



Community of social wasps (Hymenoptera, Vespidae) in Atlantic Forest remnants in the Western of the state of Paraná, Southern Brazil

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Abstract

The Atlantic Forest is among the 36 biodiversity hotspots of the world. The southern region of this biome covers 52 conservation units (CUs), including the Bela Vista Biological Refuge (RBBV), which has actions based on biodiversity conservation, scientific research, and environmental education. Biodiversity is the basis for different ecosystem services that can be carried out by social wasps, essential in terrestrial environments. Brazil has the richest fauna of social wasps (Vespidae, Polistinae) on the planet (381 species); however, some Brazilian states, such as Paraná, are “undersampled.” This study was carried out with the goal of inventorying the fauna richness of social wasps in the Atlantic Forest. This biome is located in the RBBV, Paraná, Southern Brazil, and the collections took place from September 2021 to May 2022, totaling 20 days of sampling. Active search with the aid of insect entomological nets in trails near aquatic environments was used. A total of 18 species of social wasps were recorded, including four new records for the state of Paraná. This study recorded species restricted to some biomes and others of wide geographical occurrence; therefore, the RBBV is an important CU for maintaining the fauna of social wasps in the state of Paraná.

Keywords: Fauna inventory; Itaipu; *Mischocyttarus ryani*; *Mischocyttarus paraguayensis*; Polistinae.

Introduction

The Atlantic Forest provides different ecosystem services, such as the storage of carbon from the atmosphere (AZEVEDO et al., 2018), maintenance of the volume and quality of water resources (DELONG, BRUSVEN, 1994), soil protection (OLIVEIRA-FILHO et al., 1994; 1997; CHELI, BOSCO, FLORES, 2022), pollination (BROCK, CINI, SUMNER, 2021), food production (MILANI et al., 2020), and biological control (BERGAMO et al., 2021). The biome is among the 36 hotspots of the world due to its high biodiversity, with about 15,700 species of plants and 2,208 species of vertebrates described, and also due to its history of degradation, in which its original coverage was reduced to 25.8% and distributed in 246

fragments (MYERS et al., 2000; RIBEIRO et al., 2009; MITTERMEIER et al., 2011; REZENDE et al., 2018; PROJETO MAPBIOMAS, 2020). In the state of Paraná, only 13.1% of the Atlantic Forest remains (FUNDAÇÃO SOS MATA ATLÂNTICA; INPE, 2021). Still, in the first half of 2022, Paraná was the third state that most deforested areas of this biome (FUNDAÇÃO SOS MATA ATLÂNTICA, 2023).

The southern region of the Atlantic Forest includes 52 conservation units (CUs) that contribute to the protection of its remnants (RIBEIRO et al., 2009; FUNDAÇÃO SOS MATA ATLÂNTICA, 2023). One of them is the Bela Vista Biological Refuge, an integral conservation unit with 1,780 ha, created in the 1980s by the Itaipu Hydroelectric Plant (ITAIPU, 2022). This CU

has actions based on biodiversity conservation, scientific research, and environmental education. Moreover, in 2017 it received the title of core zone of the Atlantic Forest Biosphere Reserve (ITAIPU, 2022), which, according to UNESCO's definition, is subdivided into three areas (core zones, buffer zones, and transition zones) (RBMA, 2018). This title highlights the maximum protection of biodiversity and other natural resources in these areas (RBMA, 2018).

Biodiversity is the basis for ecological processes that provide ecosystem services (JOLY et al., 2019). Many of these services are performed by insects (BROCK, CINI, SUMNER, 2021), including social wasps, which act in the biological control of pests in different agricultural crops, such as coffee (MEDEIROS et al., 2019), and in eucalyptus planting areas (ELISEI et al., 2010). Thus, these social insects are essential in terrestrial ecosystems, which reinforces the importance of preserved areas near agricultural crops, aiming at a balance of agrosystems (CARDOSO, 2016).

Brazil is home to the largest diversity of social wasps (Vespidae, Polistinae) on the planet, totaling 381 species (SOMAVILLA et al., 2021). This family includes six subfamilies, three of solitary or pre-social habit, and three that exhibit eusocial behavior, and Brazil only has Polinistinae (CARPENTER, 1993). Despite the growing effort to know the Brazilian wasp fauna, some Brazilian states are "undersampled," such as Paraná, which has only three studies on its wasp fauna, until this study, based on information obtained in biological collections (RICHARDS, 1978) and studies in specific areas, such as in the municipality of Cascavel (RIBEIRO, 2010) and at the Ilha Grande National Park (SILVA et al., 2021).

In this perspective, this study was carried out aiming to inventory the fauna richness of social wasps in remnants of the Atlantic Forest within the Bela Vista Biological Refuge (RBBV),

in the municipality of Foz do Iguaçu, Paraná, Southern Brazil and, thus, expand information on the wasp fauna in this state.

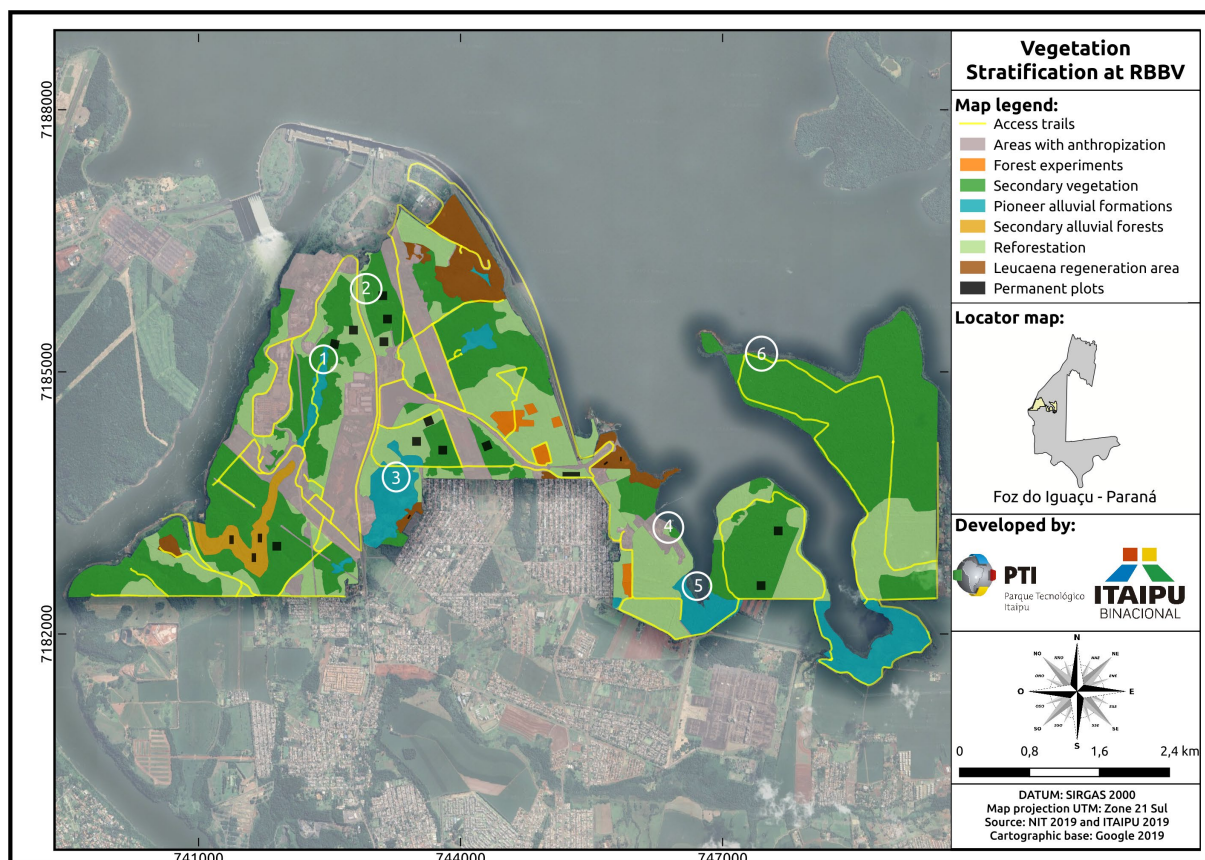
Material and methods

The study was carried out from September 2021 to May 2022, encompassing three seasons of the year (Spring, Summer, and Autumn), in the Bela Vista Biological Refuge (RBBV) (25°26'45.7"S 54°35'02.0"W), Foz do Iguaçu, Western Paraná, Brazil. The RBBV was created in 1984, comprising an area of 1,780 hectares, with a predominance of seasonal semi-deciduous forest, phytophysiology of the Atlantic Forest (ITAIPU, 2022), under the protection of the Itaipu Hydroelectric Plant. The study area is surrounded by the Itaipu reservoir, alternating crops of maize and soybeans, and also by human occupation, in addition to areas composed partly of remnants of native forest, recovered naturally, and partly by reforested area (ITAIPU, 2022). The region is characterized by Cfa climate (ALVARES et al., 2013).

To capture specimens in foraging or in their nests, the active search method was used, proposed by Souza and Prezoto (2006), in which the researcher, using an insect net, moved through pre-existing trails, close to Lentic environments, such as the Itaipu Dam, and Lotic ones, such as the Piracema and Vila Três rivers (Figure 1), which are conducive to nesting of these insects due to water resources (SILVA et al., 2022), taking photographic records of the nests. The collections took place from 9:00 to 15:00, therefore, with a daily effort of six hours, totaling 120 hours in 20 days of sampling. For Clemente et al. (2021), this method is indispensable in the inventories of Polistinae carried out in restored forests.

The specimens of social wasps collected were sacrificed and stored in 70% alcohol for subsequent assembly on insect pins. For

Figure 1. Fragments of Atlantic Forest sampled for collection of social wasps in the Bela Vista Biological Refuge, Municipality of Foz do Iguaçu, Paraná



Caption: Sample points: 1 – Lagoa da Cavalinha; 2 – Bridge over the Bela Vista River; 3 – Mirante do Jacaré; 4 – Trilha do Zoológico; 5 – Remanso da Península; and 6 – Península Pomba Cuê. **Source:** The authors.

identification in the laboratory, dichotomous keys proposed by Richards (1978) and Carpenter and Marques (2001) were used, in addition to comparison with the biological material deposited in the Biological Collection of Social Wasps (CBVS) of IFSULDEMINAS, Inconfidentes *Campus*, where the specimens are deposited. The confirmation of the identifications was carried out by the taxonomist PhD Orlando Tobias Silveira, from the Museu Paraense Emílio Goeldi, Belém, Pará.

Results and discussion

A total of 18 species of social wasps were recorded, with four new records for the state of Paraná (Tables 1 and 2; Figure 2).

This richness can be considered expressive, since it is greater than the other areas sampled in the state of Paraná, since 14 species were sampled in the Ilha Grande National Park (SILVA et al., 2021), and 16 spp. in the urban area of the municipality of Cascavel (RIBEIRO, 2010).

The genus with the richest fauna sampled in this research was *Mischocyttarus*, with ten species (Table 2). The same pattern was observed by Silva et al. (2021) in a study conducted in the Ilha Grande National Park, also located in the state of Paraná. To date, there are about 144 species of *Mischocyttarus* described in Brazil; therefore, this is the genus of Polistinae with the richest fauna in the country (SOMAVILLA et al., 2021). Some species of this taxon, such as *M. cassununga*, have ethological adaptations, such as the reuse

Table 1. Social wasps of the Epiponini tribe registered in the Bela Vista Biological Refuge of Itaipu, as well as other states and biomes of occurrence in Brazil. Foz do Iguaçu, Paraná, Brazil

Tribe	Species	States and Biomes of occurrence in Brazil
Epiponini	<i>Brachygastra augusti</i> (Saussure, 1854)	AP, AM, DF, GO, MA, MT, MG, MS, PA, PR, RO, RS, SP Amazon, Cerrado, and Atlantic Forest
	<i>Brachygastra lecheguana</i> (Latreille, 1824)	AM, AP, BA, CE, DF, ES, GO, MA, MG, MT, GO, MS, PA, PR, PB, PE, PI, RN, RS, RJ, RO, RR, SC, SP Amazon, Caatinga, Cerrado, Atlantic Forest, and Pampa
	<i>Parachartergus pseudapicalis</i> (Willink, 1959) *	BA, GO, MT, MG, PE, RJ, RO, SC, SP Amazon, Caatinga, Cerrado, and Atlantic Forest
	<i>Polybia fastidiosuscula</i> Saussure, 1854	AM, BA, DF, ES, GO, MA, MT, MG, PA, PR, RS, RJ, SC, SP Amazon, Cerrado, Atlantic Forest, and Pampa
	<i>Polybia ignobilis</i> (Haliday, 1836)	AM, BA, CE, DF, ES, GO, MA, MT, MG, MS, PA, PB, PI, PR, PE, RN, RS, RJ, RO, RR, SC, SP Amazon, Caatinga, Cerrado, Atlantic Forest, Pampa, and Pantanal
	<i>Polybia occidentalis</i> (Olivier, 1791)	AM, AP, BA, CE, DF, ES, GO, MA, MT, MG, MS, PA, PB, PI, PR, PE, RN, RS, RJ, RO, RR, SC, SP Amazon, Caatinga, Cerrado, Atlantic Forest, Pampa, and Pantanal
	<i>Synoeca cyanea</i> (Fabricius, 1775)	BA, DF, ES, MG, MS, PA, PE, PR, RS, RJ, SC, SP Caatinga, Cerrado, and Atlantic Forest

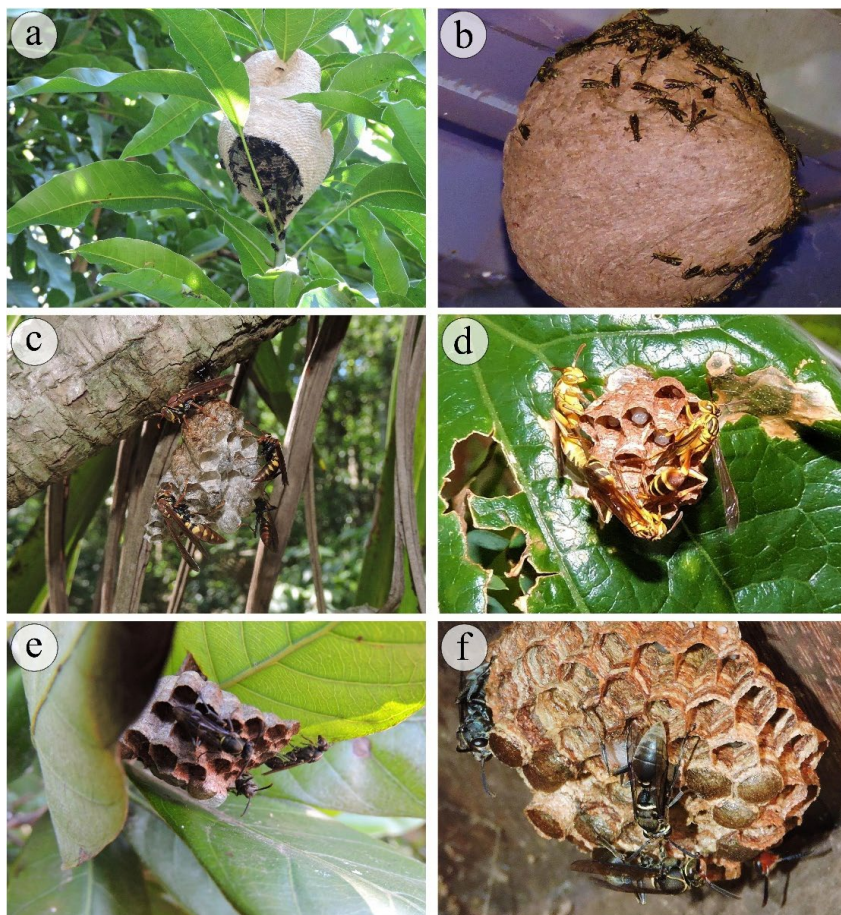
Caption: Amapá – AP; Amazonas – AM; Bahia – BA; Ceará – CE; Federal District– DF; Espírito Santo – ES; Goiás – GO; Maranhão – MA; Mato Grosso – MT; Mato Grosso do Sul – MS; Minas Gerais – MG; Pará – PA; Paraíba – PB; Paraná – PR; Pernambuco – PE; Piauí – PI; Roraima – RR; Rondônia – RO; Rio de Janeiro – RJ; Rio Grande do Norte – RN; Rio Grande do Sul – RS; Santa Catarina – SC; São Paulo – SP; * New record for the state of Paraná. **Source:** prepared by the authors.

Table 2. Social wasps of the Mischocyttarini and Polistini tribes registered in the Bela Vista Biological Refuge of Itaipu, as well as other states and biomes of occurrence in Brazil. Foz do Iguaçu, Paraná, Brazil

Tribe	Species	States and Biomes of occurrence in Brazil
Mischocyttarini	<i>Mischocyttarus bertonii</i> (Ducke, 1908)	MS, MG, RS, SP, PA, PR / Amazon, Cerrado, and Atlantic Forest
	<i>Mischocyttarus cassununga</i> (von Ihering, 1903)	BA, DF, ES, MG, RJ, RS, SC, SP, PA, PE, PR / Caatinga, Cerrado, and Atlantic Forest
	<i>Mischocyttarus consimilis</i> Zikán, 1949	MT, MS, MG, PR, SP / Cerrado and Atlantic Forest
	<i>Mischocyttarus frontalis</i> (Fox, 1898)	GO, MT, MG, MS, PR / Cerrado and Atlantic Forest
	<i>Mischocyttarus funerulus</i> Zikán, 1949	MG, RJ / Atlantic Forest
	<i>Mischocyttarus paraguayensis</i> (Zikán, 1935) *	MG, RS, SC, SP / Atlantic Forest
	<i>Mischocyttarus rotundicollis</i> (Cameron, 1912)	AM, AL, BA, DF, ES, GO, MT, MG, PA, PR, RJ, RO, RS, SC, SP/ Amazon, Caatinga, Cerrado, Atlantic Forest, and Pampa
	<i>Mischocyttarus ryani</i> Silveira, 2015 *	BA, MG / Atlantic Forest
	<i>Mischocyttarus socialis</i> (de Saussure, 1854)	AM, MG, RJ, SP, PR, SC / Amazon, Cerrado, Atlantic Forest
	<i>Mischocyttarus tricolor</i> Richards, 1945	GO, MG, MT, SP / Cerrado and Atlantic Forest
Polistini	<i>Polistes actaeon</i> (Haliday, 1836) *	ES, MG, RJ, RS, SC, SP / Cerrado, Atlantic Forest, and Pampa
	<i>Polistes simillimus</i> (Zikán, 1951)	BA, MG, MS, PB, PR, RJ, RS, SC, SP/ Caatinga, Cerrado, Atlantic Forest and Pampa

Caption: Alagoas – AL; Amazonas – AM; Bahia – BA; Federal District– DF; Espírito Santo – ES; Goiás – GO; Mato Grosso – MT; Mato Grosso do Sul – MS; Minas Gerais – MG; Pará – PA; Paraná – PR; Pernambuco – PE; Rondônia – RO; Rio de Janeiro – RJ; Rio Grande do Sul – RS; Santa Catarina – SC; São Paulo – SP; * New record for the state of Paraná. **Source:** The authors.

Figure 2. Nests of social wasp species (Polistinae) recorded at the Bela Vista Biological Refuge, Foz do Iguacu, Paraná, Brazil



Caption: *Parachartergus pseudapicalis* (a); *Polybia fastidiosuscula* (b); *Polistes simillimus* (c); *Mischocyttarus tricolor* (d); *Mischocyttarus funerulus* (e); and *Mischocyttarus frontalis* (f). **Source:** Authors' collection.

of nests for the development and formation of new adults (CASTRO et al., 2014). Moreover, *M. socialis* are able to store food (BARBOSA et al., 2017). These factors corroborate to clarify the greater representativeness of the genus in question. However, it is known that there are also species of this taxon with few records and, thus, few ecological data, such as *M. ryani* and *M. paraguayensis* (Figure 3), which constitute new records for the state of Paraná.

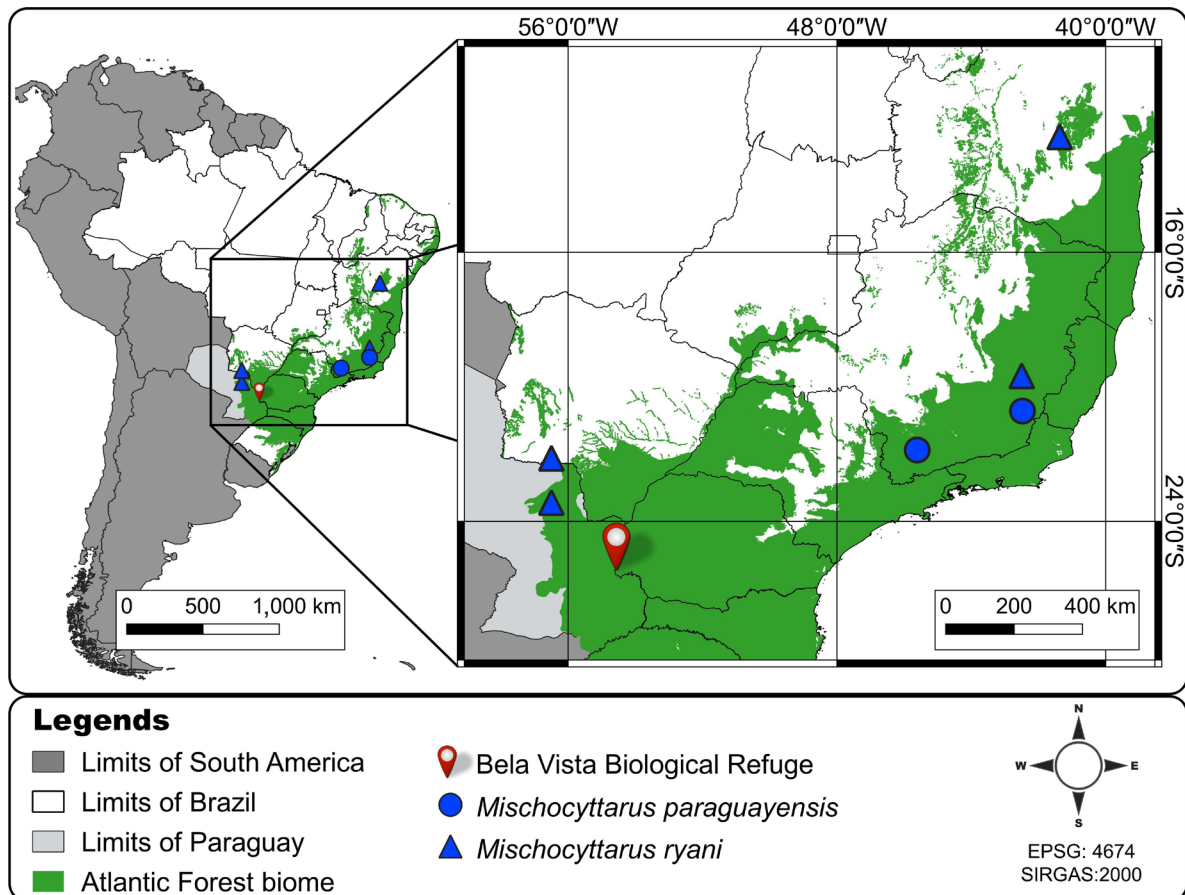
According to Silveira, Silva, and Felizardo (2015), *M. ryani* occurs in only four regions on the planet, two in Paraguay (Concepción and Bella Vista Norte) and two in Brazil (one record in Minas Gerais, in the Rio Doce State Park, and another in Bahia, in the municipality of Lençóis).

Considering that both records were also carried out in the Atlantic Forest, the rare species may be restricted to this biome.

M. paraguayensis is distributed in southern and southeastern Brazil (SOMAVILLA et al., 2021) (Table 1), having its record in the Serra do Brigadeiro State Park and in the municipality of São Gonçalo do Sapucaí, both regions of Minas Gerais (SOUZA et al., 2015), and also in the states of Rio Grande do Sul and Santa Catarina, but without locality information, and may, as well as *M. ryani*, be restricted to the Atlantic Forest.

In addition to these two species (*M. ryani* and *M. paraguayensis*), *Polistes actaeon* and *Parachartergus pseudapicalis* make up the list of new records for the state of Paraná. *P. actaeon* has

Figure 3. Occurrence of *Mischocyttarus paraguayensis* and *Mischocyttarus ryani* in Brazil and Paraguay.



Source: The authors.

a wide distribution in the country (SOMAVILLA et al., 2021) (Tables 1 and 2), occupying even small fragments (BUENO, SOUZA, CLEMENTE, 2019), forest areas that have a matrix of the environment consisting of pastures (COELHO et al., 2022), being also found in areas of lower anthropic pressure inserted in Conservation Units (OLIVEIRA et al., 2021). *P. pseudapicalis* also has a wide distribution in Brazil (SOMAVILLA et al., 2021) (Table 1), found in the Amazon (SOMAVILLA et al., 2020), Caatinga (ANDENA; CARPENTER, 2014), Cerrado (SOUZA et al., 2020), and Atlantic Forest (SOUZA et al., 2022). As suggested by Ferreira et al. (2022) e Silva et al. (2022), water availability is a determining factor for the nesting of this species. Thus, the dam of the Itaipu Binacional Hydroelectric plant may have contributed to the presence of *P. pseudapicalis* at RBBV.

Finally, we obtained the record of species of wide geographical distribution, such as *Brachygastra lecheguana*, *Polybia ignobilis*, *Polybia occidentalis*, and *Polistes simillimus*, which have a wide distribution in Brazil, occurring in different biomes (SOMAVILLA; KÖHLER, 2017; RIBEIRO, SILVESTRE, GARCETE-BARRETT, 2019; SOMAVILLA et al., 2020; SANTOS et al., 2020; CASTRO, ANDENA, ANJOS, 2021). This vast occurrence may show the generalist adaptation, already observed in social wasps, in their different nesting processes, as well as in foraging, since they explore a wide variety of food resources, such as other insects (PREZOTO et al., 2019; SOUTHON et al., 2019), flower nectar (MELLO et al., 2011), and vertebrate carcasses (SOMAVILLA, LINARD, RAFAEL, 2019). Perhaps, this knowledge supports the record of these insects in this study.

Conclusion

The Bela Vista Biological Refuge is an important CU for the maintenance of social wasp population in the state of Paraná, since it houses a rich fauna of social wasps, including new records for the state, which reinforces the need for other studies in conservation units inserted in Paraná, Southern Brazil.

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