fauna de avispas sociales en el estado de Paraná, lo que reafirma la importancia de esta unidad de conservación como instrumento para la protección de la biota brasileña.

Palabras clave: Inventario; Polistinae; Bosque Estacional Semideciduous; insectos sociales.

Introduction

In Brazil, social wasps are insects popularly known as Cabas or Marimbondos, present in different cultural manifestations in this country (Noronha et al., 2021), which is home to the greatest species richness on the planet, with about 381 species (Somavilla et al., 2021).

These vespids perform different ecosystem services (Brock, 2021) such as biological control in crops (Prezoto et al., 2019; Medeiros et al., 2019), pollination (Hermes & Köhler, 2006; Bergamo et al., 2021) and heavy metal bioindicators (Urbini et al., 2006), in addition to models for understanding the effect of forest fragmentation (Graça & Somavilla, 2018; Coelho et al., 2022).

Due to this relevance, there has been a considerable effort since the beginning of the 21st century to better understand the distribution and occurrence of these insects in Brazil (Barbosa et al., 2017), in different biomes such as the Caatinga (Santos et al., 2007; Somavilla et al., 2017), Cerrado (Souza et al., 2020a; Simplício et al., 2022), Amazon (Silva & Silveira, 2009;

Somavilla et al., 2020), Pantanal (Almeida et al., 2014), Pampa (Luz et al., 2014; Somavilla & Köhler, 2017) and Atlantic Forest (Souza et al., 2020b). However, despite these studies, there are still under-sampled areas in some states, such as Paraná, which relies on only two studies with information on the occurrence and distribution of populations of social wasps (Richards, 1978; Silva et al., 2021), therefore, without information for one of the largest conservation units for the protection of the Atlantic Forest in the interior of Brazil, the Iguazu National Park (ICMBio, 2018a).

As conservation units are the main tool for the conservation of biota in Brazil (Salvio, 2017), including social wasps (Oliveira et al., 2021), there is a need to know and ensure the preservation of biodiversity (Fonseca & Venticinque, 2018), against the reduction of natural forests, such as the Atlantic Forest.

This biome is a hotspot, due to its high biodiversity and endemism, housing around 593 species of the Brazilian fauna threatened with extinction, of which 141 species are endemic to the biome, in addition to the drastic reduction of



its original area promoted by different anthropic pressures (Myers et al., 2000; Mittermeier et al., 2011; Ribeiro et al., 2011; ICMBio, 2018b), such as the replacement of native flora with agrosystems (Pinto et al., 2022), and also by large urban centers in the country (Scarano & Ceotto, 2015), leaving only about 7% of its vegetation cover (WWF BRASIL, 2022). Given the history and negative impacts caused by the incorrect use of natural resources, it was necessary to create the Federal Law of the Atlantic Forest (Law 11428), to preserve these remaining ecosystems (BRASIL, 2006).

Thus, the objective of this study was to list the species of social wasps occurring in the Atlantic Forest at the Iguaçu National Park, West of the state of Paraná, Brazil, as well as to expand information on the richness of these insects in the state.

Material and Methods

The study was conducted at the Iguaçu National Park (PARNA Iguaçu) (25°37'32.2" S 54°27'28.7" W) between September 2021 and May 2022, with 198 sampling hours carried out over 33 days. PARNA Iguaçu is about 185.162 hectares, with a predominance of the Semideciduous

Seasonal Forest, protected since 1939 (ICMBio, 2018a), at different stages of regeneration, with a predominance of intermediate and climax areas, forming a mosaic of environments (Souza et al., 2019), resulting in one of the most important conservation areas of the Atlantic Forest in Brazil (MMA, 2000). The climate is Cfa (Köppen), humid subtropical climate, with an average temperature of 21.6 °C, and average annual rainfall of 1,728 mm (Alvares et al., 2013).

Samplings were carried out on pre-existing trails in the forest, which in turn give access to some aquatic environments, such as the rivers Floriano (25°32'02.5" S 53°48'41.5" W) and Silva Jardim (25°33'32.9" S 53°54'23.2" W) in the municipalities of Capanema and Matelândia, which also had their banks investigated; in Céu Azul, inside the forest along the Manoel Gomes Waterfall Trail (25°09'12.6" S; 53°50'41.6" W), and also through the riparian forest of this river; and in Foz do Iguaçu, along the Poço Preto Trail (25°37'29.3" S; 54°27'15.5" W), along the access trail and to the banks of the São João River (25°37'00.7" S, 54°28'12.2" W) and the Macuco Trail (25°38'50.4" S, 54°27'21.0" W), as well as environments close to the Iguaçu River (Figure 1).



Figure 1 – Areas sampled for collection of social wasps in the municipalities of Foz do Iguacu (a-b), Capanema, and Matelândia (c-d), at the Iguacu National Park, state of Paraná, Brazil. Source: Collection of the authors.

For the record of social wasp colonies and collection of specimens, the active search methodology was used (Souza & Prezoto, 2006) with the aid of entomological nets to capture specimens in flight, at rest on vegetation, and/or in colonies. Subsequently, they were sacrificed and stored in 70 % alcohol. All material was sent to the Zoology Laboratory of the Federal Institute of Education, Science and Technology of Southern Minas Gerais (IFSULDEMINAS), *campus* Inconfidentes, where the specimens were dry mounted with entomological pins for identification at a species level using taxonomic keys (Richards, 1978; Carpenter & Marques, 2001). Some specimens were sent to Ph.D. Orlando Tobias Silveira, Museum Paraense Emílio Goeldi, state

of Pará, Brazil, for confirmation, and they were later incorporated into the Biological Collection of Social Wasps (CBVS) do IFSULDEMINAS.

To assess the sampling effort, an accumulation curve was constructed using the observed richness with a 95% confidence interval, under the Bootstrap 1 estimator in the EstimateS 9.1.0 Software (Colwell & Elsensohn, 2014). The study was authorized by Sisbio license number: 76084-3.

Results and Discussion

Twenty-nine species were recorded at PARNA Iguacu, with six new records for the state of Paraná, Brazil (Table 1 and Figure 2).



Table 1 – Social wasp species collected at the Iguaçu National Park, state of Paraná, Brazil, with new records for the state (*). Source: Prepared by the authors.

Tribe	Species
Epiponini	<i>Agelaia angulata</i> (Fabricius, 1804)
	<i>Agelaia multipicta</i> (Haliday, 1836)
	<i>Agelaia pallipes</i> (Olivier, 1791)
	<i>Agelaia vicina</i> (de Saussure, 1854)
	<i>Apoica flavissima</i> Van der Vecht, 1972*
	<i>Brachygastra augusti</i> (de Saussure, 1854)
	<i>Brachygastra lecheguana</i> (Latreille, 1824)
	<i>Metapolybia docilis</i> Richards, 1978*
	<i>Polybia fastidiosuscula</i> de Saussure, 1854
	<i>Polybia ignobilis</i> (Haliday, 1836)
	<i>Polybia minarun</i> Ducke, 1906
	<i>Polybia occidentalis</i> (Olivier, 1791)
	<i>Polybia paulista</i> H. von Ihering, 1896
	<i>Synoeca cyanea</i> (Fabricius, 1775)
Mischocyttarini	<i>Mischocyttarus bertonii</i> Ducke, 1918
	<i>Mischocyttarus cassununga</i> (R. von Ihering, 1903)
	<i>Mischocyttarus collaris</i> (Ducke, 1904)*
	<i>Mischocyttarus funerulus</i> Zikán, 1935*
	<i>Mischocyttarus frontalis</i> (Fox, 1898)
	<i>Mischocyttarus paraguayensis</i> Zikán, 1935
	<i>Mischocyttarus rotundicollis</i> (Cameron, 1912)
	<i>Mischocyttarus socialis</i> de Saussure, 1854
	<i>Mischocyttarus tricolor</i> Richards, 1945*
Polistini	<i>Polistes actaeon</i> Haliday, 1836
	<i>Polistes cavapyta</i> Saussure, 1853*
	<i>Polistes cinerascens</i> de Saussure, 1854
	<i>Polistes lanio</i> (Fabricius, 1775)
	<i>Polistes simillimus</i> Zikán, 1951
	<i>Polistes versicolor</i> (Olivier, 1791)

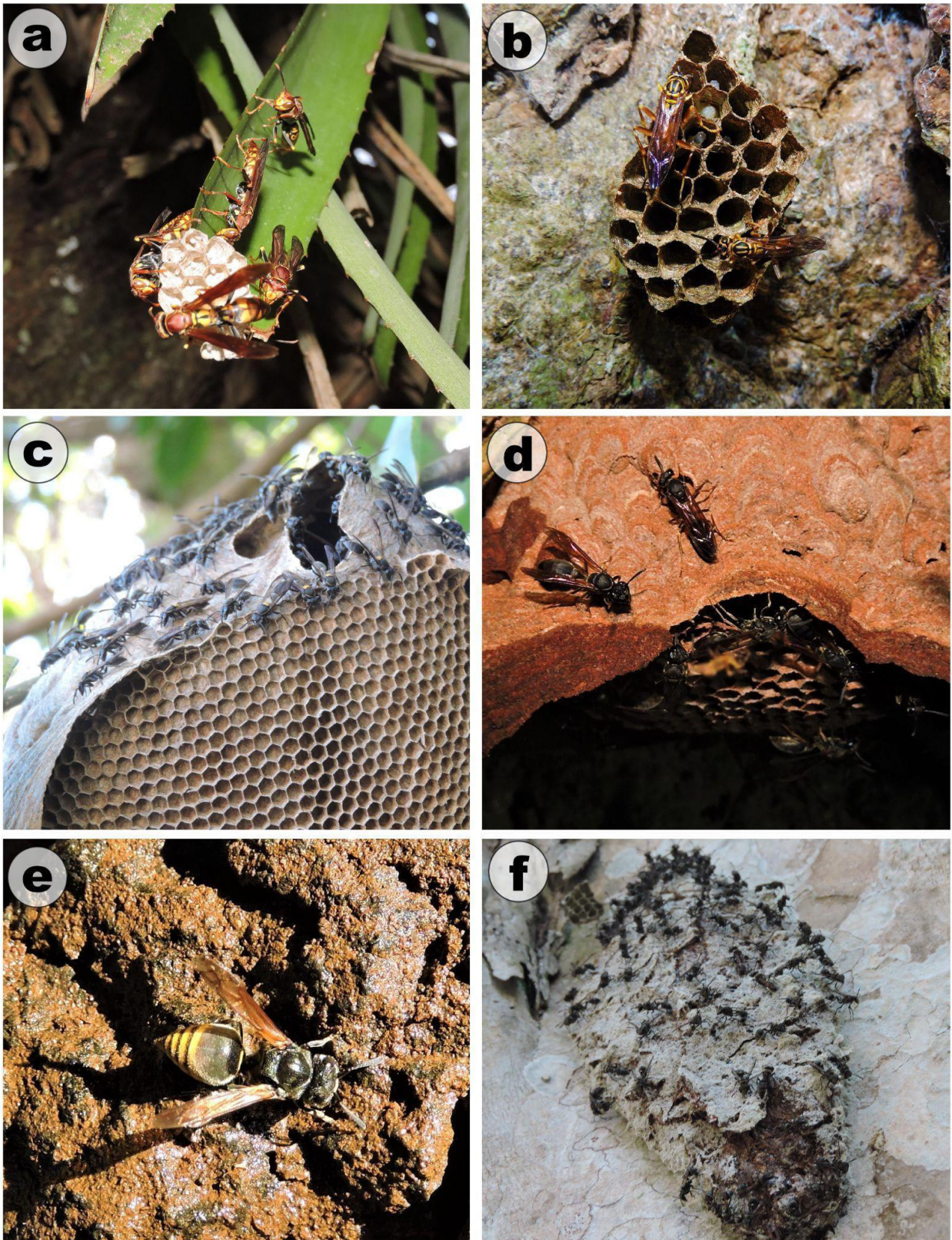


Figure 2 – Social wasp species recorded in the Iguaçú National Park, state of Paraná, Southern Brazil: *Polistes simillimus* (a); *Mischocyttarus tricolor* (b); *Polybia paulista* (c); *Polybia minarun* (d); *Brachygastra lecheguana* (e); *Metapolybia docilis* (f). **Source:** Collection of the authors.

The richness is considerably higher than in other locations in the Atlantic Forest biome, such as the Ilha Grande National Park, also in the state of Paraná, with 14 species (Silva et al., 2021). In this study, the authors performed 60 sampling hours, which corresponds to about 30% of the 198 hours of the present study; nine species in common were observed: *Polistes simillimus* Zikán, 1951; *Polistes versicolor* (Olivier, 1791) *Brachygastra augusti* (de Saussure, 1854); *Brachygastra lecheguana* (Latreille, 1824); *Polybia occidentalis* (Olivier, 1791); *Polybia paulista* H. von Ihering, 1896; *Mischocyttarus cassununga* (R. von Ihering, 1903); *Mischocyttarus rotundicollis* (Cameron, 1912), and *Mischocyttarus frontalis* (Fox, 1898).

The latter species may not be frequent in environments under strong human pressure, since, until the present study, its occurrence in the Atlantic Forest has been documented in environments protected by conservation units (Souza et al.,

2012; Souza et al., 2020b; Silva et al., 2021). The other species in common are commonly reported in inventories in Brazil, therefore, they have a wide distribution in the country (Somavilla et al., 2021) including records in anthropized areas (Silva et al., 2019; Jacques & Araújo, 2020; Milani et al., 2020; Barbosa et al., 2022; Gouvêa et al., 2023), consequently, they can be considered generalist species in terms of habitat occupation, nesting, and feeding habits.

According to the species estimator (Bootstrap) (Figure 3), the richness of the Iguaçu National Park can reach 32 species, indicating that the sampling was efficient. However new studies are required in this conservation unit, given its vast geographical area, in addition to the possibility of combining active and passive collection methods, such as malaise and attractive traps, since the simultaneous use of sampling methods can optimize results (Silva & Silveira, 2009; Souza et al., 2011; Clemente et al., 2021).

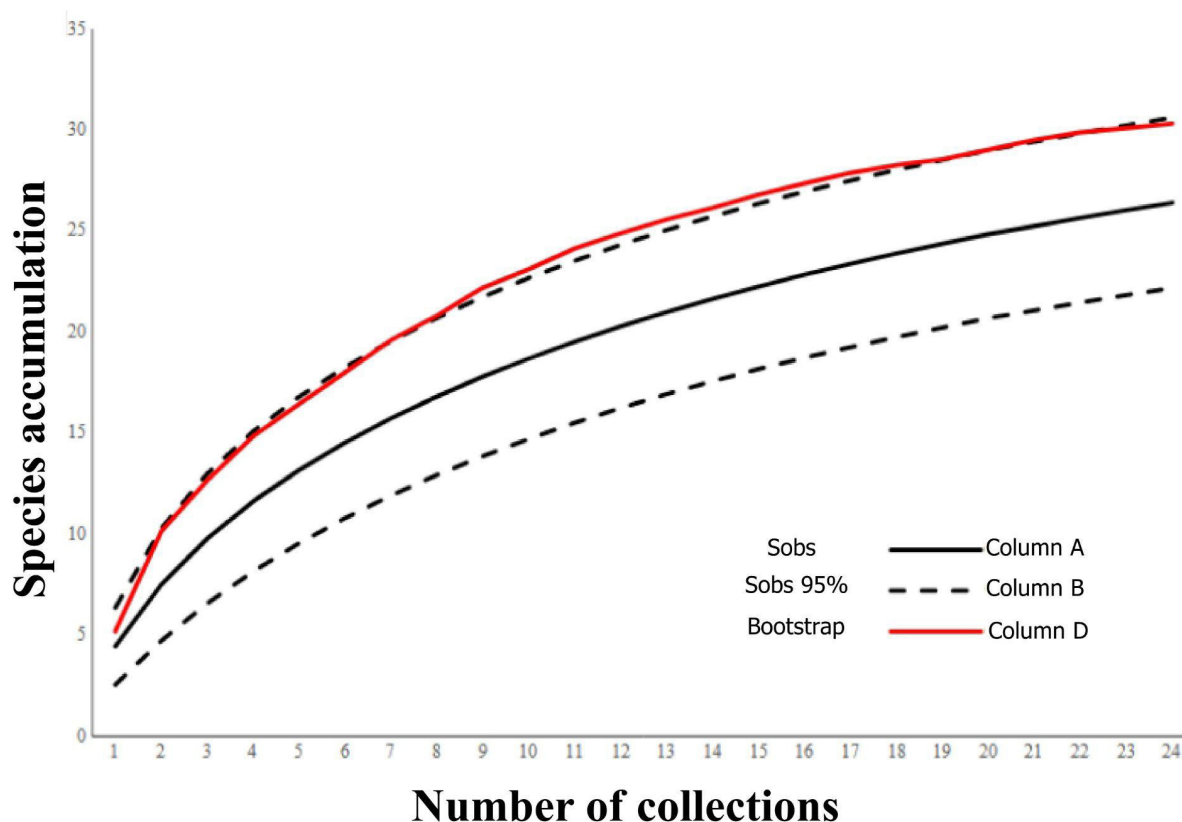


Figure 3 – Accumulation curve of social wasp species captured at the Iguaçu National Park, Brazil, using observed species richness (Sobs) within a 95% confidence interval and estimated species richness (Bootstrap). Source: Prepared by Ph.D. Jacques, G.C.

The richness is also similar to other studies, although they used different methodologies and sampling efforts, such as conservation units in Minas Gerais (Souza et al., 2010); São Paulo (Togni et al., 2014) and the same number from a study carried out in the south of the state of Bahia (Aragão & Andena, 2016). However, the result is greater than found at the Itatiaia National Park (20 spp.) and the Serra do Papagaio State Park (28 spp.) located on the border of the states of Rio de Janeiro and Minas Gerais (Souza et al., 2015, 2018; Ribeiro et al., 2019).

This richness may be a reflection of the mosaic of environments, at different stages of

ecological succession, observed in the study area (Souza et al., 2019), which may favor synanthropic species and those more frequent in environments under lower human pressure and less fragmented areas (Souza et al., 2010; Oliveira et al., 2017; Clemente et al., 2021; Coelho et al., 2022).

The new records for the state include species with a wide distribution in the country, occurring in different biomes, such as *Apoica flavissima* and *Metapolybia docilis* (Richards, 1978; Souza et al., 2020a, b; Somavilla et al., 2021), but also include species with more restricted distribution (Figure 4), not frequent in surveys (Souza et al., 2020a, b).

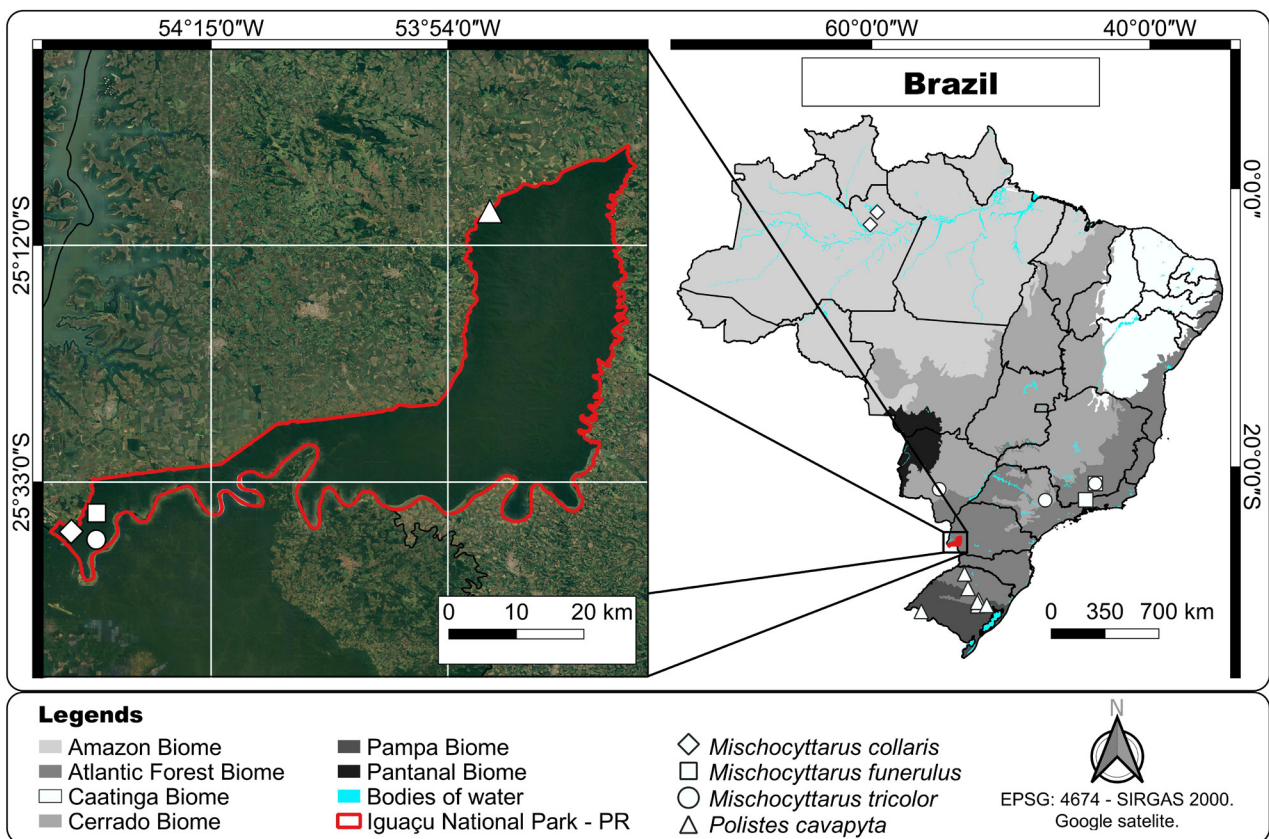


Figure 4 – Distribution of social wasps *Mischocyttarus collaris*, *M. funerulus*, *M. tricolor*, and *Polistes cavapyta* at the Iguazu National Park, Paraná, Brazil. Source: Prepared by the authors.

Apoica flavissima is registered in 16 states of Brazil (Somavilla et al., 2021) with occurrence in the Amazon (Elisei et al., 2013; Gomes et al., 2016; Barroso et al., 2017); Cerrado (Mateus & Noll, 2004; Souza et al., 2020a); Caatinga (Trindade et al., 2012) and Atlantic Forest (Yamane et al.,

2009; Souza et al., 2020b) biomes. However, there are no reports of this species in the Pantanal and Pampa biomes. Yamane et al. (2009) observed that the temperature of active nests of this species is constant throughout the day (27°C), which may help to explain its wide distribution in the country, especially in warmer regions.



Metapolybia docilis occurs in the states of Minas Gerais and Mato Grosso (Souza et al., 2020b), but without precise information on the locations and biomes. It is also found in the Caatinga, in the state of Ceará (Santos et al., 2020), in the Atlantic Forest in Rio de Janeiro (Richards, 1978), from this biome in transition to the Cerrado in the state São Paulo (Junior & Noll, 2011), and in the Amazon, in the state of Amazonas (Somavilla et al., 2020).

Mischocyttarus funerulus occurs in the Atlantic Forest in the state of Rio de Janeiro (Souza et al., 2020b) and, in transition to the Cerrado in Minas Gerais (Souza & Prezoto, 2006). This species probably has a habitat restricted to the Atlantic Forest biome, as suggested by Souza et al. (2020b).

Mischocyttarus collaris was recorded in the Amazon Forest, in the state of Amazonas (Somavilla et al., 2020), suggesting that this species may be restricted to forest environments, as occurs with other *Mischocyttarus* restricted to the Atlantic Forest (Souza et al., 2020b).

In turn, *Mischocyttarus tricolor* is recorded in the state of Goiás (no info on location or biome), Mato Grosso do Sul, municipality of Maracaju (Richards, 1978), in Minas Gerais and São Paulo, all in the transition between the Atlantic Forest and Cerrado (Souza & Prezoto, 2006; Simões et al., 2012; IBGE, 2019; Clemente et al., 2021).

Polistes cavapyta occurs in the Atlantic Forest and Pampas biomes, in the state of Rio Grande do Sul (Somavilla et al., 2010; Somavilla & Köhler, 2017), and in the Amazon Forest, Amazonas, but without precise location information (Richards, 1978), which suggests that this species may have a wider distribution, but because they supposedly have small populations possibly explains their absence in other surveys carried out in the country.

Conclusion

The Iguaçu National Park is home to an important fauna of social wasps in the state of Paraná, including six new occurrence records for the state, including four rare ones in the country, which reaffirms the importance of this conservation unit as an instrument for the protection of the Brazilian biota.

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