

Research Article / Artículo de Investigación

Social wasps (Hymenoptera: Vespidae) associated with *Eucalyptus* sp. plantations from an Altitude Field in Southern Minas Gerais State, Brazil

Avispas sociales (Hymenoptera: Vespidae) asociadas a plantaciones de *Eucalyptus* sp. en un Campo de Altitud situado en el sur del Estado de Minas Gerais, Brasil

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Abstract. In Brazil, there is little information about social wasp communities in Altitude Fields (Campos de Altitude), a phytophysionomy of the Atlantic Forest with a high rate of endemism, which is being altered and reduced in area by human activities, such as the cultivation of *Eucalyptus* spp. Therefore, the present study aimed to inventory the species of Polistinae (Vespidae) presente in an Altitude Field associated with *Eucalyptus* sp. plantations in the municipality of Poços de Caldas, Southern Minas Gerais, Brazil. The study was conducted in Morro do Ferro, central region of the Poços de Caldas Plateau, from 2020 to 2021, using active search and Malaise traps. Thirteen species of social wasps were recorded, which have a wide geographic distribution, and explore anthropic environments, such as agricultural areas, pasture and *Eucalyptus* sp. plantations. Many of them behave as synanthropic, suggesting this altitude field to be a degraded area in Poços Caldas, MG. However, further studies must be carried out in the region, in order to know and preserve these remaining ecosystems.

Key words: Atlantic Forest; degradation; Malaise; monoculture; Polistinae.

Resumen. En Brasil, hay poca información sobre las comunidades de avispas sociales presentes en los Campos de Altitud, una fitofisonomía de la Mata Atlántica con un alto grado de endemismo, área que está siendo alterada y reducida por las actividades humanas, como es el cultivo de *Eucalyptus* spp. Por lo tanto, el presente estudio tuvo como objetivo inventariar las especies de Polistinae (Vespidae) asociadas a plantaciones de *Eucalyptus* sp. en los Campos de Altitud situados en el municipio de Poços de Caldas, sur de Minas Gerais, Brasil. El estudio se realizó en Morro do Ferro, región central de la meseta de Poços de Caldas, entre 2020 y 2021, utilizando búsqueda activa y trampas Malaise. Se registraron trece especies de avispas sociales que tienen una amplia distribución geográfica, explorando ambientes antrópicos como áreas agrícolas, pastizales y plantaciones de *Eucalyptus* sp. Muchas de ellas se comportan como sinantrópicas, lo que sugiere que este Campo de Altitud es un área degradada en el municipio de Poços de Caldas, MG. Sin embargo, se deben realizar más estudios en la región para conocer y preservar estos ecosistemas remanentes.

Palabras clave: Bosque Atlántico; degradación; Malaise; monocultivo; Polistinae.

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Introduction

Social wasps of the subfamily Polistinae (Hymenoptera: Vespidae) (Carpenter and Marques 2001), perform different ecosystem services, such as pollination (Hermes and Köhler 2006; Bergamo *et al.* 2021) and composition in the trophic chains, as they are predators of other insects, such as Diptera, Lepidoptera and Hemiptera (Noll *et al.* 2018; Prezoto *et al.* 2019), in addition to being present in the diet of birds and mammals (Detoni *et al.* 2021), therefore, these insects are important in the most different ecosystems, especially in the neotropical region such as Brazil.

In this country, around 381 species of Polistinae are known (Somavilla *et al.* 2021), distributed in the most different biomes (Auko *et al.* 2017; Santos L. *et al.* 2020; Somavilla *et al.* 2020; Souza *et al.* 2020a, b). In the Atlantic Forest, up to the present study, around 170 species have been inventoried (Souza *et al.* 2020a), a high wealth, which is a reflection of the heterogeneity of abiotic and biotic factors present in this biome (Santos *et al.* 2007).

The Atlantic Forest, considered a *hotspot* of biodiversity (Myers *et al.* 2000; Mittermeier *et al.* 2011; Ribeiro *et al.* 2011; ICMBio 2018), has only 12.4% of its original area (Fundação SOS Mata Atlântica 2022), composed of different phytophysiognomies protected by the Federal Law of the Atlantic Forest N^o. 11.428 of 2006 (BRASIL 2006) such as, for example, the Altitude Fields (Oliveira-Filho 2006), where there are few studies of Polistinae inventories (Souza *et al.* 2015, 2018; Oliveira *et al.* 2021).

Altitude Fields are vegetation formations that occur in regions above 900 meters, predominantly composed of grasses and shrubs, established on igneous lithology, with shallow and dystrophic soil environments (Benites *et al.* 2003; Rapini *et al.* 2008; Neto 2014).

The evolutionary history of this highland ecosystem biodiversity was modeled, predominantly, by climatic, biogeographical and paleoenvironmental processes, besides human presence and intervention. These environmental conditions led to the pattern of high endemism of the species present in this ecotope (Alves and Kolbek 1994; Finn and Poff 2005; Jacobi *et al.* 2007; Martinelli 2007; Rapini *et al.* 2008; Veldmann *et al.* 2015). In addition, Altitude Fields are also relevant, as they have shallow soils that favor water infiltration and the insurgency of springs in adjacent environments with lower altitudes, in addition to promoting the retention of carbon stocks (Benites *et al.* 2003; Coelho *et al.* 2017; Pinheiro *et al.* 2020). However, the low woody yield of the botanical species also arouses interest in the use of the soil in these places, mainly for different monocultures, such as *Eucalyptus* spp.

Eucalyptus spp. cultivation has grown in high proportions in Brazil, but mainly in the State of Minas Gerais, exceeding 2 million hectares (Mora and Garcia 2000; IBGE 2019) including seven thousand hectares in the Poços de Caldas Plateau region (IBGE 2016, 2021). The regional native vegetation is composed of vegetation formations and Natural Fields in the regions of higher altitudes (Moraes and Jiménez-Rueda 2008). Due to the lithological formation of the Plateau, as well as the botanical specificities recorded, we can classify the Montana regions as Altitude Natural Fields (Kinoshita *et al.* 2007; Pinheiro *et al.* 2020). These regional Native Fields are still little known and most research carried out in these ecosystems has focused on botanical studies (Vasconcellos and Gouvea 1993; Matavelli and Monteiro 2012; Rezende *et al.* 2013; Pinheiro *et al.* 2020), which makes it necessary to investigate Vespidae in these ecosystems.

Although there are published data on some groups of aquatic insects (Santos 1966; Santos M. *et al.* 2020), regional analysis on the biodiversity of social wasps is lacking. Considering the altitudinal gradients, associated with the unique phytosociological features of the Altitude Field, it is possible that the social wasp communities of the Poços de Caldas Plateau present environmental signatures modeled by these elements, as it was already registered by Albuquerque *et al.* (2015) and Oliveira *et al.* (2021) in ecotope regions.

In addition to not knowing the biodiversity of these taxa, the effects of replacing

natural matrices by monoculture *Eucalyptus* spp. on a large scale are also unknown, but it is hypothesized that the richness of social wasps is low in fields of altitude modified or replaced by *Eucalyptus* spp. plantations, because the vegetation homogenization results in the loss of morphological plant diversity and, simultaneously, in the loss of fundamental ecological niches for the nesting of some species of social wasps (Santos *et al.* 2007; Milani *et al.* 2020) negatively impacting the establishment and consequently the survival of these colonies (Hunt 2007).

Therefore, the present study aimed to inventory the species of Polistinae present in a region of Altitude Field associated with the cultivation of *Eucalyptus* sp. in the municipality of Poços de Caldas, Southern Minas Gerais, Brazil.

Material and Methods

The study was carried out in the central region of the Poços de Caldas Plateau, Minas Gerais, called Morro do Ferro (21°53'31.27" S, 46°32'57.41" O; Datum: SIRGAS 2000). One of its peaks, which is elliptical in shape, with a diameter of about 1 km (Fig. 1), and altitudes from 1,400 - 1,541 m, was sampled (Bonotto 1994). These wavy geomorphological settings hold soils enriched, rare earths and with the highest levels of natural radiation in the world, presenting radiometric anomalies which have been investigated for decades (Minas Gerais 2013; Gouvea *et al.* 2014).

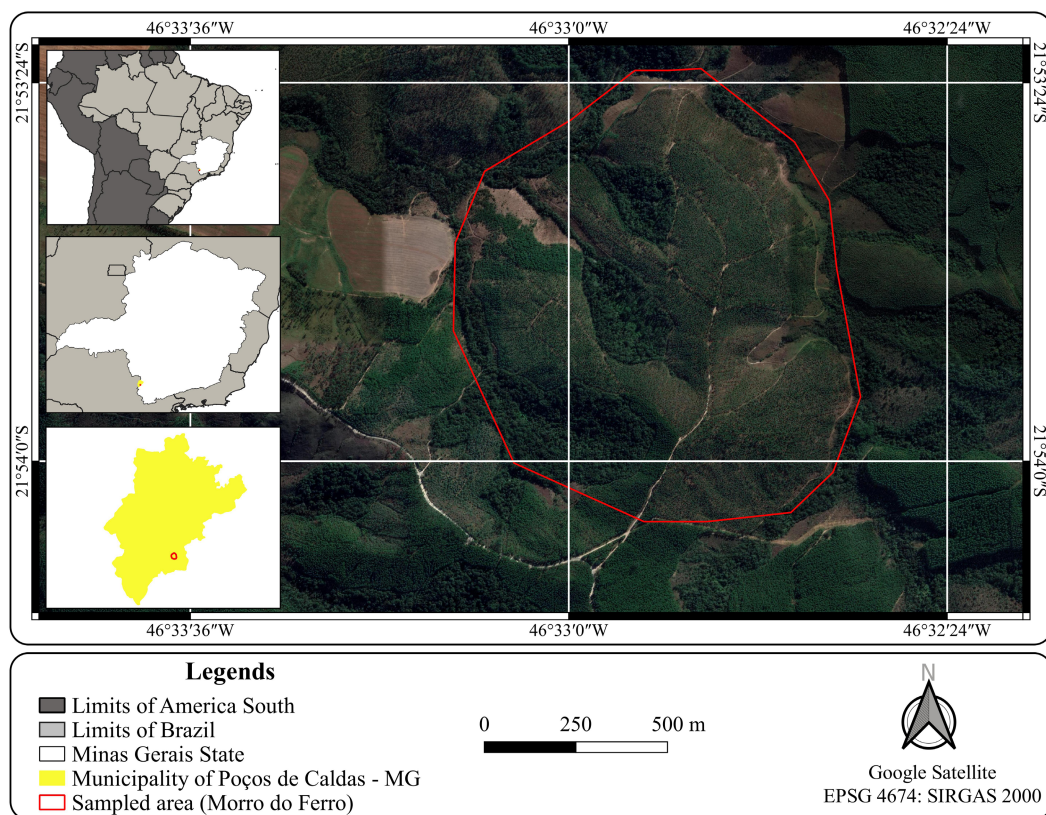


Figure 1. Limits of the sampled area in Morro do Ferro, municipality of Poços de Caldas, Minas Gerais, Brazil. / Límites del área de muestreo en Morro do Ferro, municipio de Poços de Caldas, Minas Gerais, Brasil.

Initially, this region suffered the impacts of mining and, in recent decades, it has been suffering the replacement of its natural matrices (Altitude Field) by large-scale *Eucalyptus* spp. reforestation (Santos M. *et al.* 2020). The following image shows these substitutions of natural matrices in the last decades (Fig. 2).



Figure 2. Aerial view of the sampled region, exemplifying the replacement of native vegetation by the monoculture of *Eucalyptus* spp. / Vista aérea de la región muestreada, ejemplificando el reemplazo de la vegetación nativa por el monocultivo de *Eucalyptus* spp.

The specimens were actively captured in flight and/or in the colonies with the entomological nets (hand nets) through random walking in the Altitude Field and alongside the limits with areas of *Eucalyptus* sp. plantations, according to Jacques *et al.* (2018). Active sampling campaigns took place from November 2020 to March 2021, four days per month, summing 48 hours of sampling effort. They were also collected passively, with aid of two Malaise traps permanently installed in two high-altitude streams in the region, inserted inside the *Eucalyptus* sp. matrix, over the two-year period, totaling 17,520 hours of sampling effort by trap. During this period, 12 bimonthly collections of the biological material captured and stored by the traps were carried out. All specimens were sacrificed and conditioned in 70% alcohol and sent to the Zoology Laboratory of IFSULDEMINAS *Campus* Inconfidentes - MG, where they were fixed on entomological pins and identified from the taxonomic keys proposed by Richards (1978) and Carpenter and Marques (2001), that present keys for identification of genera, species and nests, or compared with specimens deposited in the biological collection of social wasps (CBVS). The specimens of doubtful identification were sent to Dr. Orlando Tobias Silveira of the Emilio Goeldi Museum, located in the municipality of Belém, State of Pará, Brazil.

Results and Discussion

Thirteen species representing five genera, in addition to 10 colonies of social wasps, were recorded in an area of Altitude Field associated with the cultivation of *Eucalyptus* sp. in the municipality of Poços de Caldas, Minas Gerais (Tab. 1).

Table 1. Tribe and species of social wasps collected in Morro do Ferro, municipality of Poços de Caldas, Minas Gerais. / Tribu y especie de avisipas sociales recolectadas en Morro do Ferro, municipio de Poços de Caldas, Minas Gerais.

Tribe	Species
Epiponini	<i>Agelaia multipicta</i> (Haliday, 1836)
	<i>Agelaia vicina</i> (Saussure, 1854)
	<i>Parachartergus pseudapicalis</i> Willinck, 1959
	<i>Polybia fastidiosuscula</i> Saussure, 1854
	<i>Polybia ignobilis</i> (Haliday, 1836)
	<i>Polybia scutellaris</i> (White, 1841)
Mischocyttarini	<i>Polybia punctata</i> du Buysson, 1907
	<i>Mischocyttarus cassununga</i> (R. von Ihering, 1903)
	<i>Mischocyttarus drewseni</i> Saussure, 1857
	<i>Mischocyttarus socialis</i> (Saussure, 1854)
Polistini	<i>Polistes cinerascens</i> Saussure, 1857
	<i>Polistes simillimus</i> Zikán, 1951
	<i>Polistes versicolor</i> (Olivier, 1791)
Total richness	13 spp.

The presence of these 13 species can be explained by different factors; first, because they manage to explore anthropized environments, which often harbor less plant diversity, form less heterogeneous habitats, therefore they are less demanding species in terms of resources and habitats, therefore, were recorded in coffee cultivation and associated forest fragments (Medeiros *et al.* 2019; Jacques and Araujo 2020; Milani *et al.* 2021; Souza *et al.* 2022), five in pasture environments (Auad *et al.* 2010) and ten in areas of planting of *Eucalyptus* spp. (Ribeiro Jr. 2008; Souza *et al.* 2011; Barbosa *et al.* 2016); second, because they are considered common, as they have a wide geographic distribution, which increases the probability of occurrence (Richards 1978; Lopes 2020; Somavilla *et al.* 2021; Souza *et al.* 2020 a, b).

The species *Agelaia multipicta* e *A. vicina* are considered constant (frequency above 50%) in *Eucalyptus* spp. areas (Ribeiro Jr. 2008), probably because this cultivation provides them a safe substrate for nesting. Such species often use hollow trees or abandoned termite mounds (Souza and Prezoto 2006), due to the architectural pattern of their nests, which constitute several combs without protective casing (Zucchi *et al.* 1995; Wenzel 2020). The formation of hollows in *Eucalyptus* spp. occurs due to injuries caused by native insects, considered pests of the family Myrtaceae, such as *Timocratica albella* (Zeller, 1877) (Lepidoptera: Stenomiidae), known in Brazil as Myrtaceae borer, and by *Coptotermes testaceus* Linnaeus, 1768 (Blattodea: Isoptera: Rhinotermitidae), popularly known as heartwood termite (Santos *et al.* 2008).

Species *Mischocyttarus drewseni* has a wide geographical distribution in Brazil (Somavilla *et al.* 2021), considered a frequent species in anthropized environments (Souza *et al.* 2010), as well as *M. cassununga*, which presents, in turn, ethological adaptations such as the reuse of nest cells for the development and formation of new adults, leading to a longer foraging period and consequently greater survival success in these anthropized environments (Castro *et al.* 2014).

Species *M. socialis* also has a wide distribution in different ecosystems (Souza *et al.* 2020 a, b; Somavilla *et al.* 2021) including agrosystems (Milani *et al.* 2020). This species can be considered generalist (Coelho *et al.* 2022) but also have the capacity to store food (Barbosa *et*

al. 2017). Therefore, it possibly presents adaptations that can be profitable in homogeneous environments, such as in plantations of *Eucalyptus* spp.

In addition to the registered species occurring in agricultural environments and being considered common, there are those which are considered synanthropic, and are often able to explore urbanized environments, where they select anthropic substrates for nesting, such as roofs, as it was observed in *Polybia scutellaris*, *Polistes simillimus* and *P. versicolor* (Castro *et al.* 2014; Oliveira *et al.* 2017), all of them also documented in *Eucalyptus* sp. (Ribeiro Jr. 2008; Elizei *et al.* 2010; Souza *et al.* 2011; Elisei *et al.* 2012; Souza *et al.* 2012). The presence of these species may be related to the availability of food throughout the year (Zanuncio *et al.* 1993; Silva-Filho *et al.* 2020), and with the fact that these agrosystems offer protection from natural predators and pressures arising from abiotic factors such as rain, wind and temperature variations (Souza *et al.* 2012).

Colonies of *P. ignobilis* were documented in *Eucalyptus* sp. areas by Souza *et al.* (2012) in the months corresponding to the dry season. This period is characterized by the presence of different Lepidoptera in these agrosystems (Zanuncio *et al.* 1993), which probably enables the maintenance of social wasp colonies, and consequently the presence of this species in different seasons of the year.

The species *Polybia punctata* was the only species recorded exclusively by the Malaises. It is known that the simultaneous use of different sampling methods in Polistinae inventories increases sampling efficiency (Silva and Silveira 2009; Souza *et al.* 2011; Clemente *et al.* 2021) including in *Eucalyptus* sp. areas (Silva-Filho *et al.* 2020). However, even with the maintenance of two uninterrupted years of Malaise traps, associated with the active search, the richness was low, which also reinforces the assertion built by the study that Altitude Field loses species, when modified by *Eucalyptus* spp. cultivation.

For Souza *et al.* (2011) the difference in the richness of social wasps in *Eucalyptus* spp. areas from different regions may be related to variations in local abiotic factors, such as temperature and annual precipitation. However, the community composition of social wasps documented here attests to how much this ecosystem has undergone alteration in its landscape, as discussed for other taxa and ecological assessments (Santos M. *et al.* 2020; Faria *et al.* 2022; Mendes *et al.* 2022).

Another parameter which supports the observation above is the comparison to other studies carried out in Southern Minas Gerais conservation units, with a higher protection and lower anthropic pressure, such as the Papagaio State Park, which houses 28 species (Souza *et al.* 2015, 2018), including rare species in the country, such as *Mischocyttarus anthracinus* Richards, 1945 and *Mischocyttarus proximus* Zikán, 1949.

Conclusion

The present study shows the low richness of Polistinae in an Altitude Field turned into *Eucalyptus* sp. monoculture, which probably causes loss of ecological niches and local ecosystem services. Therefore, the replacement of natural fields by monocultures, especially that of *Eucalyptus* spp., should be avoided and reduced, as it can cause general losses in biodiversity, including species endemic to these environments. Greater research efforts are encouraged in areas with native fields in Poços de Caldas Plateau, Southern Minas Gerais, Brazil, in order to improve the knowledge and conservation of these remaining ecosystems.

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