Acta Scientiarum
http://periodicos.uem.br/ojs
ISSN on-line: 1807-863X
http://doi.org/10.4025/actascibiolsci.v48i1.77799

Social wasp community (Vespidae: Polistinae) from *Campo Rupestre* associated with Atlantic Forest in a Conservation Unit in southeastern Brazil

Jeicilene Barros Carvalho[1*], Andressa Negri Palandi[2], Francesca Victorino Zabatiero[2], Thainara Brito Gonçalves[4], Orlando Tobias Silveira[5], Gabriel de Castro Jacques[1] and Marcos Magalhães de Souza[2]

[1]Instituto Federal de Educação, Ciência e Tecnologia de Minas Gerais, Campus Bambuí, Fazenda Varginha, Rodovia Bambuí/Medeiros, Km 05, Bambuí, 38900, Minas Gerais, Brazil. [2]Instituto Federal de Educação, Ciência e Tecnologia do Sul de Minas Gerais, Campus Inconfidentes, Inconfidentes, Minas Gerais, Brazil. [4]Universidade Federal de Lavras, Lavras, Minas Gerais, Brazil. [5]Museu Paraense Emílio Goeldi, Belém, Pará, Brazil. *Author for correspondence. E-mail: jeicilenebarroscarvalho@gmail.com

ABSTRACT. Social wasps (Hymenoptera: Vespidae) play important ecological roles, such as pollination and biological control; however, certain Brazilian biomes, such as the *Campo Rupestre*, remain under-sampled. In this context, the present study aimed to inventory the community of these insects in a *Campo Rupestre* area associated with Atlantic Forest vegetation in the Pico do Itambé State Park, southeastern Brazil. Complementary sampling methods (active search, attractive traps, and Malaise trap) were employed over the course of one year. A total of 50 species from 10 genera were recorded, including three new records for the state of Minas Gerais. The high species richness observed is likely related to the region's environmental complexity, altitudinal variation, and vegetation mosaic. These findings highlight the importance of conservation units located in ecotonal zones as priority areas for the conservation of the Neotropical social wasp fauna.

Keywords: Biodiversity; espinhaço range; inventory; conservation.

Received on July 10, 2025
Accepted on September 15, 2025

Introduction

Campo Rupestre is considered by some authors to be a physiognomic subtype of the Cerrado (Ribeiro et al. 1998), while others regard it as a distinct biome (Oliveira et al. 2015; Silveira et al. 2016). Although it covers only about 3% of Brazil's territory, it harbors approximately 15% of the country's flora, exhibits high rates of endemism, and represents the center of distribution for several botanical families (Giulietti & Hensold, 1990; Mello-Silva, 2008). This ecosystem is characterized by quartzite outcrops occurring above 900 meters in elevation and is embedded in a mosaic landscape with the Atlantic Forest, Caatinga, and Cerrado biomes, being most prevalent in the states of Bahia, Goiás, and Minas Gerais (Silveira et al. 2016). Despite its ecological significance, there are still substantial knowledge gaps regarding many taxonomic groups, including social wasps (Vespidae: Polistinae) (Souza et al. 2010; Prezoto & Clemente, 2010), therefore, although Minas Gerais is the best-studied Brazilian state for social wasps, biomes such as the *Campo Rupestre* remain poorly sampled, which creates gaps in biogeographic understanding and conservation planning

These eusocial insects provide key ecosystem services, such as biological control of arthropod populations and pollination of various plant species (Prezoto et al. 2019; Brock et al. 2021). Although the number of studies on species distribution and occurrence has increased in the 21st century, particularly in the state of Minas Gerais (Barbosa et al. 2016; Jacques et al. 2024), many areas remain unexplored, including conservation units that encompass *Campo Rupestre*, such as the Pico do Itambé State Park, located in the Espinhaço Mountain Range, recognized by UNESCO for its biological and cultural heritage (Silveira et al. 2019), and lacking information on social wasp communities.

Moreover, additional factors reinforce the importance of studying the biodiversity of this park. The area also includes patches of Atlantic Forest, a global biodiversity hotspot (Myers et al. 2000), which harbors half of Brazil's known social wasp fauna (Souza et al. 2020a). Furthermore, the park is classified as a Strictly Protected Conservation Unit, a category considered a strategic tool for safeguarding natural resources and biodiversity in Brazil (Salvio, 2017; Silva et al. 2024). Therefore, based on the above, we expect to record a

remarkable diversity of social wasps in this Conservation Unit. Thus, the objective of this study is to inventory the social wasp fauna of the Pico do Itambé State Park, in the state of Minas Gerais, southeastern Brazil.

Materials and methods

The study was conducted in the Pico do Itambé State Park (PEPI) (18°26'37.7"S; 43°20'20.4"W), a protected area located in central Minas Gerais, encompassing the municipalities of Santo Antônio do Itambé, Serro, and Serra Azul de Minas. Covering an area of 6,520 hectares, the park is part of the Espinhaço Mountain Range complex and is notable for its rich diversity of landscapes, fauna, and flora, with predominant formations belonging to the Atlantic Forest and *Campo Rupestre* biomes. Altitudinal variation within the park ranges from 700 to 2,060 meters (Kamino et al., 2008; Chaves et al., 2012; Cardoso et al., 2020). In addition to its scenic importance, the park is known as the region's 'water tower' because it hosts numerous springs and serves as a natural divide between the Jequitinhonha and Doce river basins (IEF, 2025).

The regional climate is characterized by hot and humid summers and dry winters, influenced by the topography of the Espinhaço Range. The rainy season occurs mainly between November and March, with average annual precipitation ranging from 1,250 to 1,550 mm. Mean annual temperatures fluctuate between 18°C and 19°C, reaching highs of 35°C in summer and lows of 4°C in winter (Neves et al., 2005).

Fieldwork was conducted in four sampling campaigns during May, September, and December 2024, and February 2025. Each campaign lasted six consecutive days, totaling 24 sampling days. Sampling activities occurred in two daily shifts, from 9:00 a.m. to 1:00 p.m. and from 4:00 p.m. to 6:00 p.m., resulting in six hours of sampling per day and a total of 144 hours of sampling effort. Collections were carried out in seven areas, all with the presence of water, *Campo Rupestre* associated with the Atlantic Forest: Cachoeira do Neném (18º25'13"S, 43º18'27"W), Cachoeira da Fumaça (18°27'06"S, 43º20'05"W), Cachoeira do Rio Vermelho (18º22'57"S, 43º18'13"W), Cachoeira da Água Santa (18°26'18"S, 43º17'50"W), Trilha do Tropeiro (18º26'44"S, 43º20' 42"W); and *Campo Rupestre*: Campina (18º29'30"S, 43°21'51"W), and Pico do Itambé (18º 23'54" S, 43º 20'55"W) (Figure 1).

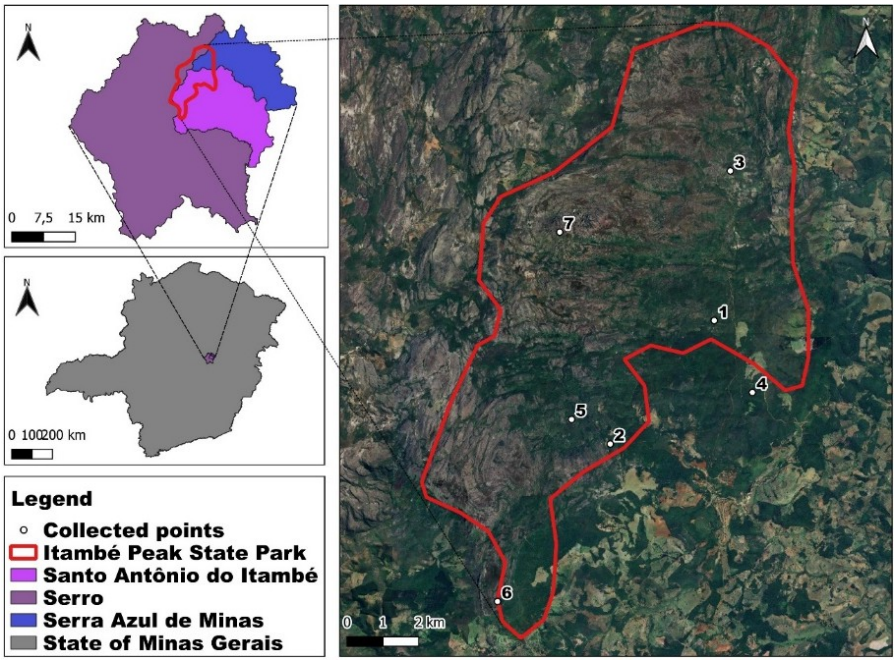

Figure 1. Location of sampling points in the Pico do Itambé State Park, Minas Gerais, southeastern Brazil. The points represent different collection environments: Forest - Cachoeira do Neném (5), Cachoeira da Fumaça (4), and Cachoeira do Rio Vermelho (6); Forest and *Campo Rupestre* - Trilha do Tropeiro (1) and Cachoeira da Água Santa (2); *Campo Rupestre* - Campina (3) and Pico do Itambé (7). (Authors, 2025).

Specimens were collected using a combination of different sampling methods to maximize the representativeness of the studied wasp fauna (Barbosa et al., 2020). Three complementary techniques were employed: active search, attractive traps, and a Malaise trap. The active search was conducted by two teams, each composed of five researchers, who followed preexisting trails near watercourses, within and at the edges of forest fragments, as well as in *Campo Rupestre* environments. Substrates likely to harbor colonies or

foraging individuals, such as trees, shrubs, rocks, and flowers, were carefully inspected. Specimens were captured using entomological nets and, in the case of colonies, were also recorded through photographic documentation (Francisco et al., 2023).

Attractive traps were made from two-liter PET bottles with three triangular openings (2 × 2 × 2 cm) cut into the sides, 10 cm from the base (Souza et al., 2015a). Each trap contained approximately 200 mL of a natural attractant prepared with 2 L of water, 200 g of passion fruit pulp (two to three fruits), and 200 g of granulated sugar, yielding enough solution for about ten traps (Palandi et al., 2025). Forty attractive traps were deployed per campaign (20 in *Campo Rupestre* and 20 in Atlantic Forest), spaced 10 m apart along elevational gradients, positioned 1.5 m above the ground, and left in the field for six consecutive days. All collections were conducted under research permit (IEF-MG: 017/2024; SISBIO: 93039-1).

The Malaise trap was installed suspended over a stream in a *Campo Rupestre* area and strategically positioned to intercept natural vegetation corridors that facilitate the movement of social wasps (Souza et al., 2015a). This setup enabled the passive capture of flying individuals. The collecting container, filled with 70% ethanol, was replaced monthly throughout the sampling period to ensure proper preservation of specimens.

All collected specimens were preserved in 70% ethanol and identified by Prof. Dr. Marcos Magalhães de Souza using dichotomous keys (Richards, 1978; Somavilla et al., 2021), with species identifications confirmed by Dr. Orlando Tobias da Silveira from the *Museu Paraense Emílio Goeldi*, Belém, Pará. The material was deposited in the Social Wasps Biological Collection (CBVS) of the *Instituto Federal do Sul de Minas* (IFSULDEMINAS).

To assess species frequency within the state of Minas Gerais, the classification proposed by Jacques et al. (2024) was adopted: rare (0–19.99%); accidental (20–39.99%); accessory (40–59.99%); frequent (60–79.99%); constant (80–100%). Sampling effort was evaluated by constructing a species accumulation curve, randomized with 1000 permutations, based on observed richness and 95% confidence intervals, using the Bootstrap 1 estimator in the EstimateS 9.1.0 software (Cowell & Elsensohn, 2014).

Results and discussion

A total of 50 species from 10 genera were recorded, including three new occurrences for the state of Minas Gerais, Brazil (Table 1). This represents the highest species richness ever documented for a single locality in the state, which is considered the best-sampled region in the country (Barbosa et al., 2016; Jacques et al., 2024).

Table 1. Tribe, species, and number of colonies recorded in Pico do Itambé State Park, Minas Gerais, Brazil. Classification of species according to their frequency in inventories from Minas Gerais (MG), Brazil, based on Jacques et al. (2024): rare (0–19.99%); accidental (20–39.99%); accessory (40–59.99%); frequent (60–79.99%); constant (80–100%); 'ND' - no data. Ecosystem of occurrence (F. = Atlantic Forest, C. = *Campo Rupestre*)

Tribe/Species	Number of colonies	Frequency/MG	Ecosystem
Epiponini			
Agelaia cf. *centralis* (Cameron, 1907)	00	ND	F.
Agelaia multipicta multipicta (Haliday, 1836)	00	Frequent	F.
Agelaia vicina (de Saussure, 1854)	00	Frequent	F.
Apoica flavissima Van der Vecht, 1973	01	Frequent	F. and C.
Apoica pallens (Lepeletier, 1836)	01	Rare	F. and C.
Brachygastra augusti (de Saussure, 1854)	01	Accidental	F.
Brachygastra lecheguana (Latreille, 1824)	00	Frequent	F. and C.
Metapolybia decorata (Gribodo, 1896)	04	New record	C.
Polybia dimidiata (Olivier, 1791)	00	Rare	F. and C.
Polybia fastidiosuscula de Saussure, 1854	01	Constant	F.
Polybia hecuba (Richards, 1951)	04	Rare*	F. and C.
Polybia ignobilis (Haliday, 1836)	00	Constant	F. and C.
Polybia jurinei de Saussure, 1854	00	Frequent	F. and C.
Polybia minarum Ducke, 1906	00	Accidental	F.
Polybia occidentalis occidentalis (Olivier, 1791)	01	Constant	F. and C.
Polybia sericea (Olivier, 1791)	00	Constant	F. and C.
Polybia (Myrapetra) sp.**	00	ND	F. and C.
Protonectarina sylveirae (de Saussure, 1854)	00	Frequent	F.
Protopolybia diligens (Smith, 1857)	00	New record	F.
Protopolybia exigua exigua (de Saussure,1854)	00	Accidental	F. and C.
Synoeca cyanea (Fabricius, 1775)	02	Accessory	F. and C.
Synoeca surinama (Linnaeus, 1767)	01	Rare	F. and C.

Mischocyttarini			
Mischocyttarus cassununga (R. von Ihering, 1903)	16	Constant	F. and C.
Mischocyttarus drewseni de Saussure, 1857	25	Constant	F. and C.
Mischocyttarus flavoscutellatus Zikán, 1949	00	Rare	F. and C.
Mischocyttarus giffordi Raw, 1985	02	Rare	F. and C.
M*ischocyttarus (Kappa)* sp.**	00	ND	F. and C.
Mischocyttarus cf. *lecointei*	02	ND	C.
Mischocyttarus matogrosoensis Zikán, 1949	00	Rare	C.
Mischocyttarus marginatus (Fox, 1898)	01	Rare	C.
Mischocyttarus (Megacanthopus) sp.**	01	ND	C.
Mischocyttarus mirificus Zikán, 1935	01	Accidental	F.
Mischocyttarus (Monogynoecus) sp. 1**	01	ND	F. and C.
M*ischocyttarus (Monogynoecus)* sp. 2**	01	ND	F. and C.
Mischocyttarus nomurae Richards, 1978	02	Rare	F. and C.
Mischocyttarus parallelogrammus Zikán, 1935	02	Rare	F. and C.
Mischocyttarus paulistanus Zikán, 1935	00	New record	C.
Mischocyttarus rotundicollis (Cameron, 1912)	12	Accessory	F. and C.
Mischocyttarus saussurei Zikán, 1949	02	Rare	F.
Mischocyttarus socialis Olivier, 1791	24	Frequent	F. and C.
Mischocyttarus wagneri (du Buysson, 1908)	02	Rare	F.
Polistini			
Polistes actaeon Halliday, 1836	01	Accidental	F. and C.
Polistes billardieri Fabricius, 1804	00	Accidental	C.
Polistes canadensis canadensis Linnaeus, 1758	00	Rare	C.
Polistes carnifex carnifex (Fabricius, 1775)	00	Rare	F. and C.
Polistes cinerascens de Saussure, 1854	03	Accessory	F. and C.
Polistes ferreri de Saussure, 1853	00	Accessory	F. and C.
Polistes satan Bequaert, 1940	06	Rare	C.
Polistes subsericeus de Saussure, 1854	00	Accessory	C.
Polistes versicolor versicolor (Olivier, 1791)	08	Frequent	F. and C.

* Considered by Jacques et al. (2024) as *Polybia flavifrons hecuba* Richards, 1978. ** Morphospecies pending identification.

The high species richness recorded can be attributed to a combination of ecological and methodological factors. Among the ecological aspects, the geographic location of the park stands out, as it is situated in a transition zone between different biomes. This setting favors the overlap of distinct faunal assemblages, allowing the occurrence of both species typical of adjacent biomes and taxa adapted to intermediate ecological conditions (Vidal et al., 2023). This mosaic of vegetation types contributes to increased structural and functional heterogeneity of the landscape, enhancing the availability of trophic resources (Law & Dickman, 1998) and providing suitable substrates for nesting (Souza et al., 2010).

In the context of *Campo Rupestre*, the high diversity of angiosperms (Silveira et al., 2016) is another key factor, as it directly influences the availability of nectar and pollen, essential resources for social wasps, as well as the plant substrates used in nest construction (Richter, 2000). Studies have shown that floristic composition affects both foraging activity and colony establishment in these insects (Sguarizi-Antonio et al., 2021; Mohamadzade et al., 2024).

Another environmental variable that contributes to the observed richness is the altitudinal variation in the park, which ranges from 700 m to over 2,000 m. This altitudinal gradient generates diverse microclimates and alters vegetation structure, gradually shifting from arboreal to herbaceous cover, thereby creating a floristic mosaic that may influence food availability and positively affect the composition and structure of social wasp communities (Albuquerque et al., 2015; Perillo et al., 2017; Ribeiro et al., 2019). Higher altitudes, for example, can support species adapted to lower temperatures, greater solar radiation, and sparse vegetation (Souza et al., 2015a), whereas lower altitudes are more favorable to species associated with forests or those inhabiting riparian zones (Souza et al., 2020a). Thus, altitudinal variation functions as a key factor in ecological niche segregation, allowing the coexistence of multiple species within the same geographic area. It is important to note that above 2,000 meters the abiotic conditions become more severe, reducing the richness of social wasps (Perillo et al., 2017; Ribeiro et al., 2019).

Another important factor for the successful sampling effort was the implementation of an integrated methodological approach, an approach recommended by several authors (Souza & Prezoto, 2006; Clemente et al., 2020) to enhance the taxonomic representativeness of Vespidae inventories.

The combination of active and passive sampling methods enabled the detection of species with different activity patterns (diurnal or crepuscular), behavioral traits (more or less attracted to fermentative odors), and

habitat preferences (closed forests, open areas, or ecotonal interfaces), highlighting the importance of complementary approaches in entomological inventories (Souza et al., 2015a). Active searching is used to detect visible colonies and foraging individuals on flowers, vegetation substrates, and near water bodies (Francisco et al., 2024). In contrast, attractive traps captured species with more pronounced olfactory behavior (Jacques et al., 2018). Finally, the Malaise trap, as a passive method, intercepted flying individuals that might not be visually detected, including those that nest in more hidden and/or camouflaged locations (Souza et al., 2020b).

The effectiveness of the applied methods is further evidenced by the colony detection patterns: for 44% of the recorded species, the nests were not located, which highlights the importance of additional strategies for species sampling.

A total of 128 colonies were recorded (Table 1), with 77 (60.15%) belonging to four species: *Mischocyttarus drewseni* de Saussure, 1857 (n = 25), *Mischocyttarus socialis* Olivier, 1791 (n = 24), *Mischocyttarus cassununga* (R. von Ihering, 1903) (n = 16) (Figure 2B, C and D), and *Mischocyttarus rotundicollis* (Cameron, 1912) (n = 12).

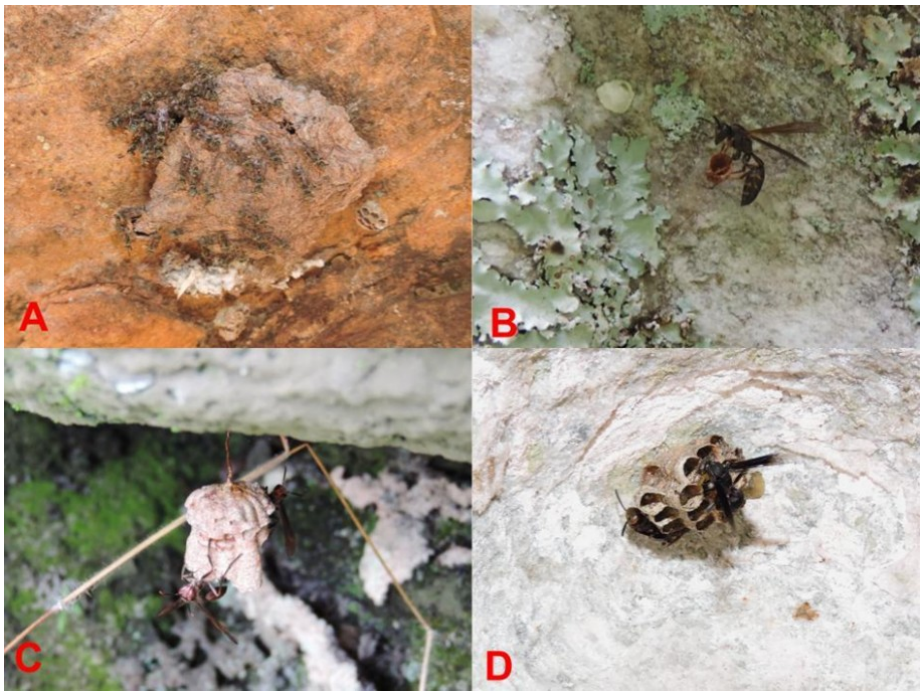

Figure 2. *Metapolybia decorata* (A), new record for the state of Minas Gerais; and species nesting on rock surfaces, *Mischocyttarus cassununga* (B), *Mischocyttarus drewseni* (C), and *Mischocyttarus socialis* (D) in Pico do Itambé State Park, Minas Gerais, Brazil. Authors, 2025.

This pattern may be explained by different factors that confer ecological advantages to these species, allowing them to survive under diverse abiotic and biotic conditions and resulting in greater nesting success compared to other wasps. First, these species exploit a wide range of environments, from natural areas to agricultural and urban ecosystems (Auad et al., 2010; Souza et al., 2016; Silva et al., 2019; Milani et al., 2020). Second, they are considered synanthropic, showing high plasticity in habitat occupation (Oliveira et al., 2017). Finally, they use a variety of nesting substrates, including plants, slopes, human constructions, rocks, and even bird nests (Souza et al., 2010; Souza et al., 2015b; Oliveira & Souza, 2024; Carvalho et al., 2025).

In addition to these aspects, specific environmental factors of the *Campo Rupestre* may also have influenced the observed abundance. Among them, a possible tolerance to marked variations in air temperature and wind, which are common features of this mountainous relief in the Espinhaço Range (Neves et al., 2005), stands out. Another relevant factor is the availability of water in this biome, characterized by shallow or absent soils that limit water retention and groundwater formation (Vasconcelos, 2011). In this context, adapted plants such as bromeliads store water in their rosettes and form micro-reservoirs (Versieux et al., 2008), which may be exploited by *Mischocyttarus* species. However, no studies have yet confirmed this hypothesis, and further data are needed to more robustly evaluate the relationship between these environmental factors and the nesting success of the recorded species.

According to the classification proposed by Jacques et al. (2024), 43.2% of the species collected in Pico do Itambé State Park (PEPI) are considered rare for the state of Minas Gerais, occurring in fewer than 20% of

existing inventories. The species composition also highlights the potential of PEPI as a priority area for the conservation of social wasp diversity, particularly due to the presence of *Campo Rupestre* vegetation associated with patches of Atlantic Forest. The protection of this area as a Strict Protection Conservation Unit reinforces the strategic role of the park in maintaining biodiversity at both regional and national scales (Salvio, 2017; Silva et al., 2024).

Among these rare species, three stand out as new records for the state of Minas Gerais, raising the number of known social wasp species in the state to 121 (Jacques et al., 2024). *Protopolybia diligens* (Smith, 1857), previously recorded in northern and central-western Brazil (Amazonas, Amapá, Maranhão, Pará, and Mato Grosso) and in several Amazonian countries (Colombia, Peru, Bolivia, and Ecuador), is typically associated with the Amazon biome (Santos et al., 2017). Its record in PEPI is particularly noteworthy as it represents a significant geographical disjunction and constitutes the first record in Brazil outside the Amazon Forest.

Metapolybia decorata (Gribodo, 1896) (Figure 2A) has a wide distribution, with occurrences in the Amazon (Amazonas and Pará), Northeast (Bahia), Southeast (Rio de Janeiro), and South (Santa Catarina) regions of Brazil, as well as in other South American countries such as Paraguay, Peru, and Bolivia (Richards, 1978; Hermes & Somavilla, 2025). This heterogeneous distribution highlights the generalist and adaptable nature of the species, capable of inhabiting distinct forest formations, including Atlantic and Amazon Forests, as well as subtropical environments.

Mischocyttarus paulistanus Zikán, 1935, previously known only from the states of São Paulo and Rio de Janeiro (Richards, 1978; Hermes & Somavilla, 2025), is likely a species typical of the Atlantic Forest (Souza et al., 2020a), although it has been rarely recorded (Tanaka Junior & Noll, 2011). Its presence in PEPI may be associated with Atlantic Forest patches that provide suitable vegetation structure and microclimatic conditions aligned with the species' ecological requirements.

Polybia hecuba Richards, 1951 was not listed in the compilation of social wasps from Minas Gerais by Jacques et al. (2024). This absence is due to a recent taxonomic revision of the *Polybia occidentalis* (Olivier, 1791) group, which includes morphologically similar species such as *P. scrobalis* Richards, 1970 and *P. flavifrons* Richards, 1978. In this revision, Amorim et al. (2024) elevated the subspecies *P. flavifrons hecuba* Richards, 1978, previously reported by Jacques et al. (2024), to full species status, now recognized as *P. hecuba*.

Mischocyttarus lecointei (Ducke, 1918) has no confirmed records for the state of Minas Gerais. The subspecies *M. lecointei lecointei* has been reported from the states of Amazonas, Amapá, and Pará, as well as from French Guiana, while *M. lecointei guianensis* is known only from Guiana (Richards, 1978). In the present study, it was not possible to confirm whether the specimen identified as *Mischocyttarus* cf. *lecointei* indeed belongs to this species; however, its occurrence may represent a new record for Minas Gerais.

A total of ten species were recorded exclusively in the *Campo Rupestre*, 11 only in the Atlantic Forest, and 29 occurred in both biomes (Table 1). However, caution is required when interpreting these records as indicative of habitat exclusivity. This limitation arises from the fact that social wasps may nest in one location and forage in another, traveling variable distances depending on the species, ranging from 48 to 300 m (Detoni & Prezoto, 2021). Furthermore, the PEPI is situated in a transitional zone between *Campo Rupestre* and Atlantic Forest, which hampers precise delimitation of biomes at most sampled sites (Chaves et al., 2012).

Considering only nesting records, some species were found exclusively in *Campo Rupestre*, such as *M. decorata*, *Mischocyttarus marginatus* (Fox, 1898), and *Polistes satan* Bequaert, 1940, which may indicate stronger ecological affinity with this environment. The abundance of rocky outcrops, frequently used as nesting substrates by social wasps (Souza et al., 2010), may have contributed to this pattern. It is noteworthy that *M. marginatus* and *P. satan* are considered rare species in Minas Gerais, whereas *M. decorata*, as already mentioned, represents a new record for the state (Jacques et al., 2024).

Finally, the scarcity of studies in *Campo Rupestre* areas (Souza et al., 2010) poses an additional challenge to understanding the ecology of social wasps in this biome. In this context, the findings presented here help to fill knowledge gaps and highlight the need for further research, especially in view of the increasing anthropogenic pressures on *Campo Rupestre*, such as mining activity (Morandi et al., 2020).

Regarding sampling sufficiency, the Bootstrap 1 estimator (57.51) did not fall within the 95% confidence interval of the species accumulation curve for the study area (56.43). This suggests that the sampling effort may have been close to sufficient, but additional species may be recorded with continued effort, with a potential to reach up to 60 species (Figure 3).

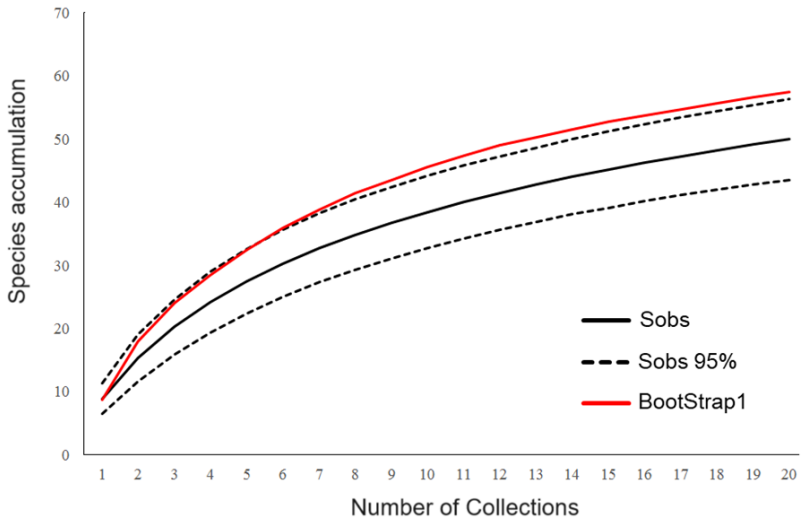

Figure 3. Species accumulation curve for social wasps collected in Pico do Itambé State Park, Minas Gerais, Brazil, based on observed species richness within a 95% confidence interval and the estimated richness (Bootstrap 1). Authors, 2025.

Conclusion

This study revealed a high species richness of social wasps in Pico do Itambé State Park, with a total of 50 species recorded, including three new records for the state of Minas Gerais. This represents the highest number of species ever reported for a single locality in the state, reflecting the influence of the environmental mosaic between *Campo Rupestre* and Atlantic Forest, the altitudinal variation, and the use of a diversified sampling effort. The high proportion of rare species reinforces the strategic role of the park in regional biodiversity conservation. The results highlight the importance of expanding inventories in ecotonal areas and high-altitude environments, especially within protected areas, thereby contributing to the understanding and management of the Neotropical social wasp fauna.

Acknowledgments

We thank the staff of Pico do Itambé State Park for their field support; the environmental manager Júlio César Moreira Dobicz for the map; the IEF-MG and SISBIO for granting the research licence; and the *Instituto Federal do sul de Minas* (IFSULDEMINAS), Inconfidentes Campus, and the *Instituto Federal de Minas Gerais* (IFMG), Bambuí Campus, for logistical support.

References

Albuquerque, C. H. B., Souza, M. M., & Clemente, M. A. (2015). Comunidade de vespas sociais (Hymenoptera, Vespidae) em diferentes gradientes altitudinais no sul do estado de Minas Gerais, Brasil. *Biotemas*, *28*(4), 131–138. https://doi.org/10.5007/2175-7925.2015v28n4p131

Amorim, D. C. A., Junior, J. N. A. S., Filho, F. D. S. C., Silveira, O. T., & Carpenter, J. M. (2024). Taxonomic study of wasp species in the *Polybia (Myrapetra) occidentalis* group morphologically related to *P. scrobalis* and *P. flavifrons*, with description of a new species (Hymenoptera, Vespidae, Polistinae). *Zootaxa*, *5477*(5), 537–562. https://doi.org/10.11646/zootaxa.5477.5.2

Auad, A. M., Carvalho, C. A., Clemente, M. A., & Prezoto, F. (2010). Diversity of social wasps (Hymenoptera) in a silvipastoral system. *Sociobiology*, *55*(2), 627–636.

Barbosa, B. C., Corrêa, B., Maciel, T. T., & Prezoto, F. (2016). Studies of social wasp diversity in Brazil: Over 30 years of research, advancements and priorities. *Sociobiology*, *63*(3), 858–880. https://doi.org/10.13102/sociobiology.v63i3.1031

Barbosa, B. C., Maciel, T. T., & Prezoto, F. (2020). Efficiency of social wasp sampling methods. *Brazilian Journal of Development*, *6*(10), 83225–83236. https://doi.org/10.34117/bjdv6n10-670

Brock, R. E., Cini, A., & Sumner, S. (2021). Ecosystem services provided by aculeate wasps. *Biological Reviews*, *96*(4), 1645–1675. https://doi.org/10.1111/brv.12719

Cardoso, P. H., Santos, J. B., & Silva, A. A. (2020). Verbenaceae no Parque Estadual do Pico do Itambé, Estado de Minas Gerais, Brasil. *Hoehnea*, *47*, e122020. https://doi.org/10.1590/2236-8906-12/2020

Carvalho, J. B., Jacques, G. C., Oliveira, G. C. S., Moura, A. S., & Souza, M. M. (2025). Nesting of *Mischocyttarus socialis* (Saussure, 1854) (Vespidae: Polistinae) inside the abandoned nest of *Tolmomyias sulphurescens* (Spix, 1825) (Passeriformes: Rhynchocyclidae) in Southeastern Brazil. *Entomología Mexicana*, *12*, 5–10.

Chaves, M. L. S. C., Andrade, K. W., & Benitez, L. (2012). Pico do Itambé, Serra do Espinhaço, MG. Imponente relevo residual na superfície de erosão Gondwana. *Sítios Geológicos e Paleontológicos do Brasil*. https://www.sigep.eco.br/sitio057/sitio057.pdf

Clemente, M. A., Coelho, E. L., Milani, L. R., Souza, M. M., & Souza, A. S. B. (2020). Community structure and composition of social wasps (Hymenoptera: Vespidae) in different vegetation types in São Paulo, Brazil. *Sociobiology*, *67*(3), 449–461. https://doi.org/10.13102/sociobiology.v67i3.5444

Cowell, R. K., & Elsensohn, J. E. (2014). EstimateS turns 20: Statistical estimation of species richness and shared species from samples, with non-parametric extrapolation. *Ecography*, *37*(6), 609–613. https://doi.org/10.1111/ecog.00814

Detoni, M., & Prezoto, F. (2021). The foraging behaviour of Neotropical social wasps. In F. Prezoto, F. S. Nascimento, B. C. Barbosa, & A. Somavilla (Eds.), *Neotropical Social Wasps* (pp. 45–69). Springer. https://doi.org/10.1007/978-3-030-72805-3_18

Francisco, S. C. C., Renne, D. G. S., Jacques, G. C., & Souza, M. M. (2024). Vespas sociais (Vespidae: Polistinae): Nidificação e ocorrência de parasitoides no Cerrado Brasileiro. *Acta Biologica Brasiliensia*, *7*(1), 38–51. https://doi.org/10.18554/acbiobras.v7i1.7645

Francisco, S. C. C., Silva, H. M., Clemente, M. A., & Souza, M. M. (2023). Social wasps (Vespidae: Polistinae) in Cerrado and Caatinga conservation units, Minas Gerais, Brazil. *Biota Neotropica*, *23*, e20231563. https://doi.org/10.1590/1676-0611-BN-2023-1563

Giulietti, A. M., & Hensold, N. (1990). Padrões de distribuição geográfica dos gêneros de Eriocaulaceae. *Acta Botanica Brasilica*, *4*(1), 133–158. https://doi.org/10.1590/S0102-33061990000100010

Hermes, M. G., & Somavilla, A. (2025). *Vespidae in Catálogo Taxonômico da Fauna do Brasil*. http://fauna.jbrj.gov.br/fauna/faunadobrasil/77503

Instituto Estadual de Florestas. (2025). *Parque Estadual do Pico do Itambé*. https://ief.mg.gov.br/w/parque-estadual-do-pico-do-itambe-

Jacques, G. C., Pires, E., Hermes, M. G., Faria, L. D. B., Souza, M. M., & Silveira, L. C. P. (2018). Evaluating the efficiency of different sampling methods to survey social wasps (Vespidae: Polistinae) in an anthropized environment. *Sociobiology*, *65*(3), 515–523. https://doi.org/10.13102/sociobiology.v65i3.2849

Kamino, L. H. Y., Oliveira-Filho, A. T., & Stehmann, J. R. (2008). Relações florísticas entre as fitofisionomias florestais da Cadeia do Espinhaço, Brasil. *Megadiversidade*, *4*(1-2), 39–49.

Law, B., & Dickman, C. R. (1998). The use of habitat mosaics by terrestrial vertebrate fauna: Implications for conservation and management. *Biodiversity and Conservation*, *7*(3), 323–333. https://doi.org/10.1023/A:1008877611726

Mello-Silva, R. (2008). Three new combinations in *Barbacenia* (Velloziaceae). *Neodiversity*, *3*, 1–2.

Milani, L. R., Jacques, G. C., Clemente, M. A., Coelho, E. L., & Souza, M. M. (2020). Influência de fragmentos florestais sobre a nidificação de vespas sociais (Hymenoptera, Vespidae) em cafeeiro. *Revista Brasileira de Zoociências*, *21*(1), 1–12. https://doi.org/10.34019/2596-3325.2020.v21.29157

Mohamadzade, S., Son, M., & Jung, C. (2024). Uncovering floral composition of paper wasp nests (Hymenoptera: Vespidae: *Polistes*) through DNA metabarcoding. *Scientific Reports*, *14*, 52834. https://doi.org/10.1038/s41598-024-52834-6

Morandi, D. T., França, L. C. J., Menezes, E. S., Machado, E. L. M., Silva, M. D., & Mucida, D. P. (2020). Delimitation of ecological corridors between conservation units in the Brazilian Cerrado using a GIS and AHP approach. *Ecological Indicators*, *115*, 106440. https://doi.org/10.1016/j.ecolind.2020.106440

Myers, N., Mittermeier, R. A., Mittermeier, C. G., Da Fonseca, G. A., & Kent, J. (2000). Biodiversity hotspots for conservation priorities. *Nature*, *403*(6772), 853–858. https://doi.org/10.1038/35002501

Neves, S. C., Almeida-Abreu, P. A., & Fraga, L. M. S. (2005). Fisiografia. In A. C. Silva, L. C. V. S. F. Pedreira, & P. A. Almeida-Abreu (Eds.), *Serra do Espinhaço Meridional: paisagens e ambientes* (pp. 47–58). O Lutador.

Oliveira, G. C. S., & Souza, M. M. (2024). Anidación de *Mischocyttarus cassununga* (R. von Ihering, 1903) (Vespidae: Polistinae), en un nido de *Phacellodomus rufifrons* (Wied, 1821) (Furnariidae) en el Cerrado brasileño. *Boletín del Museo Nacional de Historia Natural del Paraguay*, *28*, 30–33.

Oliveira, R. S., Galvão, H. C., Campos, M. C. R., Eller, C. B., Pearse, S. J., & Lambers, H. (2015). Mineral nutrition of campos rupestres plant species on contrasting nutrient-impoverished soil types. *New Phytologist*, *205*(3), 1183–1194. https://doi.org/10.1111/nph.13175

Oliveira, T. C. T., Souza, M. M., & Pires, E. P. (2017). Nesting habits of social wasps (Hymenoptera: Vespidae) in forest fragments associated with anthropic areas in southeastern Brazil. *Sociobiology*, *64*(1), 101–104. https://doi.org/10.13102/sociobiology.v64i1.1073

Palandi, A. N., Bortoluzzi, E. C., Souza, M. M., Oliveira, T. C. T., Santos, A. A., & Nogueira, M. P. (2025). Richness of social wasps (Hymenoptera: Vespidae: Polistinae) in an olive crop (*Olea europaea* L.), area associated with a mixed fragment of Atlantic Forest in southern Minas Gerais state, Brazil. *Revista Chilena de Entomología*, *51*(1), 89–99. https://doi.org/10.35249/rche.51.1.25.09

Perillo, L. N., Neves, F. S., Antonini, Y., & Martins, R. P. (2017). Compositional changes in bee and wasp communities along Neotropical mountain altitudinal gradient. *PLOS ONE*, *12*(7), e0182054. https://doi.org/10.1371/journal.pone.0182054

Prezoto, F., & Clemente, M. (2010). Vespas sociais do Parque Estadual do Ibitipoca, Minas Gerais, Brasil. *MG Biota*, *3*, 22–32.

Prezoto, F., Maciel, T. T., Detoni, M., Mayorquin, A. Z., & Barbosa, B. C. (2019). Pest control potential of social wasps in small farms and urban gardens. *Insects*, *10*(7), 192. https://doi.org/10.3390/insects10070192

Ribeiro, D. G., Silvestre, R., & Garcete-Barrett, B. R. (2019). Diversity of wasps (Hymenoptera: Aculeata: Vespidae) along an altitudinal gradient of Atlantic Forest in Itatiaia National Park, Brazil. *Revista Brasileira de Entomologia*, *63*, 22–29. https://doi.org/10.1016/j.rbe.2018.12.005

Ribeiro, J. F., & Walter, B. M. T. (1998). Fitofisionomias do bioma Cerrado. In S. M. Sano & S. P. Almeida (Eds.), *Cerrado: ambiente e flora* (pp. 89–166). EMBRAPA-CPAC.

Richards, O. W. (1978). *The social wasps of the Americas excluding the Vespinae*. British Museum (Natural History).

Richter, M. (2000). Social wasp (Hymenoptera: Vespidae) foraging behavior. *Annual Review of Entomology*, *45*(1), 121–150. https://doi.org/10.1146/annurev.ento.45.1.121

Salvio, G. M. M. (2017). *Áreas naturais protegidas e indicadores socioeconômicos: O desafio da conservação da natureza*. Paco Editorial.

Santos, J. N. A., Silveira, O. T., & Carpenter, J. M. (2017). A new species of the genus *Protopolybia* Ducke, 1905 (Hymenoptera, Vespidae, Polistinae), with taxonomic contributions to the *exigua* species-group. *Zootaxa*, *4286*(3), 432–438. https://doi.org/10.11646/zootaxa.4286.3.11

Sguarizi-Antonio, D., Michelutti, K. B., Soares, E. R. P., Batista, N. R., Lima-Junior, S. E., Cardoso, C. A. L., Torres, V. O., & Antonialli-Junior, W. F. (2021). Colonial chemical signature of social wasps and their nesting substrates. *Chemoecology*, *31*, 361–367. https://doi.org/10.1007/s00049-021-00361-5

Silva, A. F., Batista, A. D. M., Gouvêa, T. P., Saleem, K., & Souza, M. M. (2024). Uma visão comparativa de unidades de conservação de proteção integral no estado de Minas Gerais, Brasil: Conflitos locais e alternativas econômicas. *Biodiversidade Brasileira*, *14*(2), 1–17. https://doi.org/10.37002/biodiversidadebrasileira.v14i2.2446

Silva, R. C., Silva, A. P., Assis, D. S., & Nascimento, F. S. (2019). Occurrence and nesting behavior of social wasps in an anthropized environment. *Sociobiology*, *66*(2), 381–388. https://doi.org/10.13102/sociobiology.v66i2.4303

Silveira, F. A. O., Barbosa, M., Beiroz, W., Callisto, M., Macedo, D. R., Morellato, L. P. C., ... Fernandes, G. W. (2019). Tropical mountains as natural laboratories to study global changes: A long-term ecological research project in a megadiverse biodiversity hotspot. *Perspectives in Plant Ecology, Evolution and Systematics*, *38*, 64–73. https://doi.org/10.1016/j.ppees.2019.04.001

Silveira, F. A. O., Negreiros, D., Barbosa, N. P. U., Buisson, E., Carmo, F. F., Carstensen, D. W., ... Lambers, H. (2016). Ecology and evolution of plant diversity in the endangered campo rupestre: A neglected conservation priority. *Plant and Soil*, *403*, 129–152. https://doi.org/10.1007/s11104-015-2637-8

Somavilla, A., & Carpenter, J. M. (2021). Key to the genera of social wasps (Polistinae) occurring in Neotropics. In F. Prezoto, F. S. Nascimento, B. C. Barbosa, & A. Somavilla (Eds.), *Neotropical Social Wasps* (pp. 327–336). Springer. https://doi.org/10.1007/978-3-030-72805-3_18

Souza, C. A. S., Vale, A. C. G., & Barbosa, B. C. (2016). Vespas sociais (Vespidae: Polistinae) em fitofisionomias urbanas: Um checklist do município de Barra Mansa, Rio de Janeiro, Brasil. *EntomoBrasilis*, *9*(3), 169–174. https://doi.org/10.12741/ebrasilis.v9i3.620

Souza, M. M., & Prezoto, F. (2006). Diversity of social wasps (Hymenoptera, Vespidae) in semideciduous forest and cerrado (savanna) regions in Brazil. *Sociobiology*, *47*(1), 135–147.

Souza, M. M., Barbosa, B. C., Detoni, M., Mayorquin, A. Z., & Prezoto, F. (2015a). Use of flight interception traps of Malaise type and attractive traps for social wasps record (Vespidae: Polistinae). *Sociobiology*, *62*(3), 450–456. https://doi.org/10.13102/sociobiology.v62i3.708

Souza, M. M., Clemente, M. A., & Teofilo-Guedes, G. (2020b). Nest camouflage records on five social wasp species (Vespidae, Polistinae) from southeastern Brazil. *EntomoBrasilis*, *13*, e929. https://doi.org/10.12741/ebrasilis.v13.e929

Souza, M. M., Ladeira, T. E., Assis, N. R. G., Campos, A. E., Carvalho, P., & Louzada, J. N. C. (2010). Ecologia de vespas sociais (Hymenoptera, Vespidae) no campo rupestre na Área de Proteção Ambiental, APA, São José, Tiradentes, MG. *MG Biota*, *3*, 15–32.

Souza, M. M., Silva, H. N. M., Dallo, J. B., Martins, L. F., Milani, L. R., & Clemente, M. A. (2015b). Biodiversity of social wasps (Hymenoptera: Vespidae) at altitudes above 1600 meters in the Parque Estadual da Serra do Papagaio, State of Minas Gerais, Brazil. *EntomoBrasilis*, *8*(3), 174–179. https://doi.org/10.12741/ebrasilis.v8i3.519

Souza, M. M., Teofilo-Guedes, G. S., Milani, L. R., de Souza, A. S. B., & Gomes, P. P. (2020a). Social wasps (Vespidae: Polistinae) from the Brazilian Atlantic Forest. *Sociobiology*, *67*(1), 1–12. https://doi.org/10.13102/sociobiology.v67i1.4597

Tanaka Junior, G. M., & Noll, F. B. (2011). Diversity of social wasps on semideciduous seasonal forest fragments with different surrounding matrix in Brazil. *Psyche: A Journal of Entomology*, *2011*, 861747. https://doi.org/10.1155/2011/861747

Vasconcelos, M. F. (2011). O que são campos rupestres e campos de altitude nos topos de montanha do Leste do Brasil? *Revista Brasileira de Botânica*, *34*(2), 241–246. https://doi.org/10.1590/S0100-84042011000200012

Versieux, L. M., Wendt, T., Louzada, R. B., & Wanderley, M. G. L. (2008). Bromeliaceae da Cadeia do Espinhaço. *Megadiversidade*, *4*(1-2), 98–110.

Vidal, J. D., Schmitt, C. B., & Koch, I. (2023). Comparative richness patterns of range sizes and life forms of Apocynaceae along forest–savanna transitions in Brazil. *Botanical Journal of the Linnean Society*, *203*(3), 230–241. https://doi.org/10.1093/botlinnean/boad047