



## REVIEW

### Social Wasps (Vespidae: Polistinae) from the Brazilian Atlantic Forest

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#### Abstract

This study was developed aiming to compile data concerning the occurrence and distribution of social wasp species from the Brazilian Atlantic Forest, as well as recording exclusive and rare species. For this purpose, we compiled studies from the specialized literature and created a table containing the species occurrence in the different states which present the phytogeographic domain. A total of 170 species was recorded, corresponding to almost a half of the richness of social wasps in Brazil, including 50 restricted occurrence, with highlight to Rio de Janeiro state, which nevertheless is insufficiently sampled. This way, from this work, it is concluded that Brazilian Atlantic Forest must be seen as an important refuge for Polistinae.

#### Introduction

The Atlantic Forest is considered one of the main conservation hotspots (Mayers et al., 2000). This biome is recognized as one of the richest and most threatened on the planet, with greater biodiversity and rate of endemism of fauna and flora species in process of degradation and extinction (Myers et al., 2000; Fundação SOS Mata Atlântica & Conservação Internacional, 2005).

This biome comprises a set of forest formations and associated ecosystems that include: Dense Ombrophilous Forests, Mixed Ombrophilous Forest, Open Ombrophilous Forest, Semideciduous Forest, Deciduous Seasonal Forest, Restingas (coastal vegetation), Mangroves, Altitudinal Grasslands and Countryside Swamps, and Northeastern Forest Enclaves, with climatic and altimetric variations in the different latitudes (Schäffer & Prochnow, 2002).

In Brazil, the original Atlantic Forest represented an area of 1,306,421 km<sup>2</sup>, approximately 15% of the national territory. The successive economic cycles, based on the exploitation of natural resources over the years, have caused a high destruction of the original forest. As consequence, there was a drastic reduction of forests, forming isolated fragments (Castro et al., 2015). Nowadays, studies indicate the deforestation of 29,075 hectares in the 17 Brazilian states, an increase of 57.7% over the previous period (2014-2015) (Fundação SOS Mata Atlântica & Instituto Nacional de Pesquisas Espaciais, 2017).

These aspects should stimulate research involving the biota of the Atlantic Forest. However, there are still few taxa with relevant scientific knowledge for the Biome, and among invertebrates, only butterflies have an abundance of information (Fundação SOS Mata Atlântica & Conservação Internacional, 2005; Pinto et al., 2006). This shows the importance



of studying the other groups of invertebrates that inhabit the Atlantic Forest, such as the social wasps.

These animals are characteristic of neotropical insect fauna (Silveira, 2002), being the Brazilian fauna the most diverse in the world with 347 species distributed in three tribes: Mischocyttarini (*Mischocyttarus* and 117 species), Polistini (*Polistes* and 38 species) and Epiponini (19 genera and 164 species) (Carpenter & Marques, 2001; Carpenter, 2004; Carpenter & Andena, 2013).

The Taxonomic Catalog of Brazilian Fauna brings some data about the Polistinae. In according with the digital catalog, Epiponini, Mischocyttarini and Polistini tribes present records for the North, Northeast, Midwest, Southeast and South regions. However, there is not information about endemism for the three tribes (Hermes et al., 2019).

Social wasps are fundamental in the communities in which they inhabit, since they participate in a singular way of the food webs. They act as predators or in the transport of pollen grains, being part of the pollinator community of some plant species (Hermes & Köhler, 2006; Sühs et al., 2009; Somavilla & Köhler, 2012). Some species still act as bioindicators of environmental quality in natural or conservation areas (Souza et al., 2010).

Systematic studies on the social wasp community in the Atlantic Forest date back to the first half of the 20th century, with the European naturalists Joseph Francisco Zikán in the Itatiaia National Park and Adolpho Ducke in different areas of southeastern Brazil (Richards, 1978). Later, Owain W. Richards published the book “The social wasps of America: excluding the Vespinae” that became reference for neotropical vespidae taxonomists. After nearly 40 years, about 79 inventories were performed (Barbosa et al., 2016a; Jacques et al., 2018), sampling different ecosystems, such as areas of primary evergreen forests (Souza et al., 2012), urban environments (Oliveira et al., 2017) and agricultural areas (Jacques et al., 2015).

Based on the locations where these surveys were conducted, it is possible to observe a gap on the knowledge of the social wasp community for the Atlantic Forest, because many areas have not yet been sampled (Barbosa et al., 2016a; Souza et al., 2017). Therefore, it is not possible to determine precisely the number of species of social vespids for this biome, nor the occurrence and distribution of rare or endemic species (de Souza et al., 2012). Therefore, the goal of this study was to gather information on the social wasp community in the ecosystems of the Atlantic Forest Biome in Brazil, in order to group the distribution data, to produce a list of species for the Biome, and to register endemic and rare species. Also, social wasps' similarity comparisons among the different phytophysiognomies of the studied biome were carried out.

## Material and Methods

In the present study the following phytophysiognomies of the Atlantic Forest were considered: Dense Ombrophilous Forests; Mixed Ombrophilous Forest (Semideciduous Forest

associated with Araucaria Forest); Open Ombrophilous Forest; Semideciduous Seasonal Forest; Deciduous Seasonal Forest (also known as Mata Seca); Altitudinal Grasslands; areas of pioneer formations, known as Mangroves, Sandbanks, Saline Fields and Alluvial Areas; Vegetative refuges; Ecological tension areas; Countryside Swamps and Northeastern Forest Enclaves, represented by disjunctions of Dense Ombrophilous Forests, Open Ombrophilous Forest, Semideciduous Seasonal Forest, Deciduous Seasonal Forest and native vegetation of the coastal and oceanic islands (BRASIL, 2008). It should be emphasized that the Rupestrian Fields and the Dry Woods (Deciduous Seasonal Forest) may be associated with other biomes (Oliveira-Filho, 2006). Therefore, in this study, were considered only the studies where these phytophysiognomies are in areas of Atlantic Forest.

The files used as reference in the present study were obtained through the following research platforms: Scielo, Scopus, Google Scholar and Research Gate. Articles and books with works on diversity were analyzed, as well as descriptions of new species carried out in different phytophysiognomies of the Atlantic Forest biome, including associated agricultural ecosystems (Table 1), not considering works of ethology or of any other nature not related previously in the text. In the studies of Lima et al. (2010) and Tanaka et al. (2011) (Table 1), different municipalities were sampled in São Paulo state. However, only those located in the Atlantic Forest domain, according to the map proposed by the Ministry of the Environment, were considered (BRASIL, 2008).

Besides the material obtained in the research platforms, the book “The social wasps of America” (Richards, 1978) was used considering only the species that had geographic reference about their locality of collection in the respective state, and disregarding the others. This is because, in many cases, only the state in which the species was collected is mentioned, so that it is not possible to define if the occurrence of the same was associated to the biome of the present study.

Inventory study data were also included, one carried out in the Machado River Environmental Protection Area (21°47'53.93" S, 46°7'29.34" W), south of Minas Gerais, under SISBIO collecting permits (63914-1) and IEF-MG (062/2018), which began in September 2018, and another in Ilha Grande National Park (23°41'51"S, 54°0'35"W), northwest of Paraná, under SISBIO collecting permits (SISBIO 65047-2), which began in February 2019. Both studies are using active search for species registration with the use of entomological net to collect the specimens. The material is being sorted, assembled and identified in the Zoology Laboratory of IFSULDEMINAS, Campus Inconfidentes, Minas Gerais. The species of conflicting identification are being sent to Dr. Orlando Tobias da Silveira, Emílio Goeldi museum, Belém, Pará, for taxonomic confirmation.

A binary matrix, with presence-absence data of species on each region, was used for clustering analysis, using the similarity matrix obtained by Jaccard's community coefficient ( $S_j$ ), with the dendrogram constructed from the Jaccard

**Table 1.** List of inventories studies and description of new species of social wasps carried out in different phytophysiognomies of Atlantic Forest domain in Brazil, informing authors and year of publication, state where they were carried out and number of species.

Authors and year of publication	Phytophysiognomy	State	Number of species
Rodrigues & Machado, 1982	Semideciduous Seasonal Forest	São Paulo	33
Lorenzato (1985)	Agrosystem associated with Mixed Forest	Santa Catarina	12
Raw (2000)	Deciduous Seasonal Forest	Bahia	01
Hermes & Kohler (2006)	Mixed Forest	Rio Grande do Sul	25
Souza & Prezoto (2006)	Semideciduous Seasonal Forest	Minas Gerais	38
Santos et al. (2007)	Ombrophilous Forest, Coastal Vegetation and Mangrove	Bahia	21
Sühs et al. (2009)	Deciduous Seasonal Forest	Rio Grande do Sul	25
Auad et al. (2010)	Agrosystem associated with Semideciduous Seasonal Forest	Minas Gerais	13
Gomes & Noll (2010)	Semideciduous Seasonal Forest	São Paulo	12
Lima et al. (2010)	Semideciduous Seasonal Forest	São Paulo	19
Menezes et al. (2010)	Agrosystem associated with Ombrophilous Forest	Bahia	01
Prezoto & Clemente (2010)	Seasonal Forest associated with Rupestrian Fields	Minas Gerais	23
Souza et al. (2010)	Semideciduous Seasonal Forest associated with Rupestrian Fields	Minas Gerais	32
Souza et al. (2010)	Semideciduous Seasonal Forest	Minas Gerais	36
Tanaka et al. (2011)	Semideciduous Seasonal Forest	São Paulo	29
Menezes et al. (2011)	Ombrophilous Forest	Bahia	1
Bonfim & Antonialli-Júnior (2012)	Semideciduous Seasonal Forest	Mato Grosso do Sul	18
De Souza et al. (2012)	Semideciduous Seasonal Forest associated with agrosystem	Minas Gerais	8
Souza et al., 2012	Seasonal Forest associated with Rupestrian Fields	Minas Gerais	32
Jacques et al. (2012)	Semideciduous Seasonal Forest	Minas Gerais	26
Souza et al. (2012)	Semideciduous Seasonal Forest and Evergreen Forest	Minas Gerais	38
Clemente et al. (2013)	Semideciduous Seasonal Forest associated with Rupestrian Fields	Minas Gerais	15
Togni et al. (2014)	Semideciduous Seasonal and Ombrophilous Forests	São Paulo	31
Albuquerque et al. (2015)	Semideciduous Seasonal Forest	Minas Gerais	34
Locher et al. (2014)	Semideciduous Seasonal Forest associated with monoculture	São Paulo	31
Freitas et al. (2015)	Semideciduous Seasonal Forest associated with agrosystem	Minas Gerais	19
Klein et al. (2015)	Semideciduous Seasonal Forest associated with agrosystem	Rio Grande do Sul	15
Souza et al. (2015a)	Mixed Forest and Altitudinal Grasslands	Minas Gerais	22
Souza et al. (2015b)	Semideciduous Seasonal Forest	Minas Gerais	34
Souza et al. (2015c)	Semideciduous Seasonal, Ombrophilous and Deciduous Seasonal Forests	Minas Gerais e Rio de Janeiro	05
Aragão & Andena (2016)	Ombrophilous Forest	Bahia	29
Barbosa et al. (2016b)	Semideciduous Seasonal Forest	Minas Gerais	36
Brunismann et al. 2016	Deciduous Seasonal Forest	Minas Gerais	37
Virgínio et al. (2016)	Ombrophilous Forest	Rio Grande do Norte	20
Lopes & Menezes, 2017	Ombrophilous Forest	Bahia	01
Barbosa et al. (2018)	Ombrophilous Forest	Alagoas	02
Jacques et al. (2018)	Semideciduous Seasonal Forest associated with urban area	Minas Gerais	40
Souza et al. (2018)	Mixed Forest and Rupestrian Fields	Minas Gerais	11
Ribeiro et al. (2019)	Ombrophilous Forest	Rio de Janeiro	29

coefficient data by the UPGMA (Unweighted Pair Group Method with Arithmetic mean) clustering method. All data were processed in the softwares PAST 2.1 (Hammer et al., 2001) and FITOPAC 2.1 (Shepherd, 2010).

## Results and discussion

A total of 170 social wasp species belonging to 18 genera was recorded in the different phytophysionomies of Atlantic Forest biome in Brazil (Table 2). This richness makes up about 48% of the Polistinae fauna of Brazil, which currently comprehends 346 species (Carpenter & Anderna, 2013; Lopes & Menezes, 2017), highlighting the importance of this biome in maintaining social wasp diversity in the country. However, there is no information for the biome in Goiás, Sergipe, Pernambuco and Paraíba states.

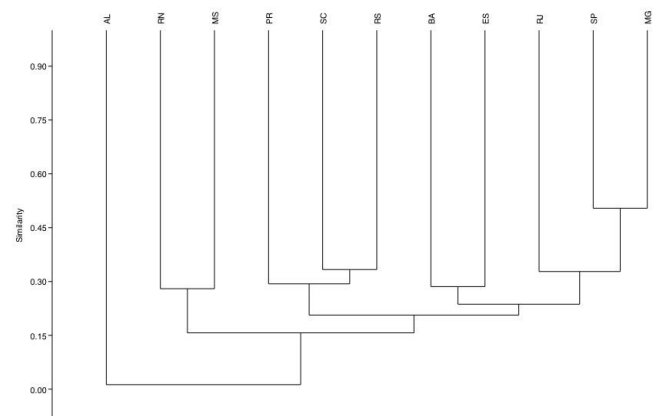
The Jaccard similarity index (Table 3) ranged from 0 (when the state of Alagoas was compared with the following states: Rio Grande do Sul, São Paulo, Paraná, Santa Catarina and Rio Grande do Norte) to 0.50427 (when the comparison was made between the states of São Paulo and Minas Gerais). According to Kent and Coker (1992), values greater than or equal to 0.5 indicate high similarity. The greatest similarity between São Paulo and Minas Gerais states (Fig 1), may be due to two factors: (1) in function of the phytophysionomy Semideciduous Forest, which constitutes the largest forest cover in both states; and (2) these states have been the best sampled for vespids, since together they account for 65% of the studies in the Atlantic Forest of Brazil.

The similarity test also revealed that states form groupings by region (Fig 1). This possibly occurs due to climatic and phytophysionomic factors, however, the Espírito Santo state differed from the other southeastern states, resembling more to Bahia state. It is also necessary to consider that extreme climatic events, such as glaciations, and consequent expansion and reduction of tropical forests, could form barriers and refuges and thus affect the distribution of vespidae fauna in Brazil.

This has already been discussed for the genus *Synoeca* (Menezes et al., 2017), showing that Espírito Santo and Bahia states have genetically similar populations, which differ from other southeastern states. This may also occur with other genera of vespids, which would support the similarity patterns found in the present study.

The genus *Mischocyttarus* presented the largest number of restricted species ( $n=35$ ) (Table 2) and much of this representativeness is the result of two studies published by Zikán (1935; 1949) in the Itatiaia National Park. Both studies have taxonomic bias, totaling 109 described species, many of which were no longer recorded after these publications. Recently another inventory for social wasps was published by Ribeiro et al. (2019) for the Itatiaia National Park. However, only five species of the genus were recorded, all of wide geographic occurrence.

In the year 2018, two species of *Mischocyttarus* identified by Zikán in 1935 and 1949 in the Itatiaia National Park were found in other localities of Minas Gerais. A *Mischocyttarus*



**Fig 1.** Dendrogram from the Jaccard similarity index of social wasps among different states of the country (RS = Rio Grande do Sul; SP = São Paulo; MG = Minas Gerais; RJ = Rio de Janeiro; BA = Bahia; ES = Espírito Santo; PR = Paraná; SC = Santa Catarina; RN = Rio Grande do Norte; AL = Alagoas; MS = Mato Grosso Sul).

**Table 3.** Similarity Matrix (Jaccard) of social wasps among different states of Brazil \*

	RS	SP	MG	RJ	BA	ES	PR	SC	RN	AL	MS
RS	1										
SP	0,30769	1									
MG	0,22936	0,50427	1								
RJ	0,18889	0,28448	0,37121	1							
BA	0,11111	0,23077	0,21008	0,15842	1						
ES	0,22414	0,24176	0,28319	0,2967	0,28571	1					
PR	0,325	0,21795	0,16514	0,16279	0,125	0,20755	1				
SC	0,33333	0,2439	0,19643	0,21591	0,18644	0,31481	0,2619	1			
RN	0,125	0,17568	0,14423	0,12195	0,17021	0,19149	0,1875	0,125	1		
AL	0	0	0,009524	0,012821	0,02439	0,02381	0	0	0	1	
MS	0,175	0,2027	0,14151	0,11905	0,16327	0,13725	0,21212	0,11905	0,28	0,055556	1

\*RS = Rio Grande do Sul; SP = São Paulo; MG = Minas Gerais; RJ = Rio de Janeiro; BA = Bahia; ES = Espírito Santo; PR = Paraná; SC = Santa Catarina; RN = Rio Grande do Norte; AL = Alagoas; MS = Mato Grosso Sul.



*interjectus* (Zikán, 1935) colony was recorded in the Machado River Environmental Protection Area, a Semideciduous Forest in south of the state, and *Mischocyttarus proximus* (Zikán, 1949) in the Serra do Papagaio State Park (Souza et al., 2018), in altitudinal grassland area. In this place, it was also recorded an unpublished species for Brazil, *Mischocyttarus anthracinus* Richards, until then with occurrence only in Paraguay. From these informations, the Itatiaia National Park and the Serra do Papagaio State Park, conservation units of the Serra da Mantiqueira complex, are considered priority areas for the conservation of Atlantic Forest vespids.

Besides these conservation units, other regions also have rare species, that is, restricted to a single area inserted in the biome. In Minas Gerais: Rio Doce State Park (*Mischocyttarus annulatus*) (Souza et al., 2012); Serra de São José Environmental Protection Area in the municipality of Tiradentes (*Polistes davillae*) (Souza et al., 2012); municipality of Barroso (*Mischocyttarus artifex*) (Souza & Prezoto, 2006), Pandeiros River Wildlife Refuge (*Chartergellus communis* and *Chartergus globiventris*) (Brunismann et al., 2016). In São Paulo: the municipalities of Magda, Matão and Barretos (*Brachygastra mouleae*) (Tanaka & Noll, 2011), municipality of Araçatuba (*Mischocyttarus aracatubaensis*) (Richards, 1978), municipalities of Magda and Bebedouro (*Mischocyttarus paulistanus*) (Tanaka & Noll, 2011) and municipality of Jundiá (*Polistes niger*) (Richards, 1978).

In Bahia: Ecological Reserve Michelin, municipality of Igrapiúna (*Agelaia cajennensis* and *Apoica pallida*) (Aragão & Andena, 2016), municipality of Itabuna (*Epipona media*) (Menezes et al., 2010) and the municipality of Ilhéus (*Synoeca ilheensis*) (Lopes & Menezes, 2017).

In Espírito Santo: (*Mischocyttarus carbonarius carbonarius*, *Mischocyttarus capichaba*, *Mischocyttarus carinulatus* and *Polistes deceptor*) (Richards, 1978). There is no information about exact location.

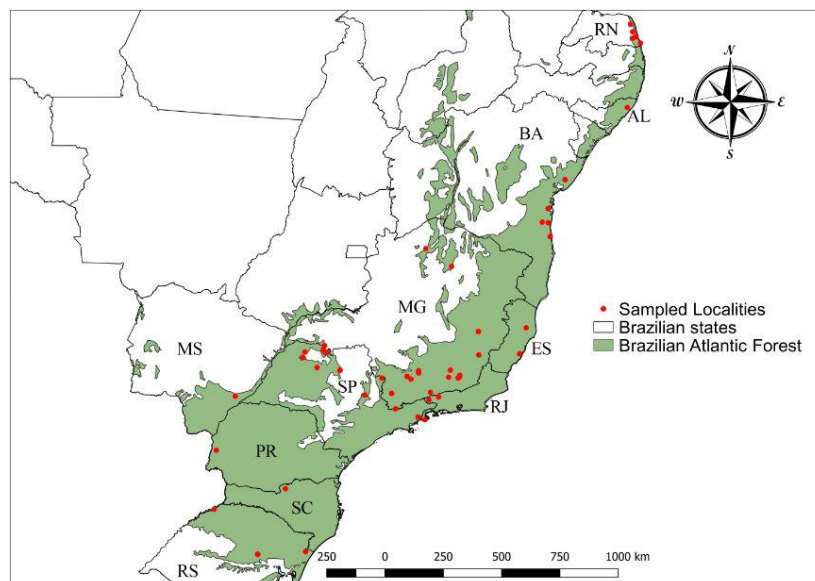
In Paraná: (*Mischocyttarus claretianus* and *Mischocyttarus curitybanus*) (Richards, 1978). There is no information about exact location.

In Rio de Janeiro: all species were recorded in the Itatiaia National Park (*Metapolybia bromelicula*, *Mischocyttarus alternatus*, *Mischocyttarus brackmanni*, *Mischocyttarus buyssoni*, *Mischocyttarus cabauna*, *Mischocyttarus confirmatus*, *Mischocyttarus confusoides*, *Mischocyttarus costalimai*, *Mischocyttarus crypticus*, *Mischocyttarus cryptobius*, *Mischocyttarus declaratus*, *Mischocyttarus extinctus*, *Mischocyttarus infrastrigatus*, *Mischocyttarus itatiaiaensis*, *Mischocyttarus mimicus*, *Mischocyttarus mutator*, *Mischocyttarus similatus*, *Mischocyttarus travassosi*, *Polybia emaciata* and *Polybia tinctipennis*) (Richards, 1978).

In Mato Grosso do Sul: municipality of Batayporã, between São Paulo and Paraná states (*Polistes brefsissus*) (Bonfim & Antonialli Júnior, 2012).

The state of Rio de Janeiro has the highest number of species of restricted occurrence (n=20), followed by Minas Gerais (n=06), Bahia, São Paulo and Espírito Santo (n=04), Paraná (n=02), Mato Grosso do Sul (n=01). This result is due to the collection effort performed by Zikán over a period of 26 years, in the first half of the 20th Century, in the Itatiaia National Park (Academia Itatiaense de História, 2015), but may also be a reflection of the forest cover, either by extension or conservation degree, of this conservation unit. These data reinforce the importance of this area for the conservation of vespids in Brazil.

Several studies carried out in different areas of the Atlantic Forest commonly record occurrences of unpublished species for their respective states (Souza & Prezoto, 2006; Menezes et al., 2010; 2011; Souza et al., 2012, 2015c, 2018; Brunismann et al., 2016; Ribeiro et al., 2019). This shows that the fauna of vespids of the biome is possibly greater than already known. This is because most of the studies are restricted to the Southeast of the country, mainly São Paulo, Minas Gerais and Rio de Janeiro (Fig 2).



**Fig 2.** Localities where diversity studies were carried out, new records or description of new species of social wasps in Atlantic Forest ecosystems. Source: Ministério do Meio Ambiente, 2008.

**Table 2.** Species of social wasps recorded in different states of Brazil: RS = Rio Grande do Sul; SP = São Paulo; MG = Minas Gerais; RJ = Rio de Janeiro; BA = Bahia; ES = Espírito Santo; PR = Paraná; SC = Santa Catarina; RN = Rio Grande do Norte; AL = Alagoas; MS = Mato Grosso Sul (Presence 1/Absence 0) (+ rare species / restricted occurrence\*).

Species of social wasps 170	RS	SP	MG	RJ	BA	ES	PR	SC	RN	AL	MS
<i>Agelaia angulata</i> (Fabricius, 1804)	0	1	1	0	1	0	0	0	0	0	0
<i>Agelaia cajennensis</i> (Fabricius, 1798) +	0	0	0	0	1	0	0	0	0	0	0
<i>Agelaia centralis</i> (Cameron, 1907)	0	1	1	0	0	0	0	0	0	0	0
<i>Agelaia multipicta</i> (Haliday, 1836)	1	1	1	1	0	0	0	0	0	0	0
<i>Agelaia myrmecophila</i> (Ducke, 1905)	0	0	1	0	1	0	0	0	0	0	0
<i>Agelaia pallipes</i> (Olivier, 1791)	0	1	1	0	0	0	0	0	1	0	1
<i>Agelaia vicina</i> (De Saussure, 1854)	1	1	1	0	0	0	0	0	0	0	0
<i>Angiopolybia pallens</i> (Lepeletier, 1836)	0	1	0	0	1	1	0	1	0	0	0
<i>Apoica flavissima</i> Van der Vecht, 1973	0	1	0	1	0	0	0	0	0	0	0
<i>Apoica gelida</i> Van der Vecht, 1973	0	0	1	0	0	0	0	0	1	0	0
<i>Apoica pallens</i> (Fabricius, 1804)	0	1	1	0	1	0	0	0	0	0	1
<i>Apoica pallida</i> (Oliver, 1791) +	0	0	0	0	1	0	0	0	0	0	0
<i>Apoica thoracica</i> Du Buysson, 1906	0	0	1	0	0	1	0	0	0	0	0
<i>Brachygastra augusti</i> (De Saussure, 1854)	1	1	1	0	0	0	1	0	0	0	1
<i>Brachygastra lecheguana</i> (Latreille, 1824)	1	1	1	1	0	1	1	1	1	0	0
<i>Brachygastra moebiana</i> (De Saussure, 1867)	0	1	1	0	0	0	0	0	0	0	0
<i>Brachygastra mouleae</i> Richards, 1978 +/*	0	1	0	0	0	0	0	0	0	0	0
<i>Chartergellus communis</i> Richards, 1978 +	0	0	1	0	0	0	0	0	0	0	0
<i>Chartergus globiventris</i> De Saussure, 1854 +	0	0	1	0	0	0	0	0	0	0	0
<i>Clypearia angustior</i> Ducke, 1906	0	0	1	1	0	0	0	0	0	0	0
<i>Epipona media</i> Cooper, 2002 +	0	0	0	0	1	0	0	0	0	0	0
<i>Epipona tatua</i> (Cuvier, 1797)	0	0	1	0	0	1	0	0	0	0	0
<i>Leipomeles dorsata</i> (Fabricius, 1804)	0	0	0	0	1	1	0	0	0	0	0
<i>Metapolybia bromelicula</i> Araújo, 1945 +/*	0	0	0	1	0	0	0	0	0	0	0
<i>Metapolybia cingulata</i> (Fabricius, 1804)	0	1	1	0	1	0	0	0	0	0	0
<i>Metapolybia decorata</i> (Gribodo, 1896)*	0	0	0	1	1	0	0	0	0	0	0
<i>Metapolybia docilis</i> Richards, 1978	0	1	1	0	0	0	0	0	0	0	0
<i>Mischocyttarus anthracinus</i> Richards, 1945 +/*	0	0	1	0	0	0	0	0	0	0	0
<i>Mischocyttarus adjectus</i> Zikán, 1935 *	0	0	0	1	0	0	0	1	0	0	0
<i>Mischocyttarus annulatus</i> Richards, 1978 +	0	0	1	0	0	0	0	0	0	0	0
<i>Mischocyttarus alternatus</i> Zikán, 1949 +/*	0	0	0	1	0	0	0	0	0	0	0
<i>Mischocyttarus aracatubaensis</i> Zikán, 1949 +/*	0	1	0	0	0	0	0	0	0	0	0
<i>Mischocyttarus araujo</i> Zikán, 1949 *	0	1	1	1	0	0	0	0	0	0	0
<i>Mischocyttarus artifex</i> (Ducke, 1914) +	0	0	1	0	0	0	0	0	0	0	0
<i>Mischocyttarus bahiae</i> Richards, 1945*	0	0	1	0	1	0	0	0	0	0	0
<i>Mischocyttarus bahiaensis</i> Zikán, 1949	0	1	1	0	1	0	0	0	0	0	0
<i>Mischocyttarus bertonii</i> Ducke, 1918	0	0	1	0	0	0	0	0	0	0	0
<i>Mischocyttarus brackmanni</i> Zikán, 1949 +/*	0	0	0	1	0	0	0	0	0	0	0
<i>Mischocyttarus buyssoni</i> (Ducke, 1906) *	0	0	1	1	0	0	0	0	0	0	0
<i>Mischocyttarus cabauna</i> Zikán, 1949 +/*	0	0	0	1	0	0	0	0	0	0	0
<i>Mischocyttarus carbonarius carbonarius</i> De Saussure, 1854 +	0	0	0	0	0	1	0	0	0	0	0
<i>Mischocyttarus capichaba</i> Zikán, 1949 +/*	0	0	0	0	0	1	0	0	0	0	0
<i>Mischocyttarus carinulatus</i> Zikán, 1949+/*	0	0	0	0	0	1	0	0	0	0	0
<i>Mischocyttarus cassununga</i> (R. von Ihering, 1903)	1	1	1	1	0	0	0	0	0	0	0
<i>Mischocyttarus catharinaensis</i> Zikán, 1949 +/*	0	0	0	0	0	0	0	1	0	0	0



**Table 2.** Species of social wasps recorded in different states of Brazil: RS = Rio Grande do Sul; SP = São Paulo; MG = Minas Gerais; RJ = Rio de Janeiro; BA = Bahia; ES = Espírito Santo; PR = Paraná; SC = Santa Catarina; RN = Rio Grande do Norte; AL = Alagoas; MS = Mato Grosso Sul (Presence 1/Absence 0) (+ rare species / endemics \*). (Continuation)

Species of social wasps 170	RS	SP	MG	RJ	BA	ES	PR	SC	RN	AL	MS
<i>Mischocyttarus scitulus</i> Zikán, 1949 +/*	0	0	0	1	0	0	0	0	0	0	0
<i>Mischocyttarus similatus</i> Zikán, 1935 +/*	0	0	0	1	0	0	0	0	0	0	0
<i>Mischocyttarus socialis</i> (De Saussure, 1854)	0	1	1	0	0	0	0	0	0	0	0
<i>Mischocyttarus souzalopesi</i> Zikán, 1949 +/*	0	1	0	0	0	0	0	0	0	0	0
<i>Mischocyttarus tomentosus</i> Zikán, 1935	0	0	0	0	1	1	0	0	0	0	0
<i>Mischocyttarus travassosi</i> Zikán, 1949 +/*	0	0	0	1	0	0	0	0	0	0	0
<i>Mischocyttarus tricolor</i> Richards, 1945	0	1	1	0	0	0	0	0	0	0	0
<i>Mischocyttarus wagneri</i> (Du Buysson, 1908)	0	1	1	1	0	0	0	0	0	0	0
<i>Mischocyttarus wygodzinskyi</i> Zikán, 1949 *	0	1	1	1	0	0	0	0	0	0	0
<i>Mischocyttarus ypiranguensis</i> da Fonseca, 1926	0	1	1	0	0	0	0	0	0	0	0
<i>Parachartergus fraternus</i> (Gribodo, 1892)	0	1	1	0	0	0	0	0	0	0	0
<i>Parachartergus pseudapicalis</i> Willink, 1959	0	1	0	1	1	0	0	1	0	0	0
<i>Parachartergus smithii</i> (De Saussure, 1854)	0	1	1	0	0	0	0	0	0	0	0
<i>Parachartergus wagneri</i> Du Buysson, 1904 *	0	0	1	1	0	0	0	0	0	0	0
<i>Polistes actaeon</i> Haliday, 1836	1	1	1	0	0	1	0	1	0	0	0
<i>Polistes bicolor</i> Lepeletier, 1836 +	0	0	1	0	0	0	0	0	0	0	0
<i>Polistes biguttatus</i> Haliday, 1836	1	0	0	1	0	0	1	1	0	0	0
<i>Polistes billardieri</i> Fabricius, 1804	1	1	1	0	1	0	0	0	1	0	1
<i>Polistes binotatus</i> De Saussure, 1853 +	0	0	0	1	0	0	0	0	0	0	0
<i>Polistes brevifissus</i> Richards, 1978 +	0	0	0	0	0	0	0	0	0	0	1
<i>Polistes canadensis</i> (Linnaeus, 1758)	0	1	1	0	1	0	0	0	1	0	0
<i>Polistes carnifex</i> (Fabricius, 1775)	0	1	1	1	0	1	1	0	1	0	0
<i>Polistes cavapyta</i> De Saussure, 1853	1	0	0	0	0	0	0	0	0	0	0
<i>Polistes cavapytiformis</i> Richards, 1978	1	0	1	0	0	0	0	0	0	0	0
<i>Polistes cinerascens</i> De Saussure, 1854	1	1	1	1	0	1	1	1	0	0	1
<i>Polistes consobrinus</i> De Saussure, 1858 *	1	1	0	0	0	0	1	0	0	0	0
<i>Polistes davillae</i> Richards, 1978 +	0	0	1	0	0	0	0	0	0	0	0
<i>Polistes deceptor</i> Schulz, 1905 +	0	0	0	0	0	1	0	0	0	0	0
<i>Polistes ferreri</i> De Saussure, 1853	1	1	1	0	0	0	1	0	0	0	0
<i>Polistes geminatus geminatus</i> Fox, 1898	0	1	1	0	0	0	0	0	0	0	1
<i>Polistes goeldii</i> Ducke, 1904	0	0	1	0	0	0	0	0	0	0	0
<i>Polistes lanio</i> (Fabricius, 1775)	1	1	1	1	0	1	1	0	0	0	0
<i>Polistes melanossoma</i> De Saussure, 1853	0	0	1	0	1	1	0	1	0	0	0
<i>Polistes niger</i> Brèthes, 1903 +	0	1	0	0	0	0	0	0	0	0	0
<i>Polistes occipitalis</i> Ducke, 1904	0	0	1	1	0	1	0	0	0	0	0
<i>Polistes pacificus flavopictus</i> Ducke, 1918 *	0	0	1	1	0	1	0	0	0	0	0
<i>Polistes pacificus pacificus</i> Fabricius, 1804	1	0	1	0	0	0	0	0	0	0	0
<i>Polistes satan</i> Bequaert, 1940	0	0	1	1	0	0	0	0	0	0	0
<i>Polistes simillimus</i> Zikán, 1948	1	1	1	0	0	0	1	1	0	0	1
<i>Polistes subsericeus</i> De Saussure, 1854	0	1	1	1	0	0	0	0	0	0	1
<i>Polistes versicolor</i> (Olivier, 1792)	1	1	1	1	0	1	0	1	1	0	1
<i>Polybia bifasciata</i> De Saussure, 1854	0	1	1	1	0	1	0	0	0	0	0
<i>Polybia bistrata</i> (Fabricius, 1804)	0	0	1	0	1	1	0	0	0	1	0
<i>Polybia brunnea</i> (Curtis, 1844) *	0	0	0	1	0	0	1	0	0	0	0
<i>Polybia catillifex</i> Moebius, 1856	0	1	0	1	1	0	0	0	0	0	0
<i>Polybia chrysothorax</i> (Lichtenstein, 1796)	0	1	1	1	1	1	1	0	1	0	1



**Table 2.** Species of social wasps recorded in different states of Brazil: RS = Rio Grande do Sul; SP = São Paulo; MG = Minas Gerais; RJ = Rio de Janeiro; BA = Bahia; ES = Espírito Santo; PR = Paraná; SC = Santa Catarina; RN = Rio Grande do Norte; AL = Alagoas; MS = Mato Grosso Sul (Presence 1/Absence 0) (+ rare species / endemics \*). (Continuation)

Species of social wasps 170	RS	SP	MG	RJ	BA	ES	PR	SC	RN	AL	MS
<i>Polybia dimidiata</i> (Olivier, 1792)	0	1	1	1	0	1	0	0	0	0	0
<i>Polybia emaciata</i> Lucas, 1879 +	0	0	0	1	0	0	0	0	0	0	0
<i>Polybia erythrothorax</i> Richards, 1978	0	0	1	1	0	0	0	0	0	0	0
<i>Polybia fastidiosuscula</i> De Saussure, 1854	1	1	1	1	0	1	0	1	0	0	0
<i>Polybia flavifrons hecuba</i> Richards, 1951	0	0	1	1	0	0	0	1	0	0	0
<i>Polybia flavitincta</i> Fox, 1898	0	0	0	0	1	0	0	0	0	0	0
<i>Polybia ignobilis</i> (Haliday, 1836)	1	1	1	1	1	1	1	1	1	0	1
<i>Polybia jurinei</i> De Saussure, 1854	0	1	1	1	1	1	0	0	0	0	1
<i>Polybia liliacea</i> (Fabricius, 1804)	0	0	1	0	0	0	0	0	0	0	0
<i>Polybia lugubris</i> De Saussure, 1854 *	0	0	1	0	1	1	0	1	0	0	0
<i>Polybia minarum</i> Ducke, 1906	1	1	1	1	0	0	0	1	0	0	0
<i>Polybia occidentalis occidentalis</i> (Olivier, 1791)	0	1	1	1	1	1	0	0	1	0	1
<i>Polybia paulista</i> H. von Ihering, 1896	0	1	1	1	1	0	1	0	0	0	1
<i>Polybia platycephala sylvestris</i> Richards, 1978	1	1	1	1	1	0	0	0	0	0	0
<i>Polybia procellosa</i> Ducke, 1910	0	0	0	0	1	0	0	0	0	0	0
<i>Polybia punctata</i> Du Buysson, 1908 *	0	0	1	1	0	1	0	1	0	0	0
<i>Polybia quadrinicta</i> De Saussure, 1854	0	1	1	1	0	0	0	0	0	0	0
<i>Polybia rejecta</i> (Fabricius, 1798)	0	0	1	1	1	1	0	0	1	0	0
<i>Polybia ruficeps xanthops</i> Schrottky, 1902	0	1	1	0	0	0	0	0	1	0	1
<i>Polybia rufitarsis</i> Ducke, 1904	0	0	0	0	1	0	0	0	0	0	0
<i>Polybia scutellaris</i> (White, 1841)	1	0	1	1	0	1	1	0	0	0	0
<i>Polybia sericea</i> (Olivier, 1792)	1	1	1	1	1	1	1	1	1	0	1
<i>Polybia signata</i> Ducke, 1910	0	0	1	0	1	0	0	0	0	0	0
<i>Polybia striata</i> (Fabricius, 1787)	0	0	1	1	0	1	0	0	0	0	0
<i>Polybia tinctipennis</i> Fox, 1898	0	0	0	1	0	0	0	0	0	0	0
<i>Protonectarina sylveirae</i> (De Saussure) 1854	1	1	1	1	1	1	1	1	0	0	0
<i>Protopolybia exigua exigua</i> (De Saussure, 1854)	0	1	1	1	1	1	1	1	1	0	0
<i>Protopolybia sedula</i> (De Saussure, 1854)	0	1	1	1	1	1	0	1	0	0	0
<i>Pseudopolybia vespiceps</i> (De Saussure, 1863)	0	1	1	1	0	1	0	0	0	0	0
<i>Synoeca cyanea</i> (Fabricius, 1775)	1	1	1	1	1	1	1	1	0	0	0
<i>Synoeca ilheensis</i> Lopes & Menenez, 2017 *	0	0	0	0	1	0	0	0	0	0	0
<i>Synoeca septentrionalis</i> Richards, 1978 *	0	0	0	0	1	1	0	0	0	0	0
<i>Synoeca surinama</i> (Linnaeus, 1767)	0	1	1	1	0	0	0	0	1	0	0
<b>Total of species for state</b>	<b>30</b>	<b>75</b>	<b>108</b>	<b>80</b>	<b>40</b>	<b>41</b>	<b>23</b>	<b>30</b>	<b>15</b>	<b>2</b>	<b>27</b>

Fifty species of social wasps have occurrence restricted to the Atlantic Forest, that is, are considered endemic for this phytogeographical domain (Table 2 \*), being 27 of occurrence restricted to a single state (Table 2 +/\*). The state of Rio de Janeiro has 31 spp, followed by Minas Gerais (16), São Paulo (10), Espírito Santo and Santa Catarina (07), Bahia (05), Paraná and Rio Grande do Sul (03). The rate of endemism of Minas Gerais is a result of the large number of studies carried out in its territory and its heterogeneity of ecosystems (Souza et al., 2017).

It is concluded with the present study that the Atlantic Forest biome constitutes an important refuge for the conservation of the Brazilian species of social wasps.

However, other studies are still necessary because there are regions without information or sub-sampled.

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