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Authors: Brügger, Bruno Pandelo, Prezoto, Fábio, Araújo de Souza, Laila Salomé, Vinha Zanuncio, Antônio José, Soares, Marcus Alvarenga, et al.

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# Use of fruit juice as a method for the collection of social wasps

*Bruno Pandelo Brügger<sup>1,\*</sup>, Fábio Prezoto<sup>2</sup>, Laila Salomé Araújo de Souza<sup>3</sup>, Antônio José Vinha Zanuncio<sup>4</sup>, Marcus Alvarenga Soares<sup>5</sup>, Carlos Frederico Wilcken<sup>6</sup>, and José Cola Zanuncio<sup>1</sup>*

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## Abstract

The ecological characteristics and adaptation of social Vespidae to artificial environments needs to be studied to evaluate the impact of these natural enemies on biotic communities and food webs. The community composition and efficiency of collection methods of social wasps were studied in 3 transects in an urban fragment of Atlantic Forest in the Municipal Lajinha Park in Juiz de Fora, Minas Gerais State, Brazil. Social wasps were captured by actively searching (visual observation) and with traps baited with fruit juices every mo for 1 yr. The diversity index of social wasps was higher with active searching than with trapping. Social wasps were more abundant in the rainy season. Forest fragments and urban areas constitute refuge sites for social wasps. *Mischocyttarus* sp. (Hymenoptera: Vespidae) was the most successful species in the anthropogenic environment studied.

Key Words: baited trap; social Hymenoptera; visual search

## Resumo

As características ecológicas e a adaptação dos Vespidae sociais aos ambientes criados pelo homem precisam ser estudadas para avaliar o impacto desses inimigos naturais nas comunidades bióticas e cadeias alimentares. A composição da comunidade e os métodos de coleta de vespas sociais foram estudados em três transectos em fragmento urbano de Mata Atlântica no Parque Municipal da Lajinha em Juiz de Fora, Minas Gerais, Brasil. Vespas sociais foram capturadas por busca ativa e armadilhas atrativas com sucos de frutas durante um ano. O índice de diversidade de vespas sociais foi maior com busca ativa que com armadilhas atrativas. Vespas sociais foram mais abundantes na estação chuvosa. A fragmentação e a urbanização constituem locais de refúgio para as vespas sociais e *Mischocyttarus* sp. (Hymenoptera: Vespidae) foi a espécie mais bem sucedida no ambiente antropogênico estudado.

Palavras Chave: armadilha atrativa; busca ativa; Hymenoptera social

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In Brazil, the original Atlantic Forest area has been reduced to small fragments, most of them less than 50 ha (Joly et al. 2014). Forest fragmentation is the main threat to the persistence (Myers et al. 2000) and diversity (Philpott et al. 2014) of species in heterogeneous islands surrounded by a low complexity matrix (Debinski & Holt 2000). Nevertheless, urban forest fragments can help protect biodiversity (Helden et al. 2012).

Social wasps (Hymenoptera: Vespidae) are important predators of insect pests (De Souza et al. 2012; Brügger et al. 2019). However, some species of this group can damage fruits, making it necessary to remove their nests (Brügger et al. 2011, 2017). Ecological interactions make social wasps appropriate for assessment of environmental impact and conservation in forest fragments (Elpino-Campos et al. 2007).

The objective of this study was to evaluate the vespidae abundance and community composition using active searching and trapping (baited with juice of guava or passion fruit) during the dry and rainy seasons.

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## Material and Methods

### STUDY AREA AND SAMPLING

Social wasps were sampled in the Lajinha Municipal Park in Juiz de Fora, Minas Gerais State, Brazil (21.789167°S, 43.367778°W; 900 masl), in a preserved semideciduous forest remnant with 867,000 m<sup>2</sup> from Sep 2012 to Aug 2013 with 18 h active searching per mo by a collector

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<sup>1</sup>Departamento de Entomologia/BIOAGRO, Universidade Federal de Viçosa, 36570-900, Viçosa, Minas Gerais, Brazil; E-mail: brunopb2002@yahoo.com.br (B. P. B.); zanuncio@ufv.br (J. C. Z.)

<sup>2</sup>Departamento de Ciências Biológicas, Universidade Federal de Juiz de Fora, 36036-900, Juiz de Fora, Brazil; E-mail: fabio.prezoto@ufjf.edu.br (F. P.)

<sup>3</sup>Departamento de Medicina, Centro Universitário Governador Ozanam Coelho, 36506-022, Ubá, Minas Gerais, Brazil; E-mail: lailasouzamed@gmail.com (L. S. A. S.)

<sup>4</sup>Departamento de Engenharia Florestal, Universidade Federal de Viçosa, 36570-900 Viçosa, Minas Gerais, Brazil; E-mail: ajvzanuncio@ufu.br (A. J. V. Z.)

<sup>5</sup>Programa de Pós-Graduação em Produção Vegetal, Universidade Federal dos Vales Jequitinhonha e Mucuri, 39100-000, Diamantina, Minas Gerais, Brazil; E-mail: marcusasoares@yahoo.com.br (M. A. S.)

<sup>6</sup>Departamento de Proteção Vegetal, Universidade Estadual Paulista, 18603-970, Botucatu, São Paulo, Brazil; E-mail: cwilcken@fca.unesp.br (C. F. W.)

\*Corresponding author; E-mail: brunopb2002@yahoo.com.br

during 3 d each mo, and traps in the field for 5 d per mo. Temperature and rainfall data were obtained from the Universidade Federal de Juiz de Fora meteorological station.

Three 100-m-long and 3-m-wide transects were established in the collecting site: T1 – a humid native forest, 200 m from a watercourse and 500 m from anthropized area; T2 – a partly preserved area, with a patch in the process of regeneration after fire and replanting native species, 300 m from a watercourse and 800 m from an anthropized area; and T3 – a partly preserved area, with a patch of non-native vegetation, 700 m from a watercourse and 200 m from the anthropized area.

Traps were prepared from 2 L plastic bottles having 3 triangular openings ( $2 \times 2 \times 2$  cm) laterally at approximately 10 cm from its base. Each trap was baited with 200 mL of commercially produced passion fruit or guava juice, and distributed in the three 100 m transects, each with 10 bait traps (5 with guava and 5 with passion fruit) at a distance of 10 m from each other. Each trap was attached to the trunks of a native tree at 1.5 m aboveground. The trap position and their respective substrates were randomly distributed, but kept at the same location during the studying period. The traps were left in the field for 5 consecutive d per mo during the 12 mo sampling period. The material was removed from the traps, screened in the field with a sieve, and the insects separated with forceps and placed in labeled Eppendorf tubes with 70% ethanol.

The areas also were searched visually for 6 h per d, 3 d each mo, for 12 mo. Rocky outcroppings, tree cavities, broad-leaved plants, and other natural cavities were inspected. Wasps were captured with an insect net, killed with ether, and placed in Eppendorf tubes with 70% ethanol for identification.

## SPECIES IDENTIFICATION

Social wasp species were identified using the taxonomic literature (Silveira 2008; Somavilla et al. 2012), and by comparison with specimens from the Laboratório de Ecologia Comportamental e Bioacústica of the Universidade Federal de Juiz de Fora.

## STATISTICAL ANALYSIS

Data were analyzed with the computer programs PAST, v. 2.17 and BioEstat 4.0. The richness and abundance were calculated by the total number of species and individuals, respectively, collected per method. The diversity of social wasps was assessed using PAST, applying the Shannon-Wiener diversity index ( $H'$ ), both relatively independent of the species sample size, and with higher weight for rare species. The Berger-Parker dominance was applied with proportional importance for the most abundant species. Species frequency was determined by calculating the percentage of wasps collected by each sampling method. Correlations of social wasp richness and abundance, with average temperature and total rainfall were obtained in BioEstat, using the Spearman coefficient ( $r_s$ ).

## Results

A total of 384 vespids wasps representing 7 genera and 23 species were captured by active search and baited traps (passion fruit or guava juice), respectively. Seventeen Vespidae species collected are swarming species: *Agelaia vicina* (Saussure) (Hymenoptera: Vespidae), *Brachygastra augusti* (Saussure) (Hymenoptera: Vespidae), *Brachygastra lecheguana* (Latreille) (Hymenoptera: Vespidae), and *Clypearia angustior* Ducke (Hymenoptera: Vespidae), *Polybia bifasciata* Saussure (Hymenoptera: Eumenidae), *Polybia chrysothorax*

(Lechtenstein) (Hymenoptera: Eumenidae), *Polybia fastidiosuscula* Saussure (Hymenoptera: Eumenidae), *Polybia ignobilis* Haliday (Hymenoptera: Eumenidae), *Polybia jurinei* Saussure (Hymenoptera: Eumenidae), *Polybia occidentalis* (Olivier) (Hymenoptera: Eumenidae), *Polybia platycephala* Richards (Hymenoptera: Eumenidae), *Polybia sericea* (Olivier) (Hymenoptera: Eumenidae), *Polybia* sp. 1 (Hymenoptera: Vespidae), *Polybia* sp. 2 (Hymenoptera: Eumenidae), and *Polybia striata* (Fabricius) (Hymenoptera: Eumenidae), *Protopolybia sedula* (Saussure) (Hymenoptera: Vespidae), *Protonectarina sylveirae* (Saussure) (Hymenoptera: Vespidae). The non-swarming species captured were: *Mischocyttarus cassununga* (R. von Ihering) (Hymenoptera: Vespidae), *Mischocyttarus drewseni* (Saussure) (Hymenoptera: Vespidae), *Mischocyttarus rotundicollis* (Cameron) (Hymenoptera: Vespidae), *Mischocyttarus* sp. (Hymenoptera: Vespidae), and *Polistes actaeon* Haliday and (Hymenoptera: Eumenidae), and *Polistes versicolor* (Olivier) (Hymenoptera: Vespidae).

Active searching allowed finding a higher social wasp diversity index ( $H' = 2.44$ ) than with juice-baited traps ( $H' = 1.21$  for passion fruit) or ( $H' = 0.99$  for guava). Ninety-six individuals of 18 social wasp species were collected with active searching, with *B. augusti*, *B. lecheguana*, *C. angustior*, *P. sericea*, and *P. sylveirae* recorded only with this method. The guava juice attracted 228 individuals of 16 species of social wasps, with *P. bifasciata*, *P. jurinei*, *Polybia* sp. and *P. actaeon* exclusive to this collection method. Traps baited with passion fruit captured 60 individuals of 10 species, none exclusively.

The percent of vespids captured using traps baited with guava juice, by active searching, or baited with passion fruit juice were 59.37%, 25%, and 15.63%, respectively. *Mischocyttarus* sp. was the species captured most often with all sampling methods (64.33%), and was the most often captured using guava-baited traps (Table 1). *Agelaia vicina*, *Mischocyttarus* sp., *P. fastidiosuscula*, *P. ignobilis*, *P. occidentalis*, *P. platycephala*, and *P. sedula* were captured with searching and traps baited with guava or passion fruit juice.

Searching and baited traps collected 285 and 99 individuals in the rainy and dry seasons, respectively, with the highest number of individuals (80) in Feb. The vespids species richness was lower from Sep to Nov 2012 and from Apr to Aug 2013, and higher from Dec 2012 to Mar 2013 (rainy season) (Fig. 1). A positive correlation was found between temperature and richness ( $r_s = 0.60$ ;  $P = 0.0384$ ), and temperature and abundance ( $r_s = 0.83$ ;  $P = 0.0008$ ) of vespids species. Vespids abundance was positively correlated with rainfall ( $r_s = 0.67$ ;  $P = 0.015$ ), but species richness was not correlated with this parameter ( $r_s = 0.8$ ;  $P = 0.091$ ) (Table 2).

## Discussion

The collection of a greater number of swarming species in the urban fragment indicates that they are more environmentally successful. These species have social organization, build their nests faster, and benefit from a protective nest covering (Jeanne 1980; Cronin et al. 2013). Behavioral characteristics, such as living in colonies with overlapping generations, older individuals taking care of younger ones (offspring care), reproductive work division (a caste responsible for reproduction), and castes for different functions reduce the chances of colony decline and increase its productivity (Dani & Turillazzi 2018).

The higher social wasp diversity index by active searching with the passion and guava juice traps demonstrates some selectivity among collection methods. Active searching is adequate to capture social wasps (Somavilla et al. 2017), with higher efficiency than searching

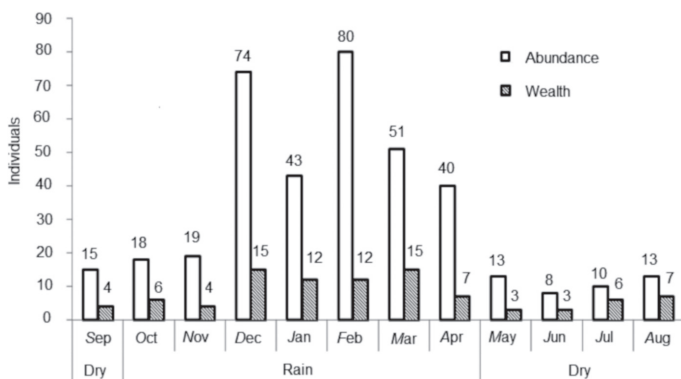
**Table 1.** Number of individuals (No.), percentage (%), and abundance (Ab.%) of social wasps collected with active searching (Active) and attractive traps with guava (Guava) and passion (Passion) fruit juices in the Lajinha Municipal Park in Juiz de Fora, Minas Gerais, Brazil

Subfamily	Species	Active No.	Active (%)	Passion No.	Passion (%)	Guava Ab. (%)	Guava Ab. (%)
Epiponini	<i>Agelaia vicina</i>	11	2.86	3	0.78	3	0.78
	<i>Brachygastra augusti</i>	1	0.26	0	0	0	0
	<i>Brachygastra lecheguana</i>	1	0.26	0	0	0	0
	<i>Clypearia angustior</i>	1	0.26	0	0	0	0
	<i>Polybia bifasciata</i>	0	0	0	0	1	0.26
	<i>Polybia chrysothorax</i>	1	0.26	1	0.26	0	0
	<i>Polybia fastidiosuscula</i>	6	1.56	2	0.52	1	0.26
	<i>Polybia ignobilis</i>	1	0.26	1	0.26	2	0.52
	<i>Polybia jurinei</i>	0	0	0	0	3	0.78
	<i>Polybia occidentalis</i>	2	0.52	1	0.26	3	0.78
	<i>Polybia platycephala</i>	5	1.3	4	1.04	6	1.56
	<i>Polybia sericea</i>	2	0.52	0	0	0	0
	<i>Polybia sp. 1</i>	0	0	1	0.26	4	1.04
	<i>Polybia sp. 2</i>	0	0	0	0	4	1.04
	<i>Polybia striata</i>	1	0.26	1	0.26	0	0
	<i>Protonectarina sedula</i>	17	4.43	4	1.04	3	0.78
	<i>Protonectarina sylveirae</i>	4	1.04	0	0	0	0
Polistini	<i>Polistes actaeon</i>	0	0	0	0	1	0.26
	<i>Polistes versicolor</i>	6	1.56	0	0	3	0.78
Mischocyttarini	<i>Mischocyttarus cassununga</i>	7	1.82	0	0	3	0.78
	<i>Mischocyttarus drewseni</i>	4	1.04	0	0	3	0.78
	<i>Mischocyttarus rotundicollis</i>	5	1.3	0	0	4	1.04
	<i>Mischocyttarus sp.</i>	21	5.47	42	10.94	184	47.92
Total individuals		96	25	60	15.63	228	59.37
Richness		18		10		16	

on flowers (Silva-Pereira & Santos 2006), at specific sampling points (Elpino-Campos et al. 2007), or using traps baited with passion fruit and sardines (Simões et al. 2012). The collection of social wasp species, exclusive to active searching, is due to their interception during foraging (Brügger et al. 2019). The exclusive species captured with guava traps is related to wasp attraction through the odor and visual stimuli during its foraging (El-Sayed et al. 2018). The collection of unique species, and the higher diversity index with active searching demonstrate

the relatively high efficiency of this method, but a greater number of social wasp species and individuals can be collected with a combination of sampling methods (Elpino-Campos et al. 2007).

The greater numbers of social wasps captured by traps can be explained by the colonies of these insects nearby, requiring sugary substances for food and water, important energy sources for thermoregulation (Kovac et al. 2018). These insects have been collected on fruits like cashew (Santos & Presley 2010), guava (Brügger et al. 2011), Brazilian cherry (Souza et al. 2013), plum (Prezoto & Braga 2013), and jambo (Brügger et al. 2017). The greatest numbers of social wasps collected with guava traps is due principally to the *Mischocyttarus sp.* individuals present in the area. *Agelaia vicina*, the second most frequently collected species, has large colonies and exploits resources in different vegetation types (De Oliveira et al. 2010). The greater social wasp diversity in the rainy season is due to higher plant biomass and nesting places with food supply, such as nectar and prey (Auaud et al. 2010; Cronin et al. 2011). The positive correlation between rainfall and social wasp abundance, but not with richness of these insects, may be explained by the high foraging activity of some species of this group during the rainy periods (Tryjanowski et al. 2010). The positive correlations between temperature and social wasp richness and abundance indicate an increase in the number of workers foraging, possibly due to greater water need (Cronin et al. 2011). *Mischocyttarus sp.*, the most collected species, has great adaptive capacity to anthropogenic environments. The sampling effort is lower when using fruit juice, but a combination of sampling methods may increase the numbers of social vespid species collected.



**Fig. 1.** Abundance and richness of social wasp species in warm/humid and cold/dry periods captured by active searching and attractive traps with guava and passion fruit in 12 mo in the Lajinha Municipal Park in Juiz de Fora, Minas Gerais, Brazil.

**Table 2.** Correlation between the abundance and richness of social wasps with temperature and rainfall in the Lajinha Municipal Park in Juiz de Fora, Minas Gerais, Brazil.

	Abundance × Temperature	Richness × Temperature	Abundance × Rainfall	Richness × Rainfall
$r_s$	0.8316	0.6018	0.6795	0.5089
t	4.7347	2.3828	2.9289	1.8693
P	0.0008	0.0384	0.0150	0.0910

Note: ( $r_s$ ) correlation coefficient, (t) distribution, (P) significance level.

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