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Social wasps (Vespidae: Polistinae) of Minas Gerais, Brazil: richness and distribution

Avispas sociales (Vespidae: Polistinae) de Minas Gerais, Brasil: riqueza y distribución

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Abstract. Minas Gerais state, Brazil, is home to significant biological diversity, including social wasps (Vespidae: Polistinae). However, they have suffered substantial losses of their original cover due to anthropogenic actions, which justifies carrying out inventory studies. Therefore, this study aims to analyze the species richness and distribution of social wasps in Minas Gerais and add information to the municipality of Luminárias, southern Minas Gerais. There are inventories in 32 locations in Minas Gerais, inside and outside Conservation Units (CUs), with a higher concentration in the Atlantic Forest. In total, 118 social wasp species are recorded in the state and 74 are considered rare, *i.e.* occurring in less than 20% of the localities. The Caatinga, along with the protected areas in the Cerrado and the Atlantic Forest in the eastern and northeastern parts of the state, is under-sampled. Luminárias, despite not being located in a UC, has a considerable richness of rare species, two of which have only been previously recorded in Conservation Units. This allows us to infer that this municipality is home to a relevant vespid fauna for the state, corroborating other studies that suggest the creation of a UC for the region.

Key words: Atlantic Forest; Caatinga; Cerrado; inventory.

Resumen. El estado de Minas Gerais, Brasil, alberga una importante diversidad biológica, incluidas las avispas sociales (Vespidae: Polistinae), pero ha sufrido pérdidas significativas de su cobertura original debido a acciones antropogénicas, lo que justifica la realización de estudios de inventario. Por lo tanto, el objetivo de este estudio es analizar la riqueza de especies y la distribución de las avispas sociales en Minas Gerais, así como agregar información al municipio de Luminárias, sur de Minas Gerais. Hay inventarios en 32 localidades de Minas Gerais, tanto dentro como fuera de las Unidades de Conservación (UC), con una mayor concentración en la Mata Atlántica. En total, se registran 118 especies de avispas sociales en el estado y 74 se consideran raras, es decir, se encuentran en menos del 20% de las localidades. La Caatinga, junto con las áreas protegidas en el Cerrado y la Mata Atlántica en las partes este y noreste del estado, está submuestreada. Luminárias, a pesar de no estar ubicada en una UC, tiene una riqueza considerable de especies raras, dos de las cuales solo se han registrado previamente en Unidades de Conservación. Esto permite inferir que este municipio

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alberga una fauna de véspidos relevante para el estado, corroborando otros estudios que sugieren la creación de una UC para la región.

Palabras clave: Caatinga; Cerrado; inventario; Mata Atlántica.

Introduction

Minas Gerais is the fourth largest Brazilian state, located in the southeastern region of the country. Its climate ranges from tropical to temperate climate, with altitudes between 76 - 2,891 m (Sá Junior 2009). Additionally, the state is home to three biomes: Cerrado (57% of the area), Atlantic Forest (41%), and Caatinga (2%) (MMA 2024).

Cerrado is the second most extensive biome in Brazil and the most biodiverse savannah on the planet, considered a hotspot due to its high diversity, high rate of endemism, and many species at risk of extinction (Myers *et al*. 2000). Even so, this biome has been suffering a rapid reduction and modification of its area, mainly due to deforestation for agricultural expansion, cattle ranching, burning, and mining activities (Sano *et al*. 2019). As a result, it is estimated that more than 50% of its original area has already been converted to other uses (Klink and Machado 2005; Oliveira *et al*. 2023).

Another biome severely impacted by environmental changes is the Atlantic Forest, also considered a biodiversity hotspot (Lima *et al*. 2020), which is facing serious threats, mainly due to deforestation for urban, agricultural and industrial expansion, as well as logging and mining (Santos *et al*. 2024). As a result, only around 12.4% of its original cover remains (SOS Mata Atlântica 2020), which is currently made up of fragments. This also represents a major challenge for biodiversity conservation, since species are isolated in small habitat patches, imposing many abiotic and biotic restrictions on these organisms (Morato and Campos 2000; Coelho *et al*. 2022).

In turn, Caatinga has the driest climate in Brazil, the semi-arid tropical (Köppen and Geiger 1928). Characterized as savannah-type (Eiten 1982), the Caatinga occurs in the northern and northeastern portions of Minas Gerais State, found as the predominant formation and in transition with the Cerrado (Brandão 2000). The biome has been suffering from intensive land use, cattle ranching and deforestation, resulting in a loss of ecosystem services (Macedo *et al*. 2023).

Preserving these biomes is crucial for protecting biodiversity and the ecosystem services provided by various taxa (Stephenson and Stengel 2020). Among these taxa, we highlight the social wasps (Vespidae: Polistinae), which play a role in the pollination of various plant species (Pereira 2014), as well as being predators, especially of caterpillars, making certain species relevant in biological control (Jacques *et al*. 2018a; Prezoto *et al*. 2019). It is therefore important to understand the distribution of these insects, whether for conservation, their use in agricultural areas or to assess their extinction risk status, since no species has been assessed by ICMBio (2024) or the IUCN (2024), which justifies carrying out inventory studies.

Minas Gerais is the Brazilian state with the highest number of samples for these wasps (Souza *et al*. 2020a, b), including inventories in the Atlantic Forest (Oliveira *et al*. 2021), Cerrado (Francisco *et al*. 2023), and Caatinga (Jacques *et al*. 2023). Additionally, studies have been conducted within Conservation Units (Souza *et al*. 2012) and in anthropized environments such as agrosystems (Barbosa *et al*. 2022), as well as in areas impacted by other economic activities, including tourism (Coelho *et al*. 2022) and mining (Rubim *et al*. 2023). This diverse body of research provides a comprehensive dataset that, when analyzed, can yield critical insights into the influence of biomes and other factors, such as geographic distance, ecotones, conservation status, anthropogenic pressures, altitude, and sampling

effort, on the community of social wasps in different regions. Furthermore, these data will enable the identification of species with greater environmental plasticity and those that are rarer, occurring in only a few locations and ecosystems.

With the compiled and analyzed data, it will be possible to aid in the development of conservation strategies by identifying the most critical areas, characterized by high species richness and the presence of rare species. Additionally, the data can be used to suggest areas within the state that require further inventory efforts due to insufficient sampling.

Therefore, in this study, we aimed to analyze social wasp species richness and distribution in Minas Gerais State based on a literature review, as well as to add information for an unprotected and transitional area of Cerrado and Atlantic Forest in the municipality of Luminárias, in the southern portion of the state.

Materials and Methods

Literature review and data analysis of vespid richness and distribution in Minas Gerais

We selected full articles and scientific notes on inventories, occurrence and distribution of social wasp species in Minas Gerais, Brazil. This selection was based on ensuring that these works had undergone peer review by experts in the relevant field. Specific studies, such as comparative taxonomy or ethology, were only used for areas that had already been inventoried, in order to complement their richness. The search for these scientific studies was carried out between February and June 2024, using keywords combined with Boolean operators such as "Social wasps AND Minas Gerais"; "Social wasps AND Inventories"; "Social wasps AND Checklist"; "Social wasps AND agricultural areas". Searching was performed in Portuguese and English, on the Scholar Google, Capes Periódicos, ResearchGate, Scopus and Scielo platforms. Additionally, we utilized the species database from the Social Wasp Collection of Minas Gerais at IFSULDEMINAS - Campus Inconfidentes (Souza *et al.* 2024).

The data was then organized by locality and biome, with those from the same municipality or conservation unit being compiled as a single locality. To determine the richness and distribution of species in each locality, only species-level identifications were considered.

The social wasps were categorized into classes based on the percentage frequency of their occurrence in the analyzed studies: rare (0 to 19.99%); accidental (20 to 39.99%); accessory (40 to 59.99%); frequent (60 to 79.99%) and constant (80 to 100%) (adapted from Silveira-Neto *et al*. 1976). These metrics were calculated using the formula: $F = p \times 100 / N$, where F = frequency, p = number of sites containing the species and N = total number of sites selected. After this, we calculated the percentage of each class per locality by dividing the quantity of each class by the total richness of each locality. We also identified the number of exclusive species, those that only appear in one location.

To produce the map, we used geoprocessing techniques with QGIS software, version 3.36.3, mapping environmental and territorial data, focusing on the distribution of social wasps. QGIS is a free, open-source Geographic Information System (GIS) that supports various vector formats, rasters and databases, with multiple functionalities that allow the creation of thematic maps and detailed spatial analysis (Qgis Development Team 2021). The vector layers of federal and municipal boundaries, Brazilian biomes and Minas Gerais phytophysiognomies were obtained from IBGE (IBGE 2021) and the MapBiomas platform (Mapbiomas 2021). Field collection data and bibliographic data were organized in XML tables, converted to CSV and imported into QGIS, where they were transformed into vector layers. The EPSG:32722 - WGS 84 / UTM zone 22S reference system was used. This methodology resulted in a detailed and accurate map, serving as the basis for analysis in both this article and for future studies on the social wasp distribution and environmental characteristics in Minas Gerais.

We performed a cluster analysis of the diversity of social wasps between the study areas, using Jaccard's similarity index, produced from data on the presence/absence of species. A Principal Coordinates Analysis (PCoA) was carried out to assess the similarity of the community of species between the Cerrado and Atlantic Forest biomes, also using Jaccard's index. Each site in this biome was entered as a repetition, and Caatinga was not included in the analysis since only one study was carried out in that biome. Subsequently, a PERMANOVA (Permutational Multivariate Analysis of Variance) was carried out to determine whether there was a significant difference in the community between the biomes. All these analyses were carried out using the PAST software (Hammer *et al*. 2005).

Social wasp fauna in the municipality of Luminárias

The study was carried out in the municipality of Luminárias (LUM), Minas Gerais state (21°31'S, 44°52'W, 845 m min. and 1,496 m max. altitude), in an Atlantic Forest area with enclaves of Cerrado, with the presence of Rupestrian fields (Figs. 1a-d). This region is considered vulnerable to the loss of fauna and flora, and susceptible to erosion, which can be intensified by anthropogenic exploitation activities in the region, mainly characterized by agriculture and quartz mining (Lima *et al*. 2011; Silva *et al*. 2011).

A 21-day sampling effort was carried out in seven campaigns, from May 2023 to March 2024. Each campaign lasted two to three consecutive days, except for the one in October, which lasted five days. Sampling was performed through active searches, between 9 am and 2 pm, with five researchers, totaling 105 sampling hours per researcher.

The social wasps were captured with entomological nets on pre-existing trails in the riparian forest, forest edges and interior, field areas and rocky outcrops, either on nests or in flight. After capture, the specimens were stored in 70% alcohol for later identification using entomological keys (Richards 1978; Somavilla *et al*. 2021). They were also compared with the biological collection of social wasps (CBVS) at IFSULDEMINAS.

The identification of specimens was confirmed by Dr. Orlando Tobias da Silveira, from the Emílio Goeldi Museum, Belém, Pará, Brazil.

An accumulation curve was constructed using the observed richness with a 95% confidence interval, using the Bootstrap 1 estimator in the EstimateS 9.1.0 software (Cowell and Elsensonh 2014) to evaluate the sampling effort.

Results and Discussion

Vespid richness and distribution in Minas Gerais

A total of 44 studies were selected from 32 locations in areas of native vegetation, inside or outside Conservation Units (CUs), and agricultural areas: 24 in the Atlantic Forest, seven in the Cerrado and one in the Caatinga (Tab. 1). These localities are home to 115 species of social wasps. Adding to this list: *Polybia brunnea* (Curtis, 1884) and *Polybia emaciata* Lucas, 1879 recorded by Richards (1978), without locality information, and *Polistes cavapytiformis* Richards, 1978 recorded in the Biological Collection of Social Wasps (CBVS, acronym in Portuguese) at IFSULDEMINAS (Souza 2024), totals 118 social wasp species for Minas Gerais state (Appendix I).

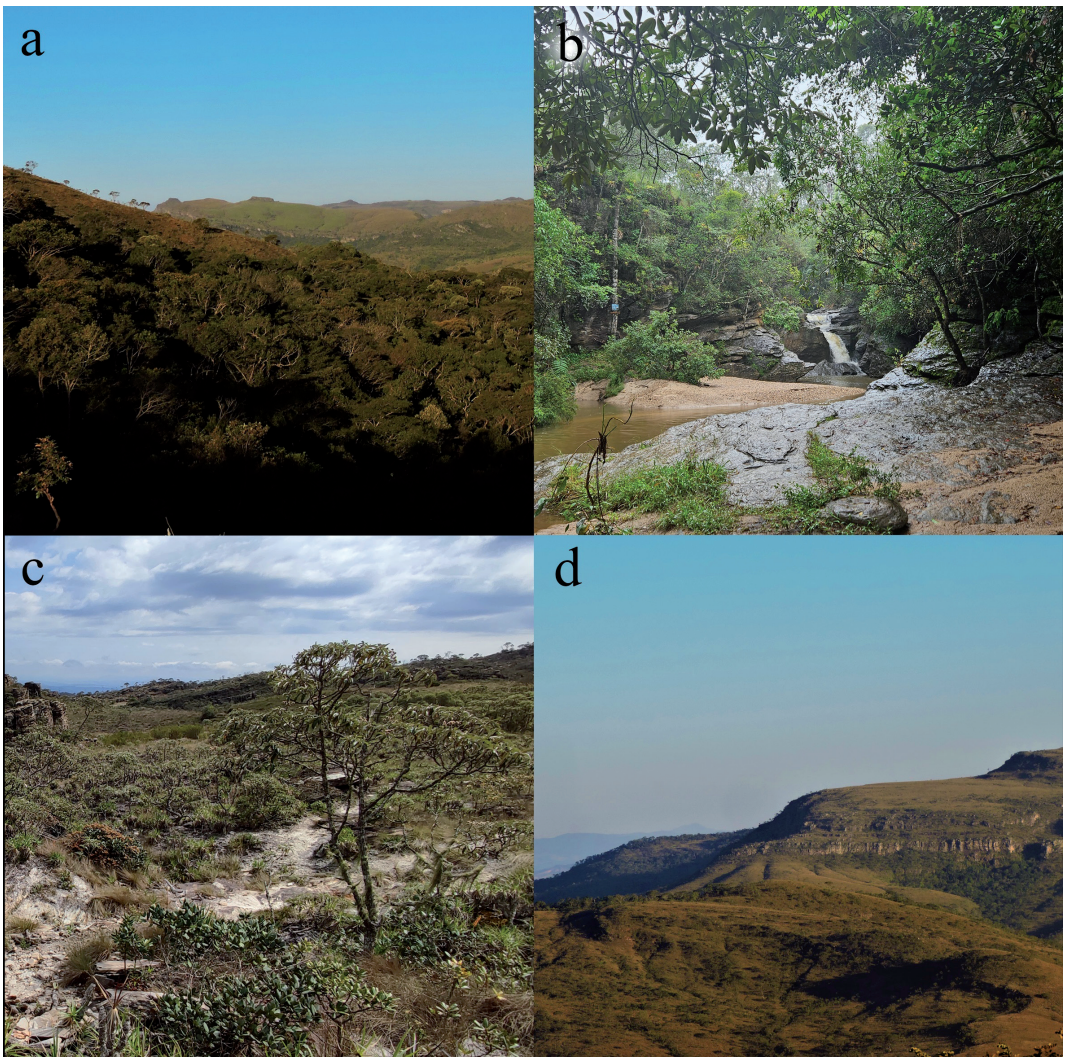

Figure 1. Environments of social wasp samplings in the municipality of Luminárias, southern Minas Gerais: **(a)** Semi-deciduous forest (Atlantic Forest domain) associated with Cerrado formations. **(b)** Semi-deciduous forest. **(c)** Rupestrian field. (**d)** Cerrado formations. / **Figura 1.** Ambientes de muestreo de avispas sociales en el municipio de Luminárias, sur de Minas Gerais: **(a)** Bosque semideciduo (dominio de la Mata Atlántica) asociado a formaciones del Cerrado. **(b)** Bosque semideciduo. **(c)** Campo rupestre. **(d)** Formaciones del Cerrado.

Rare occurrences

The locations with the highest percentage of rare species, respectively, were (acronyms in Portuguese): Dionísio municipality (DIO) and Rio Doce State Park (PERD) in the Atlantic Forest; Grande Sertão Veredas National Park (PNGSV), Pandeiros River Wildlife Refuge (RVSRP) and Sempre-vivas National Park (PNSV), in the Cerrado (Tab. 1).

Table 1. Localities with social wasp inventories in Minas Gerais, Brazil; acronyms; biome included located or not within a Conservation Unit (CU); species richness; frequency of species: constant, frequent, accessory, accidental and rare; and occurrence and number of exclusive species. / **Tabla 1.** Localidades con inventarios de avispas sociales en Minas Gerais, Brasil; siglas; bioma incluída ubicación o no dentro de una Unidad de Conservación (UC); riqueza de especies; frecuencia de especies: constante, frecuente, accesoria, accidental y rara; y ocurrencia y número de especies exclusivas.

Study	Localites	Acronyms	Biome	UC	Species Richness*	Frequency of species (%)				
						Constant	Frequent	Accessory	Accidental	Rare
1	Barroso	BAR	Atlantic Forest	no	49	12.24%	20.41%	24.49%	20.41%	22.45%
2	Juiz de Fora	JFO	Atlantic Forest	both**	41	14.63%	24.39%	24.39%	17.07%	19.51%
3	Lavras	LAV	Atlantic Forest	no	39	15.38%	25.64%	28.21%	15.38%	15.38%
4	Sempre-Vivas National Park	PNSV	Cerrado	yes	39	15.38%	25.64%	23.08%	7.69%	28.21%
5	Bambuí	BAM	Cerrado	no	36	16.67%	22.22%	16.67%	16.67%	27.78%
6	Serra de São José Environmental Protection Area	APASJ	Atlantic Forest	yes	36	16.67%	27.78%	27.78%	5.56%	22.22%
7	Grande Sertão Veredas National Park	PNGSV	Cerrado	yes	36	16.67%	22.22%	13.89%	13.89%	33.33%
8	Rio Doce State Park	PERD	Atlantic Forest	yes	35	11.43%	11.43%	14.29%	11.43%	51.43%
9	Rio Machado Environmental Protection Area	APARM	Atlantic Forest	yes	35	14.29%	28.57%	25.71%	17.14%	14.29%
10	Ouro Fino	OFI	Atlantic Forest	no	34	17.65%	29.41%	26.47%	14.71%	11.76%
11	Rio Pandeiros Wildlife Refuge	RVSRP	Cerrado	yes	33	15.15%	21.21%	21.21%	9.09%	33.33%
12	Boqueirão Biological Reserve	RBB	Atlantic Forest	yes	33	18.18%	21.21%	24.24%	15.15%	21.21%
13	Luminárias	LUM	Atlantic Forest	no	33	18.18%	24.24%	30.30%	12.12%	15.15%

Table 1 (continuation). Localities with social wasp inventories in Minas Gerais, Brazil. / **Tabla 1 (continuación).** Localidades con inventarios de avispas sociales en Minas Gerais, Brasil.

Study	Localites	Acronyms	Biome	UC	Species Richness*	Frequency of species (%)				
						Constant	Frequent	Accessory	Accidental	Rare
14	São Gonçalo do Sapucaí	SGS	Atlantic Forest	no	32	18.75%	31.25%	28.13%	18.75%	3.13%
15	Inconfidentes	INC	Atlantic Forest	no	32	18.75%	28.13%	28.13%	15.63%	9.38%
16	Ibitipoca State Park	PEI	Atlantic Forest	yes	29	20.69%	27.59%	20.69%	20.69%	10.34%
17	Serra do Papagaio State Park	PESP	Atlantic Forest	yes	29	20.69%	24.14%	27.59%	10.34%	17.24%
18	Serra da Canastra National Park	PNSC	Cerrado	yes	29	20.69%	31.03%	20.69%	10.34%	17.24%
19	Uberlândia	UBE	Cerrado	both**	28	17.86%	21.43%	21.43%	17.86%	21.43%
20	Peti Environmental Station	EAP	Atlantic Forest	yes	26	19.23%	23.08%	15.38%	15.38%	26.92%
21	Viçosa	VIC	Atlantic Forest	no	22	22.73%	40.91%	18.18%	13.64%	4.55%
22	Serra do Brigadeiro State Park	PESB	Atlantic Forest	no	22	27.27%	31.82%	31.82%	9.09%	0.00%
23	Itatiaiuçu	ITA	Atlantic Forest	no	19	26.32%	36.84%	15.79%	10.53%	10.53%
24	Santo Antônio do Amparo	SAA	Atlantic Forest	no	18	22.22%	33.33%	33.33%	5.56%	5.56%
25	Medeiros	MED	Cerrado	no	16	31.25%	37.50%	25.00%	0.00%	6.25%
26	Ritápolis National Forest	FNR	Atlantic Forest	yes	15	26.67%	33.33%	20.00%	6.67%	13.33%

Table 1 (continuation). Localities with social wasp inventories in Minas Gerais, Brazil. / **Tabla 1 (continuación).** Localidades con inventarios de avispas sociales en Minas Gerais, Brasil.

Study	Localites	Acronyms	Biome	UC	Species Richness*	Frequency of species (%)				
						Constant	Frequent	Accessory	Accidental	Rare
27	Mata Seca State Park	PEMS	Caatinga	yes	14	35.71%	21.43%	14.29%	14.29%	14.29%
28	Poços de Caldas	PCA	Atlantic Forest	no	13	30.77%	38.46%	23.08%	7.69%	0.00%
29	Fernão Dias Environmental Protection Area	APAFD	Atlantic Forest	yes	12	25.00%	33.33%	16.67%	8.33%	16.67%
30	Alto Montana Private Natural Heritage Reserve	RPPNAM	Atlantic Forest	yes	10	20.00%	40.00%	40.00%	0.00%	0.00%
31	Coronel Pacheco	CPA	Atlantic Forest	no	7	57.14%	28,57%	0.00%	14.29%	0.00%
32	Dionísio	DIO	Atlantic Forest	no	5	0.00%	0.00%	0.00%	20.00%	80.00%

* Only species-level identifications considered

** Studies in areas inside and outside protected area, the municipality was considered

1 - Souza and Prezoto 2006; Souza *et al*. 2010a; Souza *et al.* 2014; Coelho *et al.* 2022; 2 - De Souza *et al.* 2012; Barbosa *et al*. 2016, 2020; 3 - Jacques *et al*. 2018a; 4 - Souza *et al*. 2020b; 5 - Jacques *et al.* 2015, 2018b; Jacques and Araújo 2020; Araújo *et al.* 2024; 6 -Souza *et al*. 2010b; Oliveira *et al*. 2021; 7 - Francisco *et al*. 2023; 8 - Souza *et al*. 2012; 9 - Oliveira *et al*. 2021; 10 - Albuquerque *et al.* 2015; Freitas *et al.* 2015; Bueno *et al.* 2019; Milani *et al*. 2020; 11 - Brunismann *et al*. 2016; 12 - Henrique-Simões *et al*. 2011, 2012; 13 – Present study; 14 - Souza *et al.* 2015a; 15 - Freitas *et al*. 2015; Oliveira *et al.* 2017; Bueno *et al.* 2019; Milani *et al*. 2020; Ferreira *et al*. 2022; 16 - Prezoto and Clemente 2010; Souza *et al.* 2018; 17 - Souza *et al*. 2015b, 2018; 18 - Vicente *et al* 2020; 19 - Elpino-Campos *et al*. 2007; 20 - Lopes *et al*. 2020; 21 - Jacques *et al*. 2012; 22 - Souza *et al*. 2015a; 23 - Rubim *et al*. 2023; 24 - Tomazella *et al*. 2018; 25 - Barbosa *et al.* 2022; 26 - Oliveira *et al.* 2021; 27 - Jacques *et al.* 2023; 28 - Albuquerque *et al.* 2015; Silveira 2019; 29 - Gouvêa *et al*. 2023; 30 - Oliveira *et al*. 2021; 31 - Auad *et al*. 2010; 32 - Silva-Filho *et al*. 2020.

The explanation for the PERD area harboring many rare species, and also the highest number of exclusive species, lies in different conditions: firstly, it is composed of ombrophilous forest, a formation of the Atlantic Forest Biome that is not common in the state (Kersten *et al*. 2015), forming a predominantly humid and warm environment (Cupolillo *et al*. 2021), which favors the foraging of social wasps (Lima and Prezoto 2003; Ribeiro-Junior *et al*. 2006); secondly, it is a poorly sampled phytophysiognomy in the state (Souza *et al*. 2012), which decreases the frequency of occurrence of spp. especially those restricted to this ecosystem; and third, because this UC is the largest continuous area of the biome in the state, which mitigates the fragmentation effect (Morato and Campos 2000; Graça and Somavilla 2018). These conditions provided by the ombrophilous forest likely had a positive impact on the composition of species sampled in the eucalyptus cultivation area in Dionísio (Silva-Filho *et al*. 2020), which borders the PERD. As a result, most of the species recorded there also occur in the park (Souza *et al*. 2012).

The low sampling problem also applies to the Cerrado biome, which justifies the high frequency of rare species in the PNGSV, RVSRP and PNSV. It also ratifies the need for additional studies in this biome, as suggested by Oliveira *et al*. (2021) and Francisco *et al*. (2023), given the marked loss of native area (Oliveira *et al*. 2023). In addition, studies of other arthropod taxa also show how little the environment has been studied, which is why new species are often recorded for science (Vilela *et al*. 2023, 2024) and how underestimated their richness is (Rubim *et al*. 2024).

Bambuí and Barroso, even though not part of a Conservation Area, also stand out for their large number of rare and exclusive species: *Mischocyttarus bahiae* Richards, 1945, *M. nomurae* Richards, 1978 and *Polybia erythrothorax* Richards, 1978 in Bambuí; *Mischocyttarus artifex* (Ducke, 1914), *M. buysoni* (Ducke, 1906), *M. funerulus* Zikán, 1949 and *M. saussurei* Zikán, 1949 in Barroso. In addition, Barroso has the highest richness recorded for the state. In Bambuí, the studies were carried out in a very diverse environment, featuring human constructions, agricultural areas and Cerrado fragments (Jacques *et al*. 2015, 2018a; Jacques and Araújo 2020; Araújo *et al*. 2024), which may allow for a greater supply of microhabitats for the organisms, greater protection from predators, greater availability and diversity of food resources and nesting substrates (Santos *et al*. 2007). This situation is similar to Barroso, where riparian forest formations in different stages of regeneration and conservation have been sampled (Souza *et al*. 2010a), forest and field environments (Souza and Prezoto 2006), and forest remnants of Atlantic Forest phytophysiognomies with Cerrado enclaves (Coelho *et al*. 2022). In addition, there are multiple inventories carried out in both areas, both in Bambuí (Jacques *et al*. 2015, 2018a; Jacques and Araújo 2020; Araújo *et al*. 2024) and in Barroso (Souza and Prezoto 2006; Souza *et al*. 2010a, 2014; Coelho *et al*. 2022), which may indicate that studies with long sampling periods allow for obtaining more accurate data on the local fauna.

On the other hand, the sites with the lowest percentage of rare species are mostly municipalities not located in CUs, such as Viçosa, Poços de Caldas, Coronel Pacheco, Medeiros, Santo Antônio do Amparo and São Gonçalo do Sapucaí, which was to be expected since CUs harbor more than 90% of the sampled species in the state (Oliveira *et al*. 2021), not to mention the multiple anthropogenic pressures affecting these locations. Viçosa inventory was carried out on the Federal University of Viçosa campus, an anthropized area (Jacques *et al*. 2012) similar to Poços de Caldas, pressured by eucalyptus cultivation (Gouvea *et al*. 2023), or Coronel Pacheco, Medeiros and Santo Antônio do Amparo, which were carried out in agricultural areas (Auad *et al*. 2010; Tomazella *et al*. 2018; Barbosa *et al*. 2022). These locations commonly produce poorly enriched environments (Santos *et al*. 2009), making nesting difficult, especially when not associated with native vegetation (Milani *et al*. 2020). In the municipality of São Gonçalo do Sapucaí, despite the high richness, 32 spp., anthropogenic pressures such as agricultural activity and grazing, explain why the community is composed of many synanthropic species (Oliveira *et al*. 2017) or wide geographic distribution (Souza *et al*. 2020a, b), making 50% of them frequent or constant (Tab. 1).

Undersampling effect

Contrary to what was expected and seen in most of the CUs (Tab. 1), only two localities didn't harbor any rare species: Serra do Brigadeiro State Park (PESB) and Alto Montana Private Natural Heritage Reserve (RPPNAM). This may have occurred due to the sampling methodology, since the study carried out at RPPNAM used rapid sampling, of six continuous days (Oliveira *et al*. 2021), which makes it difficult to record those accidental and rare species. This situation is similar to what happened in the study carried out at PESB, in which despite being carried out with 20 field days (Souza *et al*. 2015a), the greatest sampling effort, around 80%, was concentrated in the fall, winter and spring, with low effort in the summer, due to logistical problems (personal communication Marcos M. Souza). Therefore, under-sampling occurred in the most favorable season for these insects (Souza and Prezoto 2006), and this may have reflected in the result. However, this is not conclusive, and more collection effort would be needed in these PAs to validate this hypothesis.

Although being the most sampled state in Brazil (Souza *et al*. 2020a, b), there are areas in Minas Gerais with little or no information (Fig. 2) with emphasis on five regions: (i) Caatinga with only one study (Jacques *et al*. 2023); (ii) Cerrado, especially the 130 Conservation Units where only six (4.61%) have been inventoried (Tab. 1); (iii) the eastern portion of the Atlantic Rainforest, where there are remnants of ombrophilous forest, such as the Caparaó National Park, considered a priority area for invertebrate conservation (Drummond *et al*. 2005), which also includes the Rio Doce State Park; (iv) the northeastern and central regions of the state, with no studies; and (v) the Minas Gerais Triangle with only one study (Elpino-Campos *et al*. 2007).

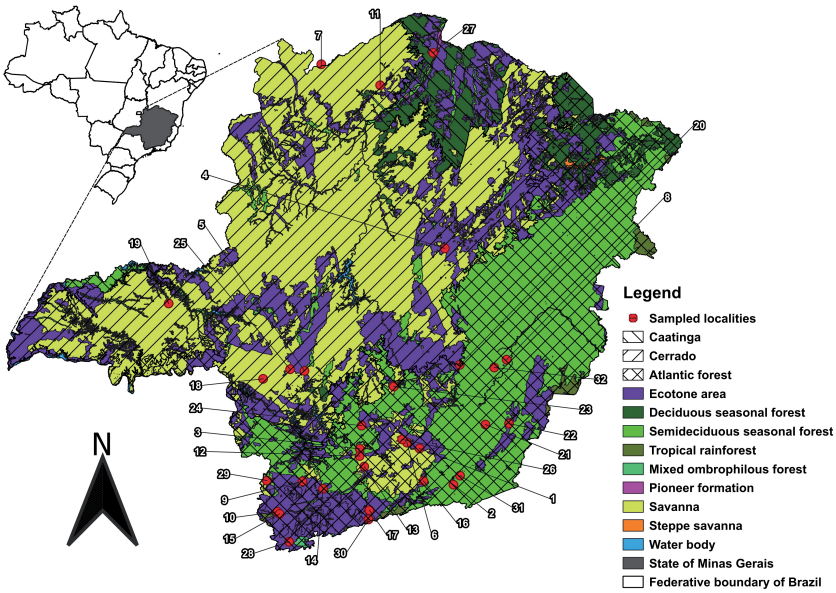

Figure 2. Localities with inventories of social wasps in the state of Minas Gerais, Brazil. / Localidades con inventarios de avispas sociales en el estado de Minas Gerais, Brasil. 1 - Barroso; 2 - Juiz de Fora; 3 - Lavras; 4 - Sempre-Vivas National Park; 5 - Bambuí; 6 - Serra de São José Environmental Protection Area; 7 - Grande Sertão Veredas National Park; 8 - Rio Doce State Park; 9 - Rio Machado Environmental Protection Area; 10 - Ouro Fino; 11 - Rio Pandeiros Wildlife Refuge; 12 - Boqueirão Biological Reserve; 13 - Luminárias; 14 - São Gonçalo do Sapucaí; 15 - Inconfidentes; 16 - Ibitipoca State Park; 17 - Serra do Papagaio State Park; 18 - Serra da Canastra National Park; 19 - Uberlândia; 20 - Peti Environmental Station; 21 - Viçosa; 22 - Serra do Brigadeiro State Park; 23 - Itatiaiuçu; 24 - Santo Antônio do Amparo; 25 - Medeiros; 26 - Ritápolis National Forest; 27 - Mata Seca State Park; 28 - Fernão Dias Environmental Protection Area; 29 - Poços de Caldas; 30 - Alto Montana Private Natural Heritage Reserve; 31 - Coronel Pacheco; 32 - Dionísio.

Species frequency

Regarding the species' frequency in the selected areas, six species were fitted as constant, ten are frequent; 12 species are accessory; 13 are sporadic; and the vast majority, 74 species, are considered rare, of which 36 were recorded in just one of the localities (Tab. 2). This high number of species considered here to be rare may be the result of different associated factors, such as availability of nesting sites, availability of food and water, altitude, plant formation, stage of regeneration and environmental conservation, fragmentation, level of anthropogenic pressure (Lawton 1983; Henriques *et al*. 1992; Graça and Somavilla 2018; Resende *et al*. 2001; Santos *et al*. 2007; Souza *et al*. 2010a; Brito *et al*. 2018; Ferreira *et al*. 2022), and even low sampling effort in many localities (Auad *et al*. 2010; Oliveira *et al*. 2021; Rubim *et al*. 2023). This is mainly because some species need very specific biotic and abiotic conditions, known as stenoecies (Dejean *et al*. 1998), as opposed to those with broad ecological valence, which therefore explore diverse environments and can nest in different conditions, such as those considered here in this study.

Table 2. Percentage frequency of species recorded in Minas Gerais state, Brazil. / **Tabla 2.** Frecuencia porcentual de especies registradas en el estado de Minas Gerais, Brasil.

Species	Frequency	Species	Frequency
Mischocyttarus drewseni de Saussure, 1857	87.50%	*Parachartergus smithii* (de Saussure, 1854)	9.38%
Polybia ignobilis (Haliday, 1836)	87.50%	*Polistes satan* Bequaert, 1940	9.38%
Mischocyttarus cassununga (R. von Ihering, 1903)	84.38%	*Polybia flavifrons* Richards, 1951	9.38%
Polybia fastidiosuscula de Saussure, 1854	81.25%	*Polybia quadricincta* de Saussure, 1854	9.38%
Polybia occidentalis (Olivier, 1791)	81.25%	*Agelaia myrmecophila* (Ducke, 1905)	6.25%
Polybia sericea (Olivier, 1791)	81.25%	*Apoica flavissima* Van der Vecht, 1972	6.25%
Brachygastra lecheguana (Latreille, 1824)	78.13%	*Apoica thoracica* du Buysson, 1906	6.25%
Protonectarina sylveirae (de Saussure, 1854)	78.13%	*Chartergus globiventris* de Saussure, 1854	6.25%
Agelaia multipicta (Haliday, 1836)	75.00%	*Mischocyttarus bertonii* Ducke, 1918	6.25%
Polistes versicolor (Olivier, 1791)	75.00%	*Mischocyttarus flavoscutellatus* Zikán, 1935	6.25%
Polybia paulista H. von Ihering, 1896	71.88%	*Mischocyttarus garbei* Zikán, 1935	6.25%
Polistes simillimus Zikán, 1951	65.63%	*Mischocyttarus labiatus* (Fabricius, 1804)	6.25%
Agelaia vicina (de Saussure, 1854)	65.63%	*Mischocyttarus punctatus* (Ducke, 1904)	6.25%
Polybia jurinei de Saussure, 1854	65.63%	*Mischocyttarus tricolor* Richards, 1945	6.25%
Mischocyttarus socialis de Saussure, 1854	62.50%	*Mischocyttarus ypiranguensis* da Fonseca, 1926	6.25%

Table 2 (continuation). Percentage frequency of species recorded in Minas Gerais state, Brazil. / **Tabla 2 (continuación).** Frecuencia porcentual de especies registradas en el estado de Minas Gerais, Brasil.

Species	Frequency	Species	Frequency
Protopolybia sedula (de Saussure, 1854)	62.50%	*Polistes carnifex* (Fabricius, 1775)	6.25%
Polistes cinerascens de Saussure, 1854	59.38%	*Polistes davillae* Richards, 1978	6.25%
Synoeca cyanea (Fabricius, 1775)	59.38%	*Polybia dimidiata* (Olivier, 1791)	6.25%
Polistes ferreri de Saussure, 1853	59.38%	*Polybia liliaceae* (Fabricius, 1804)	6.25%
Polybia chrysothorax (Lechtenstein, 1796)	59.38%	*Polybia rejecta* (Fabricius, 1798)	6.25%
Polybia scutellaris (White, 1841)	50.00%	*Brachygastra moebiana* (de Saussure, 1867)	3.13%
Parachartergus fraternus (Gribodo, 1892)	46.88%	*Epipona tatua* (Cuvier, 1797)	3.13%
Polybia platycephala Richards, 1978	46.88%	*Metapolybia docilis* Richards, 1978	3.13%
Apoica gelida Van der Vecht, 1973	43.75%	*Mischocyttarus annulatus* Richards, 1978	3.13%
Mischocyttarus rotundicollis (Cameron, 1912)	43.75%	*Mischocyttarus anthracinus* Richards, 1945	3.13%
Polybia punctata du Buysson, 1908	43.75%	*Mischocyttarus artifex* (Ducke, 1914)	3.13%
Polistes subsericeus de Saussure, 1854	40.63%	*Mischocyttarus bahiae* Richards, 1945	3.13%
Apoica pallens (Fabricius, 1804)	40.63%	*Mischocyttarus bahiaensis* Zikán, 1949	3.13%
Polistes billardieri de Saussure, 1853	37.50%	*Mischocyttarus buysoni* (Ducke, 1906)	3.13%
Polybia minarum Ducke, 1906	37.50%	*Mischocyttarus clypeatus* Zikán, 1935	3.13%
Polistes actaeon Haliday, 1836	34.38%	*Mischocyttarus camanducaia* Silveira, 2019	3.13%
Mischocyttarus paraguayensis Zikán, 1935	28.13%	*Mischocyttarus campestris* Raw, 1987	3.13%
Pseudopolybia vespiceps (de Saussure, 1864)	28.13%	*Mischocyttarus fluminensis* Zikán, 1949	3.13%
Polybia bifasciata de Saussure, 1854	28.13%	*Mischocyttarus frontalis* (Fox, 1898)	3.13%
Mischocyttarus cerberus Richards, 1940	25.00%	*Mischocyttarus funerulus* Zikán, 1949	3.13%
Protopolybia exigua (de Saussure, 1854)	25.00%	*Mischocyttarus interjectus* Zikán, 1935	3.13%
Brachygastra augusti (de Saussure, 1854)	21.88%	*Mischocyttarus montei* Zikán, 1949	3.13%
Mischocyttarus ignotus Zikán, 1949	21.88%	*Mischocyttarus mourei* Zikán, 1949	3.13%

Table 2 (continuation). Percentage frequency of species recorded in Minas Gerais state, Brazil. / **Tabla 2 (continuación).** Frecuencia porcentual de especies registradas en el estado de Minas Gerais, Brasil.

Species	Frequency	Species	Frequency
Mischocyttarus mirificus Zikán, 1935	21.88%	*Mischocyttarus nomurae* Richards, 1978	3.13%
Polybia striata (Fabricius, 1787)	21.88%	*Mischocyttarus saussurei* Zikán, 1949	3.13%
Parachartergus pseudapicalis Willinck, 1959	21.88%	*Mischocyttarus proximus* Zikán, 1949	3.13%
Agelaia pallipes (Olivier, 1791)	18.75%	*Mischocyttarus wygodzinskyi* Zikán, 1949	3.13%
Mischocyttarus latior (Fox, 1898)	18.75%	*Parachartergus wagneri* du Buysson, 1904	3.13%
Mischocyttarus marginatus (Fox, 1898)	15.63%	*Polistes bicolor* Lepeletier, 1836	3.13%
Mischocyttarus matogrossoensis Zikán, 1935	15.63%	*Polistes canadensis* (Linnaeus, 1758)	3.13%
Mischocyttarus parallellogrammus Zikán, 1935	15.63%	*Polistes erythrocephalus* Latreille 1813	3.13%
Mischocyttarus wagneri (du Buysson, 1908)	15.63%	*Polistes germinatus geminatus* Fox, 1898	3.13%
Polistes lanio (Fabricius, 1775)	15.63%	*Polistes goeldii* Ducke, 1904	3.13%
Polistes pacificus Fabricius, 1804	15.63%	*Polistes melanossoma* de Saussure, 1853	3.13%
Agelaia centralis (Cameron, 1907)	12.50%	*Polistes occipitalis* Ducke, 1904	3.13%
Chartergellus communis Richards, 1978	12.50%	*Polybia bistriata* (Fabricius, 1804)	3.13%
Clypearia angustior Ducke, 1906	12.50%	*Polybia erythrothorax* Richards, 1978	3.13%
Mischocyttarus confusus Zikán, 1935	12.50%	*Polybia lugubris* de Saussure, 1854	3.13%
Mischocyttarus giffordi Raw, 1985	12.50%	*Polybia signata* Ducke, 1905	3.13%
Mischocyttarus iheringi Zikán, 1935	12.50%	*Protopolybia pumila* (de Saussure, 1863)	3.13%
Polybia ruficeps Richards, 1978	12.50%	*Polybia diguetana* (Buysson, 1905)	3.13%
Synoeca surinama (Linnaeus, 1767)	12.50%	*Polistes cavapytiformis* Richards, 1978*	0.00%
Agelaia angulata (Fabricius, 1804)	9.8%	*Polybia brunnea* (Curtis, 1844)*	0.00%
Metapolybia cingulata (Fabricius, 1804)	9.8%	*Polybia emaciata* Lucas, 1879*	0.00%

*species recorded for Minas Gerais state lacking accurate locality.

Differences in community composition

According to the Principal Coordinates Analysis (PCoA) and subsequent PERMANOVA test (Fig. 3), there was a statistical difference between the social wasp community between the Atlantic Forest and Cerrado biomes (p= 0.0019), which corroborates studies that suggest

that there are species of social wasps that may be restricted to these biomes (Souza *et al*. 2020a, b). Some species only occur in habitats with specific substrate conditions (Dejean *et al* 1998; Santos and Gobbi 1998; Cruz *et al*. 2006), which may justify this difference in the communities, in addition to the heterogeneous characteristics of their phytophysiognomies (Oliveira-Filho 2006), also regarding rainfall, temperature and plant formations (Penereiro *et al*. 2018; Oliveira Júnior *et al*. 2021).

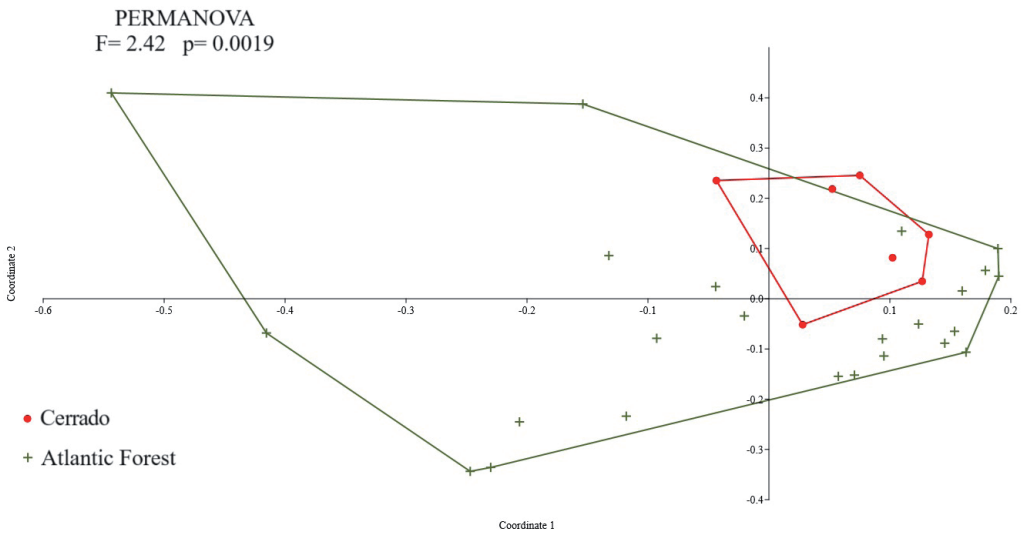

Figure 3. PCoA analysis and PERMANOVA test of the social wasp community between different biomes, identified by different colors. Cerrado: blue; Atlantic Forest: green; Atlantic Forest-Cerrado transition: brown. The results of the PERMANOVA test are shown at the top. / **Figura 3.** Análisis de PCoA y prueba PERMANOVA de la comunidad de avispas sociales entre diferentes biomas, identificados por diferentes colores. Cerrado: azul; Mata Atlántica: verde; transición Mata Atlántica-Cerrado: marrón. Los resultados de la prueba PERMANOVA se muestran en la parte superior.

These environmental differences can also be seen in the Cluster analysis (Fig. 4), which shows that the Atlantic Forest areas are generally separate from the Cerrado areas. Concerning the Caatinga, the only study carried out in the Mata Seca State Park (PEMS) (Jacques *et al*. 2023) was distinct from other studies, as this park is home to the so-called Mata Seca phytophysiognomy, a deciduous forest, which has two well-defined climatic seasons, one rainy followed by another with a long dry period, in which more than 50% of the trees are leafless (Belém *et al*. 2021), and only the best adapted species can survive (Jacques *et al*. 2023).

According to the cluster analysis, two groups of Cerrado areas were formed, the first consisting of three locations (PNSC, PNSV, BAM); the PNSC and the PNSV have 55% similarity, even though they are about 380 km apart (Google Earth 2024). However, they have similar phytophysiognomies, with areas of Cerrado influenced by the Atlantic Forest, and the presence of rupestrian grasslands (Vicente *et al*. 2020; Souza *et al*. 2020b). Bambuí (BAM), although not part of a Conservation Unit, is also located in a Cerrado - Atlantic Forest ecotone area (Fig. 2), as well as belonging to the Serra da Canastra region, located around 60 km from the PNSC (Google Earth 2024). Therefore, this similarity must be reflected in the transitional ecosystems between different biomes.

The second Cerrado group is made up of the areas RVSRP, PNGSV, and UBE, that are part of CUs (Elpino-Campos *et al*. 2007; Francisco *et al*. 2023). In UBE, collections took place in two CUs and an area outside a CU (Elpino-Campos *et al*. 2007). The similarity between

the communities (52%), once again, suggests that it is related to the biome, since PNGSV and UBE, although very distant from each other, about 495 km (Google Earth 2024), are both located in the Cerrado, with no influence from the Atlantic Forest (Elpino-Campos *et al*. 2007; Francisco *et al*. 2023). Within this group, the outermost branch is the RVSRP, probably because it is located in a transition region of Cerrado associated with dry forest formations (Brunismann *et al*. 2016), considered the arboreal Caatinga (Prado 2005). Finally, concerning the Cerrado area of MED, the fauna showed little similarity to other sites, because as already mentioned, the inventory was carried out in an agricultural area (Barbosa *et al*. 2022) and with the lowest richness for the Cerrado.

About the most similar groupings of Atlantic Forest areas, three groups of areas outside CUs were observed. One of them is formed by SGS, OFI, and INC, which have the greatest similarity between the areas, reaching 78% between OFI and SGS. This may be explained as they share similar phytophysiognomies (montane semi-deciduous forest), rural properties with coffee cultivation amid remnants of this forest formation (Freitas *et al*. 2015; Milani 2020) and because they are 90 km close to each other (Google Earth 2024). On the other hand, INC is a neighboring municipality to Ouro Fino, with a similarity of almost 70%, which was expected because they are very close to each other.

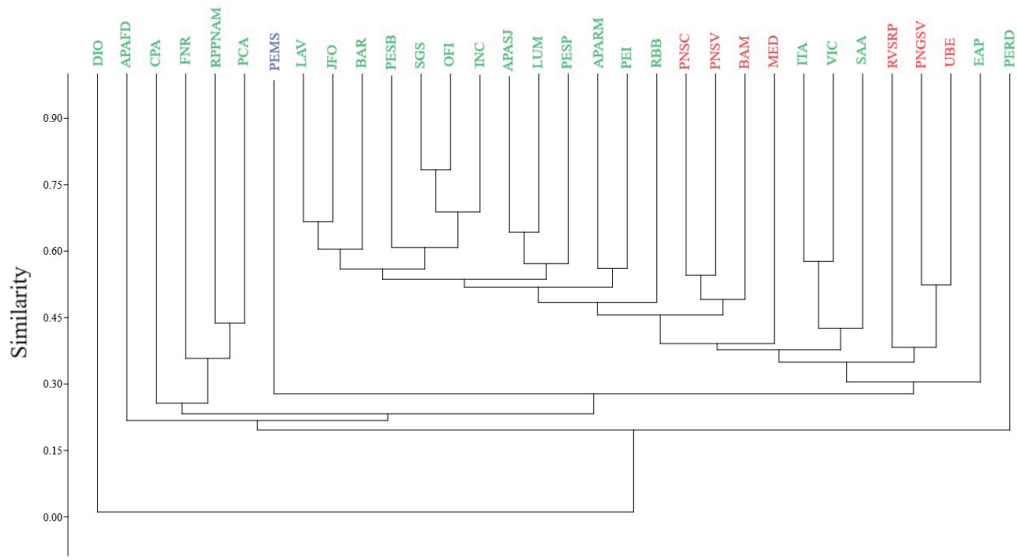

Figure 4. Cluster analysis of social wasp faunas from different localities and biomes in Minas Gerais, Brazil. / Análisis de conglomerados de faunas de avispas sociales de diferentes localidades y biomas en Minas Gerais, Brasil. DIO = Dionísio; APAFD = Fernão Dias Environmental Protection Area; PEMS = Mata Seca State Park; RVSRP = Rio Pandeiros Wildlife Refuge; PNGSV = Grande Sertão Veredas National Park; PNSV = Sempre-Vivas National Park; UBE = Uberlândia; RBB = Boqueirão Biological Reserve; APARM = Rio Machado Environmental Protection Area; JFO = Juiz de Fora; LAV = Lavras; SGS = São Gonçalo do Sapucaí; OFI = Ouro Fino; BAR = Barroso; PEI = Ibitipoca State Park; PESP = Serra do Papagaio State Park; LUM = Luminárias; APASJ = Serra de São José Environmental Protection Area; PESB = Serra do Brigadeiro State Park; PNSC = Serra da Canastra National Park; INC = Inconfidentes; BAM = Bambuí; MED = Medeiros; ITA = Itatiaiuçu; VIC = Viçosa; EAP = Peti Environmental Station; FNR = Ritápolis National Forest; RPPNAM = Alto Montana Private Natural Heritage Reserve; PCA = Poços de Caldas; CPA = Coronel Pacheco; PERD = Rio Doce State Park; SAA - Santo Antônio do Amparo. Biomes: Atlantic Forest = green; Cerrado = red; Caatinga = blue.

The second group was formed by JFO, LAV, and BAR, probably due to the sampling sites, carried out in remnants of the Atlantic Forest in different stages of succession and conservation, with the influence of anthropogenic action, such as grazing or various human constructions (Barbosa *et al*. 2016; Jacques *et al*. 2018b; Coelho *et al*. 2022). Another factor may be the proximity between the areas, with 92 km between JFO and BAR, 185 km between JFO and LAV, and 104 km between LAV and BAR (Google Earth 2024). In addition, these locations show the highest species richness, with a percentage of similar species classification.

The third group is made up of the ITA and VIC areas, with 60% similarity and separated by a distance of around 173 km (Google Earth 2024). The study in ITA was carried out with a rapid three-day sampling (Rubim *et al*. 2023), making it difficult to record accidental and rare species. In VIC, the study area is highly anthropized (Jacques *et al*. 2012), with the presence of many species considered synanthropic (Oliveira *et al*. 2017). Due to these factors, in both areas, there is a high percentage of frequent and constant species, as well as a low diversity, which makes the communities very similar.

Furthermore, we can notice that some inventories bear little resemblance to the others, such as DIO, PERD and APAFD. About PERD and DIO, this is similar to what has already been discussed with rare and exclusive species. The study in the APAFD was carried out at high altitude, between 1,800 and 2,100 m, a condition that fewer social wasp species can exploit (Albuquerque *et al*. 2015; Souza *et al*. 2015a; Oliveira *et al*. 2021), as there is a decrease in resources and foraging area (Janzen 1973), as well as a decrease in temperature. These conditions impair foraging as flight generally requires body temperature to be higher than that of the environment (Hozumi *et al*. 2010), selecting some species, such as *Mischocyttarus camanducaia* Silveira, 2019 and *M. mourei* Zikán, 1949, which only occur in this location, and therefore proved to be different from other studies.

Social wasp fauna in the municipality of Luminárias

A total of 34 social wasp species were collected and 172 colonies were recorded (Tab. 3).

Table 3. Recorded species and number of social wasp colonies (Vespidae: Polistinae) in Luminárias, Minas Gerais state, Brazil. / **Tabla 3.** Especies registradas y número de colonias de avispas sociales (Vespidae: Polistinae) en Luminárias, estado de Minas Gerais, Brasil.

Recorded species	No. of colonies
Agelaia multipicta (Haliday, 1836)	01
Apoica gelida Van der Vecht, 1972	01
Brachygastra lecheguana (Latreille, 1824)	00
Mischocyttarus cassununga (R. von Ihering, 1903)	17
Mischocyttarus drewseni (de Saussure, 1857)	10
Mischocyttarus iheringi Zikán, 1935	05
Mischocyttarus marginatus (Fox, 1898)	00
Mischocyttarus mirificus (Zikán, 1935)	04
Mischocyttarus parallellogrammus Zikán, 1949	37
Mischocyttarus rotundicollis (Cameron, 1912)	11
Mischocyttarus socialis (de Saussure, 1854)	01
Mischocyttarus wagneri (Buysson, 1908)	05

Table 3 (continuation). Recorded species and number of social wasp colonies (Vespidae: Polistinae) in Luminárias, Minas Gerais state, Brazil. / **Tabla 3 (continuación).** Especies registradas y número de colonias de avispas sociales (Vespidae: Polistinae) en Luminárias, estado de Minas Gerais, Brasil.

Recorded species	No. of colonies
Mischocyttarus ypiranguensis Fonseca, 1926	05
Parachartergus pseudapicalis Willinck, 1959	02
Polistes billardieri (Fabricius, 1804)	02
Polistes cinerascens de Saussure, 1857	00
Polistes ferreri (de Saussure, 1853)	02
Polistes simillimus (Zikán, 1951)	00
Polistes subsericeus (de Saussure, 1854)	00
*Polistes versicolor (*Olivier, 1791)	10
Polybia chrysothorax (Lechtenstein, 1796)	02
Polybia fastidiosuscula de Saussure, 1854	34
Polybia ignobilis (Halliday, 1836)	00
Polybia minarun Ducke, 1906	00
Polybia occidentalis (Olivier, 1791)	01
Polybia paulista (Von Ihering, 1896)	04
Polybia platycephala Richards, 1951	01
Polybia punctata Buysson, 1908	00
Polybia scutellaris (White, 1841)	07
Polybia sericea (Oliver, 1791)	00
Polybia sp.	01
Protonectarina sylveirae (de Saussure, 1854)	03
Protopolybia sedula (de Saussure, 1854)	03
Synoeca cyanea (Fabricius, 1775)	03
Total richness (S)	**34**
Nest abundance	**172**

Species frequency

The species with the highest number of colonies were *Mischocyttarus parallelogrammus* Zikán, 1935 with 37, and *Polybia fastidiosuscula* de Saussure, 1854 with 34. Nests of *M. parallellogrammus* are small and of the gymnodomous stellocyst type (Togni 2014). They were mostly found on rocks close to water resources, where they nest at an average height of 2.3m and are active throughout the year (Togni 2014). This may have made them easier to locate, and the species may have found very favorable abiotic and biotic conditions in the sampled environments, but this would need to be further assessed. This species is considered rare (15.63%) for the state of Minas Gerais (Tab. 2), occurring only in the Atlantic Forest in the municipality of Viçosa, the Rio Machado Environmental Protection Area, the Serra do Papagaio State Park and the municipality of Barroso (Jacques *et al*. 2012; Souza *et al*. 2015a; Oliveira *et al*. 2021; Coelho *et al*. 2022). On the other hand, *P. fastidiosuscula*, considered a constant species (81.25%) (Tab. 2), has wide geographical distribution, where it explores different phytophysiognomies and biomes (Souza *et al*. 2015; Oliveira *et al*. 2021; Francisco

et al. 2023), except for the Caatinga (Jacques *et al*. 2023), which would explain the result obtained. In addition, this species builds large nests, of the phragmocyst type, around 30 cm long (Saraiva *et al*. 2017), another facilitator for visualizing colonies.

Rare occurrences and community composition

Among the recorded species, two had only been previously reported in CUs in Minas Gerais: *Mischocyttarus marginatus* (Fox) and *M. ypiranguensis* da Fonseca (Oliveira *et al*. 2021). Both species are considered rare (Tab. 2). *Mischocyttarus marginatus* is distributed in the Atlantic Forest, in the RBB and APASJ (Souza *et al*. 2010; Henrique-Simões *et al*. 2011). In the Cerrado, it occurs in UBE and PNSV (Elpino-Campos *et al*. 2007; Souza *et al*. 2020b), as well as in the states of Goiás, Mato Grosso and São Paulo, with no information on localities (Richards 1978; Souza *et al*. 2020a, b). In Minas Gerais, *Mischocyttarus ypiranguensis* occurs in the Atlantic Forest, in APASJ (Souza *et al*. 2010), and the region of Santo Amaro and Guarulhos in São Paulo state (Richards 1978). In addition to these, two other species recorded in LUM are considered rare: *Mischocyttarus wagneri* (du Buysson) and *M. iheringi* Zikán. This information, added to the considerable richness based on other studies (Souza *et al*. 2020a, b), allows us to infer that LUM is home to a vespid fauna that is relevant to the state of Minas Gerais.

Furthermore, based on the Cluster analysis (Fig. 3), LUM formed a group together with other areas located within CUs (PESP and APASJ), with a similarity of more than 60% between them, probably because they are located within Atlantic Forest areas with Cerrado enclaves (Fig. 2). In addition, APASJ also has rocky field formations, as does LUM. Another factor is the proximity of LUM to PESP and APASJ: around 71 km for PESP and 86 km for APASJ (Google Earth 2024). The similarity of LUM, a non-preserved locality, with CU areas, reinforces that this area still maintains an important diversity of social wasps, which needs to be protected, as has already been discussed for other arthropods (Silva *et al*. 2011).

Regarding sampling sufficiency, we observed that the Bootstrap 1 estimator (38.66) was within the 95% confidence interval of the collector's accumulation curve for the study area. In addition, the graph curve reached the asymptote, showing that probably 95% of the species richness of the area was collected, indicating, therefore, a sufficient sampling effort (Fig. 5).

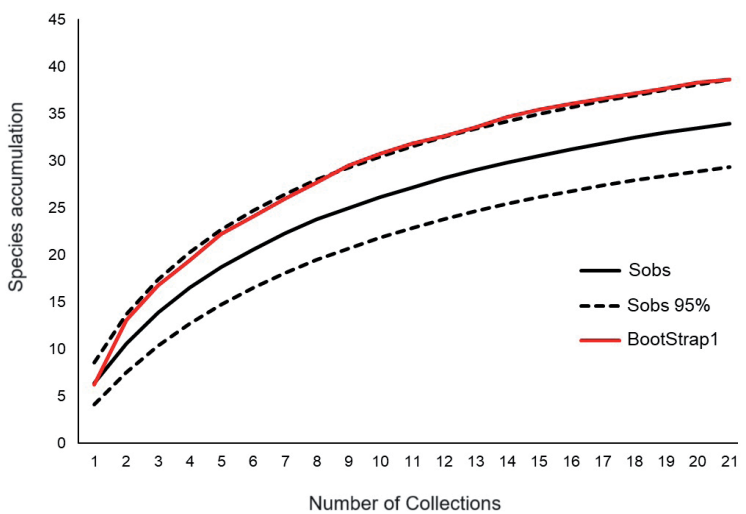

Figure 5. Species accumulation curve for social wasps collected in LUM, using observed species richness, within a 95% confidence interval, and estimated species richness (Bootstrap 1). / **Figura 5.** Curva de acumulación de especies de avispas sociales recolectadas en LUM, utilizando la riqueza de especies observada, dentro de un intervalo de confianza del 95%, y la riqueza de especies estimada (Bootstrap 1).

Conclusions

Minas Gerais state is home to a rich diversity of social wasps, with 65% of rare species, mainly in areas within Conservation Units, attesting to the importance of these locations for species preservation. However, most of the studies are centered on areas of semi-deciduous forest in the Atlantic Rainforest, indicating the need for more inventories in the ombrophilous forest in the east and northeast of the State, in Caatinga and Cerrado conservation units. The similarity of fauna among the sampled locations is influenced by the biome, but there are some mitigating factors, such as inclusion in conservation units, geographical distance, ecotones, phytophysiognomy, degree of conservation, anthropogenic pressures, altitude and sampling effort. In relation to LUM, it has a considerable diversity of rare social wasps, only previously recorded in Conservation Units. This corroborates the need for creating a conservation unit in the region of that municipality.

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Author Contributions

GCJ: Investigation, writing - original draft, visualization. **LDB:** Investigation, visualization. **DSV:** Writing - review & editing, photography. **JCMD:** Writing - original draft, map creation. **LCPS:** Writing - review & editing, supervision. **MMS:** Investigation, writing - review & editing, supervision.

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Appendix

Appendix 1. Diversity of social wasps (Vespidae: Polistinae) from different locations in Minas Gerais, Brazil. / **Apéndice 1.** Diversidad de avispas sociales (Vespidae: Polistinae) de diferentes localidades en en Minas Gerais, Brasil. 1 = presence, 0 = absence. PEMS = Mata Seca State Park; BAM = Bambuí; MED = Medeiros; PNGSV = Grande Sertão Veredas National Park; PNSC = Serra da Canastra National Park; PNSV = Sempre-vivas National Park; RVSRP = Rio Pandeiros Wildlife Refuge; UBE = Uberlândia; APAFD = Fernão Dias Environmental Protection Area; APARM = Rio Machado Environmental Protection Area; APASJ = Serra de São José Environmental Protection Area; BAR = Barroso; CPA = Coronel Pacheco; DIO = Dionísio; EAP = Peti Environmental Station; FNR = Ritápolis National Forest; INC = Inconfidentes; ITA = Itatiaiuçu; JFO = Juiz de Fora; LAV = Lavras; LUM = Luminárias; OFI = Ouro Fino; PCA = Poços de Caldas; PEI = Ibitipoca State Park; PERD = Rio Doce State Park; PESB = Serra do Brigadeiro State Park; PESP = do Papagaio State Park; RPPNAM = Alto Montana Private Natural Heritage Reserve; RBB = Boqueirão Biological Reserve; SGS = São Gonçalo do Sapucaí; SAA = Santo Antônio do Amparo; VIC =Viçosa.

Biomes	Caatinga	Cerrado							Atlantic Forest						
Species/Location	**PEMS**	**BAM**	**MED**	**PNGSV**	**PNSC**	**PNSV**	**RVSRP**	**UBE**	**APAFD**	**APARM**	**APASJ**	**BAR**	**CPA**	**DIO**	**FNR**
Agelaia angulata (Fabricius)	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
Agelaia centralis (Cameron)	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Agelaia multipicta (Haliday)	0	1	0	1	1	1	1	0	1	1	1	1	1	0	1
Agelaia myrmecophila (Ducke)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Agelaia pallipes (Olivier)	0	0	0	1	1	0	0	1	0	0	0	1	0	0	0
Agelaia vicina (de Saussure)	0	0	0	0	1	1	1	0	0	1	1	1	1	0	1
Apoica flavissima Van der Vecht	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Apoica gelida Van der Vecht	0	1	1	0	1	1	1	0	0	0	0	1	0	0	1
Apoica pallens (Fabricius)	0	0	0	1	0	1	1	1	0	1	1	1	0	0	0
Apoica thoracica du Buysson	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0
Brachygastra augusti (de Saussure)	0	0	0	1	0	0	1	0	0	1	0	1	0	0	0
Brachygastra lecheguana (Latreille)	1	1	1	1	1	1	1	1	0	1	1	1	0	0	0
Brachygastra moebiana (de Saussure)	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Chartergellus communis Richards	0	0	0	1	0	1	1	1	0	0	0	0	0	0	0
Chartergus globiventris de Saussure	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0
Clypearia angustior Ducke	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Epipona tatua (Cuvier)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Metapolybia cingulata (Fabricius)	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0
Metapolybia docilis Richards	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mischocyttarus annulatus Richards	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mischocyttarus anthracinus Richards	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mischocyttarus artifex (Ducke)	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Mischocyttarus bahiae Richards	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Mischocyttarus bahiaensis Zikán	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mischocyttarus bertonii Ducke	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0

Biomes	Caatinga	Cerrado							Atlantic Forest						
Species/Location	PEMS	BAM	MED	PNGSV	PNSC	PNSV	RVSRP	UBE	APAFD	APARM	APASJ	BAR	CPA	DIO	FNR
Mischocyttarus buysoni (Ducke)	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Mischocyttarus clypeatus Zikán	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mischocyttarus camanducaia Silveira	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Mischocyttarus campestris Raw	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Mischocyttarus cassununga (R. von Ihering)	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
Mischocyttarus cerberus Richards	0	1	0	1	1	1	1	1	0	0	0	0	0	0	0
Mischocyttarus confusus Zikán	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
Mischocyttarus drewseni de Saussure	1	1	1	1	1	1	1	1	0	1	1	1	1	0	1
Mischocyttarus flavoscutellatus Zikán	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mischocyttarus fluminensis Zikán	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mischocyttarus frontalis (Fox)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mischocyttarus funerulus Zikán	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Mischocyttarus garbei Zikán	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Mischocyttarus giffordi Raw	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0
Mischocyttarus ignotus Zikán	0	1	0	0	0	1	0	0	0	1	0	1	0	0	0
Mischocyttarus iheringi Zikán	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Mischocyttarus interjectus Zikán	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Mischocyttarus labiatus (Fabricius)	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Mischocyttarus latior (Fox)	0	1	0	1	0	1	0	1	0	0	1	0	0	0	0
Mischocyttarus marginatus (Fox)	0	0	0	0	0	1	0	1	0	0	1	0	0	0	0
Mischocyttarus matogrossoensis Zikán	1	1	0	1	1	1	0	0	0	0	0	0	0	0	0
Mischocyttarus mirificus Zikán	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0
Mischocyttarus montei Zikán	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Mischocyttarus mourei Zikán	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Mischocyttarus nomurae Richards	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Mischocyttarus paraguayensis Zikán*	1	1	0	0	0	0	0	0	0	0	0	1	0	0	1

Biomes	Caatinga	Cerrado							Atlantic Forest						
Species/Location	PEMS	BAM	MED	PNGSV	PNSC	PNSV	RVSRP	UBE	APAFD	APARM	APASJ	BAR	CPA	DIO	FNR
Mischocyttarus parallellogrammus Zikán	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0
Mischocyttarus proximus Zikán	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mischocyttarus punctatus (Ducke)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Mischocyttarus rotundicollis (Cameron)	0	1	0	1	1	1	1	0	0	0	1	1	0	0	0
Mischocyttarus saussurei Zikán	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Mischocyttarus socialis de Saussure**	0	0	0	1	0	1	0	1	0	1	1	1	0	0	1
Mischocyttarus tricolor Richards	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Mischocyttarus wagneri (du Buysson)	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
Mischocyttarus wygodzinskyi Zikán	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mischocyttarus ypiranguensis da Fonseca	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Parachartergus fraternus (Gribodo)	0	0	0	1	0	1	1	0	0	1	1	1	0	0	0
Parachartergus pseudapicalis Willinck	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0
Parachartergus smithii (de Saussure)	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0
Parachartergus wagneri du Buysson	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Polistes actaeon Haliday	0	1	0	0	0	0	0	0	0	1	0	1	0	0	0
Polistes bicolor Lepeletier	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Polistes billardieri de Saussure	0	0	0	1	1	0	0	1	0	0	1	1	0	0	0
Polistes canadensis (Linnaeus)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polistes carnifex (Fabricius)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Polistes cavapytiformis Richards***	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polistes cinerascens de Saussure	1	0	0	0	1	1	0	1	0	1	1	1	0	0	0
Polistes davillae Richards	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1

Biomes	Caatinga	Cerrado							Atlantic Forest						
Species/Location	PEMS	BAM	MED	PNGSV	PNSC	PNSV	RVSRP	UBE	APAFD	APARM	APASJ	BAR	CPA	DIO	FNR
Polistes erythrocephalus Latreille	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Polistes ferreri de Saussure	1	1	1	1	1	1	0	1	0	1	1	1	0	0	0
Polistes germinatus geminatus Fox	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polistes goeldii Ducke	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polistes lanio (Fabricius)	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Polistes melanossoma de Saussure****	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polistes occipitalis Ducke	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polistes pacificus Fabricius	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
Polistes satan Bequaert	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0
Polistes simillimus Zikán	0	1	0	1	1	1	1	1	1	1	1	1	0	0	0
Polistes subsericeus de Saussure	0	0	0	1	1	1	1	1	0	1	1	1	0	0	0
Polistes versicolor (Olivier)	1	1	1	1	1	1	0	1	0	1	1	1	0	0	1
Polybia bifasciata de Saussure	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0
Polybia bistriata (Fabricius)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polybia brunnea (Curtis)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polybia chrysothorax (Lechtenstein)	0	1	1	0	1	1	1	0	0	0	1	1	0	0	0
Polybia diguetana (Buysson)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polybia dimidiata (Olivier)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polybia emaciata Lucas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polybia erythrothorax Richards	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Polybia fastidiosuscula de Saussure	0	1	1	1	1	1	0	0	1	1	1	1	0	0	1
Polybia flavifrons Richards	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Polybia ignobilis (Haliday)	1	1	1	1	1	1	1	1	0	1	1	1	1	0	1
Polybia jurinei de Saussure	0	1	1	0	1	1	1	1	0	1	1	1	0	0	0
Polybia liliaceae (Fabricius)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Polybia lugubris de Saussure	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Biomes	Caatinga	Cerrado							Atlantic Forest						
Species/Location	**PEMS**	**BAM**	**MED**	**PNGSV**	**PNSC**	**PNSV**	**RVSRP**	**UBE**	**APAFD**	**APARM**	**APASJ**	**BAR**	**CPA**	**DIO**	**FNR**
Polybia minarum Ducke	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0
Polybia occidentalis (Olivier)	1	1	1	1	1	1	1	1	1	0	1	1	0	0	1
Polybia paulista H. von Ihering	0	1	1	1	1	1	0	1	1	1	1	1	0	0	1
Polybia platycephala Richards	0	0	0	0	0	0	0	1	0	1	1	1	0	0	1
Polybia punctata du Buysson	0	1	0	0	0	0	1	0	1	1	0	1	0	0	0
Polybia quadricincta de Saussure	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0
Polybia rejecta (Fabricius)	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Polybia ruficeps Richards	0	0	0	1	0	1	1	1	0	0	0	0	0	0	0
Polybia scutellaris (White)	0	0	0	0	0	0	0	1	1	1	1	1	0	0	1
Polybia sericea (Olivier)	1	1	0	1	1	1	1	1	0	1	1	1	1	0	0
Polybia signata Ducke	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polybia striata (Fabricius)	0	0	0	1	0	0	0	1	0	0	0	0	1	1	0
Protonectarina sylveirae (de Saussure)	1	1	1	1	1	1	1	0	1	1	1	1	0	0	0
Protopolybia exigua (de Saussure)	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Protopolybia pumila (de Saussure)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Protopolybia sedula (de Saussure)	0	1	1	1	1	1	1	0	0	1	1	1	0	0	0
Pseudopolybia vespiceps (de Saussure)	0	1	0	1	1	0	0	1	0	1	0	1	0	0	0
Synoeca cyanea (Fabricius)	0	1	1	0	0	1	0	0	0	1	1	1	0	0	0
Synoeca surinama (Linnaeus)	0	0	0	1	0	1	1	1	0	0	0	0	0	0	0
Species richness	**14**	**36**	**16**	**36**	**29**	**39**	**33**	**28**	**12**	**35**	**36**	**49**	**7**	**5**	**15**

* *M. consimilis* and *M. araujoi* are synonyms
** *M. atramentarius* is synonymous
*** Registration in the biological collection of social wasps (CBVS) of IFSULDEMINAS (Souza 2024)
****Also registered at Parque Estadual Nova Baden, Lambari
***** Recorded by Richards (1978)

Biomes	Atlantic Forest																
Species/Location	**EAP**	**INC**	**ITA**	**JFO**	**LAV**	**LUM**	**OFI**	**PCA**	**PEI**	**PERD**	**PESB**	**PESP**	**RPPNAM**	**RBB**	**SAA**	**SGS**	**VIC**
Agelaia angulata (Fabricius)	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Agelaia centralis (Cameron)	0	0	1	0	1	0	0	0	0	1	0	0	0	0	0	0	0
Agelaia multipicta (Haliday)	1	1	1	1	1	1	1	1	1	0	0	1	1	0	1	1	1
Agelaia myrmecophila (Ducke)	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Agelaia pallipes (Olivier)	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Agelaia vicina (de Saussure)	0	1	1	1	1	0	1	1	1	0	1	1	1	0	1	1	1
Apoica flavissima Van der Vecht	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apoica flavissima Van der Vecht	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apoica gelida Van der Vecht	0	1	0	0	0	1	1	0	0	0	0	1	1	1	0	1	0
Apoica pallens (Fabricius)	0	0	0	1	1	0	0	0	1	1	0	0	0	0	1	0	1
Apoica thoracica du Buysson	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Brachygastra augusti (de Saussure)	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0
Brachygastra lecheguana (Latreille)	0	1	1	1	1	1	1	0	1	1	1	1	0	1	1	1	1
Brachygastra moebiana (de Saussure)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chartergellus communis Richards	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chartergus globiventris de Saussure	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Clypearia angustior Ducke	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0
Epipona tatua (Cuvier)	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Metapolybia cingulata (Fabricius)	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Metapolybia docilis Richards	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Mischocyttarus annulatus Richards	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Mischocyttarus anthracinus Richards	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Mischocyttarus artifex (Ducke)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mischocyttarus bahiae Richards	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Biomes	Atlantic Forest																
Species/Location	**EAP**	**INC**	**ITA**	**JFO**	**LAV**	**LUM**	**OFI**	**PCA**	**PEI**	**PERD**	**PESB**	**PESP**	**RPPNAM**	**RBB**	**SAA**	**SGS**	**VIC**
Mischocyttarus bahiaensis Zikán	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Mischocyttarus bertonii Ducke	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mischocyttarus buysoni (Ducke)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mischocyttarus clypeatus Zikán	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mischocyttarus camanducaia Silveira	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mischocyttarus campestris Raw	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mischocyttarus cassununga (R. von Ihering)	1	1	1	1	1	1	1	1	1	0	1	1	0	1	0	1	1
Mischocyttarus cerberus Richards	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Mischocyttarus confusus Zikán	1	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0
Mischocyttarus drewseni de Saussure	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1
Mischocyttarus flavoscutellatus Zikán	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0
Mischocyttarus fluminensis Zikán	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Mischocyttarus frontalis (Fox)	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Mischocyttarus funerulus Zikán	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mischocyttarus garbei Zikán	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mischocyttarus giffordi Raw	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Mischocyttarus ignotus Zikán	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	1	0
Mischocyttarus iheringi Zikán	0	0	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0
Mischocyttarus interjectus Zikán	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mischocyttarus labiatus (Fabricius)	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Mischocyttarus latior (Fox)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Mischocyttarus marginatus (Fox)	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0
Mischocyttarus matogrossoensis Zikán	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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Mischocyttarus mirificus Zikán	0	1	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0
Mischocyttarus montei Zikán	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mischocyttarus mourei Zikán	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mischocyttarus nomurae Richards	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mischocyttarus paraguayensis Zikán*	0	0	0	1	1	0	1	0	0	0	1	0	0	0	0	1	0
Mischocyttarus parallellogrammus Zikán	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	1
Mischocyttarus proximus Zikán	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Mischocyttarus punctatus (Ducke)	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Mischocyttarus rotundicollis (Cameron)	1	1	0	1	1	1	1	0	0	1	1	1	0	1	0	1	0
Mischocyttarus saussurei Zikán	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mischocyttarus socialis de Saussure**	1	0	1	1	1	1	1	1	1	1	0	0	1	1	0	1	1
Mischocyttarus tricolor Richards	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Mischocyttarus wagneri (du Buysson)	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0
Mischocyttarus wygodzinskyi Zikán	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mischocyttarus ypiranguensis da Fonseca	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Parachartergus fraternus (Gribodo)	0	1	1	1	1	0	1	0	1	0	0	0	0	1	1	1	1
Parachartergus pseudapicalis Willinck	1	1	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0
Parachartergus smithii (de Saussure)	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Parachartergus wagneri du Buysson	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polistes actaeon Haliday	0	1	0	1	1	0	0	0	1	1	0	0	0	1	0	1	1

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Polistes bicolor Lepeletier	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polistes billardieri de Saussure	0	0	0	1	1	1	0	0	1	0	0	1	0	1	0	1	0
Polistes canadensis (Linnaeus)	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Polistes carnifex (Fabricius)	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Polistes cavapytiformis Richards***	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polistes cinerascens de Saussure	0	1	0	1	1	1	1	1	1	0	1	1	1	1	0	1	0
Polistes davillae Richards	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polistes erythrocephalus Latreille	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polistes ferreri de Saussure	0	0	0	1	1	1	1	0	1	0	1	0	0	1	1	1	0
Polistes germinatus geminatus Fox	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Polistes goeldii Ducke	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Polistes lanio (Fabricius)	0	1	0	0	0	0	1	0	0	0	0	0	0	1	0	1	0
Polistes melanossoma de Saussure****	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Polistes occipitalis Ducke	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Polistes pacificus Fabricius	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0
Polistes satan Bequaert	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polistes simillimus Zikán	0	1	0	1	1	1	1	1	1	0	1	1	0	0	0	1	1
Polistes subsericeus de Saussure	0	0	0	1	1	1	0	0	0	0	0	1	0	1	0	0	0
Polistes versicolor (Olivier)	1	1	0	1	1	1	1	1	1	1	0	0	0	1	1	1	1
Polybia bifasciata de Saussure	1	0	0	1	1	0	0	0	0	1	0	0	0	1	1	0	1
Polybia bistriata (Fabricius)	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Polybia brunnea (Curtis)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polybia chrysothorax (Lechtenstein)	1	1	0	1	1	1	1	0	0	1	1	1	0	1	1	1	0
Polybia diguetana (Buysson)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0

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Polybia dimidiata (Olivier)	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Polybia emaciata Lucas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polybia erythrothorax Richards	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polybia fastidiosuscula de Saussure	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1
Polybia flavifrons Richards	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Polybia ignobilis (Haliday)	1	1	0	1	1	1	1	1	1	1	1	1	0	1	1	1	1
Polybia jurinei de Saussure	1	1	1	1	1	0	1	0	0	1	1	0	0	1	1	1	1
Polybia liliaceae (Fabricius)	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Polybia lugubris de Saussure	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Polybia minarum Ducke	0	1	0	0	1	1	1	0	1	0	1	1	0	1	0	1	0
Polybia occidentalis (Olivier)	1	1	1	1	1	1	1	0	1	1	1	1	0	1	1	1	0
Polybia paulista H. von Ihering	0	1	1	1	1	1	1	0	1	0	1	1	0	1	0	1	1
Polybia platycephala Richards	1	1	1	1	1	1	0	0	0	1	1	1	0	0	1	0	1
Polybia punctata du Buysson	0	1	0	0	1	1	1	1	0	0	0	1	1	0	1	1	0
Polybia quadricincta de Saussure	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Polybia rejecta (Fabricius)	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Polybia ruficeps Richards	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polybia scutellaris (White)	1	1	0	1	1	1	1	1	1	0	1	1	0	0	0	1	0
Polybia sericea (Olivier)	1	1	1	1	1	1	1	0	1	1	1	1	0	1	1	1	1
Polybia signata Ducke	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Polybia striata (Fabricius)	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0
Protonectarina sylveirae (de Saussure)	1	1	1	1	1	1	1	0	1	0	1	1	0	1	1	1	1
Protopolybia exigua (de Saussure)	1	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	1
Protopolybia pumila (de Saussure)	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0

Biomes	**Atlantic Forest**																
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Protopolybia sedula (de Saussure)	1	1	0	1	1	1	1	0	0	0	1	1	1	1	0	1	0
Pseudopolybia vespiceps (de Saussure)	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1	0
Synoeca cyanea (Fabricius)	0	1	1	1	1	1	1	0	1	1	1	0	1	1	0	1	1
Synoeca surinama (Linnaeus)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Species richness	26	32	19	41	39	33	34	13	29	35	22	29	10	33	18	32	22

* *M. consimilis* and *M. araujoi* are synonyms
** *M. atramentarius* is synonymous
*** Registration in the biological collection of social wasps (CBVS) of IFSULDEMINAS (Souza 2024)
****Also registered at Parque Estadual Nova Baden, Lambari
***** Recorded by Richards (1978)