

Social wasps (Vespidae, Polistinae) in a Cerrado agrosystem in the state of Minas Gerais, southeastern Brazil

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Abstract

The survey and identification of social wasps, mainly in predominantly agricultural environments, is the first step to identify the ideal species to be used in biological pest control programs. The present work aims to inventory the social wasp fauna in an agrosystem in the Cerrado, Minas Gerais and identify species with potential to be used in biological control. Through active search, 478 wasps of 8 genera and 17 species were collected. The dominance of some species such as *Protopolybia sedula*, *Polybia ignobilis*, *Polybia paulista*, *Polybia fastidiosuscula* and *Polybia occidentalis* reinforces the importance of these species in agricultural environments and their potential use in biological pest control. In addition, this work confirms that some species of social wasps benefit from the anthropized environment, such as *Polistes versicolor*, which uses human constructions for nesting.

Keywords: Anthropized environment; Biodiversity; Biological control.

Introduction

Cerrado is considered the largest dry tropical forest in South America and the second largest biome in Brazil (NOBREGA *et al.*, 2017). However, some researchers indicate that approximately 50% of the original area of the Cerrado is under agricultural use (KLINK; MACHADO, 2005; BEUCHLE *et al.*, 2015; DIAS *et al.*, 2017). The disorderly occupation of the Cerrado can result in several problems, such as habitat fragmentation, reduction of biodiversity, invasion of exotic species, soil erosion and imbalance in the carbon cycle (KLINK; MACHADO, 2005). These changes can increase or decrease the faunal flow depending on the affected species (CULLEN JR. *et al.*, 2000; PERES, 2000).

Social wasps belong to the subfamilies Polistinae, Stenogastrinae and Vespinae (SCHMITZ; MORITZ, 1998), and only the former is found in the Neotropics (CARPENTER; MARQUES, 2001). These insects exploit different places such as forests, fields, urban

and agricultural ecosystems, however, with the expansion of agriculture and the increase of cities, natural environments are increasingly modified, which can affect the way of life of wasps (JACQUES *et al.*, 2015; 2018b).

Agrosystems can benefit some species of social wasps, providing water, carbohydrates, proteins and protection against the weather, in addition to reducing competition for resources with other species (LIMA *et al.*, 2000; PREZOTO *et al.*, 2007; SILVA *et al.*, 2019). Furthermore, the maintenance of forest fragments and diversified agricultural ecosystems in a rural environment positively influences the richness and nesting of social wasps (MILANI *et al.*, 2020). These insects are opportunistic in their search for food; to reduce the search efforts, they return to places they already know and that offer a rich amount of supplies and resources (PREZOTO *et al.*, 2008; ELISEI *et al.*, 2010). This characteristic and the behavior of capturing prey, especially caterpillars, make certain species potential agents of pest

control (PREZOTO *et al.*, 2008; ELISEI *et al.*, 2010; JACQUES *et al.*, 2018a).

The survey and identification of social wasps, especially in predominantly agricultural environments, is the first step to identify the ideal species to be used in biological pest control programs (PREZOTO *et al.*, 2006). Therefore, the objective of this research was to catalog the biodiversity of social wasps in an agrosystem area located in Cerrado in the State of Minas Gerais and to identify species with potential for use in biological control.

Materials and methods

The research was conducted in an agricultural environment in Medeiros, in the southeast of the State of Minas Gerais (20°07'21.3" S – 46°12'32.9" W), at 838 m above sea level, hot subtropical climate with dry winter and rainy summer (Cwa), according to the Köppen-Geiger classification (SÁ JÚNIOR, 2009). The area

has 146 hectares, is composed of two riparian forests; varied agricultural crops (vegetables, fruit trees, coffee, soybeans, corn, eucalyptus, oats and beans), human constructions and artificial ponds (FIGURE 1).

Four collections were carried out, through active search, over the course of a year, in the months of January, May, August and October, in order to follow the four seasons of the year. Active search processes were conducted by a researcher during the week from 9 am to 4 pm, the time of greatest activity of the wasps (JACQUES *et al.*, 2018a adding up to a sampling effort of 196 hours. Logs and natural cavities (abandoned termites and rocks), broadleaf vegetation, flowers and other areas with anthropic action were inspected.

The wasps were collected with an entomological net, preserved in 70% alcohol (JACQUES *et al.*, 2018b). Subsequently, they were identified with entomological keys (RICHARDS, 1978; CARPENTER, 2004) and confirmed by

Figure 1 – Location of the agricultural area in the municipality of Medeiros, Minas Gerais, sampled to inventory the fauna of social wasps (Hymenoptera: Polistinae)



Source: Google Earth Pro® (2021).

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Species diversity and dominance were calculated using the Shannon-Wiener diversity index (H') and the Berger-Parker dominance index (Dpb), using the Past program (HAMMER *et al.*, 2005). To evaluate the efficiency of collecting in the area, a species accumulation curve was performed, with a confidence interval of 95%, using the Bootstrap 1 estimator in the EstimateS 9.1.0 software (COWELL, 2013).

Results and discussion

478 social wasps of 8 genera and 17 species were collected, with a dominance index of $Dpb = 0.2008$ and a diversity index of $H' = 2.359$ (TABLE 1). All species recorded in this study were found in two other studies carried out close to the research area. One in the Parque Nacional da Serra da Canastra (VICENTE *et al.*, 2020) and the other in an agricultural area of the Instituto Federal de Educação, Ciência e Tecnologia de Minas Gerais – *Campus Bambuí* (JACQUES *et al.*, 2015), indicating that they are common species in the region.

Table 1 – Abundance of individuals, species richness (S'), diversity and dominance indices and number of nests of social wasps collected in an agrosystem in Medeiros, Minas Gerais, Brazil.

Species	Abundance	Nests
<i>Apoica gelida</i> Van der Vecht, 1972	7	0
<i>Brachygastra lecheguana</i> (Latreille, 1824)	21	0
<i>Mischocyttarus cassununga</i> (R. Von. Ihering, 1903)	76	9
<i>Mischocyttarus drewseni</i> (Saussure, 1954)	3	1
<i>Mischocyttarus</i> sp.	2	1
<i>Polistes ferreri</i> Saussure, 1853	1	0
<i>Polistes versicolor</i> (Olivier, 1971)	27	22
<i>Polybia chrysothorax</i> (Lichtenstein, 1796)	6	1
<i>Polybia fastidiosuscula</i> Saussure, 1854	53	1
<i>Polybia ignobilis</i> (Haliday, 1836)	55	1
<i>Polybia jurinei</i> Saussure, 1854	1	0
<i>Polybia occidentalis</i> (Olivier, 1971)	33	0
<i>Polybia paulista</i> (R. Von. Ihering, 1896)	50	11
<i>Polybia quadricincta</i> Saussure, 1854	17	0
<i>Protonectarina sylveirae</i> (Saussure, 1854)	19	0
<i>Protopolybia sedula</i> (Saussure, 1854)	96	8
<i>Synoeca cyanea</i> (Fabricius, 1775)	11	0
Abundance of individuals	478	-
Species richness (S')	17	-
Number of nests	-	55
Shannon-Wiener diversity index (H')	2,359	-
Berger-Parker dominance index (Dpb)	0,2008	-

Source: Prepared by the authors (2022).

The study area presented a heterogeneous environment, which favors the coexistence of more species due to the high availability of resources (KLEIN *et al.*, 2015; CLEMENTE *et al.*, 2021). Of the 17 species collected, nine are known to be important predators of agricultural pests: *Brachygastra lecheguana* (Latreille, 1824), *Polistes versicolor* (Olivier, 1971), *Polybia fastidiosuscula* Saussure, 1854, *Polybia ignobilis* (Haliday, 1836), *Polybia occidentalis* (Olivier, 1971), *Polybia paulista* (R. Von. Ihering, 1896), *Protonectarina sylveirae* (Saussure, 1854), *Protopolybia sedula* (Saussure, 1854) and *Synoeca cyanea* (Fabricius, 1775) (GOBBI; MACHADO, 1984; PERIOTO *et al.*, 2011; SOUZA; ZANUNCIO, 2012; SARAIVA *et al.*, 2016; JACQUES *et al.*, 2018a; PREZOTO *et al.*, 2019).

Protopolybia sedula showed the highest dominance, collected 96 times, representing approximately 20% of the total sampled. This species belongs to the Epiponini tribe, has thousands of wasps in its colonies (EDWARDS, 1980) and has high foraging activity, with some studies reporting a flow of approximately 105.4 foragers leaving and 108 returning to the nest every hour of the day, justifying its high incidence in samples (DETONI *et al.*, 2015). This species has already been reported preying on the whitefly *Aleurothrixus floccosus* (Maskell, 1896), a pest of citrus crops (CARPENTER; MARQUES, 2001; SOUZA; ZANUNCIO, 2012).

Polybia ignobilis was frequent in all collections, found in vegetable gardens, coffee plantations, fruit trees and close to water sources. This species is related to the biological control of several insects, such as the cabbage caterpillar *Ascia monustes arseis*, Latreille, 1819, *Chlosyne lacinia saundersii* Doubleday e Hewtson, 1849, *Diabrotica speciosa* (Germar, 1824), *Diaphania hyalinata* (Linnaeus, 1767), *Diaphania nitidalis* Cramer, 1782, *Edessa rumarginata* (De Geer, 1773) and *Elasmopalpus lignosellus* (Zeller,

1848) (CARPENTER; MARQUES, 2001; SOUZA; ZANUNCIO, 2012; JACQUES *et al.*, 2018a). Its presence benefits several crops, such as soy, sunflower, corn, tomato, sugar cane, among others (GOBBI; MACHADO, 1984; SOUZA; ZANUNCIO, 2012).

The species *P. occidentalis* e *P. paulista* were also frequent in all collections. *P. occidentalis* nests may contain several cells used to store food, such as ants and fragments of flies and termites, which can be used in unfavorable periods, such as the dry season (RICHARDS; RICHARDS, 1951; DETONI; PREZOTO, 2021). This species preys on agricultural pests *A. floccosus*, *Leucoptera coffeella* (GUÉRIN-MÈNEVILLE, 1842) and *Spodoptera frugiperda* (Smith, 1797) (SOUZA; ZANUNCIO, 2012). *P. paulista* is one of the most common species of social wasps in Brazil, found in several states of the country (RICHARDS, 1978). There are records of this species preying on *A. floccosus*, *C. lacinia saundersii* and *L. coffeella* (PREZOTO *et al.*, 2016).

Polybia fastidiosuscula was sampled abundantly in the last two collections. Some studies report that this species manages to orient itself in corn crops by locating plants damaged by the *Spodoptera frugiperda* caterpillar (J. E. Smith, 1797) and thus preying on this agricultural pest (SARAIVA *et al.*, 2016).

The presence of coffee plantations may have influenced the occurrence of the species *B. lecheguana* and *P. sylveirae*, as these are predators of the caterpillar *L. coffeella*, considered the main pest of coffee (PERIOTO *et al.*, 2011). *B. lecheguana* also preys on other agricultural pests such as *Alabama argillacea* (Hübner, 1818), *Anthonomus grandis* Boheman, 1843, *Schizaphis graminum* (Rondani, 1852) and *Tuta absoluta* (Meyrick, 1917) (SOUZA; ZANUNCIO, 2012). On the other hand, *P. sylveirae* is recognized for feeding also on the species *A. floccosus*, *C. lacinia saundersii*,

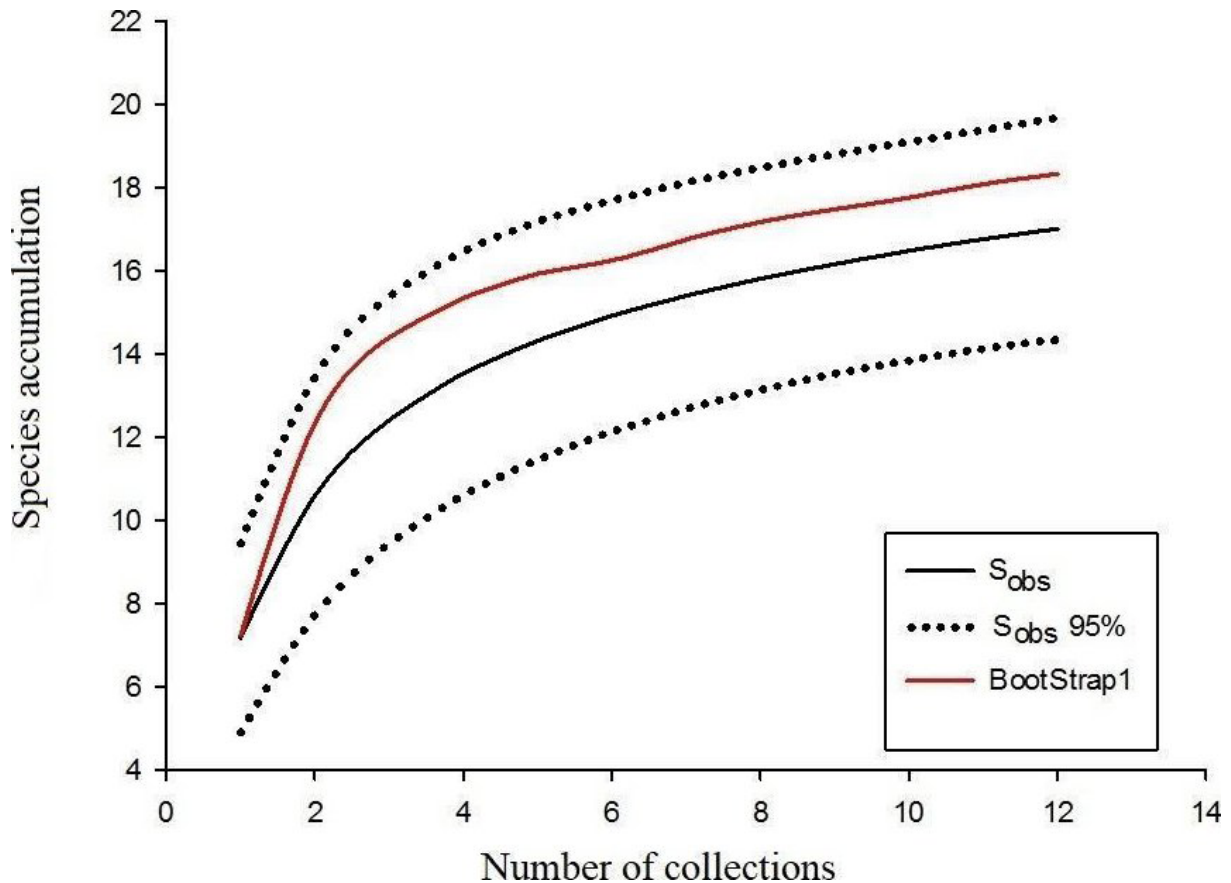
and *S. frugiperda* (PREZOTO *et al.*, 2016). *S. cyanea* was poorly sampled, however it is also related to biological control, as it is a predator of the fly *Zaprionus indianus* Gupta, 1970, a pest of several fruit crops (PREZOTO *et al.*, 2016).

Polistes versicolor is known to benefit kale (JACQUES *et al.*, 2018a), eucalyptus (ELISEI *et al.*, 2010) and coffee crops (JACQUES; ARAÚJO, 2020). This species is a predator harmful to crops such as *C. lacinia saundersii*, *Eacles imperialis magnifica* Walker, 1856, *E. lignosellus*, *Hedylepta indicata* (Fabricius, 1775), *Heliothis virescens* (Fabricius, 1781), *Heraclides anchisiades* (Huebner, 1809), *Heraclides thoas brasiliensis* Rothschild e Jordan, 1906, *Pseudoplusia includens* (Walker,

1857) and *S. frugiperda* (PREZOTO *et al.*, 2006). Twenty-two nests of this wasp were found, mainly in houses and close to crops. This wasp is synanthropic and normally uses human constructions and substrates for nesting (TORRES *et al.*, 2014), which provide more protection and reduce predation pressure (FOWLER, 1983; PREZOTO *et al.*, 2007; JACQUES *et al.*, 2012).

The Bootstrap 1 estimator curve was within the 95% confidence interval of the collector accumulation curve for the study area. Furthermore, the curve of the graph reached the asymptote, demonstrating that probably 95% of the species richness of the area was collected, indicating a sufficient sampling effort (FIGURE 2).

Figure 2 – Species accumulation curve in the research area, with a 95% confidence interval and use of the Bootstrap 1 estimator.



Source: Prepared by the authors (2022).

Conclusion

The dominance of some species such as *Protopolybia sedula*, *Polybia ignobilis*, *Polybia paulista*, *Polybia fastidiosuscula* and *Polybia occidentalis* emphasize the importance of these species in agricultural environments and the potential to act in the biological control of pests. In addition, this study confirms that some species of social wasps benefit from the anthropized environment, such as *Polistes versicolor*, which uses human constructions for nesting.

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